

Optimized way of transporting Skoda cars from manufacturer place to official auto dealer center

Khvan Artem

Bachelor's thesis

December 2020

School of Technology, Communication and Transport

Degree Program in International logistics

Jyväskylän ammattikorkeakoulu

JAMK University of Applied Sciences

Author(s) Khvan Artem	Type of publication Bachelor's thesis	Date December 2020 Language of publication: English
	Number of pages 44	Permission for web publication:
Title of publication Optimized way of transporting Skoda cars from the manufacturer place to official auto dealer center		
Degree programme International Logistics		
Supervisor(s) Pesonen Juha, Somerla Mikko		
Assigned by Major Cargo Service		
Abstract <p>Nowadays, number of new cars getting bigger and bigger, that is why transportation of cars also becoming more relevant. A well-organized car supply chain can give benefits to each participant, that is why essence of this work is big.</p> <p>So, main objective of this work was showing how logistics company can handle with car transportation. Describe routes from point of origin to final destination with all potential features and then choose the most optimal method. Cargo securing methods were shown, also important documents in terms of customs were considered.</p> <p>As research methods, author utilized combination of quantitative and qualitative research methods. Gained and then analyzed of all literature related to transportation logistics. Also, learned and then utilized formulas and information from the logistics providers in order to get appropriate results.</p> <p>The results were obtained through analyzing final costs for each examined route. Afterwards, the host company can get understanding how car transportation process was held. Finally, future development goals were provided and their importance was explained.</p>		
Keywords/tags (subjects) Transportation modes, price and time calculations, routing		
Miscellaneous (Confidential information)		

Contents

1	Introduction	3
2	Research methods	5
2.1	Data collection methods	7
2.1.1	Literature review	7
2.1.2	Interview	8
2.2	Utilized research methods	9
3	Theoretical framework	10
3.1	Transportation modes.....	10
3.2	Mode selection.....	12
3.2.1	Route planning	13
3.3	Cargo securing.....	14
3.3.1	The safety of vehicle transport.....	15
3.3.2	Insurance of car transportation.....	16
3.4.3	Container	17
3.4	Transportation documents.....	17
3.4.1	TIR Carnet	18
3.5	Technology for handling operations during transportation	19
3.5.1	Sea and rail transport	19
3.5.2	Road transport.....	21
3.6.3	Loading and unloading instructions	21
4	Research part	22
4.1	Chosen routes.....	22
4.2	Calculation of cost and time for the first route.....	24
4.3	Calculation of the cost and time for the second route	26
4.4	Calculation of cost and time for the third route	27

5 Discussion	28
6 Conclusion.....	29
References.....	31
Appendices	34
Appendix 1. Tandem Track (list of question)	34
Appendix 2. CredoTrans (list of questions)	35
Appendix 3. (ASMAP list of questions).....	36
Appendix 4. WayDisplay (list of questions).....	36
Appendix 5. Co2 emissions for the first route (rail)	37
Appendix 6. Co2 emissions for the first route (maritime)	38
Appendix 7. Co2 emissions for the first route (road).....	40
Appendix 8. Co2 emissions for the third route (rail).....	41
Appendix 9. Co2 emissions for the third route (road)	41

Figures

Figure 1. Car transportation in containers	20
Figure 2. Placement of vehicles in the wagon	20
Figure 3. Calculation of CO2 emissions	23
Figure 4. transportation cost for maritime mode	26

Tables

Table 1. Quantitative, Mixed, and Qualitative Methods	6
Table 2. Advantages and Disadvantages of a literature review	8
Table 3. Advantages and disadvantages of interview	9
Table 4. Comparison of modal capabilities	13

1 Introduction

It is common knowledge that almost every family has at least one car. Because it provides greater mobility and ease of movement and in some cases even drives down the cost of using the means of transport. As a result, automotive production is more important than ever. With it, the delivery of finished products, in this case, cars to sales centers in different cities worldwide.

In light of those things, every manufacturer wants to safely and securely deliver their cargo in the shortest possible time and most minimized possible costs. According to Universal Cargo (2011), the essential thing in the case of transportation is fast delivery. Also, the tracking system is a must in case of auto transport, since it gives a better understanding of how smooth cargo is delivering.

Different aspects of the safety of cargo during transportation will be examined and explained. Due to poorly stowed and secured cargo, many different problems can occur, and in most of the cases, the root cause is not just improper cargo securing method but rather a combination of deficiencies in cargo securing. (International Labour Organization 2010, 44.) If items of cargo are not stowed and secured in a proper manner, bearing in mind the intended voyage and the time of year, those items of cargo might shift from their stowage position, and damage might be sustained by the item of cargo or the vessel, or ship's staff might suffer an injury (Bliault and North of England P&I Association Ltd 2003, 5).

The main purpose of this study is to obtain knowledge on how to transport cars in most cost-effective way. Make a detailed analysis and describe the technological process. All potential routes will be examined to choose the most suitable transportation mode, and all possible costs will be calculated and explained. Transportation cost is

an important consideration in the modal selection decision. (Coyle, Novack, Gibson, & Bardi 2011, 79.)

Company description

"Major" is a Russian transport logistics company, founded in 2001. The company provides a wide range of services such as freight forwarding, customs clearance, warehousing. The customer plays the most crucial role for the organization, that is why regular monitoring of customer needs and offering new and cost-efficient solutions are always conducted. Since "Major" is 4PL logistics provider, the company provides industrial solutions for all businesses. The company also has its own tracking system, which let customer monitor cargo during the whole path.

The first meeting with the organization was held in the 2018 year, so by having a short internship, key tasks and responsibilities were seen and analyzed. The main purpose of being there was obtaining knowledge about how to transport logistics works. It was done by having small projects within the organization and a detailed explanation of which key mistakes were made.

Limitations

As any big project, this case has several methodological limitations that cause difficulty in finding some points. Firstly, due to pandemic, the writer has to come back to homeland as soon as possible, that is why writing time was significantly decreased. Secondly, in spite of big number of available literature related to transport logistics, some required information was paid and accordingly difficult to retrieve. Also, regarding limited access to data, some people who have knowledge about calculating transportation costs and time were extremely busy, therefore answers were given much later than expected or in some cases answers were not obtained at all. Finally, due to lack of big experience in work with formulas, a lot of time was spent to reading and analyzing certain books.

Objective

The volume of deliveries is 120 vehicles per month. There are 40 Skoda cars delivered three times a month. The weight of a single vehicle is 1160 kg, then the weight of the entire consignment is 146160 kg or 146,160 tones. (Skoda cars characteristics, 2020.) In this case, three routes will be considered. Regarding road transportation mode, vehicles will be transported through car carriers, fifteen car transporters per month and each car transporter can handle eight vehicles. For sea and rail modes of transportation, vehicles are delivered in 40-foot containers, 30 containers on monthly basis and each container takes four cars.

