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# Organization of the Delivery of Oversized Cargo

From Finland to Kazakhstan

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<p>Abstract</p> <p>This thesis was focused on the organization of the delivery of oversized cargo by different modes of transport. The main objective of this thesis was the determination of the most optimal delivery route in accordance with specified needs of a customer.</p> <p>The theoretical framework was completed by researching literature that is related to the chosen topic. The empirical part is based on analyzing the information from the theoretical research, identifying possible delivery routes and evaluating criteria for existing options. Following that, all measured routes were compared with each other. Taking into account that all customers have their requirements associated with the delivery of oversized cargo, there is not only one best way of transportation. Therefore, it was necessary to consider the importance of each criterion for the customer in order to determine the appropriate route in accordance with their requirements.</p> <p>According to the analysis, the air transport took the first place in safety of carriage and delivery time. The lowest transportation costs were achieved by waterways.</p>		
<p>Keywords:</p> <p>oversized cargo, abnormal cargo, heavy cargo, logistics, delivery options, Finland, Kazakhstan, transportation, mode of transport, route planning</p>		

## Table of content

1	INTRODUCTION.....	4
2	OVERSIZED CARGO .....	5
2.1	Types of cargo .....	6
2.2	Oversized cargo.....	8
2.3	Demand for oversized transportation.....	11
3	ORGANIZATION OF THE DELIVERY OF OVERSIZED CARGO.....	12
3.1	Selection of the appropriate mode of transport.....	12
3.2	Placing and securing cargo .....	18
3.3	Optimal delivery route.....	22
3.4	Permit documents for transportation of oversized cargo.....	25
3.5	Risks in transportation of oversized cargo .....	27
4	COMPARISON OF DIFFERENT MODES OF TRANSPORTATION FROM FINLAND TO KAZAKHSTAN.....	29
4.1	Analysis of delivery options for oversized cargo from Helsinki (Finland) to Atyrau (Kazakhstan) .....	30
4.2	Choice of the most optimal route .....	37
4.3	Common challenges associated with delivery of oversized cargo .....	40
5	CONCLUSION .....	42
6	REFERENCES.....	44
	FIGURES.....	52
	TABLES .....	52
	Appendix 1: Model of stripping column. ....	53
	Appendix 2: Distance of railway route.....	53
	Appendix 3: Distance of inland waterways route. ....	54

## 1 INTRODUCTION

Nowadays, carriages of oversized cargoes are in demand because of the existing need in transportation of industry equipment in the fully assembled form. This kind of carriage is a very complex process which includes multi-step approach and requires close attention. Therefore, not all companies are able to provide transportation of oversized cargo. The competitive advantages of logistics companies depend on the availability of appropriate vehicles with necessary characteristics which meet the parameters of abnormal cargo. Moreover, the opportunity to offer the most optimal delivery route of abnormal loads is an essential part of success.

There are many kinds of oversized products and all of them require individual approach, because there are no templates for organizing delivery processes. In order to provide the delivery in requested time and safely, it is necessary to create a special delivery route and ensure the securing of oversized cargo.

The transportation of oversized and heavyweight cargoes is a time-taking process which requires much time for preparation before the implementation of the carriage. In some cases, the delivery of abnormal loads requires an organization of cargo escort. There are different emergency situations and risks which logistics companies have to account for the planning stage of cargo carriage in order to prevent them.

In present times, the dimensions of oversized cargoes are coming more and more exacting. Because of this, a successful organization of the goods delivery is coming more difficult for logistics service providers worldwide. Besides, there are many different factors which should be accounted by logistics companies for ensure that the oversized cargo will reach the point of destination. Therefore, the choice of an appropriate mode of transport and development of optimal route are the most complicated parts of planning. In order to implement the transportation of abnormal cargoes, it is necessary to obtain all permit documents. Moreover, there is no standardized approach to organize the carriage of this type of cargo.

### **Main objective**

The main objective of this thesis is to determine the optimal delivery route in accordance with specified needs of a customer from Finland to Kazakhstan in

the existing market conditions. The main question is how to identify the most optimal route for customer.

For the purpose of achieving this objective, it is necessary to consider the following sub-questions:

- How to select the appropriate transport?
- How to provide securing of oversized cargo?
- What should be taken into account during developing of transportation route?
- What documents are needed to implement carriage of oversized cargo?
- What risks are existed? How to avoid or reduce them?
- What possible delivery routes are there from Finland to Kazakhstan?
- What challenges associated with oversized cargo are there in current time?

### **Research methods**

For theoretical research, sources of information such as: transportation literature is related to organization of oversized cargo delivery, different economic reports, journals and articles are used. In addition, interview was chosen as a research method in order to receive data, associated with the organization of the delivery of oversized cargo, from professionals in this field.

### **Theoretical framework**

The empirical part of this thesis is based on the comparison of different delivery options from Finland to Kazakhstan. The comparison will be based on such criteria as transportation costs, delivery time and safety of carriage. All data which is necessary for calculation will be taken from official sources or inquired from logistics companies which have such service as transportation of oversized cargo. As a result of this comparison, it will be possible to define the most optimal way to deliver oversized cargo.

## **2 OVERSIZED CARGO**

This chapter describes the most popular types of cargo. An oversized cargo will be separately considered in order to examine the load in accordance with legislation. The last subchapter contains an analysis of the transportation market and existing tendency.

## 2.1 Types of cargo

In logistics field, there are different definitions of freight or cargo. However, in general, all of them are based on one principle that describes cargo or freight as some goods which conveyed in a vessel, train, airplane or truck. (Merriam-Webster, 2017; BusinessDictionary, 2017).

There are four basic types of cargo such as a general cargo, perishable cargo, hazard cargo and oversized/overweight cargo. All above-mentioned types are described below:

General cargo. General cargoes include many different cargo items which has own unit package. This type of cargo can be introduced as boxes, pallets, bundles, crates and packages. A carriage of these goods is based on general approach to transportation in accordance with the requested conditions. (Kopytov and Abramov, 2013, 180-181).

Perishable cargo. Perishable cargoes have specified requirements because this type of cargo depends on both time delivery and conditions of carriage. Thus, they require a proper form of goods handling and transportation. Most of them are temperature sensitive, which influences over the quality of transportable goods. Such cargoes include the following products:

- Flowers and plants
- Fish and seafood
- Meat
- Fresh fruit and vegetables
- Dairy products
- Vaccines, medical supplies and live organs

This type of cargo is usually loaded into refrigerated containers or special compartments fitted with equipment to regulate the level of temperature inside. As a rule, for the delivery of perishable goods on a long distance, airplanes are used. This is due to the short lifetime of the products. (Gupta, 2013, 8-16).

Hazardous cargo. Hazardous and dangerous cargoes are a type of freight which needs special handling. These cargoes consist of dangerous materials. For instance, they can be toxic, flammable and explosive materials. Therefore, this kind of cargo requires many preventive and safety measures not only during transportation but also when loading/unloading processes are being performed. Hazardous cargoes must be observed in order to avoid damage to

human health, animals or the environment. There is a classification of dangerous cargoes which allows to choose a correct method of transportation to ensure maximum safety. The classification list consists of the following groups:

- Group 1. Explosives
- Group 2. Gases
- Group 3. Flammable Liquids
- Group 4. Flammable Solids
- Group 5. Oxidizing Substances
- Group 6. Toxic & Infectious Substances
- Group 7. Radioactive Material
- Group 8. Corrosives
- Group 9. Miscellaneous Dangerous Goods

The list of dangerous goods categories was created by United National Committee of Experts in the field of the transportation of dangerous goods (Det Norske Veritas AS, 2012, 5-10).

Oversized cargo. Oversized/Overweight cargoes are type of freight that has abnormal dimensions. They have parameters which are larger than standard those of cargo. Because of that, most trucks cannot deliver these goods as a result of exceeding pressure on the axles of vehicles. Therefore, the transportation of oversized and heavyweight cargoes in the majority of cases can be considered as a specific project which requires individual planning from the starting point to the point of destination. There are following examples of this kind of cargo:

- Plant equipment
- Power generation equipment
- Turbines
- Yachts
- Heavy machines
- Oil and gas equipment
- Houses

These cargoes require special attention because the cost due to damage or loss of cargo can be very large. Therefore, the logistic companies which offer such service as transportation of oversized cargo should have professional employees and vast experience in this area. (Galor, 2012, 100-103).

## 2.2 Oversized cargo

In the previous subchapter, different types of cargo were defined. An oversized cargo needs more detailed description as it has the most difficult transportation caused by the individual approach to each cargo item. (Galor, 2012, 100-103).

Definition of oversized cargo. Oversized cargoes are defined as bulky and heavy items that due to their parameters cannot be transported by containers or standard road vehicles. There are criteria such as width, height and length with some restrictions. If these restrictions are exceeded, cargo is defined as oversized. (Bağ, 2016, 141-143)

The states of the European Community have to follow the rules which are described in Directive 96/53/EC. According to the Council Directive 96/53/EC, there is information about allowable dimensions and weights for direct road vehicles in the international carriage within the European Union. Truck combinations with different trailers may convey cargo within the EU without a special permit if they do not transcend of the prescript standards. The restrictions of weight and size set by the Council Directive are reflected in Table 1 and Table 2. (European Commission, 2017).

Parameters	Vehicle	Figure
Height	For all road vehicles	4.00 m
Width	For all road vehicles	2.55 m
	Refrigerator with heat-barrier walls	2.60 m
Length	Motor vehicle	12.00 m
	Trailer	12.00 m
	Truck with ordinary trailer	18.75 m
	Truck with semi-trailer	16.50

Table 1. Maximum authorized dimensions for road transport. (European Commission, 2017)

There are not only limits of dimensions but also restrictions associated with the weight and axle loads for road transport. All of these loads have their limit which depends on the type of vehicle in accordance with legislation. (European Commission, 2017).



Parameters	Vehicle	Figure
Weight	Vehicles with 2 axles	18 tons
	Vehicles with 3 axles	24 tons
	Vehicles with 4 axles	Until 38 tons
	Vehicles with 5 or more axles	40 tons (ordinary trailer) 44 tons (semi-trailer for 40 FEU containers)
Axle loads	Single axles	10 tons
	Driving axles	11.5 tons
	Tandem axles	Until 20 tons
	Tri-axles	Until 24 tons

Table 2. Maximum authorized weight and axle load for road transport. (European Commission, 2017)

The existing limitation for the maximum axle load depends on the distance between the axles. Thus, there are certain restrictions for different distances between tandem axles and tree-axles:

#### Restrictions for tandem axles

- Less than 1 m (11 tons)
- Between 1 m and less than 1.3 m (16 tons)
- Between 1.3 m and less than 1.8 m (18 tons)
- 1.8 m or more (20 tons)

#### Restrictions for tree-axles

- 1.3 m or less (21 tons)
- Over 1.3 m and up to 1.4 m (24 tons)

According to different distances between axles, the sum of their loads per tandem or tri-axles must not exceed the existing limits. More detailed information about maximum authorized weight and axle load is reliant on a specific model of transport. (European Commission, 2017).

