SAVONIA

THESIS - **BACHELOR'S DEGREE PROGRAMME**
TECHNOLOGY, COMMUNICATION AND TRANSPORT

RAILROAD TRANSPORTATION

Silk Road rail routes comparison – transportation between EU, Scandinavian countries and China

Author/s: Anastasiia Grishkina

SAVONIA UNIVERSITY OF APPLIED SCIENCES

THESIS
Abstract

Field of Study Technology, Communication and Transport			
Degree Programme Degree Programme in Industrial Engineering and Management			
Author(s) Anastasiia Grishkina			
Title of Thesis RAILROAD TRANSPORTATION Silk Road rail routes comparison – transportation between EU, Scandinavian countries and China			
Date	26.5.2018	Pages/Appendices	39/3
Supervisor(s) Principal lecturer Jarmo Pyysalo			
Client Organisation /Partners None			

Abstract

Need for transportation of the materials, details or ready products is growing over every year and it is directly proportional to the population growth. From the economic point of view, rail freight transport opens opportunities for new market entries and larger markets can be served.

This thesis work carried out the scientific study of so-called South, Middle and North Silk Road rail routes. All of the corridors are playing significant role in the economic growth of countries involved. The Northern route is going via Finland, Southern through Slovakia and Middle one via Poland. The main idea was to show benefits of each route and compare them from the point of time in travel, distance, volumes of transitions and technologies.

The goals of the thesis work were to study each route and its possibilities, to analyze and to compare pros and cons. In addition to that, routes were evaluated from the passenger transportation point of view.

To achieve goals set and to collect valuable data for the research, several interviews with specialists were carried out.

As a result, it can be stated that the Middle route is very congested and freight transportation via two other routes will release the route via Poland. In addition to that, it was found out that the routes via Finland and via Slovakia are suitable for freight transportation, while rail route via Poland is preferable for passenger transportation.

Practically, the results of the study can be used by the logistic and rail companies to increase the attractiveness of the routes. In addition to that, the thesis work can be interesting for the SME's who are seeking to go international. The presented data gave an overlook on the rail transportation and can be used in the decision-making process for the matter of transportation mode.

Keywords
Railroad transportation, Silk Road rail routes, EU-China transportation

CONTENTS

LIST OF ABBREVIATIONS

ATP	Automatic Train Protection
ERTMS/ETCS	The European Rail Traffic Management System /The European Train Control System
GPS	Global Positioning System
GSM-R	Global System for Mobile communications — Railway
HS/HC	High speed/High capacity rail lines
HSR	High Speed Rail
KTZ	Kazakh Rail Company
LCL	Less than full container load
OBOR	One-Belt-One-Road initiative
RFC	Rail Freight Corridor
RZD	Russian Railroads
SMEs	Small and Medium-Sized Enterprise
TEU	Twenty-foot Equivalent Units
VR	Finnish Railroads

1 INTRODUCTION

1.1 Background

Delivery of goods is a crucial part of any modern business. There is a great range of ways to deliver goods to the customer –from courier services for delivery within the limits of one settlement to several modes of transport, following from one continent to another.

Transportation of freight between Asia and Europe can be done by air, maritime and railroad modes. Silk Road includes sea and land routes. According to the OSW Study for Silk Road, delivery of goods by marine transport on average takes 45 days (Jakobowski, J. Poplawski, K. & Kaczmarski, M. 2018). Previously, maritime mode was the cheapest way to transport cargo. Nowadays, due to unstable fare rates and taxations, delivery by marine Silk Road routes can be as expensive as by rail routes. Yet, still majority of freight is transported by marine transport.

Transportation by air takes 3-7 days, which is fast but expensive (Jakobowski, J. et al. 2018). Air mode is highly dependent on weather conditions and therefore it is not suitable for regular businesses. It carries out a high carbon footprint and it has a very limited weight-per-unit ratio in transportation.

Railroad transportation on another hand is becoming faster and more flexible with new technologies applied. At the same time, transportation costs are going down. Leaders of the World trade are getting more and more interested in investing into new railroad technology development. Passenger interest in rail transportation is also growing. According to the annual reports of VR (Finnish railroads), interest of passengers grew by 7% comparing to 2016 (VR Group 2017). People choose rail transportation not only because of its price, but also because of the safety and high punctuality levels. Majority of rail companies are suggesting night trains for transportation over longer distances.

It was decided to take closer look on the current situation of three rail routes between China and Europe.

1.2 Need of the transportation between EU and China

General population growth causes greater need for transportation of passengers and goods. From the economic and business point of view, freight transport opens opportunities for new market entries and larger markets can be served.

China’s motivation in developing rail connection is in expansion of national economy and increase of trade volumes with Europe. (Hillman, J.E. 2018)

Generally, people travel to get new cultural experiences and to see new places (Statista, 2014). This way it is possible to say that passenger transportation is enabling closer cross-cultural communication and greater understanding of World situation. Events, such as FIFA World Cup 2018 (which is

going to happen in Russia) or Astana Expo (Kazakhstan), are attracting people to travel. On another hand, the majority of passengers prefer air transportation mode, when the trip carries out business concern. In addition to that, closer communication might bring new contracts between European and Chinese SMEs.

1.3 Question and purpose

This thesis work carries out the scientific study of so-called south, middle and north Silk Road train routes. All of the corridors are playing a significant role in the economic growth of countries involved. Northern is going from China via Finland, South through Slovakia and Middle route via Poland to European markets. The main idea is to show benefits of each way and compare routes from the matter of time in travel, distance, volumes of transitions and technologies.

Goals of the thesis are:

1) To study each route and its possibilities
2) To compare routes pros and cons
3) To analyze and to determine which route is good for different kind of transportation needs and business activities.

Another question of the study is to find out which route is the most attractive for passengers.

The practical approach of the study can be used by the logistic and rail companies to increase the attractiveness of routes. In addition to that, the thesis work can be interesting for the SMEs who are seeking to go international. The presented data gives an overlook on the rail transportation and can be used in the decision-making process for the matter of transportation mode.

1.4 Thesis structure

This thesis consists of three main parts:

1) Theory part
2) Interviewing part
3) Analytical and Comparison part

The entire thesis is divided into eighth chapters. Introduction chapter aimed to explain reasons for topic choice, settled goals and methods used to collect valuable data.

The theoretical background of the study is given in chapters 2, 3, 4 and 5. Chapter 2 gives the overlook of Silk Road, back in its beginning and modern routes. In the same chapter there are shortly presented three rail routes. Next, Chapter 3 is concentrated on railroad logistics matters; railroad transportation itself and technologies applied in the rail transportation particularly on the routes. Chapter 4 is giving basic transportation data on the routes for freight and passenger transportation.

The data collected from interviews was applied in Chapters 6 and 7.

The analysis and comparison start with Chapter 5. The routes are compared from the perspective of distances, technologies applied, volumes of transactions back and forth, etc. The risks evaluation (political, environmental, etc.) was included in the end of the chapter.

1.5 Research methods

The methods used in thesis work are aimed at gathering reliable and relevant data of defined area. It was decided to concentrate on literature research for the theoretical part and the conduction of qualitative interviews. In general, in the thesis work qualitative approach is applied.

Majority of information was obtained from the secondary resources such as online publications, online journals, and annual reports. Nevertheless, the primary resources were used as well. Only combinatory use of both primary and secondary resources together with experts' opinion can give up-to-date overlook of the situation on the routes.

1.5.1 Qualitative research

Unlike quantitative research qualitative research does not rely on amount of specific answers. Such research is used when semi structured interviews are handled. Usually in qualitative research there are small amount of participants. This is enabling to get a deeper understanding of the topic. In addition to that, there is a chance to get extra data, which very unlikely could be collected by predetermined interview questions or questionnaires. (Dr. Ben-Eliyahu 2014)

In other worlds, qualitative research concentrates on value of the answers rather than on number of repetitive answers. Interviews in qualitative research are mainly carrying out in-depth character.

1.5.2 Interviewing

An interview is a way to collect information (data) from another person, by asking questions. According to Garry Dessler, "An interview is a procedure designed to obtain information from a person's oral response to oral inquiries" (Dessler 2005).

According to Research Methodology (2017), there are several main ways of handling the interview for the research. These are structured, unstructured and semi structured.

The first one is a structured interview. It consists of defined number of questions, which are known before the interview is handled. In such interview, all of the interviewees are answering same questions and in the same order, thus it helps to analyze collected information faster and more accurate. Therefore, it can be used in quantitative research. The biggest disadvantage of structured interviews is its inflexibility. It is not always possible to ask additional questions that can come up during the interview. (Research Methodology 2017.)

