Master's thesis

NTNU
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Communication and Contracts in Maintenance Operations

How it Affects the Swedish Railway System

Master's thesis in Mechanical Engineering
Supervisor: Nils Olsson
June 2019

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Kunnskap for en bedre verden

Preface

The master thesis is the concluding assignment of the two-year Master of Science Program of Mechanical Engineering at Norwegian University of Science and Technology. The work is partially a continuation of my specialization project "Analysis of processes in the Swedish Railway". The thesis attempt to enlighten communication and collaboration between project managers and site managers working in the railway industry in Sweden. The thesis is meant to be read by site managers, projects managers, and other personnel working in the railway industry.

I want to thank Nils Olsson for introducing me to this interesting topic and for his constructive and helpful supervision. I would also like to thank Lena Hiselius at KTH, in addition to all the interviewed project managers, site managers, and others helping me to get a better understanding of the topic studied in this thesis. A special thanks to the contractor inviting me to his worksite to learn more about Lean in the railway industry.

Robin Stenberg

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Abstract

Maintenance on the Swedish railway system is essential to prolong the systems operating time. The massive increase in railway traffic causes rapid deterioration, thus increasing the importance of maintenance. Communication and contracts between Trafikverket and the contractor companies are a central part of the maintenance operations. Therefore, an investigation of the collaboration between the participant in maintenance projects can improve the state of railway system.

This thesis study the communication and collaboration between the responsible entities of the maintenance operations at the Swedish railway. The thesis aims to investigate the frequency of the communication, the topics discussed, and how the information is shared. Also, the thesis investigates whether different contract types affect communication during maintenance projects. At last, the thesis explores how new processes could be implemented in railway maintenance operations. The results are based on a literature study combined with qualitative research of 26 interviews. Project managers from Trafikverket, site managers from contractor companies, and relevant personnel from BaneNor are among the interviewed.

The main findings show that there is a high frequency of communication between the collaborating partners in the maintenance projects. The experience of the project manager, as well as the relationship between the project manager and site manager, affects the rate of communication to a more significant extent compared to the contract type. The report shows that the contractors would like to have more AB04 contracts. Furthermore, the length of the maintenance contracts are too short for the contractors to invest in necessary equipment and personnel. The success of implementing new processes in the railway maintenance operations rests heavy on the integrity of the site manager in the contractor companies. Furthermore, implementing the processes takes time, and the support and understanding from the top management are of great importance to succeed in the implementation.

Sammendrag

Vedlikehold av det svenske jernbanesystemet er essensielt for å forlenge systemets levetid. Den enorme økningen i jernbanetrafikk har ført til en raskere forringelse av systemet, noe som øker viktigheten av vedlikeholdet. Kommunikasjon og kontrakter mellom Trafikverket og entreprenørene er en sentral del av vedlikeholdet. Derfor kan en undersøkelse av samarbeidet mellom disse aktørene bidra til en forbedring av jernbanesystemet.

Denne oppgaven studerer kommunikasjonen og samarbeidet mellom de ansvarlige for vedlikeholdet på den svenske jernbanen. Formålet med avhandlingen er å finne ut hvor hyppig kommunikasjonen foregår, hvilke temaer som blir diskutert, samt hvordan informasjonen blir delt. I tillegg vil oppgaven undersøke om ulike typer av kontrakt påvirker hvordan kommunikasjonen foregår mellom de to partene. Til slutt undersøkes hvordan nye prosesser kan implementeres i vedlikeholdet på jernbanen. Resultatene fra masteroppgaven er basert på en litteraturstudie kombinert med 26 kvalitative intervjuer. Prosjektledere fra Trafikverket, anleggsledere fra entreprenørfirmaene samt relevant personell fra BaneNor er blant de intervjuede.

Funnene fra oppgaven viser at det er hyppig kommunikasjonen mellom de samarbeidende partnerne. Kontraktstypen påvirker raten av kommunikasjon i en viss grad, men erfaringen til prosjektledere samt forholdet mellom prosjektleder og anleggsleder har sterkere påvirkning. Oppgaven viser at entreprenørene vil ha mer av AB04 kontrakter, samt at lengden på vedlikeholdskontraktene i dag er for kort for å investere i nødvendig utstyr og personell. For å vellykket implementere nye prosesser i vedlikeheoldsoperasjoner i Sverige viser rapporten at det kan være en fordel å ha en leder med høy integritet. I tillegg må denne lederen må ha støtte fra toppledelsen i entreprenørfirmaet.

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Abbreviations

Performance Measurement System	PMS
Public-Private Partnership	PPP
Design-Build	DB
Design-Bid-Build	DBB
Early Contractor Involvement	ECI
Work In Progress	WIP
Planned Maintenance	PM
Lean Construction	LC
Railway Work Plan	BAP
Planned Large Investments	PLI
Railway Exploit Plan	BUP

Chapter 1 Introduction

1.1 Background

The railway is an essential transportation method in most countries due to its capability to transport a large number of people and goods far, fast and cheap. Due to the railway's complexity and its high track-utilization, the maintenance operations need excess planning to maintain the traffic flow as well as the functionality of the system.

Trafikverket plays a critical part and has the primary responsibility for the maintenance and traffic on the railway in Sweden. On behalf of Trafikverket, various contractor companies are responsible for maintaining and building new infrastructure, by using their experience, equipment and resources. Therefore, the collaboration between the contractor companies and Trafikverket is essential to provide the necessary maintenance and investment operations on the railway in Sweden. The substantial increase in traffic during the last twenty years has increased the need for maintenance and investments to keep the state of the railway system adequate [1]. To catch up with the deteriorating railway system, more contracts, more money and more investments are increasing in numbers. Therefore, it is numeral maintenance operations continuously at the railway with multiple contracts connecting Trafikverket with contractor companies.

Communication in organizations and projects are a well-documented topic within the literature (ex [2-7]). However, communication between Trafikverket and contractors in the Swedish railway is less investigated [8-10]. The communication between the participants is one success criteria during projects [11].

Lund University has a collaboration with Trafikverket where a pre-study consists of collecting information regarding the information flow between project managers in Trafikverket and the contractor company. This master thesis is done in connection to a pre-study performed by Lund University. The thesis focuses more on factors contributing to communication between Trafikverket and the contractor companies as well as contractual factors affecting communication.

In this thesis, project managers are connected only to Trafikverket, and site managers are connected only to the contractor companies. Also, the term railway companies refer to the companies that provide the tracks with trains.

1.2 Problem Description

The scope of this master thesis has been to focus on different aspects of communication between the project managers from Trafikverket with the site managers from the contractor companies. Aspects investigated is the quality of the communication, what topics are most discussed, how is the information in addition to the frequency of the communication. Furthermore, an investigation of whether the contract type affects the communication between Trafikverket and the contractor companies is of interest. Also, tools and techniques used to make the maintenance more efficient and effective are investigated, as well as possible improvements to the collaboration.

1.3 Scientific Questions

1. What are the strengths and weaknesses during the collaboration in maintenance operations between the project manager in Trafikverket and the site manager of the contractor company?
2. Do contracts affect how communication within a maintenance project is performed?
3. How is the coordination between Trafikverket and the contractor when planning maintenance operations?
4. What are the challenges when introducing new processes that could help the efficiency of the maintenance operations?

Chapter 2 Methodology

The methodology chapter aims to describe how the information in the thesis was acquired, as well as shedding light on the writing process of the report. The emphasis of the thesis regards why the specific information is of interest and whether other methods could or should have been used. In addition, there is a discussion on how the chosen methods affected the results of the thesis as well as the validity of the collected data. The section also includes a description of the interviewed personnel.

2.1 Introduction to the Methodology

The purpose of the report is to get a better understanding of the communication and use of maintenance contracts between Trafikverket and collaborating partners. Understanding is achieved by interviewing participants from both Trafikverket and the contractor companies, this ensures a balanced information basis. Maccoby and Maccoby [12] defined an interview in 1954 as *"a face-to-face verbal exchange, in which one person, the interviewer, attempts to elicit information or expressions of opinion or belief from another person or persons*". A more specific definition of the semi-structured qualitative research interview is: *"It is defined as an interview with the purpose of obtaining descriptions of the lifeworld of the interviewee in order to interpret the meaning of the described phenomena"* [13]. Two types of research methods are commonly used during casework; qualitative and quantitative. Quantitative research focuses on the measurement of specific events of scientific interest. The measurements are later turned into statistics and analyzed. Qualitative research tries to figure out what, how, when and the whereabouts of a specific matter. In other words, qualitative research tries to understand the definitions, meanings, concepts, characteristics, and descriptions of a topic. Results from qualitative research are seldom questioned. However, the methods have been stated to be less scientific and hence can be voted invalid [14]. Based on the research questions, this thesis collects information through qualitative research from multiple sources. The individuals interviewed during the research have experience in the specific field of interest. This includes project managers from Trafikverket and site managers from the contractor companies. Moreover, other relevant personnel who had relevant information regarding the research questions was also interviewed. The reason for choosing a qualitative approach to the scientific questions was to get a better understanding of how communication was performed between the

individuals and different cooperative companies as well as understanding the underlying reason to if and why communication is performed this specific way. These questions can only be answered by using a qualitative research method.

2.2 Data Collection

The method used to collect data in this master thesis can be divided into three main parts: qualitative interviews, documents collected from Trafikverkets database and a literature study of complementary theory.

Before the interviews, the research questions were established to help decide the applicable research method. The design of the interview process was first performed individually before the process was proposed to the supervisor. During the dialogue with the supervisor, a more comprehensive approach was committed. The dialogue consisted of reviewing the possible interviewees, not only the project manager, and contractors, but also others that might be relevant. During the session with the supervisor, the structure of the report was discussed to ensure a solid foundation for further work. The specific sampling of interviewees came from the research question, where sub-grouping was possible by separating the project managers by type of project. Here the author focused on project managers working with maintenance operations in Trafikverket. The aim and optimum diversification would be to interview the project managers from similar maintenance projects, with a similar budget and timeframe, but different types of contracts. This type of diversification would remove as many variations as possible. This process has been a challenge, and the author had to manage the data collected no matter the quality. The biggest challenge was the difficulty in getting interviewees to participate in an interview, so the sampling is based more on willingness to participate rather than relevance. This could hurt the conclusion of this thesis. However, despite the difficulty in getting answers from the possible interviewee, the data collected has been sorted by the different contract used, so some diversification has been used. The sampling was helped by "snowballing" described by Harrell [5] where the project managers proposed the different site managers to interview. This helped the author to more natural get in touch with the contractor working together with the project manager. This also helped to narrow down the participants to proper subgroups which were possible to interview, as well as collecting information from managers working on both sides of the same project.

As a preparation for the interviews the questions were thoroughly analyzed to ensure well-articulated and precise questions. The questions did not include overly complicated words or specific terms, because this could make the interviewee feel challenged in the topic of the interview. The author wanted the interviewee to feel comfortable with the questions, and to try to gain their trust so that the answers were given honestly. The questions were quality assured not to be leading or double-barreled, which could cause the interviewee to answer what they think the interviewer wants to hear, or only to partially answer the question [14]. The preparation phase ensured that the answers provided did not reflect on the type of project the participates worked. This means that the questions were asked so that the difference in economy, size and timeframe did not reflect the answers. This also helped to increase the validity of the collected data, and hence improved the overall quality of the thesis.

The interview consists of mostly structural questions where the purpose is to elaborate on the relationship between specific processes. The semi-structured way of performing interviews gives the author more freedom to follow up on what the interviewee says. This could help knowledge to the surface and enlighten the expertise of the interviewee. The purpose of an interview is not the conversation, but the knowledge emerging from the conversation [2]. The questions in the semi-structured interview are sorted by topics of interest to ensure a specific flow during the interviews. Most of the interviews were done over Skype which made the process more efficient where the author could have multiple interviews per day. Some of the interviews were conducted face-to-face in Trondheim, and the author also traveled to Göteborg to perform an interview. Information was also gathered through sending emails to Trafikverket with questions the document study did not provide.

The result from the interviews cannot be generalized due to the small sample collected, however, some assumptions can be made based on the collected data. When using this method of data collection, one would expect to find personal experiences and the attitudes of the interviewee. This means that the data should be influenced by both positive and negative experiences, that can contribute to a complete picture of the problem statement. However, due to the small sample, a few “bad” interviews could affect the data and make it less relevant due to the power one individual has in a small sample. The timeframe of the research expands to a period of one school semester, with the number of interviews is executed throughout two months. The total amount of interviews performed was 26, all with a duration of approximately 30 minutes, except the physical interviews which had a longer duration up towards 1.5 hours. The 26 interviews contained an equal number of project managers and site managers. Two

approaches have been used during the qualitative study. The first approach focused on collecting answers from as many relevant personnel possible, by both project managers and site managers. After the data was collected, they were analyzed, and some chosen participants were asked to comment on the answers of the other part. This means that the site managers from the contractor companies got some statements from the project managers and was asked to comment on these, and vice versa. This method allowed both sides to comment on the different statements and gave the author a better understanding of the different processes. It has also been conducted interviews with other stakeholders from both Sweden and Norway regarding different subjects. Some of the other stakeholders interviewed were people in Trafikverket working with statistics, others were collaborating companies working with performance measurements. The last stakeholder was representatives from BaneNor who were interviewed to discuss the differences and similarities of the two organizations. The people interviewed were one project manager, head of project and one responsible for the contracts at BaneNor.

The first approach to contact the project managers was to send an email to planners at the different maintenance divisions at Trafikverket. The project managers at Trafikverket was first approached because they could be a gateway for contacting the contractors at a later stage. Some of the BUP-planners replied and provided contact information to several project managers working in active maintenance projects in the country. Out of the 36 emails sent (see Appendix A for an example of the generic email sent to the project managers), 12 emails (33%) resulted in an interview, 14 emails (39%) did not answer at all, 4 emails (11%) answered the first mail but not the emails later, and 6 emails (17%) did not want to participate. The reasons for the unwillingness to participate was; the lack of experience of the individual, they did not think they could contribute to the thesis, and no interest to participate. It is difficult to decide why some of the asked, choose not to respond. It could be the amount of work the individual had in the given period or the given project. Alternatively, one reason could have been the lack of a person to use as a gateway, when the names were chosen at random from the provided list. On the other side, 100% of the approached site managers responded to the email and agreed to an interview which was probably due to “snowballing” described above (see Appendix B for an example of the generic email sent to the site managers). Out of the five “other stakeholders” that was approached, four agreed to contribute with an interview. The different topics for these four interviews were: general information on planning, soft measurements and statistics on contracts.

Table 1 is a summary of the interviews performed. The table shows the number of project managers interviewed from the different maintenance divisions in Sweden. The same applies to the site managers. As the table shows, there is a broad distribution of maintenance divisions where every division is represented. The "Stakeholders" are other personnel not being a project manager or a site manager contributing to the thesis. The stakeholders interviewed works in Trafikverket as well as other companies collaborating with Trafikverket. A more elaborate table containing the experience, contract type and other information regarding the site managers and project managers is presented in chapter four "Results" (See Appendix C and Appendix D for the interview guide for the interviews of the site and project managers).

Table 1 Summary of the performed interviews

Interviewee	*Maintenance division*	*Number of interviews*
Project managers	Nord	1
Project managers	Syd	2
Project managers	Öst Stockholm	5
Project managers	Väst	1
Project managers	Mitt	3
Site manager	Nord	1
Site manager	Syd	1
Site manager	Öst Stockholm	3
Site manager	Väst	2
Site manager	Mitt	3
Stakeholders		4
People contacted		52
Completed interviews		26

Below follows a table describing the number of interviewed performed, as well as the number of people contacted. Table 2 describe which project manager who was interviewed and at what division he/she worked. Also, the table shows if the interview was completed or not, and how the interview was performed, either by Skype or a physical meeting. Table 3 describes the same for the site managers at the contractor companies. The table for the stakeholders (Table 4) shows which company the interviewee came from, in addition to the subject discussed during the meeting.

Table 2 Overview over executed interviews of project managers

Project managers	*Maintenance division*	*Interview completed*	*Meeting/mail/Skype*
1	Mitt	Yes	Skype
2	Mitt	Yes	Skype
3	Mitt	Yes	Skype
4	Mitt	No	
5	Nord	Yes	Skype
6	Nord	No	
7	Nord	No	
8	Nord	No	
9	Nord	No	
10	Syd	Yes	Mail
11	Syd	Yes	Skype
12	Syd	No	
13	Syd	No	
14	Syd	No	
15	Syd	No	
16	Väst	Yes	Skype
17	Väst	No	
18	Väst	No	
19	Väst	No	
20	Väst	No	
21	Väst	No	
22	Öst Stockholm	Yes	Mail
23	Öst Stockholm	Yes	Skype
24	Öst Stockholm	Yes	Skype
25	Öst Stockholm	Yes	Skype
26	Öst Stockholm	Yes	Skype
27	Öst Stockholm	No	
28	Öst Stockholm	No	
29	Öst Stockholm	No	
30	Öst Stockholm	No	
31	Öst Stockholm	No	
32	Öst Stockholm	No	
33	Öst Stockholm	No	
34	Öst Stockholm	No	
35	Öst Stockholm	No	
36	Öst Stockholm	No	
37	Öst Stockholm	No	
Sum			12

Table 3 Overview over executed interviews of site managers

Site manager	*Maintenance division*	*Interview completed*	*Meeting/mail/Skype*
1	Mitt	Yes	Skype
2	Mitt	Yes	Skype
3	Mitt	Yes	Skype
4	Nord	Yes	Skype
5	Syd	Yes	Skype
6	Väst	Yes	Meeting
7	Väst	Yes	Skype
8	Öst Stockholm	Yes	Skype
9	Öst Stockholm	Yes	Skype
10	Öst Stockholm	Yes	Skype
Sum			10

Table 4 Overview over executed interviews of other stakeholders

Stakeholder	*Company*	*Subject*	*Interview completed*	*Meeting/mail/Skype*
1	Trafikverket	General info	Yes	Meeting
2	Prifloat	Soft measurements	Yes	Skype
3	Trafikverket	Contracts	No	
4	Trafikverket	Statistics	Yes	Mail
5	BaneNor	Communication	Yes	Meeting
Sum				4

The second main data collection were the documents from Trafikverkets homepage. The search results include reports written by personnel working at Trafikverket, as well as other reports written by external scientists and personnel. Also, some information came from the main homepage, where Trafikverket informs the public about their business and activities. Steering documents, such as the contract templates were found using Trafikverkets internal system TDOK. This is a software where collaborating partners of Trafikverket can find documents, guidelines, decisions, safety legislation, routine description, role description and other required documents to perform their work. The search for documents can be sorted in the different area of interest such as planning, and management, which have been used to look for relevant documents in this thesis. When looking for a specific document in TDOK it is beneficial to know the document number. The author often found some reference to this number in the numerous other documents that were read through during the research for the thesis. Some keywords used when searching in TDOK included:

Kontrakt TDOK 2015:0484 TDOK 2015:0484

The third and last method to collect the data sampling was by a literature review. Some literature from the specialization project was evident that could be reused, and some new literature would have to be found. During the search for new literature the following keywords were used:

Principal-agent theory	Performance measures	Game theory
Contract theory	Railway maintenance	Lean
Project management	Concurrent engineering	Organization

The keywords are chosen based on the answers provided by the interview subjects, and the theory of which must describe a topic more thoroughly. The keywords were also combined to see if there were any similarities or research based on mixed subjects. Both general and advanced searches were used to narrow down the results. When the number of results was narrowed down to less than 30, the author briefly read through the introduction and conclusion of all results. The most relevant, "peer reviewed", papers were read more thoroughly at a later stage. Both NTNU`s Oria and Google Scholar were the search engines used. Other results are statistics collected from Trafikverket on the author's request. The requests were sent by mail and the author came in contact with relevant personnel who could assist with the requested statistics.

The need for a structured overview of the answers given in the semi-structured interview was crucial. Collecting data and seeing consistent answers and other subtle information is in qualitative results is not always easy. The author, therefore, used the software NVivio. This software helped with structuring the interviews to get a better overview during the analysis. The software simplified the analysis of the data, and valuable ideas and problems occurred. In the software the author could assign nodes to specific words or phrases in the results from the different interviews, and later get an overview of all the nodes connected to the specific words. This made it easier to see connections between the answers from the interviews. The results are based on all the data collected and are the basis for the discussion. The conclusion is answering the scientific questions presented in the introduction of the thesis. The process of the work is shown in Figure 1.

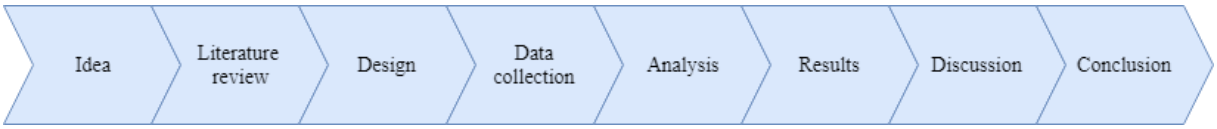

Figure 1 Process of the work [14]

2.3 Reliability, Validity and Limitations

The collected data regarding the topic of this thesis is based on qualitative interviews from different participants working in the railway industry in Sweden. As every qualitative data collection, the reliability of the data is difficult to revise because of the individual preferences and experiences. Some of the questions have been changed and restructured as the number of interviews increased, and the experience of the author as an interviewer improved. This can both improve and reduce the reliability of the data collected. The interviewee gives the answers they want, and it is unknown for the author whether there is a hidden agenda behind the answers. The reliability can be improved by asking well-considered and well-articulated questions and by having a period before the interviews to analyze the questions. However, during interviews, there is always the human perspective which must be considered where trust, chemistry, and mood can all affect the given answers.

The questions were analyzed, and quality assured by the author before the interviews. Also, after some interviews were executed another quality review was performed of the questions to help increase the validity. Even though these precautions were made, the validity of the assignment can further be improved by having more interviews. One measure that increased the validity for the provided answers was to ask follow-up questions and to ask the participants to elaborate previously given answers.

The limitation in the study are factors affecting the efficiency of the data collection or in other ways hindered the process during the development of the thesis. The differences in the interviewed projects are probably the most significant factor increasing the chance of a fault during the process. Different types of projects, different sizes of the projects, a different area of operation and the experience of the different interviewee are some of the possible factors affecting the results. In addition, some newer maintenance contracts use different planning procedures of the maintenance such as “maintenance windows”, and others do not. Brooking [15] claims that when asking people how a task is performed, they say what they think they do when performing the task, not necessarily what they actually do. This is a possible limitation and must be considered when analyzing the answers.

Another limitation could be that the author both performed the interview and took notes simultaneously, this could cause some information to be lost during the process. To minimize the loss of information the author rewrote the notes straight after the interview was finished. Furthermore, all the interviews and documents collected were in a nonnative language of the

author. This could be critical during the interviews, where information could be lost. The fact that most of the interviews are performed over Skype could also reduce the chance of the interviewee to open up fully to the interviewer due to the distance.

The last limitation could be the author evolved during the period of interviews, both linguistic as well as how to ask the questions and the follow-up questions. Because the site managers were interviewed after the project managers the questions and hence the answers from the site managers have a higher quality. This means that there is some difference in the quality of the data between the project managers and site managers. This could have influenced the thesis to emphasis the meanings and views from the site managers more compared to the project managers. Even though this can be the case, the interviews had to be conducted in that order. This was due to fact that the project managers provided the author with the contact information to their collaborating site manager through snowballing.

The composition of the thesis is as follows: a theory part that explains the main theory gained from the interviews, Results which is divided into two main parts; the first is from the study from documents from Trafikverket and the other is the interviews. Hereafter follows the discussion where the thesis discusses the results. The last part contains the conclusion of the thesis with some concluding remark, the scientific questions are answered and some suggestions for further work are presented.

Chapter 3 Theory

The function of this chapter is to enlighten the reader on relevant theory to be able to exploit this thesis fully. In addition, the theory was used to gain more insight for the author on the different topics that emerged during the process of working with the thesis.

The first steam locomotive was patented in South Whales in 1802 by Richard Trevithick and is undoubtedly one of history's most significant invention [16]. The railway secured economic growth to the society and industrial sector. Today as then the railways are mainly used for transport of goods and people. In Sweden, the cities grew more significant because of the expansion of the railway throughout the country [17]. During recent years there has been a development in passenger trains where they can travel faster than before, making them more competitive with other means of transportation.

3.1 Business Processes

3.1.1 Organization

Organization is defined by Cambridge Dictionary [18] as: *a group of people who work together in an organized way for a shared purpose.* Harold Koontz described in 1961 that the management theory was a "jungle" [19]. In 1983 Van de Ven and Astley [20] stated that the problem with the organization was that everyone used different vocabulary for the same processes which inhibit communication. Finding relevant and useful literature becomes a complicated activity due to the different vocabularies but similar definitions used.

Every organization manages its workers by a set of theories that acts as a foundation for the correlations between every actor within the company. The theory explains how the participants work together towards the common goal of the company, both internally and externally. One way to facilitate better collaboration is aligning the strategy of project or activity with the strategy of the company [21].

The organizational theory is arranged in different categorizations or frameworks to identify possible problems within the specific structure easier [22]:

- Classical / Structural approach
- Human relations approach
- Systems approach

- Contingency approach

The *classical/structural approach* has a focus on the organizational structure of roles and responsibilities rather than the people working in the organization. This means that the classical approach emphasizes to put the agents in the correct role rather than changing the people to fit in a specific role. When using the classical/structural approach Bolman and Deal [23] gives some assumptions:

- The primary purpose of an organization is to achieve determined goals and objective.
- By specializing the labor, the organization can increase efficiency.
- Combined efforts are ensured by using coordination and control.
- Restructuring is often the solution if there is a decrease in performance.

Problems that occur in a classical/structural approach can often be solved by implementing more training, restructuring or a change of management. The approach focuses on two main procedures: vertical and lateral. The vertical procedure has a focus on rules, authority, planning and control systems to steer the workers in the desired directions. This procedure is often used in military organizations. The lateral procedure tries to steer its workers by having regular meetings, a good network and coordinate the different roles in the organization. The optimal organization uses a combination of both vertical and lateral to manage their workers. The approach has gotten criticism for having too little focus on the human aspect of the organization [23].

The classical approach can be divided into two main parts: Scientific management and Bureaucracy [22]. The most significant contributor to scientific management was Taylor [24], who managed steelworkers to perform better by presenting them with higher wages. The method is criticized by the high control of how the work is performed, as well as the high focus on economic benefits and not social and physical aspects. The Bureaucratic part of the classical approach was first defined by Max Weber [25]. He stated that the bureaucratic organization is the least complex because of its rules, standardizations, and hierarchy of authority. Some criticism of the bureaucracy is that it can focus too much on the rules and procedures and overemphasis the paperwork. Other criticisms include, the management on top of the hierarchy can be dependent on their status, and if not every situation contains a specific rule or procedure the organization could lack its initiative [22]. In general, stable and quite simple tasks is best solved using a hierarchical organization with rules and clear legislation. For more complex

operations a more lateral solution with excellent communication and flatter hierarchical structure works best [23].

Human relation approach is the theory describing the organization as a social system where human resource is its primary fuel for performance. The emphasis is to humanize the work to increase the performance and production of the organization. The human relation approach has some general assumptions made by Bolman and Deal [23]:

- The organization is there to serve the humans working in it, not the other way around.
- Both the organization and the people need each other. The people need the job, payment and the opportunity, while the organization needs the resources, ideas and talent.
- The fit between the people and the organization needs to be good, or else one or both may suffer. If the fit is right, both parties will benefit.

The correlation between the organization and the workers is based on the linked questions from the workers: “Will this work suite me?”, and from the organization: “How can we find and hold on to good and resourceful people?”. Cable and DeRue [26] state that an organization can provide the rewards and challenges a person needs, but if the values do not correlate, the person is less likely to relate to the organization and is hence less likely to stay within the organization. The organization must try to fulfill most of the desired needs of the personnel it is hiring. The needs of an individual can vary, and there is a willingness to trade one need for something else. Examples of tradeoffs are; sleep for entertainment or time for money [27]. Maslow [28] came up with a hierarchy of human needs in 1943, where the hierarchy consists of five levels, starting from the lowest level; physiological, safety, love, esteem, and self-actualization. The theory was not intended to be used in an organizational setting, but it has had an impact on the way management manage [22]. Pink [29] has in his book from 2009 proposed three needs which he means are most important when working; purpose, mastery, and autonomy.

Another human relations theory comes from McGregor [30] which proposed two different theories about motivations in organizations, X and Y. The theory is based on that the way the management/principal sees the workers/agents, this is the way the workers will act. The basic idea of theory X is that the managers assume the workers to be lazy with a low ambition that needs to be led by either hard or soft management types, and the way the management sees the workers is the way the workers will act. The hard management type is based on rules and legislation to steer the workers, while the soft focus on keeping everyone happy by avoiding conflict. Over time the hard version can cause a decrease in productivity and hostility. The soft

management style can cause apathy and indifference from the workers. Theory Y is a suggestion to how the managers should think of the workers, where they should arrange the conditions in the organization so that they fulfill the workers own goals while fulfilling the organization's goals. Organizations that focus on the development of their personnel and develops their "portfolio of workers" with talented people can get a competitive advantage, as stated by multiple sources [31-33].

Where the classical approach focuses on organizations without the people, and the human relation focus on how the organization can adapt to the people, *The Systems approach* tries to combine those by looking at the organization as a part of a broader environment [22]. The systems approach sees the organization as an open system which continuously interacts with the environment. This means that the organization needs to be adaptive to be able to perform in the changing environment. One part of this approach is to provide the groups of people with more responsibility during the process [22]

Contingency approach focuses on the criticality of structures regarding the performance of the organization. This approach focuses on structuring the organization based on the demand and type of work which is to be done. Continually arrange and rearrange the structure of the organization to match the work best possible [22].

