ProRail

Master Thesis

Foreign Adoption of a Dutch innovation: The case RouteLint

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Preface

This master thesis is the final product to complete the Master of Science in Business Administration. The track of this study is named: Innovation management, which is linked to the subject of this master thesis, namely the marketing of innovations in foreign markets. With the preference for a big, nation-wide known company, I came in touch with ProRail, who provided me this project.

This master thesis provides conclusions to the subject of adoption intention in foreign railway markets, when it comes to the adoption of an innovation. With a particular innovation (RouteLint) taken as case, an applied research has been conducted to derive conclusions in this field.

The courses I attended during my masters were a small and helpful step for my master thesis. I found these courses instructive and doable. In comparison, my master thesis was from a totally different category. Here I found many challenges, which were a great but tricky experience. I had to give it the best to complete this thesis. The completion of this thesis could not have been done without the help of numerous people and some in particular. I want to thank my parents (financial) and friends (distraction) for their support. I want to thank Maarten Munster and Stefan Smink for proof reading the report, and helping with the layout.

Many credits go to my first supervisor Rik van Reekum with critical reviews and giving guiding directions and to my second supervisor Huub Ruel for his critical notes in order to complete this thesis.

This master thesis could not be completed without the help of the company ProRail and all its employees that helped me during the time being there. In particular I want to thank my supervisor Jelle van Luipen. He and ProRail gave me the opportunity to write and complete this master thesis.
With the help of Jelle and his great enthusiasm, I have been guided trough different obstacles and got valuable feedback. I felt my work appreciated and hope that it will be a guideline for further foreign market entry of ProRail's innovations.

Kind regards,

Maarten Scholte-Albers

Management Summary

Instead of sharing their innovative ideas with other railway organizations, ProRail's new strategy is to make their innovations profitable. They have already done this by successfully selling their innovations to the local (Dutch) market. After this success, they explore the possibilities to sell their innovations to foreign markets. ProRail foresees challenges entering these markets. Railway organizations all have a state-owned history, whereby self-developed techniques, rules, and work methods were used. ProRail wants to know if there is a potential foreign market for their innovations and how these markets look like. An overview of the markets including an overview of the factors that influence the intention to adopt is needed. To meet these objectives the following central research question is stated: *Which factors influence the adoption intention and what is the consequence for the market entry mode of RouteLint in European Union countries?* The answer to this question can help ProRail to create a successful foreign market entry strategy.

ProRail wants to enter foreign markets with RouteLint, a recent innovation. This innovation is used as case to determine the adoption intention and to select the entry mode. RouteLint is a device that is placed in the cabin of a train. The device gives information to the train driver, who can incorporate this information into his driving. The biggest advantage of this product is an energy reduction of 5 % on the train energy consumption.

Numerous studies are conducted in the field of the adoption of innovations in organizations. Most of these studies are based on adoption of innovations in private organizations. Hardly any scientific literature exists on adoption of innovations in railway markets. Several theories have been brought together into a conceptual model to find the factors that influence the adoption of innovations in railway markets. These theories are based on general innovation adoption theories and innovation adoption theories in public organizations. The public organization theory is used since experts within the railway industry confirmed that ProRail and other European railway organizations still have various similarities with public organizations.

First, the selection of foreign markets is based on preferences by ProRail. These preferences narrowed the foreign markets down to fifteen countries. Based on cross-national adoption theories, this group of countries is divided into an early adopter/innovative group and a late adopter/conservative group. For both of these groups a hypothesis is stated. With these hypothesis is checked if the characteristics of the railway markets in these two groups agree with the general cross-national adoption theory, which mainly aims at private organizations.

With a survey, the constructs in the conceptual model are applied on these two groups of countries. These survey showed the importance of the factors and the intention to adopt. The results of this

survey formed the base for follow up interviews. The follow-up interviews asked about the results of the initial survey, plus additional factors about the intention to adopt RouteLint.

The results of this research showed, that there is a market for RouteLint. The performance of this product was perceived as a positive factor. A negative influence on the intention to adopt was the skepticism about the technology. Most companies were uncertain if the RouteLint technology is compatible with their technology. Another fact is that the structure of the company is not made for risk taking. The gatekeepers and influencers in an organization, who start the decision making process, only bring in a product into the adoption decision process when it is completely secure. A product like RouteLint must therefore be positioned as a product full of advantages and a minimum of risks. The early adopter group showed a positive response to the adoption of a foreign innovation. The late adopter group was really skeptic about the compatibility of the technology with their system.

With the results the central research question could be answered. The factors performance expectancy, effort expectancy, social influence, facilitating conditions, and organizational innovativeness all have influence on the intention to adopt RouteLint. Also the fact that a country either belongs to the early or late adopting group influences the intention to adopt. Early adopting countries showed more intention than late adopting countries did. Early adopting countries are easier to reach and therefore there are no consequences for the mode of entry. The best suited entry mode can therefore be used. Because of the technology skepticism of the late adopting countries, the entry mode requires more investments in the markets in foreign countries, which involves cooperation with local suppliers to overcome the technology barrier.

ProRail is recommended to aim at the early adopter group. A pilot at a foreign railway organization is recommended as tool to prove that technology is not a barrier for adoption. The risks of product adoption are hereby minimized, which make it possible to enter that market with a licensing entry mode. Because of the great skepticism about the technology, a joint venture entry mode is preferred for the entrance of markets in late adopting countries. The late adopters showed all their trust in local suppliers in terms of the use of techniques. A joint venture with a local supplier can thus be used to overcome the technological barrier. However, when RouteLint is already working in early adopting countries, late adopting countries will follow. Over time, a licensing model might also be applicable on the late adopter countries.

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1. Introduction

The purpose of this first chapter is to give a motive and guideline of the assignment of this master thesis. First, the market, in which this research takes place, will be discussed. After, an overview is given of the company and the developed innovation, connected to the problems that are faced. These result in the objective of this thesis and its related research questions. Finally, the structure of this research is described.

1.1 Innovation and the railway market

An innovation, a successful exploitation of new ideas (Tidd et al., 1997), can open new doors for a company. A company can use that innovation for them, to be more competitive, but can also bring it to the market in which the company competes. To make an innovation more profitable, a company can look for other markets. Other markets can be a new market in the same country, but it can also be a foreign market. The more markets that can be conquered, the more profitable an innovation can be. But a market abroad is different than the market at home. There are barriers that have to be overcome. A market entry strategy to overcome those barriers can help a company to enter foreign markets.

The European Union supports an open European Market. With the treaty of Rome in 1957, members of the European Union want that the movement of capital, labor, goods and services, between countries in the EU must go as easy as within these countries. In 1985 the Single European Act was signed, which had to lead to a Single European Market in Europe in 1992. In order to create a single European market all the state owned companies had to be privatized. This also was the case for the companies within the railway industry.

For a long time railway companies were state owned companies. In the beginning of the railway industry, most of the railway companies started as a private company. Later in the 20th century, state governments saw the strategic importance of the railways and started to control them. The railways had an import logistic function for most countries, especially during the two world wars. The state decided for a long time how their railway companies should operate and which systems had to be used. In this way every country was using different systems, whereby they preferably choose to use systems developed in their own country. Also were most railway companies family industries. A father works for a railway company and a son follows him. Comparing with other industries the railway industry can be described as traditional or conservative. The conservative view, which was created during the state owned period, is still there. The state owned the companies for a long time before the European Union started to interfere with the railway industry in Europe.

The implementation of directive 91/440 had to lead to less control by the state and more freedom for every carrier to offer its services in every country of the European Union. In theory, the European Union ended state exploitation of the railways. In practice, most companies are still (semi-) state owned. The government has still substantial influence on the strategy, working method and the decision-making process. The culture of the country and the company is still embedded in the company. This makes it hard for foreign technologies to integrate into a company. This comes because of the technologies used by companies over the years. It is impossible to drive a train from Holland to France, without making major technological changes to a train. Doing business with railway companies in other countries is not as easy as directive 91/440 describes.

Forthcoming out of the Single European Act, on the 29th of July, 1991, the European Council adopted directive 91/440. This directive prescribes the following:

- There must be an independent management of the railway companies.
- There must be a separation between the management of the railway operation and infrastructure from the transport activity.
- There must be access to the networks of member states for the international groupings of railway companies, and for railway companies engaged in the international combined transport of goods.

1.2 ProRail

After several re-organizations, because of directive 91/440, in 2003 ProRail was founded out of a merger of Railinfrabeheer, Railned and Railverkeersleiding. ProRail is a nationally operating company that manages the Dutch railway system. In short they are responsible for the trustworthy, safety and to make sure there is sufficient capacity on the railway tracks in the Netherlands. Despite the open railway market and the independence of the management, the Dutch state is still 100% owner of ProRail and therefore has substantial influence.
In 2008, ProRail decided to become a more independent organization. The influence of the government comes in the form of a subsidy, which covers 78% of their yearly turnover. This subsidy brings many obligations. They have to justify to the government what they do with this subsidy. The subsidy is mainly meant for the basic things ProRail has to do. There is not much freedom of choice with the liquid assets they have. By earning money a different way, they obtain freedom to invest this money in projects they would like to invest in. One way to earn money is to sell innovations to the local (The Netherlands) and to foreign markets, with an emphasis on countries within the European Union.

1.3 RouteLint

Energy efficiency is a hot item in the world. Amongst others, there is the Kyoto protocol, that stands for a reduction of greenhouse gasses of 5,2% in 2012. The railways use 1,5% of the total energy

consumption in the Netherlands. Energy reduction therefore is a hot item in the railway industry and ProRail. Reducing energy is not only good for the climate, but also leads to a reduction of energy costs. ProRail's innovation department developed a system called RouteLint. RouteLint is software that gives a train driver an overview of the traffic situation ahead of him. This software can be read of a Personal Digital Assistant (PDA) in the cabin of the train. A train driver sees this information and uses this information to respond to the actual traffic situation. With good implementation of this information, a train can reduce an estimated 5% of energy.

Because of an expected high demand for energy efficient equipment in the railway industry, and other features of this product ProRail believes there must be more railway companies interested in RouteLint. After selling RouteLint to the Dutch market, they want to bring RouteLint to foreign markets. Since they have never sold anything to foreign markets, they have no clue how to enter foreign markets and if there is a market for RouteLint. Marketing has never been part of ProRail's business. ProRail used to share new ideas with everybody who was interested. Now they want to make a profit out of it. But the question is, is there an international market and how can ProRail enter these markets?

ProRail struggles with the question how to enter the foreign railway markets with a "Dutch" product. The acceptation of innovations is not as normal as in other industries. There is a clear sign of a not invented here syndrome (Katz, 1982). With this syndrome, companies do not look at innovations developed by others. They only see the virtue and superiority of their own ideas and technical activities, while dismissing the potential contributions and benefits of new technologies, competitive ideas and accomplishments, as inferior and weak (Katz, 2004, pp. 455). ProRail now wonders how to bring RouteLint to foreign markets, where a clear conservative view towards foreign innovations is.

1.4 Market Entry in the Railway Industry

To enter foreign markets, Root (1994) developed a model (figure 1.1) for an international market entry strategy. This model guides companies from their product to the target market. The model is build up in 5 phases. The first phase begins with the choice of product and market. Phase 2 sets objectives and goals for this product and market. To penetrate the target country, the mode of entry must be chosen. This happens in phase 3. In phase 4, the marketing plan must be created to penetrate the target market. This plan is based on the four P's founded by McCarty & Perreault (1990). Under these four phases, there is a control element to monitor the performance in the target market. With these performance measures, it gives feedback to the four elements in order to upgrade the international market entry strategy.

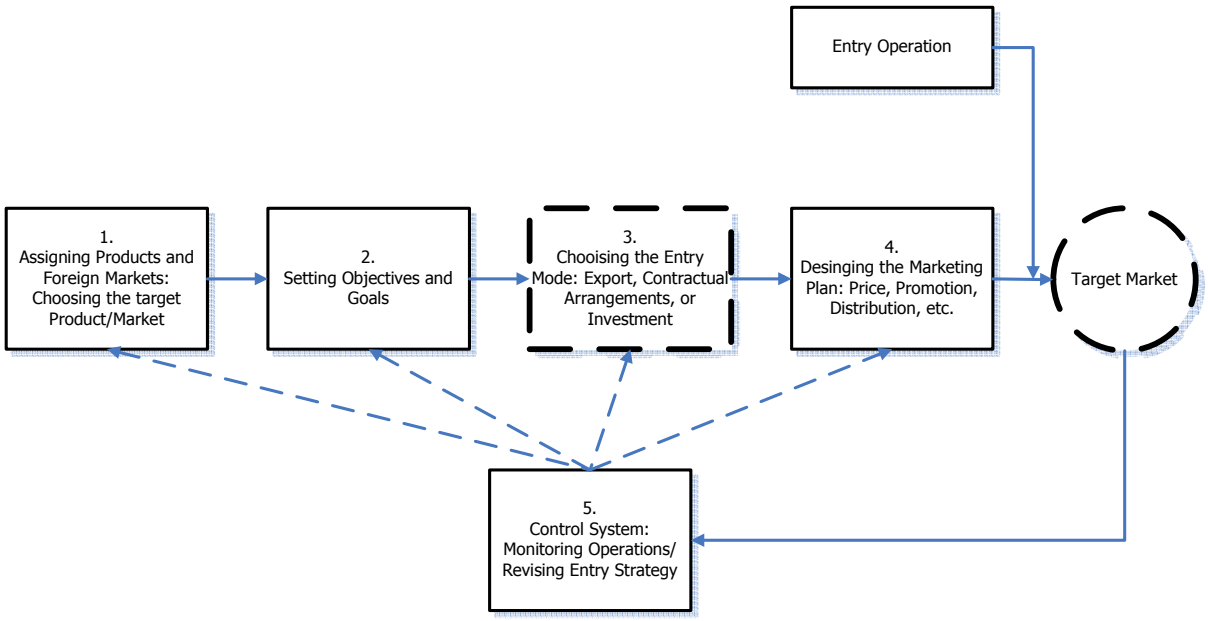

Figure 1.1: Elements of an international market entry strategy (Root, 1994)

As said before, the railway industry is a very unsure target market. The earlier mentioned not invented here syndrome (Katz, 1982) is one of the problems why products from foreign companies do not have possibilities to enter that market. A market entry strategy has no use if the target market does not accept the product, no matter how good the product is. Therefore it first must be known if the target market is open for innovations from foreign companies, and if the target market is open for foreign innovations, how do they want a foreign company to enter that market. The model of Root (1994) for that reason needs to be read backwards. First, a better understanding is needed of the target market. ProRail needs to know if there is a market for RouteLint and which factors play a role in the adoption. If there is a market ProRail would like to know what the consequences of the adoption factors are for the product proposition of RouteLint. From there, the market entry strategy can be developed.

1.5 Research contribution

RouteLint will be the first system that ProRail wants to bring to the European market. Entering the market will be a huge challenge for ProRail, but also is its adoption. Will other countries accept a Dutch innovation? Is the innovation of ProRail the solution for the same problems in other countries? And for how far is a Dutch innovation applicable outside of the Netherlands?

In order to get more knowledge about the market and the intention to adopt in the railway industry, the objective of this research, considering the fact that more innovations will follow, is to indentify factors that influence the adoption of RouteLint and the effect of these on the market entry mode that can help to profitably adopt RouteLint in the European market. This practical objective of this master thesis is inherently linked to the academic objective of this master thesis, namely contributing to the growth of scientific knowledge of adoption factors in the railway industry.

1.6 Research Questions

To meet the thesis objective to find possible markets in the European Union for ProRail's innovation RouteLint, and to describe the factors that influence the intention to adopt this product. The following research question is stated:

Which factors influence the adoption intention and what is the consequence for the market entry mode of RouteLint in European Union countries.

In order to answer this question, the four aspects of this research are separated into sub-questions.

1. **RouteLint** – What is RouteLint
    a. What are the features of RouteLint
    b. How does RouteLint distinguish itself from other RouteLint like solutions

2. **European Market** – Which countries in the European Union are interesting for ProRail
    a. Which segmentation criteria are important to ProRail in order to bring RouteLint to that market
    b. Which segments have priority to enter with RouteLint on that market

3. **Adoption intention–** Which factors influence the adoption intention of RouteLint in the railway market
    a. Which factors influence the adoption of an innovation on an organizational level
    b. What is the influence of these factors on the adoption intention
    c. How is the organization structure of DMU's organized on the target market
    d. How are adoption decisions made within these organization

4. **Market Entry Mode**– What are the consequences of the adoption factors on the market entry mode for RouteLint
    a. Is there a possible market for RouteLint
    b. What is the influence of the adoption intention factors on the market entry mode of RouteLint
    c. What entry mode suites best for RouteLint taking the influencing adoption factors into account

1.7 Research approach

Information, theories, and data are collected to answer the research questions. This is done by several different research methods. A desk research is conducted whereby information from ProRail and experts was collected. With this information getting a good overview of today's railway market and the product RouteLint indentifies the real problem.