Unlike the structured interview, the unstructured one does not do preparation of questions beforehand. Therefore, there can be a lot of struggles with comparison of collected data. Thus, it is a good option for gathering ideas, other points of view etc. (Research Methodology 2017.)

The most comfortable and suitable type of interview is a semi structured one. It combines the features of both structured and unstructured.

Nevertheless, there are advantages and disadvantages in the interviews as a research method. The advantages of interviews include possibilities of collecting detailed information about research questions. The interview gives the possibility to control the flow of the primary data collection process and to avoid unnecessary information. Sometimes it takes a long time to prepare the questions, because from their relevance and quality depends the quality of the answers and if there will be answers at all. Moreover, it is not always easy to schedule the interview, due to lack of time from interviewees. (Research Methodology 2017.)

It was decided to interview specialists in order to get information concerning pros and cons of three Silk routes from China to Europe. Interview questions were sent to representatives from EU countries as well as to Russian and Chinese specialists in logistics, railroad transportation and economic spheres.

2 SILK ROAD ROUTES

The Great Silk Road – is the ancient trade corridor, first time mentioned in 5th century (AD), which was used for trade between Far East and West countries. Silk Road got its name because of the textile material, which was used by Emperors family. It became the catalyzer to the trade relationship between Central Asia and Roman Empire. (UNESCO 2018.)

The Great Silk Road began with the basin of the Yellow River. It passed along the western part of the Great Wall, and then it divided onto two ways. South was going towards Mediterranean Sea and north leaded to Kazakhstan, where it again splits on the routes. One route leaded to Middle Asia and another towards Black Sea and Europe. (Advantour 2017.)

The Modern, new Silk Road consist of sea route, rail route, pipeline and several road connections. Maritime Silk Road takes its beginning at the port of Fuzhou (China) and leads towards ports of Greece and Italy (Fig.1). Gas pipelines directed to Nakhodka (Russia), Irkutsk (Russia), and Usan (Kazakhstan). Oil pipelines are going towards the territory of Russia, Kazakhstan and Mongolia.

Inland bridge between Europe and China is going through the territory of Kazakhstan and Russia. The end point of the rail routes is ending in ports of Hamburg (Germany), Rotterdam (Netherlands), Venice (Italy) and other strategically important ports for EU-China trade.

FIGURE 1. New Silk Road (source: Mercator Institute for China Studies 2017)

Trans-Siberian railroad as a part of Silk Road mainly goes through the territory of Russia. It is connecting European countries with China, Mongolia, North Korea and South Korea. Beyond Russia route towards EU goes through Finland, Germany, Poland, Belorussia and Hungary. (RZD 2017.)

Connection for the Scandinavian and Baltic countries is going through Northern rail route. Trans-Siberian railroad is used as for passenger trains as for freight trains. Every year the road is expanding, and new connections are appearing. The length of the original road from Moscow to Vladivostok is 10,555 km; nowadays the length is about 9300 km. (RZD 2017.)

Major cities the route goes through:

1) *In Russia*: Kaliningrad, Saint Petersburg, Moscow, Smolensk, Nizhny Novgorod, Yekaterinburg, Astana, Novosibirsk, Krasnoyarsk, Irkutsk, Chita, Khabarovsk, Vostochniy, Vladivostok.
2) *Beyond Russia*: Helsinki, Berlin, Warsaw, Minsk, Kiev, Budapest, Ulaanbaatar, Beijing, Pyongyang, Seoul, Pusan. (RZD, 2017.)

According to OSW study (2018), Trans-Siberian railroad is very well technically equipped. At the moment, it has better infrastructure among all of the routes.

The purpose of New Silk Road is to enhance the economic relationship between Europe and Chinese cities. In advance, the aim is to improve connectivity of province cities of China with its customer in the rest of the world. (Jakobowski, J. et al. 2018.) New Silk Road is supported by OBOR initiative.

OBOR is One Belt One Road initiative, which is investigating and improving trade relationship (Malterer, M. 2017). According to Head of China Industrial Research Alexious Lee, the initiative has a goal to "redirect the country's domestic overcapacity and capital for regional infrastructure development to improve trade and relations with Asian, Central Asian and European countries". (Lee, A. 2017)

Another logical reason for creation of new rail routes is to reduce congestion in already existing ports and rail terminals. This is also minimizing the risk of damage to merchandize.

Next, there will be presented three routes possibilities closer.

2.1 Southern route – via Slovakia

Southern route takes its beginning from the Dalian (China) through Russia and Ukraine towards Bratislava (Slovakia). The first train after a year-long brake launched on the November 13, 2017 (Spectator, 2017). It carried 42 containers with goods for the European customers. The whole trip took 17 days. Southern route has different gauge width. Changing of wheels is happening at the Dobra terminal from 1520 mm width gauge to 1435 mm. At this moment there are 500 trains/year (2017) planned to be transported with the approximate frequency of two trains a week. (Dzubakova & Melich, 2018, p. 74.)

Another possibility for southern rail route is construction of 1520 mm rail from Russia towards Vienna. Starting point of broad-gauge railway will be Kosice – Slovakian city near of Ukraine border and heading towards Vienna (Austria). The project was discussed on the international forum in Vienna (20-22 February). Mainly the new wide gauge rail line will allow minimizing the burden on the state budget (Forum 1520 - monitoring, 2018, 77). In addition to that, it will increase attractiveness of the route for passenger and freight transportation.

2.2 Middle route – via Poland

The rail route via Poland was the main hub between China and Central Europe for a long time, which leaded to congestion of the route. Two other routes are supposed to relieve the medium route.

The volumes of freight transportation between Europe and Asia by rail are rising. In 2013 about 57000 tons of cargo were transported, in 2016 already more than 500 thousand tons. In the first half of the 2017, volumes already overgrew by 114% (Railway Gazette 2017). All this leads to creating new corridors in Asia-Pacific region.

2.3 Northern – via Finland

11th November of 2017, the connection train between China and Finland was launched. The route connects the city of Kouvola (Finland) and Xi'an (China) and goes through Kazakhstan and Russia. The distance between points is 8000 km and it will take about 10 days to reach final destination. Kazakhstan Railways operate the corridor between Kouvola and Xi'an with a join of Chine's logistics. (China Daily 2017.)

The New Silk Road is planned to boost the economics of both counties. At the moment there will be trains going once a week, with possibility to increase up to twice a week in the second part of 2018. The competitive advantage of rail route via Finland is in its security and efficiency. As the starting point of the original Silk Road trading route, Xi'an plays an important role in the Belt and Road initiative and is one of the major road transport hubs. (Weedy, S. 2017.)

Helsinki-Tallinn tunnel

One of new planned rail connections is a tunnel from Helsinki to Tallinn going under the Gulf of Finland. The distance between two cities is 80 km and mostly transportation between cities is happening by ferries. Now transportation between cities takes about two-and-a-half-hour trip. According to feasibility, study of the TALSINKIFIX tunnel will reduce it to 30 min. (Kose 2015.)

This tunnel is going to be a part of the Rail Baltica, which construction will begin in year 2026. Rail Baltica is planning to create greater connection between Western Europe and Baltic countries. Road will go true Tallinn (Estonia), Riga (Latvia), Vilnius (Lithuania), Warsaw (Poland) and Berlin.
Rail Baltica road is going to have standard rail track width (1435 mm) for European countries and 1435 mm gauge will already be used in Helsinki-Tallinn tunnel. A European-standard track width would to be used in order to establish an easy link with Rail Baltica. (Kose 2015.)

Tunnel will be ready between 2025 and 2030 and will be able to operate freight trains as well as for the passenger trains (Yle news 2017). The approximate capacity of the tunnel will be 96 twenty-foot equivalent units (TEU). The Baltic tunnel will be joined with already existing transport systems. (Grey, E. 2016.)

3 RAILROAD TRANSPORTATION

Railroad transportation is the one of the most reasonable mode of transportation when there is a need to transport large amount of heavy or big-sized cargo for a long distance, for instance, between Finland and China or other countries of Scandinavia or EU. Mostly such route will be leading through Russia. Every year Russian railroad transports about one milliard tons of freight, which is about 43% of all freight transported in Russia by all means (Ministry of Transportation and Communication Russia 2015). Russia is on the 3rd place by the length of rail after USA and China. The route system there is very well accomplished and wide enough for comfortable transportation for passengers and cargo.