3.1.2 Project Theory

The Project Management Institute [34] defines a project as "*a temporary endeavor undertaken to create a unique product, service or result"*. Furthermore, they state that the purpose of a project is to fulfill an objective of which can be the following deliverables: a product, service result or a unique combination of one or more of the mentioned. Also, a project makes it possible for the business to create value for its stakeholders, as well as improve or create products.

By using the definition and descriptions above, a maintenance operation can be seen as a project that creates value for the organization and stakeholders.

Meredith [35] claims that a project must always struggle to fulfill three main functions; the scope, cost, and timeframe. These three functions are connected and will affect the finished output of the project. While planning a project, these three functions should always be balanced to fulfill the project according to the success criteria and the stakeholder's perception and wishes [36]. See Figure 2 for the connection between the different project goals.

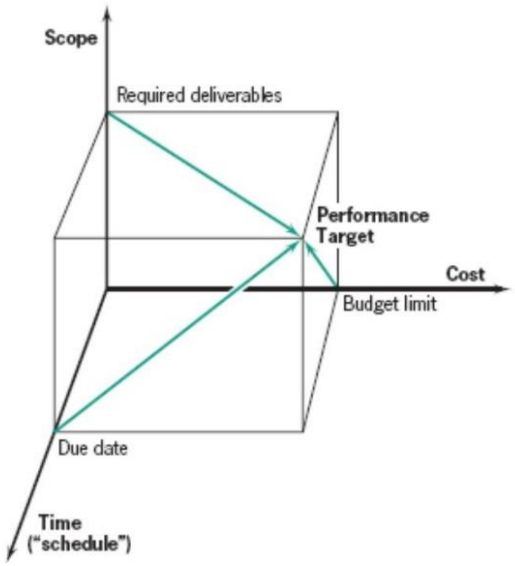

Figure 2 Direct project goals [35]

A project composes several hundred if not thousand documents during its lifecycle, however, some documents contribute more to the overall progress and success in a project. Seven primary documents and activities must be performed during a project's lifetime, shown in Figure 3.

Figure 3 Project integration [34]

The project charter is used to develop the project management plan, whose purpose is to define how the work should be executed and controlled. The plan should be the baseline for the work during the project's duration. Typical baselines are scope, budget and time. This document provides the project manager the needed authority to use the organizations resources on the specific project. The document provides high-level information and understanding of the deliverables, roles, and responsibilities for the participants in the project [34].

The purpose of *the project management plan* is to complete the decided goals for the project. The plan is also used to define how the project should be executed, which performance measures to be used as well as how to close the project [34].

When *directing and managing the project work* the managers must try to find solutions to accomplish the objectives of the project and to improve the rate of success. One of the main activities for the management is to steer the performance of the project in the desired direction [34].

Managing the projects knowledge is one of the more essential activities to facilitate the production of new knowledge which can help organizational learning to improve both current and future projects. The Project Management Institute [34] state that: *"From an organizational perspective, knowledge management is about making sure the skills, experience, and expertise of the project team and other stakeholders are used before, during, and after the project"*. Knowledge is something that is inside the minds of people, it is not something that can be collected without their approval, hence a manager must facilitate a climate of trust, to enable the sharing of information [37].

When *monitoring and controlling the project work*, the managers use the project management plan to analyze the progress of the project. It is vital to constantly monitor to work to spot trends early to be able to steer the project in another direction if needed. This is done consecutively throughout the duration of the project [34].

When performing a *change control*, the purpose is to manage all changes and communicate these changes to the project's participants. This is the primary responsibility of the project manager and is performed throughout the whole project lifetime [34]. Changes often cause disputes between the different participants in a project, and is the main reason for cost overruns in projects [38]. The extent of change control is dependent on the complexity of the project, and all changes should be registered and the plan should be updated [34].

When a *project or a phase is ready for closing*, the project manager reviews the project management plan to ensure that all objectives have been finished. The project manager must also ensure that the project has reached all its goals before officially close the project [34].

3.2 Learning

Learning occurs when humans interact with people and their surroundings, meaning that social practice plays a part during learning [37]. According to Andrew Sense [37], most of today's literature regarding learning in projects focuses on what the project can learn as part of a post-project review process i.e., after finalization. Sense also means that there should be more focus on learning between project participants, and that learning should always be implemented during projects. Furthermore, he suggests five sociological elements that facilitate learning: *Cognitive styles* refers to in what way people learn. *Learning relationships* which describe how relationships enable/constraint learning. *Pyramid of authority* is a person use of authority to support or constrain situated learning. *Knowledge management* describes the flow of a project's knowledge. *Situational context* is how the setting facilitates learning within the organization.

Chris Argyris [39] wrote in his report from 1991 that well-educated people have the most trouble learning. The main reason for learning disabilities is due to their lack of insight and using defensive reasoning. People learn from mistakes, and if an individual seldom has experienced mistakes, they do not know how to learn from them. Hence, if the first attempt fails, they turn to defensive reasoning to why it failed, which is blaming everything and everyone else than themselves.

Knowing how to learn is one part of the total picture and storing the knowledge within the organization is another. Brooking [15] describes that there are several ways to store the knowledge within the organization, but to choose which mechanism, depends on 13 different types of knowledge that exists. Some of which are: modularity of the knowledge, the longevity of the knowledge, the complexity of the problem, sensitivity and confidentiality of the knowledge and the mechanism for managing the maintenance of the knowledge.

3.2.1 Performance Measurement

Bititci et al. [40] describe in their report the development of the performance measurement over time, whereby 1912, many of the measurements had characteristics of today's performance measurement. The development comes from the industrialization where the purpose was to manage the productivity of the workers. Today's measurements are used in many industries and are an integrated performance system meant to measure innovation, intellectual property, social systems and inter-organization collaboration. The purpose of a performance measurements system (PMS) as stated by Andersen and Fagerhaug [41], is to alter behaviors to achieve the organizational targets, plans and purpose. Further, PMS can provide the following information;

early warning signs, trend monitoring, improved prioritization, improved project evaluation, marketing tool, incentive system, basis for benchmarking and increased motivation [41, 42]. According to Davenport [43], the main reason to measure performance is not to be able to control, but to gain knowledge about the organization. There is also some possibility that PMS can lead to dysfunctional behavior [41]. This can be caused by e.g., measuring the wrong things, focusing on specific measurements, or the unbalanced ratio between qualitative and quantitative data [42]. In literature there are proposed two types of management; hard and soft, where the PMS is more towards the hard side, due to its focus on the technical aspects and not on the social aspects [44].

3.2.2 Communication

Communication has been described numerous times through history, DeSactis and Monge [45] said that communication is occurring when two or more individuals share ideas, feelings and opinions. Axley [46] saw communication as a pipeline where information flows from one person to another. Orlikowski and Yates [6] studied communication within a complex organization, and concluded that the communication was dynamic i.e., that the communication changed based on norms, projects and time pressure. Stewart [47] states that communication is closely linked with cooperation. However, there could be some barriers against communication such as misunderstanding and distrust between collaborating partners. Trust is defined by Moorman et al. [48] as *"a willingness to rely on an exchange partner in whom one has confidence".* Further, they state that uncertainty and vulnerability must be in place to be able to have trust, because without vulnerability the outcomes have no consequence, and without uncertainty the one player would know the actions of the other player. It is also stated that if previous communication has been truthful between two partners, there is a higher likelihood of trusting future communications from that partner. Communication is used to obtain some sort of change in the project by interacting with different counterparts [6, 7]. Communication within a project can be used to influence or drive action and can be measured by accuracy, completeness, understanding and barriers [49].

Communication and cooperation are not only essential to have with the closest collaborative, but also with other companies, neighbors, municipality and others affected by the project, so-called stakeholders. The stakeholders are defined as "*individuals or groups who can affect or can be affected by the organization in the pursuit of its objectives"* [50]. Some literature argues that value for the organization is best created through collaboration and communication with the stakeholders [51-53]. Bundy [54] shows that collaboration can be enhanced by using two

different factors; normative and instrumental. The normative factors focus on fairness, trust and norms, while the instrumental focus on interdependencies and competence. Stakeholder management in projects is essential for a project's success [55-58].

3.3 Contract Theory

A contract is a binding agreement between two or more parties which is mostly used during formal agreements. The purpose of the agreement is to ensure a positive outcome for both participants. Examples of agreements could be buying a house, hiring new personnel or in Trafikverkets case: hiring contractors to perform maintenance operations. Several scientific reports discuss in more detail the specific contract types and theory (see for example [2, 59-61]). There is however some theoretical foundation which is central in many of these reports. *The principal-agent model* is based on the relationship between two individuals. Usually, the principal hires the agent to do specific tasks of which should be performed in the best interest of the principal. The Principal-Agent theory was first written by Michael Jensen and William Meckling in 1976 [62]. Their report describes the relationship between two collaborating partners where the principal at one point would have to delegate some of its decision-making authority to the agent. Further, the report states that if both are *utility maximizers* there is a possibility that the agent would not always make a decision in the best interest of the principal. To minimize the agent working in its "best self-interest", the principal would have to use incentives to steer the agent and to limit the wrong decisions. Information and asymmetry of information between collaborating parties is the essence of incentive questions [61]. Furthermore, Jensen and Meckling [62] define an agency cost as the sum of; the cost of the supervision, the cost for the agent to bond to the principal, and the loss of residual.

The asymmetry of information between the parties can cause difficulties during the collaboration and is one of the reasons for the principal's use of monitoring and incentives [61]. There are two types of private information that can cause information asymmetry: m*oral hazard* and *adverse selection.* In the case of moral hazard, the agent has more information about a subject and uses this information in their self-interest without having to bear the consequences of their actions [63]. One example is from USA in 2008 when the real-estate brokers sold houses to people even though they knew could not pay for the mortgage over time. When the buyers failed to pay, the real-estate brokers would be long gone and did not have to bear any of the consequences. Adverse selection is the case when one player has more information than the other player, and this information has a negative consequence for the other player [63]. This

could be the case when an insurance company has more information about the risk distribution; i.e., this knowledge makes them able to control the price of insurance for specific customer groups.

Incentive theory is another part of the contract theory where the focus of the principal is to get the agent to work in their best interest by providing a bonus or penalty to steer the agent [61]. In early history, sailors did not get paid or compensation if their ship sunk, this was an incentive to prevent them from taking the lifeboats too soon instead of trying to save the ship. This was described by Holmes [64] in his "Common Law" from 1881. Stewart [47] describes four types of incentives; *monetary equivalents* that could be medical insurance, *deferred rewards* such as stocks in the company or pension, *non-monetary rewards* that could be titles or a promise of promotion, and *negative incentives* as rebukes.

3.3.1 Public-Private Partnership and Contracts

A Public-Private Partnership (PPP) is an "umbrella term" for the different collaboration methods used between the public and private. The term has many different definitions and variations, dependent on literature and organizations [65-67]. The Public-Private Reference Guide [68] defines PPP as: "*A long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility and remuneration is linked to performance"*. While Savas [69] defines it as an "…*arrangement where government states its need for capital-intensive, long-lived infrastructure and the desired facility is built using a complex combination of government and (mostly) private financing and then operated by a private entity under a long-term franchise, contract, or lease"*.

Typically, the public agency retains ownership of the system while the private company uses its capital to maintain the system. A broad use of the term comes from Folkestad and Lindén [70] where a PPP is a project with a long duration where the private has a close collaboration with the public, and there is a common understanding of the risk distribution. When entering a partnering, the players must assume that they will not enter a zero-sum game where one wins and the other loses [66].

There are several advantages when entering a partnering: effectiveness and efficiency, legitimacy and resources. The effect and efficiency are improved due to enhanced coordination and collaboration between the two companies. Moreover, because the private partner pays for the materials and labor, the project can be initiated earlier [66, 71]. Partnering could have a

positive effect on the legitimacy because the hired company may have a local affiliation to the area or work planned. Partnering can save resources by letting each collaborating partner focus on their core competence [66]. Other researchers suggest the following advantages with PPP: a better collaboration between the public sector and private sector (e.g. [72-74]), better risk management (e.g. [75, 76]), increased maturation of contracts (e.g. [77, 78]) and revealed critical success factors (e.g. [79]). Research also states several possible disadvantages with PPP-contracts such as cost- or innovation restraints, complex negotiations, conflicting goals, and costly tender processes [66, 80].

According to Lædre [81], several factors are affecting the choice of contract strategy such as: collaboration with the contractor, flexibility in the process, costs, uncertainty and completion time. In the construction as well as railway industry two contract types are typically used; Design-Build (DB) and Design-Bid-Build (DBB) [81-86]. The payment scheme commonly used during these contract types are fixed-price and cost-plus [87]. The fixed price contracts define a price for a specific product, service or result, and should be used if the scope and requirements are well defined. The cost-plus provides the buyer with all the costs as they are occurring for each activity, in addition to an extra additional cost that acts as the profit for the buyer [34, 88]. Early Contractor Involvement (ECI) is a tender process including the contractor early in the phase of the project. Studies made of ECI projects have shown a high rate of success [86].

In the DB contract the contractor is responsible for the design and construction during the project. The result of the project is often stated in functional terms, which means that the contractor has more freedom to decide for themselves how to perform the work. In addition, more of the risk during the project is put in the contractor making the project more expensive. The payment scheme can be both fixed price and cost-plus [84]. Some literature states that the contractor is freer in a DB, which allows them to have a more significant influence on the construction phase of the project [84, 89].

In the DBB contract the client designs and describes all the work which must be performed in the project. The risk during the project is more distributed compared to a DB contract. It is most common for the lowest tender to win the contract, and the payment scheme can be both fixed price and cost-plus. However, providing a fixed based on the tendering the incentive for the contractor is to cut costs in order to maximize the possible profit of the project. This could impact the quality of the work. In a cost-plus there is less incentive to cut cost [84].

3.4 Game Theory

Game theory is a mathematical tool that studies how individuals with rational behavior would react in different situations. These situations are based on the individual's different preferences and information they have obtained [90]. The purpose of game theory is to find the best-suited choice for each player, both based on the other players choice, but also when the other players choice is unknown [91]. Strategy is an essential part of game theory, and strategy is defined as *a method or plan chosen to bring about a desired future, such as achievement of a goal or solution to a problem* [92]. The theory is versatile and can be used in numerous situations; political [93], war strategy [94], in today's modern world, game theory is used to handle conflicts [95-97], in biology [98] and engineering [99].

Game theory consists of two main branches: cooperative and noncooperative. Cooperation focuses on the combined actions of a collected mass; this theory could be used for analyzing elections. The noncooperative are connected to the individual's decision and incentives what strategies they use to make decisions [100]. The leading solution for a cooperative game is to reach a Nash Equilibrium. In a non-cooperative game, Pareto Optimum Equilibrium could be the optimum solution [90].

Game theory can be divided into three main parts: individuals (players), actions (decisions) and payoffs. The best strategy that provides the biggest payoff for both players is known as equilibrium. If the players cannot gain more payoff by changing their strategy, and they would not like to change strategy even if the other player change strategy, is known as a Nash Equilibrium. If a player can change its strategy to get a better payoff, but by doing so the other player gets a worse payoff, this is known as a Pareto Optimum Equilibrium[88].

A zero-sum game occurs when a player wins what the other player loses and is an integral part of the theory [90]. A zero-sum game can occur between two companies which have the same customers and high competition. One example is the car industry in the U.S. during the 1990s, where the competition lowered the prizes on the cars in such an extent that the profitability for the car manufacturer was lost [101]. This happened when every car manufacturer was trying to get the biggest piece of the cake for themselves, and hence providing smaller pieces for the other car manufacturer. Brandenburger et al. [102] described a different solution to this problem, where a game consists of five elements, and by changing one of these elements, a company can increase its competitive advantage. To change the game by either changing: the players, the added values, the rules, the tactics or the scope a company can increase its revenues.

There are several ways of increasing a company's revenue, and by understanding the game this can be achieved either by increasing "their own piece of the cake", or it is even possible to "enlarge the whole cake", giving every company more revenue. Getting a bigger piece can be achieved by adapting the five elements mentioned above. Enlarging the whole cake can be achieved by collaboration between companies that together ads more value for the customer. The collaborating company is then called a complementor [102].

A non-zero-sum game called the *Stackelberg* occurs when one player act as a leader, and hence makes a choice before the other player, the choice affects the strategy of the other player. According to Simaan M. and Gruz J. B. [103], the games that are best solved by Stackelberg method is games where one player plays faster, games where one player has more information and games where one player does not know the cost function of the other player. These decisions imply that one of the two players must always be the leader and take the first choice. However, as shown by Basar [104], it is not evident which player that should be the leader, and whether it is profitable to always be the leader. Basar shows that there are situations where it is not beneficial to become the leader, and this leads to three different outcomes of the game: *Concurrent solution* where both the players will mutually benefit from the one player's leadership. *Nonconcurrent solution* where none of the players think they will play the best and hence try to force the other player to use Stackelberg method by declaring their strategy first. Furthermore, *Stalemate solution* where both players refuse to declare their strategy before the other player.

3.5 Maintenance

Rausand and Høyland [105] define two basic types of maintenance, corrective and preventive maintenance. These two types have each their subgroups of maintenance groups, see Figure 4. Preventive maintenance is planned when an item is working correctly, in order to prevent future accidents and failures. The purpose of preventive maintenance is to reduce the probability of failure. The maintenance includes inspections, lubrication, repairs, and parts replacements. Preventive maintenance is done regularly no matter if the performance is degraded or not. Corrective maintenance is done after an item has failed and includes repair or a replacement of the broken item. The purpose of corrective maintenance is to get the system functioning as fast as possible, due to the extra cost the owner experiences from failed machinery.

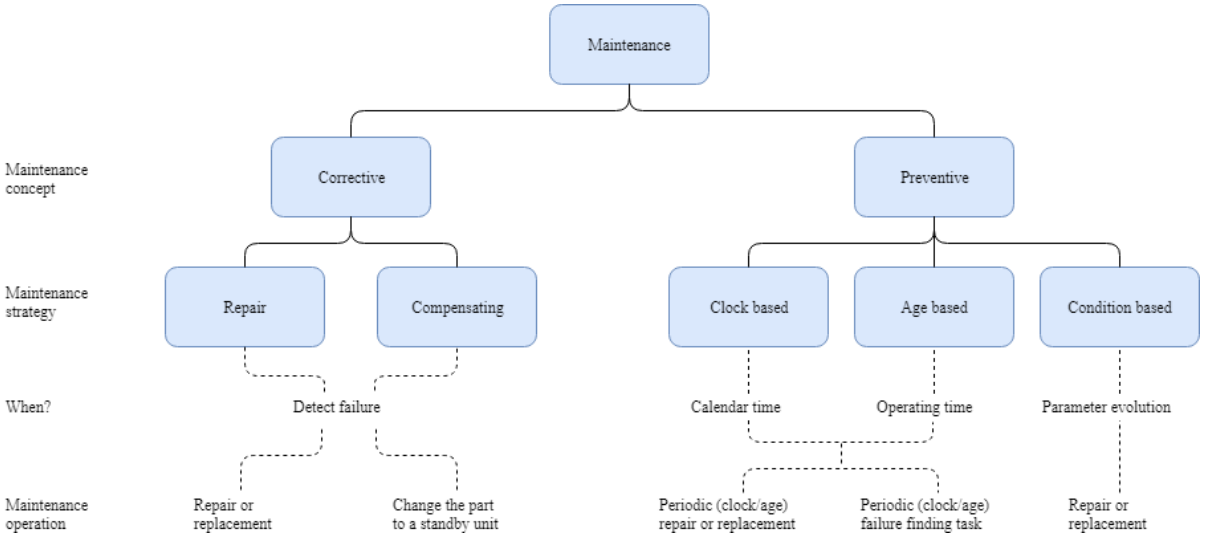

Figure 4 Types of maintenance [105]

The different subgroups of maintenance are:

1. Preventive maintenance
    a. *Clock-based maintenance.* This type of maintenance is easy to administer because the only factor affecting the period of the maintenance is the time since last maintenance. Even though the method is easy to understand and use, it can be wasteful because the items are changed at a specific time not taking into historical events. This means that the item can be changed because of failure a short time before the annual due date, and still, the part will be changed at the planned date.
    b. *Age-based maintenance.* The maintenance is conducted when an item has reached a certain age of operations. This age can be represented e.g., by the

number of hours operating or a number of kilometers running. The hourly count starts either when the item fails, or from when it reaches the given age for maintenance, whichever comes first. This type of maintenance is most commonly used when the cost of failure is higher than the cost of planned maintenance.

c. *Condition-based maintenance*. The maintenance focuses on the condition of the item and predicts when a failure will occur. This could be performed in multiple ways e.g., controlling the number of particles in the oil, the temperature of the item, vibrations or sound. The condition of the item can be controlled continuously or at regular intervals.

2. Corrective maintenance
    a. *Repair*. Repair the broken item.
    b. *Compensating*. Change the broken item with a new one.

3.6 Lean

The use of Lean principles' dates back to 1880 to 1910 when they were used by Frederick Winslow Taylor and Henry Ford. It was from Henry Ford the Japanese developed their production philosophy and made the production method of Toyota one of the more successful in the world [106]. The term "Lean production" was first used in a report published in "The machine that changed the world" where Lean was used to describe a production system. The report identified new techniques including Just in Time and Pull principles [107]. Lean is a philosophy meant to improve processes and to increase the value for the end customer.

The Lean last planner system is based on principles of Lean production combined with and used in Lean construction. A lot of the maintenance operation performed in the railway industry can be related to construction. Lean has five main principles used to gain maximum benefit from the system [108]:

Specify value for the customer

Define what is the specific value for the end customer, and make the product satisfy this value.

Identify the value stream

Define what is providing value to the end product and what is not.

Flow

Focus at the process and not the end product to ensure continuous flow.

Pull

Use Just-in-time to produce what the customer wants, when they want it.

Perfection

Produce the perfect product without defects and mistakes.

There are several tools and techniques designed to follow the Lean philosophy and the five principles. Some of the tools and techniques worth mentioning are [109]:

Concurrent engineering

Concurrent engineering is stated by Prasad [110] to be a tool which reduces the development time of a product by using two main concepts: integration and concurrency. Integration refers to the amount of information between the different actors within a project, and how the information flow from one phase to another. Concurrency refers to the way the work is planned and the interaction between members.

Last planner

Lean last planner system is constructed to be used in the construction industry. It was developed with Just-in-time in mind to enable planning and production more compatible and reliable. The focus of the system is that the decisions are made further down the organization. Where the purpose is to make decision as late as possible by the person who knows the most about the specific task. This means that the last planner includes a detailed plan, developed close to when the work is to be done, together with the person that is executing the task. Because of the team working more concurrent, everyone gets a better understanding of the whole value chain, and not just their contribution [111].

The Kanban system

Kanban is mostly used within the transportation of materials. Getting the right material to the right place at the right time. In addition, the system minimizes transportation and remove the amount materials from the workplace [112].

The 5S system

Translated from Japanese to be: Sort, Sustain, Set in order, Shine and Standardize. The process reduces wastes and lets the workers take control of the workplace. The process can reduce the time spent on non-value adding activities by 25% [113]. However, even though 5S is the most popular and most accessible tool to implement, according to Bicheno [109] the tool should not be the first Lean principle to be implemented. This because 5S can be a diversion from the real priorities and just be seen by the workers as tidying up the workplace. This perspective is not optimal when the full Lean program is to be implemented, because the concepts of what Lean really is could be misunderstood. On the contrary, Tezel et al. [114] suggest that 5S should be part of the first stage out of three when implementing Lean in a construction project. By

implementing these tools, a project can take advantages of the lean principles and opportunities, which can lead to cost reduction and time-savings in projects.

Removal of waste has a high focus in Lean thinking and is central in Lean principles. The aim is to remove as much waste as possible to improve the current process and product, improving both the value for the customer and the value for the company. Ohno [115] came up with the "original" list of seven wastes back in 1986. Bicheno [109] added seven new wastes in 2009 all of which were related to the different wastes in production. Davies [116] changed the focus from production over to maintenance in his report from 2010. Here he stated that maintenance operations were more a management issue than an operations issue. Below follows Figure 5 made by Davies to describe the examples of wastes in maintenance such as work in progress (WIP) and planned maintenance (PM).

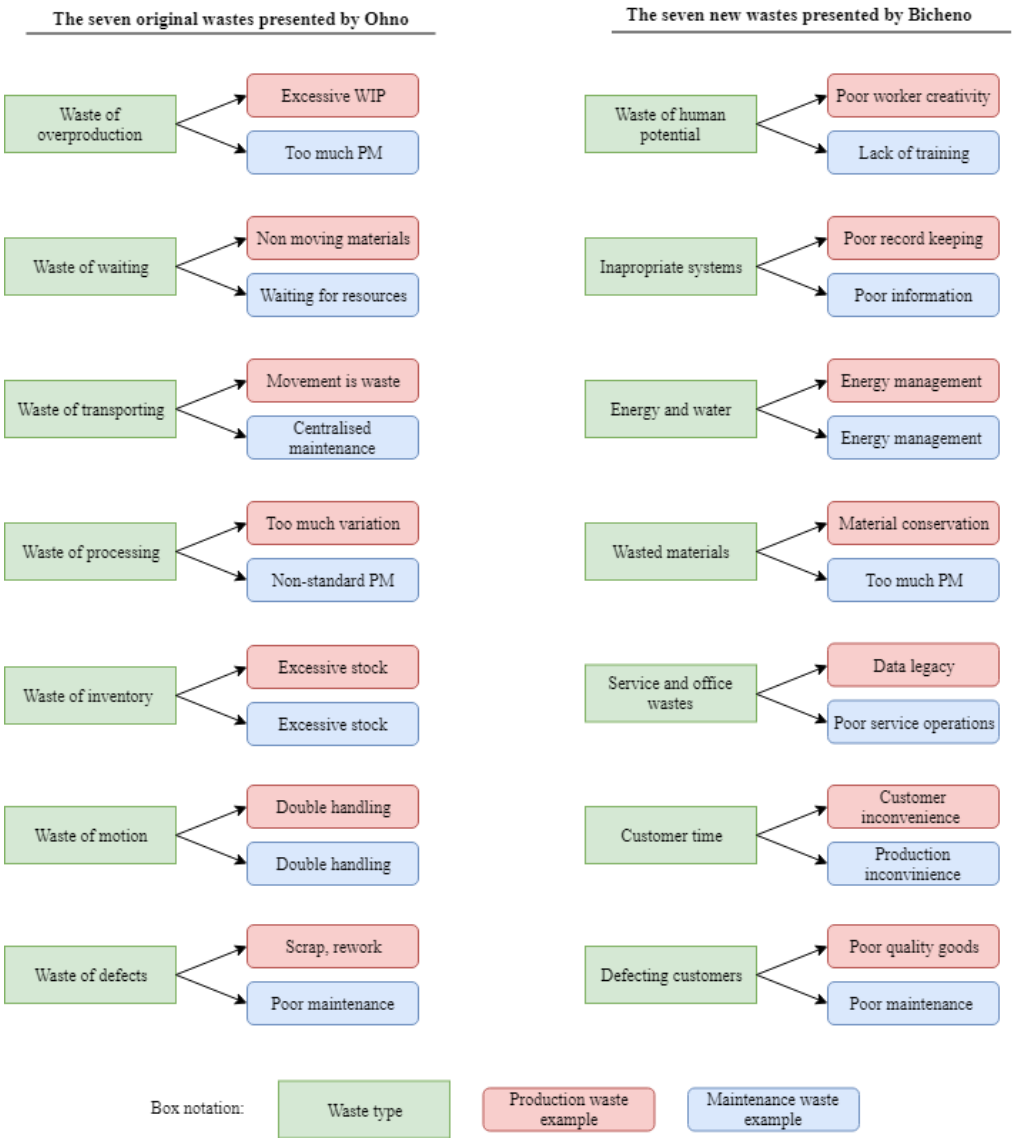

Figure 5 Lean production wastes and maintenance wastes [116]

In addition to the wastes in maintenance, Davies [116] also suggests three possible performance measurements of maintenance based on Lean see Figure 6. The figure shows three main maintenance activities that should be measured to enable a full understanding of the performance of a company's maintenance program. Davies figure describes more in detail the possible measurements that could be made.

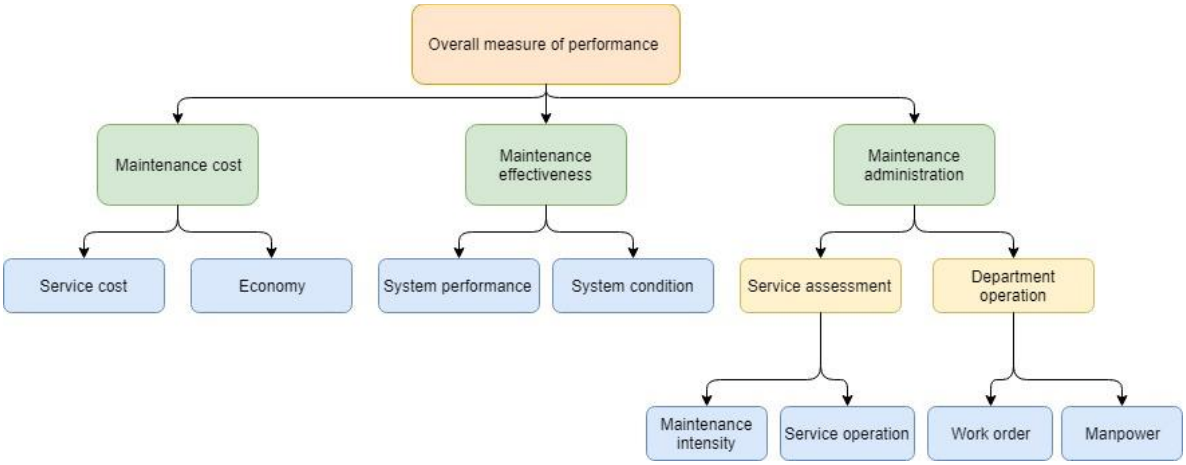

Figure 6 Performance measurement Lean [116]

A couple of examples based on the figure; under "service cost" the company can measure the maintenance cost per unit of production, under "system performance" one measurement can be the length of running, and under "service operation" one measurement can be the degree of scheduling. In the concluding remarks Davies states that there are no known Lean activities used during maintenance, and that the maintenance function should be developed.