2 Research methods

Before beginning any kind of research, it is important to understand five main questions: What, Why, Who, Where, When. Firstly, the question "What" needs to be answered as precisely as possible. The main point is to sum up in one sentence only research. In case of failing this step, the chances are research topic is too broad, ill-thought out or too obscure. Secondly, the question "Why" concerns the choice of a certain topic. This question's main task is to get the writer interested into the topic, keep up enthusiasm, and remain motivated. Also, define why exactly this topic must be chosen and make sure results will suit customer requirements. Thirdly, question "Who", at this stage think about the type of people who need to get involved and whether there is a possibility to contact them. Furthermore, bear in mind that the Internet now provides opportunities for contacting people cheaply, especially if student membership is available. Regarding question "Where", detailed analysis where more comfortable to conduct interviews of focus groups. Finally, the question "When" requires thinking about start and end date of research, by creating a well-structured schedule for the project, different negative situations will be avoided. (Dawson, 2002.) Main research methods are quantitative, qualitative and mixed and each method has its features which illustrated in table 1.

Table 1. Quantitative, Mixed, and Qualitative Methods (Creswell, 2018)

Quantitative	Mixed Methods	Qualitative Methods
Pre-determined	Both predetermined and emerging methods	Emerging methods
Instrument based questions	Both open- and closed- ended questions	Open-ended questions
Performance data, attitude data, observational data, and census data	Multiple forms of data drawing on all possibilities	Interview data, observation data, document data, and audiovisual data
Statistical analysis	Statistical and text analysis	Text and image analysis
Statistical interpretation	Across databases interpretation	Themes , patterns interpretation

Qualitative research explores attitudes, behavior, and experiences through such methods as interviews or focus groups. It attempts to get an in-depth opinion from participants. As it is attitudes, behavior, and experiences which are important, fewer people take part in the research, but the contact with these people tends to last a lot longer (Dawson, 2002, 14). Qualitative methods are also particularly suitable for examining sensitive topics, as the process of rapport building provides a comfortable atmosphere for participant disclosure. The list below indicates when to conduct qualitative research. Qualitative research is conducted to:

- understand behavior, beliefs, opinions, and emotions from the perspective of study participants themselves
- understand and explain people's views and behavior
- understand processes, such as how people make decisions, or negotiate a job, or manage a business
- uncover the meaning that people give to their experiences
- understand social interactions among people and the norms and values shared by them

- identify the social, cultural, economic, or physical context in which activities take place
- give voice to the issues of the certain study population
- provide depth, detail, nuance, and context to the research issues
- examine in detail sensitive issues such as sexuality, violence, personal relationships
- study complex issues such as human trafficking or drug use, which may be too complex or hidden to be easily disentangled by quantitative research.

(Hennink, Hutter, & Bailey 2011, 10.)

Quantitative research generates statistics through the use of large-scale survey research, using methods such as questionnaires or structured interviews. This research type reaches many more people, but the contact with those people is much quicker than it is in qualitative research. (Dawson, 2002, 14).

Mixed methods research is an approach to an inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks. The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone. (Creswell, 2014, 32).

2.1 Data collection methods

2.1.1 Literature review

According to Creswell (2009, 25), once the researcher identifies a topic that can and should be studied, the search can begin for related literature on the topic. The literature review accomplishes several purposes. It shares with the reader the results of other studies that are closely related to the one being undertaken. It provides a framework for establishing the importance of the study as well as a benchmark for comparing the results with other findings. In general, the literature review can take

several forms. According to Creswell (2018, 67), Cooper (2010) discussed four types: literature reviews that integrate what others have done and said, criticize previous scholarly works, build bridges between related topics, and identify the central issues in a field. According to Ridley (2012, 3), Hart (1998, 13) defines literature review as the selection of available documents both published and unpublished on the topic, which contains information, ideas, data, and evidence written from a particular standpoint to fulfill certain aims or express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being proposed. Potential benefits and drawbacks of using literature review illustrated in Table 2.

Table 2. Advantages and Disadvantages of a literature review (Adapted from Pros and Cons of a systematic literature review, 2012)

Pros	Cons
Collection from broad range of sources	Could limit creativity and intuition
Aids interdisciplinary as it highlights cross-disciplinary themes	Could overlook important "grey literature," e.g., reports
Increases transparency of the review	Restricted to the accessibility of sources
Increases reliability of the review	Keyword search strings need to be identifiable
Being "systematic" offers a sense of rigor	Relies on databases that support "keyword" search
Aids the process of synthesis through the increased scope possible	Relies on the quality of an abstract (often limited to 100 words)

2.1.2 Interview

An in-depth interview is a one-to-one method of data collection that involves an interviewer and an interviewee discussing specific topics in depth. In-depth interviews may describe as a conversation with a purpose. And in-depth interview, however, is not a two-way dialogue, as only the interviewee shares their story and the interviewer's role is to elicit the story. During an in-depth interview, the interviewer asks questions and motivates the interviewee to share their perspectives. Typically, in-depth interviews are used when seeking information on an individual, personal experience from people about a specific issue or topic. (Hennink, Hutter, & Bailey 2011, 109.) In a qualitative interview, good questions should be open-ended, neutral, sensitive and

understandable. It is usually best to start with questions that participants can answer easily and then proceed to more difficult or sensitive topics (Methods of data collection in qualitative research, 2008). Interview is one of the most popular data collection methods, since it grants lots of insight information, but as any other collection method interviews have benefits and drawback, that illustrated in table 3.

Table 3. Advantages and disadvantages of interview. (Advantages and disadvantages of interview in research)

Advantages	Disadvantages
Flexibility	Can be costly and time-consuming
Better response rate	Can cause biases
Availability of location choice	Provide less anonymity
Control over the order of question	Lack of accessibility to respondents

2.2 Utilized research methods

For this project, both quantitative and qualitative methods were applied. Due to the current virus situation globally, face-to-face meetings with the host company supervisor were not available, so skype conversation was chosen as the main data collection method. Thanks to skype conversations with the host company, required literature, and answers to certain questions were provided. To understand how the company dealt with transportation cases, obtained literature was analyzed and utilized. Also, the main objective of study is finding optimal way of transporting cars from original point to final destination.

In this project, the following research questions were chosen:

1. *How does route planning affect final results?*
2. *How to calculate price and time for transportation modes?*
3. *What factors provide the safest way of delivering cargo?*

Regarding the first research question, study materials retrieved from the university library and host company were given and then learnt. In this part, special attention

required, since successfully implemented route planning will simplify and improve other processes. Also, writer conducted interviews with the host company's supervisor and other transport logistics companies' representatives for getting answers to all potential questions and obtaining more practical information.

To answer the second question, a quantitative research method was applied, sending quotations to logistics providers in order to get more realistic numbers, reading and studying formulas. To find answers to time and price aspects, learning of pricelists for cargo transportation. In short, collecting data from the tables and putting required values into formulas. Furthermore, analyzing final results, which put into table and produce conclusion out those calculations.

The final question was answered through the qualitative research method's help, the same as the first question. Studying literature review for gaining better understanding how cargo must be secured and find the optimal route through well-structured planning.

3 Theoretical framework

3.1 Transportation modes

Transport modes are designed to either carry passengers or freight, but most modes can carry a combination of both. Each mode is characterized by a set of technical, operational, and commercial characteristics. Technical characteristics relate to attributes such as speed, capacity, and motive technology, while operational characteristics involve the context in which modes operated, including speed limits, safety conditions, or operating hours. (Transportation models, modal competition and modal shift.)

