

ORGANIZATIONAL STRUCTURES & PERFORMANCE EVALUATION OF RAILWAYS

Based on European railway reform experiences and applied to Israel Railways



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Based on European railway reform experiences and applied to Israel Railways

Master Thesis

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PREFACE

This report presents the end result of a thesis work conducted for the MSc program 'Transport Infrastructure and Logistics' (TIL) at Delft University of Technology. Together with close external support of HTM Consultancy, this thesis project highlights various organizational models and performances since Europe's railway reform program started in the 1990s. Optional redesigns for the structure of Israel's railway sector are included in the final thesis report.

This thesis work could not have been conducted without extensive help of a number of experts (closely) affiliated to railways.

First of all I would like to thank my thesis committee members affiliated to TU Delft for critically reviewing texts, underlying figures and outcomes of the research and design parts of this thesis work: Prof. Dr.-Ing. I.A. Hansen, dr. W. W. Veeneman and ir. P. B. L. Wiggenraad.

Additionally I would like to thank my external thesis committee member dr. ir. H.A. Körmeling (HTM Consultancy) for introducing me to the state of Israel and their railways, for providing me the opportunity to research this highly interesting and relevant subject and for his extensive and comprehensive comments on all the work produced.

Since I strongly believe an academic thesis should have a relation to 'what is experienced in practice', special gratitude is in place for drs. ir. A. Roeleveld, benchmarking expert at Dutch Railways (NS). His guiding advice, especially in the performance evaluation part of this thesis work, aided a lot in placing data and resulting figures into a more correct perspective.

I would also like to thank drs. D.M. van de Velde (TU Delft) for additional information on Europe's reform programs and the permission to make use of his framework in Part 2 of this thesis work. As external readers, I would like to thank ir. J.G. Kroon (Trans Link Systems) and ir. E.E. Wolff for critically reviewing texts and assumptions.

Special thanks are furthermore in place for all Israeli representatives that decided to award me some of their (always limited) time in understanding the Israeli system and motives behind decisions better.

Finally I would like to thank all colleagues of HTM Consultancy for sharing their facilities and expertise. Working at HTM for the past months has been a great pleasure and a very positive learning experience.

The Hague, September 2011

J. W. Wolff

TABLE OF CONTENTS

MANAGEMENT SUMMARY	I
GENERAL INTRODUCTION	1
RESEARCH OBJECTIVES AND SUB QUESTIONS	2
PART 1: ISRAEL RAILWAYS - PAST, PRESENT AND FUTURE.....	5
CHAPTER 1.1: HISTORICAL OVERVIEW ISRAEL RAILWAYS LIMITED	6
CHAPTER 1.2: CURRENT ORGANIZATIONAL STRUCTURE AND KEY CHARACTERISTICS IRL.....	10
CHAPTER 1.3: ACTOR FIELD ISRAELI RAILWAY SECTOR	12
CHAPTER 1.4: CURRENT ISSUES IN ISRAEL'S RAILWAY SECTOR.....	15
CHAPTER 1.5: CONCLUSIONS	18
PART 2: ORGANIZATIONAL STRUCTURES EUROPEAN RAILWAYS.....	19
CHAPTER 2.1: HISTORY EUROPEAN RAILWAY REFORMS	20
CHAPTER 2.2: RAILWAY SECTOR ANALYSIS - RESEARCH METHODOLOGY	22
CHAPTER 2.3: TYPICAL ORGANIZATIONAL STRUCTURES EUROPEAN RAILWAY SECTORS.....	26
CHAPTER 2.4: PUBLIC PROCUREMENT AND ORGANIZATIONAL STRUCTURES	31
CHAPTER 2.5: CONCLUSIONS	32
PART 3: PERFORMANCE EVALUATION OF RAILWAYS	33
CHAPTER 3.1: PERFORMANCES OF RAILWAYS IN 27 EU+EFTA COUNTRIES: KPI METHOD	34
CHAPTER 3.2: PERFORMANCES OF RAILWAY SYSTEMS IN 8 EUROPEAN COUNTRIES	48
CHAPTER 3.3: SERVICE QUALITY & CUSTOMER SATISFACTION.....	56
CHAPTER 3.4: CONCLUSIONS	62
PART 4: ORGANIZATIONAL STRUCTURES AND PERFORMANCES - CORRELATION ANALYSIS	65
CHAPTER 4.1: FORMULATION OF HYPOTHESES ORGANIZATIONAL STRUCTURES - PERFORMANCES	66
CHAPTER 4.2: CORRELATION ANALYSIS ORGANIZATIONAL STRUCTURES – PERFORMANCES	67
CHAPTER 4.3: CORRELATION ANALYSIS DEGREE OF MARKET OPENING - OVERALL PERFORMANCE	72
CHAPTER 4.4: CONCLUSIONS	73
PART 5: DESIGN ORGANIZATIONAL STRUCTURES FOR ISRAEL RAILWAYS.....	75
CHAPTER 5.1: EFFICIENCY DRIVERS: QUALITATIVE DESCRIPTIONS	76
CHAPTER 5.2: POSSIBILITIES AND BOUNDARIES FOR REFORM: THE VISUAL GRID TECHNIQUE	82
CHAPTER 5.3: DESIGN OF OPTIONAL ORGANIZATIONAL STRUCTURES.....	85
CHAPTER 5.4: CONCLUSIONS	94
PART 6: CHARACTERISTICS AND EVALUATION OPTIONAL MODELS FOR ISRAEL RAILWAYS.....	95
CHAPTER 6.1: CHARACTERISTICS OF DESIGNED MODELS	96
CHAPTER 6.2: EVALUATION OF SUITABILITY DESIGNED MODELS.....	104
CHAPTER 6.3: OVERVIEW OF SUITABILITY – BALANCED SCORECARD	109
GENERAL CONCLUSIONS AND RECOMMENDATIONS.....	110
REFLECTIONS.....	112
BIBLIOGRAPHY	116
GLOSSARY	119

MANAGEMENT SUMMARY

This thesis report closely examines the relationship between organizational structures of railway sectors and corresponding performances. Following organizational issues in Israel's current railway sector, this thesis work applies gained knowledge to the Israeli case in order to provide an answer to the main research objective:

"In what way can the organizational setup of Israel's railway sector be improved in order to increase overall performance, according to the specific environment and context in Israel by taking organizational structures, performances and experiences of European railways into account?"

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Israel's railways possess a much shorter history than its European counterparts. In the early years rapid expansion of network and services illustrated the initial significance of railways in the state of Israel. After termination of the British Mandate in 1948, years of negligence resulted in a derelict and barely used railway system in the 1980s. In 1988 Israel Railways was sold to the Ports Authority, presenting the first step in the recovery of Israel's railways as a main mode of transport. Since 2003, the Israeli government requires Israel Railways to become a main transport facilitator in Israel. Instigated by substantial funds from the national government, rapid modernization of infrastructure and stations updated the derelict system in high pace. For the nearby future, network extensions and additional transport services are foreseen for Israel's railways. Passenger numbers are expected to double to over 70 million travellers annually in 2017.

The current organizational setup of Israel Railways Limited (IRL) is a vertically integrated structure in which internal departments, divisions and branches take care of all tasks in the railway system, supervised and directed by the national Ministry of Transport and Road Safety. IRL's network measures around 400 kilometers of (non-electrified) lines, IRL employs approximately 2000 staff members and transported 35,9 million passengers in 2009 resulting in around 2 billion Passenger-kilometers.

The current, vertically integrated, structure of IRL results in a number of issues. The most important issues include a disappointing overall performance compared to other modes of transport (e.g. public buses), poor management of infrastructure projects, little commercial use of stations and station areas, issues in acquiring and maintaining rolling stock, issues in accurately conducting financial administration and issues regarding transparency resulting from an unclear division of roles in the company.

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Europe's railways have seen major reforms to their organizational structures over time. Originally established as private companies (operating on private, dedicated networks), most companies were nationalized after the First or Second World War. The state owned structure of railways proved to be unable in averting decreasing traffic volumes following increasingly fierce competition from road transport in the 1950s and 1960s. Annual deficits pressed more and more on state budgets; focus on the customer (being the rail passenger or shipper) was lost.

Instigated in the 1990s by the European Union (EU), railways in Europe faced their most fundamental organizational reform since the nationalization period of the 1930s and 1940s. Three subsequent railway packages, drafted by the EU, were issued to member states which aimed to liberalize and open up the railway markets in order to facilitate competition. In their

regulations, the EU deliberately left space open for national interpretation, so that member states could adopt a model that was 'best suited' for their specific situation. A vast range of organizational structures is now present in European railway sectors that, although some do represent elements of others, are more or less unique per country. All models are meticulously fine-tuned to a country's national belief 'how railways should be run'.

Investigation of organizational structures for EU+EFTA countries is conducted based on the framework Authority-Infrastructure-Transport, originally introduced by (van de Velde, et al., 2008). This framework provides the possibility to quickly compare organizational structures between various countries. Empty frameworks are filled with actors present in a national railway sector, based on information from Network Statements, various documents published by knowledge institutes and annual reports and webpages of all actors present. Analysis results in 35 filled in frameworks that present a comprehensive overview of the organization of Europe's railways today.

Although a vast range of organizational structures is visible in EU+EFTA countries, three generic organizational models become visible to which railway sectors of most countries more or less hold: the Integration Model, Holding Model and Separation Model.

In the Integration Model, a vertically integrated incumbent railway company typically takes care of all managerial and operational tasks in the railway system, monitored and supervised by national governments. In all EU+EFTA countries the integrated incumbent companies remain 100% state owned or a public entity.

In the Holding Model, a holding company serves as an umbrella of multiple subsidiaries. These subsidiaries each take care of a specific task in the railway system such as infrastructure management, provision of passenger and cargo services and conducting maintenance of rolling stock. The holding company remains in all countries 100% state owned or a public entity. The Holding Model has to be seen as a typical transition model that is located in-between the Integration and Separation model.

In the Separation Model, multiple 'core business' companies each take care of a specific task in the railway system. Actors responsible for infrastructure management are separated from actors providing transport services or rolling stock maintenance services. Licensing tasks are performed by public institutions that are either independent bodies or located inside a national ministry (as an executive railway department). A recent trend shows the initiation of a combined road and railway agency, responsible for infrastructure construction and management.

Public Procurement (PP) schemes remain limited in Europe's heavy rail sector compared to, for example, the road construction sector. Most PP schemes that are used include DBFM (Design, Build, Finance, Maintain) contracts for infrastructure construction and maintenance. Transport operations are typically awarded to (subsidiaries of) incumbent railway companies instead of separate private parties or consortia.

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Performance Evaluation (PE) of railways is a complicated task due to comparability issues in data. Two quantitative methods to evaluate performances are illustrated and applied in this thesis report, augmented by comments on evaluation of service quality and customer satisfaction.

Evaluation of performances on effectiveness and efficiency is conducted by examining Key Performance Indicators (KPI's) for 27 EU+EFTA countries. KPI's on effectiveness of production

(comparing outcomes to outputs), effectiveness of resources (comparing outcomes to inputs) and efficiency of production (comparing outputs to inputs) are examined. Although many more KPI's could be examined, the selected KPI's in this thesis report should provide a first insight in relative performances for 27 countries.

Indicator data are collected through four publicly available sources: Railisa database (UIC), Eurostat, OECD and Railway Directory. Non-mixed indicators are divided by other non-mixed indicators in order to create mixed KPI subsets. Median values of these mixed KPI subsets determine a relative ranking of countries based on KPI performances. Next to the median values of mixed KPI subsets, values are taken along originating from the most complete data source for each KPI.

Obtained results include relative ranking tables on each KPI regarding the 27 EU+EFTA countries under examination. Conducting PE on KPI's is a high-level and abstract way to benchmark, based on ratios of indicators. Incomparable and highly aggregated data influence outcomes of the KPI method. Furthermore, no specific insight is gained in internal processes within railway companies or railway systems that could be improved to increase overall effectiveness and efficiency levels.

Performance Evaluation based on multiple inputs/outputs by using Data Envelopment Analysis (DEA) is another method to investigate relative differences in performance. The shared nature of a railway system, in which both passenger and cargo services are offered on the same rail network, sometimes with shared rolling stock equipment and staff, is handled quite well by this multiple input/output assessment method. The subset of 27 EU+EFTA countries is reduced to 8 reliable European railway systems that in scale do not differ that much from the (nearby future) situation of Israel's railways. As input and output data, information is used from annual reports of transport operators and infrastructure managers that provide a less aggregated level of data than data provided by the public sources in the KPI method. Obtained results show that railway systems operating both on the efficient and effective frontier are present in all three generic organizational structures.

Measuring service quality and perceived customer satisfaction is a major addition to quantitative PE methods, in order not to consider low quality companies as efficient or effective. Euronorms identify adequate methods to investigate service quality and customer satisfaction levels, based on the 'Quality Control Loop'. While differences between targeted and delivered service quality of a service provider can be evaluated by objective and measurable specifications, estimating perceived customer satisfaction has a much more subjective nature. Perceived customer satisfaction depends on the difference between expectation and experience and is therefore not directly dependent on actual performances. Trend series, covering multiple years, provide a more adequate insight in trends in customer satisfaction over time, than sample values do (taking a single year into account). A recent study, issued by the European Union, investigates customer satisfaction levels for passenger rail transport in 25 EU countries in 2011.

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Analysis between type of organizational structure in place and corresponding performance yields little correlation regarding effectiveness and efficiency. Only regarding efficiency of production (output/input), there is a slight trend visible in the results that separated structures outperform holding and integrated structures, while holding structures outperform integrated structures. When examining the correlation between degree of market opening (established quantitatively) and performance, a similar picture is obtained: no strong correlation between organizational setup and performance is found.

This supports the hypothesis that altering a structure of a railway sector does not improve overall performance per se: in all organizational structures positive and negative outliers are visible. Organizational structures can however improve internal processes inside railway companies and railway systems. This main finding is important for design of new optional structures for Israel's railway sector.

Since quantitative Performance Evaluation yields no significant correlation between type of organizational structure and overall performance, additional qualitative performance drivers are identified regarding authority, infrastructure and transport operations. These qualitative drivers identify which processes inside a railway system facilitate improvement of efficiency and effectiveness based on European experiences. These drivers function as important input for design of new optional structures for Israel's railway sector.

A consistent and comprehensive policy approach to the transport sector in general facilitates efficient and effective railways, as experience from Switzerland shows most clearly. When governments decide to reform railway sectors; gradual reform instead of shock (package) reform seems to be beneficial for improving efficiency and effectiveness levels. Stimulating entrepreneurial freedom makes management more directly responsible, yielding in most cases an increased attention for the actual customer: not only being the government but also the 'real customer' (passengers or shippers). If authorities require railway companies to provide transport services on loss-making lines, additional public funding according to performance contracts is required.

Regarding Infrastructure management, removal of legacy systems and standardization can bring significant efficiency and effectiveness improvements. Microscopic performance tracking (e.g. on specific corridors or error prone locations) can mitigate disruptions in traffic. Attractive stations and station areas aid in attracting people to stations with different objectives than travelling alone. These multi-functional stations contain the possibility to gain income from different sources, just as in European airports (e.g. from shopping sales or business conferences).

Performances in transport operations not only benefit from competition by multiple operators, but may also benefit from emulation of operators present in a national rail sector. A safe and secure railway system is a necessary prerequisite for travellers choosing rail as their main mode of transport.

Israel's railway sector and culture contain specific characteristics that have to be taken into account as input before design of optional new structures can commence. These specific characteristics (boundaries and opportunities for new structures) are collected by using a technique called the 'Visual Grid Technique'. An abstracted playing field (the grid), including 14 main tasks of railway sectors in general, is presented to five representatives closely affiliated to Israel's railway sector. By placing these 14 tasks in the grid, the Israeli representatives indicate which possibilities and boundaries for new structures from an Israeli point of view exist regarding their railway sector in the mid- to long-term future.

Since correlation analysis proved that implementing an organizational structure does not improve overall performance per se, design of optional structures is again based on the original EU+EFTA frameworks, European experiences (described in the qualitative performance drivers) and results from the Visual Grid Technique.

Five optional new structures for Israel's railways are designed:

1. Improved Integration Model
Integrated national railway company consisting out of business units
2. Holding Model
Semi-integrated national railway company consisting of subsidiaries in a holding company
3. Hybrid Model
Mixture of a separated and integrated model based on a national land transport agency and a national railway company organized as a holding structure
4. Vertical Separation Model
Vertically separated system with multiple actors performing only core tasks in the national railway sector
5. Horizontal Separation Model
Horizontally separated railway sector with vertically integrated railway companies active on designated regional or local networks

Characteristics of these models are objectively described based on a subset of chosen criteria that are found predominant compared to others based on European experiences from literature and specific indications out of Israel. These characteristics include for example degree of transparency, required overhead, complexity and separation of financial accounts that a specific model contains.

Evaluation of advantages and disadvantages regarding each optional model is qualitatively added by means of SWOT diagrams (Strengths, Weaknesses, Opportunities and Threats). These SWOT diagrams should provide Israeli representatives sufficient insights in making a balanced decision whether or not implementation of an optional model is desired.

A specific choice regarding the most suitable model for Israel's railway sector is deliberately omitted in this thesis report. Israeli representatives should make this balanced choice themselves. As an additional evaluation tool, a Balanced Scorecard supports Israeli representatives in making a balanced decision which model would suit Israel's future railway situation best. This Balanced Scorecard summarizes in a single table all advantages and disadvantages of a specific model compared to others.

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Taking all previous information into account the main research question can now be answered:

"In what way can the organizational setup of Israel's railway sector be improved in order to increase overall performance, according to the specific environment and context in Israel by taking organizational structures, performances and experiences of European railways into account?"

European experience shows that implementing a generic organizational structure to improve overall performance per se is not a justifiable way forward. Internal issues in Israel's railway system can partly be solved by implementing one of the five designed optional models provided in part 5 of this thesis report.

The best method for implementing a suitable organizational structure in a railway system is to learn from peer countries that possess a satisfactory performance, a comparable rail network and similar scales of magnitude. Benchmarking performances to comparable railway systems in Europe stimulates Israel Railways to operate efficiently and effectively and eases adequate specification of a satisfactory performance for the railway system in the State of Israel.

GENERAL INTRODUCTION

“The printing press, the machine, the telegraph, the railways are premises whose thousand-year conclusion no one has yet dared to draw”

Friedrich Nietzsche (± 1880)

Railways are a ‘hot topic’ these days, not only in Europe but even on a global scale. The revival of railways as a main transport facilitator in a country’s national transport system has been an ongoing process for the past decades. Railways in Europe are again in sharp focus of national and international policymakers and ridership in most countries is rising steadily. After years of consolidation, new (high speed) railway lines are opened, infrastructure is modernized and investments in new rolling stock make their way through. Being seen as an environmentally friendly alternative to competing modes of transport, railways start to flourish again, especially in dense urbanized areas.

Railways in Europe have experienced large alterations to their organizational structures in the past years. Originally established as private companies, most companies were nationalized in the early 20th century into ‘state railway companies’. After years of increasingly fierce competition from road transport, importance of the state run railways in Europe’s national transport systems declined. Something had to be done to decrease (societal) costs and increase revenues. Instigated in the 1990s by European Union Directives, European railway sectors have to some extent been liberalized and railway markets have started to open up in order to introduce competition. A variety of organizational setups is now visible in Europe’s railway sectors, all meticulously fine-tuned to a country’s national belief ‘how a railway should be run’.

Railways in the state of Israel have a much shorter history than its European counterparts. After years of consolidation, underinvestment and decline, the Israeli Railways experienced a stormy development through recent years and are to become ‘a main transport facilitator’ in the nearby future. Large investments have made their way into the Israeli railway system in recent years, facilitating the rapid modernization of infrastructure and rolling stock. The organizational setup of the Israeli railway sector is typically a vertically integrated structure: a single railway company (Israel Railways Limited, IRL) possesses a monopoly on operating passenger and cargo services, managing infrastructure and acquiring and maintaining rolling stock. Israel is currently looking into possible alterations of the structure of its railway sector. Short term reform plans are already underway, the question arises which organizational structure would be appropriate for the medium term.

The Israeli reform plans form the main reason for conduction of this thesis work. Thorough knowledge on European organizational structures and performances is collected and taken along to design optional improved structures for the Israeli railway sector.

Railways will continue to play an important role in a country’s national transport system. Following the company motto of a major international rolling stock manufacturer: ‘The climate is right for trains!’

RESEARCH OBJECTIVES AND SUB QUESTIONS

Research in this thesis work focuses around the organizational setups of railway sectors in European countries and its corresponding performances. The main motive for research is provided by a specific assignment from HTM Consultancy (relating to the Israeli railway sector) and centers around five main questions:

1. How is the current Israeli railway sector organized and which issues occur as a result?
2. How are European railway sectors structured in 2011, following the European Union's railway reform program of the 1990s?
3. Which methods can systematically evaluate performances of railways and how do European railways perform in general?
4. Is a relationship/correlation visible between type of organizational structure and a specific level of performance?
5. Regarding the Israeli railway sector, what potential redesigns of the organizational structure are promising for implementation, based on current issues and European expertise gained in the years since the railway reform?
6. What strengths and weaknesses possess the optional new organization models? What are their characteristics?

These five questions define the main research objective of this thesis work:

"In what way can the organizational setup of Israel's railway sector be improved in order to increase overall performance, according to the specific environment and context in Israel by taking organizational structures, performances and experiences of European railways into account?"

The following sub questions are composed that require further examination:

1. Sub questions regarding current setup Israeli railway sector and resulting issues:
 - 1.1. What historical backgrounds play a role in understanding the current Israeli railway sector?
 - 1.2. What organizational structure is in place in the current Israeli railway sector?
 - 1.3. Which actors are currently involved in the Israeli railway sector and how do they relate to each other?
 - 1.4. Which current issues occur in the Israeli railway sector that present specific directions for further research?
2. Sub questions regarding current European railway organization models:
 - 2.1. What historical backgrounds initiated Europe's railway reform program in the 1990s?
 - 2.2. Which (sub)set of countries should be examined in order to extract general European organizational models?
 - 2.3. Which typical railway organizational models exist in Europe today? Is the European rail sector indeed privatized?
 - 2.4. How are Public Procurement schemes executed in Europe's heavy rail sector regarding the main organization models?

3. Sub questions regarding systematic evaluation of performances of European railways:
 - 3.1. Which systematic methods exist in quantitatively assessing performances of European railway sectors? What resulting performances per EU country exist?
 - 3.2. Which systematic methods exist in assessing performances of comparable European railway systems? What resulting performances exist?
 - 3.3. Which systematic methods exist in determining the quality of the delivered service and perceived customer satisfaction?
4. Sub questions regarding relation/correlation performance – organizational model:
 - 4.1. Does a correlation exist between type of organizational model in place and corresponding performance regarding European railways?
 - 4.2. Does a correlation exist between degree of market opening and performance regarding European railways?
5. Sub questions regarding optional redesigns of Israel's railway sector:
 - 5.1. What qualitative drivers influence the performance of a railway sector or railway company internally based on European experiences?
 - 5.2. Which possibilities and boundaries for reform exist from an Israeli point of view?
 - 5.3. Which optional structures can be designed, based on European experiences and Israeli boundaries for reform?
6. Sub questions regarding characteristics of optional redesigns of Israel's railway sector:
 - 6.1. What characteristics do the optional structures present?
 - 6.2. What Strengths, Opportunities, Weaknesses and Threats do the optional structures contain?

The setup of this thesis report follows research on these sub questions:

Part 1 examines the current Israeli railway sector and identifies main issues and directions for research.

Part 2 investigates for 35 countries (of which 27 EU+EFTA countries) organizational setups and presents the main generic European railway organization models.

Part 3 advises on systematic ways to evaluate performances of railways, assesses performances of 27 European railway sectors and a subset of 8 comparable European railway systems.

Part 4 examines if a correlation can be found between organizational structure and corresponding performance.

Part 5 presents optional redesigns for Israel's railway sector, based on qualitative performance drivers found in Europe and possibilities and boundaries for reform in Israel.

Part 6 describes characteristics of the designed reform models based on various criteria and shows Strengths, Weaknesses, Opportunities and Threats for each model.

In the general conclusions and recommendations section, the main research objective will be repeated and answered and recommendations will be provided for additional research.

A comprehensive overview of all cited works and a glossary, clarifying all abbreviations and used terminology, are added in the back of the report.

PART 1: ISRAEL RAILWAYS - PAST, PRESENT AND FUTURE

The chapters in part 1 provide an insight in the specifics of the Israeli railway sector. Historical backgrounds leading to the current organizational setup of Israel's railways are clarified including a main picture of actors involved.

Part 1 concludes with the need to research the organizational structure of Israel's railway sector, based on a subset of main issues that currently arise. These issues present the main reason for research and direct the research in parts 2 and 3 into a specific direction.

Chapters in part 1 are written according to information that, besides documentation and literature, has been supplied in interview meetings with multiple representatives affiliated to the Israeli railway sector.

CHAPTER 1.1: HISTORICAL OVERVIEW ISRAEL RAILWAYS LIMITED

This chapter pictures Israel Railways Limited (IRL) regarding its past, present and nearby future. It will clarify why IRL is operating in the current organizational setup and it will show the historical road that led to this organization form.¹

§1.1.1 The early days – 1890 to 1940

The history of Israel Railways comprises about half the time of European railway history. The first railway to be constructed in the Holy Land was the metre gauge railway between Jaffa (now a district of Tel Aviv) and Jerusalem, built between 1890 and 1892 by a French private company. Up to 1914, the famous ‘Hedjaz railway’ was built between Haifa and Trans Jordan, offering connections towards Damascus. During the First World War the German/Turkish military instigated and supervised the extension of the rail network towards southern Egypt (in an attempt to facilitate troop movements to British-held Egypt and the Suez Canal). This railway line was positioned in the center of the country; well away from the coast and enemy naval gunships. As a response, the British military constructed the ‘Sinai Military Railway’ that was of vital importance in defeating the German/Turkish troops. In these years, it can be concluded that railways in Israel were constructed at high pace, but for now for military purposes only.

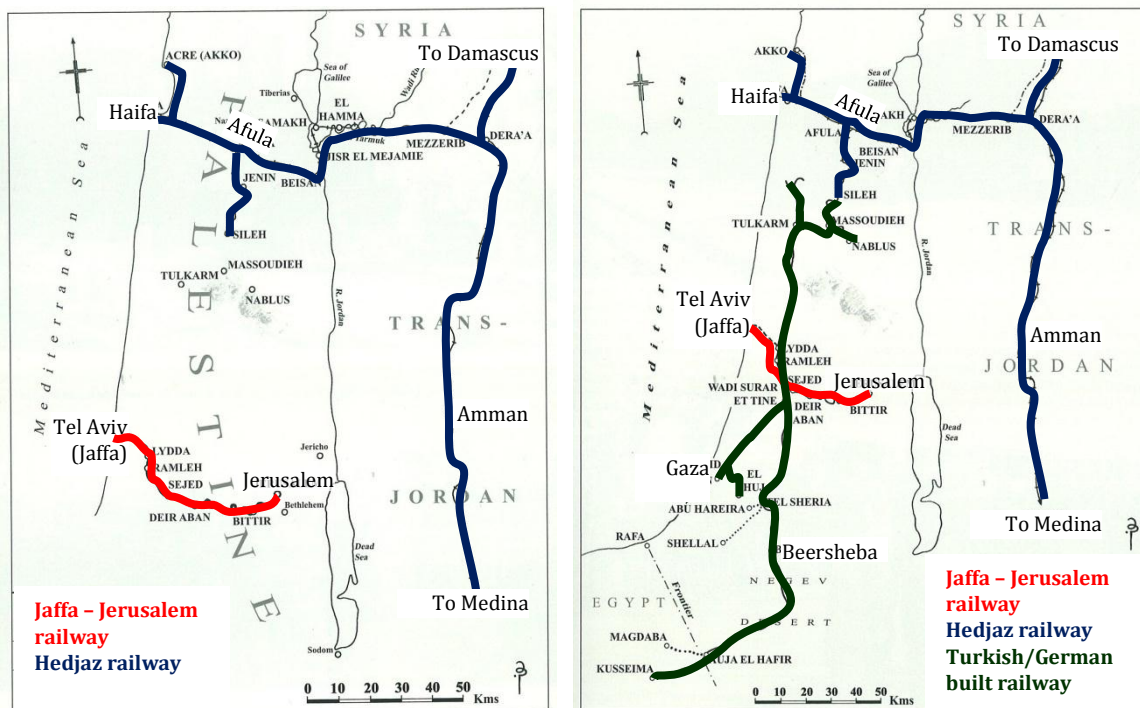
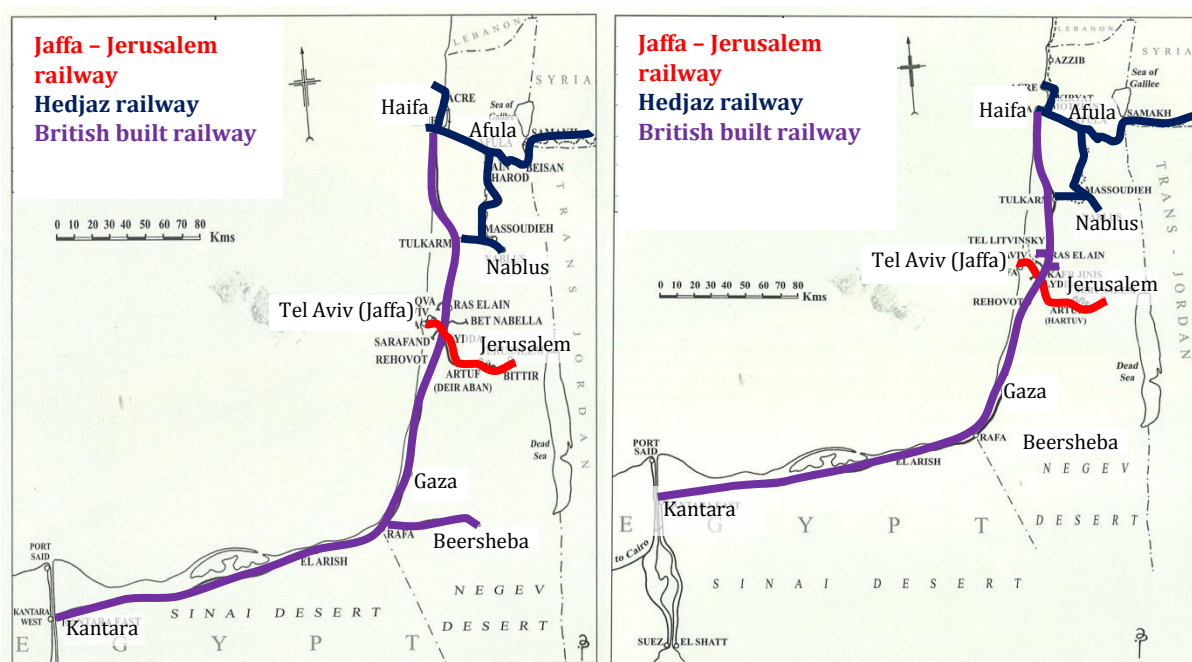


FIGURE 1: RAILWAY DEVELOPMENT IN PALESTINE UNTIL 1914 (LEFT) AND DURING WORLD WAR I (RIGHT). ADAPTED FROM (COTTERELL, 2009)

Between World War I and II the Palestine Railways operated on the line from Kantara (Egypt) via Rafa and Gaza towards Lydda and Haifa (see Figure 2). Also the Hedjaz railway towards Trans Jordan and Nablus and the railway between Jaffa and Jerusalem were operated by the Palestine Railways; the railway to Beersheba closed down in 1927.

¹ This chapter is for the largest part based on ‘Make straight the Way’ (Cotterell, 2009). Exact quotations are printed in “*Italics*” and are followed by: (Cotterell, 2009)

§1.1.2 Expansion and decline – 1940 to 1948



§1.1.3 Years of negligence – 1948 to 1985

As austerity in Israel made room for prosperity between the 1960s and 1980s, it is interesting to see that investment in railways declined. Finances were more and more awarded to road construction projects; leading to a stagnation in the services of Israel Railways especially in the transportation of passengers and to a lesser extent also regarding cargo. Between the early 1960s and late 1980s *“travellers deserted the railways and instead chose for an excellent public bus service or their now affordable private cars.”* (Cotterell, 2009)

§1.1.4 Recent changes – 1985 to present

In 1988 the Israeli government sold Israel Railways to the governmentally owned 'Ports authority' that was renamed as 'Ports & Railways authority'. Since the Ports authority had made substantial profits in the past, at last there was room to invest in the outdated and derelict rail system. Lines and stations were (re)opened and the number of passengers has since 1988 increased dramatically and is still increasing rapidly: from 17,5 million train travellers in 2002 to approximately 27 million travellers in 2005. (Vaturi, et al., 2010) This trend continues to this day, since in 2010 almost 36 million travellers have been transported and forecasts predict that 71,5 million travellers will use the rail system in 2017 (Israel Railways, 2011).

Although the selling of Israel Railways to the Ports authority seemed a perfect way to cross-subsidize the railways with money earned in port activities, *"the partnership between both parties was dissolved in 2003: Israel Railways became a state-owned independent limited liability company (Israel Railways Limited, IRL) benefitting from a suddenly generous patronage of the Israeli government."* (Cotterell, 2009) This remarkable change of policy took place to separate the port activities again from railway activities since *"the Ports and Railway authority was a 'bizarre' example of executing completely different tasks and expertise within one company"*. (TASC Consultants)

Since 2003 Israel Railways is organized as 'an independent government-owned corporation with the vision to carry passengers and cargo safely and on time while providing optimal service and to develop the railway infrastructure in the state of Israel'. (Israel Railways, 2011)

The current organizational structure of IRL, being an integrated railway company closely connected to the national government, mirrors the pre-reform organization models of European railway undertakings in a striking way.

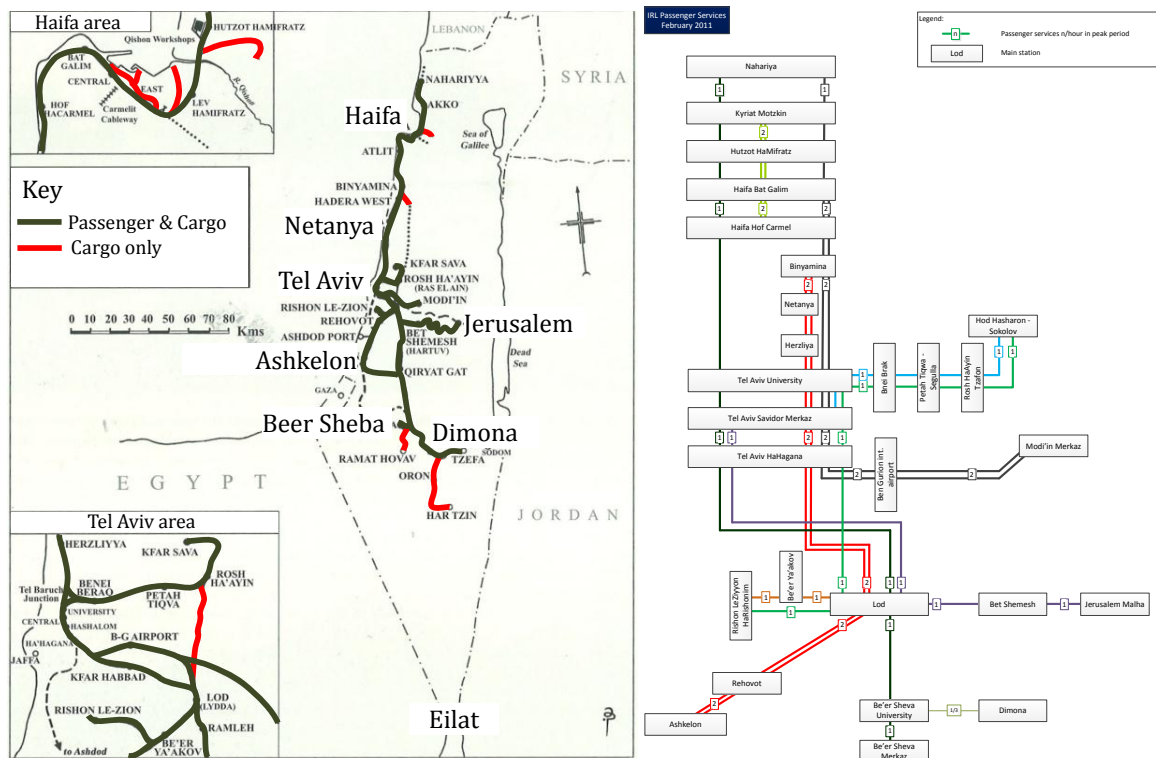


FIGURE 3: CURRENT NETWORK AND PASSENGER SERVICES ISRAEL RAILWAYS LIMITED. ENLARGED VIEW IN APPENDIX 1.1.

§1.1.5 Expanding Networks – Present to 2017

In the upcoming years, large network expansion characterizes IRL's intention to become a major transport facilitator in the state of Israel. The first High Speed Railway line between Tel Aviv, Ben Gurion International Airport and Jerusalem is planned to start operations in 2017. Additional extensions to the current rail network are planned between Ashkelon and Beer Sheba, between Haifa and Beit Shan (close to the Israeli-Jordan border), between Herzliya and Kfar Saba and between Akko and Karmiel. Studies are currently conducted for even larger expansion plans, including a high speed line to Eilat and various network extensions in the northeast.

Not only infrastructure but also passenger services on IRL's network face extensive expansion in the upcoming years:

- 14 trains per direction per hour will call at Tel Aviv's main stations in 2017 (compared to 7 trains in the current situation), offering services to all major domestic destinations.
- 4 high speed trains per direction per hour will offer high speed connections between Tel Aviv, Ben Gurion International Airport and Jerusalem. Travel time between Israel's major cities Tel Aviv and Jerusalem becomes 30 minutes (compared to 105 minutes in the current situation).
- All lines will be operated by at least an hourly service, also the less busy lines (that in the current situation are served once in 2 or 3 hours).
- 4 trains per hour per direction will connect Ashkelon and Rishon with Tel Aviv.

Israel's railway system faces rapid expansions in the upcoming years, both regarding infrastructure and services. Years of decline and consolidation have made room for a renewed interest in the railways and a prosperous future is foreseen for Israel's railways.

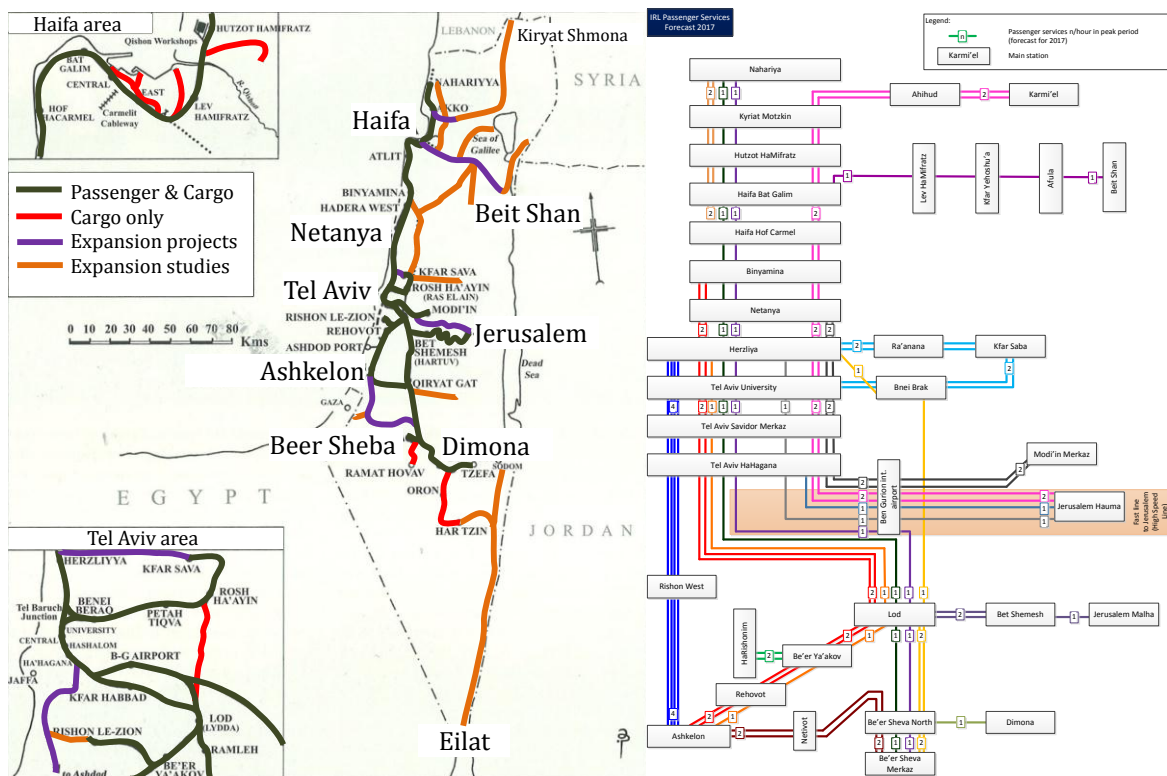


FIGURE 4: EXPANSION OF NETWORK AND SERVICES. IRL'S PASSENGER SERVICES IN 2017.
ENLARGED VIEW IN APPENDIX 1.2.