A literature study is conducted, which resulted in a theoretical framework (chapter 3). This literature gives an overview about what is known in the field of adoption in general, in railway organizations, and in the European market. It ends with an overview of the different market entry strategies. The literature is found by searching in university libraries and scientific Internet catalogues such as: Web of science, EbscoHost, Jstor and Google Scholar. Keywords in this search were: market entry, adoption, railway industry, public organizations, European Union and innovation. These indexes also helped to apply the "snowball" method. With the snowball method new literature will be searched based on references and citations found in the literature in order to find more articles.

This research is conducted in the slow and late developing open market of the railway industry in the European Union. Literature cannot provide all of the needed information to execute this research. To check the theories about adoption in the European railway market and to obtain additional information, case studies will be performed. Hereby will the founded adoption theories be tested. First, with a survey and later with two typical cases for this subject. These cases are conducted with the help of follow-up interviews after the surveys.

The cases in this research are conducted in the target countries, defined in chapter 4 research methodology). In these target countries the theories about adoption and market entry are tested. In the end all factors that influence the adoption attention must be identified. With these factors will be looked at the influence of them on the foreign market entry strategy for ProRail's innovation, RouteLint.

1.8 Structure of this research

This research starts with the introduction chapter (chapter 1). This chapter introduces the research by describing the history of the railway market, the company, the innovation and problems that are faced today by ProRail. This is followed by an outline that is given about the design of this research. The research contribution, objective, and questions are stated. In addition there is a brief overview given about the approach of this research. Finally, the structure of this research described, which serves as a reading guide for the remainder of this research.
In chapter 2 the first research questions about RouteLint are answered (research question 1). It will give an overview of energy efficient devices. RouteLint is an energy efficient device and this chapter shows how it distinguishes itself from the other devices. The next chapter (chapter 3) presents the theoretical framework of this research. In this framework, models and theories are presented about what already is known within this research area. These theories help to shape the data collection and –analysis of this research. These theories also provide an answer to research question 3a. In chapter 4 research question 2a will be answered. In this chapter a critical look will be taken towards the European Union. With theories and preferences of ProRail, market segments will be indentified that

could have priority for ProRail. In addition the methods that are used to collect data are described in order to answer the final research questions. The results of the empirical part of this research can be found in chapter (chapter 5), These results are based on the data that is collected in chapter 4. The concluding chapter (chapter 6) discusses these results and concludes the research by giving the answer to the remaining research questions 2b, 3 and 4. Finally, the references for this research are shown plus the appendixes where additional information about this research can be found.

2. The uniqueness of RouteLint

The purpose of this chapter is to explain ProRail's innovation, RouteLint. By giving an overview of the device RouteLint and other devices concerning energy efficiency, the research questions 1a and 1b will be answered. First, an overview is given of the device RouteLint. Secondly, an overview is given of different methods to drive energy efficient, in combination with the devices that are used to perform these methods will be discussed. Finally, a comparison is made between the devices, in order to look at the uniqueness of RouteLint.

2.1 RouteLint

RouteLint is an innovation developed by the innovation department of ProRail. RouteLint is developed to improve the communication between the train dispatcher and the train driver and to make more use of the skills of the train driver. This must lead to better communication between the train driver and train dispatcher, better communication between train driver and passengers, better punctuality, better work perception, better use of infrastructure and energy efficiency.

Nowadays train drivers drive based on commands. A signal is green; the driver can pass trough, an orange commands the driver to slow down and a red one to stop. A train driver follows orders and has no overview of the situation ahead or behind its train. A train dispatcher is the eye of the train. The dispatcher sets the route of the train and knows when and why a train driver has a red signal ahead of its train. When a train driver has a red signal, the driver has to call the dispatcher to ask what is going on and how long it will take in order to inform his passengers. A train driver cannot use skills as route knowledge, if the driver has no overview over the situation. By giving a train driver a better view over the situation, the driver can use that to start coasting earlier, what can lead to energy reduction.
Based on these problems, ProRail developed RouteLint. RouteLint is software that communicates between the train and the control centre of the train dispatcher. On a PDA in the cabin of a train the train driver can see 7 signal steps ahead of him and the train behind him (figure 2.1). A signal step is a block between one signal and the next one. There is only one train allowed in one signal step. A train driver has now the same overview as a train dispatcher, but only what is relevant for its situation. The driver's job is to put this information into energy efficient driving. The system is not a replacement of other safety system, like signals along the rails, but is pure for extra information. This information must give a better understanding of the surrounding area.

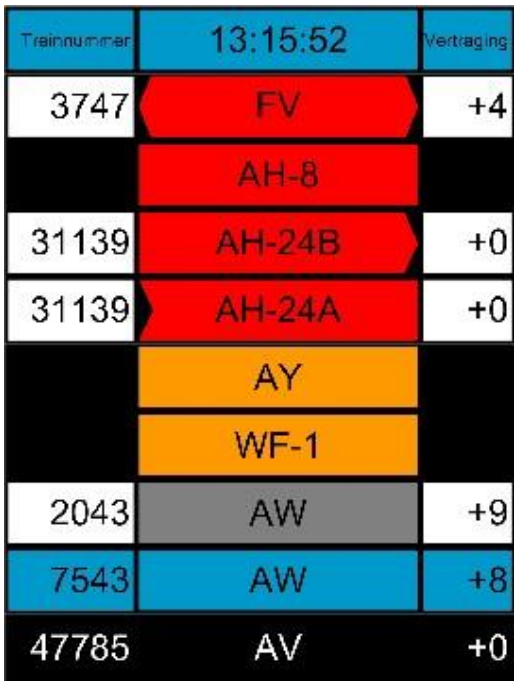

Figure 2.1: RouteLint (source: www.routelint.nl)

2.1.1 Features of RouteLint

After indentifying dynamic network related systems and RouteLint, the first research question can now be answered.

1a - What are the features of RouteLint

The factsheet of RouteLint showed features based on tests conducted by ProRail. This factsheet can be found in appendix I and distinguishes the following features:

- Punctuality increase of 1.2%
- Energy reduction of 5%
- Better use of infrastructure, because of the decrease of buffer times of 2%
- There are less calls to get information from the dispatcher, but more phone calls to help the dispatcher for better dispatching
- There is a better understanding between the train driver and dispatcher.
- Train drivers can use RouteLint to give better up to date information to their passengers
- RouteLint does not lead to safety issues
- RouteLint can function with its techniques
- There is more challenge with RouteLint since they can use their craftsmanship

Opposite all these advantages is one disadvantage. This is the need for education and experience to work with the system.

The working of this system makes RouteLint unique in the field of energy efficient devices. However, was RouteLint developed as a communication system, the 5% energy reduction is a huge additional feature. Especially the energy reduction made ProRail believe that the product would be interesting for other railway companies in the world. In the next paragraph, RouteLint will be described in the context of energy efficient devices. The different devices will be described, plus devices developed by other railway companies that aim at energy efficient devices.

2.2 Energy efficient devices

Next to the Kyoto protocol, to reduce the emission of greenhouse gasses, saving energy also leads to reduction of energy costs. In the railway industry, where most trains drive on electricity, a saving of 1% of energy already leads to substantial savings in energy costs. That is why the railway industry is busy working on new products and driving methods to reduce energy. Research is done in the fields of train driving and driver support systems (Howett & Pudney, 1995; Albrecht, 2005 and Netz, 2005). They all agree that, with another driving style, energy can be reduced. The driving style can be changed with training of the driver and/or with the help of driver support systems.

A train uses the most energy by accelerating. When it drives on a constant speed it uses a little less and by coasting it is using no energy. Coasting is the most energy efficient way, since it is not using any energy. Thereby trains can coast for a very long time without losing a fair amount of speed. If a train wants to use as little energy as possible, it has to start coasting as early as possible. This means that it has to accelerate as quickly as possible to maximum speed and then start coasting. For a train driver it is now to know when to start coasting. By training the driver and/or with the help of driver support systems, the driver knows when to start coasting and can help to reduce energy.

Albrecht (2008) distinguishes three different systems that can help a train driver to reduce energy. The three different systems are: static systems, dynamic train related systems and dynamic network related systems. These systems will now be explained.

2.2.1 Static systems

Static systems help to reduce energy by making use of static data. It is a very useful, easy and cheap way to help train drivers to reduce energy. A train driver gets information about when to start coasting. Telling train drivers to start coasting from a certain point along the route can do this. Training is necessary to make train drivers aware of when to start coasting. If the whole operation would run smooth, then this system would be excellent in order to reduce energy. However, trains hardly drive exactly on schedule. If trains depart a minute late on schedule, they cannot make use of static data anymore in order to arrive on time on the next station. In addition the train needs to drive on an exact speed in order to follow the coasting instructions.

2.2.2 Dynamic train related systems

Dynamic train related systems are like static systems, but make use of dynamic data. A train gets data based on the time it is at a certain point. If the train is early or late at a measurement point, the driver gets information in the cabin of the ideal speed it should be driving on, to be energy efficient and to be on time on the next station. Punctuality and energy efficiency are the two main points of this system, which also is called driver assistance system. These systems are very easy to use, what makes it for an inexperienced driver easy to learn how to drive a train. All driver assistance systems that have been developed have the following components:

1. A positioning or speed metering device,
2. A clock and,
3. A database containing the timetable in digital format, which must contain
    - The departure, pass and arrival times at all relevant points,
    - The maximum permitted speeds,
    - Gradients and curve radii to determine track running resistance

These components come together on a display in the cabin. This display shows a speed profile for that train. In Europe several of these systems are already developed. Examples of these are:

EBuLa – ESF

The first system that was developed in order to reduce energy is EBuLa-ESF. It is developed by the Deutsche Bahn and is already integrated in the standard control panel of first and second-generation ICE trains. In figure 2.2 can be seen how the system looks like.

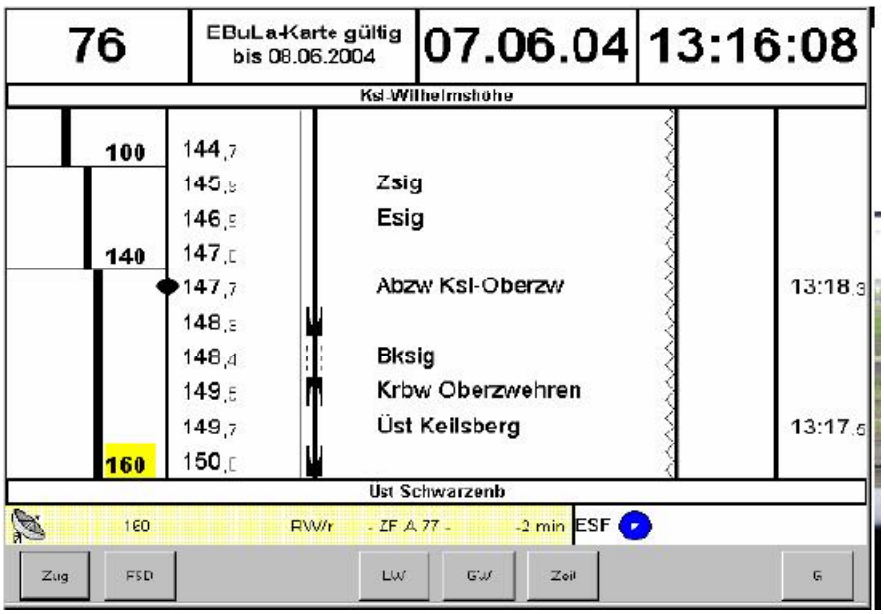

Figure 2.2: EBuLa-ESF (source: www.db.de)

GEKKO

The Danish State Railways developed a system called GEKKO. A device in the train cabin visualizes the GEKKO system (figure 2.3). A green arrow on a speedometer on the GEKKO device shows the optimal speed to be energy efficient. A train driver needs to drive as fast as the green arrow points on the GEKKO device. Both GEKKO en Ebula-ESF say that they can reduce energy by 5 %.

Figure 2.3: GEKKO Device (source: www.dsb.dk)

Freightmiser

The Australian company TMG Rail Technology developed the system Freightmiser (figure 2.4). The system is developed for heavy and long haul freight trains. Similar to the other systems the Freightmiser device is build into a display in the cabin of a train. The system gives, like GEKKO and EBuLa-ESF, a speed advice, but also shows the upcoming road and signals. This helps the driver to understand why this speed advice is given. The system provides efficient use of energy, while maintaining schedule. Instead of wasting energy through driving too quickly and arriving head of schedule, the on board advice system advises the optimum speed profile for drivers to reduce energy consumption while maintaining their schedule.

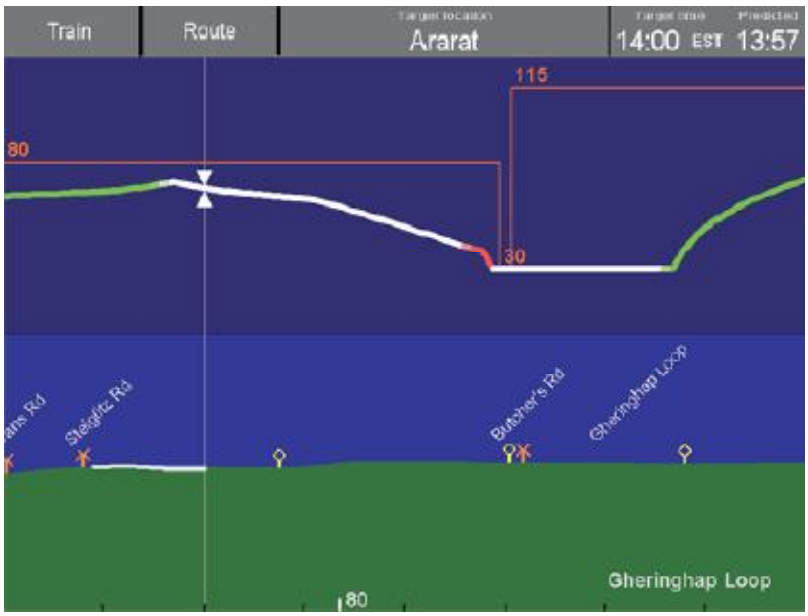

Figure 2.4: Freightmiser (source: www.railinnovation.com.au)

There are also downsides of dynamic train related systems. By telling a driver what to do, the driver cannot make use of its own skills or experience. Another point is that a dynamic train related system only looks to its own train and not to the whole network of trains. A slow train in front of the driver cannot be seen by the system. The speed advice that is given by the system has therefore no use, since the train will run into a red sign.

2.2.3 Dynamic network related systems

Dynamic network related systems are also called driver information systems. This system looks at its own train and possesses information about the state of traffic in the vicinity of the train. A train driver now sees what is coming up ahead of its own train and can anticipate to that situation. The driver can see that there is a slow train ahead of him, so the driver should coast a little earlier, in order to not stop the train and then start to accelerate again. This system needs a skilled and experienced train driver, in order to be well used.

These systems transmit data between the trains and the dispatching system in the central control. Thereby the train can get information about the current state of traffic in the railway network, as well as predictions on its future state, e.g. the position of other trains and signal aspects, in order to avoid conflicts with other trains by anticipatory driving. Downside of this product is that is asks a train driver needs to have experience. Inexperienced train drivers are not able to use this system. In this category, RouteLint, ProRail's innovation is the only product developed thus far.

2.2.4 Safety Systems

Next to the explained driver information systems, there is a European Train Control System (ETCS), which is part of European Railway Traffic Management System (ERMTS). The main goal of ERMTS is to improve the interoperability between the member states of the European Union. ETCS is a signaling, control and train protection system, designed to replace the various signaling systems that are now present on the different railway networks. ETCS is a response to directive 96/48/EC, which promotes the interoperability of high-speed trains in the European Union. Also part of ERMTS are the communication system GRM-S and the European Traffic Management Layer (ETML), which is a rail traffic management system.

ETCS is a signaling, control and train protection system, designed to replace the various signaling systems that are now present on the different railway networks. Finally, ETCS is a safety system that takes over the train if it drives to fast.

Based on the level of implementation, ETCS comes in the levels 0 till 3. Level-0 is the level with lowest implementation of ECTS, and level-3 is the highest. The highest level of ECTS that is available now is, ECTS- level 2, while level-3 is under development.
ETCS-level 2 is a digital radio-based signal and train protection system. Movement authority and other signal aspects are displayed in the cab for the driver. Apart from a few indicator panels it is therefore possible to dispense with trackside signaling. However, the track-release signaling and hence the train integrity supervision still remain in place at the trackside. All trains automatically report their exact position and direction of travel to the Radio Block Centre (RBC) at regular intervals. Train movements are monitored continually by the radio block centre. The movement authority is transmitted to the vehicle continuously via GSM-R together with speed information and route data. The Eurobalises are used at this level as passive positioning beacons or "electronic milestones". Between two positioning beacons the train determines its position via sensors (axle transducers, accelerometer and radar). The positioning beacons are used in this case as reference points for correcting distance measurement errors. The on-board computer continuously monitors the transferred data and the maximum permissible speed. In figure 2.5 an graphic overview is given of working of ETCS level-2.