There is an exception in the Directive 96/53/EC which allows to exceed above-mentioned parameters about maximum weight and dimension of the vehicle for each state of the EU. However, these rules will be valid only within the territories of the country which established them. For instance, Finland has

its own authorized limits for such parameters which are presented in the below items (Centre for economic development, transport and the environment, 2017, 1-2):

- The maximum height is 4.40 m
- The maximum length for truck with ordinary trailer is 25.25 m
- Vehicles with 3 axles has the limitation is 26 tons
- Vehicles with 5 axles has the limitation is 44-76 tons for truck with semi-trailer and 42-48 tons for truck with ordinary trailer

Cargoes which exceed the limits of authorized weight or load relate to “heavy cargoes”. Cargoes with dimensions which surpass the maximum established values are regarded as “oversized cargo”. If the cargo exceeds one of the above-noted parameters which are presented in Table 1 or Table 2, as well as and national legislation, it is automatically determined as abnormal cargo. The term “abnormal cargo” is a collective term for oversized and heavy cargoes. (Transportxxl, 2016).

An oversized cargo, known as non-standard, requires special equipment and vehicles in order to guarantee a safe delivery from consigner to consignee. There are three main definition factors for oversized cargo: weight, dimensions and shape, which are important in transportation. According to these categories, the types of oversized cargo are identified. (Galor, 2016, 2).

An ordinary oversized cargo – different kinds of steel constructions, compact-size building machines and equipment. The weight of this cargo does not exceed 30 tons, dimensions have comparatively inconsiderable excess over standard parameters permitted in road vehicle such as a length of 15-16 m, width of 3.5-4.0 m and height of 3.0-3.5 m. Thus, transportation of this type of cargo can be usually accomplished by road trucks with appropriate marks and identification signs. (Galor, 2016, 2).

A special oversized cargo – this is defined as heavy elements, such as basins for food manufacturing industry, different burner sections for an electricity-generating plant or component parts for large machines which work in the conditions of opencast mining. Frequently, these cargoes have relatively small weight despite their large dimensions. In this way, the pressure on the road surface has no negative influence, but there are limitations of cargo characteristics such as the length of 10 m, width of 7 m and height of 6 m. (Galor, 2016, 3).

Heavy lifts – this type of oversized cargo includes different machine things such as turbines and engines. This freight has a very extremely weight in comparison with relatively small dimensions. The cargo weight exceeds 100 tons and can reach 300 tons. These cargoes can be conveyed by multi-axle trucks with semi-trailers. (Galor, 2016, 3).

A large and massive cargo – frequently, this kind of oversized cargo must be transported by sea or river because these freights have a vast weight as well as large dimensions. For instance, such objects may weigh 900 tons while their height is 40 meters. (Galor, 2016, 4).

A long cargo – it can be for example building pillars and wind turbine component parts. The length of these cargo items may reach 60 m but the other measurable sides do not exceed standard parameters. (Galor, 2016, 4).

All of these types of freight belong to oversized cargo. This classification allows to quickly identify an abnormal cargo and helps to choose an appropriate way of transportation. (Galor, 2016, 4).

### 2.3 Demand for oversized transportation

The Centre for Economic Development, Transport and the Environment shows statistic information about the quantity of issued permits for abnormal cargo transportation. According to the report on their website, the special permit documents for oversized cargo carriage are annually realized in quantity from 10,000 to 14,000 pieces in Europe. Figure 1 below contains the data about demand on the market for oversized transportation. (Centre for economic development, transport and the environment, 2015).

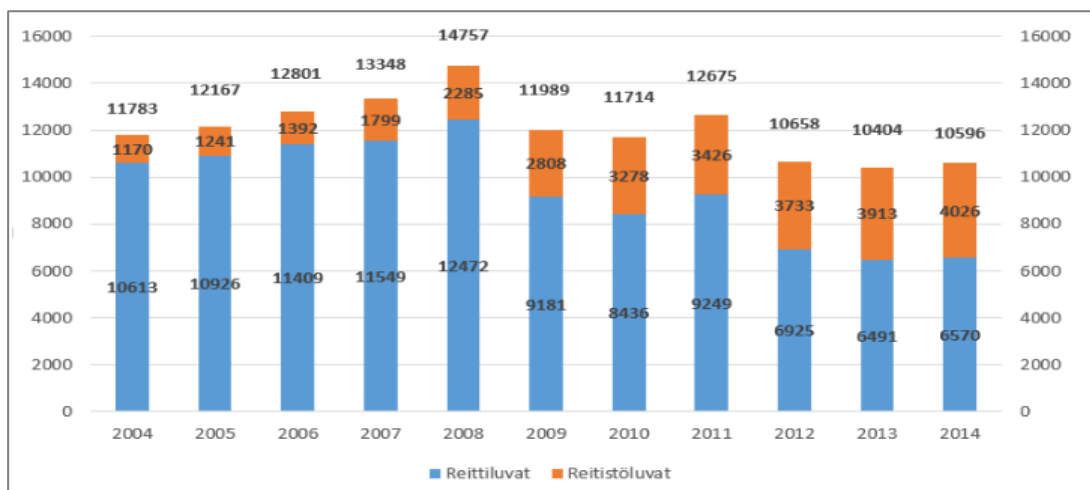


Figure 1. Quantity of issued permits by the ELY center. (Centre for economic development, transport and the environment, 2015)

This figure reflects the tendency for the past ten years. There was a growth in demand from 2004 to 2008. During the next years, the demand for issuing permits for oversized cargo transportation was unstable. The maximum demand between 2008 and 2014 was in 2011, and the point of minimum demand was encountered in 2013. Thus, there was the decline in demand for oversized cargo transportation for the period from 2004 to 2014. However, there is no information about the tendency for the last two years as there have been any investigations concerning this matter. (Centre for economic development, transport and the environment, 2015).

Nevertheless, the modern progress of technology is one of the most moving factors which have an influence the market of the oversized cargo deliveries because it leads to expanding the scope of manufacturing industry which provides demand to logistics services including oversized cargo delivery. (Atomenergomash, 2015, 20-31).

### 3 ORGANIZATION OF THE DELIVERY OF OVERSIZED CARGO

In this chapter, the process stages of organizing abnormal cargo will be considered. These stages include many aspects such as the determination of transport mode, usage of layout for placement of cargo, construction of optimal delivery route, preparation of permit documents and risks estimation with methods reducing influence of risks.

One of the basic logistics services is the transportation of various cargoes from the point of their origin to a certain destination point including transportation special freight such as oversized, heavy and abnormal cargoes. This type of service is a more time-taking process which requires vast attention. The organization procedure of transportation of these cargoes is considered as a logistics project. Therefore, the control process is thought of as logistics project management. The logistics project of delivery of oversized cargo is a multiple-stage process which requires much efforts. Frequently, the success of the project requires collaboration between several companies. (Bağ, 2016, 140-142).

#### 3.1 Selection of the appropriate mode of transport

One of the stages of logistic project is determination of correct kind of transport. The selection of transport mode is an important part of the project. Each of the transport modes has its advantages and disadvantages.

Most lorries are designed for standard cargo which does not exceed the maximum parameters established by the authorities. According to the legislation of Finland, a standard cargo has dimensions which have a width no more than 2,6 m, a height no more than 4,4 m and a length no more than 25,25 m. In the transportation of abnormal cargoes, there may be some difficulties.

The first is the large capacity of the cargo. The second is the impossibility to deliver this kind of cargo in parts as a result of the indivisible nature of the cargo. Therefore, there is a need for special transport which can implement such carriage. (Bağ, 2016, 140-142).

There are following modes of transport such as:

Road transport. Transportation by lorry is the most popular method in the world to carry goods because if a logistics company implements the delivery by other modes of transport such as air, sea transport or train, a lorry is needed to carry the carriage of goods from the place of arrival to their final destination. Shipping by truck has an important advantage in comparison with the others and allows door-to-door service which means that the receiving party does not need to collect the goods from some places, because they will be carried directly to the customer. Moreover, this type of transportation makes it possible to customize the arrival time of cargo, which will be more convenient to clients as long as trucks have not an exact schedule of arrivals. Frequently, the usage of lorries is more economically efficient on short and medium distances than other modes of transport. However, this method of delivery will have an expensive cost on long distances. Transportation by road is connected with a risk of accidents, therefore, it is necessary to insure the transported cargo. There are special vehicles for the transportation of oversized cargo as not all trucks are able to perform this type of carriage. In most cases, the trailer of vehicles depends on the parameters of oversized cargo which will be transported. Each trailer has its own weight and dimension capacity. The most appropriate kinds of trailers such as flatbed, lowboy and extendable flatbed stretch are commonly used. (Christopher, 2016, 72-84).

There are following advantages and disadvantages of this transport what are presented on the Table 3.

Advantages	Disadvantages
<ol style="list-style-type: none"> <li>1. Cost efficient</li> <li>2. Fast speed delivery</li> <li>3. The most flexible mode of transport</li> <li>4. Easy to control location of cargo</li> </ol>	<ol style="list-style-type: none"> <li>1. Impact of bad weather</li> <li>2. Possible delay</li> <li>3. Risk of road accident</li> </ol>

Table 3. Advantages and disadvantages of road transport. (Christopher, 2016, 72-84).

Railway transport. Railway transport plays a significant role in the transport infrastructure of any country because the development of railways influences directly the development of trade and industry. In general, this type of transport is used to deliver bulk goods on large distance. Railway transport is a part of an intermodal chain to carry cargoes to a port for further transportation or from ports to the point of destination. Therefore, in most cases, shipping by rail causes costs associated with the transshipment of cargo from a train to other modes of transport. These costs are reduced by using containers which are simple to handle in the processes of loading and discharging. Transportation by rail has no flexibility such as road transport, but it can be more economically efficient under special circumstances, for example on long distances. The most popular products for this means of transport are bulk commodity goods. Railway transport enables to carry extremely large cargo because of their load-bearing capacity. Moreover, the delivery of oversized cargoes by rail is more convenient on large distances than transporting these cargoes by road because the latter option requires a higher level of attention from the carrier. Shipping by rail is the safest method of conveyance as the risk of accident is at the lowest level in comparison with other means of transport. (Christopher, 2016, 72-84). There are following advantages and disadvantages:

Advantages	Disadvantages
<ol style="list-style-type: none"> <li>1. Independence from weather conditions</li> <li>2. Relatively low cost</li> </ol>	<ol style="list-style-type: none"> <li>1. Limited number of routes</li> <li>2. Unable to adapt to certain requirements</li> </ol>

Table 4. Advantages and disadvantages of road transport. (Christopher, 2016, 72-84).