CHAPTER 1.2: CURRENT ORGANIZATIONAL STRUCTURE AND KEY CHARACTERISTICS IRL

Since the reacquisition of IRL in 2003 by the national Israeli Government, IRL is organized as a public limited liability company with strong connections to the government. According to representatives, IRL remains a small railway company with a relatively small network that resembles the railways of Europe some 50 years ago (IRL interview, 2011).

This chapter clarifies the (internal) organizational structure and presents key characteristics of IRL such as network length, passenger numbers and number of stations.

§1.2.1 Organizational Structure IRL

The current organizational structure of Israel Railways is displayed in Figure 5:

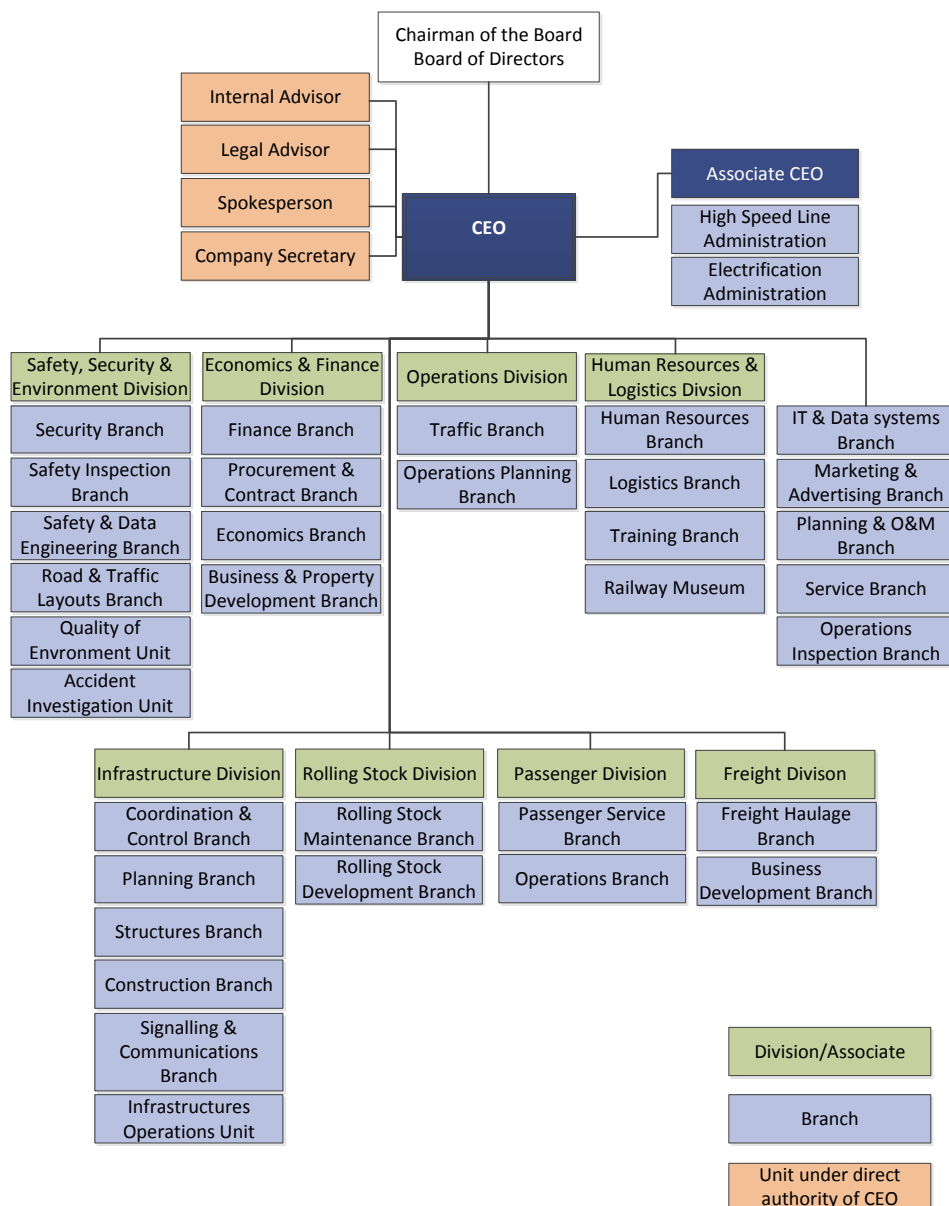


FIGURE 5: CURRENT ORGANIZATIONAL SETUP IRL (ISRAEL RAILWAYS, 2011)

As Figure 5 displays, IRL is a typical form of a so called ‘vertically integrated railway company’. All tasks regarding infrastructure management and transport operations are performed by branches and divisions that are an integral part of the same company. Interesting to note is that even accident investigation is an internal part of the IRL organization (the ‘accident investigation unit’ being part of the safety, security and environment department).

The current organizational setup is for a part a historical inheritance of the railway company of the past decades, and for the other part shaped by recent history. Israel Railways received in the past few years substantial funds from the central Israeli government, for expanding their network and service levels in order to become ‘a main transport facilitator in Israel’.

§1.2.2 Key Characteristics IRL

Israel’s current rail system consists out of the main north-south line Haifa – Tel Aviv – Beer Sheba, the railway line Tel Aviv - Jerusalem and various additional lines in the greater Tel Aviv area (e.g. to Ben Gurion International Airport).

Table 1 presents an overview of key characteristics applying to Israel’s current railway system (Israel Railways, 2011), (CBS Israel, 2010), (Survey of Israel, 2010):

TABLE 1: KEY CHARACTERISTICS ISRAEL RAILWAY SYSTEM

Rail length	1001,4 km
Network length	± 400 km
Track width	1435 mm
% Electrified	0
# Passenger stations	47
Busiest station	Tel Aviv Savidor Merkaz
# Employees	± 2050
# Daily Passenger trains (2009)	338
Annual # of Passengers (2009)	35,9 million
Annual Passenger Kilometers (2009)	2011 million
Annual # Train Kilometers Passenger Trains (2009)	9,3 million
Annual Ton Kilometers (2009)	799 million
Annual # Train Kilometers Cargo Trains (2009)	1,1 million

CHAPTER 1.3: ACTOR FIELD ISRAELI RAILWAY SECTOR

Both the cargo and passenger operations on the national rail network are currently executed by the state owned monopolist IRL. The National Government (Ministries of Transport and Finance) are closely involved in both the infrastructure and operations divisions of IRL. This chapter clarifies which main actors are further present in the Israeli railway sector and which relationships between the main actors exist.

Figure 6 and Figure 7 display the actor field as it is currently in place in Israel. More detailed clarification on the tasks and relationships between the actors in these figures is required:

- Ministry of Transport and Road Safety (MoT):
 - The Ministry of Transport and Road Safety is responsible for the strategic planning of rail transport for the mid- and long-term future. MoT determines the balance between the different transport modes (air, sea, road and rail).
 - MoT organizes and awards tenders to private companies regarding certain tasks in the railway sector (e.g. monitoring IRL and delivering rolling stock to IRL)
 - MoT determines the maximum fare prices (cap) for transport by rail (and other modes).
 - MoT determines which infrastructure expansion projects are carried out in cooperation with the Ministry of Finance and IRL.
 - **MoT has a powerful and strong relationship (based on a governmental power basis) with all actors involved in Israel's railway sector. → MOT wants IRL to become a 'main transport facilitator in Israel'.**
- Ministry of Finance (MoF):
 - Directly responsible for allocating budget to IRL regarding maintenance, operation and infrastructure management
 - Responsible for allocating budget for expansion of the rail network in Israel
 - **MoF has a powerful influence in Israel's railway sector due to the allocation of budget needed for operations and infrastructure expansion.**
- Private (inter)national parties:
 - Israel attaches high value to international (private) parties monitoring and aiding in tasks as timetabling or manufacturing rolling stock since the Israeli railway system is too small to manage these tasks on its own.
 - **The (inter)national private parties have to compete for orders (either awarded by MoT or IRL). Trust is essential in getting orders awarded.**
- Labor Unions:
 - Histadrut is the main labor union for workers in all important sectors of the Israeli economy. The unions are highly powerful in defending workers' rights.
 - **The Histadrut is, besides the central government, the most powerful actor in the Israeli railway sector.**
- Israel Railways:
 - The public state owned railway company executing all operational tasks. More detail is provided in Figure 6 and Figure 7.
 - **IRL has strong relations with the MoT and with private suppliers of for example rolling stock. IRL has to operate and comply to the desires of MoT and Histadrut.**

Figure 6 presents an overview of typical actors involved in European (blue), Dutch (green) and Israel's railway sectors. An enlargement of this picture is added in Appendix 1.3.

Regulating bodies and institutions	European Union	European Union	
	Department of Transport	Ministry of Infrastructure & Environment	Ministry of Transport and Road Safety
	Department of Finance	Ministry of Finance	Ministry of Finance
	Regional authorities	Provinces, Municipalities, City Regions	Local authorities
	Agencies: - Safety Institutions - Competition regulators - Capacity allocation office infrastructure	IVW, Onderzoeksraad voor Veiligheid NMA (Nederlandse Mededingings Autoriteit) ProRail	Safety, Security and Environment div. IRL Israel Antitrust Authority Operations division IRL
Infra-structure	Infrastructure Manager	ProRail	Infrastructure division IRL
	Infrastructure building companies	BAM Rail, Strukton Rail, Volker Rail etc.	Building contractors
Real Estate	Real Estate property owner(s)	NS Poort	Structures branch IRL
Rolling Stock	Rolling Stock (leasing) companies (Rosco's)	Rolling Stock owned by TOC	Rolling Stock division IRL
	Rolling Stock manufacturers	a.o. Bombardier, Stadler, Alstom	ABB, Alstom, Bombardier, Siemens, CAF
	Maintenance companies	NedTrain, Voith	Rolling Stock maintenance division IRL
Operations	Train Operating Companies	NS, Arriva, Veolia, ACTS, DB Schenker etc.	Passenger & Cargo division IRL
	Labor Unions	FNV, CNV, VvMC	Histadrut
	Third Party contractors	CSU Cleaning, Railcatering etc.	Third Party contractors
Customers	Passengers	Passengers	Passengers
	Freight Forwarders/Shipping Companies	Maersk, Den Hartogh, Vos Logistics etc.	B2B between IRL Cargo and customer
			Israeli Military
	Typical European Railway Sector	Dutch Railway Sector	Current Israeli Railway Sector

FIGURE 6: ACTORS TYPICAL EU (BLUE), DUTCH (GREEN) AND ISRAELI (RED) RAILWAY SECTORS.
A LARGER VERSION OF THIS PICTURE IS ADDED IN APPENDIX 1.3

The actor overview of Figure 6 indicates that in European railway sectors the amount of actors present is larger than in Israel's situation, due to the integrated nature of Israel's railway sector.

Most important differences are the absence of a supranational body (such as the European Union) and the absence of regional authorities in Israel. Israeli military personnel are a major user of the railways.

Next to the generic overview provided in Figure 6, a more detailed graphical overview of involved actors and relationships in Israel's railway sector is added in Figure 7 (next page). Next to the public bodies and IRL, various international (private) parties are active in advising the Israeli government and IRL, for example regarding acquisition of rolling stock and timetabling.

As an addition to the overview of Figure 7, a typical division regarding Infrastructure construction is present in Israel's railway sector. Multiple private building companies (domestic or international) may take care of construction of the base infrastructure (foundation, bridges, tunnels or stations). The upper track structure (tracks, switches, signals) is constructed either by IRL's infrastructure division or by a national Israeli construction company 'Lesico'. While construction of base infrastructure is conducted by multiple private building companies, construction of the upper track structure remains exclusively the domain of IRL or Lesico.

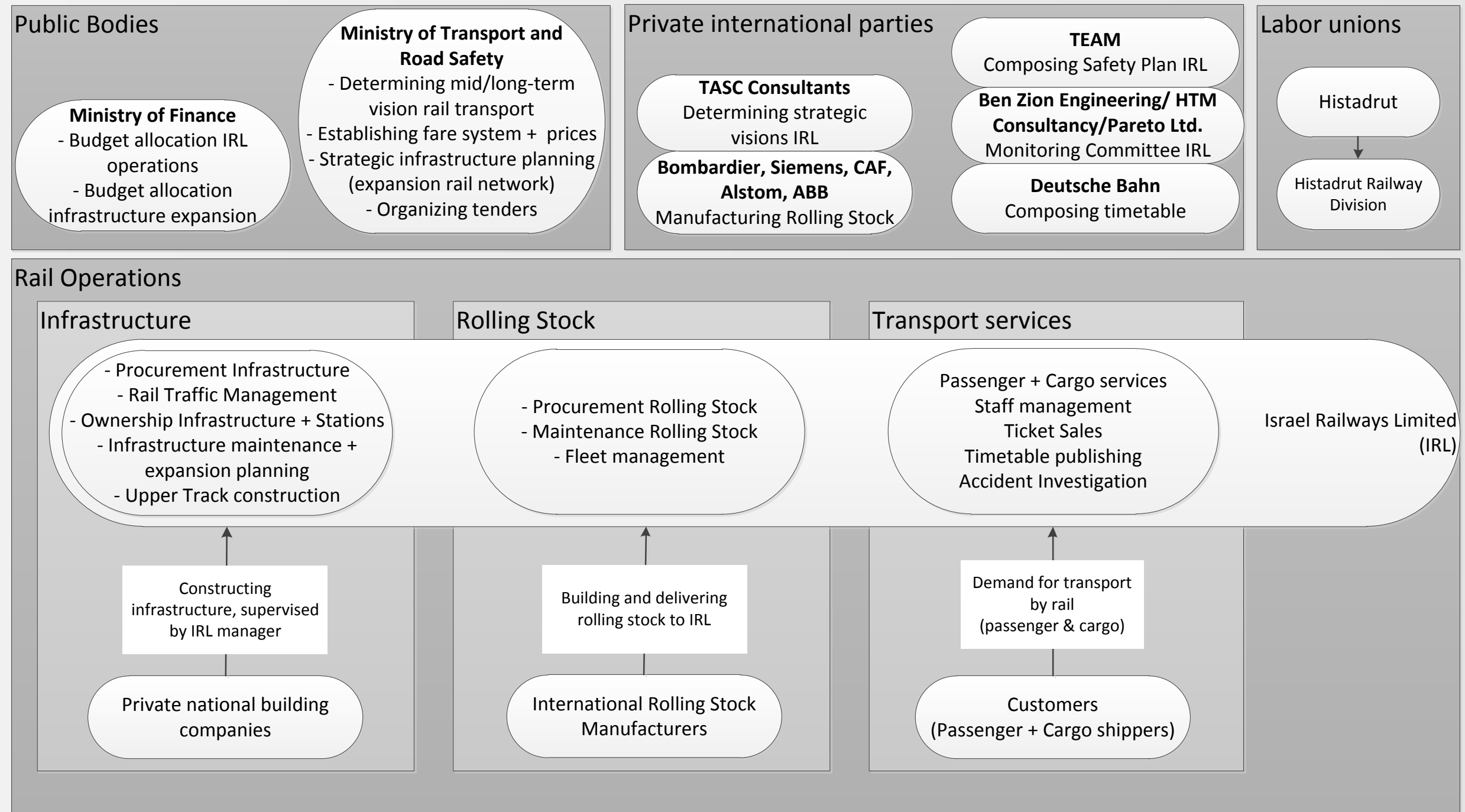


FIGURE 7: CURRENT ACTOR FIELD ISRAELI RAILWAY SECTOR

CHAPTER 1.4: CURRENT ISSUES IN ISRAEL'S RAILWAY SECTOR

In Israel, a number of issues arise that can be linked to the current organizational structure of its railway sector and the internal organization of IRL.

In all the issues 'efficiency and effectiveness' of operations play a major role. It has to be researched if efficiency gains can be obtained and in which specific divisions/branches of IRL efficiency needs to be improved or is currently at a satisfactory level.

In short, the following main issues arise and will be illustrated in the following paragraphs:

- Disappointing overall performance compared to other modes of transport
- Poor management of infrastructure projects
- Large delays and cost overruns in infrastructure projects compared to planning and budget
- Little commercial use stations and station areas
- Maintenance of Rolling Stock
- Financial administration: no separate accounts of various divisions
- Transparency issues: Unclear division of roles within the company

§1.4.1 Disappointing overall performance compared to other modes of transport

Currently, train travel can still not compete with other Public Transport modes in Israel such as public buses (provided by Egged Transportation) or Sherut's (shared taxi vans). The largest share of the total public transport demand is served by these buses/Sherut's; only a minor part by IRL.

Since the Israeli Ministry of Transport and Road Safety requires IRL to become a 'main transport facilitator in Israel' (Ministry of Transport and Road Safety, 2011), this aim does not correspond to IRL's current situation (performance). Travel times by train are much longer for certain routes and railway passenger numbers on these routes are minimal compared to the amount of bus travellers. In many cases, the railway station is located on the outskirts of the larger cities (e.g. Jerusalem), where buses/Sheruts are available from centrally located bus stations.

IRL's overall performance in providing public transport services is disappointing compared to other public transport modes. Currently, IRL does not fulfill the ministry of Transport's aim to be a 'main transport facilitator in Israel'. Public bus and rail services should complement each other in fulfilling the demand for public transport.

§1.4.2 Poor management of infrastructure projects

Presently, IRL receives a very generous subsidy from the national Government. Large investments for infrastructure expansion and upgrading have made their way into the Israeli railway system. Besides renewing existing infrastructure, large expansion projects are either in the planning or (already) in the construction phase.

These large expansion projects are plagued with trouble. In the current situation, construction of infrastructure is executed by (private, national) building companies but supervised by an IRL managing supervisor. Budget and time overruns of construction work are common. An appropriate example in this matter is the Fast Line Tel Aviv – Jerusalem where large viaducts have been built, but not a single track is yet constructed due to delays elsewhere in the project.

Since a lot of infrastructure expansion projects are either in the construction or planning phase, research into the current organizational structure is required in order to avoid planning and construction troubles that currently arise

§1.4.3 Little commercial use of stations and station areas

Investments of the past decade improved IRL's stations significantly; there can be no discussion about this point. A striking example (Rosh HaAyin station) can be seen in Figure 8.



FIGURE 8: ROSH HAAYIN STATION IN 1998 (LEFT) AND 2003 (RIGHT)

Although subsidies did improve the quality of a great number of stations, all key players bring up the lack of commercial activity both within the stations and in the adjacent station areas. Stations are no attractive 'places to stay, to shop or to meet'. They are simply functional, empty buildings for passengers waiting to board a train. IRL earns no money from sales in adjacent shopping centers or from the (very limited) commercial sales inside the stations. (TASC Consultants). Commercialization and improving the quality of stations is therefore a main point for improvement.

Stations in Israel are unattractive places to stay and to wait for trains to catch. IRL does not make full use of the commercial possibilities of its stations and adjacent areas yet and in the current organizational setup has no incentive to do so.



FIGURE 9: DIFFERENT COMMERCIALIZATION LEVELS OF STATIONS.
LEFT: LEIDEN CENTRAL STATION; MIDDLE; AMSTERDAM CENTRAL STATION;
RIGHT: TEL AVIV CENTRAL RAILWAY STATION.

§1.4.4 Rolling stock acquisition and maintenance

In the current situation, rolling stock is procured, acquired and maintained by the rolling stock division of IRL. Suppliers from Europe and the USA have delivered rolling stock in large volumes, after competitive tendering took place.

Rolling stock is maintained by IRL's rolling stock maintenance division and this is where issues arise. IRL is acquiring new rolling stock at high pace in order to cope with the growing demand of rail transport. It is unclear if the maintenance division of IRL has enough capacity and knowledge to service all these new rolling stock types adequately.

For the near future, since IRL has plans to electrify its lines, the question if there is enough capacity to maintain new electric rolling stock types as well remains yet to be solved.

Although IRL places large orders for new rolling stock on the international market (involving competitive tendering), adequate maintenance of rolling stock is a problem.

§1.4.5 Financial administration: No separate accounts of various divisions

In the current organizational structure, money streams flow between different divisions and branches within IRL. Proper accounting of these money streams is currently lacking. In this way unintentional 'cross subsidizing' takes place of divisions that operate with (constant) deficits. It remains unclear where exactly the large sums of allocated government money flow to, which divisions of the company function efficiently and which divisions make financial losses without obtaining appropriate results.

The current organizational structure does not support separate financial accounting of divisions. It remains therefore unclear which divisions operate efficiently and in which divisions losses are compensated by (unintentional) cross subsidizing.

§1.4.6 Transparency issues: Unclear division of roles within the company

As the organizational structure of Figure 5 displays, there is a division of roles in IRL, but only internal. Transparency regarding these roles is unclear to institutions and bodies outside IRL. An interesting example is the Accident Investigation Unit that is an integral branch of the Safety, Security and Environment division. If any accident happens, it remains questionable if this unit experiences enough objectivity to investigate the accident independently in order to come to appropriate results.

The lack of transparency to institutions, bodies and customers outside IRL and the unclear division of roles inside the company is problematic.

CHAPTER 1.5: CONCLUSIONS

Israel Railways has faced totally different policies from the central government for the past decades. Especially since the strong competition of road transport, starting from the 1960s up to the 1990s, the national government left IRL to cope 'on its own' without significant financial investments in infrastructure, rolling stock or services. The lack of governmental interest finally resulted in selling IRL to the Ports Authority in 1988.

This sale to the Ports Authority presented the first signs of the rebirth of IRL. The Ports Authority had money to invest and small improvements made their way through to the railway company.

Major changes took place in 2003. The national Israeli government stated that the railways should become 'a major transport facilitator in the state of Israel' and large financial contributions were awarded to IRL. The governmental ties were strengthened and IRL moved out of the Ports authority, becoming a public limited liability company fully owned by the state. Although infrastructure and rolling stock were modernized in very high pace, the organizational structure of IRL, with all divisions integrated into a single body, was not changed significantly.

This unchanged organizational setup today presents a number of issues in managing the railway company efficiently while complying with the new policy goals of the national government. Since IRL plans to expand its network and services significantly in the upcoming years, the organization might need change as well in order to cope with the challenges that lie ahead in the nearby future.

Over time, it is estimated that Israel's railways will resemble current railway systems in European countries more and more regarding network and services. This is the main reason to look into more detail at European railways in particular, in the following parts of this thesis report.

Based on Chapters 1.1 to 1.4, recommendations for the investigation of European Railway Organizational models include:

1. Pay attention to the relationship Authorities - Infrastructure - Transport
2. Pay attention to Institutions/Agencies/Authorities that manage safety aspects in railway operations
3. Look into possibilities for reform of the relationship Infrastructure and Transport operations
4. Pay special attention to possibilities for organization of Rolling Stock Maintenance
5. Pay special attention to possibilities for organization of Infrastructure Maintenance

PART 2: ORGANIZATIONAL STRUCTURES EUROPEAN RAILWAYS

Part 2 provides organizational structures in national railway sectors for 35 countries, including 27 European countries. The organizational structures are presented in a visual way by using an abstract framework adapted from (van de Velde & Röntgen, 2008).

The analysis yields insights in typical setups of European railway sectors. Three typical setups are identified to which most European railway sectors hold.

Following a specific wish from Israel; Public Procurement (PP) schemes in Europe's Heavy Rail Sector are looked at in brief. The relationship between organizational structure and PP projects is briefly discussed as well.

CHAPTER 2.1: HISTORY EUROPEAN RAILWAY REFORMS

Since the first train hit the rails in the early 1800s, railway history was written throughout the decades to follow. The railways experienced a stormy start in the early years and up till the 1950s remained to be a strong competitor in transporting both cargo and passengers over its steadily expanding networks. In those early days, railway companies were typically organized as private limited parties operating 'their' network and running 'their' services; all of them completely private business driven. (Rothengatter, 2007) This changed substantially after the First and Second World War since many governments, especially in Europe and Japan, decided to 'nationalize' the private companies into a state owned, national railway undertaking. In the USA, cargo companies remained private, while a state owned passenger company (Amtrak) was funded, both parties operating under strict state regulation. (Rothengatter, 2007)

Although the more recent history of railways differs slightly per country, general trends were apparent in almost all European countries. These general trends showed since the 1950s a decline in market share regarding passenger and cargo transport by rail while costs of maintaining and operating the railway system were rising. The increasingly fierce competition of other modalities (especially the road and aviation sector) meant that income of railway companies became more and more dependent on government grants and subsidies, rather than revenue from ticket sales or cargo payments. (Levy, et al., 2005)

The monopolistic structure of the railways was unable to adopt a strategy that could reverse the declining figures. Combined with the shift in the Western Europe economy towards a service and retail economy, turning away from the traditional heavy industry (to which the railways had been a well suited modality), most railways' market shares began to fall. Compared to the Western situation, Eastern Europe experienced a much more abrupt and severe decline in rail transport during the early 1990s after the collapse of the communist planning regime, in which railways used to play a significant role. (CER, 2005)

This decline of revenue (in both the passenger and cargo markets), combined with the increasing costs for maintaining infrastructure and rolling stock, resulted in severe debts for almost all railway companies. These historical debts pressed more and more on the financial resources of the state governments throughout Western Europe, due to the state owned structure of the railway companies. (CER, 2005) (Nash, 2008) Something had to be done to make the railway companies profitable again and to increase the market share of rail transport compared to other modes of transport. Most Western European railways were about to face the most fundamental rail reform program, since the nationalization period of the 1940s.

The start of this fundamental reform was instigated by Council Directive 91/440/EEC that was issued by the European Union (EU) in the early 1990s. In line with the new visions on railway policies, the EU approved over the subsequent years a number of 'railway packages'. In each package the EU stated main objectives and specific regulations or requirements in order to 'liberalize and open up' the railway markets (Streichfuss, 2010). National governments of EU member states were given time, but eventually had to transpose the European regulations into their national legislation.



FIGURE 10: EU RAILWAY POLICY OVER THE PAST 20 YEARS. ADAPTED FROM (STREICHFUSS, 2010)

The EU reform policy was partly preceded by the Swedish railway reform. Already in 1988, the Swedish government initiated a railway reform from a vertically and horizontally integrated monopoly towards a market characterized by decentralization and inter-modal competition. (CER, 2005) So to speak; Sweden was at that moment 'ahead of the European regulations', marking the absolute starting point of an irreversible process that would later be called the European Rail Reform program.

This starting point marked a notable change into the national policies and to the historical state ownership of railway companies. Throughout the different countries in Western Europe new organizational models were implemented that, although some did resemble elements of others, more or less are unique per country. The EU deliberately left space open for national interpretation of its regulations, so that member states could adopt a model that was 'best suited' for their specific situation and so the member states did.

This variety of railway organization models is looked at into close detail in following chapters of the thesis report. Now that the main railway reforms are already a decade behind us, the consequences of the reforms can be measured and the visions expressed in the 1990s can be evaluated.

Only one thing becomes clear from most of the literature studied: the European railway sector has in general terms managed to put a stop to the declining figures of the 1950s and 1960s. Market shares of passenger and cargo transport by rail are rising again over the past few years. Although external factors (such as increased attention for environmentally friendly transport modes and population growth) may have contributed to this increase as well, literature is quite consistent to attribute this growth at least partly to the recent restructuring of the management organization. It appears that the traditional integrated and state owned railway companies in most European countries have ceased to exist since the end of the last Millennium.

Or did they..?

CHAPTER 2.2: RAILWAY SECTOR ANALYSIS - RESEARCH METHODOLOGY

When analyzing organizational structures of European railway sectors, it is important to follow a systematic and equal research route in order to avoid differences in assessment between countries. This chapter therefore provides more information on the research methodology, introduces an appropriate framework and clarifies the chosen subset of examined countries.

§2.2.1 Framework

The framework 'Authority – Infrastructure – Transport', first used by (van de Velde, et al., 2008), is chosen as an appropriate cadre to systematically separate the three main components of a railway sector. Figure 11 presents a blank version of this framework.

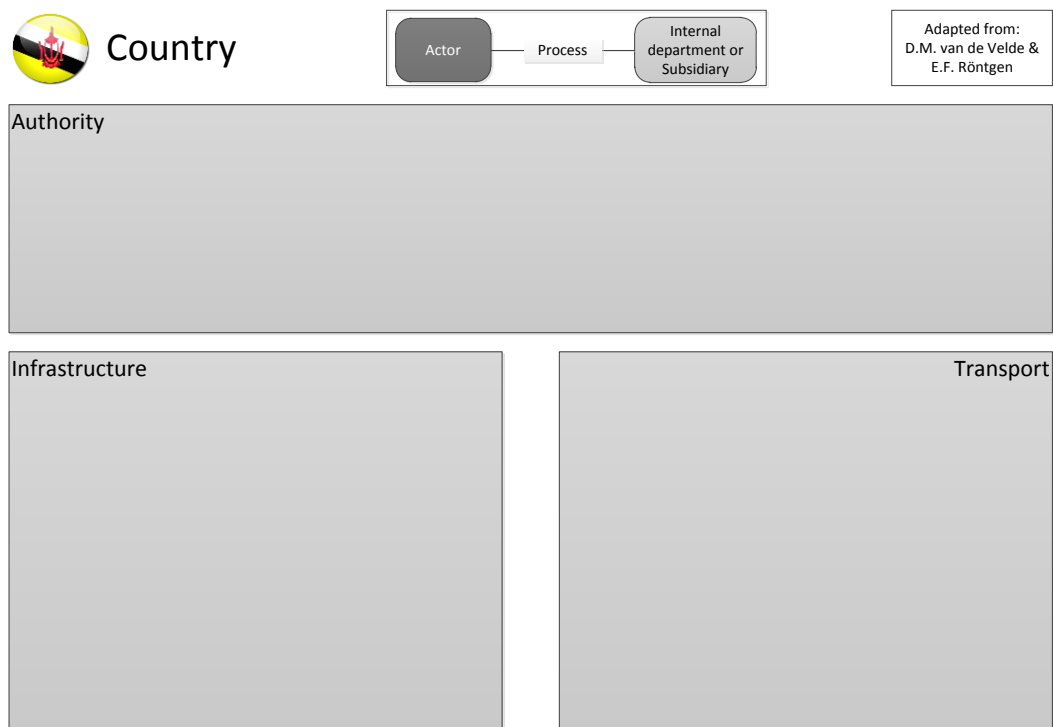


FIGURE 11: FRAMEWORK 'AUTHORITY - INFRASTRUCTURE - TRANSPORT'
(VAN DE VELDE, ET AL., 2008)

This standardized framework enables one to compare organizational models from different countries at a glance. In this framework, all the different actors active in a country's railway sector are placed in either one of the boxes Authority, Infrastructure or Transport, according to their specific role. When a specific actor plays a role in multiple components (e.g. Authority and Infrastructure) it is also possible to place them in two or even all three of the boxes.

Relationships between organizations are displayed by arrows and lines linking the organizations and explaining the nature of the relationship. Properties of ownership are added for the most important organizations.

In the original framework, used by van de Velde & Röntgen, no separation is made between cargo and passenger operations. In this thesis work this separation is provided since countries

may organize their cargo and passenger divisions quite differently and it is relevant for this research to keep this level of detail.

The financial relationships, which originally have been added by van de Velde & Röntgen, are left out in this thesis work. Although financial relationships are very important drivers in a railway organization, detailed financial analysis per country is very hard to execute, due to the confidentiality of most required data. As a result, detailed financial analysis would take too much research time to complete.

Within a railway company, infrastructure manager or public body, departments or subsidiaries take care of various tasks in a railway system. These departments and/or subsidiaries are added to the models to increase the level of detail: being able to judge the organizational setup as a whole.

One more addition to van de Velde & Röntgen is the organization of rolling stock maintenance. Organizations responsible for rolling stock maintenance are added to the frameworks. In some cases, operators take care of rolling stock maintenance internally. In this case the label 'R.S. Maintenance \cup ' is added to the companies to which this applies.

Van de Velde & Röntgen provide already filled-in frameworks for Belgium, Denmark, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the urban network of Greater London. These frameworks have been presented first in (van de Velde, et al., 2008) and are refined in (van de Velde, et al., 2009). Since in this thesis work all European countries and some non-European countries are assessed (a complete list is provided in §2.2.3), the available frameworks of van de Velde & Röntgen are further refined and used as a basis. Frameworks of other countries are added to the total set.

§2.2.2 Research Process

The main aim of this research step is to fill in the empty blocks in Figure 11 with the main actors, interfaces and processes of railway sectors in the countries under examination. As previously stated; it is important to follow a systematic and equal approach for all countries. The systematic approach contains the following research steps:

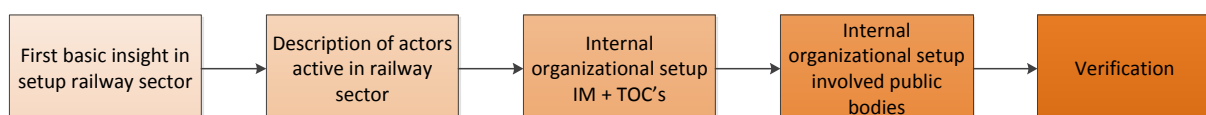


FIGURE 12: SYSTEMATIC APPROACH FILLING IN FRAMEWORKS RAILWAY SECTORS

A first, basic insight in a country's railway sector is obtained by reading the Network Statement from a national Infrastructure Manager (IM). These Statements (mandatory by EU regulation) are in most cases annually drawn up by the IM's of EU member states. All EU member states provide a Network Statement, but some statements are dating some years back. Appendix 2.1 provides an overview of the current status of the Network Statements used for this research. For countries outside the EU/EFTA, Network Statements are unfortunately not published. If a Network Statement provides too little information about a country's national railway sector, additional sources are examined, as displayed in Table 2 (next page).

A description of the main involved actors is obtained by examining the Network Statements, the additional sources from Table 2 and, as a last resource, Wikipedia webpages on a national country's railway sector.

TABLE 2: ADDITIONAL SOURCES CONSULTED

Document	Authors	Year of publication
Public Service Rail Transport in the EU: An Overview	CER	2005
Reforming Railways, Learning from experience	CER	2011
European Railways Administrations, Institutions and Legislation (Erail)	NEA, OGM, University Oxford, TINA, Erasmus University, TIS	2005
Liberalization Index 2011	IBM Business Services & Kirchner	2011
Annual Reports Infrastructure Managers & Train Operating Companies	Various	2009-2011

In the following research step, internal organizational setups of Infrastructure Managers (IM's) and Train Operating Companies (TOC's) are examined. Information on internal organizational setups is extracted from annual reports and web pages of national IM's and TOC's. This information is again augmented by additional material taken from the sources of Table 2. The same procedure is followed for examining the internal organizational structure of public bodies.

In the final research step, verification takes place if information from various sources matches. If this is not the case, the most reliable and most recent source is taken along. If information matches, finally all actors are put in the empty framework.

A summarizing overview of this procedure is added in Figure 13.

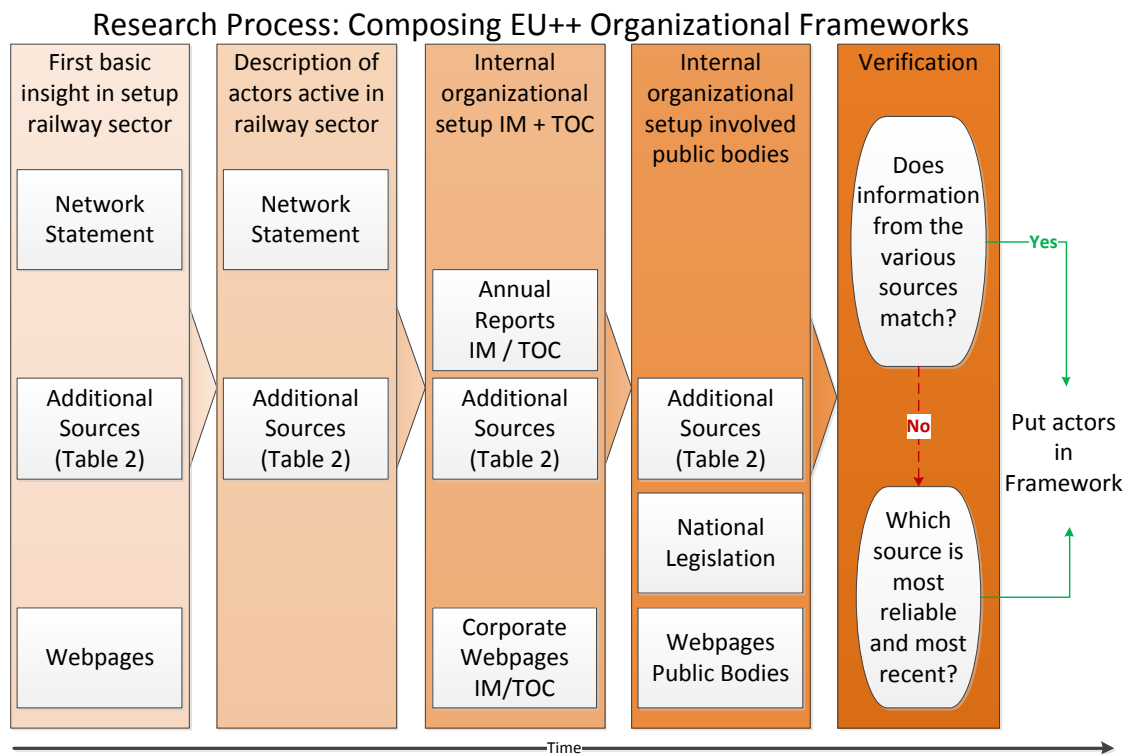


FIGURE 13: RESEARCH PROCESS OF COMPOSING EU++ ORGANIZATION MODELS

§2.2.3 Examined set of countries

For this thesis work, the railway organization models of the EU + EFTA (European Union + European Free Trade Association) countries are primarily looked at. As an addition, models from Canada, Japan, Russia, Turkey and the USA are also composed because these differ completely from the European models. Jordan and Morocco are furthermore added to the list of countries, following a specific wish from Israel, since in these countries large organizational reforms are planned for the nearby future.

The following countries are thus included in the long list:

TABLE 3: LONG LIST OF COUNTRIES TAKEN ALONG IN RESEARCH

Austria [EU]	Lithuania [EU]
Belgium [EU]	Luxembourg [EU]
Bulgaria [EU]	Morocco
Canada	Netherlands [EU]
Croatia	Norway [EFTA]
Czech Republic [EU]	Poland [EU]
Denmark [EU]	Portugal [EU]
Estonia [EU]	Romania [EU]
Finland [EU]	Russia
France [EU]	Slovakia [EU]
Germany [EU]	Slovenia [EU]
Greece [EU]	Spain [EU]
Hungary [EU]	Sweden [EU]
Ireland [EU]	Switzerland [EFTA]
Italy [EU]	Turkey
Japan	United Kingdom [EU]
Jordan	USA
Latvia [EU]	$\Sigma = 35$ Countries

In the following parts of this report, every time a referral is made to this list of countries, the abbreviation ‘**EU++ countries**’ is used (**EU + EFTA + specific countries of interest**).

Although in most literature often the same (Western) European countries are taken along, it is a specific wish of HTM Consultancy to take Eastern European and Balkan countries into account as well. These countries might provide interesting models that are located in between the modern Western European models and the former ‘state owned railway company’ models. It is therefore decided not only to take Western European countries but also Eastern European countries along, resulting in the EU++ country list, as displayed in Table 3.

Since a lot of Eastern European countries only recently joined the EU, the transformation process of railway sectors in these countries is still evolving while the countries are implementing EU regulations to their best ability.

Results of the analysis are presented in a summarized form in Chapter 2.3 and as a comprehensive overview for all 35 EU++ countries in Appendix 2.2. In the next chapter, three typical organizational structures are introduced to which most of the 27 examined European countries hold.

CHAPTER 2.3: TYPICAL ORGANIZATIONAL STRUCTURES EUROPEAN RAILWAY SECTORS

Analysis of 27 European countries yields an overview of main organizational structures in European railway sectors. Three 'generic models' are visible to which the organizational structures of most European sectors in general hold:

- Integration Model
- Holding Model
- Separation Model

In the next paragraphs these three typical models are illustrated in more detail and a list of countries, having a specific type of model in place, is added. Concise (textual) explanations of detailed setups per country are added in Appendix 2.3.

The following main actors active in a railway sector are displayed in the generic frameworks of §2.3.1 to 2.3.3:

Regarding 'Authority', actors responsible for safety licensing, operator licensing, competition monitoring, strategic transport planning, budget allocation, concession management and transport policymaking are included. Safety licensing includes licensing of rolling stock equipment and personnel. Operator licensing prevents unstable companies to enter the railway sector. Strategic transport planning and policymaking determine a country's overall transport policy regarding multiple transport modes. Budget allocation represents allocation of financial funds to either infrastructure construction, infrastructure maintenance or transport operations. Concession management includes specification of (required) public transport services, contract management and granting operation franchises to transport companies.

Regarding 'Infrastructure', actors executing construction and management of infrastructure are included. Infrastructure construction comprises renewal or maintenance of tracks and installations in the railway system. Infrastructure management contains procurement of materials, administration of maintenance, capacity allocation and provision of rail traffic management.