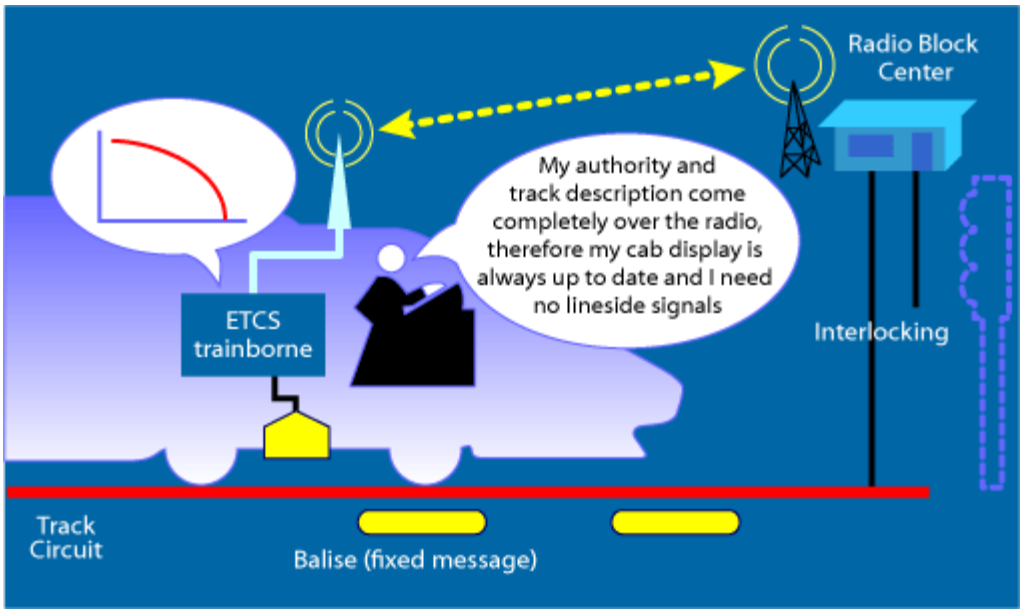

Figure 2.5: ECTS level 2 (source: www.uic.org)

2.3 Comparison of the devices

In table 3.1 there is an overview given of the different systems and the devices described in this chapter. The systems are divided into the different groups and tested on energy efficiency, information, data use, the needed experience, increase of punctuality, and the estimated amount of energy that can be saved in %. This table can lead to the answer of research question 1b.

1b - How does RouteLint distinguish itself from other RouteLint like solutions?

In table 2.1 can be seen that RouteLint distinguishes itself from the other devices by the kind of information that is given, and the data that it uses. RouteLint can therefore be called unique. That experience is needed can be seen as a disadvantage since non-experienced drivers are not able to work with RouteLint. In addition, it can be seen as an advantages since experienced drivers can make use of their skills and experience what makes a train drivers job more interesting. These differentiated features make RouteLint a unique device compared to the other devices on the market. Root (1994) says that the uniqueness of a system is a priority when it comes to selling innovations in different markets.

	System	Features					
		1 Energy	2 Information	3 Data	4 Experience	5 Punctuality	6 Savings
Static Systems	Static Systems	yes	advice	static	no experience	no	unknown
Dynamic Train Related Systems	EBuLa	yes	advice	dynamic	no experience	yes	5%
	GEKKO	yes	advice	dynamic	no experience	yes	5%
	Freighmiser	yes	advice	dynamic	no experience	yes	20%
Dynamic Network Related Systems	RouteLint	yes	information	whole network	experience	yes	5%
Safety Systems	ECTS level 2	no	safety	dynamic	no experience	no	unknown

1	promotes energy efficiency	yes/no
2	gives what kind of information to the driver	advice/information/safety
3	makes use of what kind of data	static/dynamic/whole network
4	experience needed to use the system	no experience/experience
5	increases punctuality	yes/no
6	estimated amount of energy that can be saved in %	

Table 2.1: Comparison of the devices

3. Theoretical Framework

This chapter is an overview of an extensive literature research about the topic in this research area. The results of this research ended up in a theoretical framework what will be a foundation for the remaining of this research. It starts with general theories about adoption. In the second part the theories will be more focused on the topic of this research. This will be completed with specific adoption theories, adoption by public organizations and cross-national adoption. These theories result in a conceptual model that will be used for the empirical part of this research and to answer to research question 3a. In addition, several foreign market entry strategies will be discussed.

3.1 Adoption

RouteLint is a new technology which is in its starting phase in the Netherlands. NS Reizigers, the biggest user of the Dutch railway network, bought this system from ProRail and will start implementing it in the beginning of 2009. NS Reizigers, as organization made the decision to adopt this system. Adoption is defined by Rogers (2003), as a decision to make full use of an innovation as the best course of action available. Now ProRail wants other international railway organizations make the decision to adopt RouteLint. However, the adoption of RouteLint by the NS Reizigers cannot be compared with adoption within other companies, since ProRail developed RouteLint in cooperation with and for NS Reizigers.

The decision to adopt or reject an innovation comes between the initiation and the implementation phase (Zaltman et al., 1973). In the initiation phase the organization becomes aware of the innovation, forms an attitude towards the innovation and evaluates it. In the implementation phase the organization decides to purchase the innovation and make use of it. The innovation is now accepted at the organizational level. But the adoption is fully completed when it is adopted within the organization. Ram & Jung (1991) refer to this as intra-organizational acceptance. This is in line with the definition of adoption stated by Rogers (2003). Also Bhattacherjee (1998) states that, for ProRail, RouteLint is successful accepted and integrated into the organization when the target adopters demonstrate commitment by continuing to use the product over a period of time.

Adoption is not an all or nothing decision process. There are different gradations of adoption. Dolowitz & Marsh (2000; pp 52-53) differentiate the following gradations:

- Copying – take over the innovation without making any chances.
- Emulation – the innovation will be adjusted to the wishes and needs of the adopter.
- Hybridization or syntheses – elements of different innovations will be combined to a new innovation.
- Inspiration – The innovation of someone else leads to inspiration for the own organization.

Numerous fundamental researches have been conducted about the adoption of innovations (Rogers, 2003; Ajzen, 1991; Davis, 1989; Venkatesh et al., 2003). All these researches deal with adoption of innovative technologies. Several models are developed to clarify the use of new technologies. The Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) was one of the first models to help introducing new technologies. This model was based on the 3-component model for behavioral intention of Rosenberg & Hovland (1960). Rosenberg & Hovland stated that attitude and behavior are formed trough three components: cognition, affection and conation. The difference between the 3-component model and the TRA, is the fact that the TRA also takes the subjective norm into consideration. The stemming Technology Acceptance Model (TAM) (Davis, 1989) and the Theory of Planned Behavior (TPB) (Ajzen, 1991) both take the fact into consideration that an individual has an attitude towards a subject, to clarify a behavioral intention. At the TPB the attitude of an individual is formed bases on the attitude and subjective norm-factors of the TRA, the behavioral beliefs, normative beliefs and control beliefs. The TAM presupposes that perceived usefulness and perceived ease of use, clarify the behavioral intention of the individual. This model points especially on the adoption of ICT.

The Social Cognitive Theory (SCT) (Bandura, 1988), states that behavioral use is constantly influenced by personal and external factors, but that these factors are also influenced by each other and the behavior of a human. In this theory there is an important role for the expectation of the individual. It looks if the individual can deal with the innovation and the personal factors as habit, affection or fear, but also that behavior can change by what happens in the environment of the individual. The SCT was the first theory that looked at more than just the personal factors, in order to clarify behavioral intention.

3.1.1 Two main theories

Widely used by many scholars is the Diffusion Of Innovations theory (DOI), (Rogers, 2003). The DOI uses, like the TPB model, perceived ease of use to clarify behavioral intention. According to Rogers (2003) there are several steps in the innovation-decision process that have to be done to come to adoption of an innovation. He defines the innovation decision process as the process trough which an individual (or decision making unit) passes from gaining initial knowledge of an innovation, to form an attitude towards the innovation, to make a decision to adopt or to reject, to the implementation of the new idea, and to the confirmation of this decision. The model of the DOI theory can be found in figure 3.1.

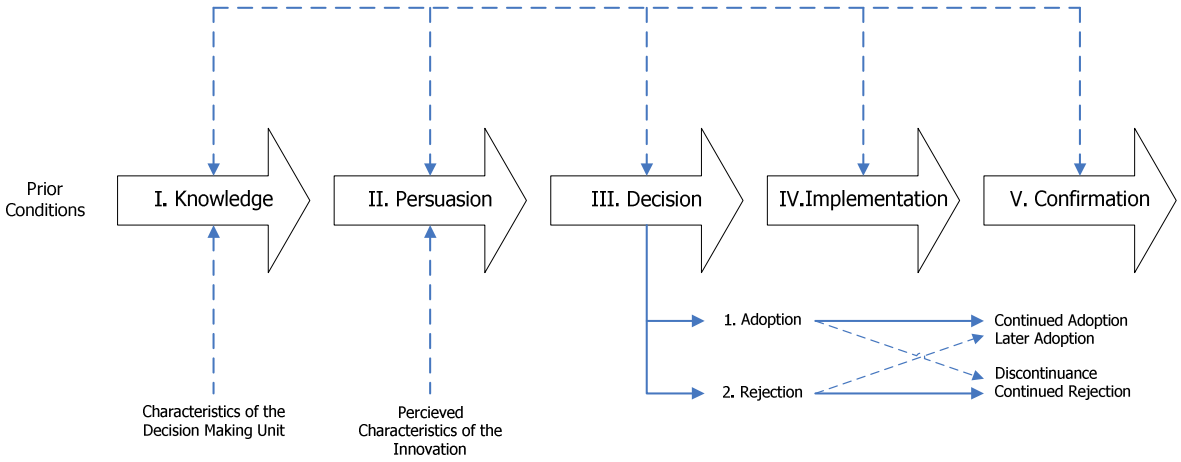

Figure 3.1: Innovation-decision model (Rogers, 2003)

In the first phase knowledge must be gathered about the innovation. In this phase personal characteristics of the people in the process and the social system play a role, like in the SCT of Bandura (1988). Also does the model take prior conditions into consideration. Rogers distinguish four prior conditions that influence the knowledge stage. These conditions are: Previous practice, felt needs/problems, innovativeness and norms of the social systems. The next phase is the persuasion phase whereby the characteristics of the innovation play the most important role. The characteristics that Rogers (2003) divides in the categories: Relative advantage, compatibility, complexity, trialability, and observability. According to Rogers (2003) the perceived attributes of innovations explain 49% to 87% of the variance in the rate of adoption. These characteristics are widely supported by different authors. Mansfield (1993) and Robinson (1990) state that the perceived net benefit the innovation offers has an important effect on the organizational adoption. In the next phase (phase 3) follows the decision to adopt or to reject the innovation. When the innovation is adopted, it will be implemented in phase 4 and in phase 5 the innovation becomes part of the company and will be a routine.

Rogers (2003) makes a difference between adoption of innovations by individuals and the adoption in organizations. By organizations he does not uses the phases from knowledge to confirmation, but the phase agenda setting, matching, redefining, clarifying and routinizing. They are comparable to the individual adoption model, but by diffusion in organizations there is assumed that the process starts based on a problem in an organization.

Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) model (figure 3.2). This UTAUT model is based on eight models in the field of acceptation and adoption of technology. The models used are:

- Theory of Reasoned Action
- Technology Acceptance Model
- Motivational Model

- Theory of Planned Behavior
- Combined TAM & TPB
- Model of PC Utilization
- Diffusion Of Innovation Theory
- Social Cognitive Theory

In an empirical study of the eight models Venkatesh et al. (2003) looked at which elements of the models clarify the most variance in the outcomes. The factors on the bottom (gender, age, experience and voluntariness of use) have a moderate influence on the effect of the factors on the left side.

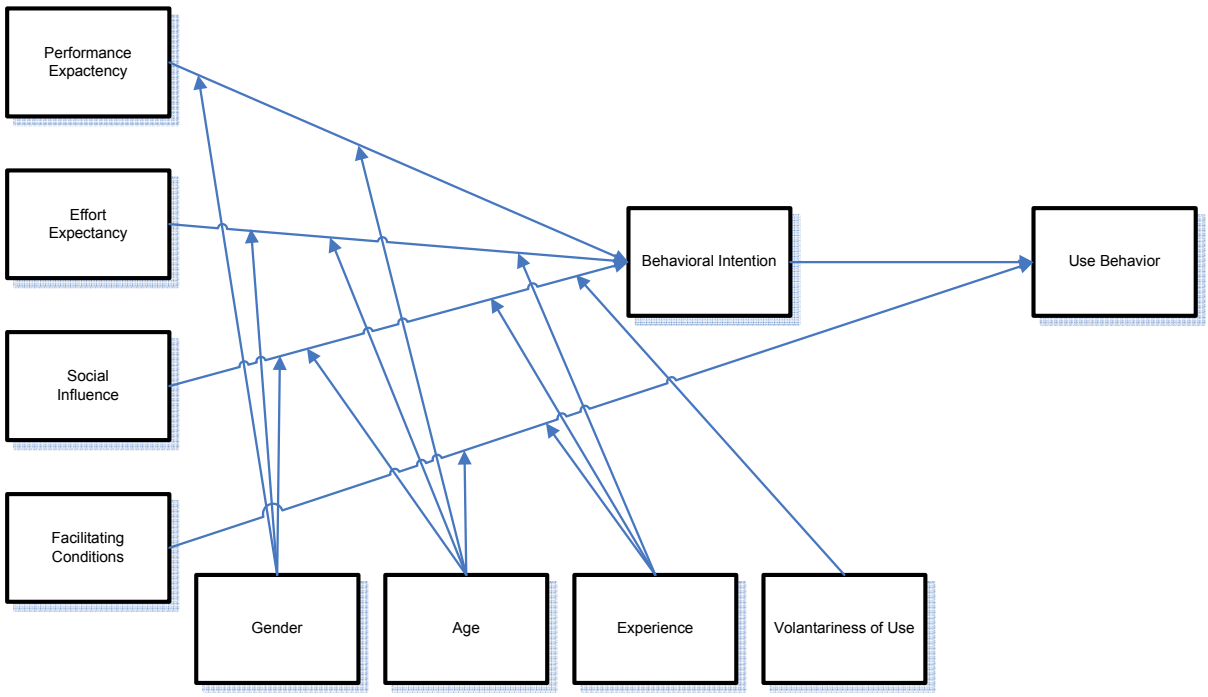

Figure 3.2: UTAUT model (Venkatesh et al, 2003)

3.1.2 Adopter categories

A main part of the diffusion of innovation theory is the S-shaped distribution curve. This curve illustrates the cumulative adoption rate of an innovation over time. According to this curve, the process of adopting an innovation is based on two important dimensions: The adoption rate and the diffusing time. In figure 3.3 can be seen that these factors are positively related to each other. On the vertical axle the level of adopters within a social system can be found. The horizontal axle shows the time they used to adopt the innovation.

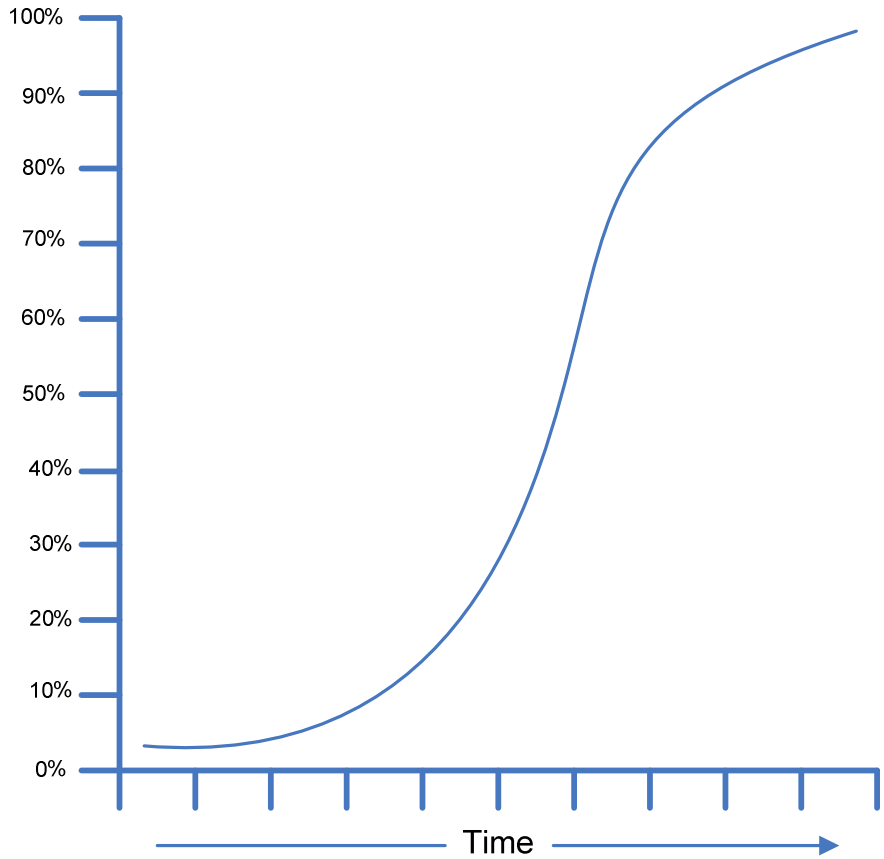

Figure 3.3: S-shaped diffusion curve (Rogers, 2003)

Based on the S-shaped distribution curve, Rogers (2003) distinguished five categories of adopters. The first 2,5% of the population that adopt the innovation are called **innovators**. This group is willing to take risks, have close contacts to scientific sources and innovators, are young of age, social, and have great financial lucidity. The **early adopters** are the second fastest category in the population who adopt the innovation. They represent 13% of the population and take a little more time before making the decision to adopt. They are very quick in recognizing advantages of the innovation. The characteristics of this group are comparable to the innovators. The **early majority** represents 34% of the population. They still can be seen as opinion leaders and their social status is above average. They take time to take an accurate look at the innovation before making the decision to adopt. The **late majority (34%)** adopts the innovation after the average group of the population has done this. They show great skepticism about an innovation, have little financial resources and mainly adopt the innovation to keep up the competition with the rest of the market. **Laggards** represent the final 16% of the population. These people can be seen as very traditional and conservative. They do not believe in the advantages of the innovation. They try to block the innovation as long as possible or do not adopt the innovation at all.