Air transport. Air-cargo operations are the fastest way to deliver goods from the point of origin to the point of destination. At the same time, air transport is the most expensive mode. This mode of transportation fits perfectly to perishable goods which must be delivered in a short period of time. However, air freight forwarding has a problem with large cargoes because the planes have more limited carrying capacity in comparison with others types of transport.

Therefore, there are only a few planes which are able to implement the carriage of abnormal cargo, for instance Antonov. However, in general, this mode of transport is not suitable for transporting oversized and heavy cargoes. (Christopher, 2016, 72-84). Air transportation has the following advantages and disadvantages:

Advantages	Disadvantages
<ol style="list-style-type: none"> <li>1. Highest delivery speed</li> <li>2. Opportunity transportation of goods to remote places</li> </ol>	<ol style="list-style-type: none"> <li>1. The most expensive mode of transport</li> <li>2. Load space and weight are very limited</li> <li>3. Dependence on weather conditions</li> </ol>

Table 5. Advantages and disadvantages of air transport. (Christopher, 2016, 72-84).

Sea transport. Transportation by sea has the largest share of the market international exports. The reason that is sea transport, which has the highest level of carrying capacity among all modes of transport ensures the delivery of large quantity of goods and all types of abnormal cargo. In addition, this way of carriage requires the lowest expenses in comparison with other alternative methods. The low price of transport by sea is a result of lower speed. The delivery by this mode of transport means longer waiting time which frequently depends on weather conditions. Therefore, this method of transportation is not appropriate for the delivery of perishable goods as long as the duration of the carriage may reduce the quality of these goods. (Netherlands Maritime Institute of Technology 2014, 12-17). There are following advantages and disadvantages of this transport:

Advantages	Disadvantages
<ol style="list-style-type: none"> <li>1. Delivery of any goods</li> <li>2. Lowest cost of carriage</li> </ol>	<ol style="list-style-type: none"> <li>1. Longer delivery time</li> <li>2. Difficult to control location of cargo</li> <li>3. Dependence on weather condition</li> </ol>

Table 6. Advantages and disadvantages of sea transport. (Netherlands Maritime Institute of Technology 2014, 12-17).

In order to implement a comparison between these means of transport, it is necessary to consider Table 7 which shows the levels of modes of transport relation to each criterion. (Logistics Operational Guide, 2015, 4-6).

Mode Criteria	Road	Rail	Air	Sea
Speed	High	Average	Very high	Slow
Cost	High	Average	High	Low/very low
Flexibility	High	Low	Low	Medium
Network	Extensive	Limited and fixed	Restricted	Limited
Dependence on weather conditions	Average	Low	High	High

Table 7. Comparison of criteria of different modes of transport. (Logistics Operational Guide, 2015, 4-6).

All modes of transport have not only their features but also quite different characteristics which will meet the cost, speed or flexibility criteria at various extents. The appropriate mode of transport must be accurately selected in order to meet requirements. Multimodal transportation may ensure the most effective transport delivery as a result of combining the best features of all modes. (Logistics Operational Guide, 2015, 4-6).

Most goods can be carried by different modes of transport, but there are products with particular characteristics such as oversized or overweight cargo or perishable goods which require special transport. Also, customer requirements must be taken into account in the selection procedure. Another important aspect which must be considered is the type and model of vehicle which will be involved in the logistics chain. (Logistics Operational Guide, 2015, 4-6).

#### Model selection criteria

In order to make the right choice of one of the modes of transport, the creation of matrix with ranking influential parameters is unavoidable. There are following key criteria (Logistics Operational Guide, 2015, 4-6):

- Speed and delivery time
- Cost of transport service
- Flexibility (ability to adapt in accordance with needs of customers)



- Network (availability in different locations)
- Dependence on weather conditions

Depending on certain requirements, the most important factors will be chosen which have a priority significance for the customer. The assessment scale in Table 8 is 1-best, 4-worst.

<b>Characteristics</b>	<b>Road</b>	<b>Rail</b>	<b>Air</b>	<b>Sea</b>
Speed	2	3	1	4
Cost	3	2	4	1
Flexibility (Ability to adapt in accordance with needs of customers)	1	2	3	4
Network (Availability in different locations)	1	4	2	3
Dependence on weather conditions	2	1	4	3
<b>Total</b>	<b>9</b>	<b>12</b>	<b>14</b>	<b>16</b>

Table 8. Comparison of different means of transport. (Logistics Operational Guide, 2015, 4-6).

The structured approach is very useful for the identification of appropriate transport mode for specific cargo. It helps to consider the following factors (Logistics Operational Guide, 2015, 4-6):

- Possibilities and limitations will be found as a result of careful analysis of all significant aspects
- Geographical factors must be taken into account as long as they may exclude the opportunity to engage some means of transport
- Infrastructure analyses of appropriate transport contribute to avoid making the wrong decision

Every method of transportation has its own pros and cons therefore it is necessary to analyse the situation carefully, particular in the characteristics of goods and influencing factors in order to make the right decision. (Christopher, 2016, 72-84).

### 3.2 Placing and securing cargo

The carriage of abnormal cargoes has many difficulties during the implementation. For instance, the loading and unloading processes. In order to perform these operations, special equipment such as cranes and rigging equipment can be used. Lifting gear may include jacks, slings, wires and hooks if it is required. All equipment must be certified and have appropriate load capacity. Moreover, qualified workers with vast experience are needed in the loading of this type of cargo.

The next important step after loading is securing of cargo. (Allianz, 2014, 20-27). Reliable and safe securing of freight on the platform of the transport vehicle is the main part of a successful organization of the delivery of oversized cargo. There have been many cases when the cargo was lost and inflicted damage to the environment. Moreover, a lost cargo may kill some random people which were near the accident site. The causes of these cases are most often defective or incorrect equipment, wrong placing or inappropriate securing of cargo. (Reimers, S., at all, 2015, 7-12). There are different groups which allow to classify the consequences of accidents:

- Damage to people and environment. The consequences of this group are the most serious and they bring an irreparable harm for human life and for the environment.
- Damage to trucks. If the cargo securing was broken, the first obstacle on the way of cargo is the lorry, therefore the truck has a huge damage.
- Damage to cargo. The transported cargo brings the most damage to itself, therefore the owners of cargo insure the freight to minimize the risks.
- Economic results. Damage to cargo leads to delay as a result of increasing delivery time, economic loss, decreasing of customers' base because of client dissatisfaction.
- Combined results. This group includes the cases when chain reaction happens due to defects of small one in cargo securing with combination of other factors leads to sunk ship. (Reimers, S., at all, 2015, 7-12).

#### Regulation documents and guidelines

The common basis of cargo securing legislation in Europe is laid by standards and guidelines. The guidelines serve as directive documents for ensuring appropriate securing of cargo for all normal traffic situations. There are different principles which provide proper cargo securing for road transport. Such information is reflected in the following standards. (Galor, at all 2012, 191-193):

1. PN-EN 12640: Cargo securing on road vehicles

2. PN-EN 12195-1: Sets for securing cargo on road vehicles (Part 1)
3. PN-EN 12195-2: Cargo securing (Part 2)
4. PN-EN 12195-3: Cargo securing (Part 3)
5. PN-EN 12195-4: Elements of cargo securing on road vehicles (Part 4)
6. PN-EN 12642: Cargo securing on vehicles

There is also a document which contains information about practice application in this field which is called European Best Practice Guidelines on Cargo Securing for Road Transport. These guidelines are based on the above-noted standard EN 12195-1. The methods in this document are expected in order to apply additional equipment in particular circumstances such as securing oversized cargo. (European commission, 2016, 9-14).

More detailed information about specific cargoes and alternative ways of securing cargo is presented in additional guidelines which must not include requirements or limitations and contravene existing European standards (Galor, at all 2012, 191-193).

According to the legislation, the driver who carries out the international shipping of cargo is responsible for the proper securing of cargo. If the securing does not correspond existing rules, the transport will be stopped until the appropriate securing will be established. (Galor, at all 2012, 191-193).

### Securing equipment

The cargo is influenced by distinct categories of forces. The first category includes forces which try to keep the cargo on one place such as gravity and friction. The second category comprises forces which try to move the cargo such as acceleration, deceleration, vibration and centrifugal force. Therefore, without securing equipment, the cargo will move because of these forces are not equal. Therefore, there is special equipment which allows to ensure the fixation of cargo on the one place. This equipment is classified. (Reimers, S., at all, 2015, 24-30):

#### 1. Lashing

This kind of equipment consists of web lashings, chains and steel wire ropes. These devices are most frequently used for road transport. Steel wire ropes are used for specific cargo. All above-noted types of lashings are able to transfer only tensile force. Each one of them has its own maximum affordable load known as lashing capacity (LC). (Reimers, S., at all, 2015, 24-30).

## 2. Friction enlarging equipment

This equipment is made of high friction materials in order to increase friction between a vehicle platform and a cargo. This equipment can be carpets, coatings, rubber mats and antislip-sheets of paper. They can be established on the platform or fixed to the cargo. (Reimers, S., at all, 2015, 24-30).

## 3. Blocking bars

Blocking bars are established on the vehicle platform in order to prevent cargo from shifting. They can be vertically or horizontally mounted in trucks. The load capacity of the blocking bar on the truck depends on its fixation. (Reimers, S., at all, 2015, 24-30).

## 4. Corner protections

The sharp corners of the cargo present an essential threat to the lashing facilities. Therefore, there are corner protections which allow to maintain cargo security. (Reimers, S., at all, 2015, 24-30).

All used equipment must be suitable for the weight, dimension and framework of the cargo in order to ensure safety of the load unit. Oversized cargoes require special securing elements which need proper certificates. The securing equipment for abnormal cargo can be very complex and therefore their usage requires a case analysis by an expert. (Reimers, S., at all, 2015, 24-30).