Road freight is the modality to transport goods from one place to another by road. To cover the route between two destinations, motorized vehicles are used. The required investment in equipment is low, compared to the other modalities, which makes it easy for competition to enter the market. It is a cost-effective means of carriage and it enables door-door delivery of materials. Furthermore, road transportation is relatively fast and reliable, which can be ordered at any preferred day and time. (Achahchah 2019, 72.) Most of the vehicles used in intermodal freight transport by road are either articulated combinations comprising a tractor or a semi-trailer (Monios, & Bergqvist 2017, 96). According to Monios & Bergqvist (2017, 98.), Lowe (2005) defines road transport is connected to a large number of government directives and regulations, including maximum vehicle dimensions and weights, operator licensing, drivers' working time.

Road freight is used in cases like short distance coverage; high and low goods value density; high and low shipping value; time and not time sensitive (Achahchah 2019, 77).

Maritime transportation is used for intercontinental low-value product flows and moves the majority of the world's volumes. Sea freight has global coverage, is less expensive compared to the other modalities, and can carry extreme sizes and weights, but it has longer time spans. The gas pollution of sea freight is limited and is one of the greenest transportation modalities as it can carry high volumes against relatively limited fuel consumption. Sea freight can be divided in three legs called pre-carriage (door-to-port), carriage (port-to-port) and on-carriage (port-to-door). (Achahchah 2019, 77.)

Sea freight is used in cases such as: long-distance coverage; low goods value density; high shipping volume; not time sensitive (ibid., 83).

Railway transportation is a reliable modality for low-value bulky goods as it is the least affected by weather conditions, which is an important factor of delays in transportation. It also brings less pollution than road and air (Achahchah 2019, 83). Some words in terms of rail wagons, the wagons used need to be compatible with the unit

load carried, particularly with regard to the dimensions and the stowage/fixing requirements of the intermodal unit type (e.g., container, swap body, a semi-trailer). The wagons can be individual wagons or permanently/semi-permanently coupled pairs (or more), often with articulated bogies. (Monios, & Bergqvist 2017, 65.) The big minus of railway transportation is that there is no door-to-door service and a road delivery is always needed. Trains cannot be used for short distances, small traffics, or rural areas (Achahchah 2019, 83).

3.2 Mode selection

Obviously, in the case of mistakes in mode selection, KPI's points can worsen such as cost, time, and customer satisfaction. Choosing among the modal options requires the consideration of multiple issues. The key determinants in choosing a mode are accessibility, capacity, transit time, reliability, cost, and product safety. Accessibility, mode's ability to reach origin, and destination facilities must be considered. The geographic limits of a mode's infrastructure or network and the operating scope authorized by governmental regulatory agencies also affect accessibility. Capacity, the amount of product being moved can render a mode infeasible or impractical. Some modes are well-suited for handling a large volume of goods in an economical fashion, while others are better suited to smaller goods and shipments. Transit time, time is a key consideration in mode selection as transportation impacts inventory availability, stockout costs, and customer satisfaction. Transit time is the total elapsed time that it takes to move goods from the point of origin to its destination. Reliability this factor refers to the consistency of the transit time provided by a transportation mode. It is easier to forecast inventory needs, schedule production, and determine safety stock levels if it is known with some certainty when goods will arrive. Safety, goods must arrive at the destination in the same conditions as when tendered for shipment at the origin. Proper precautions must be taken to choose a mode with the ability to protect freight from damage due to poor freight handling techniques, inferior ride quality, and accidents. Cost, transportation cost is an important consideration in the modal selection decision. Transportation costs include the rate for moving freight

from origin to destination plus any accessorial and terminal fees for additional services provided. (Coyle, Novack, Gibson, & Bardi 2011, 78.)

In this case, three modes of transportation will be considered – truck, rail, and water.

Each has its own benefits and drawback, shown in Table 4

Table 4. Comparison of modal capabilities (adapted from Coyle, Novack, Gibson, & Bardi 2003, 78)

Mode	Strengths	Limitations	Primary role	Primary product characteristics	Example products
Truck	Accessible, fast, customer service	Limited capacity, high cost	Move smaller shipments in local, regional, and national markets	High value, finished goods, low volume	Food, clothing, electronics, furniture
Rail	High capacity, low cost	Accessibility, inconsistent service, damage rates	Move large shipments of domestic freight and smaller shipments of international freight	Low value, raw materials, high volume	Coal, lumber, grain
Water	High capacity, low cost, international capabilities	Slow, accessibility	Move large domestic shipments via rivers, canals and large shipments of international freight	Low value, raw materials, bulk commodities, containerized finished goods	Crude oil, farm products

3.2.1 Route planning

Route planning systems specify the sequences in which the selected transport vehicles should supply the demand points by requested quantities of goods (Kosicek, Tesar, Darena, Malo, & Motycka 2011, 137). According to Knolmayer, Mertens, & Zeier (2002), route planning systems bring many advantages to customers (improved service, increased reliability, reducing delivery times, quick response to special requests), increased transparency, reliable data for decisions, reduction of routine tasks and less errors (ibid., 138). Transit time and on-time performance depend heavily on proper scheduling and sequencing of stops. Effective routing also helps avoid

unfriendly countries, poorly equipped ports, and congested border crossing points that may drastically delay cargo flows. (Coyle, Novack, Gibson, & Bardi 2011, 81.)

In short, route planning is an essential part in transportation of cargo and logistician must be ready for potential complexities and keep in mind product type and transport vehicle, because in case right chosen options route planning will bring many benefits.

3.3 Cargo securing

When appropriate stowage location for a particular item of has cargo has been decided upon thought must then be given to dunnaging and securing item so that it will not move. There are many types of lashing equipment and many different types of dunnaging material, and only those which appropriate for the particular cargo should be used correctly, to reduce friction, to support the piece of cargo and to prevent it from moving. Most common types of lashing materials are wire rope, chains, shackles, fiber robe, steel bands and many others. Container vessels are, of course, provided with specialised container lashing equipment. That equipment may comprise lashing rods or chains, turnbuckles, twist locks, deck studs and corner locators. Container lashing equipment is to be used only for the lashing of containers, and containers on container vessels must be secured using only the specially designed equipment. (Bliault and North of England P&I Association Ltd 2003, 21.) Appropriate types and amounts of dunnage materials should be used to increase friction, and to protect, support and separate the items of cargo. The best method of securing the items of cargo should be decided, this might be direct lashings to the item or items, it might be lashings around pieces of cargo, or maybe timber supports against blocks of cargo, or combination of those. (ibid., 34.)

For securing the vehicle, the wheel stops must be placed in the slotted holes closest to the vehicle wheels, slide them in the wheel's direction, and secure each stop with a spring-loaded bolt. After loading is complete, the shipper sets the crossing points in

a transport (vertical) position and fastens them with hook grips. (Zerkalov, & Timoshuk 2009, 124.)