3.1.3 Decision Making Unit

The decision-making unit (DMU) are the decision makers within an organization. They make decisions whether to adopt or reject innovations. The perception of an innovation by members of a DMU affects their evaluation of and propensity to adopt a new product (Ostlund, 1974; Tornatzky & Klein, 1982; Rogers, 2003). Many research have studied the roles in a DMU, which is also called a buying center. Webster and Wind (1972) found five roles that are involved in the DMU. They also found that more individuals can fulfill the same role or that an individual can fulfill more roles. The following roles in the DMU can be defined:

Users - The people in the organization who use the purchased products and services

Buyers - The people with formal responsibility and authority to contract with suppliers

Influencers- The people with influence the decision making process directly or indirectly by providing information and criteria for evaluating alternative buying actions.

Deciders - The people who choose among alternative buying actions

Gatekeepers - The people who control the flow of information and materials

In addition Rogers (2003) defines a role that has a great influence on the adoption of an innovation. He calls this the role of a champion. This person is a driving force behind an innovation. His enthusiasm can make an innovation works.

3.2 Adoption of RouteLint

Numerous studies have been done in the field of adoption of innovations in organizations. These innovation adoption theories must be specified to the adoption of RouteLint in the international railway industry. Not only the technological characteristics of RouteLint must be taken into consideration, but also at the fact that international borders will be crossed, and that the railway market still can be seen as a public organization. The general innovation adoption theory therefore needs to be supplemented with theories about cross-national adoption, and adoption in railway organizations.

3.2.1 Functional adoption considerations

Most theories are based on the functional adoption considerations. Rogers (2003) defines the perceived characteristics of an innovation. These characteristics can be found in the UTAUT model of Venkatesh et al. (2003) under the constructs, performance expectancy, effort expectancy, and facilitating conditions. Both of these theories can be applied when it comes to the functional adoption considerations.

3.2.2 Adoption of innovations by (public) organizations

ProRail is often still considered as a public organization. This is not strange, since all of their shares are still owned by the government. In Europe, ProRail is one of the leading organizations when it comes to the implementation of directive 91/440. Other European countries are even or behind with

the implementation of this directive, comparing to ProRail. Companies in the railway industry can therefore still be considered as public organizations.

Most scientific literature is about big commercial organizations. The railway organizations in the European Union can be considered as big, but none of them can be considered as commercial. For the adoption of RouteLint these characteristics and other factors, which are typical for public organizations, need to be taken into account.

Organizational characteristics of potential adopter

Characteristics of an organization do have an influence of the innovativeness of the organization. The more innovative an organization is, the more willing they are to adopt innovations. A qualifying factor for innovativeness is the size of an organization (Rogers, 2003). Large organizations have more possibilities to make free time, staff, and finances for the adoption and the introduction of the innovation. Another characteristic influencing the adoption decision, defined by Rogers (2003), is the formal structure of an organization. These characteristics refer to the degree of standardization, formalization, specialization, functional differentiation, and professionalization. System openness is the last characteristic defined by Rogers (2003). This characteristic stands for the openness and eye for innovations that are developed somewhere else. Also looks it at the space that is giving within an organization to experiment whit new ideas. They also call this the innovation power of an organization (Rogers, 2003: pp 411; Greenhalgh et al., 2004: 215, 220). A big organization, an organization structure that facilitates innovations and high system openness leads to a higher chance to adopt an innovation.

Political-governmental characteristics

Public organizations are called less innovative as private organizations. There is less or no competition, and these organizations are dominated by a bureaucratically culture in where standardization, formalization, stability, continuity, and equality are important values. These values can discourage individual initiative and risk taking (Schumpeter, 1994). However can public organizations be seen as innovative since they face political and social problems like: Aging of the population and ecological problems, but also media attention and the growing empowerment of civilians. These turbulences are for many public organizations an important incentive to innovate. Koppenjan et al. (1987) defines this as politicization.

Berry (1994) found out that companies are open for new innovations but they rather follow, and then be the first one to adopt. They are more sure that an innovation works and therefore more willing to adopt. Another fact out of the study of Berry (1994) is that public organizations that work closely with businesses in the private sectors have a higher rate of adoption. This is confirmed by Koppenjan et al. (1987), who found that good contacts with professional networks lead to a shared professional standard.

3.2.3 Cross-national adoption

The fact that RouteLint is aiming on to get adopted on foreign markets is another factor that must be taken into account. Beyond borders has to be dealt with different cultures. A study conducted by Van Everdingen & Waarts (2003) showed that national culture have a significant influence on adoption. They used two of the dominant culture theories. One theory is the five culture dimensions defined by Hofstede (2001), which describe aspects of national culture. These dimensions are: power distance, masculinity, long term orientation, individualism and uncertainty avoidance. The other is the distinction made between cultures defined by Hall (1976). Hall (1976), distinguish monochromic vs. polychromic cultures and cultures with a high context vs. low context. Van Everdingen & Waarts (2003) and Png et al. (2001) used these dimensions in studies for cross-national adoption of innovations in the business-to-business context. Png et al. (2001) only looked at uncertainty avoidance and power distance dimensions defined by Hofstede (2001), while Van Everdingen & Waarts researched them all.

The dimensions, high level of uncertainty avoidance and power distance have a negative influence on adoption in a country. Countries with higher levels of long-term orientation, individualism, and masculinity have a significantly positive influence. This is concluded by the research of Everdingen & Waarts (2003) and Png et al. (2001). They said that even within the European Union, large cultural differences exist that affects the adoption of innovations.

Power Distance Index (PDI)

Countries with a high power distance are often characterized by centralized decision structures, authority and the use of formal rules. Hierarchy constrains sharing of information. Zmund (1982) found that there are low rates of innovation adoption associated with high levels of centralization and formalization. This could be, due to the fact that in high-centralized organizations top management is not always able to identify operational problems. Also may subordinates may take less initiative to discuss and consider the introduction of new products within the company. Png et al. (2001) and Everdingen & Waarts (2003) found that this dimension has a negative influence on the adoption of innovations.

Uncertainty Avoidance Index (UAI)

The uncertainty avoidance index stands for the level of the acceptance of new technologies by the company. Companies with a high score in the UAI in general show characteristics such as resistance to innovations, constraining of innovations by rules and a highly formalized management (Hofstede 2001). They will not take unnecessary risk and only adopt innovations if their value has already been proven in the market. In the study of Png et al. (2001) and Everdingen & Waarts (2003) there is a negative correlation with the adoption of innovations.

Individualism index (IDV)

This dimension according to Hofstede (2001) describes the relation between the individual and the group. In collectivistic countries one act conforms to the norms of the group. Furthermore, organizations in collectivistic cultures are characterized by collective decisions, which may lead to a delay in the adoption decision process. In contrast, in individualistic countries people make their own choices. Everdingen & Waarts (2003) found a positive relation between a high level of individualism and the adoption of innovations.

Masculinity Index (MAS)

A high level of masculinity stands for a high degree of masculine workers. Masculine cultures stand for ambition, competition, material values and the focus on performance. Feminine cultures are characterized by values like equity, solidarity, social relationship and managers' use of intuition and seeking consequences. A masculine culture emphasis is on rewards and recognition of performance, and furthers, on training and improvement of the individual, both characteristics that are common to innovative organizations. The study of Van Everdingen & Waarts (2003) showed a positive relation between a high MAS index and the adoption of innovations.

Long-Term Orientation index (LTO)

This dimension are characterized in cultures by values like persistence, adaptations of traditions to new circumstances, personal adaptability, and the idea that most important event in life will occur in the future. In line with this, it is expected that companies with a high level of LTO, be more receptive to changes than companies with a short-term orientation. In the study of Van Everdingen & Waarts (2003) there is a positive relation found between a high degree in the LTO index and the adoption of innovations.

Low- versus high-context culture

Hall (1976) makes differences between high and low context cultures. A low context culture is a culture where an innovation is studied based on reports and explicit messages. These countries are the early adopters, because there is no more information available. In table 3.1 gives an overview of the countries with a low- and high-context culture and it summarizes the characteristics of these two cultures. A high context culture seeks knowledge in the personal network. They take decisions based on facts; these facts can only be seen as the innovation is already implemented in other businesses. These companies will be seen as late adopters. Van Everdingen & Waarts (2003) found that low context cultures have a higher rate of adoption.

Scale	Score	Countries	Characteristics
Low	1	German Swiss, Austrians	Message is made explicit
context	2	New Zealanders, South Africans	Interpretation of messages rests on the
	3	North Americans and Canadians	written or spoken word focus on content
	4	Scandinavians, Finns	Seek information from a research base
	5	British, Australians	reports, databases, internet, etc.)
	6	Benelux people	
	7	Other American cultures	
	8	Slavs	
	9	Central Europeans	Interpretation of messages rests on
	10	Koreans, South East Asian	contextual cues
	11	Indians, and other	Seek information from personal
		Indian sub continent	information networks
	12	Arabs, Africans	Becoming well informed about the facts
	13	Latin Americans	before making a decision
	14	Italians, Spanish, Portuguese,	
		French, Other Mediterranean people	
High	15	Chinese	
context	16	Japanese	

Table 3.1: Low- and High-context countries and their characteristics
Based on (Morden, 1999; Kotabe and Helsen, 2001)

Monochromic versus polychromic cultures

Van Everdingen & Waarts (2003) used another distinction of Hall (1976). This distinction is based on a culture's attitude towards time. Hall (1976) distinguishes a monochromic and a polychromic notion in time. Monochronic cultures are more focussed, well organized, punctual and do one thing at a time. Polychronic cultures are less organized, do many things at one time and are less punctual. Everdingen & Waarts (2003) found that countries that tend to be monochromic are more likely to adopt an innovation than polychromic cultures do. In table 3.2 gives a classification of the countries of either monochromic or polychromic, plus the characteristics of these two different types of cultures.

Scale	Score	Countries	Characteristics
Mono-chronic	1	German Swiss, Austrians	Plans ahead methodically
	2	Americans	Does one thing at a time
	3	Scandinavians, Finns	Punctual
	4	British, Canadians, New Zealanders	Stick to plans
	5	Australians, South Africans	Stick to facts
	6	Japanese	Gets info from statistics, reference
	7	Dutch, Flemish Belgian	books, database
	8	Other American cultures	Works with department
	9	French, Walloon Belgian	Focussed communication, to the point
	10	Koreans, Taiwanese, Singaporeans	Writes memoranda, uses written record
	11	Czechs, Slovakians, Slovenians,	Plans grand outline / "vision"
		Croats, Hungarians	Does several things at once
	12	Chinese	Unpunctual
	13	Northern Italians	Changes plans
	14	Chile	Juggles facts
	15	Other Slavs	Get first-hand oral information
	16	Portuguese	Goes round all departments
	17	Spanish, Southern Italian	Talks for hours
		Other Mediterranean people	Dislikes writing too much,
	18	Indians, and other	prefers flexibility to commitment
		Indian sub continent	
Poly-chronic	19	Polynesians	
	20	Latin Americans, Arabs, Africans	

Table 3.2: Monochronic and Polychronic countries and their characteristics Based on (Morden, 1999; Kotabe and Helsen, 2001)

3.3 Model choice

This paragraph shows the conceptual model that is developed out of the theories generated for this specific subject. This conceptual model is a summary of the theories discussed before.

The fundament of the conceptual model is formed by two theories. These are the DOI of Rogers (2003) and the UTAUT of Venkatesh et al. (2003). These two models explain the process of adoption or the outcome. In the UTAUT model of Venkatesh et al. (2003), organizational use and the role of decision makers play an important role. It is very concrete, when it comes to other factors to clarify the behavioral intention (adoption or rejection) of the individual. The DOI theory forms a model on meso or macro level to explain the acceptance of big groups of "receivers". It takes time into consideration when it comes to adoption or rejection. Rogers (2003) distinguishes the adopters with the help of the earlier discussed adopter categories.

The DOI theory of Rogers (2003) is only tested at technological innovations in the private sector. The limited research that has been done is only conducted in the United States (Berry & Berry, 1990). The DOI does not really give answer the question why an organization adopts or non-adopts. There is only a little attention for the motives why an organization adopts or non-adopts (Greenhalgh et al., 2004: 48)

To get better insight in the adoption intention of railway organizations in the railway industry, the UTAUT model will be the best applicable. This model is the most concrete when it comes to name other factors that influence behavioral intention, adoption or rejection, of an individual. Kuan & Chau (2001) agree that behavioral intention influences the perception of the decision taker. Other factors that they name are perceived technological advantage, perceived organizational sources en perceived social influence. In the model of Venkatesch et al. (2003)

The Unified Theory of Acceptance and Use of Technology, has four constructs that determine the outcome of the behavioral intention or use behavior. The four constructs formed by Venkatesch et al. (2003) are a group of other variables formulated in other studies. These constructs are: Performance expectancy, effort expectancy, social influence and facilitating conditions.

A limitation of the UTAUT model is that the model is designed to explain the degree of use behavior. This is of relevance when RouteLint would already be adopted, which is not the case. The variable facilitating conditions in the UTAUT model has a direct influence on use behavior. This is questionable. It is a variable that has influence on the decision to adopt or non-adopt. But it might also have a direct influence on the behavioral intention. In the railway industry there are many different techniques used. If it is not possible for RouteLint to work in that country's system, facilitating conditions has a direct influence on the intention to adopt. Also might facilitating conditions correlate with other variables in the model that explain the intention to adopt.

The effects of these constructs in the original UTAUT model are moderated by the variables age, gender, experience and voluntaries of use. These variables are all deleted out of the model. Gender is in his own way measured by the factor, which involves cross-national adoption. The age variable will

be deleted out of the model, since the cross-national adoption theories and public organization adoption theories do not mention this variable and due to the fact that this variable is especially meant to measure a big group of users. Voluntaries of use will not be taken into consideration. Organizations are not forced to use RouteLint, what makes it unnecessary to measure this variable. The experience variable cannot be measured in this research. In the UTAUT model Venkatesh et al. (2003) manipulate the experiment at several moments in time. Due to the fact that it is not possible to do this, the experience variable will not be measured. Another fact is the expectation that not many respondents can and will respond in this research, it will be hard to measure moderating variables. This also influences the decision to take these variables out of the model.

Another modification to the model is a new independent variable. This is the variable innovativeness of organizations. Innovativeness of organizations is expected to influence the adoption intention. This is especially the fact since this research deals with organizations that can be matched with public organizations, which are called less innovative.

The cross-national adoption consideration is not taken into the model. Instead the model will be applied on the target countries that will be described in chapter 4. The theories on cross-national adoption are too extensive to convert it to one factor. Another fact is that the theory made clear that even within Europe there are major differences between the countries. Therefore, the model will be applied on every target country itself.

Based on this information and by taking the influence of adoption of public organizations plus the fact that RouteLint will cross national borders a conceptual model is build (figure 3.4). This model is based on constructs that deal with the issues covered before, in order to adopt RouteLint.

Performance expectancy presents the believe of the organization that RouteLint improves the performance of the organization compared to the current situation. Performance expectancy in this research is determined by relative advantage, job-fit and, perceived usefulness.

Effort expectancy presents the believe of the organization that RouteLint is easy to get to know and the level of ease concerning the use of RouteLint compared to the current situation in the organization. Effort expectancy is determined by perceived ease of use and complexity.

Social influence is the degree of influence that the social environment has on the organization on the use of RouteLint. Social influence is determined by the subjective norm, social factors, and imago.

Facilitating conditions presents the level of believe of the organization, that the organization supports RouteLint with its resources, knowledge, technology and the compatibility to the way the

organization likes to work. Facilitating conditions is determined by perceived behavioral control and compatibility.

Organizational innovativeness presents the openness for new ideas and innovations by the whole organization.

Adoption Intention is the dependent variable of this conceptual model. It is the subjective purpose of the organization to adopt RouteLint. Adoption intention is also considered to determine the actual adoption of RouteLint into the organization Adoption intention is measured by attitude towards behavior and intrinsic motivation.