### Securing methods

The main purpose of securing methods is the prevention of cargo from sliding, tipping or deforming in any direction. These movements of cargo are the result of accelerations, deceleration, vibration and centrifugal force of the vehicle. In order to avoid the impact of these forces, there is a need for using the following methods or their combinations (Reimers, S., at all, 2015, 35-42):

1. Locking. A locking system is the best way to insure cargo security on the vehicle. This system requires that the truck and cargo have particular shapes and facilities which allow to connect them together. This method must be used under the rules of the manufacturer's specifications. (Galor, at all 2012, 194-200).

2. Blocking. A local blocking method requires sufficient cargo rigid. In this approach, rigid supports are created in four directions, forward, backward

and sideways in order to prevent any movement of the load unit. Therefore, the cargo should be put against these fences or other goods. (Reimers, S., at all, 2015, 35-42).

In case if the freight is sensitive to tilt, there is a requirement to establish the supports at an appropriate height, above the center of gravity. If a cargo unit has cylindrical shape, wedges are used in order to prevent this cargo from rolling. The angle of the wedges should be 37 degrees to block moving in the forward or backward direction and 30 degrees for preventing rolling in sideways direction. All space should be minimized by global blocking. Small gapes are acceptable between cargo items which cannot be filled. (Reimers, S., at all, 2015, 35-42).

3. Lashing. The essence of this securing method consists of creating a force by lashings elements opposite to the inertia forces. It requires different approaches depending on the type of cargo. When handling oversized and overweight load units, detailed study of the parameters of this freight is necessary in order to choose an appropriate type of lashing. (Galor, at all 2012, 194-200).

If the cargo unit has rigid lashing points, it will be secured by four lashings. All lashings are connected with the four lashing points of the vehicle and four lashing points of cargo in the diagonal directions. The angles between the loading platform of the truck and the lashing should be preferentially between 30 and 45 degrees. There are several types of this securing method:

1. Direct lashing
2. Diagonal lashing
3. Parallel lashing
4. Half-loop lashing
5. Spring lashing

Top-over lashing is a separate method also known as friction lashing. This method is used to increase friction between the load unit and the surface of the loading platform. It is reached with help of lashing' pressure of the top side of the cargo to the platform. (Reimers, S., at all, 2015, 35-42).

All existing methods of cargo securing can be combined with the exception of a locking method when there is no need for other methods of securing. The different combinations of these methods are described in EN12195-1. (Reimers, S., at all, 2015, 35-42). However, there are many cases unconventional solutions such as welded brackets are needed. For example, support

equipment is needed in cases with boats in order to prevent the deformation of the bottom. (Heavytransport, 2016, 1-2).

In most cases, in order to ensure delivery of abnormal cargo by road, an appropriate type of truck such as flat-bed platform, open flat or lowboy are used. When carrying abnormal cargo, it is necessary to develop special procedures to maintain oversized or overweight cargo securing which require close attention. Therefore, there is a need for a professional team of specialists who will ensure appropriate cargo securing. (Galor, at all 2012, 194-200).

These methods allow to protect the driver, pedestrians and any other third parties. All these methods must be able to withstand the probable weather conditions such as rain, wind or humidity. (Galor, at all 2012, 194-200).

#### Checking of cargo security

According to Article 13 and Annex 5 of Directive 2014/47/EU, the road inspection implements checking of cargo securing. All checking processes must be based on the principles of the EN 12195-1 and the standard guidelines. (European commission, 2016, 9-13).

The method of checking is the inspector executing a visual examination of an appropriate number of securing equipment and their condition. The inspector must consider all securing elements which affect the cargo securing system. (Galor, at all 2012, 191-193).

### 3.3 Optimal delivery route

One of the most difficult and important stages of organization of the oversized delivery is the determining of the optimal route of transportation. All types of abnormal cargoes have their own nonstandard shape, parameters and other features which should be considered when determining a route or developing project plan. There are no predefined solutions for the carriage of this type of cargo. Therefore, it requires an individual approach which includes all factors influencing the route planning. (Adesiyun & Ihs, 2010, 26-33).

The object of route planning is to search for the most optimal route. This includes not only the distance and delivery time but also the investigation of the impacts of transportation of oversized cargo such as road deterioration, disassembling and assembling of infrastructure elements impact on the environment. (Stalogistic, 2017, 1-2).

Route planning consists of several stages. The first stage is the identification of all allowable routes which satisfy transportation requirements of oversized and overweight cargo in accordance with the parameters of the freight. This process is based on attributes such as physical and legal restrictions. The next stage is the calculation of the costs of the selected mode of transport in order to find the most economically efficient route. After identifying the route which has the lowest cost, it is necessary to consider additional factors. For instance, there may be reduced infrastructure costs and decreased environmental impact. (Adesiyun & Ihs, 2010, 26-33).

The most optimized route is given to the driver who will be responsible for a successful transportation of oversized cargo on this route. The driver will be informed about any critical situations and other important aspects by a dispatch operator during the carriage in order to successfully complete the transportation. This approach allows to avoid different problems which have negative influences the delivery time and safety of cargo. There are guidelines for route planning which include the following four fields: (Adesiyun & Ihs, 2010, 26-33)

#### 1. Map processes

- Analysis of map
- Defining infrastructure restrictions
- Entering restrictions on the map
- Data collection

#### 2. Route guidance

- Developing possible routes based on collected data
- Routing criteria to selection:
  - Lowest fuel consumption
  - Reducing environmental effects (emissions and noise)
  - Increasing of safety
  - Decreasing of damage to infrastructure (bridges and roads)
  - Quality of road
- Selecting the most optimal route (lowest total cost as a result of combination of above-noted criteria)

#### 3. Driving support

- Tracking of truck location
- Accumulation of data about situations on the route
- Driver notification
  - Safe speed for a certain section of the road
  - Warnings about sharp turns
  - Speed limits
  - Recommended speed according to tilt risk or tipping risk for a truck with oversized cargo

- Notices about strong wind and narrow road
- Recommended route selection

#### 4. Critical infrastructure

- Optimal including of critical infrastructure
- Bridges and tunnels
- Use of “what-if” management scenarios in the event of unpredicted situations

This structured approach provides solutions to the route planning and driver navigation in order to ensure the safety of carriage, decrease damage to infrastructure and reduce the impact on the environment. Moreover, an analysis of the map enables to detect critical infrastructure and establish the optimal usage of sections such as tunnels and bridges. All stages of route planning include coordination of the processes and fast responses to external factors.

The process of route planning can be presented by Figure 2. (Bazaras, at all, 2013, 19-24).

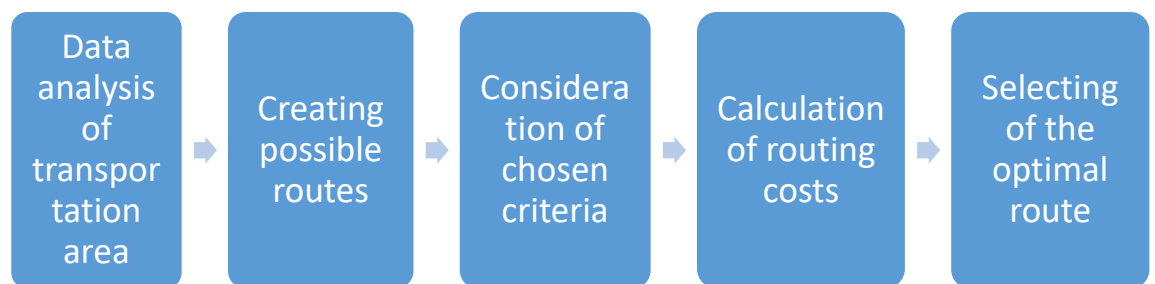


Figure 2. Process of route planning. (Bazaras, at all, 2013, 19-24).

The process of delivery routing depends on the parameters such as vehicle type, dimension of cargo, traffic conditions, infrastructure restrictions and required time of delivery. This frequently makes the process of route planning unique for each implementation. (Bazaras, at all, 2013, 19-24).

The principal infrastructure obstacles for transportation of oversized cargo by road are bridges, overpasses, small turning radiuses or widths of roads, quality of roads, objects which are located near the road and power lines which cross the roads from above. Infrastructure obstacles can be disassembled if it is necessary in order to provide transportation safety. (Murray, 2016, 1-2).

Eventually, the application of route planning consists of efficient selection of routes in accordance with all necessary parameters in order to minimize a selected object and to achieve the most efficient usage of company resources. The most optimal route is the most efficient solution among those which were



considered can be found through mathematical simulation and specific software. (Bazaras, at all, 2013, 19-24).

### 3.4 Permit documents for transportation of oversized cargo

In order to transport oversized cargo, companies need an documents. There are two groups of documents standard and special documents. The standard documents must always be prepared. With abnormal cargoes, it is necessary to prepare additional documents which enable to accomplish the carriage of this type of freight. (Lamazares, 2014, 1-4).

The international transportation of oversized cargo is more complicated because it requires the observation of not only the domestic laws of each country but also international rules. (Globalnegotiator, 2016, 1-5).

#### Standard documents

There are several standard documents which should be prepared for any carriage by road. (Marlo, 2016, 1-5).

- CMR (mandatory)
- Commercial invoice (mandatory)
- Packing List (if available)
- Carnet TIR (if available)
- Certificate of origin (if required by foreign legislation)
- Export or Import permits (if required)
- Vehicle certificates (required)

The key document in the implementation of international carriage by lorry is CMR. The CMR is an international consignment note and it is a contract between three parties, the shipper, carrier and consignee. The CMR is regulated by the convention on the contract for the international carriage of goods by road. This document regulates the liabilities and responsibilities of the parties. The shipper and carrier make their stamps on this document when cargo is loaded on the truck of the carrier. The third stamp is made by the consignee when the cargo is received. Eventually, the CMR is used as a confirmatory document by the carrier for the completed cargo delivery. This document includes all important information concerning the invoice, packing list and other certificates. Also, full information about the cargo, shipper, carrier, consignee, the customs, the point of origin and point of destination are reflected in these documents. (Lamazares, 2014, 1-4).

### Special documents

In order to implement the delivery of special cargo, it is necessary to obtain appropriate permits and agreements with certain infrastructure administrators. Therefore, there are special documents which are needed for the transportation of oversized cargo including (Ely-keskus, 2014, 1-3):

- Special permits
- Applications
- All documents on the vehicle
- Driver's license

Special permits for oversized cargo are received by the forwarder from the department of transport in each country which is included in the planned route.

On the web page of each department, there is information about the package of documents which must be attached to the application for obtaining permits.