The work activities performed in the railway industry can be related to similar activities in the construction industry, and hence Lean Construction (LC) principles can be applied. According to Tezel et al. [114], there are six principles commonly used in LC:

1. Elimination of the processes waste
2. Effective management of the value stream
3. Maintaining a reliable flow
4. Pull-based planning and production
5. Just-in-time delivery of materials
6. Implement a continuous improvement culture

Because of the differences between the production industry and the construction industry some adaption of the principles was necessary. Tezel et al. [114] defines the construction industry as: *temporary multi-organizations, fragmented supply chains and project delivery systems, regulatory intervention, different work trades moving around the capital asset (the product) leading to frequent time and space conflicts, lack of a real industry direction – the traditional laissez-faire policy justified by the industry's 'flexibility', taxation and insurance policies leading to acute self-employment and labor casualization, ……. a high emphasis on initial delivery costs instead of whole life cycle costs, …. relationships between actors influenced by a culture of conflict (low-trust economy), economic climate affecting organizations' relations quickly (amicable/supporting vs. adversarial/aggressive), superficial supply chain integration practices, low-profit margins, a high-risk aversion and a slow-take up of innovation and technology*. The definition of complex systems is also accurate for the railway industry, which provides evidence that at least some of the LC principles could also be implemented in this industry. Oehmen et al. [117] and Oppenheim [118] concludes that to be able to implement Lean in complex systems following should be emphasized:

- People must be treated as a valuable asset by the managers.
- The value of the project must be maximized
- The value stream should be optimized
- Focus on the project flow
- Plan according to the pull in the system
- Should always seek for perfection

It is however shown by Tezel et al. [114] that even though the Last planner system is the only tool specially made for construction, many other tools could also be used with only minor adaption. Also, they show that construction projects which implement Lean procedures show higher customer satisfaction and project performance. Even though the majority of projects implementing Lean gives positive feedback, some criticize precisely this, arguing that the feedback is biased and that there is a lack of theoretical proof for the effects.

3.6.1 Lean in the Railway Industry

The five principles of Lean can be introduced in the railway industry in Sweden in the following ways:

- Specify value
    - Value for the customer is a reliable train system where the trains come and leave as planned with as few disturbances as possible.
- Specify the value stream
    - The weakest link in the value stream is the maintenance program, and hence the reliability of the trains, which again affects the value Trafikverket provides to the customer.
- Flow
    - There are various ways to improve the flow in the production, an analysis of the possible improvements of activities.
- Pull
    - The amount of maintenance work possible to do is immense and hence not a problem. However, the times provided on the tracks should also be steered by the pull of the needed maintenance work.
- Perfection
    - Primary focus on how to perfect the railway system, then focus on how the maintenance work is performed.

3.7 Theory Summed Up

3.7.1 Organization, Project and Organizational Learning

A well-functioning organization is a basis for every project to succeed, and the different approaches describe how the organization manages its workers and other stakeholders. The approaches are not a description of how the owners and managers manage, but a description of the organization at the current moment. An organization can use different approaches, this is mostly dependent on the person performing the analysis. Classical approach and human relation are the two most common approaches. The classical approach emphasis purpose and structure where some of the theories used are the vertical and lateral procedures, in addition to bureaucracy. The human relation approach emphasis the humans physical and psychological needs in their work, where the managers can see and manage the workers by either Theory X or Theory Y.

A projects primary purpose is to fulfill an objective, and seven activities are performed to complete this objective with success. The project charter is one of the more essential documents which should be made before the project initiation and it defines the goal, scope and essential factors of the project. One other important activity is to manage the project`s knowledge, which can improve both current and future projects. Performance measurements are frequently used to control the direction and performance of the project. The measurements can also be used to provide incentives however, it is vital to use measurements that minimize dysfunctional behavior.

People learn differently and the organization must consider this when teaching their personnel. Another factor to consider is how to collect knowledge from the personnel, in addition to how the knowledge is stored to utilize the information later.

3.7.2 Communication and Contract Theory

Communication is crucial to obtain and withhold a functioning collaboration in projects. Communication creates value for the company and organization by involving the different stakeholders.

Contracts can be used to facilitate a more successful project through collaboration between the principal and the agent. Information asymmetry between these two collaborative partners in the form of adverse selection and moral hazard, is one challenge for the projects. Incentives are used actively to strengthen the collaboration and to either punish or reward the agent.

The partnership between a public entity and a private provider is recurrent, where the public provider holds a competitive tender for a specific project. Such a collaboration is initiated to rapidly start the process of a new project without the need to apply for the necessary funding. Two contract types commonly used in construction projects are Design-Build (DB) and Design-Bid-Build (DBB). In DB contract the contractor has most of the risk of the project, while in a DBB contract the risk is more shared between the two partners. There are usually two different payment schemes used during such contracts; cost-plus where the payment is made consecutively as the work is performed, and fixed price where the contractor is paid one fixed sum at the start of the project.

3.7.3 Game Theory

Game theory is used during interactions between individuals, and the theory describes what the possible outcome of a specific situation could be. Game theory describes the possible outcomes of a game with two or more players, and to decide what is the best strategy for each of the players. It exists different types of games which describes possible outcomes and situations, such as zero-sum game and Stackelberg.

3.7.4 Maintenance and Lean

It exists two types of maintenance: corrective; performed after a fault has occurred, and preventive; which aims to prevent the faults before they happen.

Lean principles are commonly used in production companies but are emerging in other businesses such as construction. Lean emphasis removal of waste, improving the flow through the organization and increase the value for the customer. Several different techniques are linked to Lean, such as concurrent engineering, last planner and 5S. Last planner is used to improve the planning phase of projects by late locking of the plans, concurrent engineering can be used during planning and execution, while 5S is used during execution.

Chapter 4 Results

This chapter presents the results from the study based on documents from Trafikverkets own web pages. Furthermore, the section also includes the answers provided during the interviews. First the document study is presented, where relevant theory regarding the processes in Trafikverket is emphasized. Second, the results from the interviews presented through a table, in addition, a summary of the answers are provided.

4.1 Document Study Regarding the Different Processes at Trafikverket

4.1.1 Organizational Theory at Trafikverket

Trafikverket is the authority in Sweden that governs the long-term national infrastructure plans, these responsibilities include; planning, operations, and maintenance of all traffic-related affairs in the country. Trafikverket is the product of a fusion of Banverket and Vägverket in 2010, which each were responsible for hence railway and road [119]. Trafikverkets main office is in Borlänge, with six regional offices, a combined workforce of approximately 9000 employees [120]. Trafikverket is divided into seven central functions and five scopes of practices. The five scopes consist of planning, maintenance, investment, big projects, and traffic management. See Figure 7.

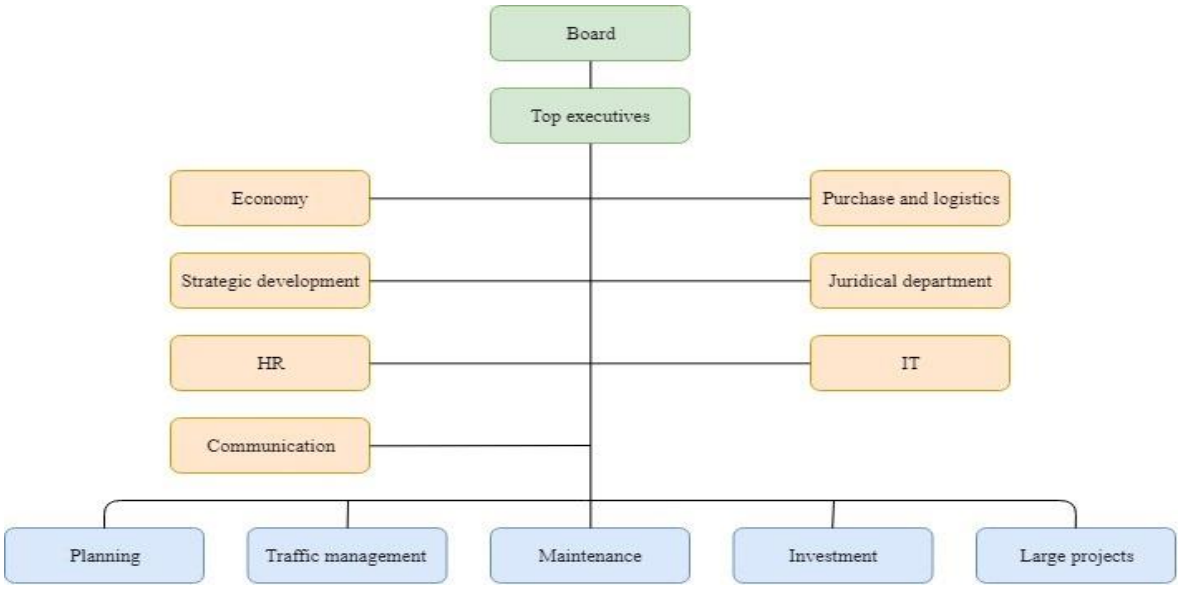

Figure 7 Simplified organizational chart, translated from Swedish [121]

Trafikverket is a state-owned institution and is each year given a specific sum to withhold the quality of the roads and railway in Sweden. The transport-plan is the overall plan for all transport related affairs in the country, this includes all transport by land, air and sea. Trafikverkets plan for transportation should with focus on the social perspective create prerequisite for a socioeconomic efficient, internationally competitive and long-term viable transport system. This plan sets the directives for how the means should be spent the best possible way to ensure good quality for the citizens of Sweden [120]. Trafikverket facilitates increased productivity in the construction business on behalf of the Swedish government. To be able to do this, four focus areas have been chosen; *project precondition* ensures a proper tender process. Trafikverket try to standardize the contract strategies to find the best possible procurement process and use this process in every project they own in the whole country. *Innovation* by freeing the contractor to find innovative solutions to problems. *Business forms* by which form of procurement is used based on the complexity of the contract. *Client* where Trafikverket has gone from being a contractor to becoming an employer and hence focus more on the client. The focus area is to work on the collaboration with the contractors and gathering experience and spread it across all the projects Trafikverket govern, to facilitate learning and optimizations for future projects [122].

4.1.2 Planning Railway Work Processes at Trafikverket

The planning process of a railway work is complicated with many different stakeholders' opinions, standards, and rules to consider. Before the railway work can begin, multiple preliminary reports must be made to ensure the effectiveness of the projects. Trafikverket performs a stakeholder analysis to define the different stakeholders within the maintenance projects. In addition, for investment projects, the stakeholder analysis is used to ensure they are initiating the correct project for the desired effect [38]. There are several different stakeholders during a maintenance project, some of which are included but not limited to; the regions, MTR, SJ, neighbors, contractors and the media. The stakeholders differ based on the size of the maintenance operation. Where a small maintenance operation requires less stakeholder involvement, e.g., work that can be performed in between trains. The more significant operations require more emphasis on the stakeholder analysis and involvement, e.g., changing a railway switch.

The "railway work plan" called BAP and contains all work on the railway, both investments and maintenance [123]. The basis for the BAP-plan is the "Railway System Description" which is established after Trafikverket has had an overall communication period with the contractors,

BUP-planners and other stakeholders [124]. The "Railway System Description" emphasis on providing a full description of the future traffic and maintenance on the railway. The plan should define which capacity that is reserved for track-work, reserve capacity for ad-hoc applications (described below) and reserve capacity for track-work that cannot be booked in the planning phase (e.g., maintenance type V and similar maintenance types) [124]. The description is published one year before the future timetable is valid, and it also contains the Planned Large Investments (PLI). These investments are work that will affect the train traffic to some extent (see Appendix E to see a more detailed description of how Trafikverket determines a PLI). To be defined as a PLI the railway work must affect a certain number of trains each day, or the tracks would have to be shut down continuously over a more extended period. During 2019, 25 PLI is planned, where 83% of the work requires to shut down the track, and 17% of the work will cause speed reduction. Moreover, 43% of the work is done continuously over a period longer than 24 hours [125].

Changes in BAP is documented in the "rail-exploit-plan" (BUP). The plan is updated every week and contains a detailed overview of all the future maintenance operation except the critical maintenance [124]. See Figure 8 for a schematic overview of the timeframe of BAP and BUP. In the figure, x is the date of the execution of the maintenance activity and "w" stands for weeks and "d" for days.

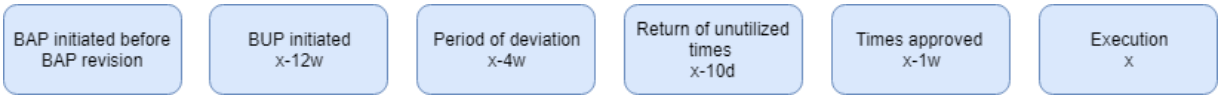

Figure 8 BAP and BUP at Trafikverket today [10]

"Maintenance-windows" is implemented in the BAP-plan and is regular periods in the timetable with no traffic. The open slots are intended to provide the contractors with enough time to perform the necessary maintenance [126]. In addition, work performed within the maintenance windows are not characterized as affecting the train traffic [127]. The purpose of the maintenance windows was to ensure more effective maintenance of the railway system. The new procedure was implemented in 2016, and within five to ten years all maintenance contracts will have these periods (see Appendix F for an overview over the current areas that have implemented the maintenance windows) [126]. During the contract negotiation, the contractor knows the duration as well as how many maintenance windows they are given during the period. The number of maintenance windows is the same for the whole contract period. The contractor is acquired to emphasis applying to use the maintenance windows when planning for work on

the tracks. However, Trafikverket reserves the right to yearly withdraw 25% of the time in the maintenance windows. The withdrawn periods are to be used for maintenance work at other stretches of railway [124]. The contractor is responsible for applying to use the provided times; this must be done between twelve to four weeks before the start of an activity. If the times are not used, they are given to the railway companies. It is the same process for the contractors to apply for time on the tracks as it is for the railway companies. The application is sent to the BUP-planners which reviews the application, and emphasis to meet the demands as best possible. The BUP-planners must strike a balance between trains on the tracks and maintenance. In addition, the planners must decide whether the maintenance should be performed over one continuous period, divided over a longer period, and at what times and day the work should be conducted. For 2019 some of the following dates apply for the allocation in the timetable [125]:

13.02.2018 first opportunity for everyone to apply for a slot in the timetable.

09.04.2018 last opportunity for everyone to apply for a slot in the timetable. Last chance for Trafikverket to define PLI.

02.07.2018 proposition for the timetable plan is published.

17.09.2018 the capacity is allocated.

12.11.2018 the finished plan is published

09.12.2018 railway plan 2019 take effect

According to Nilsson et al. [124] should there be a consensus between when a train should be given time on the tracks with when there should be performed maintenance on the tracks. Sometimes this is not possible and Trafikverket has therefore established some priority criteria to solve the conflict with the best socio-economic optimum in mind. The train traffic is measured by the number cost of a delay or the cost of a transport route traveling a longer distance. To measure the maintenance, Trafikverket uses the alternative cost of performing the maintenance at a different time than first planned to calculate the cost. If there is an application from both the contractor and a train company for the same period, these factors help the BUP-planners decide whether to perform maintenance, or to give the period to the train companies. The work that does not affect the traffic on the tracks needs less coordination with the different organizational parts of Trafikverket compared to the work affecting the traffic [128].

In addition to the BAP and BUP both the contractors and the railway companies can apply for time on the tracks “ad-hoc”. The ad-hoc application can be used on periods that have not been

exploited in the original railway plan [125]. Stenberg [129] found in his report that 38% of all freight trains were canceled in 2017.

Lidén [130] identify several issues with the planning and scheduling in the maintenance of infrastructure, and classify them as strategical, tactical and operational problems. Some of the problems that are mentioned in the report are:

- Strategical problems
    - Contract design
        - Scope
        - Form
        - Terms
    - Maintenance dimensioning
        - Dimensioning the volumes of maintenance and distribute over the railway system.
- Tactical problems
    - Major possession scheduling
        - Have clear standards for when to prioritize train over maintenance and vice versa.
    - Timetable compression
        - To guarantee train free slots in the timetable.
- Operational problems
    - Track usage planning
        - Have total control over the usage of the train tracks
    - Maintenance project planning
        - Coordinate with every user of the railway, to ensure material and resources are in place when the work is planned to start.

4.1.3 Contracts at Trafikverket

In Sweden, the maintenance operations use mainly two different contract types named AB04 and ABT06. AB04 is stated by the literature as being a DBB contract, while ABT06 is said to be a DB contract [82, 84, 89, 131].

In an AB04 contract, Trafikverket inspects the railway system and delivers orders to the contractor for every activity which must be performed on the given stretch of the railway. In an ABT06 contract, the contractor is entirely responsible for the maintenance operations on the

tracks and does their inspections of the rail to determine which work to prioritize [132]. The basis for their work is discussed and decided in the BAP plan. The two contract types are similar in the way the contract is formulated, and the contracts consist of the same main parts: a description of the scope of the project, how to fulfill the goals of the project, fines and payments. The defined incentives in the contract are negative, where the contractor is fined for not following the contract terms. There are some bonuses for certain types of employment (See Appendix G and Appendix H for drafts for the different contract types). Odolinski [133] found in his report from 2015 that an increase of incentives given during maintenance work in the railway in Sweden, reduces the number of failures in the infrastructure. Trafikverket has national contracts which describes work performed by one contractor in the whole country, work that may be part of the contract is; snowplowing, track grinding etc [134].

Before the contractor signs the contract, they must take part in the competitive tender process regarding the maintenance on the specific track. During the competitive tender process Trafikverket gives a description of the maintenance work and specifies the activities, and the contractor can inspect the rail before the bidding. The contractors then provide bids over their costs of each activity, where the lowest bid wins the tendering [88, 124]. After the signing of the contract there is a one-year collaboration period, where the contractors together with Trafikverket discusses aspects of the contracts and try to resolve possible future problems before they occur. During this period Trafikverket together with the contractor discusses the amount of time the contractors need on specific maintenance activities stated in the BAP-plan. The contractors are then responsible for applying for the desired times on the tracks in the period four to twelve weeks before the start of the activity. The application goes to the planners in Trafikverket whose job is to balance the number of trains on the tracks with the number of maintenance and investment work [124].

4.1.4 Maintenance at Trafikverket

To be able to perform maintenance on the railway inspections must be conducted in order to know which activities to prioritize. Also, the inspections are performed to maintain the system, used as insurance for Trafikverket that the contractor has conducted the work contractual stated as well as learning about the deterioration of the railway system [124]. Trafikverket uses two different inspection types; maintenance inspection and safety inspection. These inspections control the state of the railway to define the safety and reliability of the system. The rate of the inspections is based on the speed limit on the tracks and the weight of the trains and ranges from one to six times per year. During the maintenance inspection the goal is to prevent

deviations in the timetable at an early stage. The safety inspection is the last barrier to detect a fault which can lead to a fault or an accident. Some of the inspections are performed at a national level by external companies which uses non-destructive testing. Similarly, the contractor companies also have their own inspections before the tendering to be able to give a bid as well as after they have signed the contract [124, 134].

Trafikverket`s maintenance operations can be divided into three main maintenance types; *basic maintenance, reinvestments*, and *smaller maintenance operations.* The basic maintenance consists of preventive- and corrective maintenance. Preventive maintenance is the maintenance type most emphasized by Trafikverket, and in 2014, 75% of the basic maintenance was preventive [135]. The preventive maintenance can be divided into two types where the first type is performed at specified intervals hence, being a clock-based maintenance. The second type is done based on the condition of the equipment. This means that they use all three of the different preventive maintenance types described in the theory chapter. In addition to the three maintenance types, there is also the seasonal maintenance such a snowplowing or other maintenance activities conducted on a seasonal basis. Examples of reinvestments could be; a change in the equipment due to aging, or that it is uneconomical to continue the maintenance of the system. The smaller maintenance operations are operations which is too small to be characterized as either a reinvestment or basic maintenance [136]. Figure 9 visualizes the different maintenance types.

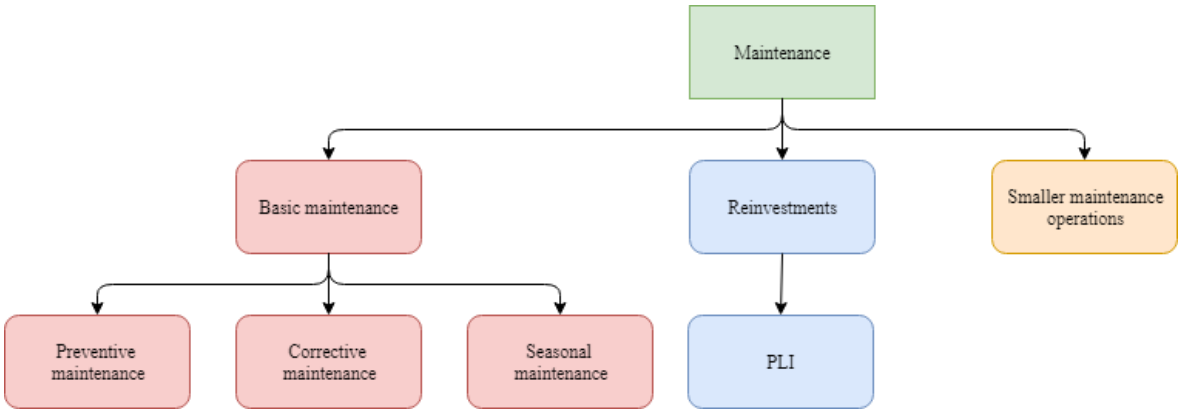

Figure 9 Maintenance types

When there is a need for corrective maintenance, the optimum solution is to plan for the work to be done when there is as less traffic as possible on the tracks. This could be when there is another maintenance planned, or at night. Often this is not possible and dependent on the seriousness of the fault, often the whole track needs to be closed until the work is finished.

Trafikverket assists the contractor who performs the maintenance with technical support and to gain information regarding the finalization of the work. The contractor and Trafikverket have regular meetings to discuss the type of work which must be conducted (AB04 contracts), practical and technical solutions as well as economic questions. The project engineers in Trafikverket controls the inspections made by the internal inspection in Trafikverket. The project engineers also control the faults registered in Bessy, the internal IT-system that is used to register faults out in the fields as well as planning the maintenance [137].

To be able to distinguish between the different maintenances and their priority, Trafikverket has assigned a letter system. This system marks the importance and criticality of each maintenance operation. Remark type M should be maintained within three months from control. Remark type V should be maintained within two weeks from control. Remark type A should be maintained as soon as possible, which means that the repair and closing of the rail should also happen as soon as possible. Remark type A is done ad-hoc, and every planned train or maintenance operation must divert until the repair is finished [134]. See Figure 10.

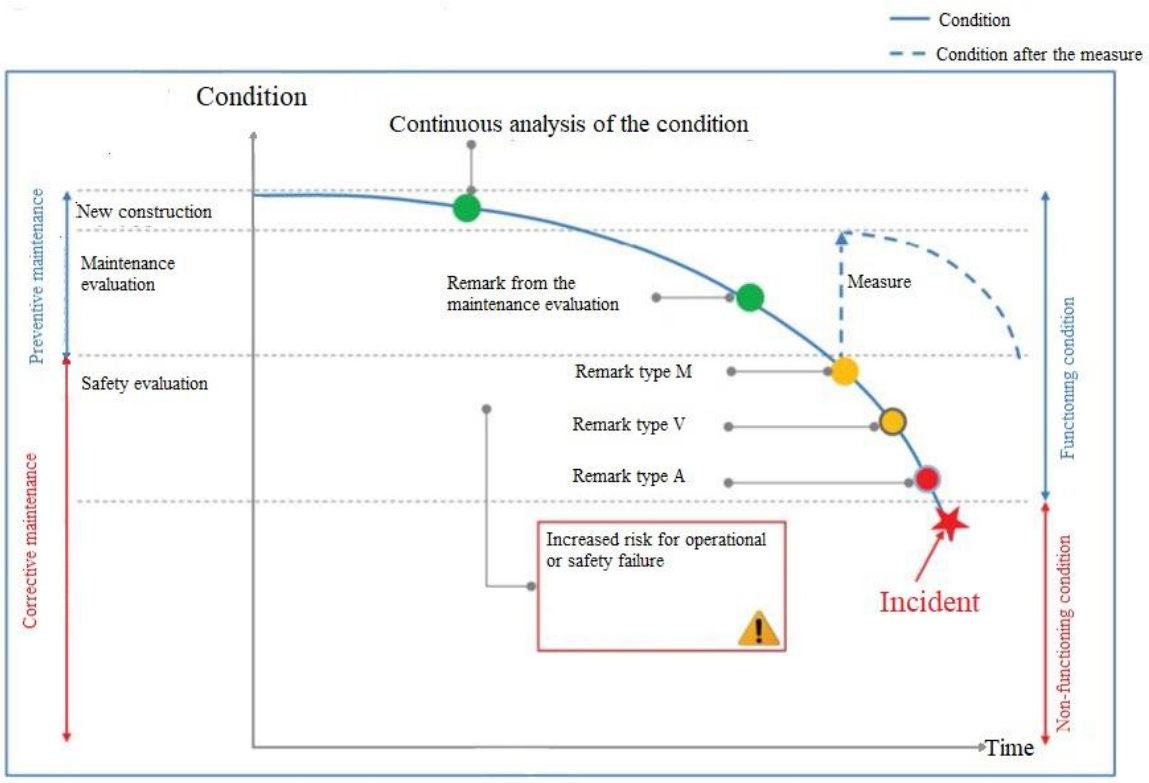

Figure 10 Letter system of the maintenance, translated from Swedish [134]

4.1.5 Environmental Considerations in the Planning Process

Focus on the environment increases every year and new legislation is implemented to improve the relationship between the development and the environment. The primary goal is to emphasize environmental protection and preservation [138]. In Trafikverket the environment is an important focus area, and many parts in the planning consist of environmental evaluations. All environmental evaluations are based on national environmental demands. The evaluation is based on a handbook with detailed examples and guidance for how to preserve the environment when planning projects [139]. In general, the handbook consists of seven steps done consecutively before or during each project:

1. A description of the project and how it should be executed
2. A description of the environmental preconditions and interests in the planned affected area
3. Asses the effects caused by the project
4. Asses the need for adaption as well as measures and protective actions
5. Asses the consequences the project could cause
6. Consider the consequences
7. Asses if there is a need for approvals or testing by government officials

After following these steps, the project initiative should have a good indication of whether the projects need a more thorough environmental assessment or not [140].

4.1.6 Software used in Maintenance Operations

Bessy

Bessy is an IT-system designed to assist the contractors and maintenance engineers during inspections of the railway system. The inspections are performed to ensure safety, maintenance and when one contractor is entering a new contract. The information from the inspections is synced directly from the railway by using a handheld computer or telephone [137]. Bessy exploits the data from BIS (Track information). BIS is a reference system which describes each component as well as its location on the railway system and it is updated daily [141]. Bessy exploits the data coming from BIS in its system, combined with the given rules and regulations for how the inspection is supposed to be performed. Bessy provides a generic inspection form based on the previous information. This inspection form consists of three topics; general information about the railway, measurements, and evaluation of the condition of the railway. This “inspection form” is what the person doing the inspection sees on their handheld computer.

The person doing the inspection then fills out the form with information gathered on the tracks. “Not inspected” could occur if there is too much snow in the area so that an inspection was not possible. The “Evaluation” is to ensure that the data in BIS are the same as the real world. The data produced three things based on the inspection; the “Inspection”, the “Inspection remarks” and if there are any BIS-deviations. It is even possible to upload pictures to Bessy to easier visualize the deviations on the railway. Se flowchart Figure 11, how an inspection in Bessy is conducted [137].

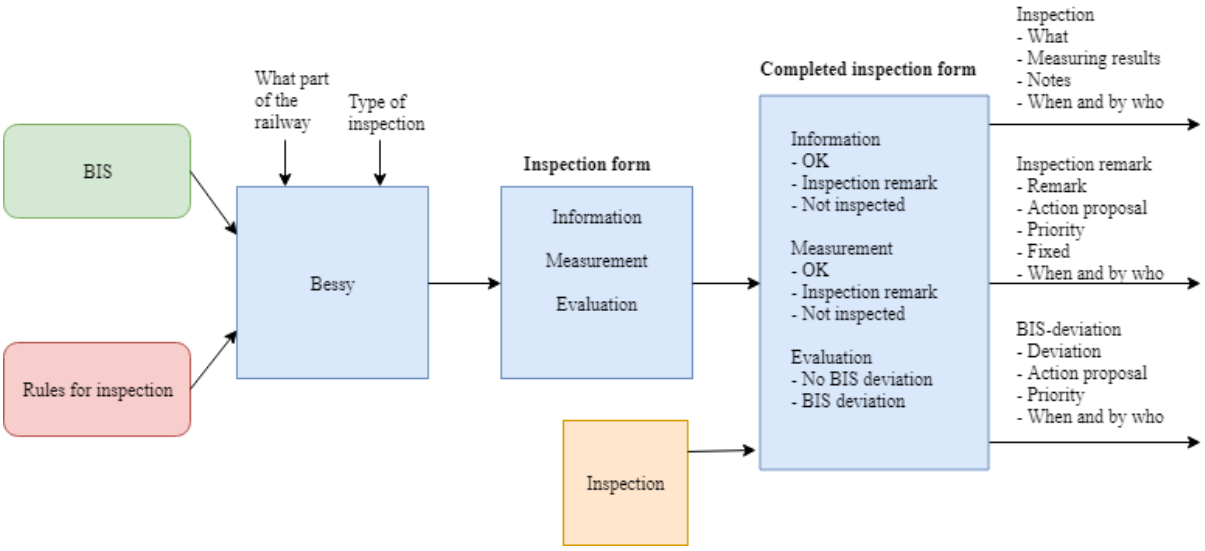

Figure 11 Bessy translated from Swedish [137]

Lupp

Lupp is a software system used to extract data and statistics about punctuality and disorders in railway traffic. The data taken from the traffic and data taken from the railway system is compiled into one computer storage in Lupp, providing a whole perspective of the railway [142].