3.3.1 The safety of vehicle transport

Vehicles are expensive cargo, that is why it is especially important to ensure that the cargo is safe during transport, otherwise the transport company and the customer itself will incur large losses. If the cargo is delivered safely, the transportation is of high quality. However, this is not always the case in reality. It is important to understand the reasons why the cargo is not safe in order to improve the quality of the transportation process. (Levkin, Kurshakova, & Dzybina 2016, 160.)

According to statistics, losses are most often incurred due to violations of transport regulations. The cargo is not prepared properly, although it is very important. Naturally, it is also very important to ensure reliable, accurate and high-quality transshipment. It is necessary to use safe fasteners, to observe the speed mode and sequence of actions. Failure to preserve the cargo may be due to poor storage conditions, as a rule, it is a violation of the temperature regime and lack of protection from atmospheric impact. Sometimes losses and damage to the cargo may occur through the fault of the shipper and the manufacturer if they do not prescribe or specify the rules and technical conditions of transportation. (ibid., 161.)

A significant number of risk factors arise during loading and unloading operations. It is important to choose reliable cargo handling devices, check the quality of materials, the cargo handling devices must match the cargo so as not to scratch or deform it, it is also important to secure the cargo and use suitable crane devices to move the cargo. It is particularly important to ensure that vehicles are firmly fixed in the rolling stock or container. Of course, so far no one has ruled out the human factor as the cause of accidents. But in order to reduce this risk, the rolling stock driver is monitored - a medical check-up is carried out before the flight, and the condition and compliance with the prescribed work and rest rules is monitored during the delivery process. (ibid., 163.)

It is impossible to exclude the risk of cargo theft; intruders often use tricky schemes, as a rule, are most exposed to the risk of theft of cargo in a transshipment point of mixed transport. Another threat is man-made and natural emergencies, from which, unfortunately, no one is insured. But in order to reduce the risk somehow, you have to plan the routes of transportation correctly. (ibid., 163.)

3.3.2 Insurance of car transportation

Due to the high probability of risks, the issue of cargo insurance is always a topical one when transporting goods, especially expensive ones. The purpose of the insurance is to safeguard the interests of the owner of the object being moved against possible transport risks while travelling on the route from the sender to the recipient. Insurance is provided on a voluntary basis. The cargo insurance contract is the main document that initiates legal relations between the parties and describes the procedure for their interaction. It must contain information about the object of insurance, established list of insured events, amount of insurance benefits, the set terms of contract and information on the amount of franchise, maximum level of material damage. (Levkin, Kurshakova, & Dzybina 2016, 163.)

Regarding procedure for concluding the contract, the customer determines the list of insured events, contacts the insurance company, gets familiarized with the insurance terms and conditions and provides the necessary information about the object being transported such as name of cargo, date of shipment department, type of vehicle and method of cargo dispatch, numbers and dates of transport documents, information on packaging, overall dimensions, weight, information on points of departure, information on number of consignments and other information that is relevant to the calculation of risk. (ibid., 170.)

Upon occurrence of an insured event, the insurance company must be notified as soon as possible by any available means, specifying the place and time of occurrence, the presumed causes and amount of loss. The insurer must then be officially notified of the occurrence of the insurance within 5 working days by a written statement. Before a representative of the insurance company examines the property, every effort

must be made to ensure the safety of the property insured under the contract. It is possible to transfer the affected cargo from the scene of an accident, if this is required to maintain a proper level of safety, having previously obtained the permission of the insurance company. (ibid., 172.)

The insurer has the right to request the documents necessary to prove the validity and determine the specifics of the insured event such as documents proving the fact of transportation, original insurance document, papers certifying the occurrence of an insured event, calculation of insurance benefits, expert opinions, photographs. (ibid., 172.)

3.4.3 Container

Today, a wide range of container types are used in international trade. While several lengths, heights, and widths still remain, 20 ft and 40 ft long units remain dominant on deep-sea vessels, and containers are therefore measured as multiples of 20 ft. Containers are the strongest and versatile loading unit, as well as being stackable. (Monios, & Bergqvist 2017, 78-79.) Regarding container stacking, a main input for the stacking strategy is the information available on a container. This is usually its type (size, reefer, dangerous goods), modality, and date/time of departure. There are several types of stacking strategies. In category stacking, one defines categories and stacks containers of the same category on top of each other. In the residence time strategy, one stacks a container on others if its departure time is earlier than that of all containers, which will be below it. (Kim, & Gunther 2007, 133.) There are many container types, but these are the frequently used ones: 20' standard, flat rack, open-top, reefer and tank; 40' standard, high cube, flat rack, open-top, reefer and tank; 45' standard and high cube (Achahchah 2019, 79).

3.4 Transportation documents

In maritime transport: the main document is the bill of lading, which is drawn up on the basis of a loading order and a navigational receipt. Also, standard shipping note

that gives the port of loading the information it needs to handle goods once goods have been loaded into the container with the predicted information supplied beforehand (Nibusinessinfo).

In railway transport: SMGS consignment note. The consignment note and its duplicate copy are transport documents for domestic and international railway freight traffic. The SMGS consignment note must accompany all documents accompanying the consignment note (certificates, specifications, packing lists).

The SMGS consignment note consists of five (5) sheets:

1. "Original waybill". It was issued to the consignee at the destination station together with the cargo.
2. "Road Register". Escorts the cargo to the final station. The number of road lists is equal to the number of roads participating in the carriage. Remains on the destination road.
3. "Duplicate bill of lading". Remains with the sender.
4. "Cargo Transfer Sheet." Like the "road sheet," it accompanies the cargo to the final station and remains on the destination road.
5. "Notification of cargo arrival." It was issued to the consignee, together with sheet No. 5 - the original waybill and cargo.

(Kurganov 2000, 42).

By road transport: An application contract for the transport of cars by motor vehicles, power of attorney for car transportation, an act of receiving-and-transfer of the vehicle, waybill, commercial bill of lading (Zerkalov 2009, 210).

3.4.1 TIR Carnet

A TIR Carnet is a document issued by national road transport associations of the TIR convention member states. It is an internationally recognized and accepted transit card that can be used only for one trip. The main benefits of TIR Carnet document are that under the TIR procedure, goods transported between member countries by

authorized TIR carnet holders are not subject to customs control at intermediate borders and can travel directly from point A to point B. Also, thanks to the TIR Carnet, no importation/exportation taxes must be paid at transit customs (What is a TIR Carnet, 2020). Four requirements form the basis of the TIR system. First one is vehicles are subject to special requirements in order to prevent unauthorized access to the cargo. Before transportation, the cargo undergoes a preliminary procedure of access to transportation under this system. Second is all taxes, duties and charges are paid and the risks of transportation are covered financially before transportation begins. Third one is the TIR Carnet, or TIR Carnet, is a document recognized by the international community and should be followed along with the cargo along its way. Finally, Customs security measures in the country of departure are recognized in transit countries and in the country of destination (Lebedev, & Mirotin 2017, 65).

3.5 Technology for handling operations during transportation

3.5.1 Sea and rail transport

To begin with, sea transport will be examined first, for this case transporting cars in 40-foot container will be considered. Before loading, a thorough inspection of the container is obligatory, as well as an assessment of its technical condition and the presence of defects that threaten the safety of the transport. In order to load the vehicles into the container, the following steps must be taken:

1. Wash and dry the car, check the tire treads and rims.
2. Check the tire pressure; it must provide a tire contact area of 130 - 150 mm.
3. The gasoline must be completely drained, and the battery switched off.
4. Make sure sealing of automotive fluids (oils, coolants, brake fluids) in good conditions.