Permit requires the following information:

1. The name, address and telephone number of the permit applicant
2. The information about vehicle
3. The all dimensions and weight of cargo
4. The total weight of vehicle with cargo
5. The dates of transportation
6. The axle load
7. The transportation route
8. The border crossing point and time

Besides above common information, the application requires layout of cargo, its overview. The specification of the cargo must be attached to the layout which reflects all significant aspects. Moreover, it is necessary to include the parameters and characteristic of the vehicle which will be used in order to implement transportation of oversized cargo. (Ely-keskus, 2014, 1-3).

There are basic conditions for transportation of oversized cargo which have to be completed such as (European commission, 2016, 9-13):

- The cargo must not limit the view of driver and encumber his visibility
- The cargo must not have negative affect on the stability of truck
- The cargo must not cover lighting devices
- The cargo must not create noise or dust
- The driver must inspect of cargo securing

### Obtaining of permit documents

The needed period of time to obtain the permit documents for abnormal cargoes frequently composes approximately seven working days. However, if the cargo is especially extraordinary, it might take more time up to a month or

even year. At the same time, logistics companies will be planning carriage of freight more detailed. In order to receive the permit documents, it is necessary to perform the following three steps (Centre for Economic Development, Transport and the Environment, 2014, 1-3):

1. Complete the permit application form
2. Return the completed form with money order
3. Notification local authorities and police

An abnormal transport permit should be received in the following cases:

- the cargo cannot be carried by other modes of transport because of unreasonable costs
- the truck has appropriate characteristics and it is registered for traffic
- there are not essential obstacles and bridges' capacity is significant

The application must be made at least 30 working days before the date of transportation starting. The department might require additional information as a part of the application. The permit document is valid only once for a certain carriage. In order to implement transportation of oversized cargo, it is necessary to notify local authorities and police which are intended to travel. (Centre for Economic Development, Transport and the Environment, 2014, 1-3).

### 3.5 Risks in transportation of oversized cargo

There are many risks in transport logistics especially during oversized cargo transportation. There is not a unified classification of risks because there are many activities. There are risks such as a wrong selection of vehicle, a choice of transportation mode, a selection of technologies for loading and unloading of cargo. The goal of logistics company is elimination or maximum decrease of possible risks. Therefore, it is necessary to estimate them and develop models which coordinate activities in case of accidents. (Hopkin, 2017, 42-47).

Estimation of risk consists of several steps. The first step is identifying of possible risks associated with transportation processes of oversized or overweight cargoes. The next stage is the estimation of existing risks and collection of data as a result of implemented analysis, it is necessary to found factors which can influence a process of carriage. This approach allows to develop appropriate strategy for reduction of negative impact and maximum decrease of degree of the risk. (Palšaitis & Petraška, 2011, 181-185).

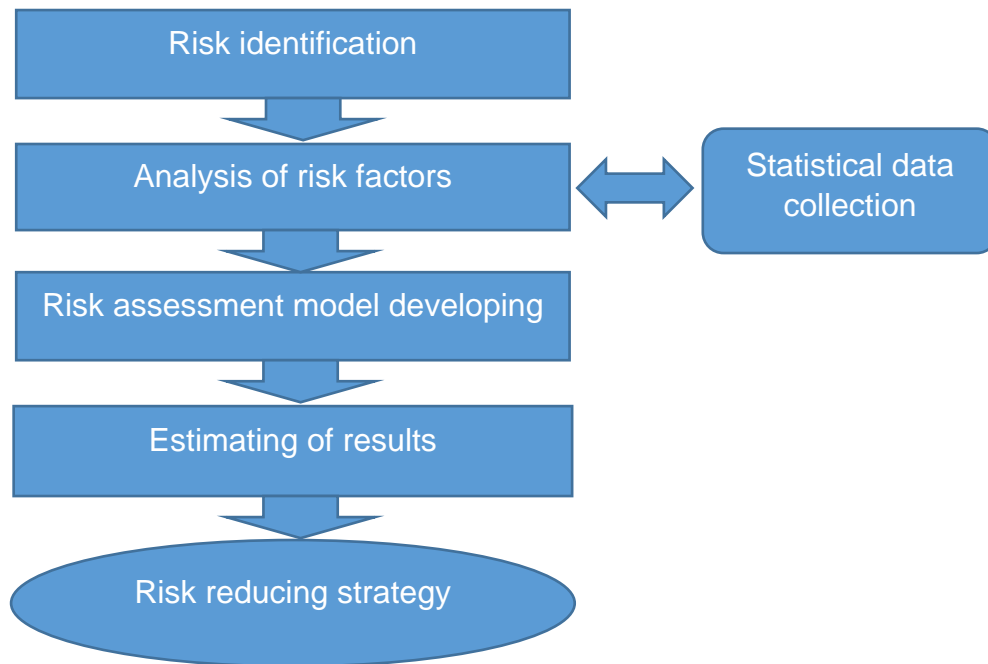


Figure 3. Process of risk estimating. (Palšaitis & Petraška, 2011, 181-185).

Development of risk model is necessary to forecast the potential impact and it allows to create a strategy in order to maximum reduce negative consequences of that cases. For example, the consequences of accident can be can be the following items: (Palšaitis & Petraška, 2011, 181-185).

- Drivers' or other road users' death
- Damage to infrastructure condition
- Undelivered or damage cargo
- Cargo delivery delay

The reducing strategy for this case with abnormal cargo can be solution about temporary block the road from other road users. Estimation of risks and creation of strategies is especially important for planning of oversized cargo transportation. Because of consequences in those cases, there are more serious and require higher attention. However, there are unpredictable situations and their factors could not be measured and controlled. (Palšaitis & Petraška, 2011, 181-185).

#### Methods of risk reducing

There are methods of increase of safety of oversized cargo transportation, some of them are regulated by the permit documents. However, the following methods can be used without requirements: (Hughes, 2016, 34-47).

- Banners. They should be placed on the front and rear bumpers at the same time it must not hide the registration sign of vehicle
- Flag. It must have red or orange color and attached to place what is noted in the permit

- Flashing lights. They should be established on the roofs of the escort vehicles
- Cargo securing. This equipment is needed to provide unmovable place of cargo
- Radio. These devices are necessary part of communication between the oversized transport and escort vehicles
- Tracking system. This system allows knowing the location of the cargo in real time
- Escorts. The enclosed vehicles must convoy the oversized cargo if it is required in permit documents

Risk management is an essential part of the planning of abnormal cargoes transportation. Examination of risks associated with the transportation of oversized and overweight cargoes allows to identify possible reasons of negative impact on the transportation process. Thus, this risk analysis ensures choosing an appropriate strategy of oversized carriage with a minimum degree of risk. (Hughes, 2016, 34-47).

#### 4 COMPARISON OF DIFFERENT MODES OF TRANSPORTATION FROM FINLAND TO KAZAKHSTAN

There were opened new places of oil born in Kazakhstan in 2016. The company which did it, wants to start crude production in 2017-2018 years. In consequents of this, the demand on oil-processing plants will be increased. (Nurjanov, 2016, 1-2).

In current time, there are three oil-processing (refinery) plants in Kazakhstan. Atyrau is the oil capital of the country because this city has the biggest and at the same time oldest oil-processing plant. Thus, the plant will be needed in new equipment in order to improve its production capacity. (Tolegen, 2016, 4-8).

Therefore, there is a good reason to consider the delivery of oversized and heavy cargoes such as tower vessels, capacitive equipment and reactors. For example, one of this equipment can be model: 3-VC2002 stripping column. (Appendix 1). This product has following dimensions: (Uralhimmash, 2015, 14-28).

- Mass: 58.5 ton
- Length is 33 metros
- Diameter: 3800 mm with wall thickness 24 mm
- Diameter: 2700 mm with wall thickness 22 mm
- Diameter: 1700 mm with wall thickness 18 mm

This equipment exceeds standard parameters of cargo such as 44t (subject to number of axles) and 25,25x4,4x2,6 metros. Therefore, it can be identified as oversized and heavy cargo. In order to perform transportation of this cargo, there is a need in the professional team of experienced logistics managers in this field. They approach detail examination and planning of each route which allows avoiding all problematic section of road. The carriage of oversized cargo is implementing with GPS system which is established on the transport in order to know the certain location in real time.

There are different modes of transport which allows implementing transportation of this cargo from Helsinki (Finland) to Atyrau (Kazakhstan). Therefore, the routes of each transport must be considered and compared between themselves.

#### 4. 1 Analysis of delivery options for oversized cargo from Helsinki (Finland) to Atyrau (Kazakhstan)

In order to implement delivery of this stripping column, it is necessary to plan the carriage options for each mode of transport. The routes of transportation from Helsinki (Finland) to Atyrau (Kazakhstan) are different in accordance with each mean of transport. Therefore, each of them will have own parameters such as distance, delivery time and costs associated with transportation.

##### Transportation from Finland to Kazakhstan by road.

According to the analysis of routes from Helsinki to Atyrau, I found the information that there are three possible routes of delivery by road in order to implement transportation of oversized cargo. The average distance between Helsinki and Atyrau is 2940 km. However, the distance will vary in accordance with the route which will be chosen. The possible routes are shown on Figure 4.

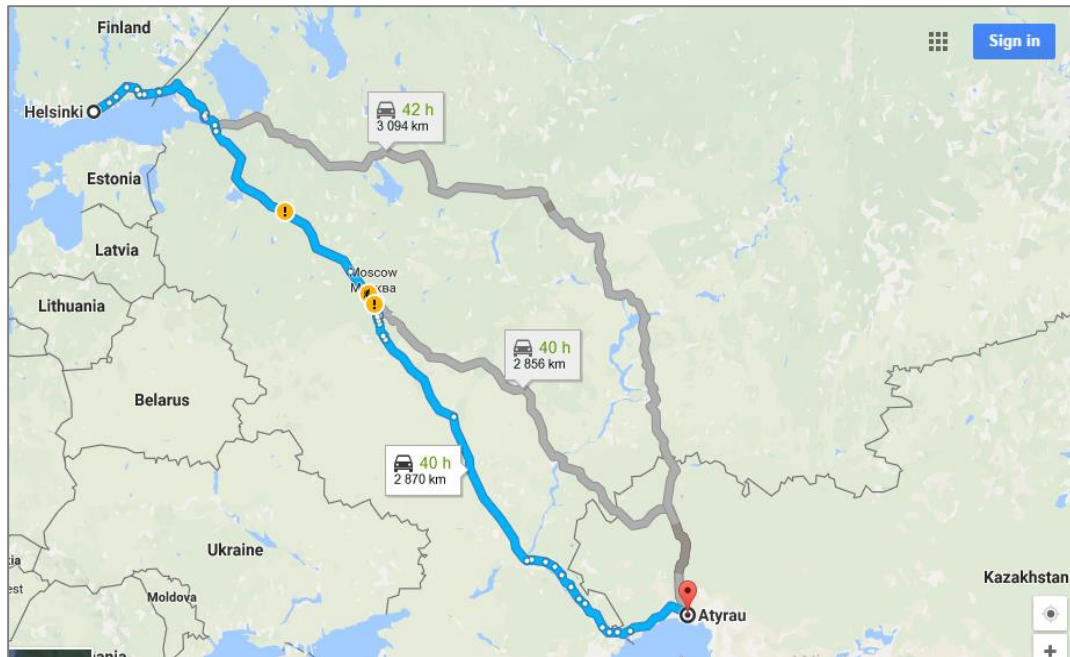


Figure 4. Possible routes of delivery by road transport. (Google maps, 2017).