Maximo

Maximo is a software system developed by IBM to assist with the asset management to increase the operational performance in projects. The purpose of the software is to reduce downtime and inventory need as well as increasing the operational efficiency. The software can store information about components condition and location. The software can also connect to the weather and other factors that affect the health of the component. The software also keeps control over the resources in the company and uses an app where the worker can see what work

should be performed, and confirm when the work has been performed [143]. For Trafikverket, the purpose of using Maximo is to control their railway system, steer and have efficient daily planning and execution of the maintenance [144].

MPK – Market-adapted planning of capacity (Marknadsanpassad Planering av Kapacitet)

In addition to the mentioned software's used by Trafikverket and its cooperative partners, they are working on a new software called MPK [145]. The purpose of the software is to collect all the information regarding the capacity in one online platform, making the process more flexible. This will enable easier application process for times on the tracks for the railway companies and the contractors [146]. The software system is planned ready to use in 2023 [147].

4.2 Interview Results

The following section provides a better description of the interview subjects. Table 5 and Table 6 show the years of experience of each interviewee, what type of maintenance contract they are currently working under, which contract type they prefer, and where they currently are in their contract period. In addition, for the project managers the table shows how often they communicate with the contractor companies. This is not shown for the contractors because almost every site manager collaborates with one of the interviewed project managers, hence, the amount of communication is the same. Further, for the site managers the table also shows how long planning period they use when planning for BUP and when they lock their BUP plans.

Furthermore, the sections below contain some statistics and a summary of the answers provided during the interviews.

Table 5 Overview of the project managers interviewed

Project manager	*Experience*	*Contract type*	*Frequency of communication*	*ABT06 and AB04*	*Preferred contract type*	*Where in the contract period*	*Maintenance windows*
1	30 + years	ABT06	Two times a month	Yes	ABT06	4th year	No
2	15 - 20 years	AB04	Every day	Yes	AB04	2nd year	No
3	15 - 20 years	ABT06	Once a week	Yes	n/a	5 + 1 option year	No
5	5 - 10 years	AB04	Once a week	Yes	AB04	2nd year	Yes
10	n/a	ABT06	Every day	No, only ABT06	n/a	5th year	No
11	5 - 10 years	AB04	Every day	Yes	ABT06	1st year	Yes
16	20 - 25 years	ABT06	Every day	No, only ABT06	n/a	5th year	No
22	15 - 20 years	ABT06	Every day	Yes	ABT06	1st year	No
23	5 - 10 years	ABT06	Three times per week	Yes	n/a	4th year	n/a
24	0 - 5 years	ABT06	Every day	No, only ABT06	ABT06	2nd year	No
25	15 - 20 years	ABT06	Three times per week	Yes	AB04	4th year	No
26	20 - 25 years	ABT06	Once a week	Yes	ABT06	5 + 1 option year	No

Table 6 Overview of the site managers interviewed

Site manager	*Experience as site manager*	*Contract type*	*BUP planning period*	*Experience from both ABT06 and AB04*	*Preferred contract type*	*Where in the contract period*	*Maintenance windows*
1	10 - 15 years	AB04	n/a	Yes	AB04	2nd year	No
2	0 - 5 years	ABT06	n/a	Yes	n/a	4th year	No
3	15 - 20 years	ABT06	3 - 6 weeks	Yes	n/a	5 + 1 option year	No
4	0 - 5 years	AB04	9 - 12 weeks	Yes	AB04	2nd year	Yes
5	10 - 15 years	AB04	9 - 12 weeks	Yes	AB04	1st year	Yes
6	0 - 5 years	ABT06	0 - 3 weeks	No, only ABT06	AB04	2nd year	n/a
7	15 - 20 years	ABT06	n/a	Yes	AB04	5th year	No
8	0 - 5 years	ABT06	n/a	No, only ABT06	AB04	2nd year	No
9	0 - 5 years	ABT06	n/a	No, only ABT06	n/a	1st year	No
10	0 - 5 years	ABT06	3 - 6 weeks	Yes	AB04	4th year	No

4.2.1 Maintenance Volume at Trafikverket 2019 – 2024

Trafikverket currently has 65 active maintenance contracts from March 2019 until August 2024. The data was provided by an internal resource in Trafikverket after a request from the author [148]. Trafikverket has 65 active maintenance contracts with a combined value of almost 13 billion Swedish kroner. 51% of the maintenance projects are under an ABT06 contract, 43% of the maintenance projects are under an AB04 contract and 6 % of the maintenance projects are under a different type of contracts.

When looking at basic maintenance contracts the largest AB04 contract has the value of 960 mill SEK (smallest 176 mill SEK), while the smallest ABT06 contract has the value of 50 mill SEK (largest 1.2 billion SEK) [148].

From the preliminary train plan for 2019, between 80-90% of the work planned requires the track to be shut down. 7-15% requires the speed on the tracks to be reduced and 3-5% only have a reduction in accessibility to the tracks [149].

4.2.2 Communication

Communication is an essential part of the collaboration between Trafikverket and contractor companies. All communication is performed in three ways: meetings, Skype-calls, and email [150-159]. Meetings are held regularly, where there is a site-meeting once a month as well as other regular technical meetings where the participants share information regarding the project. Frequently, information between the site manager and the project manager is shared by phone or Skype, and then an email is sent to confirm the discussion on the phone. Both the site manager and the project manager contact each other the same amount of times during a given period [150-152, 154, 156, 158-160]. In Table 7 below, follows an example of a communication schedule in one specific maintenance project provided by one of the project managers [156]. The table is an overview of an ABT06 contract with an experienced project manager, the contract does not have maintenance windows. The communication plan shows the type of meetings, and the purpose of the meetings. The table explains how often the meetings should be held as well as who should attend the meetings. At last, the plan describes the subject of the different meetings and who is responsible for the meeting.

Table 7 Communications plan [156]

Activity	*Purpose*	*When*	*Audience*	*Message*	*Responsibility*
Information about closures	Create understanding regarding disturbing work	When needed	The public, municipality, emergency personnel	What is planned when	Project manager
Damages	Internal announcement in Trafikverket	When needed	Internally Trafikverket	The status of the repair work	Project manager
Daily decision meeting	To get an overview over the disturbance on the railway to be able to correct	Every day	The project and the train planners	What have happened and the risks of the future	Project manager
Winter duty meeting	To minimize the disturbance during the winter season	Startup meeting as well as weekly meetings during the winter	The train planners, train companies and contractor companies	What have happened and the risks of the future	Project manager
Status report	Report regarding the project status	Once a month	Chef of unit	The status of planned economy, production and possible changes	Project manager
Weekly decision meeting	To get an overview over the project for this week and the upcoming week	Every Thursday	Railway unit	What have happened and the risks of the future	Project manager
Site meetings	Contract reconciliation	Once a month	Project manager, project engineer, site manager and contractor engineer	Follow-up on plans, economy and possible changes	Project manager
Collaboration meeting	To develop the contractor	Four times a year	Trafikverket and contractor company	Find solutions to combined challenges and risks	Project engineer
Technical meeting	Decisions regarding plans and production	Every Tuesday	Trafikverket and contractor company	Follow-up on the production, work, the performance measurements. Find solutions and improvements	Maintenance engineer
Basic maintenance meeting	Identify all activities within the contractual area	Every other Wednesday	Trafikverket and contractor company	Coordinate the work environment	Maintenance engineer
Internal weekly decision meeting	To work towards the same goal within the project	Every Monday	The project group internally	Plan for the week	Project manager

Many of the interviewees do not think there is any difference in how Trafikverket and the contractors communicate depending on the contract type [150, 152, 155, 156, 159-161]. One main opinion is that it is the relationship between the site and the project manager that decides the amount and quality of the communication between the parties [150, 152, 155, 160]. On the contrary, some mean that the contract does affect the amount of communication between Trafikverket and the contractor companies. These say that there is more frequent communication in an AB04 contract because of the information the contractor needs from the project manager [151, 157, 158, 162-164]. A higher number of the interviewed have experience from both types of contracts, which gives them high validity, see Table 5 and Table 6. In general, the site managers have a shorter experience from the railway industry compared to the project managers. One issue is the communication between the contractor companies and the BUP-planners. The time the contractor is informed whether they get a specific time to work on the tracks or not is too short [163, 165].

4.2.3 Collaboration

In a large organization as Trafikverket communication and close collaboration with the contractor companies are crucial for a project's success. That Trafikverket is such a large organization is mentioned by one contractor to be one main issue for the collaboration [164]. The contractors did not mention many challenges during the collaboration with Trafikverket. The biggest challenge was to be able to get enough time on the tracks, where they were only

able to “put out fires” and not work preventively, this was also mentioned by one of the project managers [151, 153, 162, 165-168]. In addition, changes in the preconditions were also mentioned [150], as well as trust between the site manager and the project manager [163].

The project managers had more examples of challenges during the collaboration with the contractor companies. The most significant challenge was the ability to work towards a combined goal and in a long-term perspective [162, 168-170].

Interpreting the contracts in the same way and to have a consensus of the payment and scope of the work, is another challenge [161, 166, 169, 171]. It is not explicitly stated in the contract how the two parties should cooperate during the contract period. One reason is to keep the document short to minimize misinterpretations. Despite this measure there are still many misinterpretations in the different contracts. The misinterpretations are one of the main reasons for conflicts during the contract period [161, 166, 169, 171]. At last, the project managers mentioned knowledge transfer after ended contract period as a big challenge, where a lot of the knowledge is lost from one contractor to the new [158, 169].

4.2.4 Performance Measurements

Trafikverket measures the performance of the contractors in two ways: experienced index and maintenance index. The experienced index is a yearly contract measurement that measures how satisfied the contractors and Trafikverket are with their collaboration. They are asked the same questions, and the results can be used during discussions to decide whether the contract should be prolonged or not. The results are collected by an independent external company and their experience is that the performance of the different project differs based on the type of contract used. Some projects are doing well under an ABT06, others are doing better under an AB04. In addition, different projects can use the same type of contract, but because of differences in the preconditions, the performance of the projects can be very different [171].

The maintenance index consists of multiple inputs to get a better understanding of the railway’s status. Three main parts are used as the basis for the analysis which is: “type of project”, “how/what task is performed” and “measurements”. The index is used by Trafikverket to measure the efficiency of the contractor. Some measurements measure how the work is performed under different contracts as well as the efficiency of the work. The data is collected from Trafikverkets own software system “Lupp”. According to one stakeholder [171], the measurements are different from project to project and from whom you ask. One measurement can be; the number of mistakes per km of railway divided by the time it takes to solve the fault.

Another measurement could be the punctuality of the trains. This measurement is also used to give the contractor fines if their work causes delays [150, 160]. How long the contractor uses to get out to the worksite is the measurement most commonly used by the project managers to give fines [150, 153, 172].

Some of the contractors do not know the performance measurements from Trafikverket, or they say that the measurements do not help them do a better job [152, 164, 165]. Another contractor says that a better measurement could be to measure the total number of errors in the railway system during the contracts period [165]. Others say that measurements on time spent solving issues would be a better measurement and provide a better railway [158, 172]. One project manager thinks that they measure too much, which makes it difficult for Trafikverket to utilize the data [155]. However, this is the opposite of what some of the contractors say. One said that Trafikverket does not measure a lot and that the contractor company measures themselves the most [150]. Another said that the measurements do not affect the company or their performance, and that Trafikverket measures the wrong things, and that the assumptions for the measurements are wrong [151, 152, 165, 172]. In general, the measurements are there to ensure that the contractor gets the right amount of payment for the correct amount of work they put into the project. One out of seven contractors thinks that the performance measurements used by Trafikverket are pulling the project in the right direction [163].

Incentives are frequently used in the maintenance contracts provided by Trafikverket. Often, they are in the form of fines given if the contractor does not perform as stated in the contract terms. (Examples of the different contracts are provided in Appendix G and Appendix H where the incentives are stated). Not all interviewed project managers are consequent to what kind of contractual breach that should get a fine and what should not be fined. There are situations where the contractor tried best as possible but was not able to reach the work site within the given time and would not be given a fine.

Another example could be that the contractor used a long time getting to the work site because they brought the necessary equipment right away, rather than first travel to the worksite to inspect the damage before getting the equipment. These are examples that could not be given a fine, but again this is up to each project manager [156-160]. Weather conditions can also affect if the contractor gets fines or not. Every month the fines are discussed between the site manager and the project manager where the site manager can argue for why they should not get the fine [150, 151]. It is also possible for the project manager to not give a fine, but to demand something in return from the contractor [159].

There is no clear consensus between the contractors whether they prefer fines or not. Some say that both fines and bonuses should be removed, while others would like bonuses in addition to the fines [150, 165]. One site manager says that Trafikverket should be a lot stricter, and give fines more often, that this could help improve the quality of the railway system [153]. Another project manager thinks that it can be challenging to make the contractor work more efficiently when they do not have positive incentives to use [165].

4.2.5 Contracts

Contracts are used in all projects and activities both internally and with external collaborative companies. In general, Trafikverket uses two different maintenance contracts types; ABT06 and AB04. In ABT06 the contractor has the responsibilities for a stretch of the railway, and the contract states some maintenance activities that must be conducted during the contract period. In addition, the contractor must inspect the railway in order to conduct the corrective maintenance. ABT06 is most commonly used in large projects, or in projects where the contractor has a large area of responsibility [162, 169]. One project manager said that with an ABT06 some parts of the railway could be in good condition and other parts can be in bad condition [156, 157].

In an AB04 contract, Trafikverket is responsible for inspecting the railway and for deciding what type of work is necessary to perform. An order is then sent to the contractor companies with instructions on what work should be conducted. AB04 demands more from the project managers at Trafikverket because they perform the inspections of the railway and decide what work should be prioritized [157, 169]. AB04 is most commonly used within smaller maintenance contracts [162, 169]. In an ABT06 the contractor is freer to be innovative and to decide the work they should perform themselves [162]. Regardless, some site managers say that the project managers from Trafikverket control more than what the contract states and that there is a misinterpretation of the roles [152, 164, 165, 172]. For both contract types the one requirement states that if a maintenance activity on the tracks has a longer than 15 minutes duration, the work must be applied four weeks before the start [151, 166, 172].

The contract period is typically five years, with the possibility to prolong the contract period with two additional years. Most of the site managers think today's contract period is too short to be able to invest in the necessary resources [163-167]. If the contract period is not prolonged a problem for the contractor is when the resources already working in the company will look for other jobs [170]. Some of the project managers agree that the length of the contracts can be

too short to be able to invest enough. However, they do not think they should be stuck with a bad contractor for too long if the collaboration does not work [161, 168, 170]. One project manager said that the first year of the contract period is a warm-up year where the collaborating parties get to know each other. Year two to four is the period with the best collaboration and year five is when the disturbances occur [170].

The majority of interviewed worked under an ABT06 contract and have experience from both types of contracts. Most of the contractors prefer the contract type AB04, while most of the project managers prefer ABT06. As seen by Table 5 and Table 6. Some project managers said that they would prefer an AB04 contract if they had more personnel working for them at Trafikverket [168, 170]. The contractors think that Trafikverket gets more "money for their buck", consequently as they can earn more money when working under an AB04 contract [150, 152, 163, 166, 172]. On the contrary, project managers often prefer ABT06. Some project managers argue that the contractor can more freely perform the maintenance work as well as this contract type is more cost efficient [155, 162]. In addition, the site managers say that Trafikverket is in a more comfortable situation in an ABT06 contract because the contractors take all the risk [157, 159, 161, 169].

One year before the contractor starts to work on the contracts, Trafikverket together with the contractor reviews the contract conditions and solve ambiguity at an early stage [150]. One project manager said that the contractors look for "loopholes" in the contracts. The loopholes could be activities the contractor know from previous work that must be performed but is not stated in the contract. Now the contractor can price these activities very high to try to earn as much money as possible [173]. This is confirmed by one contractor and the reason for using this tactic is due to the low possible revenue when Trafikverket uses a tendering [172]. Two project managers said that the contractors always use the equipment and personnel which is specified in the contract pays the most [157, 158]. This can be unique railway running equipment and specialized personnel. Some also say that there are trust issues between the site managers and the project managers [163, 172].

A national contract is a contract including work performed for every railway stretch in the whole country. There is somewhat consensus that machinery demanding a substantial investment should be part of the national contracts. Inspections as well as changing the railway switches and control the direction of the railway was also mentioned by the interviewees [151-153, 156, 161, 163-165, 167, 168, 170].

4.2.6 Lean

The project managers in Trafikverket does not force the contractor companies to use specific techniques such as Lean, concurrent engineering or other tools during their maintenance operations [154, 157, 159, 162, 168, 170]. However, the practices are encouraged and welcomed [162, 168]. Some practices from Lean are used by the contractor such as 5S [163, 164], and a type of late locking of the plans [150]. One project manager said that many talks about Lean, but not everyone genuinely knows what Lean is [158]. One contractor said that it is not possible to implement Lean in maintenance operations, and that it is only used during production [167]. Another said that Lean could not be applied because of the change of conditions at the different sites [165]. One contractor who is currently implementing Lean stated that time and support from the top management was crucial to be able to use the practice. He also stated that to implement Lean entirely he would need ten years [172].

4.2.7 Interview with BaneNor

The interview with BaneNor was conducted in Trodheim, and the representatives from BaneNor was one project manager, head of projects and one contract responsible.

BaneNor starts their planning of the railway plan 48 months before the plan take action. They emphasis to have four periods each year where there are two days without trains on the tracks to perform maintenance. In addition to the planned work and the four periods the contractors have “white times”, which is the times between trains to work on the tracks.

ARBIS is a software used to order work and to book time on the tracks and “Banedata” contains information about all the parts of the railway system. These two software systems combined with Maximo is used during the maintenance operations. Local knowledge will always be valuable; thus, this is difficult to implement in the software systems. Also, the software system would have to be preventive and dynamic to perform adequately.

Today the operational tasks are performed internally, however shortly a company separated from BaneNor will have this responsibility. The contracts between the newly separated company and the contractor companies will have a duration of five years with the possibility to increase the length by two years. The best incentive BaneNor gives their contractors is the prediction of having a contract lasting five years. In addition, other incentives could be to split the surplus of a project.

BaneNor uses two different approached when hiring a contractor to a project; tendering and “negotiation”. During the tendering the contractor can be chosen based on different

preconditions, which could be compared to the process in “Early Contractor Involvement”. During a negotiation the contractor is already chosen, and the promised quality can be of higher importance than the price. Before the contract is signed, BaneNor controls the documentation as well as the plans of the contractor. To be able to deliver a high-quality railway BaneNor is dependent on having excellent communication between themselves and the contractor companies as well as the people planning the railway plan. Stakeholders are an essential asset of which it is vital to have good tools for communication, and stakeholder analysis is crucial before any project. All the different divisions are represented in Trondheim which makes it easier to communicate between departments. However, for the contractor it may feel like it is a big “empire” where it is difficult to get in touch with the right people at the right time.

Another critical aspect of the projects is to ensure a common understanding of the project, this is done by holding a meeting between BaneNor and the contractor company. Before the contract period there is a nine-month introductory period where BaneNor prepares the contractor by having meetings where they discuss documentation, expectations and other aspects of the future collaboration. During the project there are held site-meetings, safety inspections, evaluation and final inspections. BaneNor emphasis a precise flow during the project where close and constructive communication is vital, as well as solving challenges as they occur. BaneNor has implemented Lean in some of their projects. The most important for them when implementing Lean, was to get the contractor to own the idea. In the end it is the contractor who owns the plan and progress of the project, and they would have to want to work with Lean if it were to work. This combined with enough investments to be able to finish the project was very important [174].

Chapter 5 Discussion

The collected data is of critical importance if they are to be used for future research or by other researchers. However, the data is not knowledge only information, and must be put in order and discussed before it can be used. In this section the results are discussed and evaluated.

5.1 Learning Perspective

Ensuring knowledge transfer during and after the ended contract period is crucial and can affect future maintenance contracts as well as the current. Because of the longevity of the railway, the knowledge concerning most of the system is relevant over a long period. The knowledge will stay the same during the lifetime of the railway where multiple actors can utilize this knowledge in their contract period. This means that the knowledge must be easily accessible by several different companies and individuals, including being understandable for different users. One aim for Trafikverket is to align the project with the company's strategy, this is best achieved by communication and learning [21].

The change of contractor companies every five years is mentioned as one of the main reasons for the loss of knowledge. The interviewees gave examples of employees of contractor companies fleeing the company if the contract is not prolonged. The employees either switches to businesses where the contract conditions can be more secure or to other contractor companies that have acquired a new tender. This means that the knowledge these individuals possess is lost when they leave their respective companies. Trafikverket operates with vertical coordination internally and externally, because they have a focus on planning, rules and authority. Companies operating in stable environments do not need to rely on flexibility and adaptability and are more likely to be a bureaucratic type of organization [23]. Trafikverket fits in this description where the organization is not threatened by high uncertainty which can affect the organization negatively. However, the contractor lives in a more unstable environment, especially closer to the end of the contract period in year four. This environmental uncertainty causes personnel to change jobs, this is evident based on the interviews. In addition, this can be seen from the experience of the personnel working at a contractor company compared to Trafikverket which is much shorter see Table 5 and Table 6. A more extended contract period, or the possibility to increase the additional years after the first five years could reduce the unstable environment for the contractors.

If it is not possible to prolong the contract period, another possible solution is to keep the knowledge within the company, by moving the knowledge from the personnel to a digital solution. According to BaneNor the success criteria for these possible software systems is that they would have to be well developed in addition to dynamic. The main goal of the software is to transfer the information from the human to software so that everyone in the railway business can utilize the information. It is also important to mention that software cannot sufficiently outperform the human mind, and local knowledge is always important. One project manager in Trafikverket said that some contractors could listen when a train passed on the tracks, and by the sound it made, would know that something would happen within a short period [169].

BaneNor uses a system called BaneData, which contains all the information regarding every component in the whole railway system in Norway. In comparison, Trafikverket uses a software called BIS, which also describes every component and its location in the railway system. BIS together with Bessy provides a full description of the whole railway system, its components and the state of the system during the last inspection. It is evident that the software does not provide enough detailed information about the railway system. Information on the system would not be lost if the software systems were optimal. Presumably, the software systems do not register all the knowledge of the contractors. Another reason could be that it is too difficult to obtain the information within the software. The last reason could be that the registrations made by the contractors are not thorough enough. The two first reasons would need an update of the software, but the last reason could be solved by incentives or learning. The knowledge capture should be implemented as early as possible, possibly using incentives in the contracts.

Working towards a combined goal is a challenge mentioned by the project managers. This could be a consequence of not knowing the state of the railway system before the start of the contract period. Even though inspections are performed by the contractors before the bidding, the inspections might not be enough to fully cover and gain enough knowledge to know the range of the maintenance needed. Furthermore, clear communication from the project managers regarding the expected quality of the work should be emphasized. This could help the contractor to easier anticipate the time each activity is going to take as well as the cost of the different activities.

There is a pretty clear distinction between what and how much information the different parties in the collaboration between the project and site managers prefer. For the project managers the most crucial information from the site managers is the progress of the production, and to know if something deviates from the production plan. The site managers are most interested in

information about changes that might affect the scope, plan or the budget of the project. However, the frequency and how fast the site managers get this information is just as important as the information its selves. The data shows some indication that more experienced project managers have less communication with the contractor. In addition, it seems as if the project manager has a good relationship with the site manager, they have more frequent communication. This is based on the number of challenges mentioned by the project managers with the collaboration seen in connection with the frequency of the communication.

The contract types affect how often the information must be shared. In an AB04 contract, there must be a more regular information flow, because the contractor needs to be told by Trafikverket which activities that should be performed. In an ABT06 contract all the activities are defined at the start of each year. Hence the contractor only needs to communicate with Trafikverket if there is any changes or other factors affecting the project.

5.2 Performance Measurements

For a performance measurement system to function optimally it is essential that the measurements used, measure the right things, provides value, in addition to not create any dysfunctions in the system. This is however not the case for some of the measurements used by Trafikverket today.

Today the contractor is measured by the time it takes for them to reach the spot where the issue has occurred. In practice this means that if the contractor is at the worksite within the given time, they can use a long time as they want to fix the problem without being given a negative incentive. A better measurement could be to measure the time the contractor uses to fix the issues; however, this can cause other challenges. Here Trafikverket would have to monitor the contractor more often, which increases Trafikverkests costs. The same measurement could be used, but without the monitoring from Trafikverket, then the trust between them must be increased.

Another issue with the performance measurements used today is that there is no difference in the measures based on the different tracks. Sweden has many different types of tracks, and there should be some difference in the measurements used on the different tracks. This will help to increase the effectiveness of the measurements. Implementing these measurements, the cost could become an issue, because of the increased number of measurements and new methods to implement.

The author has not gained access to all the measurements used by Trafikverket, so it is difficult to say something about the whole PMS in general. However, many of the known measurements are lagging and based on measurements of occurrences happening in the past. There are only a few measurements used today that can help improve the performance of future maintenance projects. Examples are some of the soft measurements such as collaboration, but these are measured too seldom, only once every year. The soft measurements can help get a better understanding of the collaboration, what works and what does not work. In a longer perspective, these types of measurements can help improve the collaboration between the two collaborating partners. Can be used at the beginning of a project to facilitate a faster collaboration, and to enlighten the parts of the collaboration that needs improvements. Most of the measurements have the trains as a basis, i.e. how the work affects the trains, and only a few on how the work by the contractors is performed. Probably the main reason for the use of this data is due to the easy accessibility, and if other measurements were used, this would have to be created. It is

cheaper and more comfortable to use measurements that are already available. It is essential to strike a balance between measure and controlling, where too much measuring could hurt the relationship with the contractor.

No matter what type of PMS system Trafikverket decides to use, it is important that the contractor approves the system, and that they want to contribute and provide data. This is not the case today where only one of the interviewed contractors thinks the PMS enables them to do a better job. By changing the focus of the PMS from giving negative incentives, towards positive incentives could facilitate an easier collaboration with the contractors. It is essential that the contractor feels the PMS pulls them in the right direction as well as increasing the overall quality of the railway system in Sweden.

5.3 Contracts

Contracts are the binding agreement that describes how the collaboration between Trafikverket, and the contractor companies should be. The contracts specify the frames for the project and define the roles of the participants.

Despite, both the frames and roles are discussed throughout the contract. The contractor means that Trafikverket controls more than what the contract states, and that they misunderstand their role in the specific contract. Seen from Trafikverkest point of view it is understandable that they want to ensure safe and reliable working conditions for everyone in the projects. However, if they control the contractors too much, especially in an ABT06, what they are trying to achieve might be undermined.

Trafikverket delegate responsibilities to the contractor and Trafikverket depends on the contractor company to act in their best interest, this is a principal-agent relationship. The relationship is based on trust, however, from the contractor's point of view it might seem that Trafikverket does not have trust in them and their operations. According to Stewart [47] distrust can worsen the communication between individuals and this can affect a project negatively.

The scope of the contracts is also discussed during the duration of the project, where the site manager and project manager discuss which activities are part of the scope and what is not. Besides the scope, the cost of the different activities is also discussed. The discussions are more frequent in the first period of the contract before the collaboration and reach a "cooperation equilibrium". Most of these discussions come from the type of contracts used, and how the contractor is chosen. If a tender process is used before an ABT06 contract, the contractor would have to deliver a tender as low as possible to win the contract. This causes the possible surplus of the contractor to decrease. Now the contractor looks for other ways to earn "what they lost" when winning the tendering. This is one reason for the contractor to use expensive machinery and to price activities that are not part of the contract very high. This is one of the biggest and most common reasons for conflicts between the two collaborative parties. By acting like this, the contractor facilitates more uncertainty and distrust between the contractor and Trafikverket. Early contractor involvement is used in investment projects and is a possible way to choose the contractor based on other criteria than the price. It must be noted that the author does not know whether early contractor involvement is also used during maintenance projects in Trafikverket.

The length of the contract is a central part of some of the challenges in the relationship between the two actors. There is a consensus among the contractors that the contract periods are too

short. The short period causes the contractors to have less education of their personnel as well as investments in machinery, because the project becomes too costly when it is divided over the shorter periods. The contract period produces a lot of uncertainty for the contractor companies which in turn causes a high turnaround of personnel. A possible verification can be seen by the difference in years of experience between the site managers and project managers. Over 60% of the interviewed project managers have experience as a project manager for 15 or more years. For the site managers only 20% of the interviewed have experience of 15 years or more. This causes it to be a significant gap in the experience level between the personnel from Trafikverket and the contractor companies. The difference could cause challenges in communication as well as the implementation of new tools and procedures in the maintenance operations.