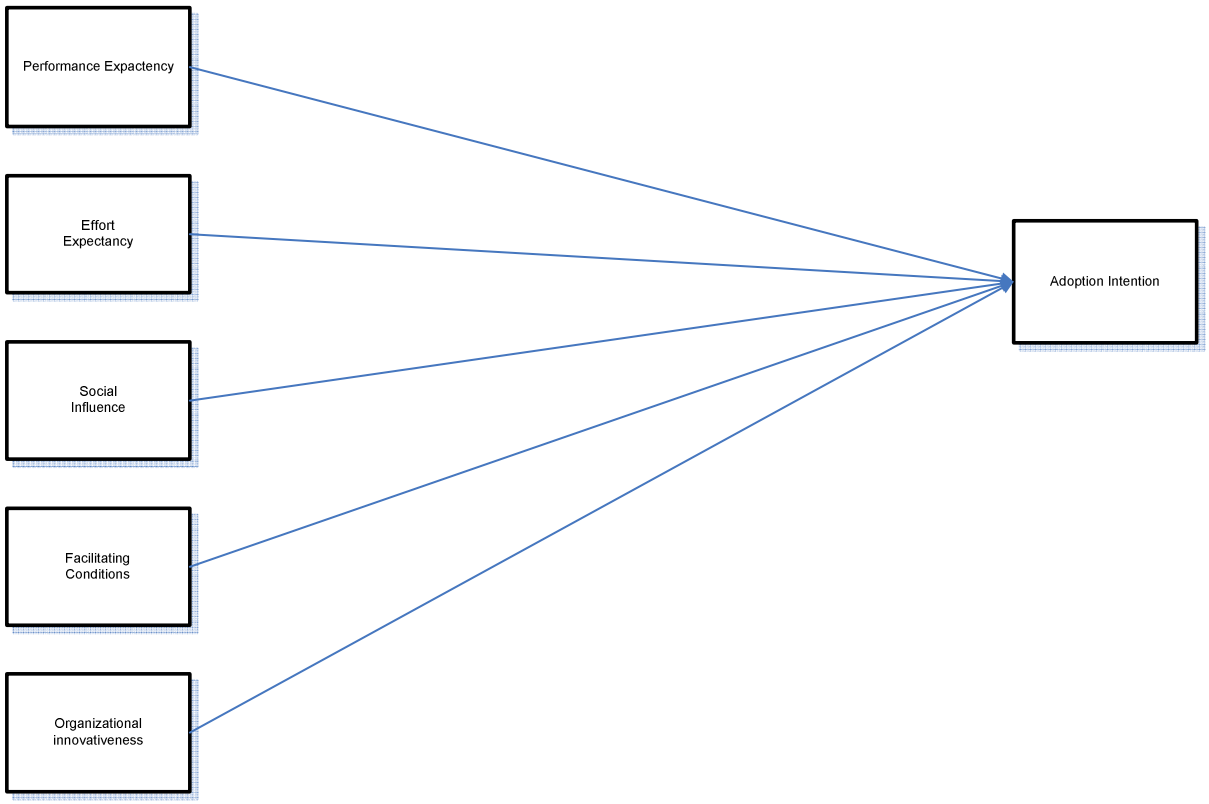

Figure 3.4: Conceptual model for the adoption of RouteLint

3.4 Entry modes

In the end, ProRail want to know what the consequences of the adoption factors are on the market entry mode. Therefore, a closer look must be taken on the different modes of entry.
Root (1994) discusses three different modes of entry, which now will be discussed.

Export entry modes

Exporting is the marketing and direct sale of domestically produced goods in another country. Exporting is a traditional and well-established method of reaching foreign markets. Since exporting

does not require that the goods be produced in the target county, no investment in foreign production facilities is required. Most of the costs associated with exporting take the form of marketing expenses.

Contractual entry modes - Licensing

Licensing essentially permits a company in the target country to use the property of the licensor. Such property usually is intangible, such as trademarks, patents, and production techniques. The licensee pays a fee in exchange for the rights to use the intangible property and possibly for technical assistance. Because little investment on the part of the licensor is required, licensing has the potential to provide a very large ROI. However, because the licensee produces and markets the product, potential returns from manufacturing and marketing activities may be lost.

Investment entry modes - Joint Ventures

There are five common objectives in a joint venture: market entry, risk/reward sharing, technology sharing and joint product development, and conforming to government regulations. Other benefits include political connections and distribution channel access that may depend on relationships.

Investment entry modes - Foreign Direct Investment

Foreign Direct Investment (FDI) is the direct ownership of facilities in the target country. It involves the transfer of resources including capital, technology, and personnel. Direct foreign investment may be made through the acquisition of an existing entity or the establishment of a new enterprise. Direct ownership provides a high degree of control in the operations and the ability to better know the consumer and competitive environment. However, it requires a high level of resources and a high degree of commitment.

In table 3.3 an overview is given about the several entry modes, the conditions that favors a specific entry mode, the advantages and the disadvantages.

Mode	Conditions Favoring this mode	Advantages	Disadvantages
Exporting	- Limited sales potential in target country; little product adaptation required - Distributions channels close to plants - High target country production costs - Liberal political risk	- Minimizes risk and investment - Speed of entry - Maximizes scale: uses existing facilities	- Trade barriers & tariffs add to costs. - Transport costs - Limits access to local information - Company viewed as an outsider

Licensing	- Import and investment barriers - Legal protection possible in target environment - Low sales potential in target country - Large cultural distance - Licensee lacks ability to become a competitor	- Minimizes risk and investment - Speed of entry - Able to circumvent trade barriers - High ROI	- Lack of control over use of assets - Licensee may become competitor - Knowledge spillovers - License period is limited
Joint Venture	- Import barriers - Large cultural distance - Assets cannot be fairly priced - High sales potential - Some political risk - Government restrictions on foreign ownership - local company can provide skills, resources, distribution network brand name, etc.	- Overcomes ownership restrictions and cultural distance - Combines resources of 2 companies - Potential for learning - Viewed as insider - Less investment required	- Difficult to manage - Dilution of control - Greater risk than exporting & licensing - Knowledge spillovers - Partner may become a competitor
Direct Investment	- Import barriers - Small cultural distance - Assets cannot be fairly priced - High sales potential - Low political risk	- Greater knowledge of local market - Can better apply specialized skills - Minimizes knowledge spillovers - Can be viewed as an insider	- Higher risk than other modes - Requires more resources and commitment - may be difficult to manage the local resources

Table 3.3: Characteristics of the different entry modes, based on Root (1994)

Root (1994) says that the choice of entry mode is based on the external and internal factors. The external factors are factors that come from outside the company. This can be the competitive structure of the target market, policies, economy and cultural distance. Internal factors show how a company responds to the external factors when choosing an entry mode. Internal factors can be related to the product, whereby they look at what kind of product it is, and if it has a high adaptation rate. There are also internal factors related to the resources and commitment of the company. A large company has usually more resources and more commitment to make a product a success on the foreign target market.

4. Research methodology

In this chapter the research method that are used to give a reliable and valid answer to the research questions will be presented. First, the research population for this research is described. With segmentation criteria from ProRail and the theory a target population is defined. After, the methods that will be used to gather the data are described. The first method is a pilot interview that must help to develop the questionnaire for the second method, the survey. After the survey data is collected, a follow up interview will be held to make sure there is sufficient and complete data. The methods are based on the conceptual model developed in the theoretical framework and must lead to the answers of the research questions.

4.1 Research population

To do further research about adoption in the target market, first this market must be defined according to phase 1 in the model of Root (figure 1.1). The target market is defined based on criteria and preferences of ProRail. The European Union is taken as research area. The companies in these countries all deal with the implementation of directive 91/440. In other words, this market should be competitive. Furthermore these companies are close to ProRail's home market, The Netherlands, what can make it more convenient for ProRail.

The European Union exists out of 29 countries. Cyprus and Malta do not have railways and are therefore on forehand eliminated out of the research population. The countries that will be selected are based on criteria and preferences selected by ProRail. These criteria and preferences are set based on the fact if RouteLint has a good chance to perform in that country or not.

The following criteria apply to define the market segment that is interesting for the marketing of RouteLint:

- Is directive 91/440 applied. If this directive is not applied, the country has no railway infrastructure or otherwise no competitive railway market.
- Are there multiple operators in that country? Multiple operators equal competition in that railway market. RouteLint must give a competitive advantage for operators using this system. By multiple operators, an operator can achieve competitive advantage by using RouteLint.
- The country must have the same or more mixture of passenger kilometers divided by good kilometers. A high degree of passenger and good trains makes RouteLint more interesting for potential customers. Since good trains are slower, multiple train passing will take place.

In the table 4.1 an overview is given of the countries in the European Union and how they are selected on the stated criteria.

	Criteria							
			Passengers	Goods				
Countries	Dir. 91/440	Multiple op.	PKm	TKm	Total	> 1,609	RouteLint ready	
1 The Netherlands	x	x	15546	9.661	1,609	x	X	Netherlands
2 Austria	x	x	9051	19.442	0,466	x	X	Austria
3 Belgium	x	x	9932	8.149	1,219	x	X	Belgium
4 Bulgaria	x	x	2424	4.711	0,515	x	X	Bulgaria
5 Cyprus	0	0	0	0	-	0		
6 Checz Republic	x	x	6855	15.241	0,450	x	X	Checz Republic
7 Denmark	x	x	5724	0	-	0		
8 Estonia	x	x	273	8.153	0,033	x	X	Estonia
9 Finland	x	x	3778	10.434	0,362	x	X	Finland
10 France	x	x	83299	42.435	1,963	0		
11 Germany	x	x	74740	91.013	0,821	x	X	Germany
12 Greece	x	x	1954	829	2,357	0		
13 Hungary	x	x	213	564	0,378	x	X	Hungary
14 Ireland	x	x	2007	129	15,558	0		
15 Italy	x	x	46456	22.320	2,081	0		
16 Latvia	x	x	983	16.735	0,059	x	X	Latvia
17 Lithuania	x	x	409	14.373	0,028	x	X	Lithuania
18 Luxembourg	x	x	316	287	1,101	x	X	Luxembourg
19 Malta	0	0	0	0	-	0		
20 Poland	x	x	17081	43.548	0,392	x	X	Poland
21 Portugal	x	x	3610	2.585	1,397	x	X	Portugal
22 Romania	x	x	0	1.478	0,000	0		
23 Slovakia	x	x	2148	0	-	0		
24 Slovenia	x	x	812	3.603	0,225	x	X	Slovenia
25 Spain	x	x	20946	11.049	1,896	0		
26 Sweden	x	x	6467	0	-	0		
27 United Kingdom	x	x	48448	8.120	5,967	x		United Kingdom

Table 4.1: Country selection based on ProRail's preferences

Based on these criteria, the following fifteen countries are interesting for ProRail to bring RouteLint to that market:

Austria, Belgium, Bulgaria, Czech Republic, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovenia and the United Kingdom.

4.1.1 The European Union and adoption

According to the studies of Van Everdingen & Waarts (2002), Png (2001), Hall (1976), and Hofstede (2001) there are several differences between countries within the European Union. This can be compared with the s-shaped curve out of the DOI theory of Rogers (2003), whereby early adopters show different behavior than late adopters do. Because of the low expected number of respondents, the European Union will be divided into two extremes. One extreme will exist out of countries that are open for new technologies and can be compared with the early adopters in the DOI theory. The other group exists out of countries that are very traditional and are skeptic about innovations. The DOI theory describes these as late majority or laggards. These studies are based on commercial organizations in Europe. As the introduction of this research make clear, railway organizations still see themselves as public organizations, while they in fact must be commercial. Before looking at the

intention to adopt, first will be checked if the patrons defined by among others Van Everdingen & Waarts (2002) can also be applied on railway organizations. With hypothesis it will be checked if railway organizations can be equaled to the commercial organizations out of the original research.

With the results of Van Everdingen & Waarts (2002), Png (2001), Hall (1976), and Hofstede (2001) a list is developed to distinguish the two extremes. The first group is called early adopters and has the characteristics of innovators, early adopters or early majority (Rogers, 2003). The second group is called late adopters, and has the characteristics of the late majority or laggards as defined by Rogers (2003). In table 4.2 an overview can be found with the criteria that are set to define the two extremes and how the countries in the European Union are divided over the two groups. The scores of the countries, which are already pre-selected by ProRail's criteria, are measured against the mean of that score on that factor. This score is then translated into early or late adopters. The total scores of all the factors involved, makes a country early or a late adopter.

4.1.2 The early adopter extreme

On the early adopter extreme are countries who are open to adopt and also can be found by the early adopters or early majority as defined by Rogers (2003). Four of the respondents came from countries that match this profile. These countries are: Austria, United Kingdom, Finland and Germany. To test if these counties match the commercial organizations that are used in previous studies, a hypothesis is stated. This hypothesis, which is based on the theory discussed in chapter 3, is tested by the data collect later on in this research. The following hypothesis for the early adopter extreme is stated:
"Railway organizations in high adoption rate countries have comparable adoption characteristics as commercial organizations in these countries".

4.1.3 The late adopter extreme

The late adopter extreme deals with the countries that are not really open to new ideas. These countries can be described as organizations that fall in the category late majority or laggards (Rogers, 2003). Two typical cases in this area are the case of the Czech Republic & Hungary and the case Portugal. The following hypothesis for the late adopter extreme is stated:
"Railway organizations in low adoption rate countries have comparable adoption characteristics as commercial organizations in these countries".

Country	II (+)	PDI (-)	MI (+)	UAI (-)	LTO (+)	Monochronic vs Polychronic	Low vs High context	Early adopter points	Late adopter points	Early or Late Adopter
Austria	E	L	E	L	E	E	E	5	2	**Early**
Belgium	E	L	E	L	L	E	E	4	3	**Early**
Bulgaria	E	L	E	L	L	L	L	2	5	**Late**
Czech Republic	E	L	E	L	L	L	L	2	5	**Late**
Estonia	E	L	E	L	L	L	L	2	5	**Late**
Finland	L	E	L	=	E	E	E	4	2	**Early**
Germany	E	L	E	L	E	E	E	5	2	**Early**
Hungary	E	L	E	L	L	L	L	2	5	**Late**
Latvia	E	L	E	L	L	L	L	2	5	**Late**
Lithuania	E	L	E	L	L	L	L	2	5	**Late**
Luxembourg	L	L	E	L	E	E	E	4	3	**Early**
Poland	E	L	E	L	L	L	L	3	5	**Late**
Portugal	L	L	E	L	L	L	L	1	6	**Late**
Slovenia	E	L	E	L	L	L	L	2	5	**Late**
United Kingdom	E	E	E	E	L	E	E	6	1	**Early**

Table 4.2: Early vs. late adopters based on Van Everdingen & Waarts (2002), Png (2001), Hall (1976), and Hofstede (2001

Countries that can be classified as more innovative and therefore as early adopters are:

1. United Kingdom
2. Austria
2. Germany
3. Finland
4. Belgium
4. Luxembourg

The United Kingdom can be seen as the most innovative on the early adopter extreme, while Belgium and Luxembourg are the lowest on the early adopter extreme. A typical case for the early adopter extreme is the United Kingdom. Austria, Germany, and Finland also score relatively high on this extreme. Belgium and Luxembourg just score high enough to belong to this group.

On the late adopter extreme the countries can be qualified as follow:

1. Portugal
2. Bulgaria
2. Czech Republic
2. Estonia
2. Hungary
2. Latvia
2. Lithuania
2. Poland
2. Slovenia

Portugal here can be seen as the extreme for a late adopter. All the other countries score the same points for late adopters, but still score high on this extreme to be considered as one. The hypotheses for both extremes are tested with the help of the research methodology that is described in the next paragraphs

4.2 Research method

Out of the shortlist, six countries were selected to participate in this study. Each of these six countries could be assigned to the early or late adopter extreme, both extremes represented a case. With the help of a questionnaire and follow up interviews the cases were tested and in the end compared.
Since there were only little respondents, it was not possible to test the model. Therefore the model was applied on the countries.

4.3 Data collection method

There are various factors that must be measured. The factors of this research exist out of the perception of people in other railway organizations. A quantitative research with the help of survey's can here for be used (Swanborn, 1994). This is in line with the method Venkatesh et al. (2003) use. Their developed UTAUT-model is proposed based on a research with surveys.

Surveys
The main objective of a survey is to gain an overall picture of a comprehensive phenomenon. Characteristics of a survey are: large numbers of respondents, more broad than depth, random sample, and quantitative data analysis. Often the goal of a survey is to generalize to the whole population.

For the main part of the research a questionnaire is developed. The construction of this questionnaire is based on the conceptual model developed in the theoretical framework. This questionnaire is filled in by individuals working in the railway industry trough Europe. Since ProRail describes the railway industry as difficult to approach, it was very hard to get a fair amount of respondents. Also could only the DMU roles of influencers or gatekeepers, as defined by Webster and Wind (1972), be reached to fill in the questionnaire.

Construction
The survey questions are divided into seven subjects: Introduction, performance expectancy, effort expectancy, social influence, facilitating conditions, organizational innovativeness and adoption intention. The introduction subject covers the background of the respondent. It asks for his position in the organization, his innovativeness the influence he has in the organization, shared problems, and how the environment influences the organization. These questions can be open ended, multiple-choice or can be measured with a 5-point Likert-scale. All the other subjects are constructs that can

be measured with the help of items. These items can all be measured with a 5-point Likert-scale. A 5-point Likert-scale measures questions on a scale from 1 to 5. By answering 1 to an item, the respondent strongly disagrees with the item. A 2 agrees. By filling in 3 the respondent neither disagrees nor agrees, while 4 agrees and by filling in a 5 the respondent strongly agrees on the item.