The advantages of the railroad transportation over other modes are in:

1) Speed vs. Volumes. Trains are able to carry big loads of freight in relatively short time
2) Lower transportation costs (or cost effective)
3) Usually scheduled. Therefore, the possibility of delays and discharging of trip is minimized
4) Low ecological impact. According to statistics this is the most ecology-friendly transport (OECD/IEA 2015).
5) Movable and traction compositions are very durable and reliable
6) Larger capacity, comparing to road or air transportation
7) High security level over whole time of transaction.

Moreover, rail transportation does not rely on weather conditions. Most of the trains nowadays are able to carry containers, which are not only able to keep goods safe from weather changes, but also are very comfortable in use because of their specialization for certain type of the cargo.
Despite the wide range of advantages, there are few disadvantages as well.

Firstly, high cost of beginning and end works thus machinery for uploading and unloading. In addition to that:

1) Low flexibility - inability of transportation of goods from door to door
2) High investment into new network connections and rail construction
3) Dependent on other transportation modes, due to the need in specific surface
4) Monopoly
5) Not very suitable for short distance transportation

In conclusion, the most effective use of railroad transportation will be in the places with well-developed railroad network and for long-distance transportation of large cargo.

4 TECHNOLOGY APPLIED PARTICULARLY ON THE ROUTES

In this chapter the reader will be given the theoretical background of technology applied, which further will be compared for each route. Main concern of this chapter is connected with railroad infrastructure and technologies, which are affecting route attractiveness for passenger and freight transportation.

Well-designed and planned railways and terminals are not only saving travelling time and money but insuring the safety of passengers and cargo carried. Another matter of this chapter is dealing with rolling stock and containerization of transportation. In the end, there is short discussion on security and safety matters.

Railroad infrastructure includes ground area, track and track bed, engineering structures, equipment ensuring the safety of railroad operation. The railroad infrastructure does not include such items as lines situated within railway repair workshops, depots or locomotive sheds, and private branch lines or sidings. (RailNetEurope 2013, 27-28.)

4.1 HSR

High-speed rail (HSR) is a system of rolling stock and rail, which are specially designed for travelling speeds over 200km/h (modern ones – 250km/h). New HRS lines are built with the correspondence to HSR lines safety and operation regulations. It is also possible to upgrade old line to fulfill HSR road requirements. (RailNetEurope 2013, 14.)

According to the Directive 96/48 /EC, the infrastructure of the High-Speed railroads should be able to perform reliable and safe work on the speed equal or over 250 km/h and upgraded lines – 200 km/h. Same Directive implies that trains must be designed in a way that it can perform flawless on speeds over 300 km/h. HS/HC – high speed/high capacity rail lines – are those, which are able to perform transportation of freight and passengers on HSR lines.

4.2 Terminals

A terminal is a point on the route (not necessary final), where are happening next activities: overloading of goods and people, moving of containers, changing of wheel pairs etc. Usually passenger and freight terminals are integrated. The most common outlay of terminal purpose is presented by figure 2. Terminals are distinguished by the size, by purpose and by mode (air terminals, rail terminals, ports). For this thesis work, the main interest is international (big sized), intermodal rail terminals.

According to The Geography of Transport Systems, the terminals can be divided into passenger, cargo and shunting terminals (Rodrigue, J.-P. 2017).

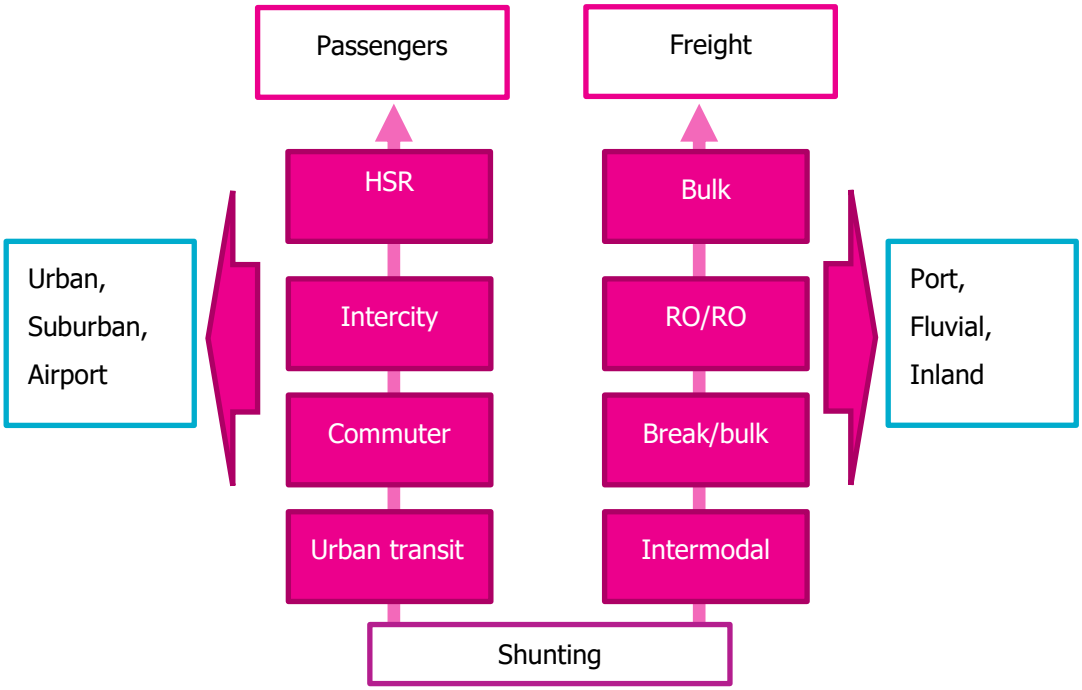

FIGURE 2. Types of rail terminals (Modified from: Rodrigue, Comtois, & Slack 2013.)

1) Passenger terminals, or rail stations, usually combine several services such as transit to the city area, HSR lines to the airports, connection point for complicated trips.
2) Cargo terminals have special facilities for loading or reloading of containers. Usually used roll on - roll off ramps, which is simplifying work and minimizing labor costs.
3) Shunting terminals are mainly used for the non-intermodal wagons and according to the 'Transport Geography'- "shunting is an important function to assemble, sort and breakdown train units based upon a variety of cargoes, origins and destinations." (Rodrigue, Comtois, & Slack 2013, 143.)

4.3 Different gauge width

Trains on the way from China are entering several railroad zones. Chinese, European and Kazakh railroads have 1435 mm width track. Russian and Finnish railroads are operating on broad-width rail track (1520 mm). Change of wheel pairs is not required on the Northern rail route. For Southern and Middle routes, the wheel changing procedure is required.

Need for adjusting of wheel pairs to gauge width carries out additional constructions for terminals and cross-border points.

Change of wheel pairs can be done by lifting the train and by lowering the wheels.

1) Raising the railway car: wagons are raised by jacks and while the current wheel pairs are rolled out, the new wheels with necessary gauge width are rolled under the wagons. Then the train is pushed down onto new wheel pairs.
2) Lowering wagon wheels: in this procedure wheel pairs are lowered down, while the carriages are fixed on one place. This is much faster and more convenient way to change wheels

on the train, but on another hand, it carries out big initial investment into technical equipment.

Wheel changing is relevant when the overload of cargo is unprofitable, or it is vulnerable to damage. Moreover, it is enabling flawless passenger transportation. Another way of dealing with track difference is adjustable wheels. Such system consists of two parts: gauge width-changing platform and adjustable wheels itself. These systems are expensive and mainly used by Chinese railroads.

4.4 Rolling stock

According to the Cambridge dictionary (2018), "train (or rolling stock) is a railway engine connected to carriages for carrying people or to wheeled containers for carrying goods". In another words, train consists of locomotive or motive wagon and wagons. For international use, trains need to satisfy ISO14001 and ISO9001 standards, referring to the environmental regulations and quality management systems.

A locomotive or motive wagon is situated in the head of the train. Usually a train has two locomotives one in the front and one at the back, for push-pull motions. The main purpose of the locomotive is to create motive power that will be moving whole train. There are several types of locomotives. In the past, there were steam engine locomotives. Modern ones are working on electricity, others are having diesel-electric engine. The use of electric locomotives decreases CO2 emissions and costs used for train operation.

In international transportation of freight container are used more and more on trains. Platforms (Appendix 3, Types of carriages.) or flatcars carrying containers are 80 ft. long. One platform is able to fit either two of 40ft containers or four of 20ft. Wagons (Appendix 3, Types of wagons.) as well as containers can be refrigerators, tank wagons, flack cars, with open roof (for bulky cargo). The choice of wagon type depends on the type of the cargo.