During the interviews it came up some options and suggestions regarding the length of the maintenance projects. One project manager suggests having an ongoing contract with a renewal every year, another suggestion was a contract period with 5+5+2 years. Another approach could be to have a test period at the beginning of the contract and then have the option to prolong the contract over a more extended period (longer than five years) after the test period (e.g., 2+7+7 years). This could ruin some of the competitiveness of having shorter contract periods, but it may improve the overall quality of the railway in Sweden. The author suggested to BaneNor to have a test period before signing a more extended maintenance contract. The grounds for this suggestion was to make it easier for Trafikverket to change contractor if the collaboration did not work. This would also make it easier for the contractor to invest in machinery and competence, especially if they get to continue the contract. However, BaneNor did not think this was a good idea due to the massive workload before a contract is signed, and that this would not facilitate for investments for the contractors. BaneNor suggested to instead have a more extended prolonging period after the first five years. The more extended contract periods would facilitate working in a longer time perspective as well as investing in new machinery and personnel. However, the more extended contract period does not increase the time the contractors get to work on the tracks which are probably the biggest threat to the quality on the railway in Sweden.

There was a clear distinction between the answers from the contractors and Trafikverket regarding what type of contracts the different interviewees preferred. The contractors prefer the contract type AB04 because they think the responsibilities in the project is more fairly divided between the participants. Also, this contract type increases their possibility to earn more money.

In an ABT06 change can occur and new legislation can be introduced which causes an extra cost for the contractor. Moreover, the tender process forces the contractors price their work lower than what they would prefer. For an AB04 the contractor and project manager discuss the price of the activity before the work takes place. On the contrary, the project managers prefer ABT06 for almost the same reasons. They state that the contractor can decide in what way, and when they should perform certain activities. This provides the contractor with more freedom and possibility to perform the activities at a lower cost. It is evident that the project managers have a more comfortable position in an ABT06 contract, where the contractor takes all the risk, at a lower cost for Trafikverket. The incentive for the contractor in an ABT06 contract is to save as much money as possible by only maintain the function of the railway. While in an AB04 contract the incentive is to work as hard as possible for the money they are paid.

It is unclear which criteria that decides the contract type used at which maintenance project. From the interviews it seems as the size of the project is the deciding factor, where a large project is typically under an ABT06 and smaller under an AB04. While this may be the case, according to the acquired scheme of ongoing maintenance contracts in Sweden, there are several cases where AB04 contracts are more extensive than ABT06. (The correlation between geographical size and economic size can be discussed, however in this thesis it is presumed that an expensive maintenance contract is linked to a relatively large geographical area.) This undermines the statement that the more substantial contracts are ABT06. Does this mean that Trafikverket chooses contract type based on their own comfort and where they do not have as much responsibility? According to Lædre [81] the choice of contract strategy depends on the project managers performing the project. There is a difference in people's perception of risk as well as the prior experiences of the project manager which plays a part when deciding the contract type. However, the main goal for both contractors and Trafikverket should be to provide a reliable railway system, and not choose to use a specific method or contract based on their own comfort. It seems however, as this is not necessarily the case. Although Trafikverket`s job is a bit easier under an ABT06 contract, it is difficult to understand why they still prefer this type of contract when it fosters more conflicts between the two collaborating parties. Conflicts regarding scope and costs would be minimized by using more of AB04 contracts.

Another consideration is the number of resources the different contract types need. An ABT06 contract does not need as much personnel but must focus on the monitoring of the contractors, which can be more costly. For an AB04 there is a higher cost by having more personnel from

Trafikverket inspect the railway to decide what activities should be performed by the contractors. Trafikverket must strike a balance between the costs of monitoring the contractors in an ABT06 contract versus cost of inspecting the railway themselves in an AB04 contract. However, the control and knowledge Trafikverket would gain by using more of AB04 contracts can surpass the expenses of the contract type. In addition, AB04 can remove several significant challenges during the collaboration such as conflicts and additional time used to discuss the contract terms.

Both Trafikverket and the contractor companies have private information about future events which is unknown and can have negative consequences for the other partner, this is a case of adverse selection. For Trafikverket, one example of adverse selection can be: the contractors working under an ABT06-contract sits on all the information regarding how and if they have performed specific work on the tracks. Trafikverket have limited resources to control the work performed by the contractor. Trafikverket must trust the contractor and believe that they have performed the work they have stated. In theory, the contractor can maintain and not improve the function of the railway during the whole contract period. The long lifespan of the railway system makes it possible to forsake the maintenance tasks, and by doing so, the lifespan may be shortened tens of years. This can provide Trafikverket with considerable future costs. This is also partly moral hazard where the contractor could forsake their maintenance tasks in their fourth year if their contract is not prolonged. The consequence of the contractor's actions would not be their problem, but the problem of a future contractor, retaining ownership of the maintenance over that geographical area.

There are several examples of adverse selection from Trafikverket towards the contractor, one of which are: Trafikverket has a lot more information about future events and other factors which might affect the costs of the maintenance projects. This can include future standards or required certifications for the contractor, as well as work hours. Another critical aspect is the information regarding the time on the tracks, this is critical for the contractors to get as early as possible, to be able to adapt their work and plan around the given period. All the information can provide the contractor with a future negative consequence if not shared.

It is unknown who decides the terms of the contracts and why some contracts have both positive and negative incentives, and others do not. Today it seems as the incentives are used for one purpose only, which is to reduce maintenance work that affects the traffic. This is also stated by Odolinski [133] in his report from 2015. Currently, Trafikverket sees the contractor

companies by using Theory X, based on McGregor [30], where the contractors need external factors such as incentives to be able to perform sufficiently.

Incentives could be used to collect more knowledge about the railway systems status, as well as steering the contractor to work towards a long-term perspective. The maintenance contracts provide the contractor with a secure income over a long period and are one of the bigger incentives given by Trafikverket. Furthermore, other incentives during the contract period can be used actively to facilitate better project execution, by steering the contractors in the desired directions. In addition, many of the contractors are favorable to an increased number of incentives, especially positive incentives. Gaining information regarding the condition of the railway could be improved by giving more positive incentive for sharing and storing knowledge.

One of the most significant issues with the incentives given today, is on what basis they are given, and that in some cases there should be incentives where there is none. One example where there could be given a positive incentive is when the contractor works at unfavorable times. When the contractor delivers their tender, they must balance their believed use of resources with their planned revenue. In addition, they must consider their competition and put in a low tender as possible. Often the contractor calculates their hourly rate by “normal” working hours (i.e. 07-15), which is also when they apply for times on the track to perform the maintenance. This is also the period of the day when the train companies want to have trains on the tracks. This can cause the BUP-planners to change their applied time to the weekends or night, which increases the costs and thus, the contractors could lose money on the work. The BUP-planner can change 25% of the date and times of the maintenance windows, this is contractually stated. Moreover, based on the comments from the site managers it seems as this percentage can be higher. This again causes the contractors to further look for, and exploit the loopholes in the contracts, fostering less trust between the parties, and worsen the collaboration.

By having more of AB04 contract a lot of the challenges the project managers mention would be removed. Trafikverket would gain more information regarding the status of the railway, hence removing the information asymmetry. The conflicts regarding the scope, costs and other discussions would be reduced. In addition, the contractors would be more pleased with the way the responsibilities and risk are shared between the two parties.

5.4 Game Theory Perspective

Both Trafikverket and the contractor companies benefit from collaborating with each other. A non-collaborative project can lead to a zero-sum game where one participant will gain from the loss of the other participant. This is quite evident that is the case when interviewing the different participants from Trafikverket and the contractor companies. When using a tender process, the lowest bid wins the tendering. This can penalize the companies that calculate accurately in the front-end phase of the maintenance projects. After the tender process, the contractor will try to gain as much as possible from the collaboration with Trafikverket, to make up for winning the tender by giving the lowest bid. One way to gain more from the collaboration is to scrutinize the contracts to find activities not stated, but that must be performed, and price this work unnormal high. Seeing the process from a game theory perspective would state that; using a tender process provides a loose-loose game for both players. However, it exists different types of tender processes where the contractor is included earlier in the decision process. This is used in BaneNor as well as investment projects in Trafikverket and is called Early Contractor Involvement. These types of processes change the game towards a more win-win system where both parties in the collaboration will have a positive outcome. AB04 contracts could also provide such a game where the contractor can earn more money as well as Trafikverket gains more information regarding the status of the railway system.

During the literature study and the interviews, Game Theory was mentioned and of such relevance that the author would like to present two examples. The collaboration between the site manager and the project manager is analyzed, one is based on a hawk and dove example and Stackelberg method.

Two players, here: Trafikverket and the contractor company working on a project with the possible profit of $V > 0$. The players get into a discussion about the interpretation of the contract. They can choose two approaches, either fight for what they mean is right (hawk), or they can give in and give the other player right (dove). If both choose to fight over the terms, they use time and resources which have a cost $c > 0$. By giving up on the fight, they have a loss of x or z which has the value $0 < x < c$ or $0 < z < c$. If one chooses to fight and the other surrenders, one player will get the gross profit, and if they cooperate, they both will share the profit equally.

If $\frac{V}{2} - c > x,$ then the haw will dominate the dove, i.e. hawk will always be chosen because hawk will have a bigger profit than the loss off choosing dove. This means that hawk will be played in an equilibrium.

If $\frac{V}{2} - c < x$, then hawk dove, and dove hawk is a "pure strategy Nash equilibrium", which means that neither of the players would like to change their strategy because the outcome would worsen.

Below follows the calculation of the above example of a possible collaboration between the project manager and site manager Table 8:

Table 8 Hawk and dove example

		Project manager	
		Hawk	Dove
Site manager	Hawk	$\frac{V}{2} - c$, $\frac{V}{2} - c$	V, $-x$
	Dove	$-z$, V	$\frac{V}{2}$, $\frac{V}{2}$

$$U_H = f\sigma_{PM}$$

$$U_H = \sigma_{PM}\left(\frac{V}{2} - c\right) + (1 - \sigma_{PM})(V)$$

$$U_D = f\sigma_{PM}$$

$$U_D = -\sigma_{PM}(x) + (1 - \sigma_{PM})\left(\frac{V}{2}\right)$$

$$U_H = U_D, \quad to\ find\ the\ equilibrium$$

$$\sigma_{PM}\left(\frac{V}{2}\right) - \sigma_{PM}(c) + V - \sigma_{PM}(V) = -\sigma_{PM}(x) + \frac{V}{2} - \sigma_{PM}\left(\frac{V}{2}\right)$$

$$\sigma_{PM}\left(\frac{V}{2} - c - V + x + \frac{V}{2}\right) = -V + \frac{V}{2}$$

$$\sigma_{PM}(-c + x) = -\frac{V}{2}$$

$$\sigma_{PM} = \frac{V}{2c - 2x}$$

$Answer\ for\ the\ site\ manager$:

$$\sigma_{SM} = \frac{V}{2c - 2z}$$

The answers from this example show that the equilibrium and possible payoff (σ) for both the contractor and project manager is: the overall project profit divided by two times the costs of the fight and two times the cost of giving up on the fight. In this case payoff for each of the players is different based on their strategy. One assumption for these answers is that both players make their move independent and at the same time.

Another relevant example of game theory, in this case a Stackelberg method where one player makes a choice before the other player, and is as follows, Figure 12 (the numbers are fictitious in this example and are just visible to prove a point):

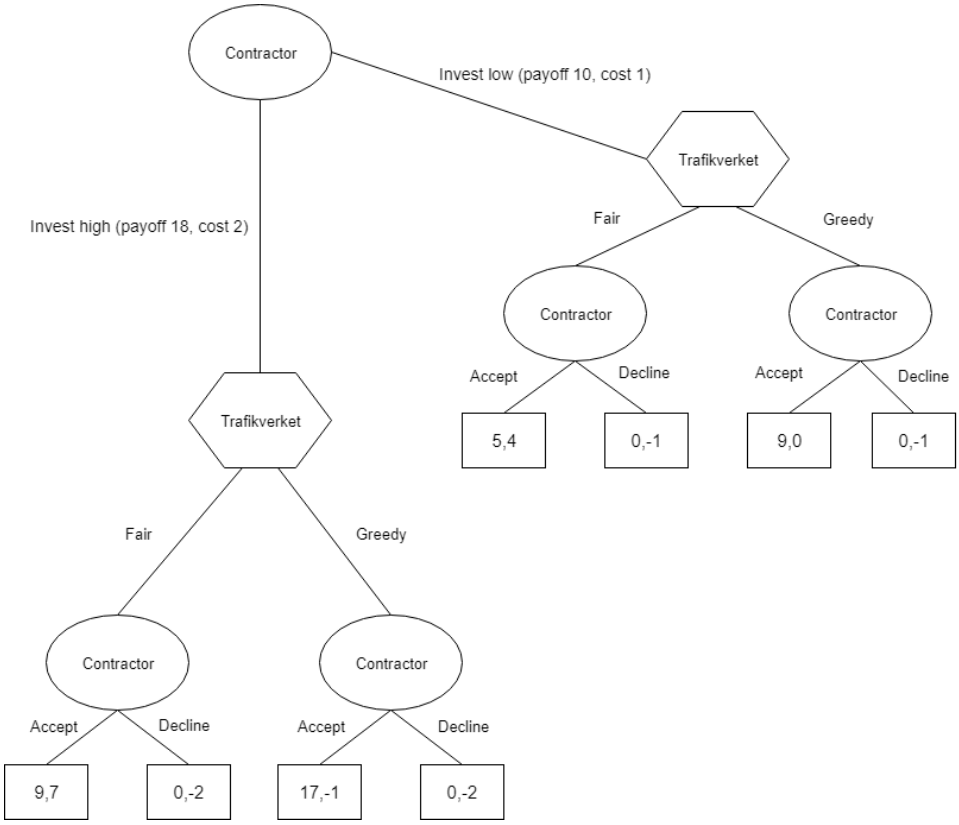

Figure 12 Stackelberg method example

In this example the contractor makes the first move by either invest high (e.g., a piece of specific railroad machinery) or invest low (e.g., education to a selected few in the company), the total payoff for the investments are eighteen and ten respectively. The payoff can either be divided greedy or fair, where it is Trafikverket that holds power to the decision, and the contractor can choose to accept or decline the offer. The problem is solved by backward induction where first it is necessary to look at the payoff for the contractor after each of Trafikverkets decisions whether they want to be greedy or fair. Both players would like to maximize their payoff from the game. First, the payoff for the contractor under high investment and the fair decision is

analyzed, this gives the highest payoff seven by accepting the offer from Trafikverket. For the greedy option, the contractor would also choose to accept the offer because the loss is less by accepting than by declining. When investing low and if Trafikverket gives a fair offer, the contractor will accept with a payoff of four. By an unfair offer, the contractor would also here accept the offer for the same reason as under high investment. Based on this example Trafikverket would always provide the contractor with an unfair offer because the contractor will always accept because they want to reduce their losses.

The example also shows that Trafikverket can give incentives to the contractor for a high investment by promising a fair division of the payoff. This would give Trafikverket the same payoff as if the contractor would invest low, but the contractor would earn a much bigger payoff. Important to understand that the numbers are fictitious and hence this example is only valid for these numbers. However, in general, the highest payoff is what guides the players during a Stackelberg method when they are making a decision.

The strategy occurring between the contractor companies and Trafikverket today, does not foster collaboration. If two players were to possibly meet to collaborate at a later stage (which is likely in the collaborative partnership between Trafikverket and the contractor companies), Osborne [66] stated that the best strategy for the first player was always to collaborate. The answers were provided by computer simulations and said that if the first player always started with collaboration and had a strategy that was based on “mimicking” the other player's choices. Meaning that if the other player collaborated the first player would collaborate, but at once the second player did not collaborate the first player should also not collaborate. The strategy could be something for both Trafikverket and the contractor companies to bring with them in their partnerships. It seems today that they have gotten into a spiral of not trusting and not collaborating optimum. By following Osborne's example, one of the players should put aside the difference and start collaborating, and hope that the second player follows. This is also mentioned in the theory chapter under the section “Communication”, where Moorman et al. [48] said that if earlier communication has been truthful, or in this case collaborative, then there is a higher likelihood of trust in the future.

5.5 Lean Perspective

The use of Lean in maintenance operations on the railway is not common in the two Scandinavian countries Norway and Sweden. Lean requires a significant change in contemporary organizational style and management. Therefore, it requires a lot of effort from the governmental agencies as well as the contractor companies. BaneNor said that the use of Lean in their maintenance projects is something they cannot force upon the contractors, but something they must take the initiative to use themselves. This corresponds with the answers given by the project managers where none forced Lean or other practices on the contractors. It can be discussed whether this is something the railway industry should emphasis and have incentives in the contracts to facilitate more use of the practice, due to the many beneficial outcomes.

It is evident from the interviews that neither Trafikverket nor the contractor companies fully know what Lean is, and therefore not able to fully implement the practice. Even though the theory discourages the implementation of 5S before the Lean practice is fully introduced some site managers have done just that. This can reduce the success of implementing Lean practices in the future, because the workers have not gotten the correct "Lean-mindset". This is one indication of the lack of knowledge from the contractors, regarding Lean practices. Another indication was the statement regarding that Lean is not possible to implement in maintenance operations as well as not possible to use outside production. Davies [116] writes in his report that the use of Lean during maintenance needs more development, which could be a possible reason why it is not used more in railway industry. As written above, Lean practice needs a lot of facilitating from both Trafikverket and internally in the contractor companies to thrive. High age and attitudes like "we have always done it this way" can be barriers for the use and knowledge of Lean practices. One way to change the mindset and implement changes within the companies is to hire new and younger personnel.

Besides 5S, the most widespread principle used in the contractor companies is the regular meeting schedule between the site manager and project manager which can be compared to Last Planner. Technical meetings once a week where common topics of interests are; production plan, remarks, solutions and suggestions for improvements. The meetings focus on how to execute the tasks optimum within the provided time period. Once a month, more significant operations and the plans are controlled as well as changes to the project are discussed. This follows the typical build-up of the Last Planner, where more significant operations are planned

over a more extended period, and the final and more detailed planning is performed closer to the execution of the activities.

BAP and BUP is another use of the Last Planner in Trafikverket. BAP is the plan with few details and specifications, and BUP is the more detailed plan closer to the execution of the work. LPS and the planning in Trafikvverket could be more similar by introducing a shorter weekly period where applications for work could be conducted. This could probably be the ad-hoc applications, but these are currently reserved for critical maintenance. The late locking should not only be used when planning the projects, but also when planning the time of the maintenance windows. This would mean that the contractor can do the necessary maintenance at best suited times. This time could be when there is available capacity or when the circumstances for the contractors are optimum. The contractor would here be involved in the planning at an earlier stage than today. This would mean that there could be added more maintenance windows to each track every year, and give Trafikverket a chance to catch up with the backlog of maintenance which has accumulated through the years [129].

Another important success factor when implementing Lean is to have the support of the top management in the contractor company, as well as the support from the collaborating project manager. This is especially important now when Lean is such a new tool in the railway industry and where few have ever used the practice. Another important factor is to have a strong site manager with previous experience from Lean practices. The site manager must stand tall when challenged by both managers and workers at the contractor company. Changing the current mindset to a Lean mindset is one of the bigger challenges. Changes in the daily routine for the average worker disturbs the “status quo” and where doing things “the way it always has been done” is not possible, which can cause irritation. This has caused the workers to struggle during the restructuring process and in some cases to work against the site manager. Several maintenance operations can be standardized to reduce different wastes. However, it is more important to fully implement the Lean principles and mindset before focusing on single tasks.

Lean has 25 characteristics provided by Bicheno in his literature [109]. Implementing some of these characteristics could be beneficial for both Trafikverket and the contractor companies:

- Knowledge
    - Build and distribute the knowledge between every participant.
- Participation
    - “True participation means full information sharing”

- Prevention
    - Should try to prevent issues, and not fix them after a problem has occurred.
- Improvement
    - Always strive to improve
- Partnerships
    - Should try to cooperate both internally and externally. Seek a win-win situation
- Value networks
    - Companies should not compete, only supply chains
- Trust
    - Trust can remove a lot of the bureaucracy and wasted time both internally and externally. Building trust also provides the confidence to invest and share knowledge.

5.6 Time on the Tracks

The most significant problem for the contractors is to get enough time on the tracks to be able to perform the necessary maintenance activities. A reoccurring problem is that they are given less time on the tracks than what was first applied for during the BAP-planning period. There is a conflict of interest, the BUP planners want to have as many trains on the tracks as possible, which brings income to Trafikverket. At the same time, the contractors also want to have as much time as possible on the tracks to perform their maintenance activities. Not being able to perform the necessary work deteriorates the track at a faster rate, and the maintenance lag grows. One method for finding the root cause of a problem is asking "why" five times, see Figure 13. Using this method, the author found that one of the main reasons for the suffering condition of the Swedish railway is due to the planning and prioritizing between maintenance and train passages. One site manager said that there is no formal education of the BUP planners, and research of the documents online as well as a request sent to Trafikverket by email, support this statement. This is curious due to the importance and impacts the BUP planners have on the priority of track time in the Swedish railway. The lack of education enables each BUP planner to plan differently, facilitating a more random and chaotic planning phase for everyone involved. By giving the BUP-planners a proper, formal and standard education could standardize the BUP-planning. This can provide the contractors with more time on the tracks to perform maintenance work, which can increase the condition of the Swedish railway.

Being a BUP planner is probably one of the most challenging positions within Trafikverket because of the extreme amount of daily consideration that must be made. This might be why Trafikverket is currently developing a new software system (MPK) which will make the process of planning and distribution of times on the tracks, more transparent. The project managers work in the contractor's best interest when communicating with the planners and try to get at much time as possible on the tracks. From the interviews it seems as this is when the site manager and the project managers are most collaborative.

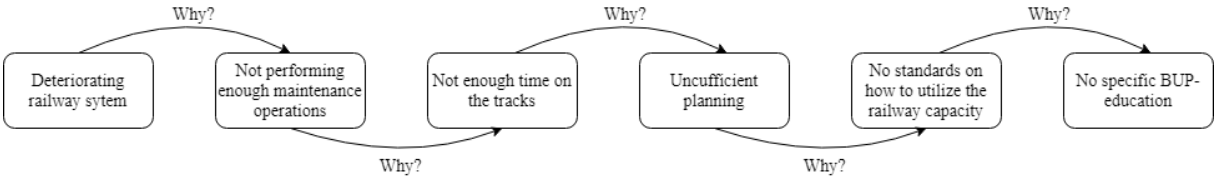

Figure 13 The five why`s

There are three main maintenance activities which all compete for as much time as possible on the railway tracks; investment projects, maintenance projects and the train companies with their trains. Both the maintenance projects and the investment projects cost Trafikverket money, while the train companies provide an income. Some of the investment projects can be performed outside of the tracks, and therefore does not necessarily have to affect the train traffic. However, the maintenance projects are often performed on the tracks and hence, affect the train traffic.

The document study shows that 75% of the basic maintenance in Trafikverket is preventive [135]. On the contrary, the interviews showed that both the site and project managers had no time to perform preventive maintenance because they do not have enough time on the tracks. The author has not found any recent statistics regarding the amount of preventive maintenance work performed today. Over a longer period, the inability to perform preventive maintenance does not benefit the railway system in Sweden, and the system will continue to deteriorate. Once every year the contractor is given a period specially reserved to perform preventive maintenance. This period can reach from two to seven hours, which the contractors say is not nearly enough. Compared to Norway the period to perform preventive maintenance is two consecutive days without traffic on the tracks.

According to the document study the BUP-plans from the contractors should be locked minimum four weeks before the start of the maintenance work. However, the interviews show that some contractors have a shorter period before locking their plans before the work (between zero to three weeks before the start of the work). This statement can build up under one of the project managers statement that some of the site managers do not plan their work very well. In addition, it takes time from when the contractor applies for times on the tracks, to when they know if the time is approved by the BUP-planner or not. This means that they can apply for a specific time four week before the work is to start, but they could get a confirmation as short as one week before work start. This makes it more challenging for the contractor to plan their work and resources needed for specific tasks.

On the other hand, most of the contractors locked their plans between three and twelve weeks before the work, which is consistent with the theory. Another factor is the areas of operation in which the different contracts are valid. The geographical areas are very large, giving Trafikverket a hard time to monitor and perform inspections, forcing them to use an ABT06 contract. If the geographical areas had been smaller, it would be possible to implement more AB04 contracts.

The bureaucracy within Trafikverket is an issue that causes a large amount of paperwork for the contractors. One example: the contractor work on a railroad where they are going to change a railroad switch. The track is closed, and all applications are approved. At the workplace the contractor sees that the railroad switch next to it is also in bad shape and should be changed. However, this is not possible due to the contractual stated rules which requires the contractors to apply at least four weeks before such work. The work could have been completed at the same time to save a lot of money for the contractor as well as work for Trafikverket, who must manage the applications. From the interview with BaneNor it seems as the bureaucracy is less evident, and the processes of applying for time on the tracks is easier. The contractors in Norway must apply for time on the tracks one to two week before the start of the work, however this could be a result of the higher capacity on the railway in Norway.

A method that could save a lot of work and reduce the number of applications could be to have a direct communication channel between the contractors and the BUP-planners. This enables a more efficient process where the contractors could get answers to their questions immediately and gain access to the tracks through ad-hoc applications. The cost for Trafikverket would increase with this method because more BUP-planners would have to be available to answer the different contractors.

Based on the literature review and interviews there are multiple reasons for the restricted time to perform maintenance on the tracks:

- The railway system in Sweden struggles with 30 years of maintenance lag [172], making it immensely difficult for the contractor to catch up. It is also stated in their contract that they should maintain the function of the railway, not improve it [124].
- It is too easy for the train companies to cancel their travels, and because the contractor must apply such a long time in advance, it is not possible to take advantage of these unused times for maintenance. Based on the report of Stenberg [129], 38% of all freight trains were canceled in 2017, which could have provided much needed available times for maintenance.
- The BUP-planners have no specific education and there is no consensus of how the planning should be performed.
- The site managers are bad planners and the BUP-planners think they put in too much slack in their plans [124]. This could be a contributing factor to that they get less time than what they apply.

Chapter 6 Conclusion

The Swedish railway system is extremely complex with many contributing factors to the current issues. Communication and collaboration have been the focus of this thesis to enlighten possible solutions to some of the occurring problems in the Swedish railway. It has focused on how contracts affect the communication as well as other factors contributing positively and negatively to the maintenance processes. In the following section follows some concluding remarks, the scientific questions are answered, and some suggestions for further work are presented.

Concluding remarks

Gaining as much knowledge as possible regarding the railway system in Sweden is critical in order to maintain the railway system. There are three ways to gain the knowledge; using software systems, more extended contracts or by using more AB04 contracts. The software systems would ensure the knowledge to be kept within Trafikverket, the challenge is to collect the information and store it in a way that makes it easily accessible and usable. Longer contracts ensure the same contractor working on the same stretch of railway over a more extended period. The contractor would have total control and knowledge over the specific stretch of railway. The challenge is that Trafikverket does not possess the knowledge, and if the contractor terminates the contract, the knowledge would be lost. Having more ABT04 contracts Trafikverket is more included in the maintenance operations, performing their own inspections which increase their knowledge.

AB04 foster better collaboration and reduces the number of conflicts occurring between the contractor and Trafikverket. The contract type facilitates less discussion regarding the scope as well as the terms within the contract, this is also the preferred contract type by the contractors. Incentives can be important to steer the contractors in the desired direction. However, it is crucial to not only focus on punishing the contractors when making mistakes, but also reward the contractors when acting in the desired way. This can be fostered through the measurements used in the PMS, where activities that improve the future outcome can provide a bigger positive reward for the contractors. The best strategy for both players is always to collaborate, this

facilitates the best project outcome. Should emphasis strategies which facilitate win-win situations for both Trafikverket and the contractor companies.

The biggest challenge for the railway system is gaining access to the railway. There is no time to perform preventive maintenance and the railway deteriorates. One of the main issues can be the lack of education of the BUP-planners, and that there is no consensus on how the planning should be performed.

What are the strengths and weaknesses during the collaboration in maintenance operations between the project manager in Trafikverket and the site manager of the contractor company?

One of the strengths in the collaboration between the site manager and the project manager is their availability. If something comes up, the other manager is only one phone call away, and good communication facilitates rapid problem-solving. They have regular meetings to discuss problems and solutions for future tasks. The project manager and site managers have a good relationship with their collaborative partner, which ensures a successful project implementation. Moreover, openness and honesty in the feedback is a strength that improves the collaboration.

The biggest challenge during the collaboration is the contract types and the length of the contract. The collaboration between the site manager and the project managers is affected by the contract types chosen in the maintenance projects, where an AB04 contract fosters a closer collaboration. Many of the project managers prefer the contract type ABT06, however it is the contractor company that executes the work and are the ones that should be comfortable with how the project is governed.

AB04 contract enables a better collaboration between the partners where the contractors are more pleased with their working conditions. In turn this enables the contractor to: earn more money, increase their efficiency as well as use less resources to look for loopholes in the contracts, the overall quality of the work on the railway tracks can over time be improved. In addition, Trafikverket gains more knowledge of the railway's conditions because they are more part of the inspections and daily operations, which reduces the loss of knowledge. The knowledge gained enables better planning and has possibility to move resources where needed.

The second challenge is the contract length which creates a lot of uncertainty for the contractor companies. Increasing the length of the contracts would provide the contractor with more

security. This also gives them the incentive to work within a longer time perspective and invest in more resources. This would also reduce the loss of knowledge and improve the working condition for the contractors and possibly have a positive impact on the railway system.

Do contracts affect how communication within a maintenance project is performed?

When considering just the contracts and what each type of contract demand from the participants, there is a difference in the communication.