If the possible routes were determined, it is necessary to examine all infrastructure restrictions such as bridges, power lines, a crossing of railways, tunnels and building works on the road. According to identified obstacles, it is possible to correct the route of oversized cargo transportation. Sometimes the logistics managers should create a bypass road for successful delivery without delays or appear of risks.

The next stage is a choice of appropriate model of truck with needed characteristics and estimation of delivery time. This kind of oversized cargo as striping column can be transported by extendable flatbed stretch trailer or specialized trailer because it has overlong size. The delivery time depends on limited speed of truck which is permitted. In general, maximum permitted speed is 50 km/h. The identified routes have different distances such as 2870km, 2856km and 3094km. Thus, the shortest way was chosen for calculation of transportation cost.

The shortest route has distance is 2856 km. In this case, it takes 57.1 drivers' hours. If it takes into account road congestion, time of delivery will increase approximately by 8 hours and it will be 65.1 drivers' hours. It means that delivery time is 7.2 days or 172.8 hours for 1 driver and 86.4 hours for 2 drivers in accordance with Directive EC 561/2006 "Mode of work and rest for drivers in international transport". (Directive EC, 2006, 6-8).

Last step is calculation of costs associated with transportation by road. Therefore, the information about distance of routes, fuel consumption of truck and cost of fuel are needed.

For example, this oversized cargo can be transported by truck is IVECO-AMT633910 which has V13 engine and 450 horsepower. This truck has fuel consumption 50 liters per 100 km. (Farpost, 2017). Also, the extendable flat-bed stretch trailer will be needed. For instance, it can be BROSHUIS 44H5-Y which is fitted for transportation of stripping column because this trailer has 46m length and 60t load capacity. (Mascus, 2017).

Nowadays, the maximum load capacity of vehicles' trailers is 250t with dimensions of platform 70x3.2 if do not take into account very special cases. (Faymonville, 2017).

Cost calculation for the shortest way of delivery by road (2856km). The route in Finland is 186 km where average price of fuel per 1 liter is 1.28 EUR. The route in Russia is 2314 km where average price of fuel per 1 liter is 0.61 EUR. The route in Kazakhstan is 356 km where average price of fuel per 1 liter is 0.4 EUR. These data are regarded in the Table 9. (Globalpetrolprices, 2017).

Country	Distance (km)	Fuel consumption (litters/km)	Quantity liters of fuel (litter)	Price of fuel per 1 litter (EUR/litter)	Cost (EUR)
Finland	186	0.5	93	1.28	119.04
Russia	2314	0.5	1157	0.61	705.77
Kazakhstan	356	0.5	178	0.40	71.2
<b>Overall</b>	<b>2856</b>	-	<b>1428</b>	-	<b>896.01</b>

Table 9. Calculation of costs associated with fuel consumption. (Globalpetrolprices, 2017).

According to finding data, the costs associated with fuel consumption for the shortest route is 896 EUR. In order to calculate full organization cost of delivery of stripping column without works of logistics managers, it is necessary to take into account the following items:

- Fuel consumption
- Salary of driver (1 or 2)
- Loading/unloading works
- Cargo securing
- Escort



- Appropriate marking
- Completion of documents

Consequently, the shortest way by road which is 2856 km has fuel costs which is 896 EUR and delivery time which is 7 days 4 hours 48 minutes (1 driver) or 3 days 14 hours 24 minutes (2 drivers). Average transportation price of oversized cargo with weight 58.5t is 4 EUR per 1 km. Transportation costs will equal 11424 EUR are based on this price. Moreover, it is necessary to include costs associated with escort vehicles which must be three in accordance with precept of transport department. The price of one shadow vehicle is 0.5 EUR/km, consequently for three vehicles is 1.5 EUR/km and total is 4284 EUR per 2856km. (Spectrans, 2017). Overall, the transportation costs by road are 15708 EUR.

#### Transportation from Finland to Kazakhstan by sea.

According to the analysis of routes from Helsinki to Atyrau by sea, there is one way of delivery in order to implement transportation of oversized cargo. The distance of the route is 10063 km. The delivery time is 24 days. The possible route is shown on the Figure 5. (SeaRates, 2017).

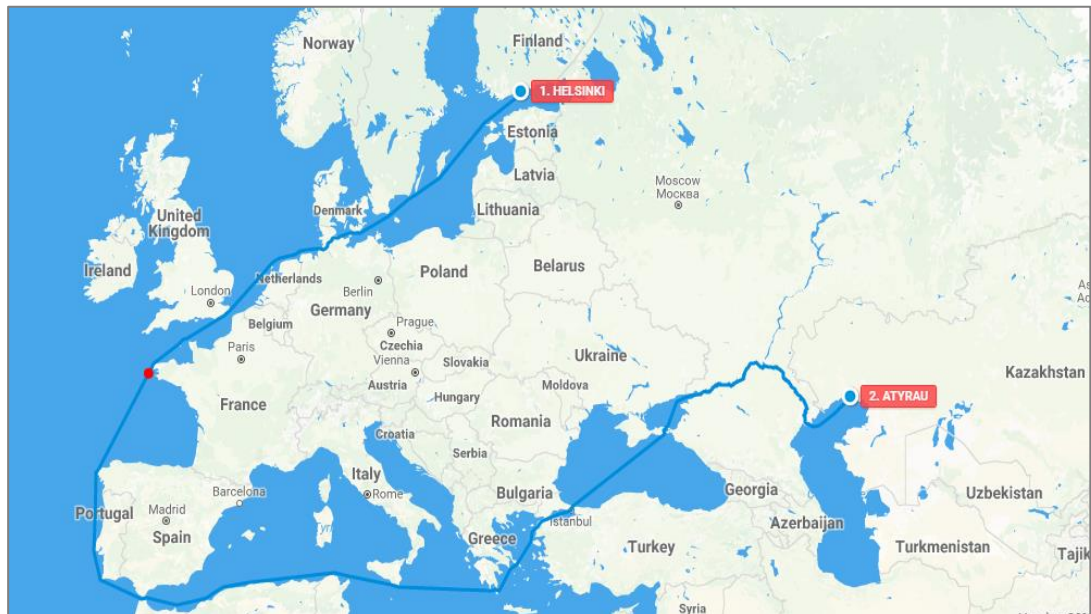


Figure 5. Transportation route by sea. (SeaRates, 2017).

Transportation of stripping column by sea requires much time of expectation. However, the costs associated with carriage by sea are significant cheaper than other mode of transport. Transportation costs are 8438 EUR without handling works. This transportation price was calculated by dimensions of oversized cargo and price per volume which composes approximately

21EUR/cbm. (Worldfreightrates, 2017). The dimensions of freight take 405cbm on the board of vessel. The volume has the largest influence over the delivery cost by sea transport.

Nowadays, the largest load capacity belongs to dockwise Vanguard. Its characteristics have the parameters 275x70m loading dock and enable perform the transportation of super heavy freight which have weight until 110000t. (Ship-technology, 2014).

#### Transportation from Finland to Kazakhstan by railway.

According to the analysis of routes from Helsinki to Atyrau by train, there is one way of delivery in order to implement transportation of oversized cargo. This route is part of the international transport corridor “North-South”.



Figure 6. Transportation route by train. (Glogist, 2016).

The distance of delivery by train is 3030 km. (Appendix 2). The speed of train is 20km per hour if take into account stop stations approximate speed will be 18km/h. (Melnikov, 2014, 3-5). Thus, the needed time of carriage is 7 days and 21 minutes.

In order to calculate transportation costs, it is necessary to know the distance of the route and oversized degree of cargo. The stripping column is identified as H0200 and has a second oversized degree. (InterRail, 2015). The delivery price of cargoes which have the oversized degree until third costs higher than standard cargo delivery on average by 30 percent. (Yanchenko, 2017, 3-4). According to received data from logistics company, the transportation of cargo

costs approximately 10800EUR. (RailwayForwarding, 2017). However, if the cargo has more than third oversized degree, it will be approximately in 2 times more expensive than general cargo.

Nowadays, the existing van-platforms have the limits which are not enable to implement carriage of oversized and heavy cargo. There are limits of both dimension is 18.3x2.8m and load capacity is 75t for one platform. (Vorobiev, 2013, 2-5).

#### Transportation from Finland to Kazakhstan by inland waterways.

According to the analysis of routes from Helsinki to Atyrau by inland waterways, there is one way of delivery in order to implement transportation of oversized cargo. This way of delivery includes Baltic sea, White Sea-Baltic Canal, Volga-Baltic Waterway and Caspian Sea. This route is shown on Figure 7. (Pimonenko, 2014, 4-10).



Figure 7. Transportation route by inland waterways. (Glogist, 2016).

The first part of route from Helsinki port to Saint-Petersburg port is 320 km. The distance between Saint-Petersburg port and Astrakhan port is 3390 km. The third part of way from Astrakhan port to Atyrau port is 440 km. Overall, the distance of this route is 4150 km. (Appendix 3).

The average speed of rivers' vessels is 15-20 km/h. (Nptechno, 2015). Therefore, it is possible to calculate time which is needed in order to implement carriage of oversized cargo. The delivery time is 276.67 hours or 11 days 12 hours 40 minutes. This method of calculation does not include waiting time for

each floodgate. The operation of a pound lock takes 20 minutes. (Peeters, 2014, 31-35). There are 14 floodgates which take 4 hours and 40 minutes. The delivery time becomes 11 days 17 hours and 20 minutes. Also, there is needed to add average waiting time around 2-3 days in a line in order to put in the Saint-Petersburg port and 1-2 days' detention in the Atyrau port. (Pimonenko, 2014, 4-10). Therefore, the final time of oversized cargo shipping is 16 days 17 hours and 20 minutes.