Unlike containers that are mainly standardized sizes, cars can have different height and width depending on the country of the production and use. An international car/wagon size is used in order to avoid problems with going under bridges, through tunnels and fitting into the track space. Passenger wagons are depending on the length of the trip. For transportation over long distances, there are night trains, which include beds and sitting places.

4.5 Container transportation

Container transportation on the route between Europe and China brings a lot of opportunities for SMEs. One of the greatest is the availability of LCL - Less than full container load. The waiting time to fill the container usually is not prolonging. This is much cheaper alternative for smaller loads of goods than air transportation.

As it was mentioned earlier, the most common ways to ship containers for international businesses are:

1) FCL – full container load, the situation when freighter has enough cargo to fulfill one container. (Bagal, S. 2015.)
2) LCL – less than full container load, the situation, which occur, when there is not enough freight to fulfill one container. Then the freighter signs the contract with consolidator to place freighters goods into the container with other freighters. (Bagal, S. 2015.)

The wide application of container in freight transportation is explained by its feasibility in use. Organizational part of container transportation is expensive, but in a matter of international transportation, it pays off very fast. Moreover, it brings a lot of benefits in multi-modal transportation. The benefits are, for example:

1) Reduction of transportation costs
2) Optimization of the documentation process
3) Safety of goods during the transportation
4) Less warehousing (goods are well protected inside of the container)
5) Reduction of additional works and costs for loading and reorganization.
6) Lower ecological risks.

4.5.1 Container types

A general-purpose container (Appendix 3, General purpose container) - Standard container is a completely closed metal box with hardened walls and the roof. On the front face, it has doors with a secure lock also for easier loading it can contain an opening rooftop. For maritime deliveries, it is made waterproof and stackable.

On each of the corner, a standard container has a casted twist lock, which is used for securing the container during the transportation. It can be used for any goods that do not need temperature regulation, ventilation or other special delivery conditions.

The typical ISO shipping containers or the general-purpose container without ventilation are 2.44 meters wide and 2.59 meters high. The length might be 6 or 12 meters. The maximum weight capacity of such container is 30400 kg out of which 2200 kg (for 20 feet container) or 3800 kg (for 40 feet container). (ISO 2013.)

Cistern (Appendix 3, Cistern) - For transportation of liquid cargo, a tank container is used. A tank container (or cistern) has cylindrical shape with overall volume of 14000l to 26000l. Almost all of the containers are made on the 20 ft. frame. General use containers – tank containers are following the ISO regulations for containers. (ISO 2013.)

According to the ITCO (2016), 46% of all tank containers are produced by CIMS (Tank container fleet survey, 2016, 4). A cistern can be with or without thermal insulation, with internal coating for acids, with additional constructions (ladder, thermometer, and path) and it can be made from stainless steel or structural steel. (ISO 2013.)

4.6 Security and safety

Security and safety of railroads is another important factor influencing attractiveness of a route. The main aspects identifying safety of rail transportation are determined by "railway safety management system". On the territory of Russia loaded containers and wagons must be closed with a locking-sealing device. (RZD 2015.)

The use of Locking-sealing devices (Appendix 3, Locking-Sealing Devices) helps:

1) To confirm the fact of access to the sealed car (container) or the absence thereof;
2) To protect the cargo from unauthorized access;
3) To divide the measure of legal and material responsibility for the safety of cargo in the process of its transportation between the participants in the transportation process;
4) To provide law enforcement authorities with additional information to investigate the theft and take appropriate decisions. (RZD 2015; ISO 2013.)

4.7 Signaling

Railway signaling systems (Appendix 3, ERTMS/ETCS levels) are ensuring traffic safety and preventing trains from colliding. For communication of trains, GSM-R mobile communication system is used. GSM-R is a sub-system used specifically in railroad transportation. The European Railway Traffic Management System (ERTMS) or ERTMS/ETCS system used for control over train. ERTMS is a completely standard programme and ETCS is its component. (ERTMS 2015.)

ERTMS/ETCS system has different levels according to The European Rail Traffic Management System, (2013):

"1 level" - Eurobalise without infill – It can be used on top of the already existing signaling system.
"2 level" - Eurobalise + infill (euroloop, radio, or extra balises)
"3 level" - Eurobalise + Euroradio (GSM-R) + Radio Block Center
"4 level" - Eurobalise + Euroradio (GSM-R) + Radio Block Center

A great advantage of ETCS is enabling to reach maximum speed (minimizing total travelling time). Moreover, integration of ETCS level 2 takes away the need in track signaling constructions and as a result, it brings lower maintenance costs. (ERTMS 2015.)

In Finland rail lines use ATP system. This system is relatively old, yet still reliable. ATP system uses a braking model concept. It is regulating maximum allowed speed of train depending on the distance to the possible obstacle and current speed of the vehicle. In addition to that, ATP system calculates breaking patter depending on the physical characteristics of the vehicle. If the speed is higher than allowed, the breaking system reacts automatically.

5 TRANSPORTATION DATA

Chapter 4 consists of three parts. The first part is concerning the freight transportation data necessary for this study in the current situation of EU/China trade, thus what and in which volumes flows. The second part is connected to the passenger transportation by the routes. Finally, the documentation requirements are presented in the third part of the chapter.

5.1 Freight transportation

It is relevant to transport by railroad such cargo as high value goods, mail/e-commerce, products with a short life cycle and food products. As a separate category, transportation of cars and spare details should be taken. Transportation of food products is limited by road and railroad through the territory of Russia and to the third countries (thus Kazakhstan). It is possible to send such goods by rail, due to the relatively high value combined with low cost of delivery.

Sea route is the slowest and the cheapest way to transport goods from China to Europe. In average shipment by maritime mode takes 44-45 days (Jakobowski, J. et al. 2018). Mainly it is used for the cargo, which does not rely on fast market change. The best example is Christmas decoration – it is cheap and is not required on the market most part of the year, therefore it is possible to be transported via maritime route. Although the problem appears when commerce needs to be delivered far into inland, total shipment cost and waiting time might double.

Railroad routes from China is the great opportunity for the cargo that depends on fast changing market – such as clothing and electronic devices, which are not valuable enough to be carried by air transport. Constantly growing rail network can almost present door-to-door transportation.

Over past few years, the trade between China and EU countries has expanded rapidly. Although the majority of the transactions are still happening by sea or air modes, rail is showing growth of popularity. That is easily explained by the constant technologies improvement, innovations and network growth. (European Commission)

European Union, Trade with China

Trade flows by SITC section 2017

Source Eurostat Comext - Statistical regime 4

	Imports				Exports			
	Value Mio €	% Total	% Extra-EU	% Growth	Value Mio €	% Total	% Extra-EU	% Growth
Total	374,823	100.0	20.2	8.6	198,200	100.0	10.6	16.8
0 Food and live animals	5,001	1.3	4.8	4.2	7,729	3.9	8.8	3.7
1 Beverages and tobacco	145	0.0	1.7	-4.6	2,357	1.2	6.9	18.8
2 Crude materials, inedible, except fuels	2,995	0.8	4.5	9.7	11,363	5.7	25.6	22.2
3 Mineral fuels, lubricants and related materials	440	0.1	0.1	-0.7	5,557	2.8	5.6	55.2
4 Animal and vegetable oils, fats and waxes	110	0.0	1.0	51.8	251	0.1	4.7	-23.0
5 Chemicals and related prod, n.e.s.	18,228	4.9	9.4	13.5	25,058	12.6	7.5	14.4
6 Manufactured goods classified chiefly by material	46,598	12.4	23.3	5.6	16,220	8.2	8.0	19.4
7 Machinery and transport equipment	195,018	52.0	32.9	12.2	107,570	54.3	13.6	16.4
8 Miscellaneous manufactured articles	104,791	28.0	37.9	3.4	18,701	9.4	8.5	17.6
9 Commodities and transactions n.c.e.	811	0.2	1.3	-15.1	1,484	0.8	2.5	-31.1
Other	686	0.2	n.a.	n.a.	1,909	1.0	n.a.	n.a.

FIGURE 3. EU trade with China (source: European Committee – Statistics, 2017)

Over the last year, exports of SITS section grew for 16.8% comparing to 2016. Significant changes happened in mineral fuels, machinery and transport equipment and miscellaneous manufactured ar-

ticles. Imports on the other hand grew only for 8.6% (figure). There were imported large amount of goods of a total value of 378,823 million €.

The railroad share in EU-China trade grew over past few years. Although even doubling transaction volumes by railroads leave it with 2.6% of share.