In an AB04, Trafikverket is responsible for inspections and to specify and order the work that needs to be performed by the contractor. This requires more frequent meetings between the different participants in the projects, such as maintenance engineers and project engineers who perform the inspections together with the contractor. In addition, there is more often meetings regarding how to solve issues on the railway in an AB04 contract.

In an ABT06 contract the participants have regular meetings, and some participants only communicate if there is a deviation from the plan, or if something occurs which affects the plan. In theory, the contractor would not have to communicate at all with Trafikverket because the work that should be conducted is contractually stated and planned at the beginning of the year.

The frequency and amount of communication between the project manager and the site manager are high in both types of contracts. There is some intimation that the more experienced project managers have less contact with the contractor compared to the project managers with less experience.

The last and most important thing is that the amount of communication often reflects the relationship between the site manager and the project manager. A good relationship implies a more frequent communication, and bad relationship less communication.

How is the coordination between Trafikverket and the contractor when planning maintenance operations?

In an AB04 contract, Trafikverket inspects the railway before ordering specific maintenance tasks from the contractor. The contractor then applies for times on the tracks to perform these tasks. In such a contract the coordination between Trafikverket and the contractor company is excellent. There are regular meetings and close collaboration between the participants.

In an ABT06 contract the activities for the whole year is planned and discussed. The contractor is then responsible for applying for time on the track to perform the work independently. There are regular meetings where discussions regarding challenges and changes to the planned work are discussed in addition to economic questions.

In both contract types the contractor is responsible for applying for the times on the tracks to perform the maintenance. The project manager from Trafikverket works in the contractors' best interest and try to argue to the BAP planners why they need the specific time on the tracks.

The work must be planned and the times they want to work on the tracks need to be applied at a minimum four weeks before the start of the work. In practice it is possible for the contractor to apply for the times on the tracks shorter than four weeks before the start.

What are the challenges when introducing new processes that could help the efficiency of the maintenance operations?

The biggest challenge is to change the mindset of the personnel working in the railway industry for decades. To start the implementation process it is essential to use a site manager with the right amount of experiences who have the ability to stand tall when being questioned. Also, the changes must be desired by the contractor to increase the chance of success. Another critical factor that can affect the outcome of implementing new processes is to be given the necessary time and budget to be able to fulfill the implementation, including the top management approval and understanding.

Suggestions for further work

During the work with the thesis some topics of interest emerged. A dilemma for Trafikverket is to balance the cost of monitoring the contractor with the incentives given to the contractor. To analyze and find the amount of monitoring needed for Trafikverket to have enough control over the railway system, and balance this with the incentive to the contractor could be of interest.

Furthermore, to look closer into the BUP-planning period to investigate why there is a difference between the "theoretical time" the contractor should apply for BUP-times, and the actual time they apply for the times. This in combination with projects that have implemented

maintenance windows to see if the maintenance windows affect how the contractors work, could be an interesting topic.

It would also be interesting to investigate whether Trafikverket had ever wanted to change the contractor company before the five-year period was finished, and to know the reason if it has ever happened. This could give an estimate if there ever has been a need to change and hence contribute to the discussion in whether the contracts should be prolonged.

The use of Lean during railway maintenance operations is an interesting topic with a lot of possible upsides. A case study of the contractor company implementing Lean, the project positives and negatives, and future development would be interesting.

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Appendix A – Generic email sent to the project managers

Hej xxxx,

Jag håller på med et examensjobb för det norska universitetet NTNU och av den anledning skulle jag vilja komma i kontakt med projektledare från Trafikverket. Efter en anmodan hos Trafikverket fick jag din mailadress från xxxx.

Mitt arbete går ut på att undersöka om olika kontrakt har betydelse för hur kommunikationen äger rum mellan projektledare och entreprenörer i underhållsprojekt.

Är det här nåt du kan vara intresserat av at hjälpa mig med att upplysa?

Jag ser för mig en intervju antingen via telefon, Skype eller mail, det som passar bäst för dig. Intervjun tar ungefär en halvtimme.

Hoppas på et positivt svar

Hälsningar

Robin Stenberg

Appendix B – Generic email sent to the site managers

Hej xxxx,

Jag håller på med et examensjobb för det norska universitetet NTNU och av den anledning skulle jag vilja komma i kontakt med platschefer från entreprenörer som jobbar med underhållsarbete för Trafikverket.

Mitt arbete går ut på att undersöka om olika kontrakt har betydelse för hur kommunikationen äger rum mellan projektledare och entreprenörer.

Xxxx har gått med på at hjälpa mig med mitt arbete, och därför skulle jag gärna också intervjua dig.

Är det här nåt du kan vara intresserat av at hjälpa mig med att upplysa?

Jag ser för mig antingen en intervju via telefon, Skype eller mail, det som passar bäst för dig. Dom förra intervjuerna jag har gjort har inte tagit längre tid än 30 minuter.

Hoppas på et positivt svar

Hälsningar

Robin Stenberg

Appendix C – Interview guide project managers

Introduktion:

Tack så mycket för at du tar dig tid till at hjälpa mig med mitt ex-jobb.

Som jag skrev i mailet så är temat för det här ex-jobbet at dyka ned i hur du och din platschef samarbetar, hur ofta ni kommunicerar och kvalitén på eran kommunikation. Om det är nåt som kan förbättras hoppas jag at den här uppsatsen kan upplysa detta och at det kan leda till en förbättring i framtiden.

Alla namn och personupplysningar blir anonyma i uppsatsen.

Är det nåt du undrar innan jag startar upp med frågorna?

Bakgrundsfrågor:

Hur länge har du jobbat i järnvägsbranschen?

Hur lång erfarenhet har du som projektledare?

Vad är din roll som projektledare?

Vilket projekt jobbar du på nu?

Vilket kontraktstyp är projektet under?

Kommunikation:

Hur ofta har du kontakt med platschefen?

Vilken information från platschefen har störst inverkan på projektet?

Vilken information är det som det blir delad mest av?

Vem av dig och platschefen tar oftast kontakt om et ärende?

Hur tar ni kontakt med varann om et ärende? Vilket medium tar ni i bruk?

Kontrakt:

Har du erfarenhet från båda ABT06- och AB04-kontrakt?

Har du någon preferens över vilken som är bäst? Varför?

Är det någon skillnad mellan hur du kommunicerar med platschefen beroende på kontraktstyp?

Är det någon skillnad mellan hur ofta du kommunicerar med platschefen beroende på kontraktstyp?

Vad tänker du om längden på underhållskontrakten i dag?

Vad gör ni om entreprenören inte följer kontraktet?

Kan du tänka dig nåt typ av underhållsarbete kom kunnat vara under et nationellt kontrakt, men som inte är under det i dag?

Har ni ändringar av kontraktet under projektets gång?

Samverkan:

Hur arbetar ni med samverkan i Trafikverket?

Vad är den största utmaningen under samarbetet med entreprenören?

Utför ni nån typ av prestandamätning av entreprenörerna?

Planering:

Hur planerar ni arbetet på spåren?

Har ni några krav till hur entreprenören gör sitt arbete?

Har ni några krav entreprenören till bruk av verktyg som kan effektivisera arbetet i spåren?

Avslutning:

Kan jag få ta kontakt med din platschef? Kontaktinfo?

Kan jag ta kontakt med dig igen om jag har fler frågor?

Appendix D – Interview guide site managers

Introduktion:
Tack så mycket för at du tar dig tid till at hjälpa mig med mitt ex-jobb.

Som jag skrev i mailet så är temat för det här ex-jobbet at dyka ned i hur du och din projektledare samarbetar, hur ofta ni kommunicerar och kvalitén på eran kommunikation. Om det är nåt som kan förbättras hoppas jag at den här uppsatsen kan upplysa detta och at det kan leda till en förbättring i framtiden.

Alla namn och personupplysningar blir anonyma i uppsatsen.

Är det nåt du undrar innan jag startar upp med frågorna?

Bakgrundsfrågor:

Hur länge har du jobbat i järnvägsbranschen?

Hur lång erfarenhet har du som platschef?

Vad är din roll som platschef?

Vilket projekt jobbar du på nu?

Vilket kontraktstyp är projektet under?

Kommunikation:

Hur ofta har du kontakt med projektledaren?

Vilken information från projektledaren har störst inverkan på projektet?

Vilken information är det som det blir delad mest av?

Vem av dig och projektledaren tar oftast kontakt om et ärende?

Hur tar ni kontakt med varann om et ärende? Vilket medium tar ni i bruk?

Kontrakt:

Har du erfarenhet från båda ABT06- och AB04-kontrakt?

Har du någon preferens över vilken som är bäst? Varför?

Är det någon skillnad mellan hur du kommunicerar med projektledaren beroende på kontraktstyp?

Är det någon skillnad mellan hur ofta du kommunicerar med projektledaren beroende på kontraktstyp?

Vad tänker du om längden på underhållskontrakten i dag?

Kan du tänka dig nåt typ av underhållsarbete kom kunnat vara under et nationellt kontrakt, men som inte är under det i dag?

Kan ni komma med ändringar av kontraktet under projektets gång?

Tycker du at dom viten som Trafikverket ger är berättigat?

Samverkan:

Vad är den största utmaningen under samarbetet med Trafikverket?

Hur är samarbetet med Trafikverket?

Tycker du at dom prestandamätningar som Trafikverket gör av er är berättigat?

Planering:

Hur planerar ni arbetet på spåren?

Hur planerar ni underhållsarbetet upp mot BUP-planen?

Hur lång tid innan arbetet låser ni era planer?

Hur lång tid innan det planerade arbetet i spåren börjar, får ni veta vilka tider ni får?

Tar ni i bruk nån form av verktyg som kan effektivisera arbetet i spåren?

Avslutning:

Kan jag ta kontakt med dig igen om jag har fler frågor?

Appendix E – Definition of PLI

Characterization of how a project is defined as PLI

To be characterized as a “planned-large-investments” one of the following criteria must be fulfilled [125]:

A – Tracks with heavy traffic. Single track with more than 51 trains per day, or double track with more than 76 trains per day.

A1: The work means closing the track for more than three consecutive days (72 hours).

A2: The work causes the track to be closed during the day for more than five days continuously, and at least 30 trains per day are affected.

A3: The work causes the track to use one rail for more than ten days, causing at least 30 trains per days to get affected by a delay of more than 5 minutes per train.

B – Tracks with “medium” traffic. Single track with between 16-50 trains per day, or double track with 16-75 trains per day.

B1: The work causes the closing of the track for more than five consecutive days (120 hours).

B2: The work causes the track to be closed during the day for more than seven days continuously, and at least ten trains get affected.

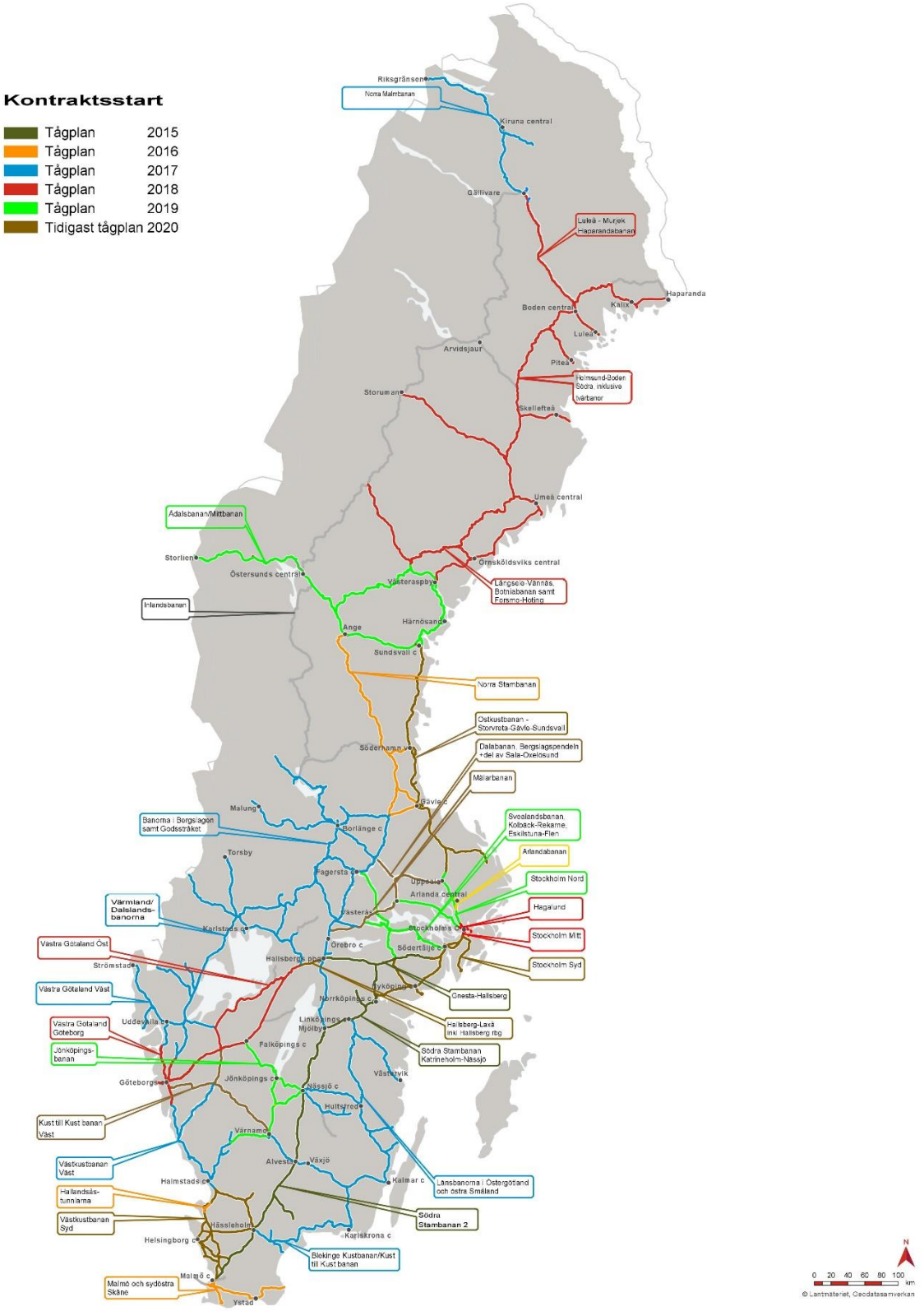
B3: The work causes the track to use one rail for more than 14 days, causing at least 30 trains per days to be affected by a delay of more than 5 minutes per train.

C – Tracks with low traffic. Single track with 0-15 trains per day.

C1: The work causes the track to be closed for more than seven consecutive days (168 hours).

C2: The work causes the track to be closed during the day for more than 14 days continuously, and at least five trains per day are affected.

Appendix F – Maintenance windows



Appendix G – ABT06 contract draft

TRAFIKVERKET

ENTREPRENADKONTRAKT

(kontraktsvillkor)
Totalentreprenad

För utförande av ? inom ? kommun, ? län

Beställare	Entreprenör
Trafikverket	?
Box ?	?
Org.nr: 202100-6297	Org.nr: ?

INNEHÅLLSFÖRTECKNING **SIDA**

EK ENTREPRENADKONTRAKT

Detta kontrakt är upprättat efter upphandling med ärendenummer CTM ?.

Kontraktet grundas på Allmänna Bestämmelser för totalentreprenader avseende byggnads-, anläggnings- och installationsarbeten, ABT 06. Om inte annat följer av kontraktstexten skall ABT 06 gälla mellan parterna.

§ 1 Omfattning

Entreprenören åtar sig att för beställarens räkning på totalentreprenad utföra ? i överensstämmelse med i § 1.1 angivna kontraktshandlingar.

//Entreprenören ska under kontraktstiden uppfylla de egenskaper eller förhållanden som efterfrågats vid anbudsutvärderingen och som där gett anbudet mervärde.//

//Entreprenaden omfattar beläggningsgrupperna: ?//

//Entreprenaden består av följande huvuddelar:

Huvuddel 1: ?
Huvuddel 2: ?, osv.//

//Beställaren har option att tilläggsbeställa nedanstående arbete/n/:

Arbeten på option ska utföras på i kontraktet gällande villkor.

Beställaren ska meddela entreprenören att option utlöses senast ? månader innan //arbetet ska utföras//ordinarie kontraktstid löper ut//.

§ 1.1 Kontraktshandlingar

1 Detta Entreprenadkontrakt. EK, med följande bilagor:
- 1.? //Protokoll från kontraktsgenomgång, dat.?//
- 1.? //Protokoll från anbudsgenomgång, dat. ?//
- 1.? //Betalningsplan dat. ?//

2 Ändringar av fasta bestämmelser i ABT 06 som är upptagna i sammanställning i Administrativa Föreskrifter, AFD.111

3 ABT 06, Allmänna Bestämmelser för totalentreprenader avseende byggnads-, anläggnings- och installationsarbeten

5 Anbud dat. ?
- 5.1 //Anbudskomplettering dat. ?//
- 5.2 //Anbud dat. ?//

6 Förfrågningsunderlag
- 6.1 //Kompletterande föreskrifter för entreprenaden lämnade för anbudets avgivande dat. ?//
- 6.2 //Objektspecifika mät- och ersättningsregler, dat. ?//
- 6.3 //MER Anläggning 17//med de ändringar och tillägg som framgår av handling 6.2 Objektspecifika mät- och ersättningsregler.//

6.4 Administrativa föreskrifter, AF dat. ?
6.4.1 //Kontraktstidplan dat. ?//
6.5 //Ej prissatt/mängdförteckning, MF, //à-prislista// dat. ?//
6.5.1 //À-prislista tekniskt godkänt material som ska prisregleras, dat. ?//
6.6 Beskrivningar
6.6.1 //Teknisk beskrivning dat. ?//
6.6.2 //Beställarens arbetsmiljöplan framtagen av BAS-P dat. ?//
6.6.3 //Objektbeskrivning, beskrivning av befintlig anläggning dat. ?//
6.7 Ritningar
6.7.1 //Ritningar//kartor// enligt förteckning dat. ?////Redogörelse för modell (RFM) + Objektorienterad informationsmodell//

7 Övriga handlingar
7.? TDOK 2018:0015 "Generella trafik- och elsäkerhetskrav för järnväg"
7.? //Grafiska tidtabeller dat. ?//
7.? //Redogörelse för modell (RFM) + Objektorienterad informationsmodell//
7.? //Fastställd Banarbetsplan dat. ?//
7.? //Ställda klimatkrav i projekt större än 50 MSEK Utgångsläge klimatkrav//
7.? //Bilaga Incitament Totalentreprenad//
7.? //Förteckning inventerade bristartiklar//

Med ändring av ABT 06 kap. 1 § 4 gäller följande:

Om i förfrågningsunderlaget förekommer mot varandra stridande uppgifter eller föreskrifter, ska handlingar förtecknade med en decimal (6.1, 6.2, etc.) gälla i den ordning de förtecknats (dvs. uppgift i 6.1 gäller före uppgift i 6.2 osv.), om inte omständigheterna föranleder annat. Om det i en och samma handling, eller i en grupp där ingående handlingar är förtecknade med två eller flera decimaler (exempelvis i 6.1.1 eller 6.1.2, etc.), förekommer mot varandra stridande uppgifter eller föreskrifter, ska den uppgift eller föreskrift gälla som medför lägsta kostnad för entreprenören, om inte omständigheterna föranleder annat.

//Om det i en och samma grupp av handlingar i förfrågningsunderlaget är fråga om motstridigheter mellan uppgifter eller föreskrifter i Objektorienterad informationsmodell och i handling av annat format (t.ex. skriftlig handling), gäller uppgiften eller föreskriften i Objektorienterad informationsmodell, om inte omständigheterna föranleder annat.//

//För innehållet i Teknisk beskrivning ska en särskild rangordningsregel gälla enligt dokumentets punkt 1.4 Kravhierarki.//

§ 2 Utförande

//Svenska språket är //kontraktsspråk//kontrakts- och kommunikationsspråk.////Svenska eller engelska språket är muntligt kommunikationsspråk.// Alla kontraktshandlingar som upprättas ska vara upprättade på svenska.//

//Arbetena ska genomföras i samverkan för ökad effektivitet enligt Trafikverkets modell för samverkan beskriven i AFD.2 i Administrativa föreskrifter.//

//Entreprenören ska uppfylla kraven på säkerhetsstyrning i TSFS 2015:34 "Transportstyrelsens föreskrifter om säkerhetsstyrningssystem och övriga säkerhetsbestämmelser för infrastrukturförvaltare med säkerhetstillstånd samt järnvägsföretag med säkerhetsintyg", antingen genom ett

eget säkerhetsstyrningssystem som ansluter till Trafikverkets, eller genom att inordna verksamheten i Trafikverkets säkerhetsstyrning. Krav avseende säkerhetsstyrningen skall föras vidare till underentreprenörer i alla led.

Om beställarens kontroll visar på allvarlig säkerhetsbrist ska beställaren underrätta entreprenören om detta utan dröjsmål. Efter sådan underrättelse är entreprenören skyldig att avhjälpa säkerhetsbristerna omgående eller inom den tid beställaren anger. Om entreprenören inte avhjälper säkerhetsbristerna inom föreskriven tid eller skriftligen har underrättat att han inte avser att avhjälpa säkerhetsbristerna, får beställaren låta avhjälpa dessa.

Om entreprenören ansvarar för säkerhetsbristerna sker avhjälpandet på hans bekostnad.//

Det får under kontraktstiden inte föreligga sådant förhållande hos entreprenören, som enligt gällande upphandlingslagstiftning innebär en skyldighet eller rättighet för en upphandlande myndighet att utesluta en leverantör från upphandling.

§ 2.1 Utförande med avseende på arbetsmiljö

Entreprenören ska betrakta samtliga i kontraktet ingående arbeten som byggnads- och anläggningsarbeten i Arbetsmiljölagens och Arbetsmiljöverkets föreskrifters mening.

§ 2.2 Förhållningssätt i etiska frågor

Entreprenören ska iaktta Trafikverkets förhållningssätt i etiska frågor, enligt nedan, då arbete utförs på Trafikverkets uppdrag.

Trafikverkets verksamhet finansieras i huvudsak av skattemedel. Vår uppdragsgivare, ytterst det svenska folket, och alla som har kontakt med Trafikverket har höga förväntningar på att vi ska utföra vårt uppdrag på ett objektivt och neutralt sätt.

Trafikverket arbetar systematiskt med att befästa en organisationsmiljö som allmänheten, våra ägare och samarbetsparter kan känna förtroende för. Som medarbetare i Trafikverket ska man följa Trafikverkets uppförandekod och förväntas vi leva upp till högt ställda krav på saklighet och opartiskhet och får aldrig ta hänsyn till ovidkommande önskemål. Det får heller aldrig ens misstänkas att så sker. Mot denna bakgrund och med beaktande av reglerna om mutor ska alla som arbetar för Trafikverket att iaktta detta förhållningssätt och också följa de principer som ligger till grund för Trafikverkets uppförandekod.

§ 3 Organisation

§ 3.1 Beställaren

Ombud är ?
//Projektledare är ?//
//Banförvaltare är ?//
//Innehavare av elanläggning är ?//
//Kopplingsledare är Produktionsplats el //Syd// Nord// //
//Byggledare är ?//
//Byggarbetsmiljösamordnare för projekteringen är ?//
//Byggarbetsmiljösamordnare för utförandet är ?//
//Ansvarig mätningsingenjör ?//
//BIM-ansvarig är: ?//
Ansvarig Inköpare är ?

§ 3.2 Entreprenören

Ombud är ?
Platschef är ?
//Projekteringsledare är ?//

//Miljöansvarig är ?//
//Kvalitetsansvarig är ?//
//Arbetsmiljöansvarig är?//
//Byggarbetsmiljösamordnare för utförandet, BAS-U, är ?//
//Byggarbetsmiljösamordnare för planering och projektering i utförandeskedet, BAS-P, är ?//
//Trafiksäkerhetsansvarig är ?//
//Ansvarig för signalprojektering?//
//Signalteknisk granskningsledare ?//
//Signalteknisk ibruktagandeledare är ?//
//Assessor för signal är ?//
//Eldriftledare är ?//
//Elsäkerhetsledare är ?//
//Kopplingsledare är ?//
//Auktoriserad elinstallatör för regelefterlevnad är ?//
//Innehavare av elanläggningen är ?//
//Tillståndsansvarig heta arbeten ?//
//Ansvarig mätningsingenjör ?//
//Ansvarig geotekniker är ?//
//Gestaltningsansvarig är ?//
//Samordningsansvarig konsult är ?//
//BIM-ansvarig är ?//

Entreprenörens övriga organisation framgår av organisationsplan med därtill hörande adress- och distributionslista som ska uppdateras och distribueras till berörda vid förändring.

Personer namngivna i kontraktet får inte ersättas utan beställarens skriftliga medgivande.

§ 3.3 Överlåtelse av kontrakt

Entreprenören får inte överlåta kontraktet eller delar av kontraktet på någon annan utan beställarens skriftliga medgivande.

§ 4 Tider

§ 4.1 Kontraktstid

Kontraktstiden börjar den dag då kontraktet träder i kraft och löper till den färdigställandetid som anges i § 4.5.

//Beställaren har som option möjlighet att med befintliga kontraktsvillkor förlänga kontraktstiden med ytterligare ?.//

§ 4.5 Färdigställandetider

//Kontraktsarbetena i deras helhet ska vara färdigställda och tillgängliga för slutbesiktning //senast ?//senast ? sista kontraktsåret//.

//Kontraktsarbetenas huvuddelar ska vara färdigställda och tillgängliga för slutbesiktning senast ? vid följande tidpunkter: ?.//

//Kontraktsarbetena ska vara färdigställda ? och anmälda till avlämnandebesiktning senast ?.//

§ 5 Ansvar och avhjälpande

§ 5.1 Vite

Nedan angivna viten ska betalas var för sig och oberoende av varandra.

§ 5.11 Vite vid försening

För varje påbörjad vecka varmed entreprenören överskrider kontraktstiden eller den ändrade tid för färdigställandet som ska gälla enligt ABT 06 kap. 4 § 2 eller 3, ska entreprenören betala vite med //belopp motsvarande //0,5//?//procent av kontraktssumman //? SEK//.

//För varje påbörjad vecka varmed entreprenören överskrider färdigställandetiden för huvuddel ska entreprenören betala vite enligt nedan,

- för huvuddel 1 med ? SEK
- huvuddel 2 med ? SEK
- huvuddel ? med ? SEK

Vid försening av huvuddel beräknas vitet enbart på belopp för aktuell huvuddel.//

//För varje påbörjad vecka varmed entreprenören överskrider deltid ska entreprenören betala vite enligt nedan,

- för deltid enligt AFD.44? med ? SEK
- för deltid enligt AFD.44? med ? SEK

//

//För varje påbörjad vecka varmed entreprenören överskrider deltid som avser läggning av anslutande allmänna och enskilda vägar och andra sidoytor respektive läggning av stödremsa, ska vite betalas med //?//15 000// SEK.

Vitets totala storlek enligt denna paragraf maximeras till ? procent av kontraktssumman.

§ 5.18 Övriga viten

Med ändring av och tillägg till ABT 06 kap 5 § 11 ska entreprenören betala övriga viten enligt nedan.

Beställaren har rätt att utöver vitet kräva annat skadestånd och annan påföljd enligt ABT 06 kap. 5 för överträdelsen. Vitena ska inte heller ingå i den ansvarsbegränsning som följer av ABT 06 kap 5 § 11.

§ 5.181 Vite vid överlast

Om det framkommer att viktbestämmelser överskridits vid transport, på väg eller gata, ska entreprenören betala vite med 500 SEK per påbörjat ton, om tillåten last överskrids med mer än 0,5 ton. Se även AFD.1891.

§ 5.182 Vite avseende bristande mervärdesegenskaper

//Om entreprenören inte //utan dröjsmål efter skriftlig anmodan//uppfyller de utfästelser som avgetts i anbudet och som gett mervärde i anbudsutvärderingen ska entreprenören betala vite med en summa som motsvarar dubbla erhållna mervärdet. Vitet ska betalas en gång för varje påbörjad tolvmånadersperiod kontraktet varar, till dess mervärdesegenskaperna är uppfyllda.//

§ 5.183 Vite avseende tillhandahållande av handlingar och uppgifter från entreprenören under entreprenadtiden

//Om entreprenören inte anmält uppstart av etablering eller avetablering enligt TDOK 2017:0612 ”Rapportering av underlag för trafikinformation”, ska vite betalas med 5 000 SEK för varje försenad eller utebliven anmälan.//

//Om entreprenören trots anmodan inte levererar //handlingar//? //till beställaren enligt AFD//.242//.38// ska vite betalas med //5 000//?// SEK vid varje enskild försening och påbörjad vecka.//

§ 5.184 Vite avseende brister i arbetsmiljö och säkerhet

Om entreprenören inte följer kraven i handlingarna för arbetsmiljö och säkerhet ska vite betalas i enlighet med TDOK 2017:0571 "Vitesmodell kopplat till Arbetsmiljö och Säkerhet".

§ 5.185 Vite vid skada på vegetation

Om entreprenören orsakar skada på i AFG.313 specificerad vegetation ska vite betalas med ? SEK för skada som äventyrar vegetationens fortlevnad. //Detta vite maximeras till //? SEK//? procent av kontraktssumman//.

§ 5.186 Vite vid hinder av spårtrafik

//Om entreprenören orsakar tågförsening, t.ex. genom att operativt beviljad banarbetstid överskrids eller på grund av arbetenas utförande, ska vite//för de första fem timmarna//utgå med 15 000 SEK för varje påbörjad tiominutersperiod per tåg.

Försening för respektive tåg beräknas som tiden mellan tidtabellsenlig passage förbi platsen för hindret och tidpunkten när hindret är undanröjt.