(Cherenkov 2010, 250)

The car must be securely locked in the container. For this purpose, four stretch marks are used. At one end, they are fastened to the lower tie hooks of the container, and at the other end, they are fastened to the running gear of the car. The car is then fixed with thrust bars: two of them, which are the same length as the width of the

container, are placed at the end walls, two longitudinal bars are placed close to the wheels between the thrust bars on the outside of the wheels, and transverse bars are nailed to the longitudinal bars on the outside of the wheels. Next, a few more stones are nailed onto the longitudinal stones close to the cross ones to secure the wheels (ibid., 120). The vehicle's placement and fixation are shown in Figure 1:



Figure 1. Car transportation in containers (Swift)

Regarding railway transport, the double-deck platforms used for the transport of vehicles are shipped to destinations with fixed or mobile devices that can be used to unload vehicles on their own from both levels of the wagons. Double-deck platforms are equipped with a guide device designed for the independent entry of cars into the car and fixing them. To secure vehicles from longitudinal and transverse movements, the platforms are equipped with inventory fasteners (wheel stops) that are installed under each wheel of the loaded vehicle (ibid., 121).

Vehicles drive on or off the upper and lower tiers of the platform through the end of the platform on the middle part of the previous platform, that shown on figure 2 below:

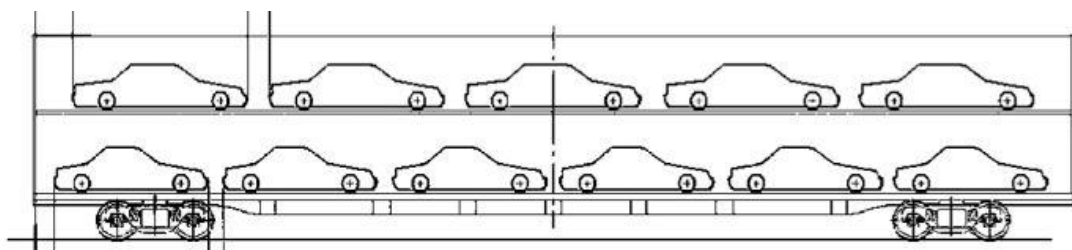


Figure 2. Placement of vehicles in the wagon (Cherenkov, 2010)

3.5.2 Road transport

Before loading cars on car transporter, cargo must be checked for sound, cleanness and availability of safety fences. Furthermore, platform floors and gangways must not have sharp structures that can damage the underside of the vehicle and the tyres and vehicles must be equipped with the necessary number of thrust pads and fastening straps. For successful transportation of cars all car deliveries by car transporters must be performed in accordance with current legislation and in compliance with traffic regulations (Levkin, Kurshakova, & Dzybina, 2016). Car carriers have significant carrying capacity, technical reliability and great resilience on the roads. Car transporters always need a tractor which will drive the system. Car carries is the most often used way in road transportation, equipped rolling stock is used to transport cars from the manufacturer to sales centers, and containers can also be used to transport goods (Optimal equipment for freight forwarding, 2018).

3.6.3 Loading and unloading instructions

Before loading the vehicles, the consignor must follow next steps. Firstly, throw the crossing platforms on the lower and upper tiers of all platforms into a horizontal position, leaving only the outermost crossing platforms of the platform to be loaded in the first place. Secondly, make sure that the wheel chocks are in good condition and complete (if necessary, grease the screw joints of the chocks) and place them on the floor so that do not hinder the free passage of vehicles. Finally, install the required number of wheel chocks in the outermost slots of the floor on the upper and lower tiers of the first loading platform from the side of the unfolded crossing platforms. At the same time, the lever swing holders must be in the middle operating position. After loading is complete, the shipper sets the crossing points in a transport (vertical) position and fastens them with hook grips. (Zerkalov, & Timoshuk 2009, 120-122).

Before unloading the vehicles, the consignee is obliged to fold the crossing areas horizontally and remove the first vehicles' wheel chocks to be unloaded. After unloading the vehicles, the consignee sets the crossing points in the transport (vertical) position and fixes the wheel chocks on the wagon. After unloading the vehicles, the consignee

sets the crossing points in the transport (vertical) position and fixes the wheel chocks on the wagon. (ibid., 124.) When unloading cars, it is prohibited to move or start the engine by inertia, move thrust pads, fastening straps, or other objects (Kurganov 2000, 92).

4 Research part

4.1 Chosen routes

For this case three routes were considered. The first route is intermodal, and it starts from Mlada Boleslav (Czech Republic) to seaport Rostok (Germany) by rail transport, then from port Rostok to port Bronca (Russia) by maritime transport and finally from the port Bronca to dealerships through auto carriers. The total distance of this route is 2007 km, where railway is 623 km, road one is 74 km and sea path is 1310 km. The second route is done by using only road mode of transportation, it begins from Mlada Boleslav until dealerships in Saint-Petersburg. The total distance of this route is 1803 km. During this transportation TIR Carnet is used in order to simplify passing of customs procedures. The final route is done by use of rail mode of transportation and road one. It starts from Mlada Boleslav to Saint-Peterburg by rail and then to dealerships by car transporters. The total route distance is 2322 km.

Environment aspect

There has been growing concern over the impact of transportation on the environment in recent years, with particular emphasis on air quality (pollution), noise, and water quality. The synergy between the transportation system and the environment is increasingly being investigated by both environmentalists and transportation planners at all government levels. (Coyle, Novack, Gibson, & Bardi 2011, 44.)

Green logistics describes the environmental positive thinking, and it refers in general to changing transport chain to burden environment as minimal as possible. Logistic

eco balance aims to measure the environmental impact of logistics chain from raw materials, procurement and production to distribution, consumption, and reverse logistics. Logistics energy efficiency can also be measured with cumulative energy consumption, transport intensity and transport footprint as well as with indirect indicators. (Green Logistics)

For finding CO2 emission for each transportation mode, the writer used CO2 calculator. In order to get results, total transport distance, weight of goods, mode of transport must be used as input material (Cichosz, Nowicka, & Pluta - Zaremba, 2018). Amount of CO2 emissions per km for the second route, illustrated in figure 3. Amount of CO2 emissions for other two routes will be attached in Appendices section.



The image shows a web-based calculator interface for CO2 emissions. At the top, it features the 'Interreg CENTRAL EUROPE' logo and the 'European Union European Regional Development Fund' logo. Below this is the title 'ChemMultimodal'. The main interface consists of several input fields and a result display:

- Total transport distance:** 1803 km
- Weight of goods:** 146 t
- Mode of transport:** Truck (selected from a dropdown menu)
- Emissions:** 16,320.76 kilograms CO2 (displayed next to a dropdown menu set to 'kilograms CO2')

At the bottom, there are two buttons: 'New calculation' and 'Reset calculation'.