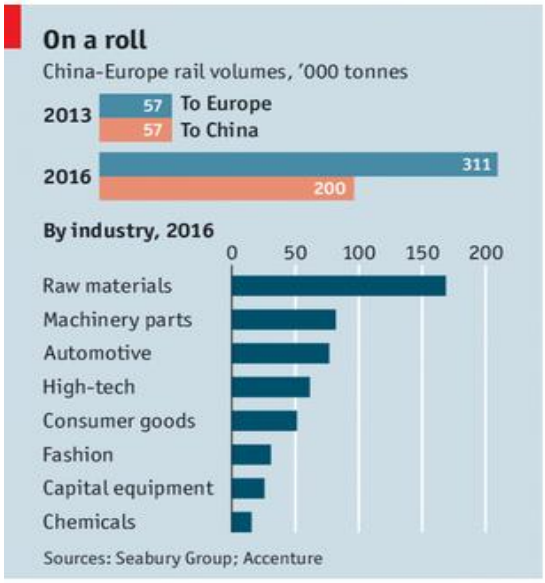

FIGURE 4. Railroad share of trade between China and Europe (Source: Seabury Group: Accenture)

In the end of 2016, the leading positions of goods transported by rail are taken by raw materials and machinery parts. The high rise of railroad transportation is also explained by subsidies given by the government of China. If in the end of 2013 trade was balanced, later it is possible to see rapid growth of volume (6 times more in 2016) transported to Europe by railroad. On the other hand, export from European side grew as well, but already in 4 times.

5.2 Passenger transportation

Passengers are choosing international rail transportation for several reasons. For example, for people who cannot use air transportation (pregnancy, heart problems, fears etc.) railroad is a great alternative. Transportation between EU and China is going through Russia. First, passenger needs to reach either St. Petersburg or Moscow. Next train goes towards Kazakhstan, where passengers need to change train again. Next destination will be China. Thus, from the point of view of a passenger transportation from Russia to Central Europe (or opposite) – route through Belorussia and Poland is still the most attractive.

Despite the fact that travelers from Saint Petersburg are supposed to be more attracted to the rail route through Helsinki, total trip cost is significantly higher than that for Polish route. In addition to that, the route through Helsinki towards Central Europe includes the need for change of several modes of transportation: railroad, by ferry and road (bus).

5.3 Documentation

Transportation from China to Europe, whether it is passenger or cargo, requires certain set of documents. Clear documentation minimizes risk of terminal congestion and total travel time prolongation. Longer waiting time means additional costs for freight transportation as well as for passengers.

Passengers, who are not citizens of Russia, need to have a visa. It is possible to apply for a visa at the local Russian Embassy or Consulate. Usually visas are issued within one or two weeks. There are few exceptions, when there is no need for visa to travel to/through Russia. One of such exceptions is a cruise from Helsinki to St. Petersburg. In such cruise the tourist spends less than 72 h on the territory of Russia.

Documents needed for freight transportation:

1) Packaging list
2) Invoice
3) Export Declaration

Nowadays most of the logistics companies are using "cargo declaration" which contains all the necessary information about the cargo carried. Clear documentation not only eases and fastens the process of crossing the border, but also ensures the secure delivery.

6 COMPARISON

In this chapter it will be compared routes from the matter of distances, volumes transferred back and forth, and technological equipment of railroads. In the end of the chapter it is discussed risks of each route – mostly political risk and environmental impact.

6.1 General overlook

Table 1 shows the general comparison of three rail routes. The route via Finland is the shortest rail connection between Europe and China at this moment. The difficulty occurs when freight needs to be transported further. Thus, even though Northern route is the shortest; overall, delivery time for customers in central Europe or Baltic countries might be longer. The delivery by Southern route via Slovakia takes 17 days in average, although the time will become shorter in the near future due to infrastructure of terminals in Slovakia and new railroad lines construction. In 2017, there were transported 500 trains of cargo and for year 2018 that is planned to be increased by 2000 trains. (Spectator 2017.) The transition of wheel pairs of the train is happening in the Dobra terminal, near the Ukrainian border.

The routes via Slovakia and Poland have standard European gauge width, 1435 mm, when the route via Finland has 1520 mm track. The changing points from broad railroad to standard happens in the Dobra Terminal (Slovakia) and Brest/ Malaszewicze (Polish/Belorussian border). Change of wheels on Northern route is not required.

All of the routes are able to work with containers as well as with wagons, but Slovakian terminals are mainly concentrated on container transportation. Nevertheless, swap-body terminals are operating as well. In Finland, flow of cargo is going through Kouvola intermodal terminal.

Nowadays, the middle route via Poland is the most convenient. The biggest advantage of this rail route is its well-established logistic systems. This route is important for economical strengthening of Belorussia.

TABLE 1. General comparison

	Northern	*Southern*	*Middle*
From - to	Kouvola (Finland) Xi'an (China)	Bratislava (Slovakia) Dalian (China)	Chengdu (China) Lodz (Poland)
Distance	~ 8000 km	11000 km	9559 km
Travel time	10 days	17 days	14 days
Volumes	-	500 trains	3000 trains
Frequency of departure	2 times/week	2 times/ week	8 round trips/week
Countries involved	Russia, Kazakhstan	Russia, Kazakhstan, Ukraine	Russia, Kazakhstan, Belorussia
Main operator	VR Group	ZSR	PKP Group
Gauge width	1520 mm	1435 mm	1435 mm
Wheels changing point	Same gauge width	Dobra Terminal (Slovakia)	Brest/Malaszewicze

6.2 Volumes and frequency of transactions

Volumes of transaction on the routes are growing. In the end of 2017, it was planned to dispatch one train per week from Finnish terminal of Kouvola, but due to growth of transition volumes, frequency of dispatches had to be increased up to two times a week. Volumes transported via the middle route are higher and therefore frequency of dispatches is eight round trips a week.

Frequency of departures on the Southern route is two times a week. Frequency of departures is going to change. The main reason for frequency increase is the growth of trade volumes trade between China and EU.

Passenger transportation by Finnish rail roads grew 7% comparing to previous year (VR Group 2017). Passenger transportation by Polish railroads for the second quarter of 2017 was 77 624.34 thousand passengers. This is 10.5 % more comparing to previous year.

Passenger and freight transition volumes data for Southern route is at least two years old and therefore it was not taken into consideration.

6.3 Infrastructure

Infrastructure of routes and railroads include such aspects as track itself (HSR, Electrified lines), rolling stock (locomotives, carriages or wagons, platforms) and terminals. The infrastructure comparison will begin with terminals evaluation.

6.3.1 Terminals

On the route via Finland, cargo is going through Kouvola terminal. The biggest advantage of this terminal is multimodal orientation and possibility for expansion. In the Cargo East Terminal (Table 2) big share of handled goods are timber, pulp, paper and steel.

Overall, it is possible to see that the route via Slovakia is concentrated on container transportation. In general, there are eight freight terminals, out of which two are suspended. Nevertheless, the rest of intermodal terminals are able to present smooth handling of containers, swap bodies and semi-trailers. The change to standard rail gauge happens in "International terminal Dobra". The terminal is equipped with two units of 2x50-tonne rail mounted gantry crane and LUNA RLS-45-CT solution for operations with containers. (Hricova 2017)

Malaszewice container terminals are able to handle about 612 TEU/day. The complex of terminals situated in Malaszewice includes a universal terminal, which has storage areas of 69 606 m^2 and re-loading capacity of 3,328,800 ton/year. (PKP cargo)

TABLE 2. Comparison of terminals

	via Finland	via Slovakia	via Poland
Terminal	Cargo East Terminal	Intermodal terminal Dobra (change or gauge)	Małaszewicze container terminal
Handling of	containers, swap body, semitrailers, bulk containers	containers, swap body, semitrailers	containers, swap body, semitrailers
Total area	-	180 750 m^2	-
Internal storage	25 000 m^2	open: 2 640 m^2, covered: 245 m^2	1 872 TEU
Technical Equipment	1x30-tonne gantry crane	2x50-tonne rail mounted gantry crane; LUNA RLS-45-CT	3x37/40/45-tonne gantry cranes; 1x40-tonne wheel crane
Level of congestion	low	average	high

6.3.2 HSR

High-Speed-Rail in Europe together with convenient railroads is a part of the TEN-T framework. European Commission Directives regulate requirements for HSR lines and rolling stock. Electrification

of track plays an essential role in control of carbon emissions. Moreover, railroad electrification enables lowering overall transportation costs.