Detta vite kan maximalt uppgå till //? SEK//? procent av kontraktssumman//årligen till 10 % av kontraktets årliga värde//.//

§ 5.187 Vite vid överträdelse av antidiskrimineringslagstiftning

Om entreprenören inte inom föreskriven tid lämnar information i enlighet med kraven avseende antidiskriminering eller om entreprenören vid utförandet av kontraktet inte uppfyllt sina skyldigheter avseende aktiva åtgärder enligt AFD.3492, ska entreprenören betala vite till beställaren om //5 000//10 000// SEK per vecka för varje vecka som påbörjas från det att sju dagar förflutit sedan entreprenören mottog beställarens underrättelse angående detta avtalsbrott till dess rättelse påvisats för beställaren.

Om entreprenören eller anställd som entreprenören svarar för, vid utförandet av kontraktet, enligt lagakraftvunnen dom brutit mot förbud mot diskriminering enligt diskrimineringslagen ska entreprenören betala vite till beställaren för varje överträdelse med //50 000//100 000// SEK.

§ 5.188 Vite avseende sysselsättningskrav

Entreprenören ska iaktta de närmare föreskrifter som framgår av TDOK 2017:0444 "Sysselsättningsskapande krav och åtgärder".

Om entreprenören inte visar att denne uppfyller krav på sysselsättning enligt AFD.346 ska entreprenören betala vite. Vitet uppgår till 240 000 SEK per anställning och 60 000 SEK per praktikplats som entreprenören underskrider ställda krav.

Vitet för delvis uppfyllt krav ska jämkas till den del som plats varit fylld enligt AFD.346.

§ 5.189 Vite avseende klimatkrav

//Om entreprenören inte uppfyller ställda klimatkrav avseende klimatreduktion enligt vad som framgår i de administrativa föreskrifterna, AFG. 36 Reducerad klimatpåverkan och energianvändning, ska vite betalas med 0,1 procent av kontraktssumman för varje procentenhets sämre prestation jämfört med reduktionskravet. Detta vite maximeras till 1 procent av kontraktssumman.//

//Om entreprenören inte uppfyller ställda klimatkrav enligt vad som framgår av de administrativa föreskrifterna, AFG. 36 Reducerad klimatpåverkan och energianvändning, ska vite betalas med 0,5 procent av kontraktssumman, dock maximalt 100 000 SEK, när något av ställda krav på material och varor eller drivmedel inte uppfylls.//

§ 5.4 Ansvar vid samverkan

Ansvarsreglerna i enlighet med ABT 06 gäller oinskränkta och fullt ut även vid entreprenader med samverkan.

§ 6 Ekonomi

§ 6.1 Kontraktssumma

Kontraktssumman är ? SEK //utan//med// indexreglering.

//Kontraktssumman fördelas på entreprenadens huvuddelar enligt följande: ?.

- huvuddel 1 ? SEK
- huvuddel 2 ? SEK
- huvuddel 3 ? SEK

//

//Option avseende ? ersätts med ? SEK //med//utan// indexreglering.//

Kursändring mellan svensk och utländsk valuta regleras inte. Tullar, importavgifter och varuskatter ingår i förekommande fall i kontraktssumman.

//Kontraktssumman består av en riktkostnad kopplad till ett incitament.

Riktkostnad kan endast justeras genom av beställaren godkända ändringar och tillägg (ÄTA-arbeten) /och i de fall begränsningsregeln enligt nedan överskrids/.

Riktkostnaden korrigeras enligt nedan// under förutsättning att gränsen i begränsningsregeln överskrids//:

Tillkommande arbeten riktkostnad justeras uppåt(+)

Avgående arbeten riktkostnad justeras nedåt (-)//

//Begränsningsregel

Riktkostnad justeras när enskild ändring överskrider ? procent av kontraktssumman eller när summan av flera ändringar överskrider ? procent av densamma. Korrigering av riktkostnad sker inte vid ändringar som underskrider ovanstående värden.//

//Incitamentsberäkning – slutkostnad

Avstämning och reglering av redovisad självkostnad i förhållande till riktkostnaden ska ske// ? gånger per år//efter avslutad entreprenad //.

Om slutkostnaden överstiger korrigerad riktkostnad ska entreprenören svara för ? procent av överskridandet och beställaren för ? procent av detsamma.

Om slutkostnaden understiger korrigerad riktkostnad erhåller entreprenören av beställaren ? procent av skillnaden mellan korrigerad riktkostnad och slutkostnad.

Option avseende ?//ersätts med ? SEK//med ersättning enligt självkostnadsprincipen//.//

§ 6.13 Övriga särskilda regleringar

§ 6.131 Beläggning

//Beläggningsarbeten regleras enligt TDOK 2014:0565 "Trafikverkets regler för reglering av beläggningsarbeten".//

§ 6.132 Bonus för sysselsättning

//Entreprenören ska iaktta de närmare föreskrifter som framgår av TDOK 2017:0444 "Sysselsättningsskapande krav och åtgärder".

Beställaren ger inom ramen för genomförandet av detta kontrakt möjlighet till bonus för sysselsättningsskapande åtgärder.

Beställaren ska betala bonus om entreprenören i kontraktet sysselsätter personer ur målgruppen genom praktik eller anställning, för det maximala antal platser som tabellen nedan anger.

//Bonus betalas för platser utöver krav i AFD.346.

Typ av plats	Maximalt antal platser inom kontraktet för vilken bonus kan ges	Bonus per plats
Praktik	? st.	60 000 SEK
Anställning	? st.	240 000 SEK

//För det fall kontraktets option//er// utlöses ska, utöver vad som anges ovan, det maximala antalet platser vara det som tabellen nedan anger.

	Antal praktikplatser inom kontraktet	Antal anställningar inom kontraktet
Option 1	? st.	? st.
Option 2	? st.	? st.
Option 3	? st.	? st.

//
//

§ 6.133 Bonus för reduktion av klimatpåverkan

//Bonus betalas linjärt för varje hel procentenhet upp till och med 10 procentenheter som entreprenören reducerar klimatpåverkan med i förhållande till ställt reduktionskrav i procentenheter enligt AFG.36.

Den maximala bonusen som kan betalas är fastställt till ? SEK.

Betalning av bonus sker efter redovisning och granskning av efterfrågade handlingar i samband med entreprenadens färdigställande.//

§ 6.134 Incitamentsreglering vid leveransbedömning

//En incitamentsmodell är kopplad till leveransbedömningen i detta projekt. Incitamentsmodellen beskrivs närmare i handling 7.? "Bilaga Incitament Totalentreprenad"

Reglering av incitament avseende leveransbedömning sker efter leveransens slutliga bedömning fastställts.

I rubricerat projekt är maximalt incitamentsbelopp fastställt till: ? SEK.//

//En incitamentsmodell är kopplad till leveransbedömningen i detta projekt. Incitamentsmodellen beskrivs närmare i handling 7.? "Bilaga Incitament Totalentreprenad"

Nedanstående tabell anger det maximala incitamentsbelopp angivna delleveranser kan erhålla. Reglering av incitament avseende leveransbedömning sker för varje delleverans efter delleveransens slutliga bedömning fastställts.

Delleverans	Maximalt incitamentsbelopp
?	? SEK
?	? SEK
?	? SEK
?	? SEK

//

§ 6.14 Ersättning för kostnadsändring (indexreglering)

//Avtalat pris ska regleras i enlighet med vad som framgår nedan. //Reglering sker för två olika delar, specifik reglering och generell reglering med anbudsmånad som basmånad.// Indextal för reglering finns tillgängliga på Trafikverkets webbplats med undantag av Entreprenadindex.//

//Kontraktspriserna ska vara oförändrade under de två första kontraktsåren. Därefter sker indexreglering av samtliga à-priser för den kommande tolvmånadersperioden och sedan var tolfte månad. Indexreglering sker avseende 75 procent av det ursprungliga à-priset. Som index ska Konsumentprisindex med konstant skatt (KPI-KS) användas.

Basmånad ska vara ? år ?.

Reglerat á-pris gäller från ? år ?

Följande formel ska tillämpas:

$S = 0{,}75*(i_r - i_b)/i_b$
$P_1 = P_0 * (1+S)$

S = Förändringskoefficient med vilken à- priserna regleras för den kommande tolvmånadersperiod
P_1=Reglerat à-pris för den kommande tolvmånadersperioden
P_0=A-pris (enligt ursprungligt kontrakt)
0,75 = Reglering avseende 75 procent av det ursprungliga à-priset
i_b = Indextal KPI-KS för basmånad
i_r = Indextal KPI-KS för den månad som föregår den tolvmånadersperiod för vilket reglerat à-pris ska gälla
//

§ 6.141 Specifik reglering

//Specifik reglering sker för utvalda resursgrupper. Reglering ska ske mot verkligt inarbetad mängd eller om sådan mätning inte är rimlig, mot den andel av kontraktssumman som resursgruppen anses utgöra. Reglering ska ske under hela kontraktstiden i efterskott när utförandemånadens indextal är kända.//

Specifik reglering resursgrupp tekniskt godkänt material

Ersättning för kostnadsförändring för tekniskt godkänt material som entreprenören köper av Materialservice utgörs av skillnaden mellan gällande materialpris för basmånad och pris enligt faktura för levererat material. Entreprenören äger ej rätt till särskild ersättning utöver den verifierade ändringen av materialpriset.

Förteckning och prislista över de artiklar som ska kostnadsregleras framgår av handling ?.

Basmånad ska vara ? år ?.

Följande formel ska tillämpas:

$K_6 = V_6 - V_b$

K_6= Regleringsbelopp för tekniskt godkänt material
V_6= Materialpris enligt faktura för levererat material
V_b= Materialpris enligt förteckning över artiklar som ska kostnadsregleras, handling ?

§ 6.1411 Specifik reglering resursgrupp bitumen

//Kostnadsreglering ska ske baserat på verkligt upparbetad mängd enligt TDOK 2014:0565, avsnitt 1.3 samt 1.3.2 för massabeläggning och avsnitt 1.4 samt 1.4.2 för tankbeläggning. Reglering ska ske under hela kontraktstiden i efterskott när upparbetad mängd bitumen är verifierad och Regleringspris (P) per ton bitumen är känt för aktuell utförandemånad. Reglering ska ske med reglering för pris per ton bitumen. Vid bitumenemulsioner regleras andelen bitumen på likartat sätt.

Tabell med Regleringspris (P) för kostnadsreglering av bitumen återfinns på Trafikverkets webbplats, sökord ”Kostnadsreglering”.

Basmånad ska vara ? år ?.

Följande formel ska tillämpas.

$K_1 = M_b*(P_u - P_b)$

K_1 = Regleringsbelopp för bitumen
M_b = Upparbetad mängd bitumen under utförandemånaden.
P_b = Regleringspris (P) för basmånad
P_u = Regleringspris (P) för utförandemånad

Tabeller för kostnadsreglering och index, se Trafikverkets webbplats, sökord ”Kostnadsreglering”.//

§ 6.142 Generell reglering

De priser som inte regleras specifikt ska vara fasta under de första 24 månaderna efteranbudsmånad. För dessa priser sker därefter indexreglering avseende 75 procent av fakturerat belopp. Som index ska Konsumentprisindex med konstant skatt (KPI-KS) användas.

Basmånad ska vara ? år ?.

Första gången reglering sker är ? år ?

Följande formel ska tillämpas:

$K_{gr} = 0{,}75 * (V - V_1 - V_2 - V_3 - .... - V_n) * (i_u - i_b) / i_b$

K_{gr} = Regleringsbelopp för generell reglering
V = Fakturerat belopp för utförandemånaden
V_n = Fakturerat belopp under utförandemånaden för respektive resursgrupp som reglerats specifikt
0,75 = Reglering avser 75% av fakturerat belopp
i_b = Indextal KPI-KS för basmånad
i_u = Indextal KPI-KS för utförandemånaden
n = olika resursgrupper.

§ 6.15 Löpande räkning enligt självkostnadsprincipen

I de fall //ÄTA-arbeten ska ersättas//ersättning ska utges// enligt självkostnadsprincipen (löpande räkning) gäller det som anges i denna bestämmelse.

//Kostnader för arbetsledning enligt ABT 06 kap. 6 § 9 pkt 2, ersätts med 9 procent av summan av kostnaderna enligt punkterna 1,3 och 4 samt med 4 procent av kostnader enligt pkt 5//

Entreprenörarvodets storlek enligt ABT 06 kap. 6 § 9 ska vara 12 procent av kostnader enligt punkterna 1-4 och 6-7. På kostnader enligt pkt 5 ska entreprenörarvodet vara 5 procent.

Av entreprenören inhyrda maskiner med förare utgör hjälpmedel enligt pkt 4.

Av entreprenören inhyrd arbetare ersätts enligt pkt 3.

Ersättning för handverktyg och mindre redskap betalas inte.

//På material och varor som tillhandahålls av beställaren för leverans från Trafikverket Materialservice enligt AFD.1522 betalas ersättning enligt följande: Kostnad för arbetsledning enligt ABT 06 kap. 6 § 9 punkt 2 ska vara 5 procent av kostnaden enligt kap. 6 § 9 punkt 1. Entreprenörarvodets storlek enligt ABT 06 kap 6 § 9 ska vara 5 procent av kostnaden enligt punkt 1.//

//På material och varor som tillhandahålls av beställaren //från näraliggande depå// enligt AFD.1522 äger entreprenören med ändring av ABT 06 kap 6 § 9 inte rätt till entreprenörsarvode eller annan ersättning.//

§ 6.2 Betalning

Betalning erläggs //enligt uppmätning// efter av beställaren godkänd värdering av utfört kontraktsarbete.

//Godkännande av mätsedel innebär inte att beställaren är hindrad från att erhålla återbetalning av erlagd betalning efter konstaterad felaktig uppmätning.//

//Betalning erläggs:

- för ? efter betalningsplan enligt § 6.22
- för övriga arbeten enligt uppmätning//
- //Betalning erläggs inte förrän handlingar enligt § ? har överlämnats.

//

Beställaren har rätt att av de sista fakturorna under entreprenadtiden innehålla sammanlagt 5 procent av kontraktssumman som säkerhet för framtida avhjälpande av fel.

§ 6.21 Betalningsansvar

Kostnaden för tekniskt godkänt material som entreprenören beställer via avtal som Trafikverket anvisar enligt AFD.1521 ingår i kontraktssumman och betalas av entreprenören mot faktura från Trafikverket Materialservice enligt TDOK 2012:195 "Leveransförutsättningar beställning av tekniskt godkänt material".

//Beställd bearbetning av räler enligt AFD.1521 tillhandahålls utan kostnad för entreprenören.//

Tekniskt godkänt material som Trafikverket tillhandahåller enligt AFD.1522 tillhandahålls utan kostnad för entreprenören.

§ 6.22 Betalningsplan

//Entreprenören ska upprätta en betalningsplan med tydligt avgränsade poster med belopp, där värdet av posterna ska representera utfört arbete.//

//Betalningsplanens poster ska uppta belopp för färdigställda permanenta konstruktionsdelar.//

//Betalningsplanen ska upprättas i beställarens tillhandahållna mall för betalningsplaner med tillhörande fördelning enligt kalkylblock.//

//Betalningsplanen ska uppta belopp för innestående medel.//

//Betalningsplanen ska även redovisa betalningsposter kopplade till leverans av slutdokumentation enligt leveransposter i tidplanen.//

//Betalningsplanen ska godkännas av beställaren.//

//Betalningsplan för //OR-mängder//?// ska upprättas av entreprenören i samråd med beställaren.//

§ 6.23 Förskott

//Förskott beviljas med ? SEK, och betalas ut efter erhållande av säkerhet. Säkerheten ska utfärdas i digital form. Kopia av säkerheten ska biläggas förskottsfakturan. Förskottsbeloppet ska amorteras proportionerligt i takt med upparbetningen.//

//Förskott beviljas inte.//

//Förskott beviljas inte på optioner.//

§ 6.24 Fakturering

Fakturering får ske högst en gång per månad efter det att uppmätning av utförda arbeten och värdering godkänts och verifikaten gällande fakturerat kontraktsarbete presenterats för beställaren och godkänts.

Separata fakturor ska upprättas för ÄTA-arbeten.

//Av beställaren upprättat fakturaunderlag i form av mätsedelsverifikat ska bifogas fakturan.//

//Slutfakturering får ske när entreprenaden har godkänts och redovisande dokument enligt AFD.2493 har överlämnats till beställaren.//

//Ersättning för //skötsel av vegetationsytor, se "TB DB33. Vegetation"//?// under garantitiden ska inte ingå i betalningsplanen för entreprenaden i övrigt. Särskild betalningsplan ska upprättas för detta arbete, av vilken framgår att ersättning betalas //månadsvis//en gång per år.// //

Beloppen ska redovisas dels för aktuell månad och dels till och med aktuell månad.

//Faktura kan bara märkas med ett inköpsordernummer, samfakturering av olika inköpsordrar får ej ske.//

//Vid indexreglering sker månadsfakturering efter ursprungliga priser. Index faktureras separerat från ordinarie månadsuttag och när indextalet för aktuell månad föreligger.//

//Fakturering av index ska ske//månadsvis//årsvis// ?//.//

Beställaren omfattas, i enlighet med 1 kap. 2 § 4 b pkt Mervärdesskattelagen, av omvänd skattskyldighet vid köp av byggtjänster varför, med ändring av ABT 06 kap. 6 § 8, utgående moms inte ska debiteras vid fakturering av byggtjänster. Felaktigt utbetald ersättning avseende moms ska återbetalas till beställaren.

Faktureringsavgift och expeditionsavgift betalas inte.

Fakturan ska märkas med följande:

//
- Trafikverkets referens: EF ? Namn Namnsson
- Trafikverkets avtalsnummer: 5?

//

//

- Trafikverkets referens: Framgår av inköpsorder
- Trafikverkets avtalsnummer: 5?
- Trafikverkets inköpsordernummer: Framgår av inköpsorder

//

Även följande uppgifter ska framgå av fakturan:

- //Objektsnummer: ?//
- //Trafikverkets projektbeställningsnummer:?//
- //Arbetsordernummer ?//
- Trafikverkets VAT-nummer /momsreg.nr SE202100629701
- entreprenörens VAT-nummer /momsreg.nr
- entreprenörens referensperson
- //utbetalt förskott//
- //innehållet belopp för utbetalt förskott//
- //innehållna medel för arbetets fullgörande//

Om fakturan saknar angiven märkning eller uppgifter kan Trafikverket komma att returnera fakturan för komplettering. En faktura anses inte mottagen av Trafikverket förrän den är korrekt. Betalningspåminnelser ska inte utfärdas och dröjsmålsränta inte utgå i de fall fakturan inte är korrekt utställd.

Fakturering ska ske via e-faktura: GLN-nummer

//för Trafikverket : 7350005120115//
//för Trafikverket Förarprov : 7350005120146//
//för Trafikverket Färjerederiet: 7381010051316//
//för Trafikverket Trafikverksskolan: 7350005120603//
//för Trafikverket Materialservice: 7350005120092//

Om du som leverantör inte redan är ansluten till e-faktura hittar du information om hur du gör på Trafikverkets webbplats, sökord ”Fakturor”.

§ 6.31 Säkerhet till beställaren

//Entreprenören ska ställa säkerhet för förskott. Säkerheten ska utfärdas i digital form. Säkerheten ska gälla till dess förskottet fullt ut är reglerat.

Trafikverket accepterar säkerheter från banker, kreditmarknadsbolag, kreditinstitut och försäkringsbolag som enligt svensk lag har rätt att bedriva verksamhet i Sverige.

Säkerheten skall alltid märkas med kontraktets ärendenummer och skickas direkt från säkerhetens utställare till:

trafikverket@trafikverket.se

eller

Trafikverket
Ärendemottagningen

Box 810
781 28 Borlänge//

§ 8 Hävning

§ 8.1 Beställarens rätt att häva

Med ändring i form av tillägg till ABT 06 kap. 8 § 1 gäller att beställaren har rätt att skriftligen häva kontraktet såvitt avser återstående arbeten om:

- entreprenören inte följer avtalade skyddsföreskrifter, arbetsmiljövillkor och arbetsmiljölagar
- entreprenören i sanningsförsäkran uppsåtligen förtigit lagakraftvunnen dom avseende diskriminering
- entreprenören inte vidtar åtgärder avseende grundläggande rättigheter för arbetstagare inom överenskommen tid
- det under avtalstiden föreligger sådant förhållande hos entreprenören att det enligt gällande upphandlingslagstiftning innebär en skyldighet eller rättighet för Trafikverket att utesluta en leverantör från upphandling. Detta gäller även om sådant förhållande avser underentreprenör som entreprenören anlitat för utförande av kontraktsarbete och entreprenören inte har bytt ut sådan underentreprenör
- entreprenören lämnat osanna uppgifter under anbudstiden om sådana förhållanden som hade kunnat medföra uteslutning från upphandlingen enligt gällande upphandlingslagstiftning.

Med ändring i form av tillägg till ABT 06 kap. 8 § 1 har beställaren utöver möjlighet att häva kontraktet, när sådan rätt föreligger på ovan angivna grunder, rätt att häva kontraktet genom att ange från vilken tidpunkt kontraktet hävs och/eller för vilka delar kontraktet hävs. Beställarens rätt till ersättning för skada och entreprenörens rätt till ersättning för utförd del av entreprenaden motsvarar vad som i övrigt gäller vid hävning.

§ 8.6 Skada

Med tillägg till ABT 06 kap. 8 § 6 gäller bestämmelsen även då kontraktet hävs i enlighet med vad som särskilt anges i EK § 8.1.

§ 8.8 Övertagande

Med tillägg till ABT 06 kap. 8 § 8 gäller bestämmelsen även då kontraktet hävs i enlighet med vad som särskilt anges i EK § 8.1.

§ 9 Tvistelösning

Med ändring av ABT 06 kap. 9 § 1 ska tvist på grund av kontraktet avgöras av svensk allmän domstol.

Svensk rätt gäller för kontraktet.

§ 10.1 Överlämnande av handlingar

Entreprenören ska senast ? veckor efter kontraktstecknandet eller innan arbetena påbörjas till beställaren överlämna:

- //handlingar enligt ?//
- //produktionstidplan//
- //tidplan för kontroll av handlingar//

§ 10.4 Kontraktets giltighet

Kontraktet träder i kraft då båda parter har undertecknat kontraktet.

Kontraktets ikraftträdande förutsätter dock att beställaren har lämnat upplysningar om tilldelningsbeslutet samt att kontraktet får ingås med antagen entreprenör enligt lagen (2016:1146) om upphandling inom områdena försörjningssektorerna (LUF).

Detta kontrakt är upprättat i två likalydande exemplar av vilka parterna tagit varsitt.

Beställare
Trafikverket ?
Datum ?

_____
//Namn, enhet, befattning//

_____
Ansvarig inköpare, //Namn, enhet//

Entreprenör
//Entreprenör//
Datum ?

_____
//Namn, befattning//

Appendix H – AB04 contract draft

TRAFIKVERKET

ENTREPRENADKONTRAKT

(kontraktsvillkor)
Utförandeentreprenad

För utförande av ? inom ? kommun, ? län

Beställare	Entreprenör
Trafikverket	?
Box ?	?
Org.nr: 202100-6297	Org.nr: ?

INNEHÅLLSFÖRTECKNING **SIDA**

EK ENTREPRENADKONTRAKT

Detta kontrakt är upprättat efter upphandling med ärendenummer CTM ?.

Kontraktet grundas på Allmänna Bestämmelser för byggnads-, anläggnings- och installationsentreprenader, AB 04. Om inte annat följer av kontraktstexten skall AB 04 gälla mellan parterna.

§ 1 Omfattning

Entreprenören åtar sig att för beställarens räkning på utförandeentreprenad utföra ? i överensstämmelse med i § 1.1 angivna kontraktshandlingar.

//Entreprenaden omfattar beläggningsgrupperna: ?//

//Entreprenaden består av följande huvuddelar:

Huvuddel 1: ?
Huvuddel 2: ?, osv.//

//Entreprenaden omfattar konstruktions- och bygghandlingar för //byggnadsverk och// ?.//

//Beställaren har option att tilläggsbeställa nedanstående arbete/n/:
?//enligt ?//

Arbeten på option ska utföras på i kontraktet gällande villkor.

//Beställaren ska meddela entreprenören att option utlöses senast ? månader innan //arbetet ska utföras//ordinarie kontraktstid löper ut//.

§ 1.1 Kontraktshandlingar

1 Detta Entreprenadkontrakt. EK, med följande bilagor:
- 1.? //Protokoll från kontraktsgenomgång, dat.?//
- 1.? //Protokoll från anbudsgenomgång, dat. ?//

2 Ändringar av fasta bestämmelser i AB 04 som är upptagna i sammanställning i Administrativa Föreskrifter, AFC.111

3 AB 04, Allmänna Bestämmelser för byggnads-, anläggnings- och installationsentreprenader

5 Anbud dat. ?
- 5.1 //Anbudskomplettering dat. ?//
- 5.2 //Anbud dat. ?//

6 Mät- och ersättningsregler
- 6.1 //Objektspecifika mät- och ersättningsregler, dat. ?//
- 6.2 //MER Anläggning 17//med de ändringar och tillägg som framgår av handling 6.1 Objektspecifika mät- och ersättningsregler.//

7 //Prissatt // Mängdförteckning, MF//, à-prislista// dat. ?//

8 //Kompletterande föreskrifter för entreprenaden lämnade för anbudets avgivande dat. ?//

9 Administrativa föreskrifter, AF dat. ?

10 //Ej prissatt/mängdförteckning, MF, //à-prislista// dat. ?//
10.1 //À-prislista tekniskt godkänt material som ska prisregleras, dat. ?//

11 Beskrivningar
11.1 //Teknisk beskrivning dat. ?//
11.2 //Allmänna tekniska beskrivningar//

12 Ritningar
12.1 //Ritningar//kartor// enligt förteckning dat. ?////Redogörelse för modell (RFM) + Objektorienterad informationsmodell//

13 Övriga handlingar
13.? //Redogörelse för modell (RFM) + Objektorienterad informationsmodell//
13.? //Ställda klimatkrav i projekt större än 50 MSEK Utgångsläge klimatkrav//
13.? //Bilaga Incitament Utförandeentreprenad//

//Med ändring av AB 04 kap. 1 § 4 gäller följande:

//Om det i en och samma grupp av handlingar förekommer mot varandra stridande uppgifter eller föreskrifter i Objektorienterad informationsmodell och information i annat format (t.ex. skriftlig handling), gäller uppgiften eller föreskriften i Objektorienterad informationsmodell, om inte omständigheterna uppenbarligen föranleder annat.//

//För innehållet i Teknisk beskrivning ska en särskild rangordningsregel gälla enligt dokumentets punkt 1.4 Kravhierarki.//
//

§ 2 Utförande

//Svenska språket är //kontraktsspråk//kontrakts- och kommunikationsspråk.////Svenska eller engelska språket är muntligt kommunikationsspråk.// Alla kontraktshandlingar som upprättas ska vara upprättade på svenska.//

//Arbetena ska genomföras i samverkan för ökad effektivitet enligt Trafikverkets modell för samverkan beskriven i AFC.2 i Administrativa föreskrifter.//

Det får under kontraktstiden inte föreligga sådant förhållande hos entreprenören, som enligt gällande upphandlingslagstiftning innebär en skyldighet eller rättighet för en upphandlande myndighet att utesluta en leverantör från upphandling.

§ 2.1 Utförande med avseende på arbetsmiljö

Entreprenören ska betrakta samtliga i kontraktet ingående arbeten som byggnads- och anläggningsarbeten i Arbetsmiljölagens och Arbetsmiljöverkets föreskrifters mening.

§ 2.2 Förhållningssätt i etiska frågor

Entreprenören ska iaktta Trafikverkets förhållningssätt i etiska frågor, enligt nedan, då arbete utförs på Trafikverkets uppdrag.

Trafikverkets verksamhet finansieras i huvudsak av skattemedel. Vår uppdragsgivare, ytterst det svenska folket, och alla som har kontakt med Trafikverket har höga förväntningar på att vi ska utföra vårt uppdrag på ett objektivt och neutralt sätt.

Trafikverket arbetar systematiskt med att befästa en organisationsmiljö som allmänheten, våra ägare och samarbetsparter kan känna förtroende för. Som medarbetare i Trafikverket ska man följa Trafikverkets uppförandekod och förväntas vi leva upp till högt ställda krav på saklighet och opartiskhet och får aldrig ta hänsyn till ovidkommande önskemål. Det får heller aldrig ens misstänkas att så sker. Mot denna bakgrund och med beaktande av reglerna om mutor ska alla som arbetar för Trafikverket att iaktta detta förhållningssätt och också följa de principer som ligger till grund för Trafikverkets uppförandekod.

§ 3 Organisation

§ 3.1 Beställaren

Ombud är ?
//Projektledare är ?//
//Banförvaltare är ?//
//Innehavare av elanläggning är ?//
//Kopplingsledare är Produktionsplats el //Syd// Nord// //
//Byggledare är ?//
//Byggarbetsmiljösamordnare för projekteringen är ?//
//Byggarbetsmiljösamordnare för utförandet är ?//
//Ansvarig mätningsingenjör ?//
//BIM-ansvarig är: ?//
Ansvarig Inköpare är ?