Figure 3. Calculation of CO2 emissions (CO2 Calculator for Chemical Transports)

4.2 Calculation of cost and time for the first route

Because of the first route is intermodal, then more than one mode is utilized, so let is begin with route which is done through rail mode of transportation. The total distance of rail path is 628 km, where one part is 148 km and covers railways of Czech Republic and another part is 480 km and covers German railways (Rail map online, 2020). Due to the emergence of sovereign independent states and national currencies on the political map of the world, a so-called tariff break has appeared in railway transport organizations. The purpose of tariff break is that fees determined by the railways to the border stations in national currencies and translated into Swiss francs. (Defining freight price in international forwarding, 2014).

Regarding time and price for the first railway part, according to Eduard Katasonov from logistics company Tandem Track, the freight charge for 10 containers will be 2568 swiss francs. How Eduard Katasonov explained, freight charge for transporting 40-foot-long container, gross weight 30 tons or more should computed with a coefficient of 1.20. Also, the cost of carrying a loaded container over 30 feet to 40 feet at a distance of 145-154 km is equal to 214 swiss francs per container. So, based on this information following calculation is formed:

$$P = 214 \cdot 10 \cdot 1.2 = 2568 \text{ swiss francs}$$

In order to find delivery time for this part of route, writer retrieved information regarding low transport speed, container loading time and time for customs operations at railway station. As reported by Eduard Katasonov, container loading time is 6 hours, time for customs operations is 4 hours and low transport speed is 25 km per hour. So, delivery time of the cargo will be speed divided by velocity and adding of time required processes.

$$T = 148/25 + 6 + 4 = 15.84 \text{ hours}$$

Regarding the second part of railway path, the same calculation method is implemented, all data is also almost the same, except for price of container. Because this railway path is longer, then price is accordingly higher. According to Eduard Katsanov, the cost of carrying a loaded container over 30 feet to 40 feet at a distance of 475 – 484 km is 664 swiss francs. So, based on this information following calculation is done:

$$P = 664 \cdot 10 \cdot 1.2 = 7968 \text{ swiss francs}$$

Delivery time of the cargo will be:

$$T = 480/25 + 6 + 4 = 29.2 \text{ hours}$$

According to the Central Bank of the Russian Federation, as at 03.12.2020 the price per swiss franc is 83.41 rubles, so the total price for rail path is **2 636 423. 28 rubles** and the lead time is 45.04 hours.

The second part of the first route was implemented by use of maritime mode. In order to find the total freight charge of 10 x 40-foot containers, writer sent quotation to Credotrans company and put retrieved information into formula. According to Dmitrii Romanov from the Credotrans company, the cost of vessel parking in port is 122.5 \$, the cost of running the vessel is 119.28 \$ for this route, the cost of transportation of 40-foot container from the seaport Rostock to the seaport Bronca is 1155 \$, loading and unloading times are 42 hours, weight of 40-foot container is 4 ton, the cost of processing the documentation in port is 500 \$ and price for loading and unloading operations per container unit is 380 \$. After retrieving all required information, the carriage fee is determined by a formula illustrated in Figure 4. In this formula, c_1 is the cost of transportation 40-foot container, n_1 is number of containers, c_2 is the cost of vessel parking, t_1 is loading and unloading time, c_3 is the cost of running the vessel, c_4 is price for loading and unloading, n_2 is number of containers, c_5 is the cost of processing the documentation, p_1 is number of ports and m_1 is total gross weight of cargo. So, basing on this data transportation cost is 16 678.18 \$ for 10 containers, then monthly delivery amount will be 50 034.54 \$. According to the Central

Bank of the Russian Federation, as at 03.12.2020 the price per one dollar is 74.12 rubles, so the total price for maritime path is **3 708 560.1 rubles**.

$$P = c_1 * n_1 + c_2 + c_3 + c_4 * n_2 + c_5 * p_1 + m_1$$

Figure 4. transportation cost for maritime mode
Regarding finding of time for maritime path, distance was divided by average speed and time required processes added (loading and unloading time). Average vessel travel time is 37 km per hour (Fuel consumption by containership).

$$T = \frac{1296}{37} + 42 \cdot 2 = \mathbf{119 \text{ hours}}$$

4.3 Calculation of the cost and time for the second route

The second route is done by using only a road mode of transportation. In order to find answers for cost and time, writer decided to utilize pricelist, because all required information is available. According to chapter IV of tariff plan, ratio related inflationary processes from 1990 to the present time is 150, cars which are longer than 4.5 meters cost 17 kopecks for 1 km, cargo mass is over 5 to 10 tones cost 24.96 rubles per ton, if route distance is over 600 km, then 36.75 rubles added. (Tariff Plan, 1990.) Also, successful passing of customs procedures requires TIR Carnet document. According to Vladimir Ermolov from the association of international road carrier "ASMAP", TIR Carnet will cost 12 015 rubles per one car transporter. After gathering all the needed information, calculation of cost become available.

$$((0,17 \cdot 1803 + ((24,96 + 36.75)) \cdot 150 = 55\,233 \text{ rubles}$$

$$(55\,233 + 12\,015) \cdot 3 \cdot 5 = \mathbf{1\,008\,720 \text{ rubles}}$$

Regarding calculation of the time for this route is done in way as length of transportation route divided by transport speed and adding time required procedures. Speed limits for trucks exceeding 3.5 tones outside inhabited areas, not by motorways: Russian Federation, Latvia, Lithuania, Poland is 80 km per hour, Poland is 70 km per hour

(Heavy goods vehicles, 2015). As it was mentioned in the first route calculation, customs processes take 4 hours and since number of borders is 4, then the total hours are 16. According to Vladimir Ermolov from "ASMAP", the time for loading and unloading operations is 1 hour each.

$$T = \frac{860}{70} + \frac{956}{80} + 4 \cdot 4 + 2 \cdot 1 = \mathbf{42.81 \text{ hours}}$$

4.4 Calculation of cost and time for the third route

Because of there is no fixed tariff plan and formulas for this route, then all numbers were retrieved from logistics provider. According to Sergey Prohorov from "WayDisplay", this route will cover four countries: Czech Republic, Poland, Belarus and Russian Federation. The total freight cost for this route will be **5 029 615.83 rubles** per month. The method of transporting cars is 10 40-foot containers, so 4 cars will fit in one container. For calculating time for this route, distances of railways were obtained: Czech Republic is 357 km; Poland is 684 km; Belarus is 726 km and Russian Federation is 476 km (Rail map online, 2020). As it was mentioned in calculation of the railway part in the first route, low transportation speed is 25 km per hours and time for processing customs procedures is 4 hours per each border. So, the total spent time for the third route is 105.69 hours.

$$\left(\frac{357}{25} + 4\right) + \left(\frac{684}{25} + 4\right) + \left(\frac{726}{25} + 4\right) + \left(\frac{476}{25} + 4\right) = \mathbf{105.69 \text{ hours}}$$

Calculation of cost for the delivery of cargo to dealerships

In order to find cost for transporting cars to dealerships, tariff plan for road transportation was again utilized. The distances from the seaport and railway station until dealerships are 74 and 79 km (Google maps, 2020). Passenger cars over 4.5 m long cost 17 kopecks per 1 km, shipment weight exceeding from 5 to 10 tones cost 24.96 rubles, coefficient related to inflation processes is 150. (Tariff Plan, 1990.) So, the cost for delivering cars to the first dealership is 5631 rubles and to the second one is

5758.5 rubles per month. This cost applied only to the first and the third routes, because the second route has door-to-door option.

5 Discussion

The main purpose of the thesis was defining the most cost-efficient way of transporting cars, by considering three routes. The host company provided the concrete number of transported cars in order to make thesis results look more realistic. Achieved results were based on numbers retrieved from the tariff plan and logistics providers. The choice of the optimal transporting way was obvious because the difference in terms of cost and time was significant. Most of the details related to transporting cars were covered such as cargo security, routing, environment impact, calculation methods.

The main limitations of work were related to time constraints and data access, because of the host company based in Russian, then addressed logistics providers also were located in this country. So, some of the companies refused to provide their Skype or WhatsApp nicknames and insisted on using regular calls. Moreover, some organizations gave false promises and thus caused time loss. Additionally, due to coronavirus writing time was cut a lot and therefore some topics were not examined.

Because of the host company is the transport logistics organization, which not familiarized with transporting cars, this work results can grant main understanding how vehicles can be delivered, which safety requirements must be followed. The results can be implemented since all numerical data was obtained either from pricelists or people who working in logistics sphere, but beforehand require some modifications.

Regarding future development, more attention can be paid to information technology (systems for monitoring cargo movement), document processing during transportation, learning more detail related to international vehicle carriage, a method for balance between environment and cost. Furthermore, it is common fact that there

are big problems with roads in Russia, that is why there is a room for learning how create route basing on a road quality, since cars are expensive cargo and even little damage can cause negative consequences.

After finishing of calculating three routes, results can be wrapped up and analyzed. By looking at Table 4, it is obvious that optimal way of transporting Skoda cars will be by road mode, since combination of transportation cost and lead time at very good level. Unfortunately, amount of CO2 emissions is very high, but because this route is much cheaper and faster than two others it will be the best solution for the customer. Moreover, the second route has door-to-door option, thus there is no need in distribution centers. The transportation of vehicles can be done by use five car transporters per one consignment and accordingly 15 car carrier for a month delivery.

Table 4. Final results for three routes

	Transportation cost (monthly)	Lead time (hours)	CO2 emissions per km
Route 1 (rail + maritime)	6 350 742.33 RUB (70 673.74 €)	164.04	8615
Route 2 (road)	1 008 720 RUB (11 225.46 €)	42.81	16 320.76
Route 3 (rail)	5 035 374. 33 RUB (56 035.77 €)	105.69	7919.63

6 Conclusion

The work covered the transportation of Skoda Rapid cars, which are popular in Russia. It was necessary to plan the routes of cargo delivery from the city of Mlada-Boleslav in the Czech Republic to Russia to the dealerships of St. Petersburg and determine the most advantageous option of transportation.

The research methods are represented by study and analysis transport logistics literature, tariff plans and going through answers from logistics providers. Due to pandemic, writer could not have face-to-face interviews, so online interviews were chosen instead.

Three routes were considered and by calculating each of them optimal transporting way was found. The final calculation showed that the best option would be to deliver the cargo in a specialized rolling stock of motor vehicles - a car carrier. The cost of transportation will be 1 008 720 rubles per month and the time will be 42 hours, with the possibility of door-to-door delivery.

To conclude, one more important point in terms future development goals, finding a way for decreasing costs for rail and sea modes, because if cost will be at least not that higher than road mode when there is a chance to convince customer use more environmentally friendly transportation way. Because green logistics getting more relevant every day, it will be a good benefit for the company to have a solution which does less pollution.

References

- Achahchah, M. 2019. *Lean Transportation Management. Using Logistics as a Strategic Differentiator*. Routledge.
- Advantages and disadvantages of interview in research*. N.d. Page on sociology group website. Accessed on 27 November. Retrieved from: <https://www.sociologygroup.com/advantages-disadvantages-interview-research/>
- Bliault, C., & North of England P&I Association. 2003. *Cargo stowage & securing. A guide to good practice*. North of England P & I Association Limited. Braun, V., & Clarke, V. 2013. *Successful Qualitative Research*. SAGE Publications.
- Car transportation in containers*. N.d. Page on Swift website. Accessed on 20 November 2020. Retrieved from: <http://swiftrus.ru/uslugi/perevozka-auto/>
- Cherenkov. 2010. *Basics of international logistics*. State Saint-Petersburg University.
- Cichoz, M., Nowicka, K., & Pluta-Zaremba, A. 2018. *Toolbox element : CO2 calculator*. Accessed on 2 December. Retrieved from: <https://www.interreg-central.eu/Content.Node/ChemMultimodal/D.T1.2.9-CO2-Calculator.pdf>
- Coyle, J. J., Novack R. A., Gibson B. J., & Bardi E. J. 2011. *Management of Transportation*. 7th. ed. South-Western Cengage Learning.
- Creswell, J. W., & Creswell, J. D. 2018. *Research Design: qualitative, quantitative, and mixed methods approaches*. 5th. ed. Los Angeles: SAGE
- Creswell, J. W. 2014. *Research Design: qualitative, quantitative, and mixed methods approaches*. 4th. ed. SAGE Publications. Inc.
- Creswell, J. W. 2009. *Research Design: qualitative, quantitative, and mixed methods approaches*. 3rd. ed. SAGE Publications. Inc.
- Dawson, C. 2002. *Practical research methods. A user-friendly guide to mastering research*. How to books Ltd. *Defining freight price in international forwarding*. 2014. Page on expeducation website. Accessed on 29 November. Retrieved from: <https://www.expeducation.ru/ru/article/view?id=4684>
- Edmonds, W. A., & Kennedy, T. D. 2017. *An Applied Guide to Research Designs. Quantitative, Qualitative, and Mixed Methods*. 2nd ed. *Fuel consumption by containership*. N.d. Page on the geography of transport systems website. Accessed on 28 November. Retrieved from: [https://transportgeography.org/?page_id=5955#:~:text=Most%20containerships%20are%20designed%20to,long%20distances%20\(compounding%20effect\)](https://transportgeography.org/?page_id=5955#:~:text=Most%20containerships%20are%20designed%20to,long%20distances%20(compounding%20effect))

Green logistics. N.d. Page on the Logistiikan Maailma website. Accessed on 4 December. Retrieved from: <https://www.logistiikanmaailma.fi/en/logistics/logistics-and-supply-chain/green-logistics/>

Google maps. 2020. Page on Google maps website. Accessed on 29 November. Retrieved from: <https://www.google.com/maps>

Heavy goods vehicles. 2015. Page on studentnews website. Accessed on 1 December. Retrieved from: <https://trip.studentnews.eu/s/4086/77068-Heavy-goods-vehicles-over-35-t-standard-speeds-limits-in-Europe.htm>

Hennink, M., Hutter, I., & Bailey, A. 2011. *Qualitative Research Methods*. Sage Publications, London, Los Angeles, New Delhi, Singapore, Washington DC. *How to move goods by sea*. N.d. Page on Nibusiness Info. Accessed on 25 November 2020. Retrieved from: <https://www.nibusinessinfo.co.uk/content/key-document..>

International Labour Organization. 2011. *Safety in the supply chain in relation to packing of containers*. Accessed on 21 November 2020. Retrieved from: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_161660.pdf Kim, K. H., & Gunther, H. O. 2007. *Container Terminals and Cargo Systems. Design, Operations Management, and Logistics Control Issues*. Springer – Verlag Berlin Heidelberg.

Kosicek, Tesar, Darena, Malo, & Motycka. 2011. *Route planning module as a part of supply chain management system*. Accessed on 8 November 2020. Retrieved from: https://www.researchgate.net/publication/273207454_Route_planning_module_as_a_part_of_Supply_Chain_Management_system

Kurganov, V. 2013. *International road freight transport*. Academy.

Lebedev, & Mirotin. 2017. *Fundamentals of transport logistics*.

Levkin, G., Kurshakova, N., & Dzybina, K. 2016. *Logistics concepts*. Accessed on 19 November 2020. Retrieved from: http://files.informio.ru/files/main/documents/2016/06/Levkin_Osnovy_logistiki_978_5_44.pdf

Machi, L. A., & McEvoy, B. T. 2016. *The Literature Review. Six steps to success*. 3rd. ed.

Methods of data collection in qualitative research. 2008. Page on Nature website. Accessed on 29 November 2020. Retrieved from: <https://www.nature.com/articles/bdj.2008.192>

Monios, J., & Bergqvist, R. 2017. *Intermodal Freight Transportation & Logistics. Pros and Cons of a systematic literature review*. 2012. Page on Research Gate website. Accessed on 5 November 2020. Retrieved from: <https://www.researchgate.net/figure/Pros-and-cons-of-..>

Rail map online. 2020. Page on railmap online website. Accessed on 3 December. Retrieved from: <https://www.railmaponline.com/UKIEMap.php>

Ridley, D. 2012. *The literature review. A step-by-step guide for students (2nd ed.)*. Accessed on 10 November. Retrieved from: [The Literature Review A Step-by-Step Guide for Students by Diana Ridley \(z-lib.org\).pdf](#)

Route Planning for Logistics and Distribution Companies. 2018. Page on the balance small business website. Accessed on 25 November 2020. Retrieved from:

<https://www.thebalancesmb.com/route-planning-2221322>

Rules of car transportation by auto transporters. N.d. Page on Studwood website. Accessed on 15 November 2020. Retrieved from: https://studwood.ru/1734305/tehnika/pravila_perevozki..

RZD. 2020. Page on Russian Railways website. Accessed on 20 November 2020. Retrieved from:

<https://cargo.rzd.ru/ru/9436/page/103290?redirected..>

Skoda cars characteristics. 2020. Page on Skoda-vitebskiy website. Accessed on 20 November. Retrieved from:

<https://www.skoda-vitebskiy.ru/>

Tariff Plan. 1990. Page on Electric Fund website. Accessed on 24 November 2020. Retrieved from: <http://docs.cntd.ru/document/901861760>

The best way to transport a car. 2017. Page on USA today website. Accessed on 19 November 2020. Retrieved from: <https://traveltips.usatoday.com/ways-transport-car-21..>

[car-21..](#)

Transportation models, modal competition and modal shift. N.d. Page on transport-geography website. Assessed on 22 November. Retrieved from: https://transportgeography.org/?page_id=1731

[https://transportgeography.org/?page_id=1731](#)

What is a TIR Carnet. 2020. Page on Eurosender website. Accessed on 20 November 2020. Retrieved from: <https://www.eurosender.com/blog/en/tir-carnet-procedu..>

Zerkalov, D., & Timoshuk, E. 2009. *International freight forwarding*. Accessed on 5 November 2020. Retrieved from: http://static.scbist.com/scb/uploaded/1_zerkalov_d_v_timoshuk_e_n_mezhdunarodnye_perevozki_gruzov.pdf

Appendices

Appendix 1. Tandem Track (list of question)

Tandem Track |

1. How does price for rail path calculated? (Number of containers is 40)
2. Main factors affecting cost, explanation of main points which creating cost
3. Which main processes affecting on time formation?
4. How long does loading and unloading processes take?
5. Is it better to transport cars in containers or in covered wagons?
6. Why does swiss francs used as main currency in railway transportation in Russia?

Appendix 2. CredoTrans (list of questions)

CredoTrans

1. What is the cost of vessel parking in port?
2. What is the cost of running vessel?
3. What is the cost of transportation of 40-foot container from the seaport Rostock to the seaport Bronca?
4. How long do loading and unloading take?
5. What is weight of 40-foot container?
6. What is price for processing the documentation in port?
7. How much are loading and unloading operations in seaports?
8. What is the best method for transporting cars by maritime?

Appendix 3. (ASMAP list of questions)

ASMAP

1. Which method is good for transporting cars from seaport and railway station to dealership center?
2. What is price for TIR Carnet document for chosen route?
3. Can you explain process of getting TIR Carnet document and what is main purpose of this document?
4. Can you explain how tariff plan for road transportation works?
5. Main processes affecting time

Appendix 4. WayDisplay (list of questions)

WayDisplay

1. How to transport 40 units of Skoda cars from Mlada Boleslav to Saint-Petersburg dealership by use of rail mode?
2. Which technology is the most suitable for this route?
3. Explanation related offered route
4. Which safety requirements for cargo in rail mode of transportation?

Interreg
CENTRAL EUROPE
ChemMultimodal

European Union
European Regional
Development Fund

Total transport distance: 628 km

Weight of goods: 146 t

Mode of transport: Rail

Emissions: 2,017,136.00 grams CO2

New calculation | Reset calculation

Appendix 6. Co2 emissions for the first route (maritime)



ChemMultimodal

Total transport distance

1310

km

Weight of goods

146

t

Mode of transport

Inland waterway

Emissions 5,929,060.00

grams CO2

New calculation

Reset calculation

Appendix 7. Co2 emissions for the first route (road)

The screenshot displays the 'Interreg CENTRAL EUROPE ChemMultimodal' web application. The interface includes the following elements:

- Header:** 'Interreg CENTRAL EUROPE' logo and 'ChemMultimodal' title, with the European Union logo and 'European Union European Regional Development Fund' text.
- Input Fields:**
 - Total transport distance:** 74 km
 - Weight of goods:** 146 t
 - Mode of transport:** Truck
- Output:** Emissions: 669,848.00 grams CO2
- Buttons:** 'New calculation' and 'Reset calculation'

Appendix 8. Co2 emissions for the third route (rail)

Interreg
 CENTRAL EUROPE
 ChemMultimodal

European Union
 European Regional
 Development Fund

Total transport distance 2243 km

Weight of goods 146 t

Mode of transport Rail

Emissions 7,204,516.00 grams CO2

New calculation Reset calculation

Appendix 9. Co2 emissions for the third route (road)



ChemMultimodal

Total transport distance

79

km

Weight of goods

146

t

Mode of transport

Truck

Emissions

715,108.00

grams CO2

New calculation

Reset calculation