TABLE 3. HSR lines comparison

	Finland	Slovakia	Poland
Total length of HSR	610 km	-	470 km
Aplicapable for passenger trains Freight transport	combined	combined	combined
Maximum speed	220 km/h	250 max allowed	200 km/h
Electric cuttent	25 kV 50 Hz	3 kV DC	3 kV DC

Length of HSR lines in Finland is 610 km. The maximum speed allowed on the route is 220 km/h; however, that has changed for urban HSR connection (for example train from airport). The length of Slovakian HSR lines is very small and it is not defined. HSR lines in Poland are connected with German lines. Total length of HSR lines in Poland is 470 km with maximum allowed speed of 200 km/h.

6.3.3 Rolling stock and track

The trains on the route do not always belong only to the main railroad operator (inside of the country). This way trains and containers on the route via Finland belong to KTZ (Kazakh Rail Company). Therefore, it was decided to compare track capabilities. (European Parliament 2016.)

The maximum axial load estimated by the agreement between Finland and Russia is 22.5 tons. Southern and Middle routes' maximum axial loads are different. The estimation is at 27 tons per axile for Southern route and 22 tons for Middle route. Rolling stock dimensions are necessary for ensuring safe moving of train under the bridges, in the tunnels, etc.

Rolling stock dimensions are estimated (table 4) in order to ensure safe transportation of trains under the bridges, into the tunnels and in narrow spaces.

TABLE 4. Track capabilities comparison

	via Finland	via Slovakia	via Poland
Maximum axile load	22.5 tons	27 tons	22 tons
Maximum allowed speed	120 km/h (220 km/h)	120 km/h	120 km/h (160 km/h)
Maximum train length	more than 800 m	750 m with locomotive	750 m with locomotive
Rolling stock dimensions	5300 mm x 3400 mm	4700 mm x 3200 mm	4700 mm x 3200 mm

6.3.4 Signaling systems

On the territory of Europe ERTMS/ETCS systems are mainly used. On the end of year, 2017 according to official VR data in Finland majority of the trains are equipped with automatic train protection (ATP) and only 80 trains are operating with ETCS level 1 system. In the near future VR, will completely integrated ERTMS system.

Southern and Middle routes have greater usage percent of ETCS systems of level 1 and level 2. Level 2 is necessary for safe operation of HS/HC rail lines.

TABLE 5. Signaling systems

	Northern	Southern	Middle
Main System	ATP-VR/RHK	LSD	SHP
ERTMS level	Level 1	Level 1, Level 2	Level 1, Level 2
N of vehicles	80 units	5 units	88 units
Length of track (total)	100 km	232 km	1960 km

6.4 Connectivity

The main goal of EU (and World) transportation development is to present flawless transportation of freight and passengers over different destinations. That is achieved by expansion of inland and sea routes network.

TEN-T core corridors are connecting Scandinavian countries with Central Europe. The Scandinavian-Mediterranean corridor, which length is more than 9300 km of railroads (European Commission, 2016) is connected with Northern route. Except for inland corridors, Northern route is connected with central Europe through seaports of Rotterdam (Netherland), Copenhagen (Denmark) and Hamburg (Germany). Despite the fact that Kouvola terminal is located far inland, there is streight rail connection to Finnish seaports and airports. Streight connection between Kouvola and St. Petersburg by the Allegro train takes just 2h 20min. (The city of Kouvola 2017.)

Poland is crossed by two European Rail Freight Corridors - RFC 8 and RFC 5. Similarly, Southern route railroads are integrated with RFC 5, RFC 7 and RFC 9.

European Rail Freight Corridors (RailNetEurope 2017):
RFC 5 – Baltic-Adriatic corridor, with the length in 4,825 km. It connects Poland, the Czech Republic, Slovakia, Austria and Italy.
RFC 7 – Orient-East Med corridor, length in 7,700 km. It connects the Czech Republic, Austria, Hungary, Romania, Greece, Bulgaria and Slovakia.
RFC 9 – Rhine-Danube corridor, length in 970 km. It connects the Czech Republic and Slovakia Speed allowed for freight containers is 120 km/h. Connecting terminals are in Bratislava, Zilina, Kosice and Dobra.

On the other hand, distribution companies, retail, and passengers already tested rail route through Poland. That leads to greater trust to the Polish rail route. Slovakia is just one hour away from the capital of Austria, Vienna. When the train with cargo is arriving to Bratislava, it can go further by the same railroad to Austria, Check Republic and Hungary.

6.5 Risk Evaluation

Political risk has a great impact on route choice for passengers, who are seeking for safe and fast way to get to the destination, as well as for SME's and government companies. Constantly changing situation between EU and Russia and Russia and Ukraine leads companies for seeking new ways of transportation of their goods, simply because they are afraid their cargo will be arrested at the border.

On the other hand, the situation is stabilized by OBOR arrangements and specifically contracts between Russian and Chinese governments. As it was mentioned in Chapter 4, the EMBARGO is slowing down whole progress of trade between EU and China. Meat and fish products, which could be transported by rail, are yet transported either by air or by marine transport. In the end, it leads to over high product prices on the market, which majority of population simply cannot afford to buy.

Due to geographical positioning of Slovakian route, the impact of political risk is the highest among other rail routes. Agreements and long-term contracts are ensuring the stability and protecting low dependency of Northern and Middle rail route from change of political situation.

TABLE 6. Risk evaluation

	Northern	*Southern*	*Medium*
Political risk	2	4/5	1
Environmental	1	1	1
Cargo damage	1	2	3
Rolling stock break.	1	2	1
Punctuality – delays	1	3	4/5

(The evaluation is done by 0-5, where 0 – is the minimal impact and 5 – is high impact)

Environmental risk is correlated with not only carbon emissions, but also the effection of construction for people living near by the railroad. Thus, noise pollution caused by the cast iron braking systems (for freight trains) and in general, noise caused by train is one of the main concerns for all of railroads. On the other hand, all of the EU railroads have to satisfy the requirements of Directive and therefore the environmental impact is estimated at a minimum level.

Risk of cargo damage depends on several factors: level of congestion of ports and rail terminals, level of handling of wagons and containers during wheel changing or cargo overload.

Rolling stock breaks are possible to be minimized by increasing the level of maintenance works and amount of maintenance points.

Risk of delay – as well as cargo damage depend on congestion of terminals. Another factor affecting risk impact is unclear or not full documentation is needed for cross-border points. According to the key figures of VR annual report (VR Group, 2017) train punctuality in average reaches 90%, where-

as punctuality in rail freight services is 91.2%. This way it is possible to say that, the risk of delay on route via Finland has a low impact.

7 RESULTS

The results of this study are based on the literature research and data collected from specialists. In the previous chapter, the routes were compared on the matters of technological equipment of the roads, distances and flexibility. In addition to that, routes were evaluated from the point of different risks that might occur. Further in this chapter presented pros, cons, and evaluation of each route will be. All of the interviewed specialist answered that route attractiveness firstly comes from the final destination and the specifics of the cargo. As for passenger transportation, there is no clear outline for choosing one or another route, but usually it also depends on the final destination and mostly on the estimated correlation of budget /to time, that the passenger is ready to spend on a trip.

7.1 Northern – via Finland

Northern route is attractive mostly for transportation to the Scandinavian countries – especially Sweden and Norway. Previously all of the cargo was going either by sea route or through Poland and then delivered to the ports of Scandinavian countries.

Table 7 is presenting pros and cons for the Finnish rail route. The strength of Northern rail route is in the same gauge width with Russian railroad. It means there is no need to overload cargo twice on the way from China, only once on the Chinese-Kazakhstan border. Therefore, there is less risk of damage to the cargo carried and less need for labor involving. Labor expenses are high in Finland, and the possibility to minimize it creates a great advantage. On the other hand, there are plenty of maintenance points and labor is very well educated, so there is lower risk of repetitive maintenance works.

TABLE 7. Pros and Cons for Northern route

Pros	*Cons*
- Terminals and ports are not congested - Time of delivery (10 days) - Distance - 1520 mm rail gauge - Long HSR lines - Possible expansion of Kouvola terminal area - Construction of Baltic tunnel - Arctic connection to Norway and Russia - New connections with sea ports - High impact on economy of Nordic countries - Strong development in the planning and maintenance of VR Track - Use of "Green" technologies	- Expensive labor - High taxes - Possible economic problems - Additional time for customers in Central Europe - "isolation" of Finnish railroad from rest of the EU countries - Low use of ECMS signaling systems

The competitiveness of the Kouvola-Xi'an route is boosted by subsidies that China offers to all Europe-bound cargo train links launched under its Belt and Road initiative. The opening of Baltic tunnel will bring many opportunities for transportation to Central Europe. It will connect corridors of Central Europe with Finnish railroad.