§ 3.2 Entreprenören

Ombud är ?
Platschef är ?
//Projekteringsledare är ?//
//Miljöansvarig är ?//
//Kvalitetsansvarig är ?//
//Arbetsmiljöansvarig är?//
//Byggarbetsmiljösamordnare för utförandet, BAS-U, är ?//
//Byggarbetsmiljösamordnare för planering och projektering i utförandeskedet, BAS-P, är ?//
//Trafiksäkerhetsansvarig är ?//
//Ansvarig för signalprojektering?//
//Signalteknisk granskningsledare ?//
//Signalteknisk ibruktagandeledare är ?//
//Assessor för signal är ?//
//Eldriftledare är ?//
//Elsäkerhetsledare är ?//
//Kopplingsledare är ?//
//Auktoriserad elinstallatör för regelefterlevnad är ?//
//Innehavare av elanläggningen är ?//
//Tillståndsansvarig heta arbeten ?//
//Ansvarig mätningsingenjör ?//
//Ansvarig geotekniker är ?//
//Gestaltningsansvarig är ?//
//Samordningsansvarig konsult är ?//

//BIM-ansvarig är ?//

Entreprenörens övriga organisation framgår av organisationsplan med därtill hörande adress- och distributionslista som ska uppdateras och distribueras till berörda vid förändring.

Personer namngivna i kontraktet får inte ersättas utan beställarens skriftliga medgivande.

§ 3.3 Överlåtelse av kontrakt

Entreprenören får inte överlåta kontraktet eller delar av kontraktet på någon annan utan beställarens skriftliga medgivande.

§ 4 Tider

§ 4.1 Kontraktstid

Kontraktstiden börjar den dag då kontraktet träder i kraft och löper till den färdigställandetid som anges i § 4.5.

//Beställaren har som option möjlighet att med befintliga kontraktsvillkor förlänga kontraktstiden med ytterligare ?.//

§ 4.5 Färdigställandetider

//Kontraktsarbetena i deras helhet ska vara färdigställda och tillgängliga för slutbesiktning //senast ?//senast ? sista kontraktsåret//.

//Kontraktsarbetenas huvuddelar ska vara färdigställda och tillgängliga för slutbesiktning senast ? vid följande tidpunkter: ?.//

//Kontraktsarbetena ska vara färdigställda ? och anmälda till avlämnandebesiktning senast ?.//

§ 5 Ansvar och avhjälpande

§ 5.1 Vite

Nedan angivna viten ska betalas var för sig och oberoende av varandra.

§ 5.11 Vite vid försening

För varje påbörjad vecka varmed entreprenören överskrider kontraktstiden eller den ändrade tid för färdigställandet som ska gälla enligt AB 04 kap. 4 § 2 eller 3, ska entreprenören betala vite med //belopp motsvarande //0,5//?//procent av kontraktssumman //? SEK//.

//För varje påbörjad vecka varmed entreprenören överskrider färdigställandetiden för huvuddel ska entreprenören betala vite enligt nedan,

- för huvuddel 1 med ? SEK
- huvuddel 2 med ? SEK
- huvuddel ? med ? SEK

Vid försening av huvuddel beräknas vitet enbart på belopp för aktuell huvuddel.//

//För varje påbörjad vecka varmed entreprenören överskrider deltid ska entreprenören betala vite enligt nedan,

- för deltid enligt AFC.44? med ? SEK

– för deltid enligt AFC.44? med ? SEK

//

//För varje påbörjad vecka varmed entreprenören överskrider deltid som avser läggning av anslutande allmänna och enskilda vägar och andra sidoytor respektive läggning av stödremsa, ska vite betalas med //?//15 000// SEK.

Vitets totala storlek enligt denna paragraf maximeras till ? procent av kontraktssumman.

§ 5.18 Övriga viten

Med ändring av och tillägg till AB 04 kap 5 § 11 ska entreprenören betala övriga viten enligt nedan.

Beställaren har rätt att utöver vitet kräva annat skadestånd och annan påföljd enligt AB 04 kap. 5 för överträdelsen. Vitena ska inte heller ingå i den ansvarsbegränsning som följer av AB 04 kap 5 § 11.

§ 5.181 Vite vid överlast

Om det framkommer att viktbestämmelser överskridits vid transport, på väg eller gata, ska entreprenören betala vite med 500 SEK per påbörjat ton, om tillåten last överskrids med mer än 0,5 ton. Se även AFC.1891.

§ 5.182 Vite avseende bristande mervärdesegenskaper

//Om entreprenören inte //utan dröjsmål efter skriftlig anmodan//uppfyller de utfästelser som avgetts i anbudet och som gett mervärde i anbudsutvärderingen ska entreprenören betala vite med en summa som motsvarar dubbla erhållna mervärdet. Vitet ska betalas en gång för varje påbörjad tolvmånadersperiod kontraktet varar, till dess mervärdesegenskaperna är uppfyllda.//

§ 5.183 Vite avseende tillhandahållande av handlingar och uppgifter från entreprenören under entreprenadtiden

//Om entreprenören inte anmält uppstart av etablering eller avetablering enligt TDOK 2017:0612 ”Rapportering av underlag för trafikinformation”, ska vite betalas med 5 000 SEK för varje försenad eller utebliven anmälan.//

//Om entreprenören trots anmodan inte levererar //handlingar//? //till beställaren enligt AFC//.242//.38// ska vite betalas med //5 000//?// SEK vid varje enskild försening och påbörjad vecka.//

§ 5.184 Vite avseende brister i arbetsmiljö och säkerhet

Om entreprenören inte följer kraven i handlingarna för arbetsmiljö och säkerhet ska vite betalas i enlighet med TDOK 2017:0571 ”Vitesmodell kopplat till Arbetsmiljö och Säkerhet”.

§ 5.185 Vite vid skada på vegetation

Om entreprenören orsakar skada på i AFG.313 specificerad vegetation ska vite betalas med ? SEK för skada som äventyrar vegetationens fortlevnad. //Detta vite maximeras till //? SEK//? procent av kontraktssumman//.

§ 5.186 Vite vid hinder av spårtrafik

//Om entreprenören orsakar tågförsening, t.ex. genom att operativt beviljad banarbetstid överskrids eller på grund av arbetenas utförande, ska vite//för de första fem timmarna//utgå med 15 000 SEK för varje påbörjad tiominutersperiod per tåg.

Försening för respektive tåg beräknas som tiden mellan tidtabellsenlig passage förbi platsen för hindret och tidpunkten när hindret är undanröjt.

Detta vite kan maximalt uppgå till //? SEK//? procent av kontraktssumman//årligen till 10 % av kontraktets årliga värde//.//

§ 5.187 Vite vid överträdelse av antidiskrimineringslagstiftning

Om entreprenören inte inom föreskriven tid lämnar information i enlighet med kraven avseende antidiskriminering eller om entreprenören vid utförandet av kontraktet inte uppfyllt sina skyldigheter avseende aktiva åtgärder enligt AFC.3492, ska entreprenören betala vite till beställaren om //5 000//10 000// SEK per vecka för varje vecka som påbörjas från det att sju dagar förflutit sedan entreprenören mottog beställarens underrättelse angående detta avtalsbrott till dess rättelse påvisats för beställaren.

Om entreprenören eller anställd som entreprenören svarar för, vid utförandet av kontraktet, enligt lagakraftvunnen dom brutit mot förbud mot diskriminering enligt diskrimineringslagen ska entreprenören betala vite till beställaren för varje överträdelse med //50 000//100 000// SEK.

§ 5.188 Vite avseende sysselsättningskrav

Entreprenören ska iaktta de närmare föreskrifter som framgår av TDOK 2017:0444 ”Sysselsättningsskapande krav och åtgärder”.

Om entreprenören inte visar att denne uppfyller krav på sysselsättning enligt AFC.346 ska entreprenören betala vite. Vitet uppgår till 240 000 SEK per anställning och 60 000 SEK per praktikplats som entreprenören underskrider ställda krav.

Vitet för delvis uppfyllt krav ska jämkas till den del som plats varit fylld enligt AFC.346.

§ 5.189 Vite avseende klimatkrav

//Om entreprenören inte uppfyller ställda klimatkrav avseende klimatreduktion enligt vad som framgår i de administrativa föreskrifterna, AFG. 36 Reducerad klimatpåverkan och energianvändning, ska vite betalas med 0,1 procent av kontraktssumman för varje procentenhets sämre prestation jämfört med reduktionskravet. Detta vite maximeras till 1 procent av kontraktssumman.//

//Om entreprenören inte uppfyller ställda klimatkrav enligt vad som framgår av de administrativa föreskrifterna, AFG. 36 Reducerad klimatpåverkan och energianvändning, ska vite betalas med 0,5 procent av kontraktssumman, dock maximalt 100 000 SEK, när något av ställda krav på material och varor eller drivmedel inte uppfylls.//

§ 5.3 Väghyra för åtgärder under garantitiden

//Med ändring av AB 04 kap 5 § 19 gäller följande.

Om entreprenören måste ta vägen i anspråk för avhjälpande av fel under garantitiden ska väghyra betalas till beställaren.

Entreprenören ska betala väghyra enligt tabellen nedan, per felavhjälpningstillfälle och per körriktning och vägavsnitt. Väghyran betalas med följande belopp per påbörjad timme.

	Vardag 06-21	Vardag, natt 21-06	Lör-, sön-, o helgdag 09-21	Lör-, sön-, o helgdag, natt 21-09
1 av 1 eller 2 av 2 körfält, första 2 timmarna	?	?	?	?
1 av 1 eller 2 av 2 körfält, efter 2 timmar	?	?	?	?
1 av 2 körfält, första 2 timmarna	?	?	?	?
1 av 2 körfält, efter 2 timmar	?	?	?	?

//

§ 5.4 Ansvar vid samverkan

Ansvarsreglerna i enlighet med AB 04 gäller oinskränkta och fullt ut även vid entreprenader med samverkan.

§ 6 Ekonomi

§ 6.1 Kontraktssumma

Kontraktssumman är ? SEK //utan//med// indexreglering.

//Kontraktssumman fördelas på entreprenadens huvuddelar enligt följande: ?.

- huvuddel 1 ? SEK
- huvuddel 2 ? SEK
- huvuddel 3 ? SEK

//

//Option avseende ? ersätts med ? SEK //med//utan// indexreglering.//

Kursändring mellan svensk och utländsk valuta regleras inte. Tullar, importavgifter och varuskatter ingår i förekommande fall i kontraktssumman.

//Kontraktssumman består av en riktkostnad kopplad till ett incitament.

Riktkostnad kan endast justeras genom av beställaren godkända ändringar och tillägg (ÄTA-arbeten) /och i de fall begränsningsregeln enligt nedan överskrids/.

Riktkostnaden korrigeras enligt nedan// under förutsättning att gränsen i begränsningsregeln överskrids//:

Tillkommande arbeten riktkostnad justeras uppåt(+)

Avgående arbeten riktkostnad justeras nedåt (-)//

//Begränsningsregel

Riktkostnad justeras när enskild ändring överskrider ? procent av kontraktssumman eller när summan av flera ändringar överskrider ? procent av densamma. Korrigering av riktkostnad sker inte vid ändringar som underskrider ovanstående värden.//

//Incitamentsberäkning – slutkostnad

Avstämning och reglering av redovisad självkostnad i förhållande till riktkostnaden ska ske// ? gånger per år//efter avslutad entreprenad //.

Om slutkostnaden överstiger korrigerad riktkostnad ska entreprenören svara för ? procent av överskridandet och beställaren för ? procent av detsamma.

Om slutkostnaden understiger korrigerad riktkostnad erhåller entreprenören av beställaren ? procent av skillnaden mellan korrigerad riktkostnad och slutkostnad.

Option avseende ?//ersätts med ? SEK//med ersättning enligt självkostnadsprincipen//.//

§ 6.12 Ändringar av eller tillägg till reglerna i MER

//Ändringar av eller tillägg till reglerna i MER Anläggning 17 är följande:?//framgår av handling 6.1, Objektspecifika mät- och ersättningsregler//.

§ 6.13 Övriga särskilda regleringar

§ 6.131 Beläggning

//Beläggningsarbeten regleras enligt TDOK 2014:0565 "Trafikverkets regler för reglering av beläggningsarbeten".//

§ 6.132 Bonus för sysselsättning

//Entreprenören ska iaktta de närmare föreskrifter som framgår av TDOK 2017:0444 ”Sysselsättningsskapande krav och åtgärder”.

Beställaren ger inom ramen för genomförandet av detta kontrakt möjlighet till bonus för sysselsättningsskapande åtgärder.

Beställaren ska betala bonus om entreprenören i kontraktet sysselsätter personer ur målgruppen genom praktik eller anställning, för det maximala antal platser som tabellen nedan anger.

//Bonus betalas för platser utöver krav i AFC.346.

Typ av plats	Maximalt antal platser inom kontraktet för vilken bonus kan ges	Bonus per plats
Praktik	? st.	60 000 SEK
Anställning	? st.	240 000 SEK

//För det fall kontraktets option//er// utlöses ska, utöver vad som anges ovan, det maximala antalet platser vara det som tabellen nedan anger.

	Antal praktikplatser inom kontraktet	Antal anställningar inom kontraktet
Option 1	? st.	? st.
Option 2	? st.	? st.
Option 3	? st.	? st.

//
//

§ 6.133 Bonus för reduktion av klimatpåverkan

//Bonus betalas linjärt för varje hel procentenhet upp till och med 10 procentenheter som entreprenören reducerar klimatpåverkan med i förhållande till ställt reduktionskrav i procentenheter enligt AFG.36.

Den maximala bonusen som kan betalas är fastställt till ? SEK.

Betalning av bonus sker efter redovisning och granskning av efterfrågade handlingar i samband med entreprenadens färdigställande.//

§ 6.134 Incitamentsreglering vid leveransuppföljning

//En incitamentsmodell är kopplad till leveransbedömningen i detta projekt. Incitamentsmodellen beskrivs närmare i handling 13.? ”Bilaga Incitament Utförandeentreprenad”

Reglering av incitament avseende leveransbedömning sker efter leveransens slutliga bedömning fastställts.

I rubricerat projekt är maximalt incitamentsbelopp fastställt till: ? SEK.//

//En incitamentsmodell är kopplad till leveransbedömningen i detta projekt. Incitamentsmodellen beskrivs närmare i handling 13.? ”Bilaga Incitament Utförandeentreprenad”

Nedanstående tabell anger det maximala incitamentsbelopp angivna delleveranser kan erhålla. Reglering av incitament avseende leveransbedömning sker för varje delleverans efter delleveransens slutliga bedömning fastställts.

Delleverans	Maximalt incitamentsbelopp
?	? SEK
?	? SEK
?	? SEK
?	? SEK

//

§ 6.14 Ersättning för kostnadsändring (indexreglering)

//Avtalat pris ska regleras i enlighet med vad som framgår nedan. //Reglering sker för två olika delar, specifik reglering och generell reglering med anbudsmånad som basmånad.// Indextal för reglering finns tillgängliga på Trafikverkets webbplats med undantag av Entreprenadindex.//

//Kontraktspriserna ska vara oförändrade under de två första kontraktsåren. Därefter sker indexreglering av samtliga à-priser för den kommande tolvmånadersperioden och sedan var tolfte

månad. Indexreglering sker avseende 75 procent av det ursprungliga à-priset. Som index ska Konsumentprisindex med konstant skatt (KPI-KS) användas.

Basmånad ska vara ? år ?.

Reglerat á-pris gäller från ? år ?

Följande formel ska tillämpas:

$S= 0{,}75*(i_r-i_b)/i_b$
$P_1 = P_o * (1+S)$

S = Förändringskoefficient med vilken à- priserna regleras för den kommande tolvmånadersperiod
P_1=Reglerat à-pris för den kommande tolvmånadersperioden
P_0=A-pris (enligt ursprungligt kontrakt)
0,75 = Reglering avseende 75 procent av det ursprungliga à-priset
i_b = Indextal KPI-KS för basmånad
i_r = Indextal KPI-KS för den månad som föregår den tolvmånadersperiod för vilket reglerat à-pris ska gälla
//

§ 6.141 Specifik reglering

//Specifik reglering sker för utvalda resursgrupper. Reglering ska ske mot verkligt inarbetad mängd eller om sådan mätning inte är rimlig, mot den andel av kontraktssumman som resursgruppen anses utgöra. Reglering ska ske under hela kontraktstiden i efterskott när utförandemånadens indextal är kända.//

§ 6.1411 Specifik reglering resursgrupp bitumen

//Kostnadsreglering ska ske baserat på verkligt upparbetad mängd enligt TDOK 2014:0565, avsnitt 1.3 samt 1.3.2 för massabeläggning och avsnitt 1.4 samt 1.4.2 för tankbeläggning. Reglering ska ske under hela kontraktstiden i efterskott när upparbetad mängd bitumen är verifierad och Regleringspris (P) per ton bitumen är känt för aktuell utförandemånad. Reglering ska ske med reglering för pris per ton bitumen. Vid bitumenemulsioner regleras andelen bitumen på likartat sätt.

Tabell med Regleringspris (P) för kostnadsreglering av bitumen återfinns på Trafikverkets webbplats, sökord "Kostnadsreglering".

Basmånad ska vara ? år ?.

Följande formel ska tillämpas.

$K_1 = M_b*(P_u - P_b)$

K_1 = Regleringsbelopp för bitumen
M_b = Upparbetad mängd bitumen under utförandemånaden.
P_b = Regleringspris (P) för basmånad
P_u = Regleringspris (P) för utförandemånad

Mängdreglering
Utöver kostnadsreglering enligt ovan ska även mängdreglering ske enligt TDOK 2014:0565, avsnitt 1.1.1. Vid reglering enligt publikationens avsnitt 1.3.1 samt 1.4.1 ska grundpriset beräknas.

Grundpriset utgörs av Regleringspris (P) per ton bitumen inklusive aktuella tilläggspriser per ton bitumen enligt tabell nedan:

Bitumentyp	Tilläggs-pris per ton
50/70	850 SEK
70/100	800 SEK
100/150	800 SEK
160/220	800 SEK
330/430	850 SEK
Viskositets-/Mjukbitumen (MB), alla sorter	1550 SEK
Polymerbitumen (PMB), alla sorter	2500 SEK

Vid bitumenemulsioner skall tilläggspriset sättas till det ingående basbitumenets tilläggspris.//

§ 6.142 Generell reglering

De priser som inte regleras specifikt ska vara fasta under de första 24 månaderna efteranbudsmånad. För dessa priser sker därefter indexreglering avseende 75 procent av fakturerat belopp. Som index ska Konsumentprisindex med konstant skatt (KPI-KS) användas.

Basmånad ska vara ? år ?.

Första gången reglering sker är ? år ?

Följande formel ska tillämpas:

$K_{gr} = 0{,}75 * (V - V_1 - V_2 - V_3 - .... - V_n) * (i_u - i_b) / i_b$

K_{gr} = Regleringsbelopp för generell reglering
V = Fakturerat belopp för utförandemånaden
V_n = Fakturerat belopp under utförandemånaden för respektive resursgrupp som reglerats specifikt
0,75 = Reglering avser 75% av fakturerat belopp
i_b = Indextal KPI-KS för basmånad
i_u = Indextal KPI-KS för utförandemånaden
n = olika resursgrupper.

§ 6.15 Löpande räkning enligt självkostnadsprincipen

I de fall //ÄTA-arbeten ska ersättas//ersättning ska utges// enligt självkostnadsprincipen (löpande räkning) gäller det som anges i denna bestämmelse.

//Kostnader för arbetsledning enligt AB 04 kap. 6 § 9 pkt 2, ersätts med 9 procent av summan av kostnaderna enligt punkterna 1,3 och 4 samt med 4 procent av kostnader enligt pkt 5//

Entreprenörarvodets storlek enligt AB 04 kap. 6 § 9 ska vara 12 procent av kostnader enligt punkterna 1-4 och 6-7. På kostnader enligt pkt 5 ska entreprenörarvodet vara 5 procent.

Av entreprenören inhyrda maskiner med förare utgör hjälpmedel enligt pkt 4.

Av entreprenören inhyrd arbetare ersätts enligt pkt 3.

Ersättning för handverktyg och mindre redskap betalas inte.

//På material och varor som tillhandahålls av beställaren för leverans från Trafikverket Materialservice enligt AFC.1522 betalas ersättning enligt följande: Kostnad för arbetsledning enligt AB 04 kap. 6 § 9 punkt 2 ska vara 5 procent av kostnaden enligt kap. 6 § 9 punkt 1. Entreprenörarvodets storlek enligt AB 04 kap 6 § 9 ska vara 5 procent av kostnaden enligt punkt 1.//

//På material och varor som tillhandahålls av beställaren //från näraliggande depå// enligt AFC.1522 äger entreprenören med ändring av AB 04 kap 6 § 9 inte rätt till entreprenörsarvode eller annan ersättning.//

§ 6.2 Betalning

Betalning erläggs //enligt uppmätning// efter av beställaren godkänd värdering av utfört kontraktsarbete.

//Godkännande av mätsedel innebär inte att beställaren är hindrad från att erhålla återbetalning av erlagd betalning efter konstaterad felaktig uppmätning.//

//Betalning erläggs:

- för ? efter betalningsplan enligt § 6.22
- för övriga arbeten enligt uppmätning//
- //Betalning erläggs inte förrän handlingar enligt § ? har överlämnats.

//

Beställaren har rätt att av de sista fakturorna under entreprenadtiden innehålla sammanlagt 5 procent av kontraktssumman som säkerhet för framtida avhjälpande av fel.

§ 6.21 Betalningsansvar

Kostnaden för tekniskt godkänt material som entreprenören beställer via avtal som Trafikverket anvisar enligt AFC.1521 ingår i kontraktssumman och betalas av entreprenören mot faktura från Trafikverket Materialservice enligt TDOK 2012:195 "Leveransförutsättningar beställning av tekniskt godkänt material".

//Beställd bearbetning av räler enligt AFC.1521 tillhandahålls utan kostnad för entreprenören.//

Tekniskt godkänt material som Trafikverket tillhandahåller enligt AFC.1522 tillhandahålls utan kostnad för entreprenören.

§ 6.22 Betalningsplan

//Entreprenören ska upprätta en betalningsplan med tydligt avgränsade poster med belopp, där värdet av posterna ska representera utfört arbete.//

//Betalningsplanens poster ska uppta belopp för färdigställda permanenta konstruktionsdelar.//

//Betalningsplanen ska upprättas i beställarens tillhandahållna mall för betalningsplaner med tillhörande fördelning enligt kalkylblock.//

//Betalningsplanen ska uppta belopp för innestående medel.//

//Betalningsplanen ska även redovisa betalningsposter kopplade till leverans av slutdokumentation enligt leveransposter i tidplanen.//

//Betalningsplanen ska godkännas av beställaren.//

//Betalningsplan för //OR-mängder//?// ska upprättas av entreprenören i samråd med beställaren.//

§ 6.23 Förskott

//Förskott beviljas med ? SEK, och betalas ut efter erhållande av säkerhet. Säkerheten ska utfärdas i digital form. Kopia av säkerheten ska biläggas förskottsfakturan. Förskottsbeloppet ska amorteras proportionerligt i takt med upparbetningen.//

//Förskott beviljas inte.//

//Förskott beviljas inte på optioner.//

§ 6.24 Fakturering

Fakturering får ske högst en gång per månad efter det att uppmätning av utförda arbeten och värdering godkänts och verifikaten gällande fakturerat kontraktsarbete presenterats för beställaren och godkänts.

Separata fakturor ska upprättas för ÄTA-arbeten.

//Av beställaren upprättat fakturaunderlag i form av mätsedelsverifikat ska bifogas fakturan.//

//Slutfakturering får ske när entreprenaden har godkänts och redovisande dokument enligt AFC.2493 har överlämnats till beställaren.//

//Ersättning för //skötsel av vegetationsytor, se "TB DB33. Vegetation"//?// under garantitiden ska inte ingå i betalningsplanen för entreprenaden i övrigt. Särskild betalningsplan ska upprättas för detta arbete, av vilken framgår att ersättning betalas //månadsvis//en gång per år.// //

Beloppen ska redovisas dels för aktuell månad och dels till och med aktuell månad.

//Faktura kan bara märkas med ett inköpsordernummer, samfakturering av olika inköpsordrar får ej ske.//

//Vid indexreglering sker månadsfakturering efter ursprungliga priser. Index faktureras separerat från ordinarie månadsuttag och när indextalet för aktuell månad föreligger.//

//Fakturering av index ska ske//månadsvis//årsvis// ?//.//

Beställaren omfattas, i enlighet med 1 kap. 2 § 4 b pkt Mervärdesskattelagen, av omvänd skattskyldighet vid köp av byggtjänster varför, med ändring av AB 04 kap. 6 § 8, utgående moms inte ska debiteras vid fakturering av byggtjänster. Felaktigt utbetald ersättning avseende moms ska återbetalas till beställaren.

Faktureringsavgift och expeditionsavgift betalas inte.

Fakturan ska märkas med följande:

//
- Trafikverkets referens: EF ? Namn Namnsson
- Trafikverkets avtalsnummer: 5?

//

//
- Trafikverkets referens: Framgår av inköpsorder
- Trafikverkets avtalsnummer: 5?
- Trafikverkets inköpsordernummer: Framgår av inköpsorder

//

Även följande uppgifter ska framgå av fakturan:

- //Objektsnummer: ?//
- //Trafikverkets projektbeställningsnummer:?//
- //Arbetsordernummer ?//
- Trafikverkets VAT-nummer /momsreg.nr SE202100629701
- entreprenörens VAT-nummer /momsreg.nr
- entreprenörens referensperson
- //utbetalt förskott//
- //innehållet belopp för utbetalt förskott//
- //innehållna medel för arbetets fullgörande//

Om fakturan saknar angiven märkning eller uppgifter kan Trafikverket komma att returnera fakturan för komplettering. En faktura anses inte mottagen av Trafikverket förrän den är korrekt. Betalningspåminnelser ska inte utfärdas och dröjsmålsränta inte utgå i de fall fakturan inte är korrekt utställd.

Fakturering ska ske via e-faktura: GLN-nummer

//för Trafikverket : 7350005120115//
//för Trafikverket Förarprov : 7350005120146//
//för Trafikverket Färjerederiet: 7381010051316//
//för Trafikverket Järnvägskolan: 7350005120603//
//för Trafikverket Materialservice: 7350005120092//

Om du som leverantör inte redan är ansluten till e-faktura hittar du information om hur du gör på Trafikverkets webbplats, sökord ”Fakturor”.

§ 6.31 Säkerhet till beställaren

//Entreprenören ska ställa säkerhet för förskott. Säkerheten ska utfärdas i digital form. Säkerheten ska gälla till dess förskottet fullt ut är reglerat.

Trafikverket accepterar säkerheter från banker, kreditmarknadsbolag, kreditinstitut och försäkringsbolag som enligt svensk lag har rätt att bedriva verksamhet i Sverige.

Säkerheten skall alltid märkas med kontraktets ärendenummer och skickas direkt från säkerhetens utställare till:

trafikverket@trafikverket.se

eller

Trafikverket
Ärendemottagningen
Box 810
781 28 Borlänge//

§ 8 Hävning

§ 8.1 Beställarens rätt att häva

Med ändring i form av tillägg till AB 04 kap. 8 § 1 gäller att beställaren har rätt att skriftligen häva kontraktet såvitt avser återstående arbeten om:

- entreprenören inte följer avtalade skyddsföreskrifter, arbetsmiljövillkor och arbetsmiljölagar
- entreprenören i sanningsförsäkran uppsåtligen förtigit lagakraftvunnen dom avseende diskriminering
- entreprenören inte vidtar åtgärder avseende grundläggande rättigheter för arbetstagare inom överenskommen tid
- det under avtalstiden föreligger sådant förhållande hos entreprenören att det enligt gällande upphandlingslagstiftning innebär en skyldighet eller rättighet för Trafikverket att utesluta en leverantör från upphandling. Detta gäller även om sådant förhållande avser underentreprenör som entreprenören anlitat för utförande av kontraktsarbete och entreprenören inte har bytt ut sådan underentreprenör
- entreprenören lämnat osanna uppgifter under anbudstiden om sådana förhållanden som hade kunnat medföra uteslutning från upphandlingen enligt gällande upphandlingslagstiftning.

Med ändring i form av tillägg till AB 04 kap. 8 § 1 har beställaren utöver möjlighet att häva kontraktet, när sådan rätt föreligger på ovan angivna grunder, rätt att häva kontraktet genom att ange från vilken tidpunkt kontraktet hävs och/eller för vilka delar kontraktet hävs. Beställarens rätt till ersättning för skada och entreprenörens rätt till ersättning för utförd del av entreprenaden motsvarar vad som i övrigt gäller vid hävning.

§ 8.6 Skada

Med tillägg till AB 04 kap. 8 § 6 gäller bestämmelsen även då kontraktet hävs i enlighet med vad som särskilt anges i EK § 8.1.

§ 8.8 Övertagande

Med tillägg till AB 04 kap. 8 § 8 gäller bestämmelsen även då kontraktet hävs i enlighet med vad som särskilt anges i EK § 8.1.

§ 9 Tvistelösning

Med ändring av AB 04 kap. 9 § 1 ska tvist på grund av kontraktet avgöras av svensk allmän domstol.

Svensk rätt gäller för kontraktet.

§ 10.4 Kontraktets giltighet

Kontraktet träder i kraft då båda parter har undertecknat kontraktet.

Kontraktets ikraftträdande förutsätter dock att beställaren har lämnat upplysningar om tilldelningsbeslutet samt att kontraktet får ingås med antagen entreprenör enligt lagen (2016:1145) om offentlig upphandling (LOU).

Detta kontrakt är upprättat i två likalydande exemplar av vilka parterna tagit varsitt.

Beställare	**Entreprenör**
Trafikverket ?	//Entreprenör//
Datum ?	Datum ?
_____	_____
//Namn, enhet, befattning//	//Namn, befattning//

_____
Ansvarig inköpare, //Namn, enhet//

Robin Stenberg

Communication and Contracts in Maintenance Operations

NTNU
Norwegian University of
Science and Technology