All the respondents of the questionnaire fulfill either an influencing or gate-keeping role in the organization. Most of the respondents are innovators and visitors of European congresses were new ideas are shared. These people can therefore be called innovative. With four items is asked about the innovativeness of the respondent. These items can be compared with innovative attitude of the top-management. There are also three items that ask for problems in the respondent's organization. RouteLint is developed to solve three main issues (electricity, communication, and punctuality). Three items check these issues. With these items is checked if they deal with the same issues that ProRail deals with and it can help explain some of the answers that are given.

Pilot interview

Before the final questionnaire was send out, pilot interviews were held to test the current questionnaire. The theories of Venkatesh et al. (2003) are developed for adoption of an individual. This research aims at adoption on an organizational level. Another fact is the various number of other theories that are involved, which may not be clear to the respondent. Questions can for an outsider be vague or not understandable. The questionnaire was tested and replenished with the results of the pilot interviews.

Two ProRail insiders and two people in the European railway organization were asked to fill out the pilot interviews. These people can be matched to the research population, who are asked to fill out the final questionnaire. The people in the pilot interviews tested if the questions in the questionnaire are understandable, relevant and complete. After de pilot interviews, 3 questions were changed into 5-point Likert-scale answer options. In the introduction subject two additional questions were added.

Final questionnaire

A web-based survey was chosen as format for the questionnaire. The advantage of this method has relative low costs and quick response compared to written survey. Another advantage is that the respondent is not influenced by the interviewee. This web-based survey is developed with the help of www.thesistools.com. The final questionnaire can be found in appendix II.

4.4 Data collection & -analysis techniques

The data that is generated by the survey questionnaires is punt into a table for further analysis. This analysis includes a follow up interview with the respondents. These follow up interviews are held to gather additional qualitative data and ask for background information of the answer to some questions. This qualitative data must give the research more body. For this method is chosen since

there where only a few respondents. The few respondents make it not possible to quantify the model. In the follow up interview questions was asked about the several factors and the answers they gave to questions on the questionnaire. This all together must lead to a fair amount of data, to give answer to the research questions.

4.5 Follow-up interviews

The follow-up interviews were held with the respondents of these questionnaires. These interviews were held face-to-face or by phone. The interviews can be characterized as semi-structured and unconstraint by time. During these interviews, the results of the questionnaire were reviewed and there was asked for patrons that have come forth out of the answers of the questionnaire. This qualitative method was used since the answers of the questionnaire could not be presented in numbers in a meaningful way (Lekvall & Wahlbin, 1993). This method, which often is carried out by interviews, has the possibility to find interdependencies between variables and to get a holistic view of the studied problem. In appendix III an overview can be found of the questions that were asked in the follow-up interviews.

5. Results

This chapter discusses the results forthcoming out of the surveys and the interviews as described in the research methodology chapter (chapter 4). These results are analyzed and lead to the answers of the remaining research questions, which will be discussed in the conclusion chapter (chapter 6). First, an overview is given of the respondents. Then, the answers of the respondents to the survey are described. After, the results of the follow-up interviews are discussed in combination with the survey results. All the results are divided over the early- and a late- adopter group, whereby both stated hypothesis will be tested. This chapter ends with an comparison of the early- and late –adopter group.

5.1 Respondents

After having send out the questionnaire two times, all possible data was gathered for the surveys. There were six respondents who took time and effort to fill in the questionnaire. An overview of the respondents can be found in table 5.1

Country in which the organization operates	# Employees	Function of the respondent	Function of Respondent in the DMU
Austria	25 000	Head Process and Methods	Gatekeeper
United Kingdom	35 000	Research Specialist (engineering)	Influencer & Gatekeeper
Finland	10 000	Energy Advisor	Influencer & Gatekeeper
Germany	240 000	Program Manager	Gatekeeper
Czech Republic, Hungary	12 000	Investment Analyst	Gatekeeper
Portugal	4 000	Program Advisor	Gatekeeper

Table 5.1: Respondents to the questionnaire

5.2 Other questionnaire results

Next to the Likert-scale questions, which test the five constructs, there were also some multiple choice and open-ended questions. The multiple-choice questions asked about the structure of the DMU and how the DMU was influenced. The open-ended questions ask about general information about the respondent and the company. To test the innovativeness of the respondent there were some questions about its attitude towards new ideas. In the end the adoption intention is checked by Likert-scale questions.

The respondent in the DMU

All respondents had a role in the DMU. All of them were gatekeepers, some of them also had an influencer role in the DMU. These persons do not make decisions in the organizations but make other people in the DMU aware about new products and trends (Webster & Wind, 1990).

Innovativeness of the respondent

With the question related to system openness (Rogers, 2003), is among others asked how open the respondent is to innovations from outside the regular supplier network. All respondents scored far above average on this item. The scores on this item can be found in table 5.2. The respondents from Finland and the United Kingdom both score the maximum of 5. Germany scores a 4,33 and all others score 4. These scores are higher than the scores of the innovativeness of the top-management of their organization. This is not a surprise, since the respondents all go to congresses in the European Union whereby new ideas and innovations are presented. It is there job to become aware of innovations, but also to present their own. This fact given, it must be taking in account that these people are more open to innovations then other people in the same organization do.

All countries agreed on the presence of ProRail's problems in their country. They all agreed to the questions asked about punctuality, energy efficiency, and a communication problem. The United Kingdom scores the highest on these items with the maximum of 5. Finland scores the lowest with a 3,33, which agrees a little on these problems.

Respondent	Innovativeness of top-management	Innovativeness of respondent	Problem
United Kingdom	4	5	5
Austria	3	4	3,67
Finland	4,33	5	3,33
Germany	3	4,33	4
Czech Republic	3,67	4	4,67
Portugal	3	4	3,67

Table 5.2: Respondent innovativeness

5.3 Survey results

First, the results of the survey will be discussed. These results are all measured with a 5-point Likert-scale. The results for the constructs can be found in table 5.3. The mean score of every respondent in each construct is shown, plus a total of the two adopter categories, and an overall total.

The results coming out of the questionnaire show that most of the means are above the average of 3. Some of them are lower than 3 and some score the average of 3. However, differences can be seen

between countries on the several constructs and there are differences found between the several constructs in a country.

Early Adopter	PE	EE	SI	FC	IO	AI
United Kingdom	3,67	4,00	3,50	3,00	4,08	4,00
Austria	3,44	3,57	2,75	3,14	3,50	3,25
Finland	3,67	2,57	3,25	2,71	4,08	3,50
Germany	3,56	3,85	3,00	3,42	3,58	3,50
Ea mean	3,59	3,50	3,13	3,07	3,81	3,56
Late Adopter						
Czech Republic	3,56	3,57	3,00	2,85	3,33	4,00
Portugal	4,11	4,00	2,75	3,57	3,33	4,00
LA mean	3,84	3,79	2,88	3,21	3,33	4,00
Overall mean	3,67	3,60	3,04	3,12	3,65	3,71

Table 5.3: Means of the survey results

Figure 5.1 shows these scores when they are integrated into the model.

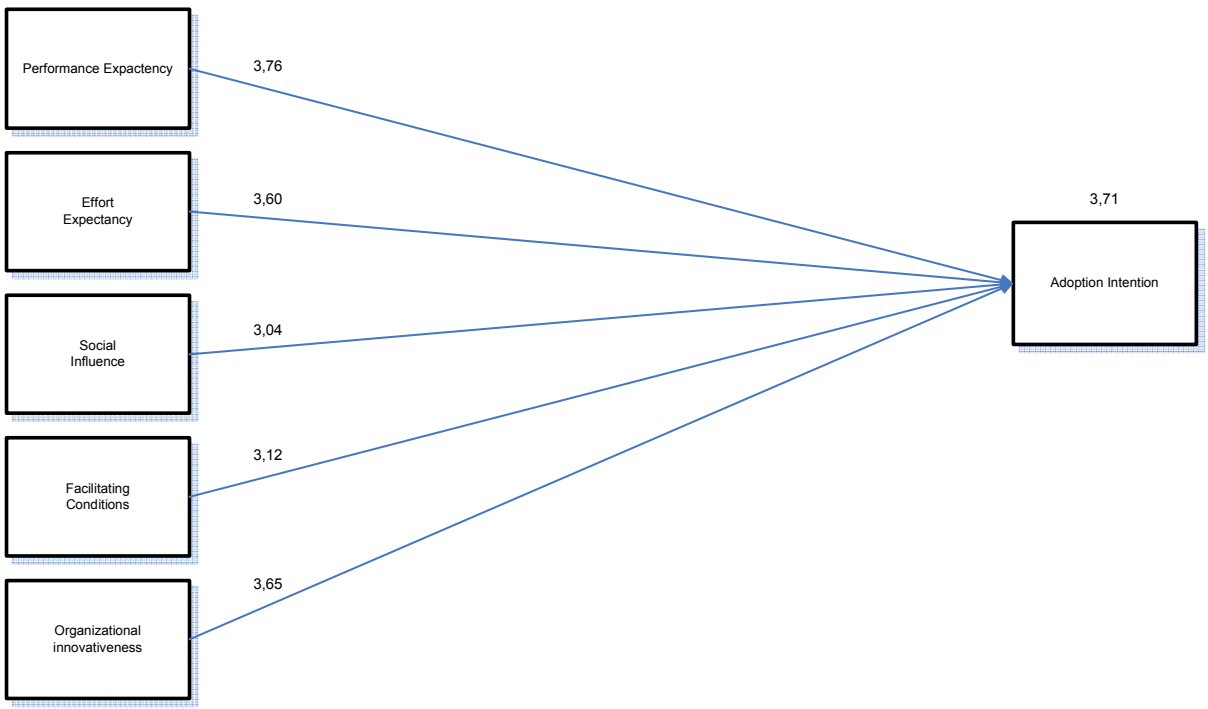

Figure 5.1 Values of the constructs in the conceptual model

5.3.1 The Early Adopters case

The construct **Performance Expectancy**, which asked the respondent to his expectation to the performance outcome of RouteLint, scored between the 3.44 and the 3.67. It shows that all countries

believe in the performance of this product on their job. The construct **Effort Expectancy** had mixed answers. Finland believed that RouteLint was difficult to understand and to get skilled at, while the United Kingdom scored high with an average of 4.00. The other two countries scored also above average with a 3.57 for Austria and a 3.85 for Germany. All of these three countries score on this construct higher then on the performance expectancy construct. **Social Influence** shows whole other figures. Austria scores below average with 2.75, while Germany with 3.00 has an average score and Finland and the United Kingdom score above average with 3.25 and 3.50. **Facilitating Conditions** is for ProRail one of the most important constructs. In this construct is among others checked if other European railway companies believe that Dutch technique is compatible with their system. The Finnish organization does not believe that Dutch technique will work in their system. The United Kingdom scores in the middle and does not know if it will work or not, Austria agrees with a score slightly above average and Germany agrees that it will be compatible to the way they work, with the highest score on this construct with 3.42. Interesting is the **Innovativeness of an Organization** construct. With scores between the 3.08 and the 3.33 all the countries score slightly above average. However do the respondents all score relatively high on the items system openness and size. The scores on these two items are around the 4. They score low on the items related to the formal structure of the company. It shows that the top-management is really open for new-ideas but that the company has high standardization, formalization, specialization, functional differentiation, and professionalization, what blocks the innovativeness of the top-management.

The measurements on the **Adoption Intention** construct show that the respondents agree that RouteLint is a good product and is a good idea for their organization. Striking is the fact that Finland does not agree on every construct but still has the intention to adopt RouteLint.

5.3.2 Late Adopters

Both the Czech Republic and Portugal agree on the fact that RouteLint is a system that can improve the performance on the job. Portugal scores higher on this construct than the Czech Republic, and agrees with the highest score overall on the **Performance Expectancy** construct. On **Effort Expectancy**, Portugal shows another high score, and the Czech Republic scores above average. It shows that both do they believe that the system is easy to use and understandable. On **Social Influence** the Czech Republic scores the average and Portugal below average. Especially Portugal scores lower than the earlier measured constructs, and they score lower on this construct than the early adopters do. The **Facilitating Conditions** construct scores below average for the Czech Republic, while Portugal scores relatively high. For **Organizational Innovativeness** they both score 3,33. What tells that their organization is innovative, and therefore open for adopting innovations. Also here can be seen that the top-management is more innovative then the company structure.

On the **Adoption Intention** construct, these two countries score relatively high. Were especially the Czech Republic scores higher than they did on the other constructs. It is surprising that these two countries scores high on several constructs, while according to the theory about cross-national adoption and late adopters (a.o. Van Everdingen & Waarts, 2003), they should not be this positive and open to innovations. Especially since they only have little information about RouteLint.

5.4 Follow up interviews results

For this research four out of the six questionnaire respondents were willing to participate in a follow-up interview. They gave their opinion about the results coming forth out of the questionnaire and their opinion about factors that could influence the adoption of a foreign innovation. Out of the early adopter group the countries Austria, the United Kingdom and Finland participated. In the late adopter group, the Czech Republic was willing to participate.

5.4.1 Early Adopters

Performance expectancy

The respondents out of the early adopter group all believed that RouteLint could enhance the performance on the job according to the questionnaires. The follow up interviews makes clear that they believe the system works, based on the factsheet and the test that have been done so far in the Netherlands. For all of the respondents, performance is called the most important factor, before they look at effort expectancy or facilitating conditions.

Effort Expectancy

The United Kingdom named ProRail one of the best, as not the best infra managers in Europe. They believe that if ProRail says that the system would be free of effort, they believe ProRail. Of course they do not just follow ProRail blind, but they believe in the test results of RouteLint. Austria therefore already uses an energy efficient device and knows how to work and implement it in the cabin. In contrast with the Finnish who never have worked with devices in the cabin. They are more skeptical when asking about the idea of having a device in their cabin and the expected effort. In line with the theory of Hall (1976), the United Kingdom relies on company document as an early adopting country, the Finnish however were a little more skeptical and show the behavior of a late adopter who first wants to see, before they believe. Because of past experience, this fact cannot be checked by Austria.

Social influence

The theory of Berry & Berry (1990), who found that public organizations adopt innovations when more of them have done that, could not be found in one of these organizations. Politicization as defined by Koppenjan et al. (1987) is another factor that cannot be found in the railway market. Influence by the social or political environment has only little influence on adoption decisions by these organizations. The social environment talks about the need for energy efficient products, but the

pressure to do this, is little. Austria and the United Kingdom both said that media and environmental groups rather come up with negative stories, instead of pressuring them to become better.

Facilitating conditions

The United Kingdom already adopted an inventive product developed by another railway organization in a foreign country. The difference with RouteLint was that this product is a stand-alone system that could be implemented in any railway infrastructure. Asking about technology, the respondents did not immediately say that the "Dutch" technology, ProRail used to develop RouteLint, would work in their system. The knowledge they had about RouteLint was therefore too little. The United Kingdom was the most enthusiastic, since they profiled their market as open to everyone. Austria made the comment that, since trains already drive form the Netherlands to Austria, this product could probably work for them. Finland was more skeptical since they did not have any proper knowledge yet. But all organizations said they needed more knowledge to give a proper answer to the question if RouteLint can be implemented based on technology. But no one immediately denied it. All respondents said that RouteLint is compatible with the way they work or like to work. All of them saw RouteLint fit into their work process in order to save energy. The Finnish respondent said, that in Europe we all work the same way and we want to achieve the same things, the problem is that right now most of us do this their own way with their own technology.

Organizational innovativeness

According to the survey, the top-management and the respondents are open for change and new ideas. They all score high on the item, attitude to change. However do they score relatively low on items like centralization and complexity. This contradicts within this construct. The top-management is really open for change, but the structure of the company prohibits this. The United Kingdom and Finnish organizations both exists out of various layers. The top-management exists out of people who come out diverse commercial organizations and do not necessarily have a railway background. They are all driven to reduce cost and make more profit. In the United Kingdom they work with the 4C-model, which stands for the four spear points in their organization; Costs, capacity, customer and carbon. They want to reduce costs, increase capacity, have more and satisfied customers and want to reduce the emission of carbon. RouteLint is something that fits into this 4C-model. The respondents also say that, because of the layers, the top does not know what is going on, on the bottom. They see it as a barrier, since they first have to make the top aware of the problem before they can come up with a possible solution to this problem.

Re-organizations

The organizations deal time-to-time with re-organizations. These re-organizations take place to improve the results of the organization, make the organization more flat or to increase the transparency of the organization. Re-organizations might be good for the organization in these ways, but for informal networks within the organization they are disasters. According to the United Kingdom

respondent, informal networks disappear after a re-organizations. People within the organization get other responsibilities and are on different positions. They have to build up their network again, and find out where to go and who is needed for particular thing. It takes time to figure out where to go.

Adoption Intention

All the countries that respondent in the follow-up interviews had the intention to adopt. Their intention to adopt was based on the information they had so far. They mainly made this decision on the performance- and effort- expectancy factor. They were skeptic about the technology what is measured under facilitating conditions, but did not see it as a main issue. Another factor that could have a negative influence on the adoption intention were the total costs of RouteLint.

Other factors

The United Kingdom respondent named the factor **language** as a factor that also influences innovativeness. Research is done by companies themselves but also by universities. Most of the research is done in English. According to the United Kingdom this gives them an advantage, same as countries in Northern and Western Europe. Southern and Eastern European countries have less English language skills. Northern and Western European countries are therefore more aware of new technologies and trends and based on that, more innovative. The defined professionalization (Berry, 1994; Koppenjan, 1987; Rogers, 2003) can be found here. Whereby public organizations have professional contacts with other companies and a shared professional standard.

The respondents out of the early adopter group were all enthusiastic about the idea of RouteLint or other inventive products that are valuable for their organization. The United Kingdom already adopted an inventive product developed by another railway organization in a foreign country. The difference with RouteLint was that this product is a stand-alone system that could be implemented in any railway infrastructure.

DMU

All respondents named their railway organization vertical organized. The respondents in this research are gatekeepers or influencers, but no one can take decisions. The decisions are made within the top-management. The top-management is on top of the organization, while they as gatekeepers are in the lower part of the organization. A proposition, for an innovation, needs to pass all these layers in order to get adopted. The proposition has to pass a couple of layers, before the decision to reject or adopt is made. The many layers are not a barrier and it does not take much time before the adoption decision reaches the top-management. All ideas they put into the innovation decision have come to an adoption decision. However, never did they try to put something "risky" into the decision process. Schumpeter (1994) described that public organizations are not willing to take risks, what can be found in the answers of these respondents.

5.4.2 The hypothesis of the early adopters

As hypothesis for the early adopter extreme was stated:
"Railway organizations in high adoption rate countries have comparable adoption characteristics as commercial organizations in these countries".
The early adopter group shows various characteristics that can are comparable to the results found in the early adopter group in the railway market. The respondents rely on company documents without having seen the innovation. All respondents were masculine, which are, According to Hofstede (2001), more innovative than feminine. Another fact is that more respondents came out of the early adopter group, while there were more countries contacted in the late adopter group. It shows more interest from their side. During the follow-up interviews the early adopter countries were also more positive and saw possibilities for RouteLint. All these are characteristics that belong to early adopters.
However, is the company structure not compatible with an innovative organization. This structure results in the avoidance of risks. Based on these results, it is not possible to confirmed the hypothesis. They have some early adopter characteristics, but the company structure avoids them to be one.

5.4.3 Late Adopters

Performance expectancy
In the survey results both countries score high on performance- and effort- expectancy. The Czech respondent said that he liked the factsheet and presentation. He believed in ProRail and the working of the system and they are looking for systems that can help to reduce energy.

Effort Expectancy
In line with the performance expectancy the Czech respondent did not foresee many problems in getting along with RouteLint. For him it was clear and understandable how RouteLint works.

Social influence
This group says that besides the government no one has really an influence on them. So do not other companies who have already adopted the innovation. The Czech Republic says that they follow their own way and the way of the European Union. If the European Union would make a law they will follow these rules. Other countries have not really influence on their behavior. The theory of Berry (1994) that stated that public organizations follow other organizations cannot be found here. They follow the majority, in this case the European Union, but are not influenced by other companies. Politics and their suppliers have little influence on their behavior. The politics own the company, what gives them influence. The suppliers influence the company, since they own the technique that are used.

Facilitating conditions

Here disagrees the Czech Republic with the fact that RouteLint will be compatible with other systems they use. They do think the system is compatible in the way they like to work. They still think it is a great product but do not think it will be compatible with their techniques. The Czech respondent was really negative about the fact that Dutch technology would work in their system. They thought that ProRail did not know how the Czech system works and therefore RouteLint was not compatible at all with their technology. This can be seen as a clear example of the not invented here syndrome as described by Katz (1982). The Czech Republic thinks that only systems made by their own suppliers can work into their system, since they know how they work, and which techniques they use.

Organizational innovativeness

According to the survey results and follow up interviews, the top-management can be described as innovative. Their organization structure is vertical with several layers, and divisions, who all have their tasks and responsibilities. The innovativeness of the organization is comparable to the early adopter group, whereby the formal structure blocks the system openness.

Adoption intention

The intention to adopt, is based on the constructs of performance- and effort- expectancy. The respondent thought it was a great product, what explains the high score on adoption intention. However the respondent did not think that RouteLint could work in their organization based on the technology. The Czech respondent told that they used a totally different technique and thought it was impossible for RouteLint to work with their technology. Therefore they only work with their own suppliers, since they know what technique to use. If the European Union would prescribe the use of RouteLint they would adopt it. According to the theory, late adopting countries usually do not rely on documents and media. They first must see it work in other companies before they make an adoption decision (Hall, 1976).

DMU

The structure of the company consists out of many layers. Decisions are made on the top. The top-management makes a plan every year. The government has to approve this plan before it can be carried out. Most of the time, the plan is approved without making major changes. This plan does not consist out of new stuff but out of things that have to be done.

Another fact is that many decisions are made based on law & legislation. They follow rules that are made by the government. Most of these rules come from the past. The respondent could name the rules, but could not tell why these rules were there. There were rules and they had to follow them. Rules made by the European Union will also be followed. Innovations that are within the rules and are compatible to the technology will be put into the adoption process if it has shown performance.

5.4.4 The hypothesis of the late adopters

For the late adopting group the following hypothesis was stated:

"Railway organizations in low adoption rate countries have comparable adoption characteristics as commercial organizations in these countries".

In the survey, the respondents in this group were positive about adopting RouteLint. The follow-up interviews however, showed opposite results. In the follow-up interviews the late adopters showed strong agreements with the commercial late adopters found in the theory. They were really skeptic about the fact that the Dutch technology would be applicable in their organization. Also made the follow-up interviews made that there was no intention to adopt products that did not came from their own suppliers. They did not believe that it would work in their system. They showed no further interest in RouteLint, but shared the opinion with the early adopters that it was a great product. These facts given, the hypothesis for the late adopters can be confirmed. They show all characteristics that are defined in the theory and are sure not the first organizations that would adopt RouteLint.

5.5 Early vs. late adopters

The survey results show not much difference between the early and late adopters. In contrast with the follow-up interviews, which have shown more differences between these two extremes. Late adopters in the railway industry can be seen as real late adopters as described in the theory. The hypothesis of the early adopters could not be confirmed, but there is a clear difference between the early and late adopters. The two groups can therefore still be split up into the two extremes and used when concluding this research.

6. Conclusion & Discussion

This chapter presents the answers to the main research questions and thereby the conclusions to this research. The findings of this research will be discussed by flagging limitations and by making implications for further research.

6.1 Conclusion

The goal of this research was to provide answers to the research questions. Here will the answers be given to the research questions 2, 3, and 4. The answers of these questions must give an answer to the central problem of this research as well to the main research question. In the following paragraphs every research question will be discussed.

6.1.1 Segmentation criteria

2a -Which segmentation criteria are important to ProRail in order to bring RouteLint to that market

The answer to this question can be found in chapter 4. Here are segmentation criteria made based on preferences by ProRail and criteria coming forth out of the theory. The following important segmentation criteria can therefore be distinguished:

ProRail

- Is directive 91/440 applied. If this directive is not applied, the country has no railway infrastructure or otherwise no competitive railway market.
- Are there multiple operators in that country? Multiple operators equal competition in that railway market. RouteLint must give a competitive advantage for operators using this system. By multiple operators, an operator can achieve competitive advantage by using RouteLint.
- The country must have the same or more mixture of passenger kilometers divided by good kilometers. A high degree of passenger and good trains makes RouteLint more interesting for potential customers. Since good trains are slower, multiple train passing will take place.

Theory

- Is the country an early or late adopter? According to the theory early adopters are more open to innovations and therefore an better group to aim at. Late adopters are known as less open to innovations.

2b -Which segments have priority to enter with RouteLint on that market

The criteria set by ProRail have priority, since RouteLint otherwise would not have the impact as it should have. Next to that the results show that countries on the early adopter extreme are more open for RouteLint than the late adopting countries. This is shown by testing the hypothesis about early and

late adopters. Early adopter showed more interest en openness in RouteLint, while late adopters were skeptic. Priority for ProRail are the countries that can be found within the segment of early adopters.

6.1.2 Adoption Intention in theory

3a - Which factors influence the adoption of an innovation on an organizational level in theory

This research question is answered in the theory of chapter 3. This was done by extensive literature research on adoption in different contexts. The theoretical framework was the result of this research. The framework resulted in a conceptual model that measured the influence of different adoption factors on the intention to adopt. The conceptual model is presented in figure 6.1.

Based on this model it can be concluded that there are five factors that influence the adoption of an innovation on an organizational level. Adoption is in this research is named adoption intention. Since this research aims at a possible market for RouteLint, whereby the target market organizations is asked for their intention to adopt. Adoption intention is considered to determine the actual implementation of RouteLint in their organization. The five factors that can explain adoption intention according to the theory are:

Performance expectancy – presents the believe of the organization that RouteLint improves the performance of the organization compared to the current situation.

Effort expectancy – presents the believe of the organization that RouteLint is easy to get to know and the level of ease concerning the use of RouteLint compared to the current situation in the organization.

Social influence – Is the degree of influence that the social environment has about the use of RouteLint.

Facilitating conditions – Presents the level of believe of the organization, that the organization supports RouteLint with its resources, knowledge, technology and the compatibility to the way the organization likes to work.

Organizational innovativeness – presents the openness for new ideas and innovations by the whole organization.

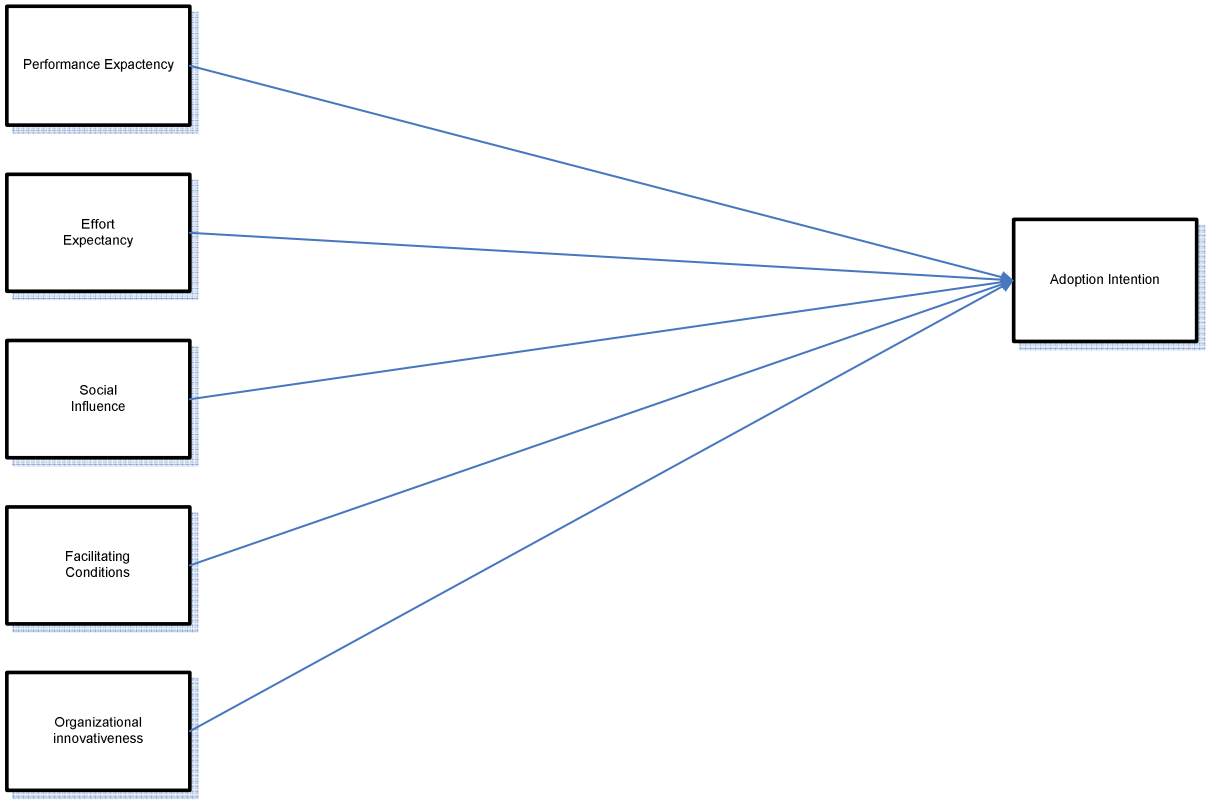

Table 6.1: Conceptual model for the adoption of RouteLint

6.1.3 Adoption Intention

The answer to the next research questions comes forth out of the results in chapter 5. In this chapter data is collected with the help of a survey and follow up interviews as presented in the research methodology in chapter 4. The data is collected and analyzed to answer the last research questions.

3b - What is the influence of these factors on the adoption intention

The results of the survey showed high scores on adoption intention, while, especially social influence and facilitating conditions, scored relatively low. According to these results, they have shown that these two constructs should have a little influence on the intention to adopt. The follow-up interviews show evidence for the influence of performance expectancy, effort expectancy, and organizational innovativeness on the adoption intention. The influence by their social environment had only very little influence on the intention to adopt. This influence came mainly from the government and other suppliers. Especially in the late adopting countries could be seen that especially suppliers have a big influence. This comes because of the technology that is used in their railway infrastructure. These suppliers determine for a big part which technologies they use. Media and other external groups had no or just a very little influence, when they had the intention to adopt a product. There was not a factor that was named as biggest influencer. The factors performance expectancy and effort

expectancy were named as the two factors were would be looked at first. If the product was something they understand and could see as a performance boost for their organization, they looked at the facilitating conditions. If the product is compatible to their technology and work style, they have the intention to adopt. They will show this intention by making aware the rest of this organization of the possibilities of that innovation.

3c - How is the organization structure of DMU's organized on the target market

The follow-up interviews gave a clear vision of the structure of the DMU's in the several target markets. All of the responding countries deal with a same sort of DMU structure in their organization. There was no difference found between the early and late adopters. The structure was basically the same, with a top-management that makes the decisions. Between the top-management (decision makers) and the bottom, where the gatekeepers and influencers are, are some other management layers. The users have no contact with the top-management. The top-management does therefore not know what problems are in that part of the organization.

3d - How are adoption decisions made within these organization

In line with the DMU structure of the previous research question, the top-management makes the decisions. The gatekeepers and influencers on the bottom of the organization are initiators, when it comes to adopting an innovation. If they see the added value of a product, plus the possibility to be implemented in their organizations with a minimum of risks involved, they initiate the product to the layer above them in the organization. These people initiate it to their superiors, and this all the way to the top-management, were the decision makers are. This depends on the number of layers in that organization. The top-management is the only group who can make decisions concerning the adoption of an innovation like RouteLint. When a gatekeeper sees the advantages and the possibilities of an innovation and sees no risks or downsides, he will start to make the rest of the organization aware of this innovation. The decision process goes very fast trough the layers and the innovation almost get adopted every time. This is only the case when there are no risks involved. The innovation must already be well tested and there must be known that it would fit in their system. There is never tried to get an innovation without any risks into the decision process.

6.1.4 Market Entry Mode

After knowing how the DMU's in the target markets are organized, and knowing which factors influence the adoption intention of gatekeepers and influencers of European railway organizations, the next step is to determine if there is a market for RouteLint and what entry modes suites RouteLint best.

4a - Is there a possible market for RouteLint

The results in chapter 5 show positive numbers for the intention to adopt RouteLint. Based on the surveys, this research question can be answered with "yes". The follow-up interviews show a little more skepticism about the intention to adopt, especially by the late adopters. But there is still an overall positive opinion about RouteLint. The device RouteLint is developed for the Dutch market, based on "Dutch" problems. Other countries in the European Union share all or some of these problems. Based on the question stated under Performance Expectancy, Effort Expectancy and the Adoption Intention, the responding countries believed that RouteLint is a satisfying product to solve one of these, or all of their problems. The follow-up interviews confirmed this. These respondents could therefore be potential customers, since they showed interest in the product.

The early adopting countries, especially the United Kingdom and Finland, believed that it must be possible to adopt RouteLint in their technology. Especially the United Kingdom was positive, since they described their market as open to everything. Finland was a little more skeptical and first had to see if it could work. Germany and Austria thought the Dutch technology would work since there are already trains crossing borders between Netherlands, Germany and Austria.
The late adopting countries saw the technology of RouteLint not working with their technology. They thought that their technology was completely different and could therefore not work. These countries believed in their own suppliers since they know how they work and, which technology is needed. The innovativeness of the organization is another burden. The top-management is described as innovative, the respondents can even be called more innovative. However, does the structure of the company blocks innovativeness and risk taking. This means that there is a market but the product must be free of risks and difficulties that avoids gatekeepers to start to bringing the idea of RouteLint to the organization, and the decision makers.
RouteLint is a unique product, and different respondents trough Europe had the intention to adopt this product. Based on the surveys, both the early and late adopting countries were positive about the performance of RouteLint. In the follow-up interviews, the early adopting countries see possibilities for the Dutch technology in their railway infrastructure. What makes the early adopting countries the most interesting group to aim on.

4b - What is the influence of the adoption intention factors for the market entry mode of RouteLint

The early adopters show little skepticism about the technology that is involved in RouteLint. But since there is only little skepticism about the factor technology, there is no reason that this factor is of great importance when determining the market entry mode for RouteLint in the early adopting markets.
The late adopting countries are really skeptic about the RouteLint technology, and do not think it will work at all, even by making changes to it. Offering RouteLint as an export or license product, will

therefore not work. They believe in products made by their suppliers. This is something that must be taking into consideration when entering late adopter markets.

4c - What entry mode suites best for RouteLint taking the influencing adoption factors into account

The early adopter countries see the advantages of the product and are only a little skeptic about the technology. A licensing model as entry mode in these countries can here for be justified. A licensing model is, according to Root (1994), preferred whit a technology intensive product on a market with low sales potential. Licensing is known for the minimum of risks and investments. Other advantages are the speed of entry and a high ROI.
The late adopting countries do not think a product from a different country will work with their technology. Exporting of licensing will therefore not work. A joint venture with a local company in that target market can be a solution. This local company can provide skills, resources and technology to make RouteLint work. Also the local company can provide RouteLint with an own brand name. The organization in that country has more trust in RouteLint and knows it will work in their organization. ProRail can make use of the network of that company to get in touch with possible smaller organizations in the target country's railway market.

The conclusions for this late adopter are made based on this moment in time. The s-shaped model of Rogers (2003), shows that late adopters are followers. The barrier of the technology could be gone, since they see how easy it works with other technologies. Therefore, over time, it might not be necessary to work with a joint venture entry mode, since the late adopters have seen proof of how RouteLint works in early adopting countries. Over time, a license entry mode can be applicable in late adopting countries.

6.2 Recommendations

Energy efficiency is a hot item in the railway industry. ProRail has developed a device that can help trains to be more efficient. This device, RouteLint, is already taken into use by the biggest transporter in the Dutch railway market, the NS, also known as the Dutch Railways. The conclusions of this research showed interest from other foreign railway organizations in RouteLint. With these conclusions the following recommendations are made for the entry of new foreign markets with RouteLint.

Results from RouteLint in the Netherlands
All respondents filled in the questionnaire, with the help of a presentation, a factsheet and a small movie. Result of the follow-up interviews showed that most companies did not rely too much on documents. Therefore they could not give a complete honest answer if RouteLint could work for them. Especially in the follow-up interviews they were more skeptical about the technology and the results

so far of RouteLint. With the results of an extensive pilot in the Netherlands, and a good overview of the technology the advantages and possibilities should be shown.

Aim at early adopter

In the follow up interviews, the early adopter show a greater interest in RouteLint and the compatibility with their technology. With a license entry mode these markets could be entered. A license model has the advantages that it minimizes risk and investment, the entry speed is high and it has a high ROI. Countries in the early adopting group are: United Kingdom, Finland, Austria, and Germany.

Later adopters

The following recommendation is made for this moment in time. Late adopters are followers and can therefore change their opinion over time, since they never will be the first one to adopt.

Late adopting countries have shown no trust in the Dutch technology. A joint venture with a local target markets supplier is therefore recommended. These people have the knowhow of the local technology. Organizations in these target markets will therefore have trust in the innovation and earlier will take the decision to adopt. However do joint ventures have downsides, since there have to be worked with local companies in that target market. It is not known if ProRail understands this as value creation.

Over time the attitude towards RouteLint might change. They have seen the advantages of RouteLint, but also that the technique would be compatible to their system. A license entry mode is preferable over an joint venture entry mode. There are less risks involved, less investments have to be made and there has not to be worried about the partner in the joint venture.

Pilot

A way to avoid risks and to show a organization on a target market that RouteLint works, a pilot is recommended. During this pilot an organization can see the advantages of RouteLint for their specific situation. A pilot is considered to be a guiding instrument that shows the pros and cons, and the cost and returns, of RouteLint adoption over a certain period of time. Rogers (2003) stated that innovations that can be divided for trial are generally adopted more rapidly.

Pilot setup

The results of this research have shown information that has to be taken into consideration before starting a pilot project.

Organization: It is recommended that the pilot organization is one out of an early adopting countries. These countries have shown more interest in the product and were positive about the applicability of RouteLint in their organization.

Top-management: It is important that not only the users and gatekeepers are enthusiastic, but also the top-management. By showing them the possibilities of RouteLint, they might be more interested in buying it.

Experiences

The last recommendation is the fact that there should be learned from the entry in early adopting countries. The gained knowledge and experiences can be used for the entry in other countries. This should not only be the case for RouteLint, but also for other innovations that ProRail wants to enter foreign markets with.

6.3 Limitations and future research

In this paragraph the limitations of this research will be indentified and discussed. This will be done by reflecting on the used research methodology and by indentifying the consequences for the findings of this research. The findings of this research will be discussed by reflecting on the used research methodology. At last will, based on the indentified limitations and findings of this research, implications made for future research.

6.3.1 Limitations to the research

The conceptual model developed to conduct this research is based on the UTAUT model of Venkatesh et al. (2003). This model is especially developed for empirical research with questionnaires, for a large group of respondents. Venkatesh et al. (2003) quantified their model with a N of 133. This research is conducted with a N of 6. The low number of respondents made it not possible to check the reliability. Reliability checks if all items are reliable and can be used for further analysis. It was already hard to check the reliability since all respondents have different cultural backgrounds. What could be of influence on the answers to the items.

The little respondent in this case were the most innovative people of the organization and all fulfilled a role as gatekeeper and/or influencer. These people can be seen as more innovative. Results of the survey and the follow-up interview may therefore be more positive, since all the respondents are more open to new ideas and innovations. The respondents are also limited concerning the generalization of the research findings (external validity). Only one respondent per country was consulted. A generalizations for that country is therefore based on little information. More respondents in different DMU roles in a country would give a better view of the reality.

These facts given, it was not possible to quantify the model, measure significance, and explain adoption intention with the help of the five constructs. Also the model is now tested in organizations in the public atmosphere in Europe. Where the original UTAUT model is tested in commercial organizations in the United States.

There were more countries participating in the early and late adopter group, but since there were only single respondent consulted in these countries, these results can also be named as limited. More respondents per country or organization would increase the external validity.
The constructs are based on various items. These items are not the same. For example in the construct facilitating conditions is not only measured if RouteLint is compatible with their technology but also if RouteLint facilitates in their work style. A respondent can disagree to the question if they think RouteLint is compatible with their technique. But the respondent can answer with a 4 or 5 to questions if they think that RouteLint is compatible with the way they work. An answer to this construct may therefore be up for discussion.
The innovativeness of the organization is tested on 12 items. These items are all different. So does size have influence on the innovativeness of the organization. All of the railway organizations are big and have the resources to innovate. All the top-management wants to innovate and is open for new ideas, also from other countries and suppliers. However they score low on the structure of the company and the way that they work. Various layers, reorganizations, complex structures, and no room for risk taking make it impossible to be as innovative as the top management wants to be. The score to this construct can therefore be contradicted.
Despite the many limitations associated with the used research methodology, this research still provides various useful findings that should be of interest to both ProRail and academics.

6.3.2 Implications for further research

This study is pioneering in the railway industry. The market did only open up a while ago and will probably open up more and more. Results of this research can therefore be totally different next year.
Another fact is that only one respondent per country took time and effort to fill in the questionnaire. A more extensive study with more respondents per country, in different DMU roles would be recommended, for more accurate results.
ProRail now only aimed at countries that looked at the first sight to be potential adopters for RouteLint, mainly based on passenger- and goods train kilometres in that country. Other European countries or even in other parts of the world might also be interesting for ProRail. Whereby especially the data what can be received from decision makers be really useful.
Finally, this research aimed at the adoption intention of RouteLint in several European Union countries. An interesting fact would be to study the adoption of RouteLint if a foreign organization which has adopted RouteLint. Results of these two studies can then be compared to get a better analysis of the European railway market.

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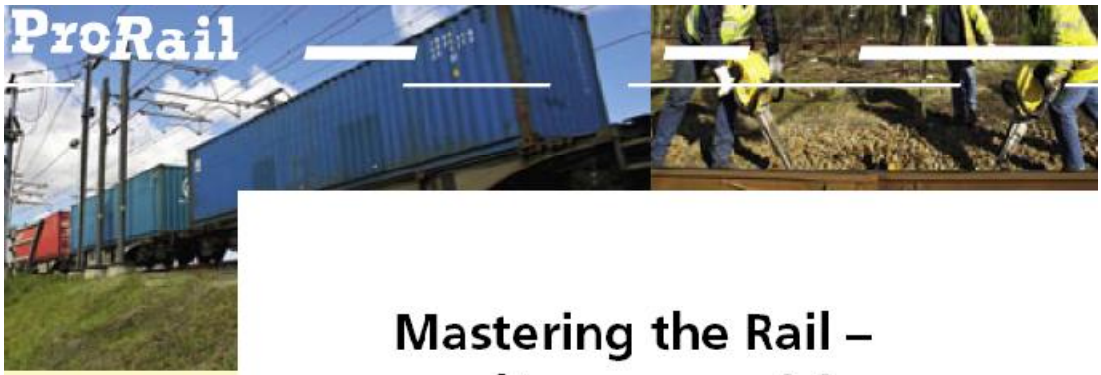
Appendix I. Factsheet of RouteLint



Mastering the Rail – results are promising

More information results in better driving, this is in short the conclusion after the trial: "The Master of the Rail" (Het Spoor Meester). During this trial, engine drivers and train dispatchers worked with RouteLint. This onboard system visualizes accurate information regarding speed and location of other, nearby trains, allowing drivers to anticipate. The results: trains driving more closely to schedule, with less energy consumption and increased work satisfaction for the drivers.

Workmanship, the central issue

Expertise is vital. Particularly when moving millions of people by train on a daily basis, one depends heavily on workmanship of drivers and train dispatchers that make this happen in a safe and efficient manner. How can new technology support their work? Will accurate, real time information available to the driver in his cabin improve the quality of his work? And will this improve punctuality and reduce energy consumption? What impact will this have on his work satisfaction? With these questions in mind, the project "The Master of the Rail" kicked off in 2003. During two years, ideas were developed, discussed, tested and improved, jointly with 'the shop floor'.

Trials between Rotterdam and Dordrecht

After 2 years of development and preparation, the system was put to the test in 2005. Trials were set up between Rotterdam en Dordrecht a congested corridor with intense passenger travel as well as significant freight transport volumes. Over a period of eight days specially trained ambassadors (themselves also drivers), equipped with a PDA with RouteLint, boarded the trains between Rotterdam and Dordrecht. One day they would pass on information from RouteLint to the driver, the other day he would not, to allow for adequate control information.

The trial left the team with precious information regarding:

- Driving characteristics (speed, accelerating and decelerating)
- Delays and punctuality
- Energy consumption
- Communication between dispatcher and train driver

The ambassador used the information provided by RouteLint to advise the driver, for example to adjust speed, based on the routesetting and the position of the train ahead. During the journeys data was recorded for fuel consumption, handling, punctuality, communication between train dispatchers and drivers and on-the-job experience. The trials were overseen from a specially equipped 'control room' in Rotterdam.

During that same time, train dispatchers also worked with a screen displaying RouteLint information. This screen displayed several additional types of information that were new to them, such as the length and weight of freight trains. At the end of each day they discussed their experiences with supervisors.

The RouteLint

Additional research was done parallel to the trials using computer simulations, literature and model-based analyses. Particular attention was paid to safety issues (what are the risks posed by additional information in the driver cabin), ergonomics and fuel consumption.

Able to anticipate

It was clear during and after the trials that drivers really appreciated the ability to anticipate. RouteLint allowed them to do just that! They were able to better adapt their driving style to what lies ahead and to better understand the decisions of the train dispatcher.

With RouteLint drivers:

- drove more in line with their planned path
- drove more slowly and smoothly (no unnecessary braking and accelerating)
- consumed less energy.

During trials the drivers, surprisingly, sought more contact with the train dispatcher. During preparation this was not considered necessary. However, as they rang with specific and relevant questions, train dispatchers did not experience these calls as a hindrance. This confirms another result: trial participants found that the use of RouteLint enhanced mutual understanding between train dispatchers and drivers. An additional advantage of this form of "quiet communication" is allowing them to work more closely together. All in all participants were highly enthusiastic about the use of RouteLint and mastered it easily.

The trial results were translated to a business case by extrapolating the local results to a national level. The case for national implementation looks promising – varying slightly for freight and passenger trains. It indicates an increase in punctuality between 1.2% and 1.6% and energy savings of 4-5% are achievable.

Next Steps

ProRail has decided to implement RouteLint, working closely with Dutch Railways, Railion and several other transport companies.
This is part of the overall programme Dynamic Traffic Management which ProRail is implementing with key partners in the railway sector.

"The Master of the Rail" Project Organisation

"The Master of the Rail" is a joint venture between ProRail, NS Reizigers, Railion, NS Internationaal and NS Opleidingen. Delft Technical University and University of Groningen participated in the research. A project team consisting of partner representatives coordinated the preparation and execution of the trials.

Approximately thirty ambassadors – primarily drivers – were actively involved in trial runs and a number of them were also involved in preliminary investigations, development of RouteLint and the setting up of the trials. The project was led by a Daily Steering Committee on behalf of all partners.

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Appendix II. Construction of the questionnaire

Performance expectancy - the believe of the organization that RouteLint improves the performance of the organization compared to the current situation.

Question	Code
With RouteLint we can reduce energy	PE1
With RouteLint punctuality can be improved	PE2
With RouteLint we can improve the communication between train driver and train dispatcher	PE3
With RouteLint the job of a train driver is more challenging	PE4
The use of RouteLint will have no effect on the performance of a train driver	PE5
The use of RouteLint can decrease the time needed for the import job responsibilities	PE6
The use of RouteLint leads to advantages, like energy reduction, for the same amount of effort	PE7
We would find RouteLint useful for a train driver	PE8
We would find RouteLint useful for a train dispatcher	PE9

Effort expectancy - the believe of the organization that RouteLint is easy to get to know and the level of ease concerning the use of RouteLint compared to the current situation in the organization.

Question	Code
Learning to operate RouteLint would be easy for train drivers	EE1
It would be easy to become skillful at using RouteLint	EE2
I think that RouteLint is easy to use	EE3
RouteLint will take too much time away from the normal duties	EE4
Working with RouteLint can be to complicated, it is difficult to understand what is going on	EE5
Using RouteLint involves too much doing mechanical operations (e.g., d. input)	EE6
It will take too long to learn how to use RouteLint to make it worth the effort	EE7

Social Influence - the degree of influence that the social environment has about the use of RouteLint.

Question	Code
People who influence our behavior think that we should use RouteLint	SI1
People who are important to us think that we should use RouteLint	SI2
People who are important for the decision to make use of ICT are:	SI3

(multiple choice)	
We attend to use RouteLint if other organizations will start to use RouteLint	SI4
Having RouteLint would be a status symbol for our organization	SI5

Facilitating conditions - the level of believe of the organization, that the organization supports RouteLint with its resources, knowledge, technology and the compatibility to the way the organization likes to work.

Question	Code
We have the resources necessary to use RouteLint	FC1
We have the knowledge necessary to use RouteLint	FC2
Given the resources, opportunities and knowledge it takes to use RouteLint, it would be easy for us to use RouteLint	FC3
RouteLint is not compatible with other systems we use	FC4
The use of Routelint is compatible with all aspects of a train driver's job	FC5
think that the use of RouteLint fits well in the way we like to work	FC6
Using RouteLint would fit into our work style	FC7

Organizational innovativeness - the openness for new ideas and innovations by the whole organization.

Question	Code
How many employees does your organization have (open)	IO1
The top-management is open for change within our organization	IO2
The top-management is open for new ideas that could be applicable in our organization	IO3
The top-management takes risks to make new business activities work	IO4
The top-management is free to adopt of non adopt innovations	IO5
In our organization people and processes are centrally headed	IO6
The processes in our organization can be described as complex	IO7
Processes in our organization are formally fixed	IO8
All employees in our organization keep to the fixed processes	IO9
The different units in our organization are highly correlated	IO10
There are sufficient resources available which are not appointed to an task yet	IO11
Employees in our organization have a lot and active professional contacts	IO12
Is there political pressure to adopt RouteLint (multiple choice)	IO13
Is there social pressure to adopt RouteLint like systems (multiple choice)	IO14

Adoption Intention – The intention to adopt RouteLint

Question	Code
Using RouteLint in our organization is a good idea	AI1
I like the idea of using RouteLint	AI2
Using RouteLint would be pleasant for the train drivers	AI3

Appendix III. Follow-up interview questions

The questions in the follow-up interviews are mainly based on the survey results. These are the basic questions and are adapted to the specific respondent.

1. Why this score on Performance expectancy
2. Why this score on Effort Expectancy
3. Why this score on Social influence
4. Why this score on Organizational innovativeness
5. Why this score on adoption intention
6. How do you explain the patrons in your score
7. What are for you barriers to adopt when it comes to RouteLint
8. What is for you the first issue when adopting a new innovation
9. How do you describe the structure of you company
10. How does your company make adoption decsions
11. What is the character of the top-management
12. What do you think about the fact that RouteLint is Dutch
13. What is the influence of these factors on your intention to adopt
14. Which factor do you think is the most important considering adopting RouteLint
15. Do you have any other comments