7.2 Southern – via Slovakia

The competitive advantage of Slovakian route is its geographical location. Slovakian rail lines are integrated with three other European Rail Freight corridors. Another advantage is its infrastructure of terminals and specialization on container transportation. Sealing-locking devices together with electronic custom clearance minimize time spend on the border. Gantry cranes used for loading of containers are able to perform at high speed. Construction of broad-gauge track will enable direct transportation of goods to Vienna. This way customer in Central Europe will be receiving their orders sooner.

All these factors should lead to the increase of transaction volumes via Slovakia. Moreover, the capacity of Slovakian railroads allows increasing volumes of transactions. Despite this, further work of the route and its attractiveness is highly depending on the political situation.

The rest of pros and cons of Southern rail route are presented in Table 8.

TABLE 8. Pros and Cons of Southern route

Pros	*Cons*
- Low taxes - Broad-gauge rail line construction - Specialization on work with containers - Geographical location - Cheap labor - High integration of lines operating with ERMS signaling systems	- High political impact on route attractiveness - Low flexibility of railroad network - Few own units (vehicles) operating on ERMS systems

7.3 Middle – via Poland

The Middle route is very congested nowadays. There are many delays because of long time spend on the border. On the other hand, the route is already time-tested, and many logistic companies have long/term contracts especially for this route.

Transportation by the Middle route carries out the need for cargo overload. The first one is happening on the Chinese/Kazakhstan border (change from 1435 mm to 1520 mm). Second overload of freight is happening on Brest/Malaszewicze border (from 1520 mm gauge to 1435 mm). Additional operations are prolonging the delivery time.

The Polish rail route is highly attractive for passengers going from Russia (through Belorussia) to West and Central Europe. Flexible system of discounts for students, elderly passengers, kinds and groups of travelers the increase interest of people. In overall, there are two cross-border check-points, but there is no need for changing the train. It means that a passenger can travel from the beginning to the end on one train with one ticket purchased.

TABLE 9. Pros and Cons of Medium route

Pros	Cons
- Shortest route connection between Central Europe and Russia - Easy access to the ports - High passenger interest - Hi-tech infrastruture - Low-cost labor - High impact on the economy of Belorussia	- Need for cargo overload - Congestions in terminals - Delays at Malaszewicze / Brest border crossing - Distance - Time of delivery - Terminals exploited all possible capacity

8 CONCLUSIONS AND DISCUSSIONS

This thesis work was arranged in the logical line from presenting the routes, explaining reasons for railroad transportation and leading towards comparison of three routes from China to Central Europe and Scandinavian countries.

The main goals of the study were:

1) To study each route and its possibilities
2) To compare routes pros and cons
3) To make analysis and to determine which route is good for different kind of transportation needs and business activities.

The secondary goal was to find out which rail route is the most attractive for the passenger transportation.

The routes were analyzed, compared and evaluated and final data was presented in Chapters 6 and 7. All in all, it is clearly seen that each route is aimed for its own market areas. New routes' construction is connected with the congestions of previously existing rail routes and marine ports.

The rail route via Finland mainly concerns Scandinavian countries and partly Northern European countries. The hub happens via seaports, from where cargo can be transported further to Germany and Baltic countries. The rail route via Finland is the most favorable at this moment for freight transportation. It is safe, technologically advanced and fast. Attractiveness of the route for passenger transportation can be achieved by reduction of prices for international connections.

Southern route, via Slovakia is concentrated on container trains. The terminals on the route are fully equipped for overloading containers. The competitive advantage of the route is in its geographical location, but at the same time near location with Ukrainian border creates high dependence on political risk.

The Polish rail route is the most attractive for passenger transportation between European countries and Russia. The situation with the freight transportation is different. Transportation takes longer than by the rest of the routes, not only because of the routes' length, but also because of the congestion situation in the terminals.

As a conclusion, it could be said that the distribution of freight by the existing routes and creation of new ones could change the situation with congestions in ports and rail terminals of Europe.

During the thesis work the author improved skills in academic writing. The most complications occur with collecting the relevant data, which is changing fast due to the fast growth of railroad connections. The literature existing is already outdated. The decision was to rely on official statistical data and certified web resources.

Another complication was in finding specialists for interview in railroad transportation, economics, and logistics sphere. The interview questions were sent to 13 specialists, out of which two gave valuable data for the thesis work. Due to the strict data protection policies the majority of the specialists were not able to answer interview questions. Nevertheless, the collected data brought significant value to the thesis work.

In conclusion, it is possible to say that the author is satisfied with the results of the study. Despite various issues met, the set goals of the thesis work were achieved. The collected data is relevant and can be used for further research.

REFERENCES

ADVANTOUR 2017. Маршруты Великого Шелкового пути [webpage]. Advantour [Accessed 13 May 2018). Available from: https://www.advantour.com/rus/silkroad/routes.htm

BAGAL, S. 2015. Difference between FCL and LCL [web publication]. LinkedIn [Accessed 5 December 2017]. Available from: https://www.linkedin.com/pulse/difference-between-fcl-lcl-bagal-seeking-challenging-position-with

CAMBRIDGE DICTIONARY 2018. Meaning of "train" in the English Dictionary [webpage]. Cambridge University Press [Accessed 1 November 2017]. Available from: https://dictionary.cambridge.org/dictionary/english/train

CHINA DAILY 2017. First China-Finland train connection launched [webpage]. China Daily Information Co. [Accessed 2 December 2017]. Available from: http://www.chinadaily.com.cn/world/2017-11/11/content_34404277.htm

DESSLER, G. 2005. Human Resource Management. Interviewing Candidates. [online presentation]. Slideshare [Accessed 12 January 2018]. Available from: https://www.slideshare.net/hcc79/hrm-chapter-no7-interviw-of-employee

DR BEN-ELIYAHU, A. 2014. The Chronicle of Evidence-Based Mentoring [web publication]. On Methods: What's The Difference Between Qualitative and Quantitative Approaches? [Accessed 11 December 2017]. Available from: https://chronicle.umbmentoring.org/on-methods-whats-the-difference-between-qualitative-and-quantitative-approaches/

DZUBAKOVA, M., & MELICH, P. 2018. The Slovak Republic as a part of the Silk Road project. Economic Review, 47(1).

ERTMS 2015. European rail traffic management system [webpage]. Rail System [Accessed 2 April 2018]. Available from: http://www.railsystem.net/european-rail-traffic-management-system/

EUROPE UNION 2008. Directive 2008/57/EC [webpage]. EUR-Lex [Accessed 11 January 2018]. Available from: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32008L0057

FORUM 1520 - MONITORING 2018. Monitoring SMI [Document]. Forum1520 [Accessed 18 March 2018]. Available from: http://forum1520.com/2018/monitoring.pdf

GREY, E. 2016. Helsinki-Tallinn rail tunnel: a future European link? [web publication]. Railroad-Technology [Accessed 6 November 2017]. Available from: https://www.railway-technology.com/features/featurehelsinki-tallinn-rail-tunnel-a-future-european-link-4827400/

GUDOK 2018. Monitoring SMI [Document]. Forum1520 [Accessed 18 March 2018]. Available from: http://forum1520.com/2018/monitoring.pdf

HILLMAN J. E. 2018. The Rise of China-Europe Railways [web publication]. CSIS [Accessed 2 April 2018]. Available from: https://www.csis.org/analysis/rise-china-europe-railways

HRICOVÁ, R. (2017). Situation On Intermodal Terminals in The Slovak Republic. Acta logistica - International Scientific Journal about Logistics, 4(3), 19-23.