Regarding 'Transport', actors providing Passenger transport services, Cargo transport services and Rolling stock management services are included in the frameworks. Passenger transport services include provision of passenger information. Rolling stock management includes procurement, acquisition and maintenance of equipment suitable to offer passenger or cargo transport services by rail

§2.3.1 Integration Model

The Integration model typically contains a vertically integrated national railway company, dominating the railway sector. Although differences per country exist, these integrated companies typically organize (one or more of) the following tasks internally:

- Accident investigation
- Determining standards for safety, environmental issues and personnel licenses
- Procuring, inspecting and licensing rolling stock and infrastructure material
- Usage monitoring of the railways
- Performance monitoring of the railways

Infrastructure construction and management, transport operations and rolling stock management and maintenance are all organized by internal divisions of the integrated railway company. This integrated railway company is in all European countries 100% owned by the state or a public institution.

Public bodies that, next to the integrated railway company and national ministries, execute rail related functions are national railway inspectorates, licensing authorities (in some countries included in the railway inspectorate) and competition authorities. Tasks and responsibilities of competition authorities in the integrated model remain limited, since in the integration model typically little competition takes place in the railway sector. A simplified and abstracted visualization of the Integration Model is provided in Figure 14.

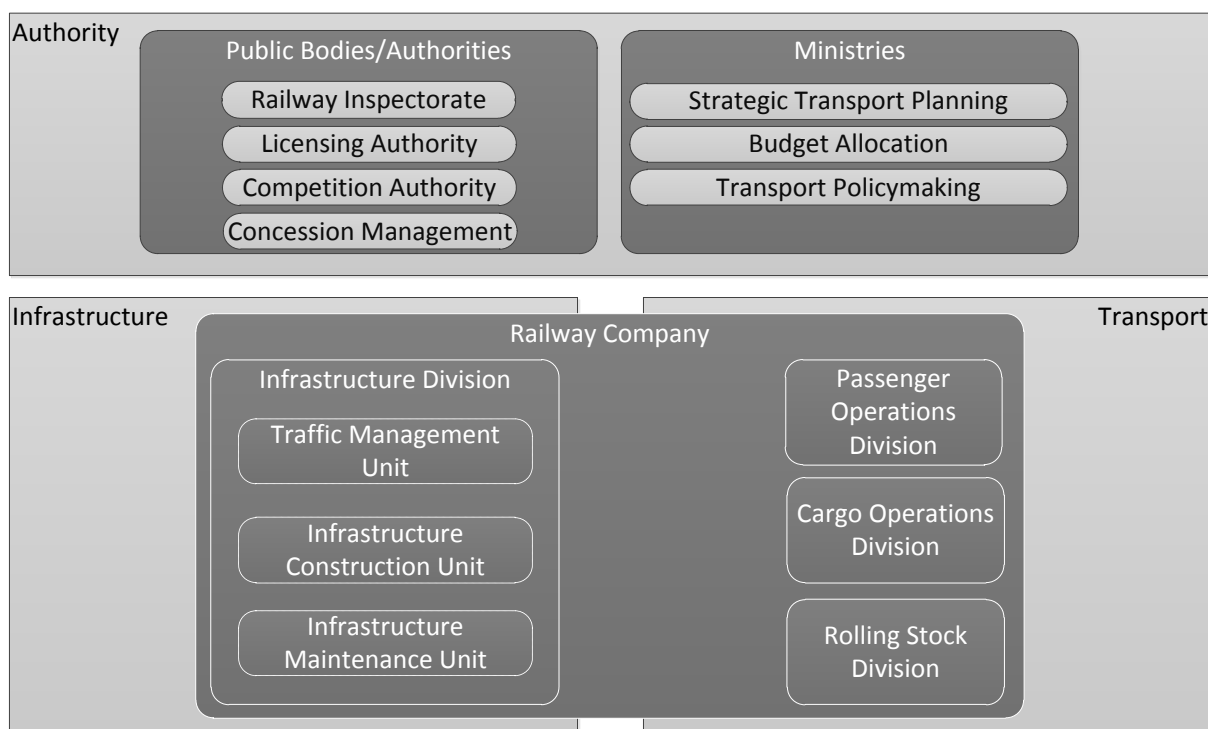


FIGURE 14: SIMPLIFIED INTEGRATION MODEL USED IN EUROPEAN RAILWAY SECTORS

The integration model is likely to conflict with current European regulations since no accounting separation between infrastructure and transport operations is guaranteed.

European countries that in 2011 still have an integrated organization model in place are:

- France²
- Ireland
- Lithuania
- Luxembourg
- Slovenia
- Switzerland

² France did separate IM RFF from SNCF, but links between these parties remain that strong that one can still speak of an integrated structure. As an example, all construction and maintenance of French railway tracks is conducted by internal departments of SNCF. Rail traffic management is also provided by an internal department of SNCF. Furthermore, the French railway market for all passenger transport operations remains closed for external TOC's; SNCF possesses a clear monopoly on all domestic passenger transport services. These characteristics form the main reasons for France to be categorized in the 'integrated' group of countries.

§2.3.2 Holding Model

The Holding model sees the initiation of a Holding company that remains 100% state owned or a public institution. The Holding company functions as an umbrella, covering multiple subsidiaries. These subsidiaries take care of the main tasks in a specific business area (e.g. infrastructure management or transport operations). The Holding company is in all countries detached from the authority part (all regulatory tasks are in the hands of public agencies or ministries). A typical (simplified) Holding setup is displayed in Figure 15.

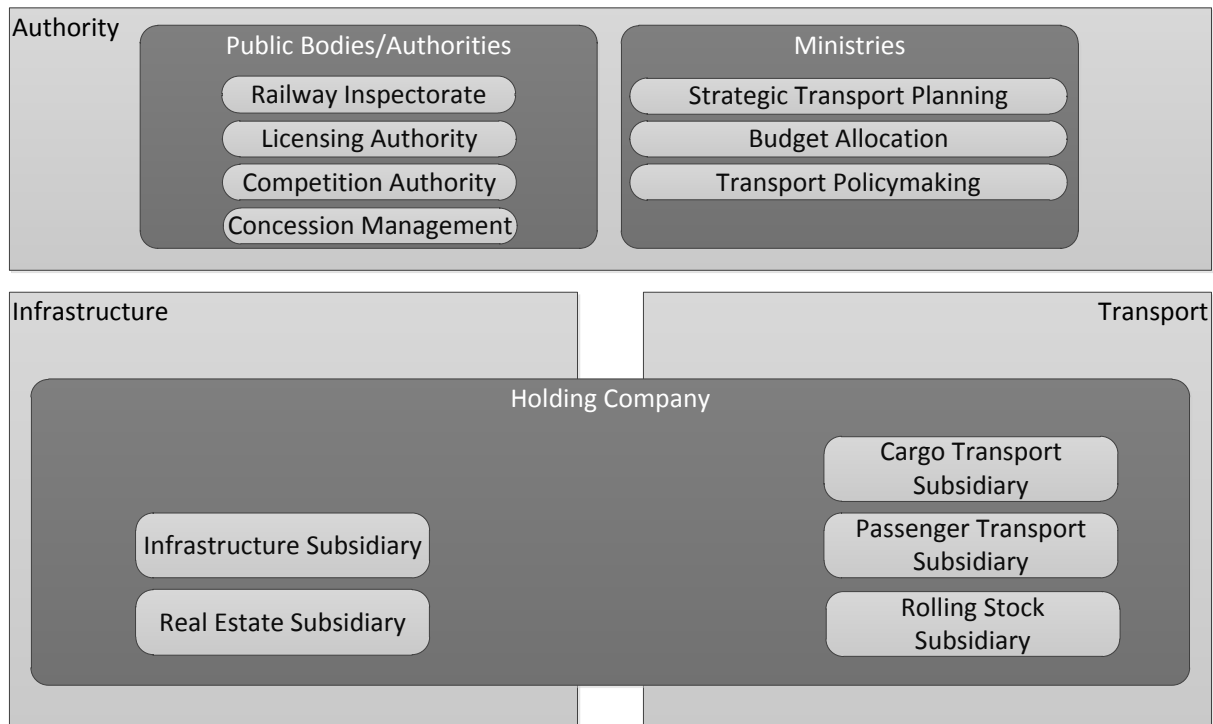


FIGURE 15: SIMPLIFIED HOLDING MODEL USED IN EUROPEAN RAILWAY SECTORS

Although the Holding model might at first glance resemble the integration model regarding the overall structure; the most important and fundamental difference is the transition of internal departments to subsidiaries inside the Holding company. These subsidiaries are in most EU countries independent Ltd. companies, conducting independent financial accounting and experiencing a certain degree of entrepreneurial freedom.³ The Holding model is typically a 'transition' model that is situated in between a vertically integrated and a vertically separated railway sector.

The Holding model separates financial accounts between infrastructure management and transport operations. The Holding model therefore meets EU regulations and is frequently used throughout Europe. Although there are internal differences, the following European countries have an organizational setup in place that resembles the Holding model closest:

- | | | |
|-----------|-----------|-----------|
| - Austria | - Estonia | - Hungary |
| - Belgium | - Germany | - Latvia |
| - Croatia | - Greece | - Poland |

³ The degree of entrepreneurial freedom subsidiaries possess, differs significantly per European country. In Belgium for example the subsidiaries of NMBS Group (Infrabel, NMBS Holding and NMBS) are largely independent companies whereas Deutsche Bahn subsidiaries experience a much stronger influence from the Holding company.

§2.3.3 Separation Model

The separation model is the most far reaching liberalization model in Europe present today. It places a clear cut between regulatory tasks, infrastructure management and transport operations.

As a sub variant of the separation model, models containing a combined executive agency for road and railway infrastructure management are emerging (e.g. Trafikverket in Sweden).

Authority

Ministerial departments and (semi) independent public bodies are responsible for regulating the railway sector; determining transport policy, issuing and monitoring safety regulation and guaranteeing a level playing field. These public actors are responsible for licensing rolling stock equipment and for licensing Train Operating Companies (TOC's), willing to offer transport services, in order to prevent unstable companies entering the system.

Infrastructure

In most European countries, railway infrastructure and railway related (signaling) systems are still owned by national governments, but management is 'outsourced' to independent Infrastructure Managers (IM's), based on management and performance contracts. These IM's are responsible for organizing infrastructure construction, maintenance and provision of rail traffic management to all TOC's using their network. IM's may conduct small maintenance internally or may outsource all maintenance work to external (private) construction companies. All Infrastructure Managers in EU+EFTA countries are 100% state owned companies or public entities.⁴

Station Management is in some cases still conducted by (subsidiaries of) incumbent TOC's. A typical example is visible in the Netherlands: Dutch Infrastructure Manager ProRail is responsible for platforms and walking routes only, a subsidiary of Dutch Railways (NS Poort) is responsible for real estate management and commercial exploitation of stations and station areas. In Sweden, a separate state owned company (Jernhusen) is responsible for station management.

Transport services

TOC's provide both passenger and cargo services on the network managed by IM's. TOC's are (a.o.) responsible for staff management, providing travel information and timetables (sometimes in cooperation with the IM) and selling tickets.

In most countries an incumbent TOC still takes care of a large share of passenger operations. External (sometimes private) TOC's operate passenger services on specific lines (competition 'for the track'). In a limited amount of cases, external (private) TOC's directly compete to incumbents on the same lines (competition 'on the tracks').

Regarding provision of cargo services, (private) external TOC's compete to incumbent TOC's directly. Large international players have succeeded national incumbent TOC's. National subsidiaries of these large international cargo TOC's organize cargo transport services throughout Europe. Next to the large international TOC's, smaller (national) cargo TOC's still serve niche-markets.

⁴ The United Kingdom initially privatized Infrastructure Manager 'Railtrack plc' in 1994. Railtrack plc was placed into administration in 2001. In 2002 Railtrack's assets were transferred to the 'Not for Divident' public company 'Network Rail'. Network Rail remains to this day the main manager of railway infrastructure in the UK.

Rolling Stock Management & Maintenance

Regarding rolling stock maintenance and management, most European countries having a Separation Model in place, still put this responsibility in the hands of the (incumbent) TOC. The incumbent's rolling stock maintenance division or subsidiary performs refurbishment and overhaul services and may also offer these services to external (private) TOC's, other than the incumbent. External TOC's may also contract directly with external (private) maintenance companies (e.g. Bombardier, Alstom).

Only the United Kingdom currently has separate (private) 'Rolling Stock Companies' (Rosco's) in place. These Rosco's own and lease rolling stock equipment to various TOC's, for the duration of the TOC's franchise. Small maintenance is carried out by the TOC's themselves, refurbishment and overhaul of equipment is executed by the Rosco's.

The separation model is widely used throughout Europe, in different (detailed) setups. Some countries have a mix between a Holding and a Separation Model in place when taking station (real estate) management into account (e.g. the Netherlands, Norway); others present a more 'pure' form of the separation model (e.g. Romania, United Kingdom). Figure 16 displays an abstracted and simplified setup of the Separation Model.

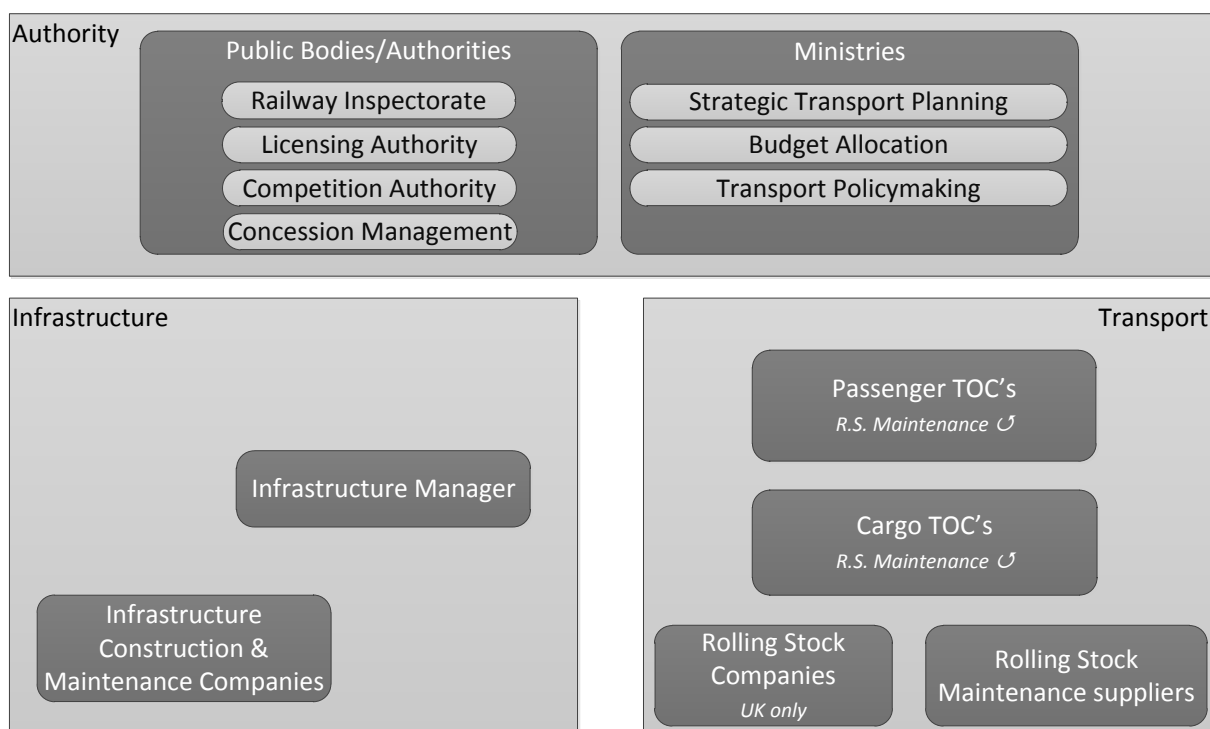


FIGURE 16: SIMPLIFIED SEPARATION MODEL USED IN EUROPEAN RAILWAY SECTORS

The following European countries currently have an organizational setup in place that resembles the separation model closest:

- Bulgaria
- Czech Republic
- Denmark
- Finland
- The Netherlands
- Norway
- Portugal
- Romania
- Slovakia
- Spain
- Sweden
- United Kingdom

CHAPTER 2.4: PUBLIC PROCUREMENT AND ORGANIZATIONAL STRUCTURES

Public Procurement (PP) schemes have been used widely in construction of infrastructure; most cases apply to road construction. Traditionally, governmental agencies are responsible for infrastructure planning and drafting detailed designs, while construction companies build the infrastructure according to these detailed designs.

In recent years, more and more involvement of construction companies also in the planning and design phases of infrastructure projects resulted in new PP schemes:

- Design&Build (DB)
- Design, Build, Finance, Maintain (DBFM)
- Design, Build, Finance (DBF)
- Design, Build, Operate, Finance, Maintain (DBOFM)

In European heavy rail systems, only 12 projects have been conducted using new PP schemes over the past 20 years, excluding projects that are 100% financed by private capital (Hansen, 2010). Most of the executed projects contain construction of new rail links and high speed rail lines, a complete overview is provided in Appendix 2.4

PP contracts in Europe's heavy rail sector typically do not include transport operations. Transport concessions are awarded separately to (subsidiaries of) incumbent, state owned railway companies (Hansen, 2010). By far, most PP projects are DBFM contracts in which a consortium is responsible for infrastructure design, construction, maintenance and in some cases rail traffic management. The only DBFOM contract to date is signed in France, but 'operation' remains limited to the communication systems and does not include transport operations (Hansen, 2010). Under a DBFM contract Authorities/Public bodies are in most cases responsible for payback of investment costs while transport operators pay an annual usage fee for operating on the infrastructure.

This thesis report does not aim to provide extensive detail about PP projects undertaken in the heavy rail sector. All the organizational structures (Integration, Holding and Separation) are in principle suitable for executing heavy rail projects using new PP schemes. However, problems may arise if new PP schemes are executed in the integration model. In the integration model the incumbent railway company possesses 'a monopoly on knowledge' and is responsible for all transport operations. Operation of a specific railway line by external operating companies instead of the incumbent is unlikely. It should be concluded that new PP schemes can be more easily implemented in the Holding and Separation structures. A summarizing overview of the setup of PP projects in the European Heavy Rail sector is displayed in Figure 17.

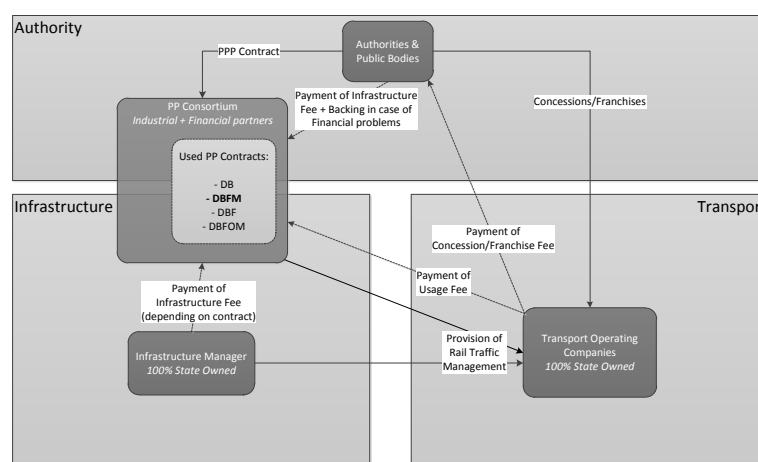


FIGURE 17: TYPICAL SETUP OF PP PROJECTS IN THE EUROPEAN HEAVY RAIL SECTOR, ENLARGEMENT OF THIS FIGURE PROVIDED IN APPENDIX 2.5.

CHAPTER 2.5: CONCLUSIONS

Thorough analysis on Europe's heavy rail sectors yields the following conclusions:

- Three Railway Packages issued by the European Union between 1991 and 2007 liberalized and opened up the railway sectors in EU member states.
- EU legislation deliberately left space open for national interpretation; all member states implemented a structure, meticulously fine-tuned to their national situation. A single generic structure cannot be abstracted, but three typical models are visible: the Integration, Holding, and Separation model.
- Railway sectors are liberalized, but not privatized. In all EU+EFTA countries (except the United Kingdom), incumbent railway companies remain 100% state owned or public entities (corporization instead of privatization). These incumbent railway companies remain in general responsible for the main share of passenger operations in a domestic railway system. Large international cargo operators (in most cases closely affiliated to incumbent national railway companies) operate on a liberalized market, serving multiple EU+EFTA states.
- Authority powers remain in smaller member states in the hands of national governments; in larger member states responsibilities are shared between national and regional/local governments. Licensing duties and safety monitoring are in most countries attributed to a (semi) independent public institution (Transport Inspectorate).
- In the separation model; all Infrastructure Managers remain 100% state owned companies or public institutions.
- External TOC's (new entrants) emerge in passenger operations next to incumbents, but their share remains limited (the only exception being the United Kingdom). A recent development shows that external (private) TOC's are again acquired by incumbent state owned railway companies (e.g. acquisition of Arriva by German State Railways).
- In passenger operations, 'competition for the track' is used in most member states; 'competition on the track' remains very limited until now. In cargo operations, 'competition on the track' is becoming more and more common in EU member states.
- Large differences in the degree of liberalization are visible between EU+EFTA countries, caused by the fact that particular member states only recently joined the EU (e.g. Balkan countries), while others already have years of experience to build on.
- New Public Procurement schemes have been executed in Europe's heavy rail sectors, but only in a limited amount of cases. European heavy rail PP projects are mostly contracted as DBFM contract in which a private consortium takes care of infrastructure design, construction, maintenance and in some cases rail traffic management. Transport operations are typically not included, but awarded separately as concessions to train operating companies. New PP schemes can be implemented easily in holding and separated structures. The integration structure complicates implementation of new PP schemes.

PART 3: PERFORMANCE EVALUATION OF RAILWAYS

Performance Evaluation (PE) of railways is a very important topic these days in Europe. It is essential for the European Union, national governments, infrastructure managers and train operating companies to identify if operations are executed efficiently and effectively. PE enables countries and railway companies to benchmark their performance against peers in order to find out if services and products are on a (dis)satisfactory level.

Quantitative ways to measure performances of railway systems are provided by literature and experience from the business sector itself. The chapters in part 3 will analyze and apply two quantitative PE methods:

- Key Performance Indicators (KPI's) on performances of railways in 27 EU+EFTA countries
- Data Envelopment Analysis (DEA) on performances of railways in 8 selected countries

The quantitative performance evaluation yields conclusions on performances of railway sectors regarding efficiency and effectiveness of the production process. These conclusions are taken along in the following parts of this thesis report.

CHAPTER 3.1: PERFORMANCES OF RAILWAYS IN 27 EU+EFTA COUNTRIES: KPI METHOD

In order to gain a first insight in performances of national railway sectors, a quantitative method is used that identifies generic and high-level Key Performance Indicators (KPI's) to evaluate the external (= overall) performance. These KPI's are based on single input-output relationships.

§3.1.1 Approaches to the KPI Method based on literature and practice

KPI's are identified as ratios between inputs and outputs of the 'production process'. By benchmarking the KPI's to railway sectors in different countries, a relative ranking is obtained. Three approaches to conduct a PE on KPI's are illustrated:

1. Comprehensive Combined Performance Evaluation Model (Martin, 2008)
2. Performance Measurement of non-storable commodities, applied to the rail sector (Lan & Lin, 2006)
3. Main pillars of performance measurement using KPI's (Roeleveld, 2011)

1. Comprehensive Combined Performance Evaluation Model

Martin identifies a comprehensive combined performance evaluation model that can be used for comparison of railway sectors. The combination of technological, economic and ecological effects facilitates a strongly abstract comprehensive evaluation.

Before introducing the combined performance model, the terms effectiveness and efficiency need to be defined more accurately:

Effectiveness is the ratio of the result of the work (output) to the achieved effect (outcome). Effective operations mean that the defined goals are fully accomplished by the implemented actions (Martin, 2008). Effectiveness is not related to the production process itself, but to its outcomes.

Efficiency either means to achieve the best possible result (output) with the given resources (input) or to obtain a defined result with the least amount of effort. (Martin, 2008). Efficiency is related to the ratio of input and output in a production process.

Martin combines KPI's on Technological and Economical Effectiveness with KPI's on Economical and Ecological Efficiency. A short explanation of these four different KPI's is provided first:

- Technological Effectiveness KPI's determine the ratio between used supply and offered supply:
 - Used supply is identified as the annual amount of Passenger kilometers (Pkm)⁵ or Ton kilometers (Tkm)⁶ served by a national railway network.
 - Offered supply is identified as the annual amount of Train kilometers (Train-km)⁷ for Passenger (P) and Cargo (C) trains driven on a national railway network
- Economical Effectiveness KPI's determine the ratio between used supply and effort:
 - Used supply is defined again as the annual amount of Pkm or Tkm served by a national railway network

⁵ One Passenger kilometer (Pkm) is defined as one passenger transported over one km of railway network

⁶ One Ton kilometer (Tkm) is defined as one Ton of Cargo transported over one km of railway network (Netto Tkm: excluding the weight of rolling stock equipment. Gross Tkm: including the weight of rolling stock equipment)

⁷ One Train kilometer (Train-km) is defined as a (Passenger or Cargo) train driving one kilometer on a railway network, regardless of train length, train weight or train usage.

- Effort is defined as the annual amount of staff required to perform Passenger or Cargo operations.⁸
 - Economical Efficiency KPI's determine the ratio between offered supply and effort:
 - Offered supply is defined again as the annual amount of Train-km Passenger or Cargo trains have driven on a railway network
 - Effort is defined again as the annual amount of staff required to perform operations
- Ecological Efficiency KPI's determine the ratio between effort and impact:
- Effort is in this respect defined as the costs connected to improvements
 - Impact is defined as the costs of weighted impacts

Figure 18 displays an adaptation of Martin's comprehensive performance evaluation model, summarizing the four introduced KPI's into a single figure:

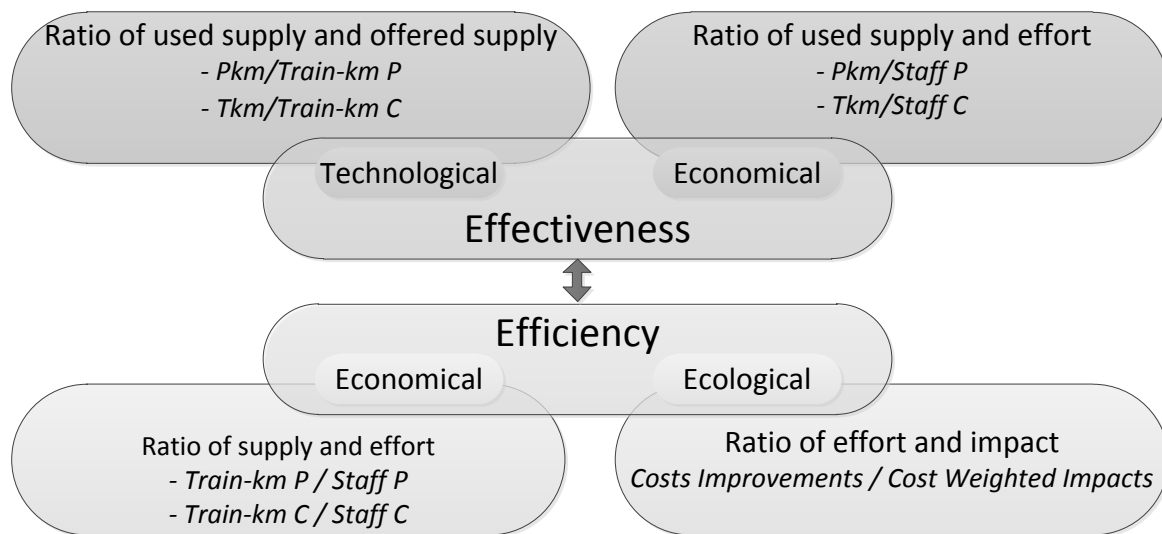


FIGURE 18: COMBINED PERFORMANCE EVALUATION MODEL BASED ON EFFECTIVENESS AND EFFICIENCY. ADAPTED FROM (MARTIN, 2008)

As Martin points out, the influence of the quality of the offered service (e.g. punctuality) is only indirectly taken along in this evaluation method. If the quality of service decreases, the train operating company will lose customers and it will reduce the number of trains as a result.

2. Performance Measurement of non-storable commodities, applied to the rail sector

Next to Martin's model, Lan & Lin define a framework for performance measurement of non-storable commodities, illustrated for the rail transport case (Lan & Lin, 2006). They identify inputs, outputs and outcomes as main indicators; inputs are defined as labor, vehicles, infrastructure and energy; outputs are identified as Train-km (P), Train-km (C); Outcomes as Pkm, Tkm, Passenger Revenues, Cargo Revenues and Affiliated Revenues.⁹

Lan & Lin define the following KPI ratios:

- KPI's Technical efficiency: ratio of inputs to outputs
- KPI's Technical effectiveness: ratio of inputs to outcomes
- KPI's Service Effectiveness: ratio of outputs to outcomes

⁸ Next to staff; rolling stock equipment and invested capital could also be defined as effort.

⁹ E.g. sales of consumption goods in stations or provision of rolling stock maintenance to external operators

It becomes clear that Martin's model and Lan & Lin's model use approximately the same ratios (composed out of the same variables), but use a somewhat different terminology.

Lan & Lin's performance measurement model is sketched in Figure 19.

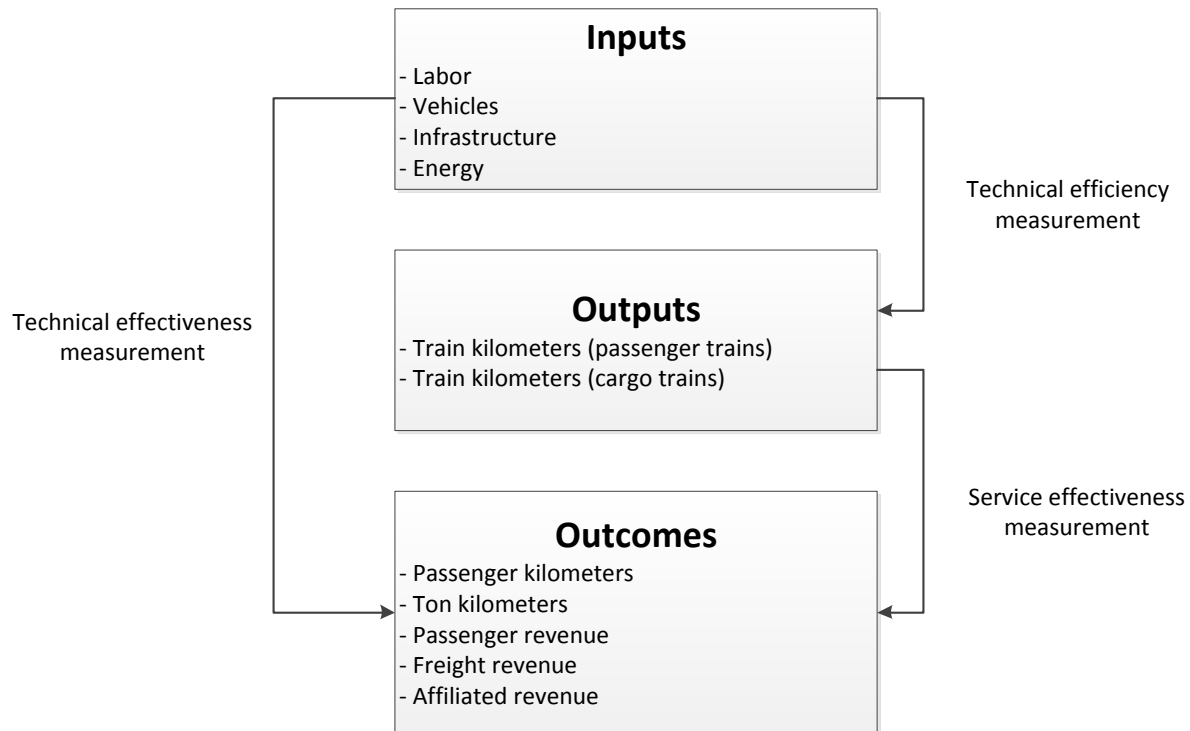


FIGURE 19: FRAMEWORK FOR PERFORMANCE MEASUREMENT NON STORABLE COMMODITIES ILLUSTRATED FOR RAIL TRANSPORT. ADAPTED FROM (LAN & LIN, 2006)

Figure 19 suggests that any poor performance in transport services can be attributed to either poor technical efficiency or poor service effectiveness or a combination of both.

3. Main pillars of performance measurement using KPI's

A further refinement of KPI's indicating relative performances of railways is suggested by Roeleveld (Roeleveld, 2011):

- Maintenance of Infrastructure
Annual amount of Netto Tonkilometers of Passenger + Cargo trains produced on a railway network compared to the annual costs of infrastructure maintenance.
- Usage of Infrastructure
Annual amount of Train-km Passenger + Cargo trains produced on a railway network compared to the length of the railway network.
- Usage of Rail Transport services
Annual amount of Pkm and Tkm compared to the annual amount of Train-km P + C.

Overview of KPI's provided by literature and practice

Martin, Lan & Lin and Roeleveld more or less make use of the same ratios of input, output and outcome indicators in order to obtain suitable KPI's. However, terminology between these

authors varies unfortunately. Table 4 presents therefore a summarizing overview of identified terminology and ratios per actor.

TABLE 4: OVERVIEW OF RATIOS AND TERMINOLOGY USED BY MARTIN, LAN & LIN, ROELEVELD

<i>Ratio Indicators</i>	<i>KPI definition Martin</i>	<i>KPI definition Lan & Lin</i>	<i>KPI definition Roeleveld</i>
Pkm/Train-km P Tkm/Train-km C	Technological Effectiveness	Service Effectiveness	Usage of Rail Transport Services
Pkm/Staff P Tkm/Staff C	Economical Effectiveness	Technical Effectiveness	N/A
Train-km P/Staff P Train-km C/Staff C	Economical Efficiency	Technical Efficiency	N/A
Costs Infra/Netto Tonkm P+C	N/A	N/A	Maintenance of Infrastructure
Train-km P/Network length Train-km C/Network length	N/A	N/A	Usage of Infrastructure

In §3.1.2 a subset of KPI's out of Table 4 will be selected and taken along for performance evaluation of 27 EU+EFTA countries. A clear and unambiguous KPI terminology will be illustrated that is used throughout the subsequent chapters of this thesis report (avoiding terminology differences).

§3.1.2 Selected KPI's and data sources

The previous paragraph introduced a set of KPI's taken from literature and practice. For this thesis report; that aims to investigate the relationship between organizational structure and performance, the following ratios are chosen to be taken along in further research:

- Pkm/Train-km P
- Pkm/Staff P
- Train-km P/Staff P
- Train-km P+C/Network length
- Tkm/Train-km C
- Tkm/Staff C
- Train-km C/Staff C

It should be mentioned that, next to the KPI's introduced in §3.1.1, many more KPI's can be identified by using different inputs, outputs or outcomes. Additional KPI's could include (a.o.) indicators that reflect costs of operation, costs of infrastructure maintenance, amount of rolling stock equipment and energy usage.

In the selected subset of KPI's taken along in analysis, KPI's involving (capital) cost or revenue indicators are deliberately left out. Although cost and revenue analysis is important in determining efficient operations; these data are assumed to be highly commercially sensitive and therefore very hard to obtain for 27 countries. Comparability of cost data between countries is also assumed to be very limited. Therefore the selected subset of KPI's mainly takes the effectiveness and efficiency of the production process into account, rather than 'monetize' values into cost/revenue efficiency analysis.

The selected subset of KPI's is assumed to give a first overview of effectiveness and efficiency of operations. An unambiguous KPI Terminology is introduced that will be used throughout the subsequent chapters of this thesis report. The following terms are used in describing the KPI's:

- Effectiveness of Production: describes the ratio between supply of transport services by rail (output) and actual usage by customers (outcome).

- Effectiveness of Resources: describes the ratio between use of resources in order to provide transport by rail (input) and actual usage by customers (outcome).

- Efficiency of Production: describes the ratio between use of resources in order to provide transport by rail (input) and actual supply of driven train kilometers (output).

Table 5 summarizes and presents an overview of KPI's and Indicators taken along in analysis of performances regarding 27 EU+EFTA countries.

TABLE 5: KPI'S & INDICATORS TAKEN ALONG IN PERFORMANCE EVALUATION 27 EU RAILWAY SECTORS

<i>KPI #</i>	<i>Indicator Ratio</i>	<i>Passenger or Cargo services</i>	<i>Production Process elements</i>	<i>Selected KPI Terminology</i>
1	Pkm / Train-km P	Passengers	Outcome / Output	Effectiveness of Production
2	Tkm / Train-km C	Cargo		
3	Pkm / Staff P	Passengers	Outcome / Input	Effectiveness of Resources
4	Tkm / Staff C	Cargo		
5	Train-km P / Staff P	Passengers	Output / Input	Efficiency of Production
6	Train-km C / Staff C	Cargo		
7	Train-km P + C / Network length	Passengers + Cargo		

As Table 5 displays, selected KPI terminology includes 'Effectiveness of Production', 'Effectiveness of Resources' and 'Efficiency of Production'. These terms will be consequently used in the subsequent chapters of this report.

§3.1.3 Data Collection

Obtaining reliable data on indicators, regarding railway operations, is a complex and time consuming task. Large differences in datasets (internally and compared to other countries) occur. Operational data are in some cases confidential and differences in data measurement methods are common.

The following sources are used for obtaining indicator data in order to determine the KPI's displayed in Table 5:

Source 1: Railisa database UIC

The Union Internationale des Chemins de Fer (UIC) is an international organization representing around 200 members worldwide. Members are typically incumbent state owned railway companies and Infrastructure Managers.

The Railisa database provides various datasets regarding transport performance, volumes of staff, rolling stock and infrastructure. Data is directly supplied to UIC by railway companies that are affiliated members of UIC.

Data is supplied by UIC members only. Since a lot of (especially private) railway companies are no member of UIC, the datasets are incomplete for research of the entire railway sector in a specific country. The UIC data are therefore quite correct if in a country still a single railway company takes care of almost all operations (e.g. Lithuania, Belgium), but data becomes underestimated if a lot of private parties are active on the national market that are no UIC member (e.g. the Netherlands, Germany or Switzerland).

A typical characteristic of Railisa data regarding used Ton kilometers (Tkm) is that these data are consistently higher than other sources for all examined countries. It is therefore assumed that Railisa measures the amount of Tkm in a different way than other sources do. It is likely that Railisa uses Gross Tonkilometers instead of Net Tonkilometers, including the weight of rolling stock equipment in the data. Since this characteristic is consistent for all assessed countries it is assumed that for the final ranking this has little influence (all countries are equally favored/harmed).

Source 2: Eurostat

Eurostat is the European statistics office that is responsible for collecting and providing statistics regarding various topics from European Union member states.

Tables regarding rail transport are available containing statistics on various performance indicators such as transport performance, infrastructure and rolling stock volumes. Eurostat draws the main share of its data from national statistical offices, such as the CBS¹⁰ in the Netherlands. Unfortunately, the datasets are in a relatively large amount of cases incomplete (or in some cases marked 'confidential').

Eurostat does measure the transport performance of all companies in a specific country, not only the incumbents or state owned railways which is, from the viewpoint of this research, an advantage over Railisa data.

Source 3: Railway Directory 2011

Railway Gazette International is a renowned worldwide publisher of railway related publications. This commercially active player provides an annual overview of railway companies in countries all over the world: Railway Directory.

All involved actors in a national railway sector are mentioned including data regarding performance, staff and infrastructure volumes per company. All information is gathered from Annual Reports of the railway companies. Most included data originate from 2009, in some cases datasets from 2006-2008 are supplied.

The Railway Directory presents the most complete source of information, but unfortunately not all railway companies provide details such as Pkm's and staff size.

Source 4: OECD Statistics

The Organization for Economic Co-Operation and Development (OECD) is an international forum in which governments work together in order to promote policies that will improve the economic and social well-being of people around the world. (OECD)

The OECD Statistics Database provides additional information on Pkm's and Tkm's regarding rail transport in various countries around the world.

OECD, like Eurostat, does measure the transport performance of all railway companies in a specific country, not only the incumbents or state owned railways are taken along. Data are

¹⁰ Central Bureau for Statistics

collected through peer reviews with governments and by collecting data through national statistical offices. Some overlap with Eurostat data is likely to be expected, since Eurostat also draws its datasets from national statistical offices.

Overview of used sources

Table 6 summarizes which specific sources of information are taken along in estimating values of different indicators:

TABLE 6: CLARIFICATION ON DATA COLLECTION: INDICATORS AND SOURCES

<i>Used Source Indicator</i>	<i>Railisa</i>	<i>Eurostat</i>	<i>Railway Directory</i>	<i>OECD</i>
Pkm	✓	✓	✓	✓
Tkm	✓	✓	✓	✓
Train-km P	✓	✓		
Train-km C	✓	✓		
Staff P + C	✓	✓	✓	
Network length	✓	✓	✓	

§3.1.4 Methodology Data Analysis

Performance Evaluation on KPI's is conducted for railway sectors in 27 EU+EFTA countries. Data taken from the sources, illustrated in §3.1.3, is collected and processed resulting in relative ranking tables for each KPI. Data analysis methodology consists out of four main steps:

1. During analysis, data taken from a specific source is always kept together for all 27 EU+EFTA countries regarding a specific indicator, yielding 'non mixed indicators'. These 'non mixed indicators' contain indicator values for 27 EU+EFTA countries, based on one of the four sources established in §3.1.3. If a particular source does not provide indicator data; N/A is added.
2. In order to construct KPI's (determining a ratio of indicators), non mixed indicators are for reference divided by other non mixed indicators. The result of this procedure presents multiple 'mixed KPI subsets'. The amount of mixed KPI subsets (N) depends on the availability of data from a specific source. If all sources present information about indicators used in a specific KPI than N = 16. If only a single source presents information about indicators used in a KPI, than N = 1. N therefore ranges between 1 and 16.
3. The median value is taken from the mixed subsets in order to isolate outliers in data and to try to filter out noise influencing the dataset. This median value presents the ranking value of a country in the relative ranking tables.
4. Next to the median values, resulting values of the most complete dataset are also displayed in the relative ranking tables.

A schematic overview of this research methodology is displayed in Figure 20.

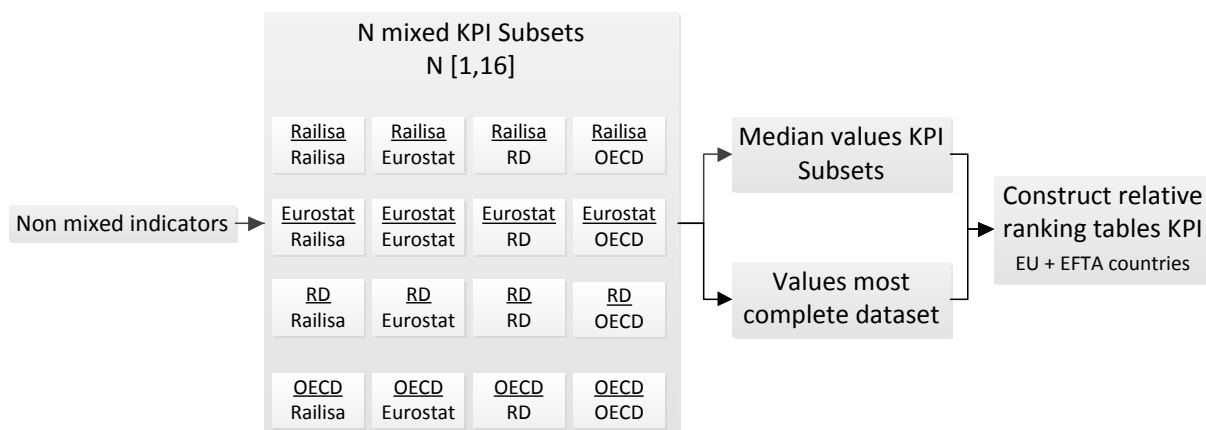


FIGURE 20: CONSTRUCTING RELATIVE RANKING TABLES KPI'S; RESEARCH METHODOLOGY

The research methodology displayed in Figure 20 is chosen to try to mitigate outlying data from the resulting ranking tables (by taking the median values) and to fill in gaps in datasets taken from the various sources (due to absence of data). By systematically following the research route displayed in Figure 20, resulting relative ranking tables are obtained for all EU+EFTA countries regarding the KPI's, established in Table 5.

§3.1.4 Obtained results

After evaluating performances based on 7 abstract and high-level proxies, relative rankings are obtained for 27 EU+EFTA countries. All ranking tables present a similar lay-out, containing columns A to G, as displayed in Figure 21.

Efficiency of Production [Train-km P+C / Network length (km)]							Examined KPI
Median Values Subsets				Most Complete Dataset (Eurostat/RD)			
Country	Value [10 ³]	N	Base Year(s)	Country	Value [10 ³]	Base Year(s)	
1 Netherlands	46,25	3	2007-2009	1 Netherlands	46,25	2008-2009	
2 Switzerland	42,58	4	2008-2009	2 Switzerland	34,73	2008-2009	
3 United Kingdom	33,11	6	2008-2009	3 United Kingdom	34,40	2008-2009	

A

B

C

D

E

F

G

FIGURE 21: LAY-OUT RELATIVE RANKING TABLES

Column A displays the relative KPI ranking (ranging between 1 and 27) of EU+EFTA countries, based on median values taken from the mixed KPI subsets. Column B displays the calculated median values of the examined KPI. Column C displays the amount of available mixed KPI subsets (N), depending on availability of data. Column D displays the source year of base data used in determining values of indicators.

Column E displays the relative ranking of EU+EFTA countries, based on resulting values of the most complete dataset. Column F displays the KPI values taken from the most complete dataset and Column G displays base years of source data regarding the indicators.

A complete overview of all resulting KPI ranking tables is provided in Appendix 3.1. As an example, Table 7 displays the resulting ranking table of KPI 'Efficiency of Production – Train-km P+C/Network length'.

TABLE 7: RELATIVE RANKING TABLE KPI TRAIN-KM P+C/NETWORK LENGTH

Efficiency of Production [Train-km P+C / Network length (km)]						
Median Values Subsets				Most Complete Dataset (Eurostat/RD)		
Country	Value [10 ³]	N	Base Year(s)	Country	Value [10 ³]	Base Year(s)
1 Netherlands	46,25	3	2007-2009	1 Netherlands	46,25	2008-2009
2 Switzerland	42,58	4	2008-2009	2 Switzerland	34,73	2008-2009
3 United Kingdom	33,11	6	2008-2009	3 United Kingdom	34,40	2008-2009
4 Belgium	27,58	6	2008-2009	4 Belgium	31,12	2008-2009
5 Luxembourg	25,87	3	2008-2009	5 Austria	26,23	2008-2009
6 Austria	25,84	6	2007-2009	6 Germany	24,71	2008-2009
7 Germany	25,25	6	2008-2009	7 Denmark	23,19	2008-2009
8 Denmark	23,19	3	2008-2009	8 Italy	18,80	2005-2009
9 Italy	18,98	6	2008-2009	9 Czech Republic	16,42	2008-2009
10 Czech Republic	16,16	6	2008-2009	10 France	15,94	2008-2009
11 France	15,66	6	2005-2009	11 Slovenia	15,07	2007-2009
12 Slovenia	14,95	6	2008-2009	12 Hungary	14,29	2005-2009
13 Portugal	14,55	2	2008-2009	13 Spain	11,74	2008-2009
14 Hungary	13,61	6	2007-2009	14 Sweden	11,57	2008-2009
15 Spain	13,43	4	2008-2009	15 Slovakia	11,52	2008-2009
16 Sweden	12,84	3	2008-2009	16 Norway	10,52	2008-2009
17 Slovakia	11,63	2	2008-2009	17 Poland	10,28	2007-2009
18 Norway	10,45	3	2008-2009	18 Finland	8,48	2008-2009
19 Poland	9,31	6	2008-2009	19 Greece	8,24	2008-2009
20 Finland	8,45	6	2008-2009	20 Latvia	8,06	2008-2009
21 Greece	8,29	6	2008-2009	21 Lithuania	7,95	2008-2009
22 Ireland	8,06	6	2005-2009	22 Romania	7,91	2008-2009
23 Lithuania	7,84	6	2008-2009	23 Ireland	6,72	2008-2009
24 Bulgaria	7,48	6	2008-2009	24 Estonia	5,73	2008-2009
25 Latvia	6,48	6	2008-2009	25 Bulgaria	4,28	2008-2009
26 Estonia	5,02	6	2008-2009	Luxembourg	N/A	
27 Romania	4,19	4	2008-2009	Portugal	N/A	

In Table 7 the relative ranking of 27 EU+EFTA countries is visible regarding the median values of KPI subsets (left) and the values obtained from the most complete dataset (right). In this particular case, indicator data for Luxembourg and Portugal are not available in the most complete subset, as denoted by N/A.

Values indicate that in the Netherlands, the most densely used rail network is in operation. By sorting values from largest to smallest, a relative ranking is obtained ranging between rank 1 to 27 in case of the mixed KPI subset method, and ranging between rank 1 to 25 in case the most complete dataset is taken along.

§3.1.5 Interpretation of results

When looking into the resulting ranking tables there is little consistency in a particular country systematically outperforming others regarding all examined KPI's. Overall, Western European countries outperform Eastern European and Balkan countries regarding KPI's on Effectiveness of Resources (outcome/input) and Efficiency of Production (output/input). Baltic countries (especially Estonia and Latvia) rank fairly high in numerous KPI tables.

In the next sections, a short description regarding the main outcomes of the relative ranking tables is added for each KPI. For a complete overview of resulting ranking tables, please refer to Appendix 3.1.

A complete and summarizing overview of the highest performing countries for each KPI, is added in Table 8 (page 45).

KPI Effectiveness of Production – Passenger services (Pkm/Train-km P)

Western European countries produce in general more effective than Eastern European and Balkan countries regarding passenger transport. This underlines the assumption that in Western Europe supply and demand are more balanced than in Eastern European and Balkan countries.

Latvia's and Estonia's high ranking in the median value subset is a peculiar result. Especially Latvia's median value (being three times as high as the following country) should be processed and interpreted with great caution since Latvian railway data may have distorted the resulting value significantly. KPI values range in general between 200 Pkm per Train-km P (highest scoring countries) and 50 Pkm per Train-km P (lowest scoring countries).

When taking the most complete dataset (Eurostat) into account, the only major difference in obtained ranking is attributed to the ranking of Latvia and Estonia (significantly lower than the median values subsets score). The subset of countries ranked between 1 and 10 presents slight differences between both tables, as displayed in Table 8.

KPI Effectiveness of Production – Cargo services (Tkm/Train-km C)

The resulting ranking yields a remarkably high score for the Baltic States. Values are significantly higher than other EU+EFTA countries. Again, interpretation of the Baltic States should be conducted carefully and with great caution. Differences in ranking regarding other countries between the two resulting tables remain limited; in the subset of countries ranked 1 to 10, no differences at all result, as Table 8 shows.

KPI Effectiveness of Resources – Passenger services (Pkm/Staff P)

Regarding this KPI there is a trend visible that Western European countries outperform Eastern European and Balkan countries in general. The general assumption that in Eastern Europe and Balkan countries relatively large amounts of staff are (still) present in passenger railway companies, combined with lower wages compared to Western European standards, supports these results.

A large difference occurs between the highest performing country (Spain); in which 930.000 Passenger-kilometers are offered per staff member in 2009, and the lowest ranking country Lithuania in which (only) 80.000 Passenger kilometers are offered per staff member in 2009.

Differences between values taken from median value subsets and the most complete dataset remain limited; especially for countries ranked between 1 and 10, following Table 8.

KPI Effectiveness of Resources – Cargo services (Tkm/Staff C)

Regarding this KPI, again Western European countries outperform Eastern European and Balkan countries. Unfortunately, the most complete dataset (Railway Directory) does not supply data on cargo operations in the United Kingdom.

KPI values typically range between 7 million Tkm/Staff member (in 2009) for the highest ranking countries (Sweden, Estonia) and 0,15 million Tkm/Staff member for the lowest performing country (Ireland).

KPI Efficiency of Production – Passenger services (Train-km P/Staff P)

Western European Countries outperform Eastern European and Balkan countries again in general regarding this KPI. KPI values typically range between 7000 Train-km per Staff member in 2009 for the highest ranking countries (UK, Finland) and 720 Train-km per Staff member in 2009 for the lowest ranking country (Romania).

In the subset of countries ranked 1 to 10 a slight difference arises between both tables. Based on median values of mixed subsets Hungary, Norway and the United Kingdom are included, while in

the most completed dataset Austria, Ireland and Italy are included instead as summarized by Table 8.

KPI Efficiency of Production – Cargo services (Train-km C/Staff C)

Resulting tables regarding this KPI indicate a somewhat similar result as Efficiency of Production in Passenger services. The most efficient countries are located in Western Europe; KPI values range between 10.000 Train-km/Staff member in 2009 for the highest ranking country (Sweden) and 1000 Train-km/Staff member in 2009 for the lowest ranking country (Bulgaria).

KPI Infrastructure Usage (Train-km P+C/Network Length)

A consistent picture emerges from both tables: the Netherlands, Switzerland and the United Kingdom, followed by Belgium, Austria and Germany have the most densely used rail infrastructure network. Although Portugal and Luxembourg are unfortunately excluded in the most complete dataset, both ranking tables of the other countries resemble each other closely.

KPI values range between 46000 Train-km/Network km in 2009 for the most densely used rail network (the Netherlands) and 4000 Train-km/Network km in 2009 for the least densely used networks (Romania, Bulgaria).

Overview of 10 highest performing countries per KPI

The previous brief explanations per KPI identified general trends and outcomes visible in the results. A summarizing overview of highest performing countries for each examined KPI is added in Table 8.

The following important remarks on this table are identified:

- For each KPI, countries ranking between 1 and 10 regarding a particular KPI are marked (✓).
- In order to increase readability of the table, country names are abbreviated following ISO guidelines. All country abbreviations are stated in the Glossary, situated at the end of this thesis report.
- In order to increase readability of the combined table, KPI terms are abbreviated:
 - Effect_{prod} P: Effectiveness of Production Passenger Transport
 - Effect_{prod} C: Effectiveness of Production Cargo Transport
 - Effect_{res} P: Effectiveness of Resources Passenger Transport
 - Effect_{res} C: Effectiveness of Resources Cargo Transport
 - Effic_{prod} P: Efficiency of Production Passenger Transport
 - Effic_{prod} C: Efficiency of Production Cargo Transport
 - Infra_{usage} P+C: Infrastructure Usage Passenger + Cargo Transport
- Highest performing countries regarding the median values of mixed subsets (MIX) and regarding values of the most complete dataset (MCD) are both displayed in the table.

TABLE 8: OVERVIEW OF HIGHEST PERFORMING COUNTRIES ON SELECTED KPI'S.

	$Effect_{prod}^P$		$Effect_{prod}^C$		$Effect_{Res}^P$		$Effect_{Res}^C$		$Effic_{prod}^P$		$Effic_{prod}^C$		$Infra_{usage}^{P+C}$	
	MIX	MCD	MIX	MCD	MIX	MCD	MIX	MCD	MIX	MCD	MIX	MCD	MIX	MCD
AT										✓		✓	✓	✓
BE	✓	✓	✓	✓		✓							✓	✓
BG														
CH					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CZ													✓	✓
DE							✓	✓			✓	✓	✓	✓
DK					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EE	✓		✓	✓			✓	✓						
EL												✓		
ES	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		
FI		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
FR	✓	✓			✓	✓								✓
HU									✓					
IE		✓								✓				
IT	✓	✓			✓	✓				✓			✓	✓
LT			✓	✓				✓						
LU													✓	
LV	✓	✓	✓	✓			✓	✓						
NL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NO									✓		✓			
PL	✓	✓	✓	✓										
PT	✓				✓	✓			✓	✓	✓	✓		
RO			✓	✓										
SE	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		
SK			✓	✓										
SL														
UK			✓	✓	✓		✓		✓		✓		✓	✓

§3.1.6 Validity of obtained results

Evaluating performances based on KPI's is a very abstract, high level and generic way to benchmark. Interpretation of the results and critical remarks regarding the validity of obtained results are essential in order to place the resulting ranking tables into perspective.

Advantages and shortcomings of the KPI method

This section will at first describe the main advantages and shortcomings of the KPI method to evaluate performances.

The following advantages are attributed to the KPI method:

- + Easy to calculate KPI's, no complex statistics required that may influence results
- + No specific, high-detailed and confidential data required
- + Data can be obtained from public sources (e.g. UIC, Eurostat, OECD)
- + Provides first insight in relative performance compared to competitors
- + Multiple Sources available to check consistency/variance of input/output data
- + Data available for all EU+EFTA countries

The KPI method should be typically regarded as a first estimation of railway sectors' performances in investigated countries. Data are obtainable from multiple sources and since highly abstract and aggregated data are required, few problems arise in availability restrictions (due to for example a competitive, confidential nature of data). Still, some countries apply more strict confidentiality rules than others which makes data comparison in some cases difficult.

Besides the advantages, the KPI method has the following important shortcomings:

- Comparability of data between countries is difficult due to its aggregated nature:
 - Variety of base year: there is little consistency in the annual supply of data (countries only reporting once in five years versus countries that report data annually).
 - Different measurement methods of data: does 'staff' data for example include infrastructure maintenance employees or only operational staff? The abstracted, aggregated data does normally not indicate this difference.
 - Data does not indicate which share of staff is working in passenger or cargo businesses in the national railway sector: only the total staff number is provided in the data.
 - The most accurate way to measure 'offered supply' would be to take offered seat kilometers into account. By using offered seat kilometers, differences between the capacity of trains (and thus the available supply) become visible. Unfortunately, data on offered seat kilometers are unavailable for all of the EU+EFTA countries except for the Netherlands.
 - In Europe, large international cargo operators are nowadays active on the market, replacing national operators. It remains unclear if performance data is attributed to the country to which the international operator belongs (e.g. Germany for DB Schenker) or that data are attributed to the country in which the Tonkilometers are actually produced.
- The relative KPI ranking on ratios assumes a linear dependency between inputs and outputs. In reality this is typically not the case: a very busy and complex railway network (e.g. two times as high output) requires relatively more staff (e.g. five times as much input) than a low used and simple railway network. In other words: it is arguable whether inputs and outputs are linearly dependent.
- Little information is provided about the internal processes inside railway companies that currently might be inefficient or ineffective (e.g. rolling stock management, rail traffic management or staff attribution). Only generic information about performances compared to other countries becomes available.
- Customer satisfaction is only indirectly taken along and does not allow for the fact that a certain group of travellers/cargo shippers depends on transport by rail.

Applied workarounds for major shortcomings of the KPI method

The shortcomings described in the previous section would seriously influence the results obtained in §3.1.4 if not mitigated. The following workarounds try to mitigate (part of the) shortcomings:

- Data is collected that is no older than 2005. It is assumed that data that originates before 2005 has no connection to current data. The economic climate seriously declined in the EU+EFTA countries in the past five years, so taking data into account that originates from before the economic downturn would yield irrelevant results.

- In order to be able to segregate staff working in cargo and passenger operations, it is assumed that the ratio between produced Train-kilometers Passenger trains versus Cargo trains is a measure for an estimated division between staff working in passenger or cargo operations. This assumption is validated by comparing resulting data to countries that do publish segregated staff data. It is concluded that this assumption is valid in general and no additional correcting factors are required. However, it should be mentioned that further research has to be conducted regarding a more reliable division of staff employed in either the passenger or cargo markets.

- The offered supply is measured in (offered) Train-kilometers for Passenger and Cargo trains instead of seat kilometers. Data on Train-kilometers are available for all EU countries. This is a simplification of reality, not taking the length of trains into account.

The other described shortcomings cannot easily be taken care of by the abstract nature of the KPI method. These shortcomings have therefore to be mitigated by applying a different type of evaluation method or by reducing the subset of countries under examination.

§3.1.7 Conclusions on the KPI method

As the previous paragraphs have shown, the KPI method at first seems an interesting way to evaluate performances of a large subset of countries in a quantitative way. Seven KPI's have been selected that are estimated to give a first insight in performances of a national railway sector regarding:

- Outcome/output ratio's: Effectiveness of Production
- Outcome/input ratio's: Effectiveness of Resources
- Output/input ratio's: Efficiency of Production

Indicator data has been extracted from four public available sources. Non-mixed indicator sets (keeping all countries together regarding a specific source) are divided by other non-mixed indicator sets to yield mixed KPI subsets. Median values from the mixed KPI subsets determine a relative ranking of countries regarding the seven KPI's identified. Next to these median values, KPI values obtained from the most complete dataset are provided in the resulting ranking tables.

The resulting ranking tables do present a first insight in differences in network usage, balancing of supply and demand of services and the level production achieved in 27 EU+EFTA countries. In general, Western European countries outperform Eastern European and Balkan countries. Differences in ranking between median values of mixed subsets and values taken from the most complete data source remain limited.

The 'learning by doing' experience of applying the KPI method to a subset of 27 countries proves that comparability of data is an important prerequisite for a successful outcome. Since data currently does not present a sufficient level of detail, results of the KPI method should be taken along with caution in the remaining parts of this thesis report.

Additional research is now required that indicates which backgrounds and processes account for efficiency improvement within railway companies. The single input-output relationships are replaced by multiple input-output relationships. This is described in the next chapter that introduces a multiple input-output evaluation method based on Data Envelopment Analysis.

CHAPTER 3.2: PERFORMANCES OF RAILWAY SYSTEMS IN 8 EUROPEAN COUNTRIES

Main aim of this chapter is to provide an additional level of detail compared to the KPI method in order to ‘open up’ the black box that is located behind the performance ranking tables that presented the output of Chapter 3.1.

It is important to state that from this moment on not the entire railway sector in a country is looked at anymore, but specific transport companies and infrastructure managers offering passenger and cargo transport services by rail are now under investigation. Railway companies and Infrastructure Managers provide in their annual reports often more accurate and segregated information than the aggregated data used in the KPI method.

This chapter will introduce a technique that is widely used in performance evaluation of railway systems: Data Envelopment Analysis (DEA). The DEA method will be briefly explained and the chosen subset of railway systems justified before applying this method to 8 European railway systems.

§3.2.1 Multiple input-output efficiency and effectiveness estimation

Railway systems typically use multiple inputs to produce multiple outputs. Using the same terminology as introduced in Chapter 3.1, the following estimations are identified:

- Efficiency of Production (output/input): With given inputs, how many outputs can a railway system produce? Figure 22 displays an example of multiple input-output estimation.



FIGURE 22: ESTIMATING ‘EFFICIENCY OF PRODUCTION’. ADAPTED FROM (ROELEVELD, 2011)

- Effectiveness of Resources (outcome/input): what is the derived utility in the allocation of resources? In other words: is input indeed consumed by customers? An example of multiple input-outcome estimation is displayed in Figure 23.



FIGURE 23: ESTIMATING ‘EFFECTIVENESS OF RESOURCES’. ADAPTED FROM (ROELEVELD, 2011)

In order to determine multiple input-output efficiency and effectiveness of a (sub)set of railway systems, a method is introduced that is frequently applied in performance evaluation of economic processes and businesses: Data Envelopment Analysis (DEA).

DEA is a non-parametric estimation technique that uses linear programming to construct a piecewise linear envelopment frontier over the data points such that all observed points lie on or below the production frontier (Coelli, et al., 1999). In other words: DEA constructs a non-parametric surface or frontier over the data. Compared to others, railway systems located on the frontier are considered more efficient, systems located outside the frontier are considered less efficient. The relative distance to the frontier specifies the degree of inefficiency.

To illustrate the DEA process, Figure 24 displays an example of the construction of an efficiency frontier based on fictitious data of 6 systems. Systems 3 and 6 are considered to produce relatively efficient compared to others since these are located on the efficiency frontier. Systems 1, 2, 4 and 5 are considered to produce less efficient; their relative distance to the efficiency frontier indicates the degree of inefficiency (a system located at a larger distance to the frontier is relatively more inefficient than a system closer to the frontier). In this fictitious example two inputs and one output is considered. DEA is able to construct these pictures also for more inputs or outputs although visualization in 2D becomes, as one can understand, difficult.

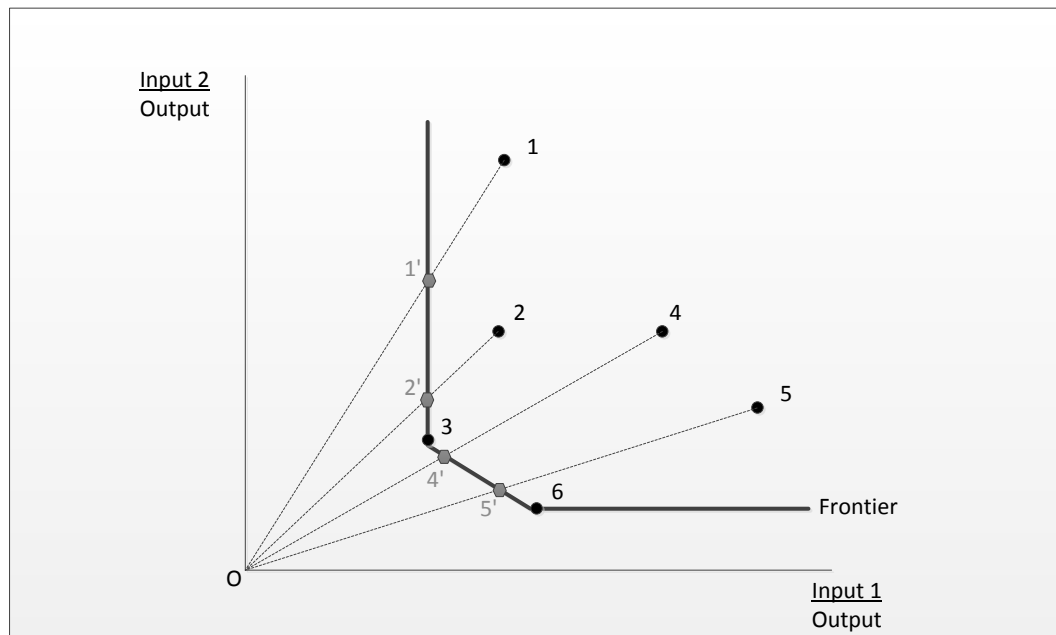


FIGURE 24: EXAMPLE OF EFFICIENCY MEASUREMENT USING DEA OF 6 (FICTITIOUS) SYSTEMS.
ADAPTED FROM (COELLI, ET AL., 2005)

DEA is a preferred methodology in regulated industries (e.g. rail transport) where objectives as cost minimization or profit maximization might not be the prime objective (but a well-functioning, frequently used rail system is) (Abate, et al., 2009). DEA can handle the multiple input-output relationships quite well. **The shared nature of a railway system, in which both passenger and cargo services are offered on the same rail network, sometimes with shared rolling stock equipment and staff, is handled quite well by this multiple input-output assessment method.** Together with the fact that DEA does not require data to be specified in monetary terms, it remains a popular way to estimate efficiency of railway systems due to the large difficulty of gathering price and cost data in the railway industry (Abate, et al., 2009).

DEA can be executed using either Constant Returns to Scale (CRS) or Variable Returns to Scale (VRS). CRS assumes that all systems operate at an optimal scale and a company may thus be benchmarked against systems that are substantially larger or smaller than this system. Since imperfect competition, government regulations or constraints on finances may cause a system not to be operating at an optimal scale; efficiency measurement may be confounded with scale efficiencies. Using VRS, calculation of efficiency is possible avoiding scale efficiency effects.

DEA also presents some disadvantages compared to other efficiency analysis methods. DEA does not specify a 'satisfactory' or 'disappointing' performance; it only benchmarks the efficiency compared to the other railway systems (peers) taken along in the analysis. Another disadvantage is that error of measurement and other noise can influence the shape and position of the frontier: all deviation of the frontier is attributed to inefficiency (since there is no account for statistical noise). Furthermore; efficiency scores from two different analyses are not directly comparable because DEA only reflects the dispersion of efficiencies within each analysis.

When taking these disadvantages into account, DEA still provides interesting results regarding relative efficiency of railway systems compared to each other. DEA will be used further in this report to determine efficiencies of a (sub)set of 8 European railway systems.

§3.2.2 Selected subset of countries

Since the level of detail and accuracy is enhanced when performing Data Envelopment Analysis, it is chosen to look at 8 reliable and comparable European railway systems. Countries selected for DEA assessment possess the following characteristics:

- Scale of railway networks more or less comparable. This means that large countries (possessing large railway networks) such as the United Kingdom, France or Germany are left out of this DEA. These countries possess such a different level of scale that comparing them to countries as Belgium or Austria is deemed improper.
- More detailed (segregated) data publicly available. Annual reports of transport operators and infrastructure managers present an additional level of detail regarding the inputs, outputs and outcomes (staff size Passenger and Cargo operations, staff size Infrastructure management, amount of rolling stock equipment, length of rail network, resulting train-kilometers and Passenger- or Tonkilometers).
- Level of services and size of rail network comparable to the 2017 situation of Israel Railways. As Chapter 1 introduced, Israel Railways faces large extension plans to their network and services up to 2017. The countries selected can be interesting peers for future benchmarking regarding railway network and transport service levels.
- Possibility to assume Constant Returns to Scale (CRS). By inserting countries that have a more or less equal 'scope of activity', it is valid to assume Constant Returns to Scale instead of Variable Returns of Scale while executing DEA.
- The 8 countries chosen present a representative sample of railway systems operating in an integrated, holding and separated organizational structure as displayed in Table 9. Furthermore countries with a focus on passenger (e.g. the Netherlands) or cargo transport (e.g. Finland) are both included in the selection.

By selecting this specific subset of countries for DEA assessment, it is possible that a certain degree of bias is introduced, compared to other possible selections. Most of the countries chosen typically contain a compact and densely used railway network in which long distance, high speed passenger services play a relatively modest role (the only exception being Spain). Long distance, high speed passenger services typically result in large volumes of Passenger kilometers

so this selection of countries may underestimate the potential of high-speed passenger transport.

Another bias can be appointed to the fact that in all selected countries an incumbent railway company plays a major role in offering passenger transport services. Countries in which external (private) entrants play a more significant role in offering passenger services (e.g. Sweden and the United Kingdom) are not included in the selection.

Table 9 summarizes the selected countries, infrastructure managers and transport companies that are taken along in DEA assessment.

TABLE 9: OVERVIEW OF EUROPEAN COUNTRIES AND ACTORS TAKEN ALONG IN DEA ASSESSMENT

Organizational Structure	Country	Infrastructure Manager	Main Passenger Operator	Main Cargo Operator
Integration model	Switzerland	SBB Infrastruktur	SBB Personenverkehr	SBB Cargo
Holding model	Austria	OeBB Infrastruktur	OeBB Personenverkehr	Rail Cargo Austria
	Belgium	Infrabel	NMBS Mobility	NMBS Logistics
	Hungary	MÁV Szolgáltatások	MÁV Start	Rail Cargo Hungaria
Separation model	Denmark	BaneDanmark	DSB	DB Schenker Rail Danmark
	Finland	Finnish Transport Agency	VR Passenger Division	VR Transpoint
	The Netherlands	ProRail	NS Reizigers	DB Schenker Rail Nederland
	Spain	ADIF	Renfe Operadora	Renfe Mercancías

IRL's passenger, cargo and infrastructure divisions are also taken along in DEA assessment in order to investigate the present relative position of IRL compared to the 8 selected European railway systems.

§3.2.3 Input and Output data used

Input and Output data needed for application of DEA are extracted from annual reports of the transport companies and Infrastructure Managers. All data represent the situation for 2009.

Following the visualizations of Figure 22 and Figure 23; the following inputs are identified including clarification of Data Sources used to fill in the dataset:

TABLE 10: OVERVIEW OF USED INPUTS AND SOURCES OF DATA

Input	Illustration	Data Sources
Number of Staff P+C+IM (fte)	Number of employees working in the main Passenger railway company + main Cargo railway company + Infrastructure Manager	Annual reports railway companies / Infrastructure Managers
Number of Locomotives	The number of locomotives used in transport operations (excluding shunting equipment)	Annual reports railway companies
Number of carriage units	The number of carriage units used in passenger and cargo operations ¹¹	Webpage: www.railfaneurope.net / Annual reports railway companies
Length of rail tracks (km)	Length of the rail network in a country, corrected for single/multiple tracks	Annual reports railway companies / Infrastructure Managers

Following Figure 22 and Figure 23, Table 11 identifies the used output variables:

TABLE 11: OVERVIEW OF USED OUTPUTS AND SOURCES OF DATA

Output	Illustration	Data Sources
Trainkilometers Passenger Trains	Annual amount of offered Trainkilometers passenger trains	Annual reports railway companies / Infrastructure Managers
Trainkilometers Cargo Trains	Annual amount of offered Trainkilometers cargo trains	Annual reports railway companies / Infrastructure Managers
Passenger-kilometers	Annual amount of Passenger-kilometers	Annual reports railway companies / Infrastructure Managers
Gross Ton-kilometers	Annual amount of Gross Ton-kilometers	Annual reports railway companies / Infrastructure Managers

Taking the inputs and outputs of Table 10 and Table 11 into account, two DEA assessments are executed:

- DEA Efficiency of Production (output/input):

Taking all inputs into account and taking Train-kilometers for passenger and cargo trains as outputs into account

- DEA Effectiveness of Resources (outcome/input):

Taking all inputs into account and taking Passenger-kilometers and Gross Ton-kilometers as outputs into account

¹¹ In passenger operations, both the amount of hauled coaches and the number of carriage units are taken along since passenger train sets normally consist out of multiple carriage units. (in Dutch 'bakken'). In cargo operations the number of cargo cars is taken along.

Appendix 3.2 provides an overview of the data values used in DEA; retrieved from the annual reports of railway companies and Infrastructure Managers. Comparability of values between companies has been a major driver in deciding which input and output data are selected. It is assumed that only minor differences in data measurement between companies arise. This means that for example measurement of staff size at Renfe is more or less comparable to measurement of staff size at NS. It is therefore assumed that the dataset used in the DEA application is somewhat less distorted by incomparable, aggregated data than in the KPI method.

Another slight improvement in reliability and comparability is that the base year of all data is equal (all data represent the 2009 situation). The selected railway companies (and infrastructure managers) all publish an annual report containing figures describing the 2009 situation. Instead of comparing countries based on data within a bandwidth of 3 to 4 years (as has been done in the KPI method), companies are now assessed based on data originating from a comparable annum.

Slight improvements furthermore include a more clear segregation of staff working in passenger or cargo operations and the number of carriage units being taken along. Also the track length is corrected for multiple/single tracks. However, it should be mentioned that a completely reliable segregation of staff between passenger and cargo operations cannot be made, and the length of carriage units (being single or double deck) is not taken along. Therefore no substantial, but only slight improvements to the dataset are introduced.

These slight improvements in comparability of data result in a little more reliable outcome of efficiency scores than has been provided in the resulting ranking tables of the KPI method. It should be remarked that the amount of available sources is reduced (only the annual reports are taken along), although it is expected that data from Eurostat or Railisa in the end also originate from reporting figures of railway companies or infrastructure managers. This reduction of the amount of sources is therefore assumed to be justifiable.

§3.2.4 Obtained results

In running the DEA model, constant returns to scale (CRS) and a single periodic model are assumed since data are only available for the (single) period 2009. Expanding the dataset with data covering multiple periods provides additional details and identifies trends, but is not executed in this thesis report. Calculating efficiency and effectiveness scores is performed by an online DEA tool (DEA Online Software, DEAOS) and validated by the Efficiency Measurement System (EMS) gratefully used from (Scheel, 2000).

Figure 25 presents Efficiency of Production scores for the selected subset of countries.

According to these results, railway systems in Switzerland, Austria, Denmark and the Netherlands are located on the efficient frontier. Analysis shows that railway systems in Belgium, Hungary, Finland, Spain and Israel currently produce less efficient than peer systems. Their relative distance to the efficient frontier is displayed in Figure 25; a larger distance to the efficient frontier symbolizes a less efficient situation compared to peer countries.

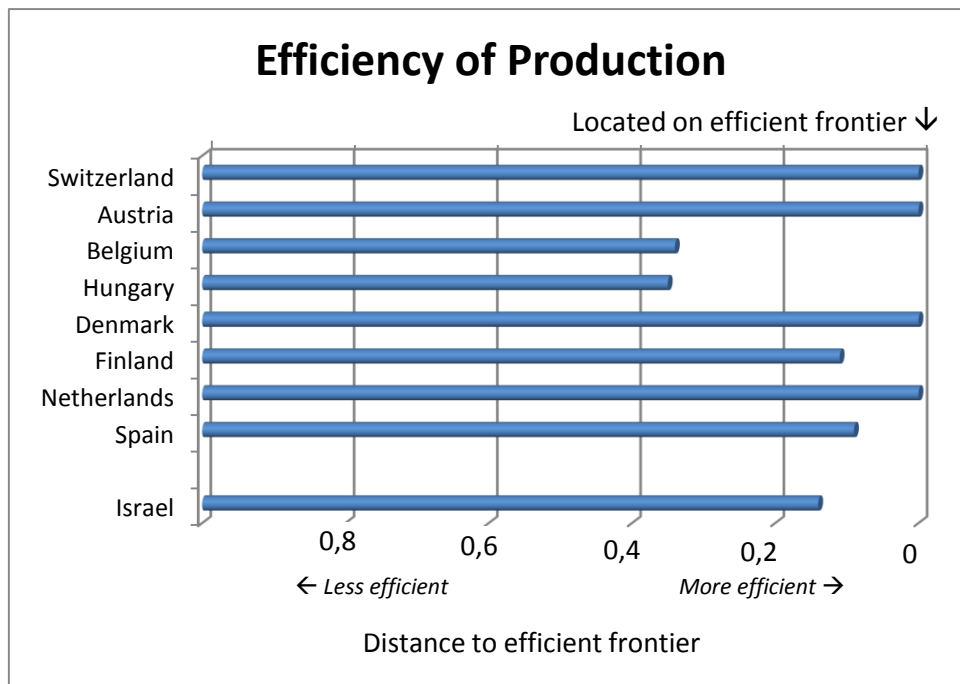


FIGURE 25: DEAOS RESULTING SCORES 'EFFICIENCY OF PRODUCTION'

Figure 26 presents DEAOS scores regarding Effectiveness of Resources. Based on the results, Switzerland, Austria, Finland, the Netherlands and Israel are located on the effective frontier. Belgium, Hungary, Denmark and Spain currently make less effective use of resources when comparing to peer systems.

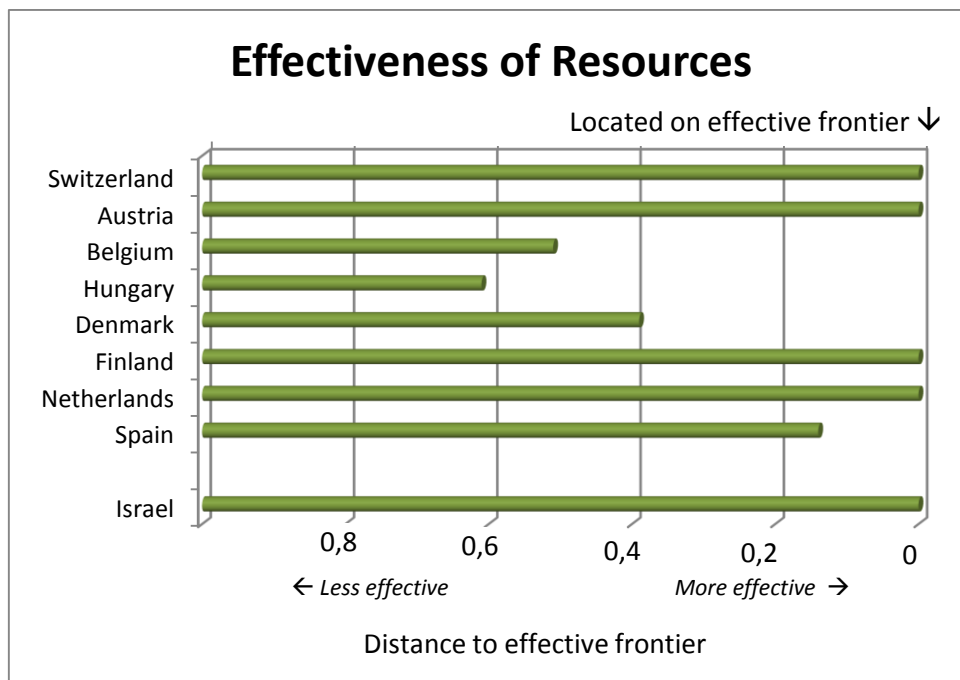


FIGURE 26: DEAOS RESULTING SCORES 'EFFECTIVENESS OF RESOURCES'

Resulting efficiency and effectiveness values of DEAOS are validated by conducting a similar DEA assessment (using the same dataset) in the 'Efficiency Measurement System' (Scheel, 2000). Both resulting efficiency and effectiveness values of DEAOS and EMS resemble each other regarding all railway systems.

§3.2.5 Interpretation of results

Results displayed in §3.2.4 show that railway systems in Switzerland, Austria and the Netherlands operate both on the efficient and effective frontier, compared to railway systems in other countries. Based on the DEA assessment, these countries possess a railway system in which resources are relatively effectively used and in which the production process converts inputs to outputs in an efficient way.

Denmark is located on the efficient frontier, but not on the effective frontier. Although inputs are relatively efficiently converted into outputs, this railway system could use its resources more effectively (e.g. by increasing the amount of Pkm's and Gross Tkm's) when comparing to peer countries.

In Finland and Israel, the railway system makes relatively effectively use of resources but, compared to peer countries, the production process of converting inputs to outputs could be conducted more efficient (e.g. by increasing the amount of Train-km's of passenger and cargo trains).

Regarding Belgium, Hungary and Spain, both effectiveness and efficiency levels could be improved when comparing to peer countries. Based on the results of the DEA assessment, these countries are neither located on the efficient nor on the effective frontier.

§3.2.6 Conclusions on the DEA method

Multiple input-output efficiency and effectiveness analysis has been conducted using the non-parametric DEA technique that is widely used in performance evaluation of railway systems. The shared nature of a railway system, in which both passenger and cargo services are offered on the same rail network, sometimes with shared rolling stock equipment and staff, is handled quite well by this multiple input-output assessment method.

A subset of 8 European railway systems has been selected that present more or less equal scopes of activity and that can be interesting peers for Israel's railways in the nearby future. The 8 selected systems operate in integrated, holding and separated structures and are therefore a suitable reflection of the main models identified in Part 2.

DEA outcomes indicate that railway systems located on the efficient and effective frontier (compared to other countries) may either be organized as integrated, holding or separated structures.

Compared to the 8 European railway systems, outcomes of DEA assessment indicate that Israel's current railway system is located on the effective frontier, but not on the efficient frontier. This indicates that in the current situation Israel Railways makes relatively effective use of its resources (resources are effectively sold to customers), but efficiency of operations could be improved (e.g. by increasing the amount of driven train-kilometers for passenger and cargo trains).

CHAPTER 3.3: SERVICE QUALITY & CUSTOMER SATISFACTION

Performance evaluation of railways has, in the previous chapters, focused on the relationship between production processes and resulting outputs or outcomes. The final important driver for well performing railways is the level of quality of the delivered service. The mentioned performance measures with input-output ratios should be augmented by incorporating quality attributes not to consider low quality companies as efficient or effective (Abate, et al., 2009).

Customer Satisfaction (CS) is a topic that in the KPI and DEA methods is taken along only indirectly. When evaluating performances of railways, customer satisfaction indicators are therefore a necessary addition and directly take the quality of the delivered and perceived service into account.

Evaluating customer satisfaction regarding rail services and benchmarking them to other European countries is a very elaborate and extensive task. A recent study, instigated by the Directorate General Mobility and Transport of the EU, presents a survey of customer satisfaction in European countries, based on questionnaires posed to more than 9.000 European citizens (EU Directorate General Mobility and Transport, 2011).

This thesis report provides extensive elaboration on methods to evaluate performances of railways. The actual assessment of Customer Satisfaction in the 25 EU countries is taken from the EU study, since it is deemed impossible to conduct such an extensive and profound study in the scope of this thesis work.

§3.3.1 European standards on quality measurement of Public Transport services

Regarding quality measurement in Public (rail) Transport, two Euronorms of the European Committee for Standardization (CEN) are relevant:

EN 13816 (April 2002): Transportation – Logistics and services – Public Passenger Transport – Service quality definition, targeting and measurement

EN 15140 (April 2006): Public Passenger Transport – Basic requirements and recommendations for systems that measure delivered service quality

EuroNorm 13816 specifies the ‘requirement to define, target and measure quality of service in public passenger transport, and provides guidance for the selection of related measurement methods.’ This norm is used by operators and (tendering) authorities to translate customer expectations into ‘viable, measurable and manageable quality parameters’. (CEN, 2002) If, instead of passengers, logistic clients are taken (shippers), this norm can also be applied to cargo transport.

Quality Control Loop:

EN13816 is constructed around the so called ‘Service Quality loop’, displayed in Figure 27.

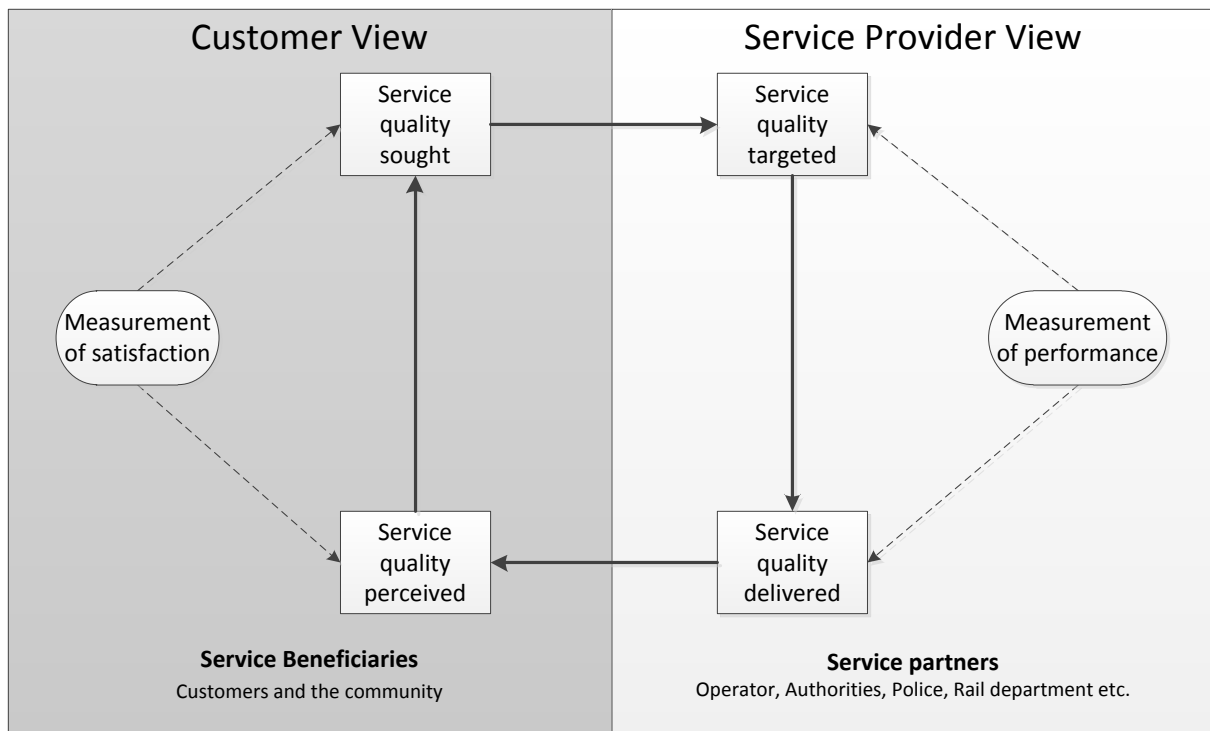


FIGURE 27: SERVICE QUALITY LOOP. ADAPTED FROM (CEN, 2002)

Regarding the Service Quality loop, the following illustrations clarify the used terminology:

Service Quality Sought: displays the quality level that customers seek in a PT system.

Service Quality targeted: displays the level of service that the operator aims to provide to its passengers. This targeted quality is influenced by internal and external pressures, budgetary and technical constraints and performance of competitors active on the market.

Service Quality delivered: the level of quality (e.g. punctuality) that is delivered on a daily basis, measured from the customers viewpoint (a train can be punctual, but a passenger inside that train can be delayed because of earlier delays of feeder trains).

Service Quality perceived: (subjective) perception of service quality experienced by the customer. This perceived service quality can be based on personal experiences regarding service levels, information supply or personal environment.

Measurement of performance: Determining the differences between the targeted and delivered service quality from a service provider point of view. An example can be the difference between offered train kilometers (in the timetable) and delivered train kilometers.

Measurement of satisfaction: Determining the differences between sought and perceived service quality from a customer point of view.

Quality Criteria

Assessing the performance of public transport contains a large number of quality criteria. EN13816 identifies eight categories in which quality criteria are contained:

TABLE 12: QUALITY CRITERIA (LEVEL 1 & 2). ADAPTED FROM (CEN, 2002)

Level 1	Level 2
1. Availability	1.1 Modes 1.2 Network 1.3 Operation 1.4 Suitability 1.5 Dependability
2. Accessibility	2.1 External interface (e.g. accessibility cyclists/car users) 2.2 Internal interface (e.g. accessibility platforms/other PT modes) 2.3 Ticketing availability
3. Information	3.1 General information 3.2 Travel information normal conditions 3.3 Travel information abnormal conditions
4. Time	4.1 Length of trip time 4.2 Adherence to schedule
5. Customer care	5.1 Commitment 5.2 Customer interface (e.g. ease of filing complaints) 5.3 Staff 5.4 Assistance 5.5 Ticketing options
6. Comfort	6.1 Usability of passenger facilities 6.2 Seating and personal space 6.3 Ride comfort 6.4 Ambient conditions 6.5 Complementary facilities 6.6 Ergonomics
7. Security	7.1 Freedom from crime 7.2 Freedom from accident 7.3 Emergency management
8. Environmental impact	8.1 Pollution 8.2 Natural resources 8.3 Infrastructure

As can be seen from Table 12, some quality criteria can be assessed with (mostly) objective data (e.g. availability, accessibility, time) while others have a more subjective nature (e.g. comfort, security). This mix of objective and subjective quality criteria should ultimately lead to a balanced assessment of the performance of a service operator, or in this case a railway company.

Methods to obtain required information include Customer Satisfaction Surveys (CSS), Mystery Shopping Surveys¹² (MSS) and Direct Performance Measures (DPM).

EN15140, published in 2006, is an addition to EN13816 and provides basic requirements for systems that measure delivered service quality of public transport. (CEN, 2006) It describes additional requirements for adequately collecting data (samples), processing of data and measurement processes. Regarding the actual content of this publication, no important alterations or updates to EN13816 are supplied.

¹² Mystery Shopping Surveys are ‘inspections’ conducted by trained survey teams that observe and compare the provided service quality to specific criteria, while acting as if they were genuine PT travelers.

§3.3.2 Measurement of Performance Service Provider

The right half of the Service Quality loop, introduced in Figure 27, identifies measurement of performance of the service provider. This measurement of performance relates to the specification of the offered (targeted) product and the degree to which this product is delivered in reality.

Regarding rail transport, ‘targeted service quality’ is typically defined by objective and measurable specifications. Examples include (among others):

- Frequencies of services
- Punctuality of services
- Cancellation of services
- Average (travel) speed of transport services
- Accessibility of stations, platforms and rolling stock (e.g. for disabled travellers)
- Cleanliness of equipment

Specification of these items (defining the ‘targeted service quality’) is typically conducted by actors granting transport concessions but can also be conducted by railway companies themselves in order to be able to objectively evaluate the targeted versus the actual performance.

In European railway systems, specification of targeted service quality varies significantly per country. A typical example in this respect is definition and measurement of punctuality: European governments may use different definitions for acceptable punctuality levels (e.g. 85% or 95%) and may use different definitions for ‘delayed’ trains (e.g. 3, 5 or 8 minutes behind schedule). Furthermore, European countries use different ways to measure punctuality: while in some member states punctuality is measured only at the end stations, other member states also measure punctuality at in-between stations.¹³

Differences in specification and measurement of service quality levels currently impede a justifiable and fair benchmark of international performances of service providers. Standardization throughout European countries is required regarding acceptable and comparable ways to define and measure targeted versus delivered service quality.

§3.3.3 Measurement of Customer Satisfaction

The left half of the Service Quality loop identifies measurement of (perceived) satisfaction of the customer. Based on this Service Quality loop, the EU Directorate General Mobility and Transport issued a report in which more than 9.000 passengers have been interviewed about their experience with rail services. This report provides a sample value for the perceived customer satisfaction in 2011 regarding passenger rail transport in 25 European countries.

This thesis report presents the concluding ranking table that is the output of the European report. For detailed backgrounds the reader is advised to read the full report (EU Directorate General Mobility and Transport, 2011).

¹³ When measuring punctuality at end-stations only, a frequently applied trick to increase punctuality levels is to include a large amount of slack time in the station located just before the end-station. Due to this large slack time, trains that are delayed throughout their entire journey may catch up with the original timetable just before reaching the end-station and are as a result reported ‘punctual’. In order to avoid these practices, measurement of punctuality at in-between stations is clearly a better way to measure the actual performance delivered by a service provider.

The following Customer Satisfaction (CS) drivers have been included in the overall CS score:

TABLE 13: OVERVIEW OF CS DRIVERS TAKEN ALONG IN OVERALL CS ASSESSMENT EU COUNTRIES

Frequency of Journeys by Rail	Ease of buying tickets	Provision of information on train schedules and platforms	Personal security in rail stations
Connections other modes of public transport	Quality of the facilities and services in railway stations	Cleanliness and maintenance of station facilities	Facilities for car parking
Ease of complaint handling mechanisms	Personal security on board the train	Frequency of trains	Length of scheduled journey time
Punctuality and reliability	Provision of information during the journey in case of disruptions	Connections to other train services	Comfort of Seating area on board the trains
Sufficient Seating Capacity on board the trains	Cleanliness and maintenance of carriages	Availability of Staff on board the trains	Assistance and information disabled or elderly people

As becomes visible from Table 13, the CS drivers more or less directly resemble the Quality Criteria composed by Euronorm (as derived in Table 12).

Per CS driver, a ranking is provided for the 25 European countries under examination (an overview is provided in Appendix 3.3). The overall Customer Satisfaction Score per country is added in Figure 28.

Country	Overall CS Score	Country	Overall CS Score
Luxembourg	59,6	Czech Republic	23,0
Portugal	55,1	Italy	22,8
Lithuania	50,8	Estonia	22,5
Spain	50,8	Slovakia	22,5
Ireland	50,4	France	21,4
United Kingdom	38,2	Netherlands	21,2
Finland	34,2	Germany	18,8
Slovenia	33,5	Hungary	18,3
Belgium	28,3	Greece	18,1
Denmark	28,0	Romania	16,1
Austria	26,6	Bulgaria	16,1
Latvia	25,6	Poland	13,3
Sweden	25,0		

FIGURE 28: OVERALL CUSTOMER SATISFACTION SCORES RAILWAY SYSTEMS EU (EU DIRECTORATE GENERAL MOBILITY AND TRANSPORT, 2011)

A first analysis of the results yields that countries with the highest overall CS scores possess a relatively limited rail network. The highest ranking country with an extensive rail network is the United Kingdom. Countries as France, Germany and Italy rank in the middle section of the list. Poland ranks significantly poor (in most CS drivers Poland occupies the last position).

The conducted study again provides a first insight in relative positions of EU railways regarding the satisfaction of customers. Some important remarks should be made regarding the method investigators used yielding the results from Figure 28:

- Over 9.000 railway passengers aged 15 years and above have been interviewed EU wide. This represents a sample size of around 400 passengers per country, which is a very limited group compared to the millions of daily train travellers in European railway systems.
- The ranking tables provide one sample value for 2011 only. No information is provided about the relative increase or decrease in customer satisfaction compared to previous years (trends over time).
- No information is provided about CS drivers that are either more or less important to rail customers compared to other drivers (no weights attached).
- Only the perception of rail travellers is taken along in assessment of CS. No link is provided with actual performances (e.g. on punctuality); results may therefore be colored by national perception (e.g. influence by the media). A highly relevant remark should be made in this respect: as Roeleveld points out, there is no direct connection visible between actual and perceived punctuality. Satisfaction of customers is influenced by the difference between expectation and experience of the service. (Roeleveld, 2010). Roeleveld adds that it thus makes more sense to look at the relative improvement of customer satisfaction over time instead of taking the absolute annual sample value. Trend series provide an insight in the performance over time of a railway company. Figure 29 provides these trend series for a period of seven years of 8 anonymous European railway companies and the relative position of Dutch Railways (NS).

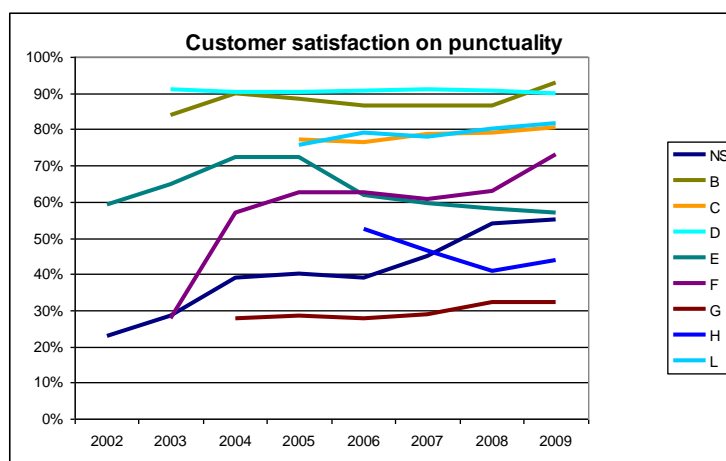


FIGURE 29: TRENDLINES CUSTOMER SATISFACTION ON PUNCTUALITY OF 8 ANONYMOUS EUROPEAN RAILWAY COMPANIES. (ROELEVELD, 2010)

The study conducted by the EU Directorate General Mobility and Transport yields a first overview of perceived Customer Satisfaction in the 25 EU member states. The methodology used by the researchers does not take some important background processes and characteristics into account that influence the results.

CHAPTER 3.4: CONCLUSIONS

Performance evaluation of railways is a complex and abstract task. Two quantitative methods of evaluating performances have been applied in part 3, supplemented by remarks regarding service quality definition and measurement.

A first estimation of performances of railway systems is provided by KPI's on efficiency and effectiveness of passenger and cargo transport by rail. Required data has been extracted from multiple sources: the Railisa database (UIC), Eurostat, OECD Statistics and Railway Directory.

In the resulting ranking tables, the Baltic states rank in numerous tables peculiarly high. In most of the resulting ranking tables there is little difference between the rankings based on mixed subsets or the most complete dataset (single source). Regarding effectiveness in passenger and cargo operations, Western European railways outperform Eastern European and Balkan railways regarding most of the KPI's. This also holds for Efficiency of the production process, since in the Eastern European and Balkan states still lots of staff are employed in the railway system. Regarding Infrastructure usage there is a consistent picture: the Netherlands, Switzerland and the United Kingdom have the most densely used infrastructure, based on the available data.

The resulting ranking tables do present a first insight in differences in network usage, balancing of supply and demand of services and the level of production in 27 EU+EFTA railway sectors. The major obstacle of the method is the aggregated level of data provided and a limited comparability of data between countries. The method based on KPI's does not present sufficient insights in internal processes and backgrounds for efficiency improvement within railway companies and does not take the shared nature (passenger and cargo transport) of railways into account.

To gain more insight in these processes, a multiple input-output evaluation has been conducted using a method that is common practice in railway performance evaluation: Data Envelopment Analysis (DEA). The shared nature of a railway system, in which both passenger and cargo services are offered on the same rail network, sometimes with shared rolling stock equipment and staff, is handled quite well by this multiple input-output assessment method. Data reliability is slightly improved, although no longer 27 European railway sectors are under examination but a chosen subset of 8 reliable and comparable European railway systems. These systems present a more or less similar level of scale and less aggregated data is publicly available.

Results of DEA assessment show that, compared to peers, railway systems operating on the efficient and effective frontier are present in all three organizational structures (integrated, holding or separated). Israel Railways currently makes effective use of its resources but can improve efficiency of its production by increasing the amount of driven Trainkilometers for passenger and cargo trains.

In order to avoid high efficiency and effectiveness rankings of low quality firms, an additional topic is evaluation of service quality and Customer Satisfaction. Objective and measurable specifications indicate differences between targeted and delivered service levels. Euronorms and a recent European study show methods to measure perceived customer satisfaction and present overall levels of customer satisfaction in 25 EU countries. Research shows that the relationship between actual performance (e.g. on punctuality) and perceived performance by the customer is limited. The difference between expectation and experience determines for a large part the opinion of a customer.

Perceived customer satisfaction is higher in countries possessing smaller passenger rail systems compared to countries with extensive rail systems. Rail systems in Balkan countries score in general low on overall customer satisfaction, while Poland is in most of the CS drivers the country located at the bottom of the rankings, indicating a significant low performance.

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As a general conclusion it is assumed that the combination of KPI analysis, DEA analysis and service quality analysis provides a comprehensive method for assessing the overall and relative performance of railways. Although every method has its advantages and disadvantages, the combination of these methods facilitates an appropriate evaluation of performances of railways.

Results and experiences acquired in part 3 are taken forward in the next parts of this thesis report. In Part 4 the relationship between organizational structure and resulting performance will be investigated, in Part 5 all knowledge is placed into practice when designs for a modified structure for Israel's railway sector are proposed.

PART 4: ORGANIZATIONAL STRUCTURES AND PERFORMANCES - CORRELATION ANALYSIS

In part 2, three typical setups of European organization models for railway sectors are established including subsets of countries that have a particular model in place. Part 3 identifies performances of railways on efficiency, effectiveness and customer satisfaction.

Part 4 combines the results of parts 2 and 3 and examines the relationship between organizational model and performance of 27 European railway sectors. Also an analysis between organizational structure and performance of 8 selected European railway systems is provided.

Part 4 should provide an answer to the question if a correlation exists between a particular type of organizational model and performance. In order to answer this difficult question, four hypotheses are composed first in Chapter 4.1. Chapters 4.2 and 4.3 will look graphically and numerically into the relationship between organizational structure and performance.

In Chapter 4.4 the hypotheses will be accepted or not, based on results obtained in Chapters 4.2 and 4.3.

CHAPTER 4.2: CORRELATION ANALYSIS

ORGANIZATIONAL STRUCTURES – PERFORMANCES

Paragraphs 4.2.1 to 4.2.4 aim to find out if a correlation exists between type of organizational structure and performance in 27 EU+EFTA railway sectors (KPI method). Paragraph 4.2.5 examines the relationship between organizational structure and performance regarding 8 European railway systems (DEA method).

A comprehensive overview of all composed scatter plots can be found in Appendix 4.1. The next paragraphs aim to find out if clusters of scatter points become visible in the rankings for all KPI's. These clusters of scatter points identify outliers and indicate if in general a specific organization model outperforms others.

§4.2.1 Effectiveness of Production - EU + EFTA countries

Based on KPI values indicating effectiveness of production (Pkm/Train-km P, Tkm/Train-km C), no correlation can be identified between effectiveness and organizational structure in the passenger sector. No specific clusters of scatter points become visible; indicating no strong relation between organizational structure and corresponding effectiveness of production.

Regarding effectiveness of production in the cargo sector, countries containing a Holding or Separation model in general outperform countries having an Integration model in place as Figure 31 shows. A single positive outlier is visible in the Integration model (Lithuania), as well as negative outliers in the Holding model (Austria, Greece and Italy) and Separation model (Norway, Portugal and Spain).

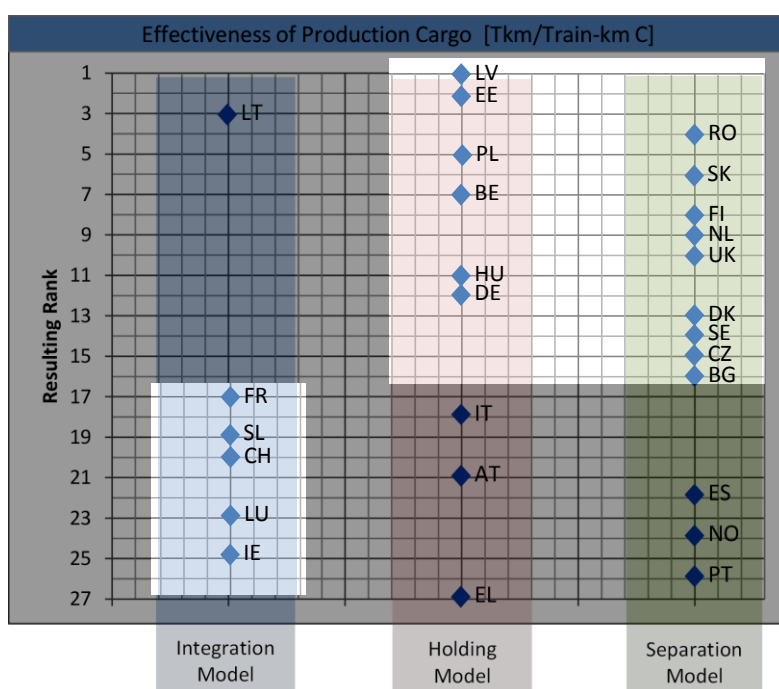


FIGURE 31: CLUSTERS OF SCATTER POINTS - EFFECTIVENESS OF PRODUCTION CARGO

§4.2.2 Effectiveness of Resources - EU + EFTA Countries

KPI Values on Effectiveness of Resources (Pkm/Staff P, Tkm/Staff C) indicate that in the passenger sector positive as well as negative outliers are visible in Integration and Separation models. Holding models perform in general on average as visualized in Figure 32.

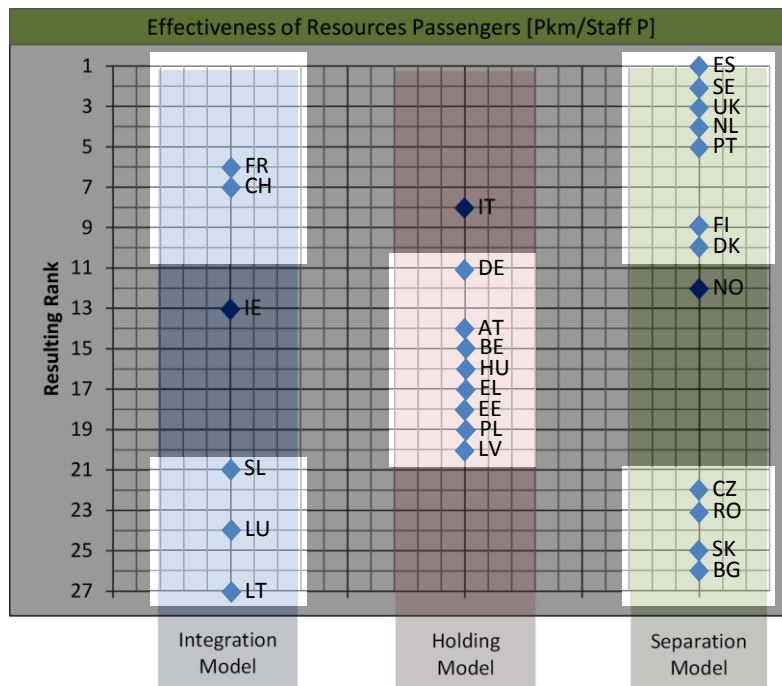


FIGURE 32: CLUSTERS OF SCATTER POINTS – EFFECTIVENES OF RESOURCES PASSENGER

In the cargo sector, no specific clusters of scatter points are visible in the scatter diagram indicating no relation at all between organizational structures and performances.

§4.2.3 Efficiency of Production - EU + EFTA Countries

KPI values on efficiency of production (Train-km P/Staff P, Train-km C/Staff C) indicate for passenger transport that Separation models in general outperform Integration or Holding models, as visualized by Figure 33.

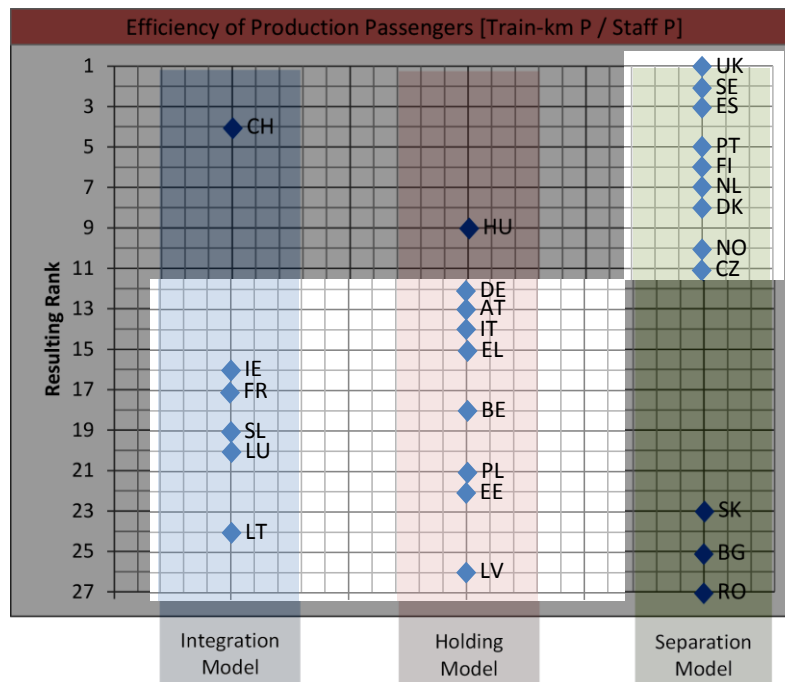


FIGURE 33: CLUSTERS OF SCATTER POINTS - EFFICIENCY OF PRODUCTION PASSENGERS

Positive outlier in the Integration model is Switzerland, while negative outliers in the Separation model include Bulgaria, Romania and Slovakia.

In Cargo transport a similar picture is visible: in general Separation models outperform Holding models, while Holding and Separation models outperform Integration models, as visualized by Figure 34.

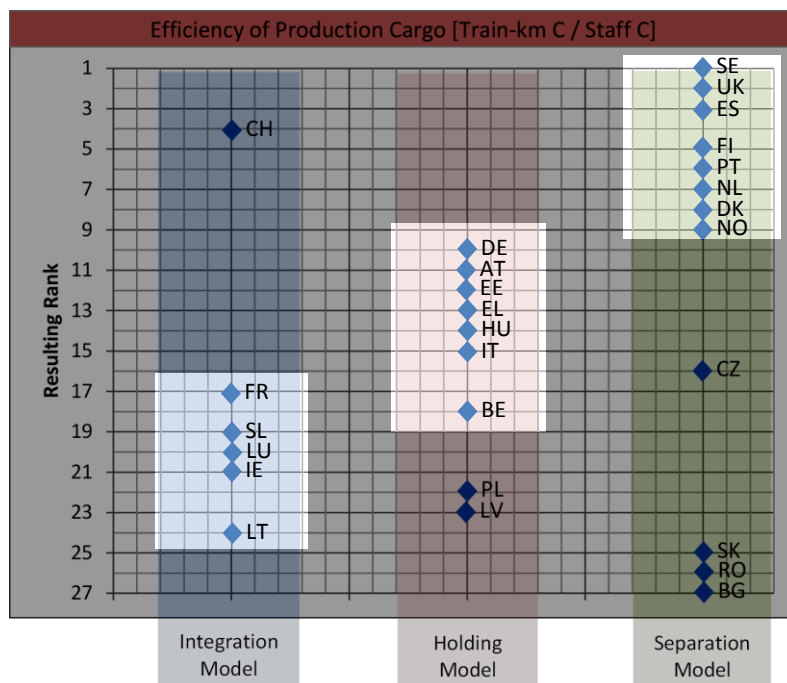


FIGURE 34: CLUSTERS OF SCATTER POINTS - EFFICIENCY OF PRODUCTION CARGO

Switzerland results again as a positive outlier in the Integration model. Negative outliers in the Separation model again include Bulgaria, Romania and Slovakia. In the Holding model Latvia and Poland are performing below average.

Regarding efficiency of production based on network usage (Train-km P+C/Network length) no clusters of scatter points are visible.

§4.2.4 Customer Satisfaction - EU + EFTA Countries

Perceived Customer Satisfaction indicates that Integration models outperform Holding and models in general. Regarding the ranking of countries with Separation models in place, there is no strong tendency visible; Separation models in specific countries perform above average, while in other countries separation models perform on or below average.

EFTA countries Norway and Switzerland are unfortunately not taken along in the Customer Satisfaction survey instigated by the EU, so these countries are also excluded from the scatter plot.

Figure 35 indicates clusters of scatter points visible regarding customer satisfaction.

France is the only country that scores lower than other countries with an Integration model in place.

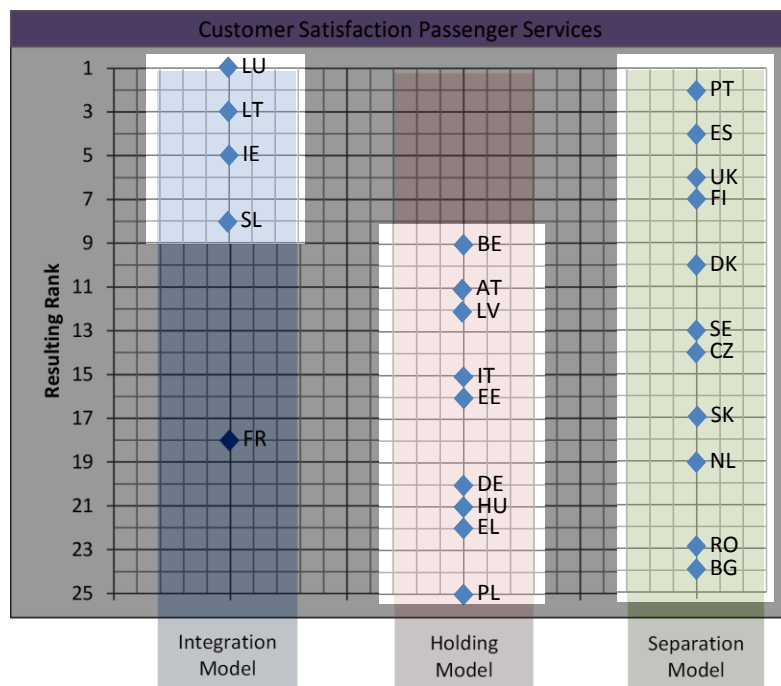


FIGURE 35: CLUSTERS OF SCATTER POINTS - CUSTOMER SATISFACTION

§4.2.5 Efficiency and Effectiveness - 8 European railway systems

The previous paragraphs presented scatter plots regarding railway sectors in 27 EU+EFTA countries. This paragraph provides similar scatter plots, now for the 8 European railway systems examined during DEA assessment (Chapter 3.2).

Figure 36 presents resulting efficiency scores (taken along from DEA assessment) grouped towards railway systems functioning in an Integrated, Holding or Separated railway sector.

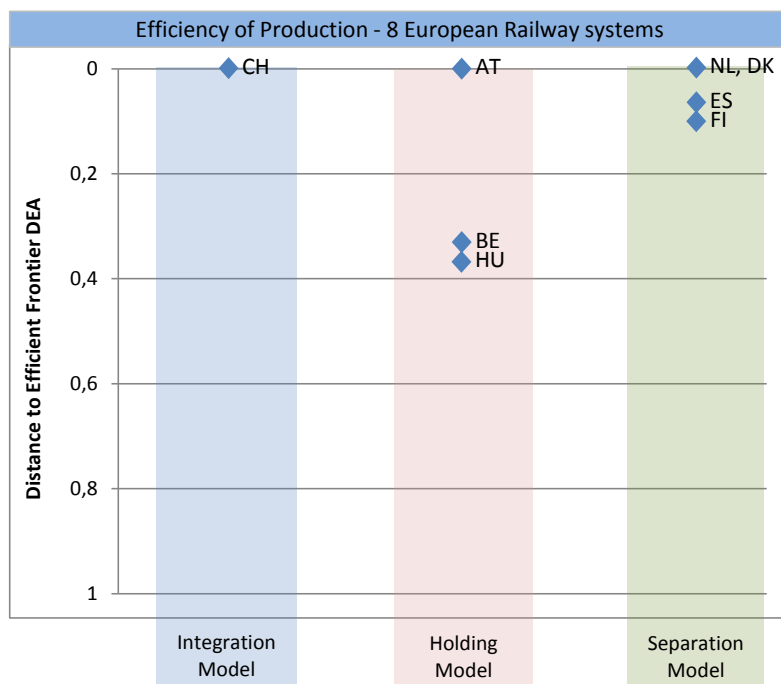


FIGURE 36: EFFICIENCY OF PRODUCTION - 8 EUROPEAN RAILWAY SYSTEMS

As indicated by Figure 36, there is no strong relationship visible between systems operating on the efficient frontier and the type of organizational model in place: all models contain systems located on the efficient frontier. A similar result yields Figure 37, plotting DEA effectiveness scores.

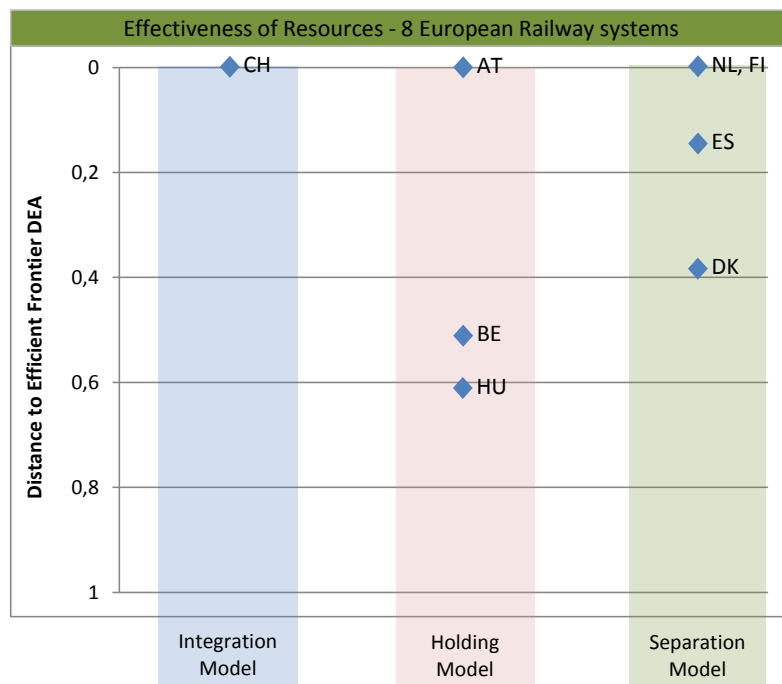


FIGURE 37: EFFECTIVENESS OF RESOURCES - 8 EUROPEAN RAILWAY SYSTEMS

§4.2.6 Summary

Results from §4.2.1 to 4.2.5 indicate that there is no strong relationship visible regarding effectiveness of resources and effectiveness of production. Positive and negative outliers in all models occur, general trends are hardly visible.

Regarding efficiency of production (Train-km per Staff) there is a slight trend visible that Separation models outperform Holding models. Separation and Holding models again outperform Integration models. Especially in the cargo sector this trend is visible, as indicated by Figure 34.

When looking at perceived Customer Satisfaction, Integration models outperform Holding and Separation models in general.

Results of DEA assessment indicate no strong relationship between railway systems located on the efficient or effective frontiers compared to the organizational model of the railway sector in which they operate. Companies operating on the efficient and effective frontier function in all types of structures.

The only relationships that are found in Chapter 4.2 include a higher efficiency of production (Train-km/Staff) in Holding and Separation models and a higher perceived Customer Satisfaction in Integration models. Positive and Negative outliers are common in all structures; so the type of organizational setup does not necessarily induce a weak or strong performance per se.

CHAPTER 4.3: CORRELATION ANALYSIS

DEGREE OF MARKET OPENING - OVERALL PERFORMANCE

This chapter examines the correlation between the degree of market opening in a national railway sector and corresponding performance. A quantitative value indicating the degree of market opening is provided by the 'Rail Liberalization Index 2011', conducted by IBM Global Business Services and Kirchner. The degree of market opening is compared to KPI rankings, resulting from Part 3 of this thesis report.

This chapter summarizes the main findings by means of the resulting values of Spearman's and Pearson's rank correlation coefficients. An extensive elaboration on the IBM Liberalization index and backgrounds regarding Spearman's and Pearson's correlation coefficients is added in Appendix 4.2. Table 14 expresses how resulting values of Spearman's Rank Correlation Coefficient (SRCC) and Pearsons Product Moment Coefficient (PPMC) should be interpreted.

TABLE 14: INTERPRETATION RESULTING SRCC AND PPMC VALUES

SRCC/PPMC Value	Interpretation
Positive $0 < \text{Value} \leq 1$	Market opening degree increases (+) Performance increases (+)
Zero $\text{Value} = 0$	No correlation between market opening degree and performance
Negative $-1 \leq \text{Value} < 0$	Market opening degree increases (+) Performance decreases (-)

SRCC and PPMC have been established for all KPI's defined earlier for 27 EU+EFTA countries. Regarding the KPI on Customer Satisfaction, 25 EU Countries have been examined (excluding Norway and Switzerland). Results of the assessment are displayed in Table 15

TABLE 15: RESULTING SRCC AND PPMC VALUES

KPI	SRCC	PPMC
Effectiveness of Production Passengers (Pkm/Train-km P)	+0,08	-0,20
Effectiveness of Production Cargo (Tkm/Train-km C)	+0,23	-0,10
Effectiveness of Resources Passengers (Pkm/Staff P)	+0,35	+0,31
Effectiveness of Resources Cargo (Tkm/Staff C)	+0,42	+0,43
Efficiency of Production Passengers (Train-km P/Staff P)	+0,42	+0,38
Efficiency of Production Cargo (Train-km C/Staff C)	+0,45	+0,48
Efficiency of Production - Network utilization (Train-km P+C/ Staff P+C)	+0,55	+0,47
Customer Satisfaction	-0,21	-0,42

The resulting SRCC and PPMC values from Table 15 indicate that there is little to none correlation visible between the degree of market opening and performance ranking based on the results from part 3. Almost all of the resulting coefficient rankings range between -0,5 and +0,5 indicating that there is no significant correlation present between degree of market opening and corresponding (overall) performance.

CHAPTER 4.4: CONCLUSIONS

No strong correlation can be found between the three main European organizational models and performances based on the quantitative ranking tables that presented output of Part 3. Regarding effectiveness there seems to be little correlation visible at all. With respect to efficiency of production, results indicate a slight improvement of efficiency in Separation and Holding models. When looking at customer satisfaction a slight preference of customers towards Integration models is visible.

Based on the results displayed in the previous chapters, the hypotheses expressed in Chapter 4.1 can now be accepted or not:

1. By increasing the degree of separation in a country's railway sector, effectiveness of production and resources increases – **Not accepted**
Based on results shown in Chapter 4.2 this hypothesis is not accepted. Effective railway sectors can either be organized as an Integrated, Holding or Separated structure. There is no consistent and strong evidence visible that a Separated model increases effectiveness.
2. By increasing the degree of separation in a country's railway sector, efficiency of production increases – **Not accepted**
*Although no strong correlation is found in Chapter 4.2 results do indicate that there is a slight improvement of efficiency visible in Holding and Separated structures compared to Integrated structures. This relationship is visible in the cargo sector and to a lesser extent also in the passenger sector.
The absence of a strong correlation leads to the decision not to accept this hypothesis as well, but with a remark in place that a slight improvement of efficiency is visible in Holding and Separated structures respectively.*
3. By increasing the degree of separation in a country's railway sector, the perceived Customer Satisfaction level increases – **Not accepted**
This hypothesis is not accepted, based on the results shown in Chapters 4.2 and 4.3. Based on results of a comparative study in 25 European countries, customer satisfaction in most of the examined Integrated railway sectors and in some of the Separated railway sectors outperform Holding structures, but again, a clear trend is not visible.
4. By increasing the degree of market opening in a country's railway system, overall performance increases – **Not accepted**
This hypothesis is not accepted based on the results shown in Chapter 4.4. The resulting Spearman and Pearson Correlation Coefficients show that there is no significant correlation visible between degree of market opening and overall performance ranking.

The main conclusion from the correlation analysis is that altering the structure of a railway sector is clearly no guarantee for overall performance improvement per se. As results from this part show, the degree of separation or market opening inside railway sectors has little correlation with a satisfactory or dissatisfactory performance. Best and worst practices are visible in all major European organizational models.

However, it is assumed that internal processes within railway sectors and systems may benefit from alteration of the organizational structure. In the remaining parts of this report, this essential finding should be constantly kept in mind. The quantitative results should be augmented with additional qualitative descriptions of performance drivers. These qualitative performance drivers identify internal processes that can aid in improving efficiency and effectiveness levels and are introduced in the next part before design of optional new structures for Israel's railway sector starts.

PART 5: DESIGN ORGANIZATIONAL STRUCTURES FOR ISRAEL RAILWAYS

Part 5 takes all results and knowledge regarding organizational structures and performances along that is established in Parts 2, 3 and 4.

As part 4 shows, altering the organizational structure to increase overall performance of the railway sector is considered inaccurate since these two are proved to be uncorrelated. Organizational structures may however facilitate a performance improvement internally within the railway sector or within railway companies present.

Therefore in part 5 optional redesigns for new organizational structures for Israel's railway sector are designed based on:

- Qualitative performance drivers of railways, based on European experiences and literature that will be introduced in Chapter 5.1
- Additional possibilities and boundaries of new organizational structures, based on additional Israeli knowledge that will be introduced in Chapter 5.2
- Specific (internal) issues of IRL's current setup, illustrated in Part 1
- Detailed organizational structures in 27 European countries, composed in part 2

Resulting from Part 5 are multiple optional designs for Israel's railway sector that will be simulated and evaluated in the remaining parts of this thesis report.

CHAPTER 5.1: EFFICIENCY DRIVERS: QUALITATIVE DESCRIPTIONS

In Part 3 quantitative methods have been applied to determine (relative) efficiency and effectiveness levels of railways in various countries. In Part 4 no correlation has been found between overall (quantitative) performances and type of organizational structure in place. A qualitative addition is required to place the quantitative results into perspective and to include additional drivers of efficiency that are only indirectly taken along in the quantitative results.

This paragraph aims to add qualitative comments to the quantitative results based on the three main actor blocks: Authorities, Infrastructure and Transport (identified in Part 2). All comments are extracted from European literature and experiences in the Dutch railway sector of recent years.

§5.1.1 Authorities

Authorities play a significant role in determining efficiency and effectiveness of railways. Literature is consistently in agreement that the following institutional characteristics are major drivers for obtaining efficient and effective railways:

- Consistent policymaking covering the entire transport sector
- Gradual reform instead of shock reform
- Stimulation of entrepreneurial freedom for railway companies
- Public funding where necessary, subject to Performance Contracts
- Comprehensive planning and policy approach: 'Railways in their environment'

- Consistent policymaking covering the entire transport sector

Railways clearly benefit from consistent policymaking over time, not only policymaking in the rail sector but covering a country's transport sector as a whole.

A specific example in this respect is Switzerland. Railways in Switzerland have benefited from operating within a favorable and extraordinarily consistent political environment with few changes of transport policy. The Swiss example shows that internalization of external costs for road transport¹⁴ stabilized rail's already high market share in cargo (40%) and increased its share of passenger transport to more than 15% (CER, 2011).

- Gradual reform instead of shock reform

When authorities decide to reform their railway sector they should keep in mind that, as Friebe et al. point out, efficiency and effectiveness improvements are achieved much earlier in case of gradual reforms than in case of 'shock' (package) reforms. Improvements have shown to be only marginal in those cases where governments implemented a number of reforms at the same time (shock) while in case of gradual reforms (sequential), efficiency and effectiveness did improve significantly. (Friebe, et al., 2010). In other words, as Kemp points out: "Evolution might be preferred over Revolution" (Kemp, 2011)

Authorities should be very careful to 'transfer' experiences from other business sectors (e.g. the energy industry) to the railway sector as completely different circumstances are likely to be present. There are currently severe doubts if experiences can easily be transferred across business sectors. (Friebe, et al., 2010).

Finally, gradual reform facilitates tranquility in the railway sector avoiding employee strikes or immediate coordination problems. Disturbances in the railway sector can severely damage the

¹⁴ e.g. heavy truck toll, highway toll

reputation and attractiveness of rail transport as a whole resulting in very deluding efficiency and effectiveness figures.

- Stimulation of entrepreneurial freedom for railway companies

Originally, railway companies have been managed as part of a government ministry with little incentives for managers to meet market requirements. Managers in railway companies had to please the responsible public servants and they had to deal with often conflicting incentives from different branches of government ministries representing transport, finance, industry, labor, regional development and even defense. (CER, 2011) The 'customer' came in this traditional setup at second place; passengers merely 'filled' up carriages, shippers were 'lucky' if their shipment arrived on time at the final destination and if they were kept updated in case of disturbances.

Entrepreneurial autonomy makes management directly responsible and accountable for decisions regarding the 'product' on offer: passenger or cargo transport by rail. Customers become more important to the management, are treated accordingly and as a result are more inclined to take the train instead of other modes of transport to which rail competes. A delicate balance emerges in which railway companies have to facilitate both governmental institutions and customers at the same time.

Under entrepreneurial freedom, most European railways have been able to increase outputs while staff numbers decreased; SBB for example attributes the overall gain in productivity per employee to an increase in entrepreneurial autonomy. (CER, 2011)

- Public funding where necessary, subject to Performance Contracts

Railways typically offer a 'public service' and represent a 'public interest'. If authorities decide to follow a policy in which all people should have access to rail transport ('principle of equity') and cap prices at maximum levels, authorities also need to financially compensate railway companies accordingly. 'Efficient' railway companies might otherwise face insufficient financial funds and the inability to alter politically-determined service patterns and tariffs: both inevitably resulting in an accumulating debt.

Public funding in infrastructure construction and maintenance remains an inevitable obligation for national and international authorities. Although Public-Private Partnerships in the (heavy) railway sector have been applied, a government cannot discharge itself from its obligations to make funds available since railway infrastructure has to be seen as a public interest. A subset of European countries now have a 'National Rail Infrastructure Fund' in place (e.g. Switzerland, Belgium) that is, in the Swiss case, financed by income obtained from a tax on heavy road vehicles passing the country. The money in this national rail infrastructure fund is earmarked and can only be used for investments in enhancing, expanding or maintaining rail infrastructure.

Efficient and effective railways benefit from public funds only if sufficient agreements have been made that match financial rewards to performances. Companies operating in the railway sector should be given an effective incentive to perform according to performance standards (or targets) predefined by the authorities and are to be financially compensated accordingly. In other words: performance agreements should be in place stimulating railway companies to offer a satisfactory service to as many potential customers as possible. Accurately monitoring the performance of railway companies should be a governmental spear point.

Separating awarding authorities (awarding transport concessions) from transport service contractors is a necessary prerequisite in order to be able to monitor performance and to convert state subsidies into payment of a delivered service (Kroon, 2011).

- Comprehensive planning and policy approach: 'Railways in their environment'

Integrated, tailor made policies for the railway sector are highly influencing efficiency and effectiveness of railway companies. A specific example in this case is Japan where spatial planning is executed in close cooperation with (or even by) railway companies. This comprehensive policy approach gives railways a competitive advantage over other modes of transport right from the start of construction. Clustering large office and residential buildings close to railway stations clearly places rail transport in an advantageous environment and increases usage not only in peak hours, but during the entire day resulting in a more effective use of resources.

A typical example from recent history in which the comprehensive policy approach failed is in the Netherlands. New residential areas ('Vinex' locations) were planned and constructed outside the city centers with very limited access to rail transport. After all residents had just bought their second car, a new railway station opened that in most cases remains poorly used to date. The Netherlands learned from its mistakes in the past and access to public rail transport is now often an integrated part in development plans of new residential areas.

Coordinated policymaking is furthermore stimulated by combining ministerial departments. In most of the EU countries, the ministry of Transport is now combined to form for example a Ministry of Infrastructure, Spatial Planning, Communications and Energy. Combining competences inside the same ministry has the opportunity to provide a more coordinated policy approach to (rail) infrastructure located in its surrounding environment - potentially resulting in more efficient and effective railways.

§5.1.2 Infrastructure

Next to authorities, companies involved in rail infrastructure have a high influence in increasing efficiency and effectiveness within the rail sector as a whole. The following drivers for obtaining efficient and effective railway networks are identified:

- Standardization and removal of legacy systems
- Performance tracking of the network and removing error prone locations
- Accessible, comfortable and multi-functional station areas
- Transparent management of infrastructure construction and maintenance
- Combining expertise: construction of a National (Land) Transport Agency

- Standardization and removal of legacy systems

Efficient networks are driven by standardization of infrastructure, (signaling) systems and the removal of legacy (national) systems; provided that replaced systems provide at least an equal reliability. In European rail networks, national legacy systems are a large obstacle in further efficiency improvement since all rolling stock and infrastructure has to be certified and tailor made to each European country specifically.

The European Union recognizes the above and instigated standardization on a generic European Train Management System (ERTMS) improving cross border transport and standardization of signaling systems (ETCS) throughout the member states. For the Israeli situation, harmonization and standardization (interoperability) will play an insignificant role, since the railway network is not internationally connected (yet), but a very interesting option is to examine if Israel can join Europe's international systems. In this way, European rolling stock can be implemented directly in Israel, without necessary modifications required.

- Performance tracking of the network and removing error prone locations

By collecting detailed data on availability and reliability of the railway network and by conducting operational analysis, insight is gained in sub processes within the rail network that can be optimized. Two Dutch examples illustrate the need for performance tracking:

- Error prone locations, such as level crossings, have the potential to severely disturb availability of the railway track in case of accidents, jeopardizing network efficiency. Dutch Infrastructure Manager ProRail is replacing level crossings located on the main railway network in high pace. New rail infrastructure no longer sees the construction of level crossings at all.
- ProRail acquired data on causes of delays in the country's most important railway station Utrecht Central Station. After detailed analysis it became clear that too many trains 'interfered' each other on the crossing yard next to the station. ProRail decided to use an alternative routing (in corridors) for the trains based on the data research. This 'unraveling' of lines and platforms yielded a higher capacity, an increased punctuality and fewer dependencies of trains at Utrecht Central Station. (Weeda, 2010)

Both examples show that performance analysis on a microscopic level can yield significant efficiency improvements regarding the rail network.

- Accessible, comfortable and multi-functional station areas

Although this might at first seem a paradox; efficient stations are not just functional platforms where passengers wait to board a train. Although a large difference exists in importance and appearance between a city center station and a rural, remote station, especially larger hub stations should possess a major attractive value on potential customers.

Accessible railway stations with easy and quick connections to underlying (regional or municipal) public transport or private transport (bicycle, car) combined with integrated real estate development lead to efficient stations that are able to finance themselves. Stations offering meeting rooms for business conferences, lounges for first class international passengers and a variety of shopping possibilities also attract people to the station that have no intention to travel. These multi-functional stations are becoming more and more common in efficient European railway networks such as in the Netherlands or Switzerland.

In the Netherlands ProRail, Dutch Railways and local/national authorities currently join forces in modernizing major stations in Dutch city centers to 'Stations of the World'. These stations closely resemble airports; economical efficiency is increased through a differentiation in sources of income.

- Transparent management of infrastructure construction and maintenance

In the past decades infrastructure construction and maintenance has been increasingly outsourced and conducted by private construction companies in a wide variance of Public Procurement schemes. While short-term construction costs may increase in these Public Procurement schemes; total life cycle costs may well decrease in the mid- to long-term resulting in less maintenance costs during the operational phase of infrastructure.

In order to reach efficiency gains in infrastructure construction and maintenance, outsourcing is a possibility providing that construction management is conducted transparently.

- Combining expertise: construction of a National (Land) Transport Agency

Recently, Sweden and Finland assigned the tasks of the rail infrastructure manager to a national (public) Transport Agency. This agency combines competences in the road, rail and inland shipping sectors and reduces required overhead. Projects regarding infrastructure renewal and

maintenance are jointly executed and overseen by the Transport Agency itself. For the national government, a single responsible party (independent from governmental ministries) can be held accountable for executing transport policies issued by the ministry. For private construction companies, a single public entity is responsible for tendering and managing infrastructure construction.

Efficiency improvement by reduction of staff can be an outcome of combining the competences in a single Transportation Agency. This 'Joint Venture' of executive agencies within the transport sector is an interesting next move in increasing efficiency of transport infrastructure managers as a whole.

§5.1.3 Transport Operations

In European countries, the following drivers have a large effect on the efficient and effective organization of transport operations in rail's passenger and cargo sectors:

- Emulation and Competition
- Transport safety and security
- Adequate Rolling Stock Maintenance
- Tariff differentiation

- Emulation and Competition

Emulation¹⁵ in passenger and cargo operations can be a major driver for efficient and effective railways. While in most literature, introducing competition into railway systems is seen as the most promising way of improving efficiency, effectiveness and quality of the offered service, emulation of peers can also significantly influence railway companies 'to perform better' compared to peer companies that may even be operating completely different networks and services (and are thus no direct competitors).

Taking Switzerland again as a typical example, the vertically integrated railway companies (that typically do not face direct competition) benchmark themselves against peer operators and by doing so have an internal stimulus to improve performance. The power of emulation must therefore not be underestimated. Instead of direct competition, the Swiss example proves that emulation of peers drives railway companies to improve their own performance.

- Transport safety and security

Safety and security within the rail system are essential for a railway company to operate efficiently. The specific security situation in a country may require additional safety and security staff to be employed compared to other countries. Although, at a first glance, efficiency seems to suffer from additional staff required in securing the railway system, it must be stated that prevention of unsafe or insecure situations is a major driver for a railway system to perform satisfactory.

Customers will easily choose for alternative modes of transport if safety and security of the rail system are at unsatisfactory levels. Another major point of interest is that customers expect a higher level of safety while inside a rail system than for example when driving a car. Unsafe situations in the rail sector typically have a very large influence on the choice behavior of travellers and thus on the effectiveness of railway companies in general.

¹⁵ Sometimes also referred to as 'yardstick competition'

- Adequate Rolling Stock Maintenance

Adequate maintenance of rolling stock is another main driver for performance improvement of railway systems. Disruptions due to failures that can be attributed to rolling stock breakdowns have shown to have a major impact on reliability of operations as a whole. Internal improvements to the rolling stock maintenance cycle have proven to increase efficiency and effectiveness of operations (Roeleveld, 2006).

Benchmarking Mean Times Between Failures (MTBF) with peer companies is an effective way to determine if a railway company achieves an acceptable rate of rolling stock breakdowns. At the same time, this benchmark study should provide information if a realistic percentage of rolling stock is kept as strategic reserve.

- Tariff differentiation

Railway companies might investigate if tariff differentiation can increase efficiency and effectiveness of Transport Operations. By differentiating tariffs, customers are attracted to make use of, for example, off-peak trains. By flattening the peak; a railway system is used more effectively throughout the day, avoiding peak usage periods. Since peak usage periods are typically expensive (due to the large amount of rolling stock, staff and infrastructure required), flattening these periods can directly improve a railway companies' efficiency and effectiveness.

Different schemes of tariff differentiation are visible throughout European countries. While SBB and NS have for example more or less 'fixed discounts' for regular travellers in place ('HalbTax' at SBB and 'Voordeelurenkaart' at NS), Deutsche Bahn and SNCF provide more and more flexible tariff schemes. Train travellers booking 'early in advance' receive discounts on regular fares, while 'last minute bookers' pay either the regular fee and in some cases a peak hour addition. The German and French tariff differentiation schemes resemble the tariff systems used in the aviation industry closely.

§5.1.4 Conclusions

The previous paragraphs introduced the most important qualitative drivers that influence performances of railways, but that are only indirectly taken along in the quantitative evaluation methods.

It should be mentioned that even more qualitative drivers could be thought of; the presented drivers are estimated to be a representative sample of drivers.

Information described in the previous paragraphs will be taken along in design of new optional organizational structures for Israel's railway sector. In the next chapter, boundaries and possibilities for new structures from an Israeli point of view will be introduced before design of new structures is conducted.

CHAPTER 5.2: POSSIBILITIES AND BOUNDARIES FOR REFORM: THE VISUAL GRID TECHNIQUE

All optional redesigns of structures for Israel's railway sector must hold to certain constraints. These design constraints are established in this chapter and are based on results from a graphical technique that, in cooperation with Israeli representatives, identifies possibilities and boundaries for new structures from an Israeli perspective. The graphical technique is called the Visual Grid Technique in the remaining parts of this report.

§5.2.1 Visual Grid Technique – Methodology

The Visual Grid Technique consists out of two main components:

1. **The Grid:** This grid visualizes the abstracted playing field in which railways typically have to operate. The grid contains a horizontal and vertical axis with extreme situations at the outer ends of these axes. Figure 38 displays the established grid.
2. **List of main tasks of railway sectors:** 14 main tasks of a railway sector in general are brought up. Although many subtasks exist, these 14 tasks are found predominant. The established tasks are displayed in Figure 39. Detailed explanations and clarifications regarding specific meanings of a particular task are added in Appendix 5.1.

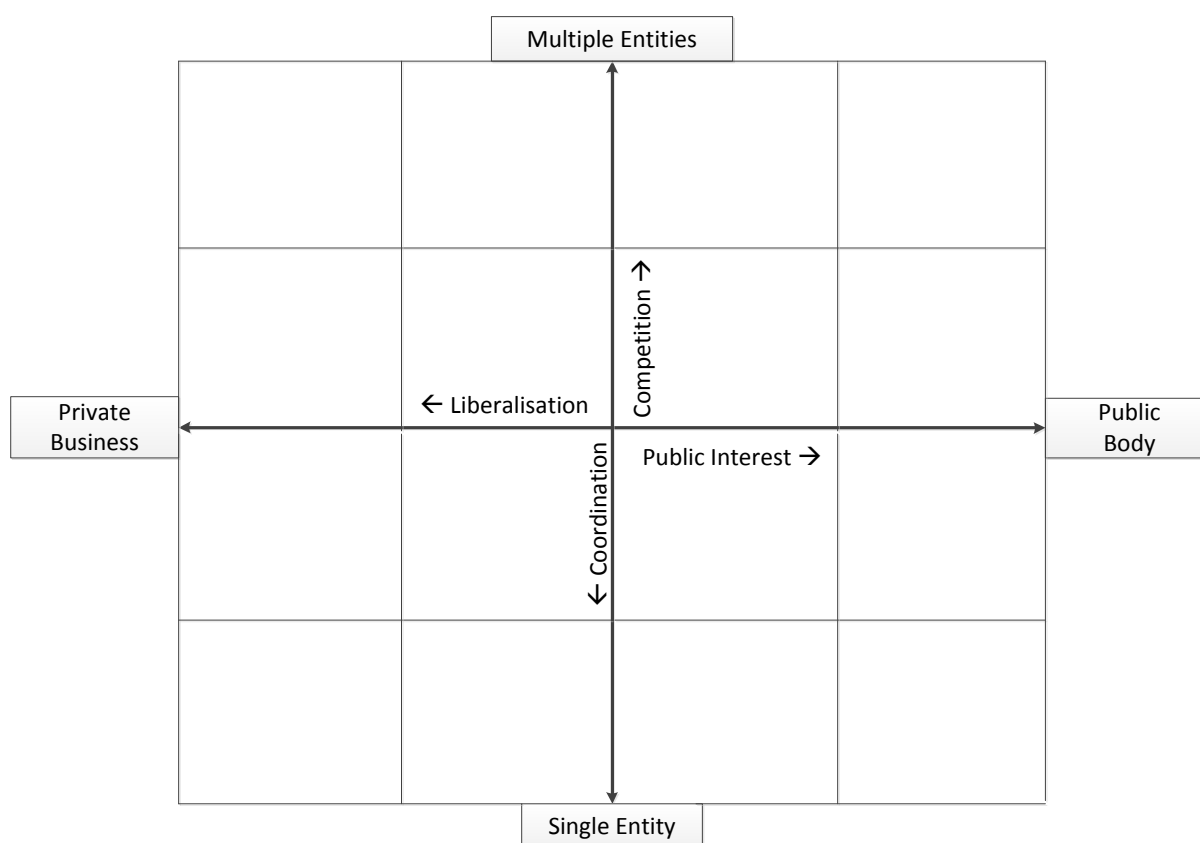


FIGURE 38: ABSTRACTED PLAYING FIELD RAILWAY SECTORS IN THE VISUAL GRID TECHNIQUE

As Figure 38 shows, the relative position on the horizontal axis determines to which extend a private business or a public body should be responsible for carrying out a specific task (liberalization versus public interest). The relative position on the vertical axis determines to which extend a single entity or multiple entities should execute a specific task (coordination versus competition). Figure 39 clarifies which 14 main tasks are positioned in the grid.

Main Tasks Heavy Rail System
1. Strategic infrastructure planning
2. Procurement Infrastructure
3. Procurement Rolling Stock
4. Infrastructure construction and maintenance
5. Infrastructure management
6. Capacity management infrastructure + composing timetable
7. Rail Traffic Management
8. Maintenance rolling stock
9. Establishing fare system
10. Ticket sales
11. Providing travel information
12. Train operations Passengers
13. Train operations Cargo
14. Monitoring systems

FIGURE 39: ESTABLISHMENT OF 14 MAIN TASKS IN RAILWAY SECTORS IN GENERAL

For reference, the main tasks are numbered 1 to 14 (the numbers do not represent any specific meaning or ranking of importance). During subsequent meetings these tasks were presented to five Israeli representatives closely affiliated to the Israeli railway sector. These representatives have been asked to place the 14 tasks in the grid regarding:

- 1) The organization responsible for executing the main task....
- 2) ...in the national Israeli railway sector...
- 3) ...for the mid-term future (10 to 15 years).

An example of a resulting, filled in grid is displayed in Figure 40. A complete overview of all filled in grids, resulting from all five representatives, is added in Appendix 5.2.

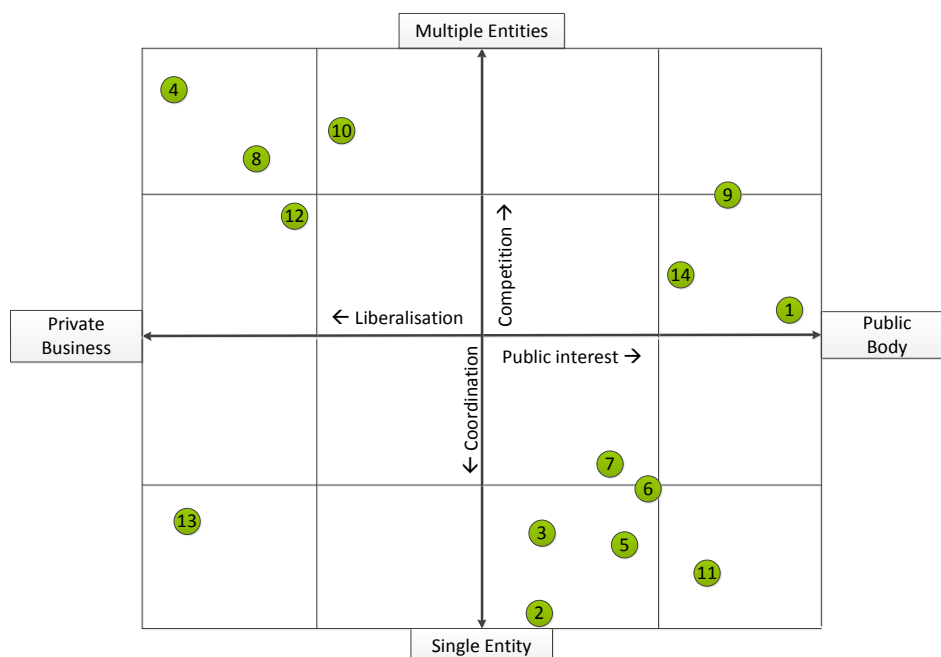


FIGURE 40: EXAMPLE OF A GRID, FILLED IN BY AN ISRAELI REPRESENTATIVE

§5.2.2 Visual Grid Technique – Main Outcomes

All representatives place Strategic Infrastructure Planning (1) firmly in the hands of a public body. Four representatives express that a single public entity should take care of this task. One representative expresses no distinctive choice whether a single public entity or multiple public entities should take care of this task.

Either a completely public body or a public-private partnership (PPP) body should take care of procurement of Infrastructure (2). Representatives differ in opinion if a single entity or multiple entities should take care of this task. Regarding procurement of Rolling Stock (3), there is large inconsistency in the resulting grids. One representative for example indicates that this task can be performed by multiple private business entities while another representative attributes this task to a single public body. A consistent outcome remains unavailable.

Most representatives attribute the task of Infrastructure Construction and Maintenance (4) to multiple private business entities. One representative indicates that a PPP body could be responsible. Infrastructure Management (5) is appointed to a single public body by most representatives. Only one representative indicates that multiple private entities/PPP entities could take care of this task. Capacity management of infrastructure (6), timetabling and provision of rail traffic management (7) is appointed to a single public body by all representatives.¹⁶

Maintenance of Rolling Stock (8) is attributed by almost all representatives to multiple private business entities. Only one representative is indifferent whether a single private entity or multiple private entities should be involved.

Establishing a Fare system (9) is by most representatives attributed to a public body, regardless if a single or multiple bodies take care of this task. One representative indicates that multiple public bodies should take care of this task. Selling tickets (10) is attributed to multiple private business entities by all representatives, although some representatives place this task close to the middle of the grid, indicating only a minor preference.

Provision of travel information (10) yields no consistent outcome. One representative makes a distinction between provision of an annual timetable (attributing it to a single public body) and provision of disturbance information (attributing it to multiple private entities). Other representatives do not make this distinction. One of the representatives indicates that a single, public body should be responsible for this task, whether other representatives indicate no strong preference (placing this task around the center of the Grid).

Operating Passenger services (12) is attributed to either a single or multiple private business entities by most representatives. One representative attributes this task to a single public body. Most representatives indicate that operation of Cargo services (13) can be executed by a limited amount of private business entities. Because of Israel's limited rail network it is assumed that a large amount of private business entities operating cargo services is an unfeasible situation.

Monitoring the railway system (14) is by most representatives attributed to a public body; only one representative places this task near the center of the grid, not indicating a strong preference. Two representatives express that a single public body should be responsible for monitoring, three representatives indicate that multiple public bodies could take care of the monitoring task.

¹⁶ One representative did not place the task of Infrastructure management and timetabling in the Grid

CHAPTER 5.3: DESIGN OF OPTIONAL ORGANIZATIONAL STRUCTURES

This chapter introduces multiple organizational designs for possible application in the Israeli railway sector. Five new designs are proposed that could aid in improving the internal organizational setup of Israel's railway sector.

Part 4 showed that efficiency and effectiveness are not directly related to a generic organizational model. In other words; just implementing a generic model in Israel's railway sector, in order to improve its efficiency and effectiveness, is an inaccurate way forward.

Therefore a step back is made and design of new structures is based again on the organizational frameworks of 27 EU+EFTA countries, as composed in part 2. Parts 3 and 4 identified in all generic models positive and negative outliers regarding performances. Organizational structures of positive outliers and other 'well performing countries'¹⁷ are therefore examined in more detail and are taken along in designing optional structures for Israel. Experiences with these structures (described in various literature studies) and possibilities and boundaries for new structures (taken from the Visual Grid Technique) are taken along as important input for the designs of new structures for Israel.

A schematic overview of this design process is added in Figure 41.

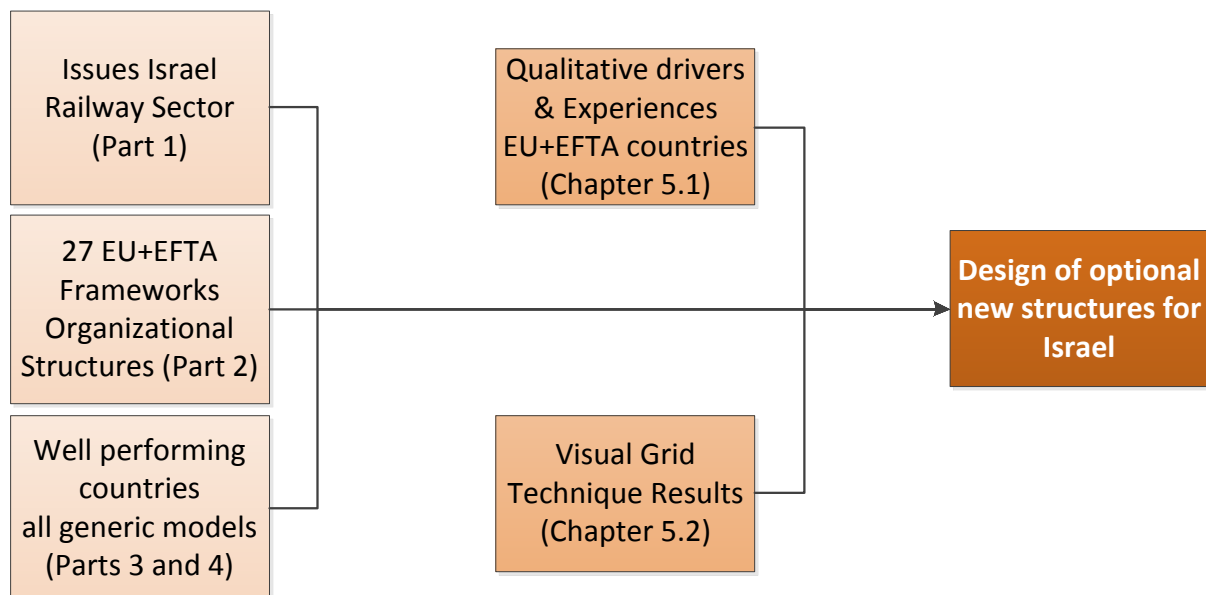


FIGURE 41: SCHEMATIC OVERVIEW OF DESIGN PROCESS

In the following paragraphs, five optional structures for Israel's railway sector will be introduced. A similar framework will be used in displaying the structures as has been used in part 2 (Authority-Infrastructure-Transport). Besides the abstracted structure itself, detailed information in writing will be provided regarding the setup of the organizational structure.

Larger pictures of all designed models are included in Appendix 5.3.

¹⁷ 'Well performing countries' in this respect are countries that rank on multiple KPI's between 1 and 10, as identified in §3.1.5.

§5.3.1 Improved Integration Model

Figure 42 presents the design of an improved integration model. The designed model is particularly based on the organizational frameworks of Switzerland and Lithuania.

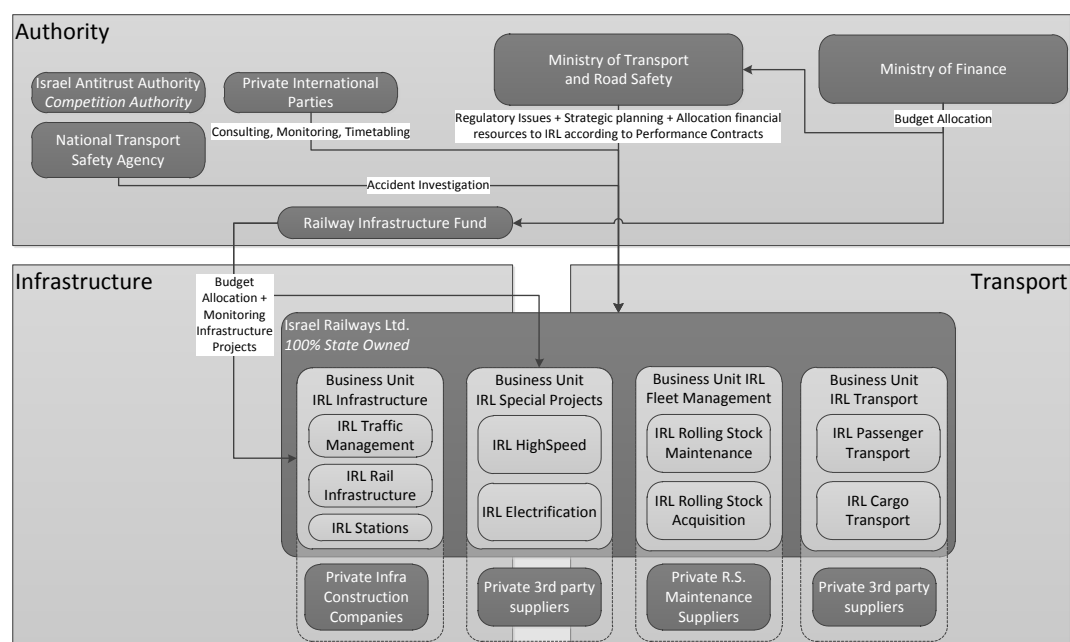


FIGURE 42: IMPROVED INTEGRATION MODEL

The improved integration model proposes to keep Israel Railways Ltd. as an integrated structure intact. A clear division of roles within the company is achieved by constructing four Business Units (BU's) closely related to IRL's core tasks: IRL Infrastructure, IRL Special Projects, IRL Fleet Management and IRL Transport. All BU's are held accountable for their own financial and performance figures, preventing cross subsidizing between BU's. The BU's experience a certain degree of entrepreneurial freedom so that they are able to optimize and fine-tune their specific expertise: BU's may contract external (private) parties to perform (parts of) tasks if these parties prove to work more efficiently. Synergy advantages and cooperation between BU's are stimulated and facilitated by keeping the integrated structure of IRL as a single entity intact.

To increase transparency in the railway system, an independent public body is erected that performs accident investigation tasks: The National Transport Safety Agency. This agency not only investigates accidents, but publicly presents results and preventive measures in order to avoid similar accidents in the future ('learn from experience'). Regular advice on safety improvements, based on results of accident investigation, should be made to the national government in order to improve and update safety regulation in the railways to the latest knowledge and standards.

The National Ministry of Transport and Road Safety remains the public body responsible for drafting regulatory issues and composing strategic planning in the railway sector. This ministry is also responsible for allocation of financial resources required to purchase transport services from IRL but allocation is always subject to performance contracts in order to stimulate IRL Transport to perform according to a predefined standard.

These performance contracts should include Bonus/Malus incentive schemes. If BU IRL Transport outperforms the predefined standards, additional financial funds become available. If BU IRL Transport performs below the predefined standards, available financial subsidies are diminished. If financial pressure alone does not influence BU IRL Transport sufficiently,

additional pressure measures are required.¹⁸Independent monitoring bodies/committees should have unlimited and extensive access to the financial and performance data of BU IRL Transport in order to assess compliance to the predefined standards. The Bonus/Malus incentive scheme is assumed to be an effective stimulus for BU IRL Transport to perform according to the desires of both customers and the government.

Regarding allocation of budget for BU IRL Infrastructure, the Ministry of Finance allocates financial funds to the newly established Railway Infrastructure Fund (RIF) based on performance contracts. Direct allocation to BU IRL Infrastructure is no longer a possibility.

The public entity RIF earmarks and allocates financial funds to BU IRL Infrastructure (and/or to private construction companies) based on independent and realistic cost assumptions. RIF oversees and monitors all financial flows within BU IRL Infrastructure and has the power to intervene if budgets are exceeded or used for different goals than for which the funds are earmarked. In case of projects conducted in Public Procurement (PP) schemes, RIF can act as a powerful public partner, being not directly linked but strongly connected to the national government. RIF serves in this respect as a consistent bridging partner between financial, political and technical knowledge in the field of construction and maintenance of infrastructure.

BU IRL Fleet Management maintains and acquires rolling stock for BU IRL Transport. BU IRL Fleet Management has the possibility to perform all maintenance duties internally, subject to three conditions:

- No additional financial funds from the government are required
- A satisfactory performance (acceptable Mean Time Between Failure Rate) is provided
- A realistic percentage of rolling stock is kept as strategic reserve

If these conditions are not met, mandatory cooperation with private maintenance providers is enforced. The need for benchmarking with peer railway companies (e.g. in Europe or Asia) presents an adequate method to investigate if an acceptable MTBF rate is achieved and if a realistic percentage of rolling stock is kept as strategic reserve.

The Ministry of Finance allocates earmarked budgets to BU IRL Fleet Management for acquisition of new or updated rolling stock.

§5.3.2 Holding Model

The Holding model represents a further step in corporatizing the Business Units that have been presented in the improved integration model. The Holding model sees the establishment of five independent limited companies that have to be seen as 100% subsidiaries of IRL Holding: the parent company functioning as an umbrella. Since all subsidiaries are Ltd. companies, separate financial accounts are automatically a result of implementation of this structure. An increased level of entrepreneurial freedom and accountability is achieved by corporatizing the Business Units into full subsidiaries.

The Holding model presented in Figure 43, is for the largest part based on organizational frameworks from Belgium, Hungary and Italy.

¹⁸ Because BU IRL Transport remains a state owned enterprise, it may not sufficiently be stimulated to perform better based on financial pressure alone. Replacing the executive management or publications in the national media in case of performance issues are examples of additional pressure measures.

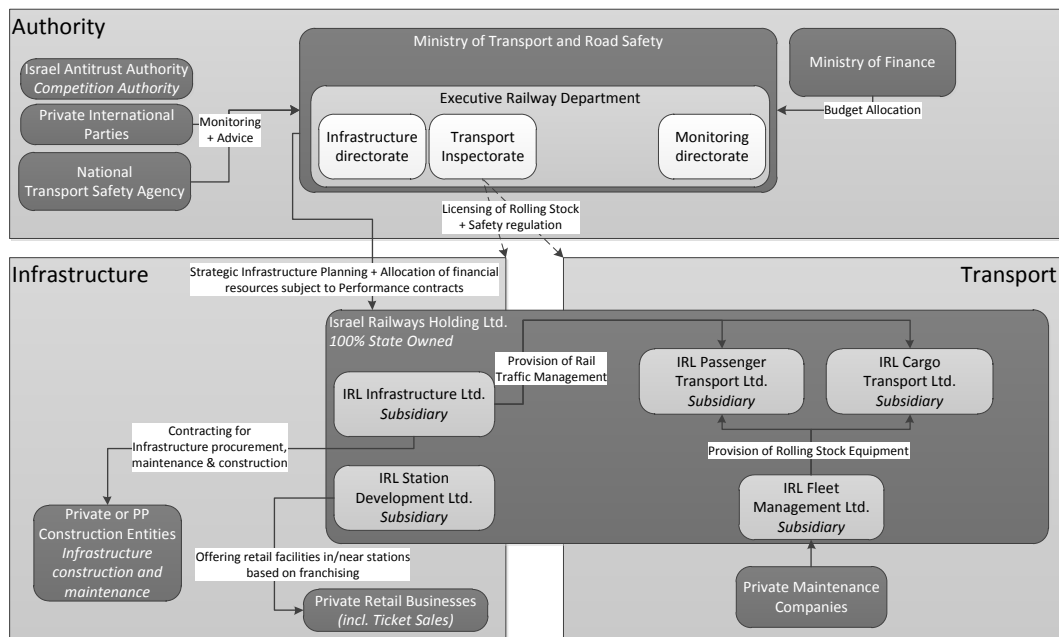


FIGURE 43: HOLDING MODEL, NO EXTERNAL TRAIN OPERATING COMPANIES PRESENT

IRL Holding Ltd. as parent company takes care of group wide issues (e.g. legal issues), facilitates cooperation between all subsidiaries and implements corporate strategies that determine the general direction in which the railway system is heading.

IRL Infrastructure Ltd. is responsible for infrastructure management tasks, in cooperation with private or PP entities constructing or maintaining the actual infrastructure. IRL Infrastructure Ltd. receives earmarked budgets from the Ministry of Transport and Road Safety for construction of rail infrastructure. IRL Passenger Transport Ltd. and IRL Cargo Transport Ltd. pay IRL Infrastructure Ltd. an annual fee for offered services regarding rail traffic management and rail maintenance based on infrastructure usage.

IRL Station Development Ltd. is the responsible subsidiary for managing, expanding and exploiting the commercial business entities within stations and surrounding station areas. This subsidiary works together closely with external (private) retail businesses in order to transform IRL's stations into attractive places to meet, stay, shop and wait for a train. IRL Station Development Ltd. should be provided the freedom to negotiate with real estate development companies and local authorities in order to develop surrounding station areas into business or residential districts. Cooperation with other subsidiaries (e.g. regarding expansion of station buildings, platforms and walking routes) is aided by the fact that both subsidiaries operate under the same roof (being the IRL Holding).

IRL Passenger Transport Ltd. is the responsible subsidiary taking care of all passenger services on the national rail network. Subsidies for public services that are not profitable are subject to performance contracts including Bonus/Malus schemes (as already explained in §5.3.1). IRL Passenger Transport Ltd. has the freedom to sell various ticket types in order to attract more customers, but fare prices are capped at a maximum, established by the government. IRL Cargo Ltd. is no longer subsidized by public funds regarding operations: this subsidiary needs to offer commercial cargo services to shippers based on market tariffs.

Rolling stock is provided by IRL Fleet Management Ltd.; the subsidiary that is responsible for acquisition and maintenance of locomotives, train units and coaches. IRL Fleet Management Ltd.

possesses a mixed fleet of passenger and cargo equipment and provides this equipment both to IRL Passenger Transport Ltd. and IRL Cargo Transport Ltd.

IRL Fleet Management Ltd. has the possibility to apply for public funding that is used to acquire new rolling stock from manufacturers, subject to tender procedures. Maintenance duties need to be financed completely by the fee IRL Transport Ltd. and IRL Cargo Ltd. pay IRL Rolling Stock Ltd. for using rolling stock equipment. External maintenance providers offering maintenance services may be contracted by IRL Fleet Management Ltd. for execution of maintenance tasks.

Regarding the authority part, again the establishment of a national Transport Safety Agency is foreseen. This Agency resembles the setup as illustrated in §5.3.1. Inside the Ministry of Transport and Road Safety, an Executive Railway Department is established. This Executive Railway Department (ERD) is the Ministry's executive organization; commissioned to transpose the Ministry's strategic (infrastructure) planning into Israel's railway system. ERD supervises IRL Infrastructure Ltd. based on infrastructure performance contracts. Furthermore, ERD is responsible for licensing Rolling Stock and implementing updated safety regulations. A separate entity inside ERD takes care of monitoring duties of all subsidiaries within IRL Holding, assisted by international companies. This entity reports its findings to the Ministry of Transport and Road Safety.

The structure presented in Figure 43 sees no entrance of external operating companies¹⁹ yet. However, the Holding structure facilitates easy adaption in order to facilitate a limited number of external transport operating entrants to the railway sector. Figure 44 includes a limited number of external (private) Train Operating Companies (TOC's) in the organizational structure, based on open access agreements between IRL Infrastructure Ltd. and the new entrants.

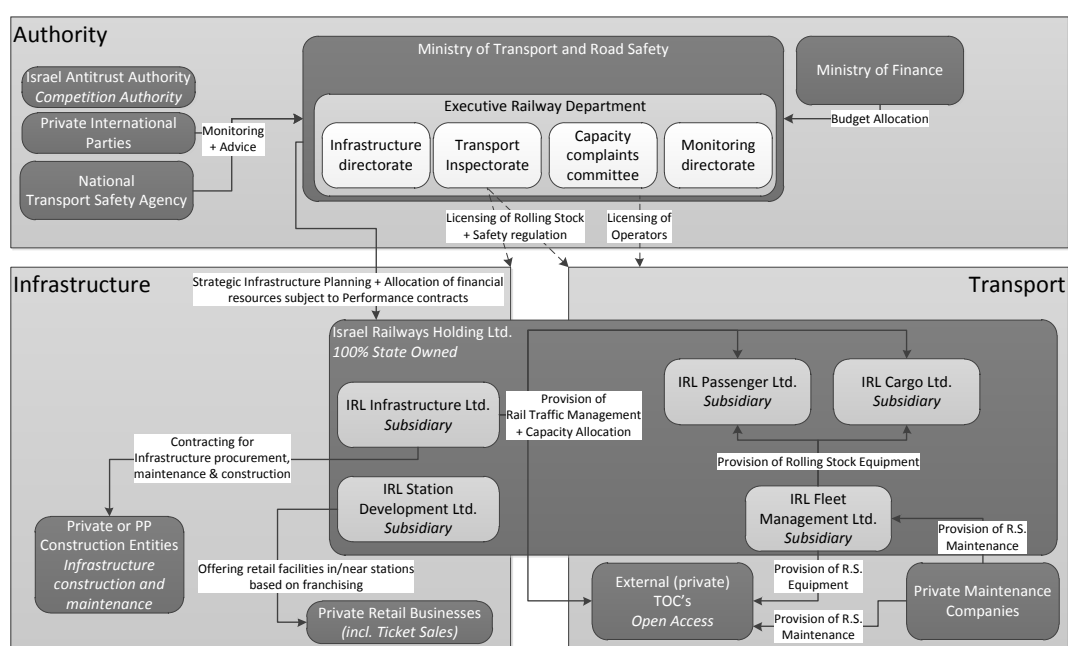


FIGURE 44: HOLDING MODEL INCLUDING EXTERNAL (PRIVATE) TOC'S

The Holding structure including a limited amount of external TOC's, sees the initiation of a capacity complaints committee within the Executive Railway Department that oversees a fair allocation of capacity by IRL Infrastructure Ltd. to IRL Passenger and Cargo Ltd. and the external

¹⁹ External Train Operating Companies (external TOC's) are private or public transport companies that offer passenger and/or cargo services by rail next to the incumbent operator, in this case IRL Holding Ltd.

TOC's. ERD becomes also responsible for licensing new TOC's in order to avoid unstable companies to enter the railway system.

The external TOC's may provide passenger and cargo services based on the 'open access' competitive regime. External TOC's apply for a train path at IRL Infrastructure Ltd. and, if sufficient capacity is available, a train path is allocated to the TOC concerned. TOC's can acquire licensed rolling stock directly from IRL Fleet Management Ltd. or import their own equipment. However, this new equipment should be licensed first by the Executive Railway Department before operation can commence. Rolling stock maintenance can either be provided by IRL Fleet Management Ltd. or by private maintenance providers.

Summarizing; the Holding structure displayed in Figure 44 presents a first possibility to introduce a limited form of competition in the Israeli railway system by allowing a limited number of new external TOC's to compete to IRL Passenger and/or Cargo Transport Ltd. based on the open access regime.

§5.3.3 Hybrid Model

If an additional level of competition is required inside Israel's national railway system, the Holding model can be adapted further; however in that case an increasingly problematic relationship results in conflicting interests between IRL's Infrastructure subsidiary and external (private) Train Operating Companies. This is the reason that the Hybrid model is advocated if external TOC's should be given the possibility to operate completely independent from IRL on specific lines (competition 'for the tracks'). The Hybrid model presents a mix of integrated and separated entities as displayed in Figure 45.

The Hybrid model is based on organizational frameworks of Sweden and Finland.

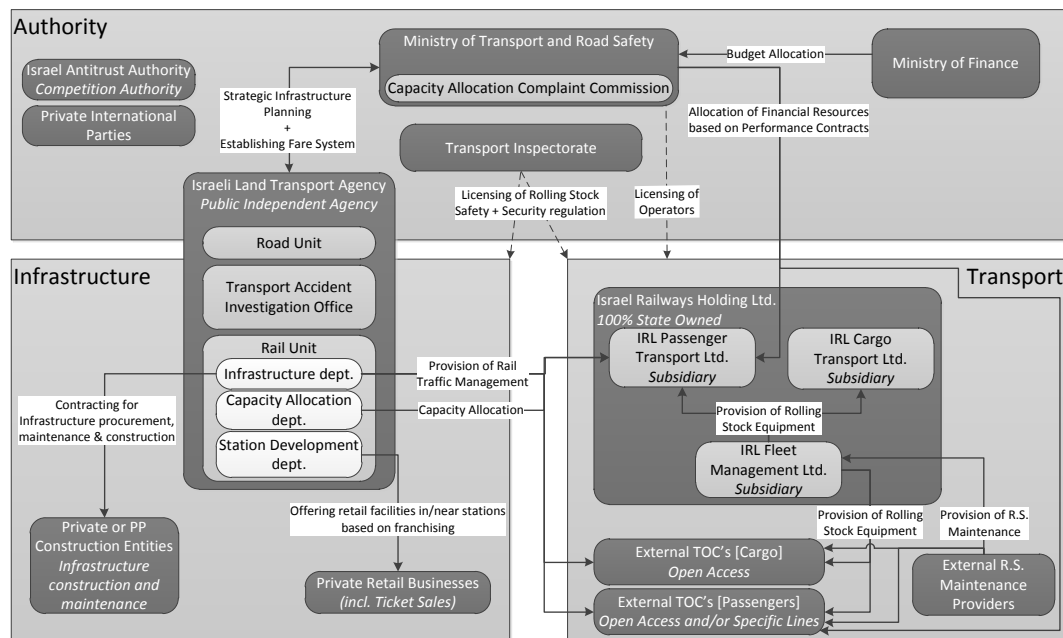


FIGURE 45: HYBRID MODEL

The Hybrid model sees the creation of a national Land Transport Agency (LTA) (comparable to the transport agencies setup in Finland and Sweden). The LTA is the responsible organization for executing policies in the field of land transportation (roads and railways) and for investigating transport related accidents. The rail unit, being an integral body of the Transport

Agency, is responsible for rail traffic management and capacity allocation to all operators willing to offer transport services in cargo or passenger operations. The Capacity Allocation Complaint Commission (internal department within the Ministry of Transport and Road Safety) ensures a fair allocation of train paths between operators.

A separate Transport Inspectorate, being an independent public body, is established that takes care of tasks regarding safety and security regulation. In case of new rolling stock entering the railway system, this body performs the necessary safety licensing of equipment.

The Ministry of Transport and Road Safety remains the public body responsible for drafting national transportation policies. This ministry issues their strategic plans to the LTA for execution and allocates earmarked financial resources to the LTA following incentive based Performance Contracts with Bonus/Malus structures in place. The LTA uses the earmarked financial resources to invest in new road and rail infrastructure and to maintain existing infrastructure.

The Ministry of Transport and Road Safety may also allocate financial resources to passenger TOC's in case of publicly desired but unprofitable services. It should be mentioned that these subsidies can either flow to IRL Passenger Transport Ltd. or to external (private) passenger TOC's. All financial subsidies are subject to performance contracts with Bonus/Malus incentive structures in place.

External TOC's may rent already licensed rolling stock equipment from IRL Fleet Management Ltd. or import own equipment subject to licensing by the Transport Inspectorate. Maintenance of this imported rolling stock is performed by IRL Fleet Management Ltd. or by external (private) maintenance companies.

External TOC's in the cargo sector apply for train paths based on open access in order to be able to provide through services. External TOC's in the passenger sector may either apply for open access services or may operate on a specific line only (with the precondition that they have access to connection stations). In the latter case, the external TOC operates to a franchise with a specific duration during which the TOC is the sole operator on a specific stretch of network ('competition for the tracks'). Infrastructure management of these dedicated tracks remains under responsibility of the LTA.

§5.3.4 Vertical Separation Model

While the Hybrid model integrated infrastructure management for rail and road transport, and kept the IRL holding as a more or less integrated structure upright, the Vertical Separation model places clear divisions between all responsible tasks leading to a vast array of actors as displayed in Figure 46.

The Vertical Separation model is for the largest part based on frameworks of the United Kingdom, the Netherlands, Portugal and Spain.

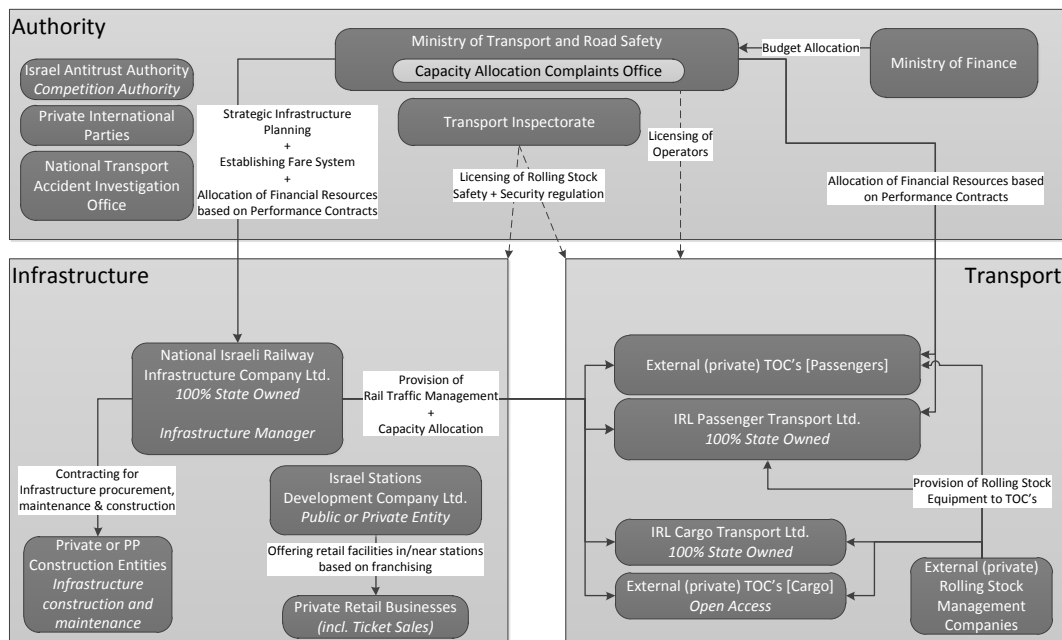


FIGURE 46: VERTICAL SEPARATION MODEL

The Separation model establishes a public Infrastructure Manager; the National Israeli Railway Infrastructure Company Ltd. (NIRIC) that is responsible for provision of rail traffic management, capacity allocation and management of construction projects. Accident investigation is performed by a separate, public independent body; also station development is performed by a separate company; the Israel Stations Development Company Ltd.

External (private) TOC's in the passenger and cargo sectors are able to enter the market and directly compete to IRL Passenger Transport Ltd. and IRL Cargo Transport Ltd. Rolling stock acquisition, maintenance and provision is no longer organized by a subsidiary of IRL, but by separate, independent Rolling Stock Management Companies.

The national government may choose to grant IRL Passenger Transport Ltd. an exclusive right to operate on the main railway network; that has to be defined accordingly. Other (external) TOC's may in that case operate services on regional/local lines based on franchises or concessions. The government may also decide not to grant IRL an exclusive right to operate the main railway network; in that case direct competition between TOC's (competition 'on the tracks') takes place: the vertically separated structure provides this possibility.

The ministry of Transport and Road Safety remains the sole authority body responsible for strategic planning and establishment of a (capped) fare system. It is also responsible for licensing financially stable TOC's to enter the market. This ministry may allocate budget to TOC's that have to operate unprofitable public services, based on performance contracts with incentive schemes in place.

§5.3.5 Horizontal Separation Model

Figure 47 presents a complete different optional setup of the Israeli railway sector; based on horizontal separation instead of vertical separation. Next to Israel Railways (organized as a Holding structure), vertically integrated TOC's are active in the system managing their own lines, possessing their own rolling stock and offering their own transport services.

The horizontal separation model is partly based on the German, Swiss and Japanese frameworks.

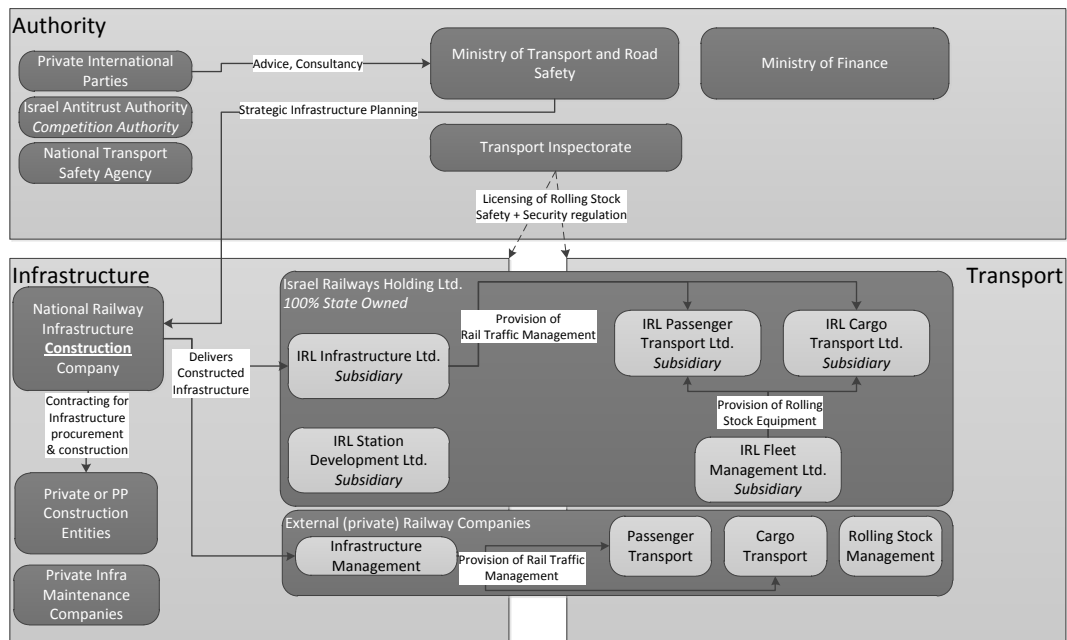


FIGURE 47: HORIZONTAL SEPARATION MODEL

The external (private) railway companies typically operate specific regional or local lines or segments completely independent from other companies. Mutual cooperation between external companies and Israel Railways Holding has to be ensured in order to facilitate through trains for cargo transport on each other's networks. For passenger transport services; transferring stations should be served by both the external operator and IRL Passenger Transport Ltd. in order to facilitate through connections.

Railway infrastructure is constructed by the National Railway Infrastructure Construction Company (NRICC) and after completion transferred to Infrastructure Management units belonging to IRL Holding or external railway companies. These Infrastructure Management units are from the moment of transfer responsible for management of infrastructure maintenance (either based on outsourcing to private construction companies or by performing maintenance tasks internally). Furthermore; the Infrastructure Management units provide rail traffic management services to Passenger Transport and Cargo Transport units.

The Horizontal Separation model keeps the tasks belonging to a railway company closely together within an integrated structure, but offers multiple parties the opportunity to provide coordinated railway services based on regional or local networks. The national government (financially) aids in constructing rail infrastructure and infrastructure remains in possession of the government. A long-lasting infrastructure management contract is setup with the Infrastructure Management units to ensure that sufficient care is taken in keeping the infrastructure well maintained.

Rolling stock needs to be acquired by the integrated TOC's themselves, subject to licensing by the independent public Transport Inspectorate.

CHAPTER 5.4: CONCLUSIONS

Chapter 5.1 identified various qualitative drivers for performance improvement. It is concluded that consistent policymaking, gradual reform, stimulation of entrepreneurial freedom, availability of public funds subject to performance contracts, a comprehensive planning and policy approach facilitate efficient and effective railways from an authority point of view.

Standardization and removal of legacy systems, performance tracking, improving accessibility and attractiveness of stations, transparent management of infrastructure construction and combining expertise in a national transport agency facilitate an efficient rail sector from an infrastructure point of view.

The power of emulation, a satisfactory level of safety and security and internal improvements in rolling stock maintenance to increase mean time between failures of rolling stock attribute to efficient rail systems from a transport point of view. Tariff differentiation may aid in 'flattening' peak periods resulting in a more efficient and effective allocation of resources.

Chapter 5.2 introduced possibilities and boundaries for new organizational structures, based on obtained results from a graphical technique called the Visual Grid Technique. Five Israeli representatives, working in various disciplines in the Israeli railway sector, have been asked to fill in the grids based on 14 main tasks of a railway sector in general.

In Chapter 5.3, five main designs have been drafted based on issues arising in the Israeli railway sector (part 1), the organizational structures of EU+EFTA countries (part 2) and resulting performances (parts 3 and 4). The drafted designs could transform the current Israeli railway sector into a more transparent, efficient and effective system.

The five sketched designs include:

1. Improved Integration Model
Integrated national railway company consisting out of business units
2. Holding Model
Semi-integrated national railway company consisting of subsidiaries in a holding company
3. Hybrid Model
Mixture of a separated and integrated model based on a national land transport agency and a national railway company organized as a holding structure
4. Vertical Separation Model
Vertically separated system with multiple actors performing only core tasks in the national railway sector
5. Horizontal Separation Model
Horizontally separated railway sector with vertically integrated railway companies active on designated regional or local networks

These five models will be taken along in part 6 of this report. Before assessing advantages and disadvantages of all models; Part 6 will first objectively describe characteristics of these designs. Following these objective descriptions, the designed models will be assessed on suitability by describing strengths, weaknesses, opportunities and threats of each design.

PART 6: CHARACTERISTICS AND EVALUATION OPTIONAL MODELS FOR ISRAEL RAILWAYS

In the previous part, five optional organizational structures for the Israeli railway sector have been drafted. Part 6 aims to provide more understanding about (objective) characteristics of the drafted models before evaluating their suitability.

Chapter 6.1 investigates objectively the characteristics per sketched model, based on 10 criteria and corresponding to experiences in European railways.

Chapter 6.2 evaluates advantages and disadvantages of the drafted designs in the Israeli railway sector based on a description of strengths, weaknesses, opportunities and threats per model.

Chapter 6.3 concludes with a Balanced Scorecard; summarizing suitability per designed model for each criterion. This summarizing overview aids Israeli representatives in making an adequate choice which designed model would best suit the future Israeli situation.

CHAPTER 6.1: CHARACTERISTICS OF DESIGNED MODELS

Description of characteristics regarding the five sketched models, designed in part 5, is conducted on a subset of 10 criteria. Although many more criteria could be drafted, the chosen criteria are found predominant in accurately describing similarities and differences between drafted models.

The chosen criteria are found to be predominant compared to others based on:

- Specific issues arising in Israel's current railway sector, as described in Chapter 1
- Experiences from altering organizational structures in European railway sectors, as described in Chapter 2, 3 and 4
- Information taken out of various literature studies on European experiences on the railway reform program of the 1990s as explained in Chapter 5.1 (qualitative performance drivers).
- More detailed experiences from the British and Dutch railway reform programs in the 1990s (taken from literature, TU Delft lectures and by interviewing representatives)
- Additional information from Israeli representatives given in interviews regarding the specific Israeli situation
- Information resulting from the Visual Grid Technique, introduced in Chapter 5.2.

Table 16 presents an overview of the established criteria.

TABLE 16: CRITERIA FOR ASSESSMENT OF CHARACTERISTICS DESIGNED MODELS

<i>Criterion</i>	<i>Illustration</i>
Transparency	Discussion of degree of transparency that a model contains
Overhead	Discussion of resulting increase or decrease in magnitude of the overhead staff size
Division of roles	Discussion of the division of roles inside the railway system a model instigates
Financial separation of accounts	Discussion to which degree separation of financial accounts is guaranteed by a model
Juridical consequences	Discussion of the consequences for formalizing relationships/agreements a model instigates
Role of competition	Discussion of the possibility to introduce competition inside a model
Coordination	Discussion of the possibility to guarantee a sufficient level of coordination between actors
Shock versus Gradual reform	Discussion about the degree of shock versus gradual reform a model causes compared to the current situation
Complexity railway system	Discussion of the level of complexity regarding relationships/interfaces between actors
Level of scope	Discussion of applicability of a model in small, medium or large national railway systems

Paragraphs 6.1.1 to 6.1.10 objectively describe characteristics based on the 10 selected criteria; they do not assess a model's suitability for implementation in Israel's railway sector yet. This assessment of suitability is conducted in Chapter 6.2 by means of a SWOT analysis.

A balanced scorecard, providing a summarizing overview of advantages and disadvantages of all designed models is added in Chapter 6.3.

§6.1.1 Transparency

Improved Integration Model

In return for an increase in entrepreneurial freedom, the four BU's within Israel Railways Ltd. are liable for publishing annual accounts regarding performance and financial data. Aggregated figures per business unit are to be published publicly; more detailed data (obtained from internal departments within a business unit) can either be kept confidential or can also be made public. RIF needs to present annual performance figures separate from IRL.

The separate National Transport Safety Agency is able to conduct accident investigations independent from governmental influences or influence from IRL. Findings from this agency are published publicly increasing the level of transparency to the public.

Holding Model

All subsidiaries inside Israel Railways Holding are automatically mandatory to keep their own accounts regarding performance and financial figures, since all subsidiaries are established as Limited companies. The separation of the National Transport Safety Agency improves transparency in a similar way as in the improved integration model.

In case of (limited) competition in transport operations, transparency issues may arise in allocation of capacity (performed by IRL Infrastructure Ltd.). IRL Infrastructure may favor IRL's passenger subsidiaries over external transport operators in allocation of train paths. Therefore, an independent capacity complaints committee is established within ERD, taking complaints from external (private) competitors into account.

Hybrid Model

Israel Railways' subsidiaries are mandatory to keep separate accounts. The National Land Transport Agency should be given clear incentives to report transparently regarding its internal units, otherwise cross subsidizing between road and rail departments may take place.

Vertical Separation Model

Since all core tasks in a railway system are attributed to separate companies, the level of transparency in a vertically separated railway system is considered high. All separate entities have the obligation to publish annual reports regarding operational and financial performances.

A very important remark has to be made; since the vertically separated structure typically facilitates a high level of competition, confidentiality of operational and financial data becomes an increasingly tedious problem. Sensitive data are kept out of public reports and performances can be analyzed only with increasing pressure from a national government to make the confidential data available. This mechanism may reduce transparency in the railway sector significantly.

Horizontal Separation Model

The vertically integrated companies consist out of subsidiaries or BU's that are mandatory to provide separate annual reports. Analog to the Vertical Separation model, the risk of performance figures becoming confidential is also present in the Horizontal Separation model.

§6.1.2 Overhead

Improved Integration Model

The overall (parent) company Israel Railways Ltd. facilitates a limited amount of required overhead staff. Tasks that have to be executed for all BU's can be performed by overhead staff belonging to the parent company. These tasks are for example: strategy analysis, juridical tasks, HR management or statistical analysis.

Holding Model

Since all subsidiaries are covered by the parent company Israel Railways Holding, shared tasks may be performed by staff working in the Holding company as has also been the case in the improved integration model. In case of external (private) operators entering the market, the amount of required staff in the ERD increases the overhead size of the railway sector as a whole.

Hybrid Model

The amount of independent actors in the Hybrid model increases the level of overhead staff required. Combining road and railway infrastructure actors into the Land Transport Agency may in turn reduce overhead staff numbers again.

Vertical Separation Model

The overhead levels in a vertically separated railway system are considered high. Synergy advantages by jointly performing shared tasks are no longer an option. Every independent company needs for example a board of directors, HR department and Legal division.

Horizontal Separation Model

Required overhead in the Horizontal Separation model is relatively large since all railway companies require overhead staff that takes care of shared tasks. Within an integrated railway company, this overhead staff can take care of various shared tasks of its subsidiaries, yielding again some synergy advantages.

§6.1.3 Division of Roles

Improved Integration Model

The improved integration model facilitates a modest division of roles inside Israel Railways grouped around the four main tasks IRL has to undertake. The separation of the accident investigation unit (now being an independent public body) and the increased monitoring of infrastructure funds by RIF results in a more clear division of roles within the railway sector. The relationships between government and IRL are formalized based on performance contracts, yielding a more clear division of roles.

Holding Model

The Holding model places a total division of roles between authority and Infrastructure/Transport operations but keeps an integrated approach to infrastructure management and transport operations intact. Subsidiaries taking care of infrastructure tasks and transport operations tasks (including rolling stock maintenance) remain accountable to the same parent: the holding company.

In case of external (private) operating companies entering the market, issues may arise in the unclear relationship between IRL Infrastructure Ltd., IRL Transport subsidiaries and the external TOC's.

Hybrid Model

Division between Authority, Infrastructure and Transport tasks is provided, although in the Land Transport Agency authority and infrastructure tasks may still be combined. It should be mentioned that in the Hybrid model, the accident investigation unit is located inside the Land Transport Agency, conducting research into both road and railway related accidents. It might be better to assign this task to a completely independent body to prevent any undesired relations with departments inside the Land Transport Agency itself.

Vertical Separation Model

Since all main tasks are performed by 'core business' companies, a clear division of roles within the railway sector is assured by this model.

Horizontal Separation Model

Inside the railway companies, divisions of roles are guaranteed by the subsidiary or 'Business Unit' structures of the entities performing main tasks, although this division is definitely less clear as in the Vertical Separation model.

The Infrastructure construction company is completely independent from the integrated railway companies and transfers infrastructure after completion to the infrastructure subsidiaries.

§6.1.4 Financial Separation of Accounts

Improved Integration Model

All BU's are required to keep independent financial bookkeeping; invisible cross subsidizing between BU's is therefore no longer possible. Allocation of earmarked funds by the Ministry of Finance is divided between Infrastructure projects (via RIF) and Transport Operations.

Holding Model

Financial separation of accounts is guaranteed in the Holding model by the establishment of subsidiaries as Limited companies.

Hybrid Model

Separation of financial accounts in transport operations is guaranteed by establishing subsidiary companies within the Holding company.

The Land Transport Agency should be given clear incentives to keep separate financial accounts of different departments in order to avoid cross subsidizing between road and railway departments inside the agency.

Vertical Separation Model

Separation of accounts is automatically provided by the separation of railway companies into multiple core business companies. Cross subsidizing between actors is not possible in a visible way.

Horizontal Separation Model

The railway companies must be stimulated to keep separate accounts regarding infrastructure management, transport operations and rolling stock management. Otherwise financial separation of accounts might become problematic due to the integrated structure in place.

§6.1.5 Juridical Consequences

Improved Integration Model

The improved integration model results in a limited amount of juridical consequences. The performance driven contracts between Government, Rail Infrastructure Fund and IRL are to be judicially constructed; furthermore a solid independent base for the National Transport Safety Agency has to be established.

Holding Model

Juridical consequences include a formalization of relationships between the responsible authorities, and subsidiaries IRL Infrastructure Ltd. and IRL Passenger Transport Ltd. In case of external companies entering the market, possible juridical consequences include complaints

about unfair capacity allocation or insufficient availability of licensed rolling stock by IRL's subsidiaries.

Hybrid Model

The Hybrid model introduces significant juridical consequences, especially in the relationship between authority and transport operating companies. Since multiple external operators may enter the market, formal relationships need to be constructed between Ministries, public independent bodies, the Land Transport Agency and the Transport operators in order to create a level playing field. Internal (and informal) cooperation between authorities, infrastructure managers and operators is no longer a possibility in order not to damage the level playing field.

Vertical Separation Model

Juridical consequences of implementing a vertically separated structure are considerable. All relationships between parties need to be formalized in order to guarantee a level playing field for (competing) companies. Monitoring formal agreements and conducting juridical procedures in case of misbehavior are becoming new key tasks in the railway sector that can cause large delays and can become increasingly costly.

Horizontal Separation Model

Juridical consequences in the Horizontal Separation model include the construction of formal agreements between authorities and railway companies (franchises, operating contracts). Internally (inside the railway companies), little arrangements need to be contracted formally, due to the integrated structure.

§6.1.6 Role of Competition

Improved Integration Model

The improved integration model facilitates a limited possibility for competition in the railway sector. The integrated structure only permits competing companies to be present as 3rd party suppliers to the BU's of IRL. Competition in transport operations is not facilitated by this model. IRL keeps the overview and is the leading and dominant partner in contracting (private) 3rd party suppliers.

Holding Model

The Holding model provides possibilities for introducing (a limited amount of) competition in transport operations based on an open access regime. Travellers are in that case able to choose between multiple operators on selected routes.

Either private maintenance companies or IRL Fleet Management Ltd. may service rolling stock equipment belonging to the external (private) operating companies, yielding a modest form of competition in this business area.

Infrastructure construction and maintenance is contracted by IRL Infrastructure Ltd. to competing construction companies yielding again a modest form of competition.

Hybrid Model

The Hybrid model facilitates a further extension in the degree of competition regarding transport operations. Since capacity allocation is no longer provided by an (internal) subsidiary or Business Unit, but by an independent public body, external operators now also possess the possibility to offer services on dedicated lines ('competition for the tracks') next to the open access regime.

Vertical Separation Model

Competition in Transport Operations is possible in various forms in the vertically separated structure. Either competition ‘on the tracks’ (direct competition) or competition ‘for the tracks’ (based on franchises) are optional.

In the Infrastructure part, construction companies directly compete for contracts, tendered by the Infrastructure Manager, but this is not completely different from the Holding and Hybrid models.

External Rolling Stock Management Companies provide licensed rolling stock equipment to operators willing to offer transport services on the network.

Horizontal Separation Model

A completely different scope of competition is introduced in the horizontal separation model. No direct competition between railway companies is foreseen, but it is likely that emulation between different companies will arise in transport operations and infrastructure management.

§6.1.7 Coordination

Improved Integration Model

Coordination is facilitated by the improved integration model since all BU’s operate under the same roof. The parent company has the possibility to intervene in the BU’s management decisions in order to create a comprehensive, coordinated solution for rail transport. The duality between the Rail Infrastructure Fund (RIF) and IRL benefits less from coordination advantages since these two entities have different objectives and targets and RIF has to monitor the performance of IRL’s BU Infrastructure.

Holding Model

Coordination between IRL’s subsidiaries is facilitated by the parent Holding company that has the power to intervene in subsidiaries’ strategies and decisions. Coordination between authority bodies and actors in the infrastructure and transport business is becoming increasingly difficult due to the increase in the amount of actors present and the increasing number of resulting interfaces.

Hybrid Model

The integrated Land Transport Agency facilitates easy coordination in the planning, construction and maintenance of infrastructure. Coordination between Authority, Land Transport Agency and Train Operating Companies is getting increasingly complex due to the increasing amount of interfaces between actors.

Vertical Separation Model

Coordination becomes very difficult in vertically separated structures. The large amount of actors combined with the rigidity of formal agreements complicates coordination between actors in this model. Informal discussions between actors are no longer possible in order not to disturb the level playing field; competition authorities guard this level playing field strongly.²⁰

²⁰ European Experience shows that coordination problems are tackled by establishing a joint Operational Control Centre (OCCR). In this OCCR, representatives of Infrastructure Managers, Operating Companies and Rolling Stock Maintenance providers cooperate in jointly fighting disturbances occurring on the railway network. This is actually a step back from separating responsibilities to jointly ‘fighting’ causes of disturbances. Actors involved in OCCR’s are closely monitored by European competition authorities.

Horizontal Separation Model

Coordination is eased by the integrated structure of the railway companies, being completely responsible for all tasks on a specific stretch of the railway network. Coordination between railway companies (e.g. on through trains for Cargo Transport) might be problematic if no formal arrangements have been drafted. This also holds for connections between operators at connecting stations (making use of each other's networks/stations).

§6.1.8 Shock versus Gradual Reform

Improved Integration Model

Compared to the current Israeli situation, the improved integration model presents only a minor change to the structures currently in place. The instigation of the Business Units, the Railway Infrastructure Fund and the National Transport Agency are deemed not to be radical changes in Israel's current system. The improved integration model resembles a gradual type of reform.

Holding Model

The establishment of subsidiaries in a Holding structure, combined with a limited form of competition in transport operations and rolling stock maintenance presents a mixture between shock and gradual reforms at the same time. Since staff is allocated to either one of IRL's five subsidiaries, this presents something of a shock reform, but creation of the Holding structure is seen as a more gradual reform process.

The decision whether to allow external (private) train operating companies is an important feature in the degree of shock Israel's railways have to endure.

Hybrid Model

The instigation of the Israeli Land Transport Agency, merging the national roads authority with the infrastructure department of Israel Railways, is identified as a shock to the system. The clear cut between infrastructure management and transport operations compared to the current integrated structure has also to be seen as a considerable shock to the system.

Vertical Separation Model

The vertically separated structure presents a significant shock if it supersedes an integrated structure because of the 'immediate and hard cuts' that are placed between Authority, Infrastructure and Operational tasks and actors. The introduction of extensive levels of competition is clearly another shock reform compared to an integrated, monopolistic structure.

Having an integrated structure currently in place, the Vertical Separation Model presents the most considerable shock to Israel's railways sector compared to all other models.

Horizontal Separation Model

The horizontal separation model presents a gradual way to transform from an integrated, monopolistic structure since new operators can exist next to incumbents on different networks. It leaves original, existing structures almost intact and places additional companies on new stretches of network that are constructed by a separate infrastructure construction company. This process can therefore be described as a more gradual type of reform.

§6.1.9 Complexity railway sector

Improved Integration Model

The level of complexity that is present in the improved integration model remains in general low. The amount of actors and interfaces present remains limited and so is the amount of necessary regulatory powers. The improved integration model proposes a 'small, but powerful'

railway company that, in coordination with RIF, is responsible for all important tasks in the national railway sector, monitored by national governmental authorities.

Holding Model

Resulting complexity, after implementing the Holding model, remains limited in case no external (private) operating companies enter the system. In case external companies do enter the system complexity is increased to a medium level, since Infrastructure now has to be shared equally between multiple operators. The inclusion of the Executive Railway Department inside the Ministry of Transport reduces interface and coordination problems and limits complexity of the relationship between authority and infrastructure/transport actors.

Hybrid Model

Complexity increases because of the increased amount of interfaces and formal relationships between actors in the Authority, Infrastructure and Transport parts. The entrance of multiple external (private) operating companies adds to the level complexity inside the Hybrid model.

Vertical Separation Model

The vertically separated structure presents a considerable complex system with a large amount of actors and interfaces present. The rigid, formal relationships between actors in order to establish a level playing field, add to the systems complexity.

Horizontal Separation Model

Complexity in a horizontally separated system remains limited, but is dependent on the number of (integrated) railway companies that emerge. The total responsibility of an integrated company yields little interface problems and a consistent, long term operating franchise stimulates (larger) investments in rolling stock and infrastructure equipment.

§6.1.10 Level of Scope

Improved Integration Model

The setup of the improved integration model is typical suitable for countries with smaller rail systems in which possibilities for competition are limited or undesirable.

Holding Model

The Holding model's flexible setup makes it possible for both smaller and larger railway systems, as European experience shows. Introducing (a modest form of) competition inside a Holding structure is typically a commonly used feature for larger railway systems organized according to a Holding model.

Hybrid Model

The Hybrid model is suitable for medium to large size railway systems.

Vertical Separation Model

The vertically separated system is typically suitable for larger railway systems. The large number of actors present, combined with the rigid formal relationships in place, make it unnecessary complex and costly for smaller railway systems.

Horizontal Separation Model

The Horizontal separation model can be used both in smaller and larger systems. The scope can be varied from companies operating a single line to operators operating a complete regional network. It is therefore very flexible in adapting to a specific scale of magnitude.

CHAPTER 6.2: EVALUATION OF SUITABILITY DESIGNED MODELS

Chapter 6.1 objectively described typical characteristics of the five optional models designed in part 5. This chapter evaluates suitability of these optional models for implementation in Israel's railway sector. This evaluation is qualitatively conducted by assessing Strengths, Weaknesses, Opportunities and Threats of each model (SWOT analysis).

Figure 48 presents a graphic overview of the specific meaning of the SWOT boxes:

		<i>For the main aim... (improving IRL's internal performance)</i>	
		<i>Helpful</i>	<i>Harmful</i>
<i>For a specific model...</i>	<i>Internal Characteristics</i>	Strengths	Weaknesses
	<i>Response to external changes</i>	Opportunities	Threats

FIGURE 48: OVERVIEW TERMINOLOGY SWOT ANALYSIS. ADAPTED FROM (LUDEMA, ET AL., 2009)

- Strengths relate to the internal characteristics of a specific model that provide a specific advantage over other models.
- Weaknesses relate to the internal characteristics of a specific model that provide a specific drawback compared to other models.
- Opportunities describe advantages of a specific model compared to other models in case of external changes to the railway system²¹
- Threats describe drawbacks of a specific model compared to other models in case of external changes to the railway system

Appendix 6.1 presents filled in SWOT diagrams for all designed models. The main conclusions drawn from these diagrams are summarized below.

§6.2.1 Strengths

Improved Integration Model

The Improved Integration Model typically facilitates a coordinated railway sector with limited complexity. Synergy advantages occur inside the vertically integrated railway company yielding little increase in required overhead staff levels. Implementation of this model in Israel's current railway sector presents little juridical consequences and can be seen as a gradual type of reform compared to the current integrated structure in place.

The level of scope to which the Improved Integration Model is suitable (typically smaller rail systems) suits the smaller size of Israel's current rail system quite well.

²¹ E.g. Policy changes or introducing competition (multiple entrants) in the system

Holding Model

The Holding model presents a large degree of entrepreneurial freedom for management of the subsidiaries while at the same time coordination is facilitated on the 'top level'. This mixture between coordination and entrepreneurial freedom both yields synergy advantages (e.g. reduction of overhead staff) and incentives for managers to meet market requirements. Subsidiaries inside a Holding company are mandatory by law to draw up separate financial accounts²², guaranteeing a separation of financial accounts.

The flexibility of the Holding model, being applicable to larger and smaller railway systems, facilitates Israel's network expansion plans in the nearby future, while at the same time facilitating its smaller network, currently in use.

Hybrid Model

One of the Hybrid model's strengths is combining the national public road and railway authorities into a single public body. This body can become a strong partner in PP schemes and may combine expertise in case of joint projects.

Cross subsidizing between Infrastructure and Transport operations becomes impossible in the Hybrid model due to the complete separation of actors in these fields. Because the Land Transport Agency serves as an independent, public owned agency a fair allocation of capacity to transport operators is guaranteed since there is no (top-level) relationship anymore present between capacity allocator and transport operator.

Vertical Separation Model

In the Vertical Separation Model all actors execute their 'core businesses'. Concentrations of expertise and knowledge on these core businesses occur within the separated companies. Cross subsidizing between actors becomes almost impossible due to the fact that completely separated companies emerge: all companies are automatically responsible for drafting their annual performance and financial reports.

Fair capacity allocation between all transport operating companies is ensured by a completely independent public body. Fair allocation of rolling stock to transport companies is ensured because independent companies take care of rolling stock management and large rolling stock maintenance.

Emulation between competing companies results into 'automatic' benchmarking. The form of direct competition makes it necessary to keep a clear customer focus in order to attract customers that otherwise might be served by competitors.

Horizontal Separation Model

The Horizontal Separation Model contains an integrated and coordinated approach to all tasks in the railway sector by multiple integrated railway companies. Emulation of companies might result in automatic benchmarking and synergy advantages inside railway companies reduce overhead staff required.

Construction of infrastructure is conducted by an independent, public body so that the railway companies can concentrate on Infrastructure Management, Transport Operations and Rolling Stock Management.

The flexible structure of the Horizontal Separation Model makes it suitable for usage in smaller and larger railway systems. Just as the Holding model, the Horizontal Separation model is likely to facilitate both Israel's current (smaller) and future (larger) railway systems.

²² Due to the fact that they are organized as separate Ltd. companies

Improved Integration Model

Compared to other models, the Improved Integration Model contains only limited possibilities for facilitating additional forms of competition in Israel's railway sector. The monopolistic structure of IRL leads to a dominant position in the national rail market, dominating 3rd party suppliers. The monopolistic structure does not contain many emulation incentives to improve performance, although benchmarking to comparable (European) railway companies is possible.

For the government there are few possibilities in stimulating IRL to perform better, since no other parties are available that can 'step in' or 'take over' IRL's tasks.

In the improved integration model there are little commercial incentives for securing or improving customer satisfaction; customer focus has to be enforced by performance contracts between government and IRL. Inside IRL, there remains a possibility for cross subsidizing of activities, since BU's are not mandatory by law to draw up separate financial accounts.

Holding Model

The Holding Model in itself does not present many commercial incentives to secure a sufficient level of customer focus due to the absence of (extensive degrees of) competition. Emulation incentives to improve performance are absent in the Holding model.

In case of limited competition, a problematic relationship arises between IRL's infrastructure subsidiary and external (private) Train Operating Companies willing to offer transport services on IRL's infrastructure.

Hybrid Model

There is a risk that mixing of budgets inside the Land Transportation Authority might occur between road and railway projects, since the Land Transportation Authority is not mandatory by law to keep separated financial accounts between these departments.

The Accident Investigation Unit, located internally inside the Land Transport Agency reduces the amount of transparency perceived by the public (risk of covering up outcomes).

The Hybrid Model furthermore places a 'hard cut' between infrastructure management and transport operations; coordination between these two is becoming more difficult due to the formal arrangements that need to be composed. In case of disturbances inside the railway system, there is a risk of 'finger-pointing' between the Infrastructure Manager, Transport operator and Rolling Stock Management company, yielding a potential loss of customer awareness and expensive and lengthy juridical procedures.

Vertical Separation Model

The Vertical Separation Model contains the most complex structure including a vast array of complex formal arrangements between all actors. In case of disputes, juridical consequences can become increasingly costly. A large number of interfaces easily results into finger-pointing between actors in case of disturbances. Coordination between actors is easily lost and overhead staff levels rise. Financial flows between actors become increasingly complex; especially in case of operating unprofitable services subject to state funding.

Since the Vertical Separation Model is typically suitable for larger railway systems, it is less suitable for Israel's current smaller railway system. The model is simply too complex and presents too little (synergy) advantages for implementation in smaller railway systems. Implementing the Vertical Separation model in Israel's current system furthermore yields a

large degree of shock reform, resulting in numerous 'hard-cuts' between actors during the time of implementation.

Horizontal Separation Model

Coordination and synergy advantages are lost between Infrastructure Construction and Infrastructure Management tasks. The Horizontal Separation Model furthermore instigates the need for mandatory passenger transfers between operators at the ends of the network operated by a particular operator.

Smaller railway companies possess little scale advantages compared to the incumbent or compared to larger (external) railway companies; yielding for example more expensive maintenance facilities.

§6.2.3 Opportunities

Improved Integration Model

Not many opportunities of the Improved Integration Model become visible. The only opportunity the model offers is to facilitate external (private) 3rd party suppliers to enter the railway sector.

Holding Model

The Holding Model contains the opportunity to facilitate external (private) entrants to enter the system in the Transport Services area. 3rd party suppliers may be contracted by the Holding company or external companies.

Hybrid Model

The Hybrid Model can easily adopt multiple external (private) Train Operating Companies due to the detached Infrastructure Manager. If the Israeli government decides that additional Public Procurement schemes need to be implemented in the railway sector, the Land Transport Agency can act as a powerful public partner. Extensive expertise in this field can be gained that can be used both in road and railway infrastructure projects in Israel and that can also be exported abroad.

If the Israeli government decides that 'competition for the track' is to be introduced, the Hybrid model can facilitate this type of competition easily and without significant modifications to the structure.

Vertical Separation Model

The Vertical Separation Model's level playing field is able to facilitate additional external TOC's in the future easily. If the Israeli government wants to introduce performance driven incentives into the formal relationships; the Vertical Separation model does not need extensive adaptation.

Horizontal Separation Model

Franchising specific rail lines is relatively easily implemented in the Horizontal Separation Model. The model also allows for open access contracts between TOC's facilitating necessary through-connections in the cargo sector.

The Horizontal Separation Model can be gradually expanded; additional TOC's can gradually enter the system based on new infrastructure becoming available over time. This mechanism reduces the degree of 'shock reform' to Israel's current system if the Horizontal Separation Model is implemented.

Improved Integration Model

In case of external (private) 3rd party suppliers entering the railway sector, IRL's position remains dominant since IRL can directly choose which companies to do business with. This one-way relationship might scare private suppliers off resulting in an absolute monopoly for IRL regarding all main tasks in the national railway sector. If the government decides to allow external (private) train operators to enter the railway sector; the Improved Integration Model is not very suitable in handling this demand, since it does not allow for competition on the national rail network.

If policy implicates an increase in Public Procurement schemes, the Improved Integration Model is also less suitable than other models due to the integrated structure in which IRL is responsible for both infrastructure management and transport operations. Fitting in PP schemes in the integrated structure is assumed to be problematic.

Holding Model

There is a risk that unfair allocation of available capacity between IRL's transport subsidiaries and external TOC's arises, because IRL Infrastructure and IRL's Transport subsidiaries are part of the same Holding structure. IRL Infrastructure may favor IRL's Transport subsidiaries over the external TOC's in allocating train paths. Cooperation between IRL Fleet Management Ltd. and external (private) TOC's may face similar issues; IRL Fleet Management might be inclined to favor IRL's transport subsidiaries over competing TOC's requiring provision and maintenance of rolling stock equipment.

Another threat for the Holding model is presented by differences in scale that arise between the incumbent Holding company and external TOC's. The large incumbent Holding possesses scale advantages that smaller external TOC's lack. It is thus questionable if a level playing field arises when these differences of scale are taken into account.

Hybrid Model

As in the Holding Model, cooperation between IRL Fleet Management and external (private) TOC's may be problematic. Furthermore there is a delicate power balance present between the road and railway departments inside the Land Transport Agency that is dependent on the political climate.

Vertical Separation Model

When more external TOC's enter the market there is a real risk of performance and financial figures becoming 'economically sensitive' and therefore these are no longer publicly published.

Extensive regulation is required to ensure a level playing field and to ensure satisfactory safety and performance levels in case multiple external TOC's enter the railway sector. Significant levels of overhead staff in public bodies are required to deal with the increasing amount of regulation and legislation.

Horizontal Separation Model

As in the Vertical Separation model, performance and financial figures might become 'economically sensitive' reducing the level of transparency in the railway sector. When 'competition for the tracks' (franchising) is implemented, a sufficient length of the franchise is a very important factor in avoiding uncertainties for railway companies resulting in underinvestment and lack of responsibilities. There is a risk of the National Infrastructure Construction Company becoming obsolete in case network extensions have been completed, since maintenance of infrastructure is performed by the vertically integrated railway companies themselves.

CHAPTER 6.3: OVERVIEW OF SUITABILITY – BALANCED SCORECARD

Choosing the most appropriate model for implementation in Israel, based on the material illustrated in the previous chapters, is not conducted in this thesis report. Based on descriptions of characteristics and overviews of strengths, weaknesses, opportunities and threats per design; representatives in Israel should be able to make a balanced decision themselves. This chapter provides a summarizing overview of suitability per model regarding the criteria established in Chapter 6.1 by means of a balanced scorecard.

Attaching weights of criteria (indicating a higher or lower importance compared to other criteria) is deliberately left out in this overview. Israeli representatives should attach weights to criteria themselves, based on their opinion which specific criterion is more or less important than others from an Israeli point of view.

A summarizing overview of strengths and weaknesses per designed structure is provided in Table 17 by means of a balanced scorecard. This balanced scorecard is a summary of the Strengths, Weaknesses, Opportunities and Threats analysis conducted in Chapter 6.2. Colors reflect if a designed new structure possesses (mainly) advantages or disadvantages over other structures regarding a specific criterion. A legend explaining the used color scale is added below Table 17.

TABLE 17: BALANCED SCORECARD - OVERVIEW OF SUITABILITY DESIGNED MODELS PER CRITERION

<i>Optional Structure</i> <i>Criterion</i>	Improved Integration Model	Holding Model	Hybrid Model	Vertical Separation Model	Horizontal Separation Model
Transparency					
Overhead					
Division of Roles					
Financial separation of accounts					
Juridical Consequences					
Role of Competition					
Coordination					
Shock versus Gradual reform					
Complexity railway sector					
Level of scope					

Legend:

Less suitable compared to other structures	--	-	+/-	+	++	More suitable compared to other structures
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GENERAL CONCLUSIONS AND RECOMMENDATIONS

Israel's railways have experienced a shorter history than its European counterparts. Rapid expansions of network and services have been followed by years of negligence and decline. Recent developments foresee Israel Railways to become a major transport facilitator in Israel.

Israel Railways' current integrated organizational structure yields issues in adequately managing a rapidly expanding railway company. Lack of transparency, an unclear division of roles, limited separation of financial accounts and a disappearing overall performance are assumed to be the main arising issues.

Europe's railway sectors do not present a single, generic type of organizational setup. European legislation deliberately left space open for national interpretation; yielding a vast range of organizational setups visible in EU+EFTA countries.

Although differences per country exist, three generic organizational setups become visible to which most of the organization models of EU+EFTA countries hold: the Integration Model, Holding Model and Separation Model.

Europe's railway sectors are not privatized, but incumbent railway companies have been corporatized (the only exception being the United Kingdom). Shares of incumbent railway companies are in most countries still 100% owned by state governments. Private Train Operating Companies (TOC's) emerge in the cargo market and to a lesser extent also in passenger markets. A recent development shows that 'private' TOC's are again taken over by state owned incumbents.

Infrastructure Managing companies (IM's) are in all EU+EFTA countries 100% state owned or public entities (including the United Kingdom). Active and passive IM's are visible throughout Europe. Active IM's conduct regular maintenance duties internally; passive IM's outsource all construction and maintenance work to (private) construction companies.

The amount of Public Procurement schemes in Europe's Heavy Rail Sector remains limited to date. In principle, Public Procurement can be executed in all three generic organization models, but the integration model complicates Public Procurement in awarding transport operations to another party than the integrated railway company (and monopolist) present.

There is little correlation visible between type of organizational structure in place and corresponding performance. Regarding effectiveness of production (outcome/output) and effectiveness of resources (outcome/input); no correlation is visible at all. Regarding efficiency of production (output/input) there is a slight trend visible that separated structures outperform holding and integrated structures, but again; no strong correlation is present.

Correlation analysis between degree of market opening and overall performance confirms that no strong correlation is visible between performance and organizational structure per se. However, organizational structures might improve internal processes inside railway companies and railway sectors.

Based on issues arising in Israel's current railway sector, European experiences on qualitative performance drivers and Israeli views on possibilities and boundaries for reform, five new optional models aim to improve the internal performance of Israel's railway sector. The Improved Integration, Holding, Hybrid, Vertical Separation and Horizontal Separation models all present specific advantages and disadvantages.

Based on the results obtained, a final answer can be given to the main research objective stated in the introduction of this report:

“In what way can the organizational setup of Israel’s railway sector be improved in order to increase overall performance, according to the specific environment and context in Israel by taking organizational structures, performances and experiences of European railways into account?”

European experience shows that implementing a generic organizational structure to improve overall performance per se is inaccurate. Internal issues in Israel’s railway system can partly be solved by implementing one of the five designed optional models provided in part 5 of this report. A preferable method for implementing a suitable organizational structure in a railway sector is to learn from peer countries that possess a satisfactory performance, a comparable rail network and similar scales of magnitude.

The following main recommendations are identified:

- Conduct additional research into management issues arising in the railway infrastructure construction and maintenance business of the Israeli railway sector. Identify internal processes and interfaces that are problematic in the current situation and are to be improved accordingly.
- Conduct additional research into organization of rolling stock maintenance in European countries. Identify good practices, suitable (strategic) reserve levels and acceptable Mean Time Between Failure (MTBF) rates.
- Conduct additional performance evaluation analysis on more detailed KPI’s for a selected subset of European countries that resemble the (future) Israeli system. Use less aggregated data that provide additional detail (e.g. regarding staff division, types of carriages) in order to increase comparability of data. Include cargo operations in the more detailed performance analysis.
- Conduct performance evaluation analysis on internal processes within railway companies. Activity based costing or detailed Cost-Benefit analysis methods are suitable for identifying internal processes within a railway company that require efficiency improvement.
- Enhance first insights in all performance evaluation analyses by using time series instead of one sample values. Identify trends in performances over time.
- Analyze in detail all financial streams between actors in railway systems and add the financial streams to the frameworks drawn in part 2.
- Examine in detail the difference between the performance intended/demanded by the government and the actual performance delivered. Governments (including the Israeli government) should define in detail the amount of rail transport services required in order to define an acceptable performance. Only if these specifications are clearly defined, the difference between required and delivered rail transport services can become visible.
- Learn from benchmarking practices in other business sectors. A specific example in this respect is the oil industry in which an experienced firm (in this case ‘Solomon associates’) conducts benchmark studies for all major international actors. Confidentiality of data is secured; only the relative position of a specific firm compared to others is published.
- Stimulate standardization of methods to measure and publish railway related data. In order to increase comparability of data between European railway systems, standardization of measurement methods is an essential step forward. The European Union should impose standardized guidelines to European railway companies for measuring and reporting operational railway data. Confidentiality of operational data should be avoided.

REFLECTIONS

Learning ‘fast forward’. That is the main conclusion I draw from conducting this thesis work in the past months. This reflection aims to address the added value this thesis work possesses compared to existing literature and reflects on methods chosen, validity of results and the personal experiences and choices that are hidden ‘behind the pages’ of this thesis report.

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The subject of this thesis work; that combines policymaking, engineering and organizational principles of international railways, provides in my opinion a truly fascinating and highly interesting field of research. The Master program TIL prepared me for this multidisciplinary subject and a lot of the knowledge obtained in the TIL program has found its way into this thesis report.

The motive for research originated in Israel, since representatives affiliated to the Israeli railway system required additional background information on organizational structures and corresponding performances of European railways. As the next sections will explain, results of this thesis work add a specific kind of nuance to alteration of organizational structures in railway sectors as an attempt to increase overall performance levels.

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Identifying the main issues in the current Israeli railway system could not have been conducted without visiting the State of Israel and speaking to various representatives closely affiliated to the Israeli railway system. I am very grateful for being given the opportunity to travel two weeks to Israel resulting in the possibility to conduct multiple interview sessions with Israeli representatives. These interviews, especially during the first trip, clearly shaped the direction of the thesis work; defining which subjects had to be taken along and which subjects could be left out of the thesis report. After return in The Hague, I had a clear picture in mind which chapters should shape the thesis report. Analysis on European railways could commence.

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Analysis on organizational structures of European railway sectors presented a first main choice whether to provide a comprehensive (but less detailed) overview of all railway sectors in EU+EFTA countries or to provide highly detailed schemes for a selected subset of countries. Based on information out of Israel and based on the fact that HTM Consultancy specifically required also to take Eastern European and Balkan countries along in analysis, I immediately chose for the first option: provide a comprehensive ‘first glance’ overview of railway sectors in European countries and distillate the main organizational models visible for further analysis.

An adequate framework for analysis was provided by literature (van de Velde, et al., 2008) in which all organizational structures of railway sectors could be portrayed in an equal and comparable way. The frameworks, originally composed by van de Velde et al. for a subset of Western European railway sectors, have been refined and additional countries have been added to the set. In my opinion, this analysis resulted in a comprehensive and relatively complete overview of organizational structures and actors visible in European railway sectors today.

This comprehensive overview gives a first indication of the large differences (and the vast range of organizational models) in European railway sectors visible today. Although generic European regulations are transposed in national legislation of member states, this analysis strongly indicates that all countries have a more or less unique organizational model in place that is

meticulously fine-tuned to a country's national belief how a railway system should be run. This total overview of railway sectors in 35 EU++ countries adds a degree of proof to already existing literature that railway sectors in Europe are differently organized per member state.

Unfortunately neither the available time nor the resources could facilitate interviews with representatives of all EU+EFTA railway sectors that could add additional detail to the frameworks (e.g. financial analysis). The composed frameworks are therefore based on various documents that are composed by railway companies, infrastructure managers and European knowledge institutes. Interviews with local representatives could improve the correctness of the frameworks resulting from this study.

Another interesting finding from railway sector analysis is the fact that European railway sectors are liberalized but not privatized (the only exception being the UK). Instead of additional private entrants, large international incumbent railway companies become responsible for transport operations of passengers and cargo on rail networks managed by national public Infrastructure Managers. Almost all these large incumbents remain in the end 100% state owned. Instead of privatizing Europe's railways, incumbent railway companies retain a dominant position in domestic passenger services, while international subsidiaries of incumbents take care of the lion share of Europe's cargo operations by rail. This information contradicts with the public opinion and statements made in domestic media stating that European railways 'are a privatized business sector'. This particular nuance came to me as a surprise and I estimate that this finding is highly relevant for Israeli representatives.

The conducted European railway sector analysis yields a comprehensive overview of organizational setups visible in most European countries. Resulting frameworks proof that a variety of organizational structures is visible today, as described in already existing literature. Results proof furthermore that Europe's railway sectors are not privatized but liberalized in which state owned incumbents retain a dominant position in offering transport services. I am really happy with the results of this analysis and the way this analysis has been conducted. Results closely provide the information requested by thesis committee members and Israeli representatives.

—

Performance Evaluation of railways remains an important but very difficult subject to conduct. Authors in various literature documents use inconsistent terminology to describe appropriate KPI ratios. Defining a suitable subset of KPI's for analyzing 27 EU+EFTA countries has been a lengthy process. Advice from thesis committee members aided a lot in eventually selecting a subset that was suitable for further examination.

A significant amount of research time was required in order to filter data and to place results into a correct perspective. The 'slippery' nature and the aggregated level of the data taken from various public sources sometimes caused true nightmares. The fact that I really wanted to include all 27 EU+EFTA countries in the KPI analysis made analysis difficult and after weeks of research it became clear that a reduction in the subset of countries and a slight improvement of reliability of the dataset was required as an addition to the resulting outcomes of the KPI method.

At that moment contact was established with drs. ir. A. Roeleveld, benchmarking expert at NS. Following his advice, an additional PE method (using Data Envelopment Analysis) proved a welcome addition to the KPI evaluation, paying more attention to the shared nature of railway

systems facilitating both passenger and cargo transport services. It was immediately clear that DEA could only be conducted for a selected subset of comparable and reliable European railway systems. In other words; the subset of countries was reduced and the reliability and comparability of data was slightly improved compared to the aggregated data used in the KPI method.

Results from performance evaluation indicate that no strong correlation is visible when comparing them to organizational structures in place. Although this finding is in practice often expressed by experts in the railway sector, this thesis work confirms and proves that these two are uncorrelated based on a selection of objective and measurable input/output/outcome ratios. Implementing a generic organization structure in order to improve overall performance is no justifiable way forward; again an important nuance is offered to Israeli representatives.

Adding qualitative remarks to the quantitative results of the KPI and DEA methods regarding service quality measurement and customer satisfaction is important in order not to consider low quality companies as efficient or effective. This thesis work provides tangible methods to evaluate targeted and actual performances and provides methods to identify perceived customer satisfaction levels. Both methods can be implemented more or less directly in Israel to define satisfactory service levels, to measure if these targeted services are actually delivered, and to determine if customers indeed perceive the service as satisfactory.

The fact that overall performance is uncorrelated to a generic organizational structure provided a problem for the design of new optional structures for Israel's railway sector. Advising Israeli representatives to insert a generic European structure in order to increase performance is not justifiable as the uncorrelated nature of these two has been shown in chapter 4. There had to be something else.

The original 27 EU+EFTA frameworks, various literature studies, lecture materials and experiences from the Dutch business sector were again consulted in order to identify additional (qualitative) drivers that influence performance levels of railways. Together with the Visual Grid Technique (that I personally set up and conducted during meetings in Israel) five optional structures were designed that should fit Israel's particular situation and can help to solve specific issues arising in Israel's current system. The fact that no single organizational model is advised as 'the best solution' to Israeli representatives, but enough information is provided so these representatives can make a balanced decision themselves, is in my opinion a satisfactory outcome of the design process.

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After the first versions of the draft report were composed, remarks both from the thesis committee and the business sector (by means of detailed checks of texts and results by Roeleveld and Kroon) improved the drafted texts significantly regarding structure and content.

I have always believed an academic thesis work should have a relation to what is experienced in practice, so all additional comments made by Roeleveld and Kroon have been critically assessed and all relevant comments have been gratefully used to refine results and texts.

—

This thesis work adds important nuances to the idea of altering organizational structures in order to increase overall performance levels of railways. Experiences from Europe show that altering an organizational structure per se does not improve overall performance levels, but that it can facilitate internal improvements in adequately managing railway systems. Measurement and reporting methods of operational data from European railway companies should be

standardized in order to ease international benchmarking. The European Union has to play ball in stimulating all European private and public railway companies to report objectively their operational performance.

This thesis work has given me the opportunity to look into organizational structures of railways in entire Europe and has provided me a first insight in performance evaluation methods used in academic environments and in practice.

I am grateful for the extensive support of my thesis committee members and the critical reviews of texts and outcomes. Conducting a thesis work is indeed learning fast forward. Applying gained knowledge of the TIL Master program into practice, combined with full responsibility for all produced work is a challenging combination that has given me great pleasure in the past months.

J.W. Wolff
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BIBLIOGRAPHY

- Abate, M., Lijesen, M., & Roeleveld, A. (2009). Estimating efficiency of reliable railroad companies.
- Alexandersson, G., Hultén, S., Fearnley, N., & Longva, F. (2010). Impact of regulation on the performances of long-distance transport services: a comparison of the different approaches in Sweden and Norway. *Research in Transportation Economics Vol 29*, 212-218.
- Alexandersson, G., Nash, C., & Preston, J. (2008). Risk and reward in rail contracting. *Research in Transportation Economics Vol 22*, 31-35.
- Behin Cara. (2011). DEA Online Software (<http://www.deaos.com>).
- Bente, H., & Roeleveld, A. (2006). Benchmarking identifies good practice in rolling stock maintenance. *Railway Gazette International*, 224-226.
- Cantos, P., Pastor, J., & Serrano, L. (1999). Productivity, Efficiency and Technical Change in the European Railways: A Non parametric approach. *Transportation 26*, 337-357.
- Cantos, P., Pastor, J., & Serrano, L. (2010). Vertical and Horizontal Separation in the European Railway Sector and its Effects on Productivity. *Journal of Transport Economics and Policy Vol 44 Part 2*, 139-160.
- CBS Israel. (2010). *Transport Statistics Quarterly*. Jerusalem: CBS Israel.
- CEN. (2002). *EN 13816*. Brussels: European Committee for Standardization.
- CEN. (2006). *EN15140*. Brussels: European Committee for Standardization.
- CEN. (2011, April 13). Retrieved April 13, 2011, from CEN: www.cen.eu
- CER. (2005). *Public Service Rail Transport in the EU: An Overview*. Brussels: CER.
- CER. (2005). *Reforming Europe's Railways - An assessment of progress*. Hamburg: Eurailpress.
- CER. (2011). *Reforming Railways, Learning from experience*. Hamburg: Eurailpress.
- Clark, S. (2005, December 15). DfT Rail Group - Working with Local Interests. United Kingdom.
- Coelli, T., & Perlman, S. (1999). A comparison of parametric and non-parametric distance functions: With application to European Railways. *European Journal of Operation Research 117*, 326-339.
- Coelli, T., Prasada Rao, D., O'Donnell, C., & Battese, G. (2005). *An Introduction to Efficiency and Productivity Analysis*. New York: Springer Science+Business Media.
- Cole, B., & Cooper, C. (2006). Deskillling in the 21st century: The case of rail privatisation. *Critical Perspectives on Accounting 17*, 601-625.
- Cotterell, P. (2009). *Make straight the way - A historical album of railways in the land of Israel*. Tel Aviv: Israel Railways.
- Cretegny, L., Springer, U., & Suter, S. (2007). The Swiss railway investment fund. *Research in Transportation Economics Vol 19*, 189-215.
- Dekking et al. (2005). *A Modern Introduction to Probability and Statistics*. London: Springer.
- Department for Transport. (2010). *Reforming Rail Franchising*. London: Department for Transport.
- Dutch Railways (NS). (2010). *Jaarverslag*. Utrecht: Dutch Railways.
- Estival, J.-P. (2004). Railway organisational models - Criteria for a national choice. *Rail International*, 16-25.
- EU Directorate General Mobility and Transport. (2011). *Survey on passengers' satisfaction with rail services*. Brussels: Flash Eurobarometer.
- Eurostat. (n.d.). *Eurostat*. Retrieved March 2, 2011, from epp.eurostat.ec.eu
- Evans, A. (2007). Rail safety and rail privatisation in Britain. *Accident Analysis and Prevention Vol 39*, 510-523.
- Evans, A. (2010). Rail safety and rail privatisation in Japan. *Accident Analysis and prevention Vol 42*, 1296-1301.

- Fielding G.J. et al. (1985). Performance Evaluation for Bus Transit. *Transportation Research*, 73-82.
- Freeman, R., & Shaw, J. (2000). *All Change - British Railway Privatisation*. London: McGraw Hill.
- Friebel, G., Ivaldi, M., & Vibes, C. (2010). Railway (De)Regulation: A European Efficiency Comparison. *Economica* 77; *London School of Economics and Political Science*, 77-91.
- Growitsch, C., & Wetzel, H. (2007). Testing for Economies of Scope in European Railways: An Efficiency Analysis. *Working paper series in Economics University of Lüneburg*, Vol 72.
- Hansen, I. (2010). Review of public-private partnerships in heavy railway infrastructure projects. *COST Public Private Partnerships in Transport: Trends & Theory - Research Roadmap*. Lisbon: COST.
- Hellawell, A., & Jackson, C. (2011). *Railway Directory 2011*. Sutton: DVV Media Group.
- Histadrut. (2011, 02 04). *www.histadrut.net*. Retrieved 02 04, 2011, from *www.histadrut.net*: *www.histadrut.net*
- IBM Business Services, & Kirchner, C. (2011). *Rail Liberalisation Index 2011*. Brussels: IBM Global Business Services.
- IRL interview. (2011, February). Tel Aviv, Israel.
- Ishikawa, T., & Imashiro, M. (1998). *The Privatisation of Japanese National Railways*. London: The Athlone Press.
- Israel Railways. (2011, 02 01). *Israel Railways*. Retrieved 02 01, 2011, from Israel Railways,: <http://www.rail.co.il>
- Israel, E., & Cohen-Blankshtain, G. (2010). Testing the decentralization effects of rail systems: Empirical findings from Israël. *Transportation Research Part A: Policy and Practice Vol 44*, 523-536.
- Kemp, R. (2011, March). Dossier Openbaar Vervoer: Evolutie in plaats van Revolutie. *Verkeerskunde*, p. 24.
- Koppejan, J., & Leijten, M. (2007). How to Sell a Railway: Lessons on the privatization of Three Dutch Railway Projects. *European Journal of Transport and Infrastructure Research*, 201-222.
- Kroon, J.G.J. (2011, August 26th). Interview
- Lalive, R., & Schmutzler, A. (2007). Entry in liberalized railway markets: The German experience. *Working Paper*.
- Lalive, R., & Schmutzler, A. (2007). Exploring the Effects of Competition for Railway Markets. *Working Paper*.
- Lan, L., & Lin, E. (2006). Performance Measurement for Railway Transport. *Journal of Transport Economics and Policy (JTEP)*, 383-408.
- Levy, M., Guimarães Silva, A., & Vilaça Moura, R. (2005). Railway regulation in Portugal: lessons from experience. *Thredbo - International Conference Series on Competition and Ownership in Land Passenger Transport*. Lisbon.
- Ludema, M., & van Nes, R. (2009). *TIL 4030 Course Reader*. Delft: Delft University of Technology.
- Lutje Schipholt, L. (2004, January). De toekomst van de spoorwegen. *OV.magazine*.
- Martin, U. (2008). Performance Evaluation. In I. Hansen, & J. Pacht, *Railway Timetable & Traffic* (pp. 192-208). Hamburg: Eurailpress.
- Merkert, R. (2010). Changes in transaction costs over time - The case of franchised train operating firms in Britain. *Research in Transportation Economics Vol 29*, 52-59.
- Ministry of Finance. (2011, 02 04). *Ministry of Finance*. Retrieved 02 04, 2011, from Ministry of Finance: www.financeisrael.mof.gov.il
- Ministry of Transport and Road Safety. (2011, 02 04). *Ministry of Transport and Road Safety*. Retrieved 02 04, 2011, from Ministry of Transport and Road Safety: en.mot.gov.il
- Ministry of Transport, Ministry of Finance. (2008). *Recommendations for the Evaluation of Additional Transport Projects to be promoted in cooperation with the private sector (PPP) during the years 2008-2015*. Jerusalem: State of Israel.
- Nanninga, H., Röntgen, E., & Wessel, M. (2009). Denken, doen en laten op het spoor. *Colloquium Vervoersplanologisch Speurwerk*. Antwerpen.
- Nash, C. (2008). Passenger Railway reform in the last 20 years - European experience reconsidered. *Research in Transportation Economics Vol 22*, 61-70.
- Nash, C. (2010). European rail reform and passenger services - the next steps. *Research in Transport Economics Vol 29*, 204-211.

- NEA, OGM, Oxford, U. o., TINA, University, E., & TIS. (2005). *European Railways Administrations Institutions and Legislation (Erail)*. Brussels: European Commission, DG Transport and Energy.
- OECD. (n.d.). *www.oecd.org*. Retrieved 04 08, 2011, from *www.oecd.org*: *www.oecd.org*
- Pittman, R. (2007). Options for restructuring the State-Owned Monopoly Railway. *Research in Transportation Economics Vol 20*, 179-198.
- Roeleveld, A. (2006). Benchmarking identifies good practice in rolling stock maintenance. *Railway Gazette International*, 224-226.
- Roeleveld, A. (2010). *NS Benchmark*. Utrecht: NS.
- Roeleveld, A. (2010). The Dutch Railways - Setting, Strategy and Performance. *Lecture CT 4811, TU Delft*. Delft.
- Roeleveld, A. (2011, May 20). Interview.
- Roeleveld, A. (2011, June 23). Interview.
- Rothengatter, P. D. (2007). Integration or Disintegration of Infrastructure and Transport Companies in the European Railway Sector - The Pro's and Con's. *11th World Conference on Transport Research*. Berkeley CA: World Conference on Transport Research Society.
- Rydzkowski, R., & Barry Spraggins, H. (1994). Restructuring, Privatization and Deregulation of Transport in Poland: New Transport Policy Implications. *International Journal of Physical Distribution & Logistics Management*, 23-29.
- Sachar, H. (1977). *A History of Israel*. Oxford: Blackwell.
- Scheel, H. (2000). Efficiency Measurement System Version 1.3.
- Smith, A. (2006). Are Britain's railways costing too much? *Journal of Transport Economics and Policy Vol 40 Part 1*, 1-44.
- Smith, S., Wheat, P., & Nash, C. (2010). Exploring the effects of passenger rail franchising in Britain: Evidence from the first two rounds of franchising (1997-2008). *Research in Transport Economics*, 72-79.
- Solomon, C. (2008). *Get in Trains and Infrastructure - Economic strategy of developing and running trains in Israel in cooperation with the private sector*. Jerusalem: Ministry of Transport.
- Stanley, J., & van de Velde, D. (2008). Risk and reward in public transport contracting. *Research in Transportation Economics, Vol 22*, 26-30.
- Streichfuss, M. (2010). *Railway Transformation*. Hamburg: Eurailpress.
- Survey of Israel. (2010). Railway Network Map. Tel Aviv.
- TASC Consultants. (n.d.). Interview Week 8. Tel Aviv, Israel.
- Thompson, L. (2003). Changing railway structure and ownership: Is anything working? *Transport Reviews Vol 23 No 3*, 311-355.
- Tweede Kamer. (2009). *Evaluatie spoorwetgeving*. Den Haag: Sdu Uitgevers.
- UIC. (2011). *Railisa - The UIC statistics database*. Paris: UIC.
- van de Velde, & Röntgen. (2009). Railway Separation European Diversity. *12th Annual International Conference on the Economics of Infrastructures*, (pp. 211-230). Delft.
- van de Velde, D. (2008). A new regulation for the European public transport. *Research in Transportation Economics Vol 22*, 78-84.
- van de Velde, D., & Röntgen, E. (2008). *Landenoverzicht Spoorordening*. Amsterdam: Inno-V.
- van de Velde, D., Veeneman, W., & Lutje Schipholt, L. (2008). Competitive tendering in The Netherlands: Central planning vs. functional specifications. *Transport Research Part A 42*, 1152-1162.
- van Lunteren, B., Lutje Schipholt, L., & Nanninga, H. (2006, March). Regionaal materieel apart aanbesteden. *OV.magazine*, pp. 28-29.
- Vaturi, A., Portnov, B., & Gradus, Y. (2010). Train access and financial performance of local authorities: greater Tel Aviv as a case study. *Journal of Transport Geographphy*.
- Veeneman, W. (2004). *Creating System Innovation - Chapter 3: The Rail Revolution*. Oxford: Taylor & Francis.
- Weeda, V. (2010). Operations Performance Analysis at ProRail. *Lecture May 18 TU Delft*. Delft.

GLOSSARY

AT	Austria
B2B	Business to Business; direct relationship between IRL Cargo and suppliers.
BE	Belgium
BG	Bulgaria
BU	Business Unit; separate entity within a larger company that is grouped around a specific activity, product group or technology.
C	Used in this thesis report to express Cargo services (and not Passenger services).
CER	Community of European Railway and Infrastructure Companies; organization representing 74 railway companies and infrastructure managers in delivering practical and reliable information to all European institutions in the debate about the future of rail transport.
CH	Switzerland
CRS	Constant Returns to Scale (Data Envelopment Analysis)
CS	Customer Satisfaction
CZ	Czech Republic
DE	Germany
DEA	Data Envelopment Analysis; non-parametric technique to estimate efficiency and effectiveness of (in this case) passenger railway companies.
DEAOS	Data Envelopment Analysis Online Software; online tool used in determining efficiency and effectiveness levels of 8 passenger railway companies.
DK	Denmark
EE	Estonia
Effectiveness of Production	Outcome/Output relationship used in Performance Evaluation
Effectiveness of Resources	Outcome/Input relationship used in Performance Evaluation
Efficiency of Production	Output/Input relationship used in Performance Evaluation
EFTA	European Free Trade Association; includes countries that are not direct member states of the European Union, in this thesis report Switzerland and Norway are meant (Iceland is also EFTA member, but possesses no railway network at all).
EL	Greece
ERD	Executive Railway Department (Holding Model).
ERTMS	European Rail Traffic Management System; EU initiative to enhance interoperability of national rail networks by standardizing systems for train control and communication in EU member states.
ES	Spain
ETCS	European Train Control System; Standardized signaling, control and train protection system advocated by the EU and a designated part of ERTMS.
EU	European Union
EU++	EU+EFTA+specific countries of interest; taken along in examination of organizational structure (part 2).
Eurostat	Statistical Office of the European Union. Draws its statistics from national bureaus of statistics of EU member states.
External TOC	Train Operating Company that operates transport services next to an incumbent operator. Examples of external TOC's in European countries: Veolia

	Transport in various countries, WestBahn in Austria, Connexxion in the Netherlands.
FI	Finland
FR	France
fte	Full Time Equivalents (staff)
Heavy Rail (system)	Railway systems excluding light rail systems, metro systems, tramways and funiculars.
HU	Hungary
IE	Ireland
IM	Infrastructure Manager; separate entity responsible for managing Infrastructure operations, construction and maintenance. Typically present in vertically separated railway sectors.
Incumbent	Traditional railway company or railway undertaking that has offered services for many years and still is a dominant player in the current railway sector. Examples of incumbents in European countries: NS in the Netherlands, Deutsche Bahn in Germany, OeBB in Austria.
Indicator	Variable to analyze performances of (railway) companies. An example of an indicator used in this thesis report is 'Train-kilometers Passenger Trains'.
IRL	Israel Railways Limited; the only railway company currently present in Israel.
IT	Italy
KPI	Key Performance Indicator; Ratio of Indicators used to determine a companies' relative performance compared to peer companies.
LT	Lithuania
LTA	Land Transport Agency (Hybrid Model).
LU	Luxembourg
LV	Latvia
MTBF	Mean Time Between Failure of Rolling Stock; measure for reliability of rolling stock in transport operations.
N/A	Not Available
NIRIC	National Israeli Railway Infrastructure Company (Vertical Separation Model).
NL	Netherlands
NO	Norway
NRICC	National Railway Infrastructure Construction Company (Horizontal Separation Model).
NS	Dutch Railways (incumbent operator in the Netherlands)
OECD	Organization for Economic Cooperation and Development; International forum of 34 countries worldwide committed to exchange experiences in democracy and market economy sectors.
Organizational Model	See 'Organizational Structure'.
Organizational Setup	See 'Organizational Structure'
Organizational Structure	Complete structure of actors, relationships and interfaces in place in a national railway sector.
P	Used in this thesis report to express Passenger services (and not Cargo services).
Passenger-km	Passenger-kilometer: a single passenger driven a single kilometer on a rail network.
PE	Performance Evaluation
Peer	Equal company to the company under investigation; suitable for benchmarking performances.

PL	Poland
PP	Public Procurement (schemes); all activities performed by governments aiming to establish contracts for execution of governmental projects. Includes tendering, evaluation of bids and contract awarding.
PPMC	Pearson's Product Moment Coefficient
ProRail	Dutch Infrastructure Manager rail network
PT	Portugal
Railway Sector	Abstract term describing the collection of all actors present in a national railway system. In this thesis report the collection of all actors in the Authority, Infrastructure and Transport blocks is meant.
Railway System	Technical/tangible term describing the rail transport system as is visible in the environment (actual infrastructure, rolling stock and staff present).
RD	Railway Directory; annual publication of publisher 'Railway Gazette International' containing information about railway companies and organizations present in countries all over the world.
RIF	Railway Infrastructure Fund (Improved Integration Model).
RO	Romania
Rosco	Rolling Stock Company; separate entity responsible for managing and conducting large maintenance (refurbishment & overhaul) of rolling stock equipment. Rosco's lease equipment to Train Operating Companies.
R.S.	Rolling Stock (equipment); Locomotives, Trainsets and hauled coaches used for transporting passengers and cargo.
SE	Sweden
SK	Slovakia
SL	Slovenia
SRCC	Spearman's Rank Correlation Coefficient
SWOT	Strengths, Weaknesses, Opportunities and Threats.
TOC	Train Operating Company; a company that offers transport services by rail both for passenger and cargo transport.
Ton-km	Ton-kilometer: a ton of Cargo driven a single kilometer on a rail network.
Train-km C	Train-kilometer Cargo trains: a Cargo train driving a single kilometer on the rail network regardless of train length, train weight or train usage.
Train-km P	Train-kilometer Passenger trains: a Passenger train driving a single kilometer on the rail network regardless of train length, train weight or train usage.
UIC	Union Internationale des Chemins de Fer; International organization representing (mostly) incumbent railway companies all over the world.
UK	United Kingdom
VRS	Variable Returns to Scale (Data Envelopment Analysis)