Transportation cost of delivery of oversized cargo by inland waterways generally is depended on such factors as duration of navigation, volume of cargo and infrastructure costs. These expenses less approximately in 2 times than delivery by railway. In order to calculate more certain consideration, it is necessary to add 16 percent in accordance with existing duties in Russia. Thus, in this case, the costs associated with carriage of stripping column equal 6264 EUR. (Trassa-express, 2015).

Transportation by this way has own limits. Opportunity of delivery by inland waterways depends on season. Because of that, this way of transportation cannot be used several months in year due to rivers are frozen. There are other restrictions for this kind of transportation such as different deep of rivers, stream course and maximum load capacity of rivers' vessel. Therefore, the logistics company should choose an appropriate type of vessel for delivery of oversized cargo and do not exceed load capacity of vessels. The navigable depth is no less than 4m, what is enable to access of vessels with maximum load capacity is 5000t. (Pimonenko, 2014, 4-10).

Nowadays, the largest load capacity among rivers' motor vessels belongs to "Volgo-Don". Its characteristics have parameters 130x16m loading dock. The load capacity of this transport enables to perform the transportation of oversized cargoes which have weight until 5000t. (Volga shipping, 2016)

#### Transportation from Finland to Kazakhstan by air.

According to the analysis of routes from Helsinki to Atyrau by airplane, there is a one way of delivery in order to implement transportation of oversized cargo. This route is the shortest delivery option. The distance of transportation by air is 2262 km. The direction of shipping is shown on the Figure 8.

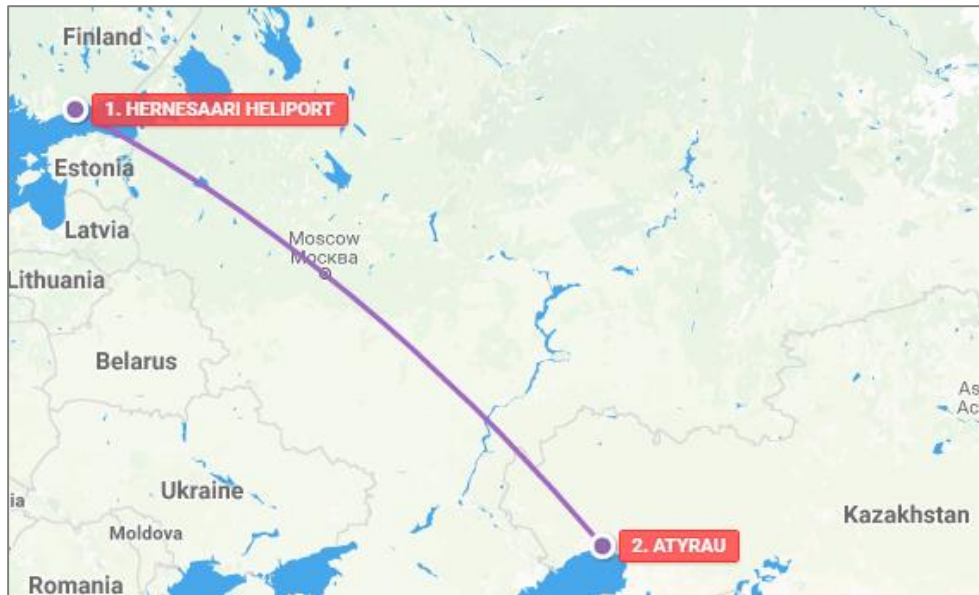


Figure 8. Transportation route by airplane. (SeaRates, 2017).

Carriage of oversized cargo in accordance with this route takes 3 hours without accounting of handling time. However, in order to execute this delivery, it is necessary to use special aircraft. For instance, such model can be An-225 Mriya it is the largest airplane. Its load capacity is 250t and cargo bay is 1211cbm(43x6,4x4,4m). (Sivak, 2015, 2-4). Thus, this airplane and other similar models are able to implement the transportation of oversized cargo as the stripping column. Exactly for this case the most suitable variant will be An-124 with load capacity is 120t and cargo bay is 36,5x6,4x4,4m. The rental value of An-124 is 23618 EUR per hour. According to delivery time, the costs associated with carriage by air without handling works are 70853 EUR. (Kamaev, 2016, 1-4).

#### 4.2 Choice of the most optimal route

Each mode of transport which were noted above has limitative dimensions of load place and weight of load capacity. Therefore, there is a good reason to consider all of them on the Table 10. It is based on maximum capacities of different modes of transport.

Transport	Road	Railway	Sea	Inland waterways	Air
Restrictions					
Dimensions (length&width &high)	70x3.2m (+overhang)	18.3x2.8m (+overhang)	275x70 m	130x16m	43x6.4x4.4m
Weight (t)	250	75	110000	5000	250

Table 10. Load capacity restrictions of modes of transport.

The Table 10 is needed in order to provide customer with information about existing restrictions of different means of transport. For example, if the customer wants to carry oversized cargo with specified dimensions, he needs to decide which type of transport is able to implement delivery of his cargo. Therefore, this table will be useful for the consumer which is needed in shipping of abnormal cargo.

When the customers already known which kinds of transport are fitted to their oversized cargo, the next step will be choosing of the best way of transportation in accordance with customer' criteria. There are criteria which have the most important meaning for a customer in different cases. They are shown on the Table 11 with key: 1-worst, 5-best evaluation.

Transport Criteria	Road	Railway	Sea	Inland waterways	Air
Costs (the cheapest delivery)	2(15708)	3(10800)	4(8438)	<b>5(6264)</b>	1(70853)
Time (the fastest delivery)	4(86.4)	3(168.3)	1(576)	2(401.3)	<b>5(3)</b>
Safety (the most safety deliv- ery)	1	2	4	3	<b>5</b>
Total (quan- tity of points)	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>

Table 11. Criteria of oversized cargo delivery.

The costs were approximately evaluated for implementation of carriage. They include fuel consumption, permit documents, logistics services.

The delivery time was calculated as a result of distance and transport speed dividing. It allowed to know how many days are needed in order to implement transportation of oversized cargo from Helsinki to Atyrau.

The safety of oversized cargo means that will not appear problems on the route such as accidents, influence of weather, theft of cargo. (Bureau of transportation statistics, 2015).

There are three possible wishes of customers which are based on the previous table with criteria.

1. If the customer wants to deliver the strip column with minimum level of costs, he should to choose river transport.
2. If the customer wants to deliver the strip column with minimum time of delivery and the highest level of safety he should choose air transport.
3. If the customer wants to deliver the strip column with the best retia of price of transportation and delivery time he should choose railway transport.

The sea transport is appeared to be the cheapest way of carriage. However, the route of inland waterways has less distance 4150km against 1063km by sea. Therefore, the sea transport has longer delivery time and more expensive price of carriage. As long as the delivery route by sea has not any advantages over river transport in accordance with the criteria, this kind of transportation will be excepted.

When the customer has not the one main criterion, the following table can be used in order to take into account the significance of all criteria. In this table will be shown evaluations from the previous table and estimations in accordance with weight of criterion. For instance, the customer identified significant for criteria as 0.6 for safety and 0.4 for costs. It means that safety of delivery is the most important criterion but at the same time the costs should not be very high.

Transport Criteria	Criterion weight	Road	Railway	Inland waterways	Air
<b>Costs</b>	0.4	2(0.8)	3(1.2)	4(1.6)	1(0.4)
<b>Time</b>	0.0	3(0)	2(0)	1(0)	4(0)
<b>Safety</b>	0.6	1(0.6)	2(1.2)	3(1.8)	4(2.4)
<b>Total</b>	1.00	1.4	2.4	<b>3.4</b>	2.8

Table 12. Customers' criteria to delivery of oversized cargo.

According to the found results from Table 12, the best choice for our customer will be transportation of stripping column by inland waterways. Because this way of carriage includes the best retia of safety level and costs in case if delivery time is not important for the customer.

This table shows how importance of each criterion influences choosing of transport mean. If in the previous Table 11 each criterion was separately considered, then in this table all criteria take participate in identifying of appropri-

ate mode of transport. Therefore, this approach of evaluation and selection allows to make the right decision of delivery option in accordance with needs of customer.

It is possible to create the graph of correlation which is based on calculated data of transportation costs and delivery time. It allows to understand the dependence between the price of transportation and waiting time.

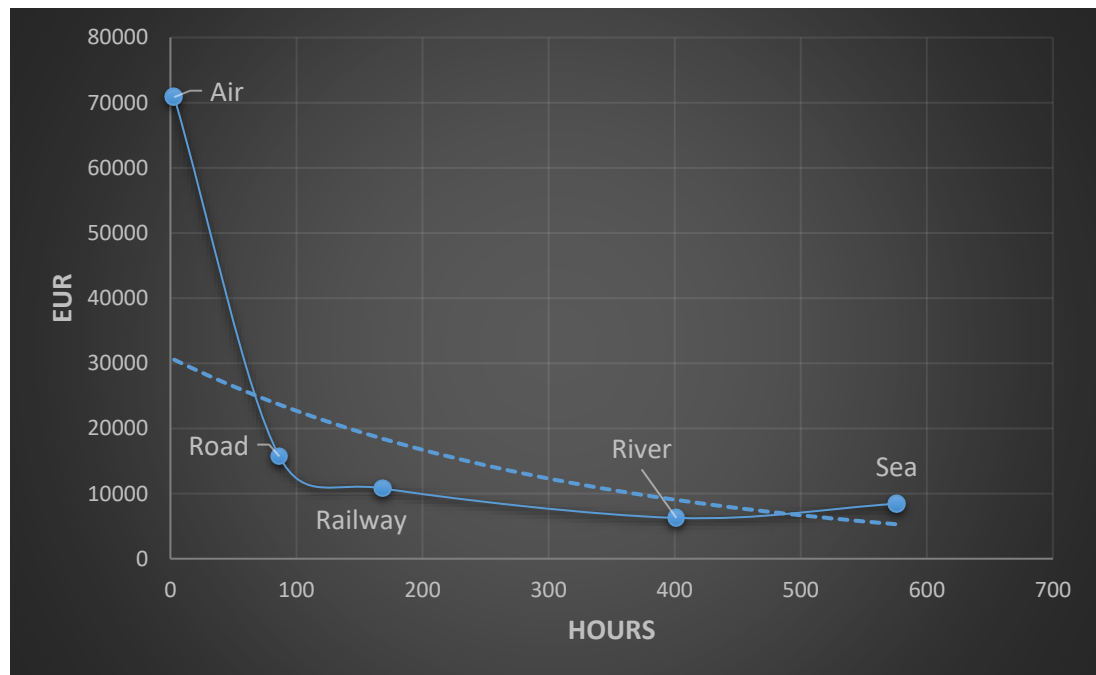


Figure 9. Correlation of costs and delivery time of transportation.

Overall, there is the obvious correlation between delivery time and price of transportation. If there is a need in the fastest delivery of cargo, it will have the highest price. Otherwise, the transportation of cargo will take the longest delivery time however the price of carriage will be the lowest. In this case, the sea transport is an exception. It is more expensive and its delivery time is longer than river transport has. I assume this is due to the fact that distance of route by sea is much longer in comparison with other routes.

#### 4.3 Common challenges associated with delivery of oversized cargo

In order to identify existing problems from practical point of view, I conduct an interview with logistics manager of «Silvasty». This company has been on the logistics market for many years and offers such logistics service as logistics project and oversized cargo delivery. Therefore, the answers from the expert in this field are very useful.

The interviewer is Danil Fabrichkin.

The interviewee is Mikko Lietosaari.



## Questions

1. What challenges you have had associated with oversized cargo in general, for example with handling or securing? How did you decide these challenges?

- “The challenges usually arise when something proves to be otherwise than agreed or planned”
- “Cargo dimensions and/or weight differ from informed”
- “Transport supports missing or not similar as informed”
- “lifting points, lashing points missing or not similar as informed”
- “In any case, defects need to be corrected before the operations can continue.”

2. What is most difficult in planning of oversized cargo transportation?

For instance, which processes and activities require a lot of time?

- “Route planning of large transports often takes time, especially if there are obstacles on route (overhead cables etc), or the high weights limit the route options we can use.”

3. What are the methods and criteria you use in developing optimal routes for deliveries and on what bases do you make decisions on the transport mode?

- “Due to the customer requirements, the route with the lowest total costs is usually chosen.”
- “For sensitive cargoes, the customers accept also higher transport costs due to safety and security, e.g. if the transport is made without any transshipments on route.”

4. How do you oversee unpredictable cases which can effect negatively on transporting oversized cargo? Which actions do you make in case of unpredictable situation? For example, in the case of accident, in the case of blocking roads, reconstructing work.

- “In Finland, such unpredictable conditions occur very seldom.”
- “In the Central Europe, such are more likely due to higher traffic density.”
- “In case of accident and similar unexpected conditions, the only option usually is to wait until the site has been cleared.”
- “The road construction areas are usually known beforehand and the transport route must be (re)planned to avoid such routes/areas.”

5. How do you see the oversized cargo transportation is developing in the future?

- “We expect that the need will continue, and in some cases even grow. The production work in manufacturers’ own premises is safer, cheaper and better compared to the conditions at project/installation site, which increases the need of oversize transports. There are also several products that must be manufactured in suitable factory conditions, e.g. some pressure vessels, machinery etc.”

6. Are there any specified problems in your supply chains for oversized cargo that students could study further?

- “Actually no, the challenges are often very case specific and the solutions must be developed and tailor made for each case.”

According to received answers, the following moments deserve special attention. The most frequently problems associated with wrong noted dimensions and lashing points of oversized cargo by a customer. Route planning is the most complex part of the organization of abnormal freight transportation. In general, the criterion of transportation costs is the most important for a customer. In the case of accidents or unexpectable situations, waiting is only one option.

## 5 CONCLUSION

Oversized cargoes have unstandardized parameters and requirements of transportation. Therefore, in order to implement carriage of these cargoes, it is necessary to pay great attention to choosing appropriate mode and model of transport which will meet special requirements of certain cargo. In additionally, it is critical to use holding elements for abnormal cargo since they are the essential part of safety transportation. In the theoretical part, all stages which are needed to organize delivery of abnormal cargo and features associated with these processes were considered.

According to the theoretical part, the organization of delivery of oversized cargo can be interpreted as a complicated logistics task which requires responsible care throughout this process. There are not templates with a description of operation processes which are needed in order to implement this kind of logistics service. Because of this, every step of the organization requires an individual approach and has significant importance from planning to implementation of carriage.

In practical part of thesis, the different delivery options of oversized cargo were considered by the example of route from Finland to Kazakhstan. In order to implement transportation, it is necessary to decide what kind of transport is needed. Therefore, the comparison of different modes of transport was performed. The comparison was based on such criteria as transportation costs, delivery time and safety of carriage. The air transport is the most expensive mode but it has the shortest delivery time and the highest level of safety as a result of comparison. At the same time, the transportation by inland waterways is the cheapest way for transportation of oversized cargo from Helsinki to Atyrau. However, the choice of the most optimal route depends on customer's needs and his importance of criteria such as costs, time and safety.

Thus, the main object of the thesis was achieved as the most optimal route in accordance with specified needs of a customer was determined. For example, if a customer wants to implement delivery with elevated level of safety and save his money, the most optimal choice is inland waterways. When the time is a dominator, the air transport should be used. Moreover, according to the statistic information, the air transport is the most safety.

Summing up, the main question of the thesis was answered. The most optimal route can be different. As various customers have their own preferences and requirements. There is not only one variant of way which will satisfy all clients. In confirmation of this, there was found the correlation between the price of transportation and delivery time. According to the received result, the higher price, the faster shipping of oversized cargo. Conversely, the lower price, the longer delivery time. Therefore, there is not variant which simultaneously has the lowest costs and shortest time of carriage.

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## FIGURES

Figure 1. Quantity of issued permits by the ELY center. (Centre for economic development, transport and the environment, 2015) .....	11
Figure 2. Process of rout developing. (Bazaras, at all, 2013, 19-24).....	24
Figure 3. Process of risk estimating. (Palšaitis & Petraška, 2011, 181-185) .....	28
Figure 4. Possible routes of delivery by road transport. (Google maps, 2017).....	31
Figure 5. Transportation route by sea. (SeaRates, 2017). .....	33
Figure 6. Transportation route by train. (Glogist, 2016).....	34
Figure 7. Transportation route by inland waterways. (Glogist, 2016). .....	35
Figure 8. Transportation route by airplane. (SeaRates, 2017).....	37
Figure 9. Correlation of costs and delivery time of transportation.....	40

## TABLES

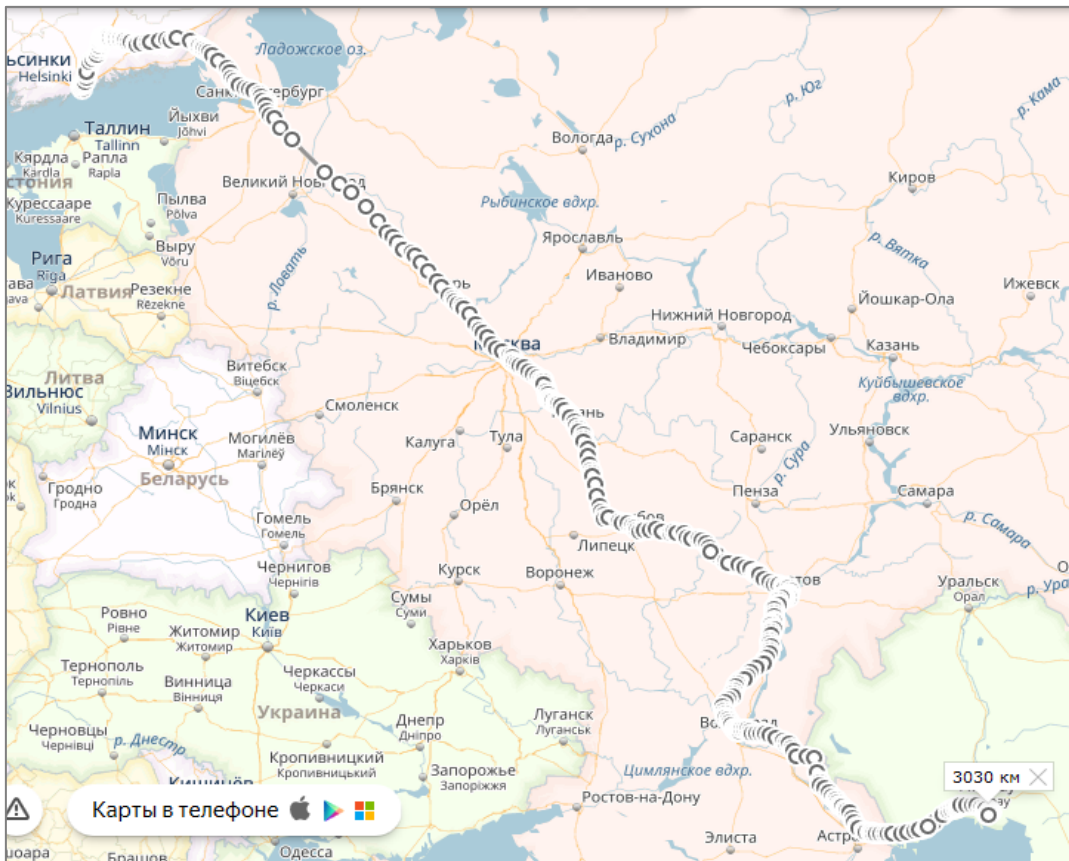
Table 1. Maximum authorized dimensions for road transport. (European Commission, 2017) .....	8
Table 2. Maximum authorized weight and axle load for road transport. (European Commission, 2017) .....	9
Table 3. Advantages and disadvantages of road transport. (Christopher, 2016, 72-84).....	14
Table 4. Advantages and disadvantages of road transport. (Christopher, 2016, 72-84).....	14
Table 5. Advantages and disadvantages of air transport. (Christopher, 2016, 72-84). .....	15
Table 6. Advantages and disadvantages of sea transport. (Netherlands Maritime Institute of Technology 2014, 12-17). .....	15
Table 7. Comparison of criteria of different modes of transport. (Logistics Operational Guide, 2015, 4-6). .....	16
Table 8. Comparison of different means of transport. (Logistics Operational Guide, 2015, 4-6).....	17
Table 9. Calculation of costs associated with fuel consumption. (Globalpetrolprices, 2017).....	32
Table 10. Load capacity restrictions of modes of transport. ....	37
Table 11. Criteria of oversized cargo delivery. ....	38
Table 12. Customers' criteria to delivery of oversized cargo. ....	39

## Appendix 1: Model of stripping column.



(Uralhimmash, 2015, 14-28)

## Appendix 2: Distance of railway route.



Appendix 3: Distance of inland waterways route.