ISO 2013. ISO 17712:2013 - Freight containers - mechanical seals [webpage]. ISO/IEC [Accessed 6 February 2018]. Available from: https://www.iso.org/obp/ui/#iso:std:iso:17712:ed-2:v1:en

ISO 2013. ISO 668:2013. General purpose containers

ISO 2013. ISO14001:2015 Environmental management systems [webpage]. ISO [Accessed 12 February 2018] Available from: https://www.iso.org/obp/ui/#iso:std:iso:14001:ed-3:v1:en

ISO 2016. ISO 9001 Quality management [webpage]. ISO [Accessed 14 November 2017]. Available from: https://www.iso.org/iso-9001-quality-management.html

JAKOBOWSKI, J. POPLAWSKI, K. & KACZMARSKI, M. 2018. The Silk Railroad. *The EU China connections: background, actors, interests*. [Online journal] Warsaw, Poland: Ośrodek Studiów Wschodnich im. Marka Karpia. 72. [Accessed: 10.03.2018] Available from: https://www.osw.waw.pl/sites/default/files/studies_72_silk-railroad_net.pdf

KOSE, K. 2015. Project – TALSINKIFIX [online presentation]. Liikennevirasto [Accessed 7 December 2017]. Available from: https://www.liikennevirasto.fi/documents/20473/205877/KaarelKose.pdf/df4b5884-fb54-4708-af5d-1ee7bc3bb3ab

KOUVOLA 2017. Businesses, entepreneurship and work [webpage]. The city of Kouvola [Accessed March 12, 2018]. Available from: https://www.kouvola.fi/en/index/services/businessesentrepreneurshipandwork.html

LEE, A. 2017. A brilliant plan: One Belt, One Road [web publication]. CLSA [Accessed 14 April 2018]. Available from: https://www.clsa.com/special/onebeltoneroad/

MALTERER, M. 2017. China - what is OBOR? - A succinct summary from The World Bank [web publication]. LinkedIn [Accessed 10 March 2018]. Available from: https://www.linkedin.com/pulse/china-what-obor-succinct-summary-from-world-bank-malterer-%E7%B1%B3%E9%AB%98%E9%A9%AC%E7%89%B9%E9%9B%B7%E5%B0%94%E5%8D%9A%E5%A3%AB

MERCATOR INSTITUTE FOR CHINA STUDIES 2017. The Silk Road Initiative [image]. Merich China Mapping [Accessed 23 February 2018]. Available from: https://www.merics.org/en/china-mapping/silk-road-initiative

OECD/IEA. (2015). Sustainable freight transport. Geneva.

PKP CARGO. Characteristics of intermodal terminal [webpage]. Clmalaszewicze [Accessed 10 April 2018] Available from: http://en.clmalaszewicze.pl/images/stories/kontenerowy/eng/Characteristics%20of%20INTERMODAL%20TERMINAL.pdf

RAILNETEUROPE 2013. Railway / Rail Infrastructure (EU Definition) [webpage]. Defined term [Accessed 2 April 2018]. Available from: https://definedterm.com/railway_rail_infrastructure_eu_definition

RAILNETEUROPE 2017. European Freight Corridors [webpage]. RailNetEurope [Accessed 12 December 2017]. Available from: http://www.rne.eu/rail-freight-corridors/rail-freight-corridors-general-information/

RESEARCH METHODOLOGY 2017. Interview [web publication]. Research methodology [Accessed 11 November 2017]. Available from: https://research-methodology.net/research-methods/qualitative-research/interviews/

RODRIGUE, J.-P. 2017. The Geography of Transports Systems [webpage]. Transport geography [Accessed 14 April 2018]. Available from: https://transportgeography.org/?page_id=3606
RODRIGUE, J-P. CLAUDE, C. & SLACK, B. 2017. The Geography of Transport Systems 3th edition. New-York

RZD 2017. Trans-Siberian railways [webpage]. Russian Railways [Accessed 10 December 2017]. Available from: http://eng.rzd.ru/statice/public/en?STRUCTURE_ID=87

RZD 2017. Грузовые перевозки [webpage]. Запорно-пломбировочные устройства [Accessed 9 February 2018]. Available from: http://cargo.rzd.ru/static/public/ru?STRUCTURE_ID=5189

SPECTATOR 2017. First trial freight train from China arrives in Bratislava [web publication]. The Slovak Spectator. [Accessed 2 December 2017] Available from: https://spectator.sme.sk/c/20695576/first-trial-freight-train-from-china-arrives-in-bratislava.html

STATISTA 2014. Reasons for international traveling [webpage]. Statista [Accessed 10 May 2018]. Available from: https://www.statista.com/statistics/367749/reasons-for-international-travel-among-travelers-us/

UNESCO 2018, About the Silk Road [webpage]. Unesco [Accessed 1 January 2018]. Available from: https://en.unesco.org/silkroad/about-silk-road

VR GROUP 2017. Annual report 2016 [webpage]. VR Group [Accessed 12 February 2018]. Available from: http://www.vrgroup.fi/en/annual-report-2016/

VR GROUP 2017. VR Financial Statement 2016. Helsinki, Finland: Authorized Public Accountant

VR GROUP 2017. VR Group Responsibility report 2016. Helsinki, Finland: VR Group

WEEDY, S. 2017. Timber & fish cargo marks Finland's entry to New Silk Road [web publication]. RailFreight [Accessed 2 February 2018]. Available from: https://www.railfreight.com/corridors/2017/11/14/timber-fish-cargo-marks-finlands-entry-to-new-silk-road/

YLE 2017. Feasibility study for Helsinki-Tallinn tunnel to wrap up this year [web publication]. Yle News [Accessed 7 December 2017]. Available from: https://yle.fi/uutiset/osasto/news/feasibility_study_for_helsinki-tallinn_tunnel_to_wrap_up_this_year/9458362

APPENDIX 1: INTERVIEW QUESTIONS

Specialists interview questions:

1) What are competitive advantages of (Southern/Medium/Northern) route?
2) What are the disadvantages?
3) How opening of Baltic tunnel can change the situation?
4) Does capacity of (Slovakian, Polish, Finnish) railroads allows increasing transit volumes from China to central Europe?
5) How does the technological equipment of railroads influence routes choice for (the passenger?) logistic companies?
6) What could be done in order to increase attractiveness of (Southern/Medium/Northern) route?

APPENDIX 2: COMPARISON OF THREE COMPETING RAIL ROUTES

Article for e-magazine: "SILK ROAD: COMPARISON OF THREE COMPETITIVE RAIL ROUTES"

Transportation of passengers and freight between Asia and Europe can be done by air, maritime and railroad mode. While the passengers obviously prefer air mode, goods are mainly transported by maritime mode. General population growth causes greater need for transportation of passengers and goods. Railroad transportation is becoming faster and more flexible with new technologies applied. From the economic and business point of view, freight transport opens opportunities for new market entries and larger markets can be served. Passenger transportation is enabling cross-cultural communication, which can lead to new connections and contracts.

Three new rail routes connecting China and Europe are so-called Northern, Southern and Middle. Northern is going via Finland, Southern – via Slovakia and middle – via Poland.

Northern route is the shortest one. Its length only 8000 km (from Xi'an to Kouvola) and delivery takes on average from 10 to 12 days. Comparing to two other routes, Northern is the least congest and therefore the risk of delay is minimized. Rail route via Finland main concern is Scandinavian countries and partly Northern European countries. The hub so far is happening via seaports, where cargo can be transported further to Germany and Baltic countries. Northern rail route is the most favorable at this moment for freight transportation. It is safe, technologically advanced and fast. Attractiveness of the route for passenger transportation can be achieved by reduction of prices for international connections.

Rail route via Slovakia is going through the territory of Kazakhstan, Russia and Ukraine. The length of the route from Dalian (China) to Bratislava (Slovakia) is 11 000 km and trip takes 17 days. The advantage of southern route is its geographical location. Slovakian rail roads are integrated with tree Rail Freight Corridors (RFC) – RFC 5, RFC 7 and RFC 9. Another advantage is its infrastructure of terminals and specialization on container transportation. Sealing-locking devices together with electronic custom clearance minimize time spend on the border. Gantry cranes used for overload of containers are able to perform at high speed. Construction of broad-gauge track will enable direct transportation of goods to Vienna. These way customers in Central Europe will be receiving their orders sooner. All these factors should lead to increase of transaction volumes via Slovakia, moreover capacity of Slovakian railroads allow increasing volumes of transactions. Despite said above, further work of the route and its attractiveness highly depending on the political situation.

Middle route – via Poland is 9559 km and delivery takes 14 days. Transportation by middle route carries out the need for cargo overload from 1435 mm gauge to 1520 mm width. Additional operations are prolonging the delivery time. Moreover, middle route is very congested nowadays. There are many delays because of long time spend on the border. On another hand, route is already checked by the time and many logistic companies got long-term contracts especially for this route. Despite the situation with freight transportation, Polish rail route is highly attractive for passengers going from Russia (through Belorussia) to West and Central Europe.

In conclusion it could be said that all of the routes carrying positive effect for the economics of countries involved. Situation with congestion could change with construction of new rail connections (Tallinn-Helsinki tunnel and Broad rail gauge) and by even distribution of cargo flow from China.

Written by: Anastasiia Grishkina

Anastasiia.a.grishkina@edu.savonia.fi

Route map: