Master thesis

Warehousing locations in the EU

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Abstract

Warehousing is an important part of the supply chain. Therefore it is interesting to research the locations of warehouses. First of all are the types of goods of influence. In this research a distinction is made between functional and innovative goods. Besides many other determinants are of influence on the location decision of warehouses. In this research the following determinants are considered; real estate costs, wages, low educated labor force, population, road density, railway density, inland waterway density, road infrastructure quality, railway infrastructure quality, port infrastructure quality, seaport distance and inland port distance. Data of those determinants is used in order to create maps which could be compared with the founded location quotients of warehousing. The results are that Western Europe is the most attractive region for warehousing. Furthermore the most preferred region for functional goods is Zuid-Holland, while it is Brussels for innovative goods.

Introduction

You can easily find news articles about openings of new warehouses, distribution centers or other logistics activities in the newspapers. That such articles appear in the newspapers, stresses the importance of it. The economical and societal relevance is notified, e.g. how many jobs it brings. However the decision of the location of these facilities is not a wild guess.

The company Wehkamp decided in 2013 to build a new warehouse at another location, because of the enormous growth of the e-commerce segment of the company. At that moment their warehouse was located in Dedemsvaart, a village in the north of the province Overijssel. Their new warehouse arose in Zwolle (Logistiek.nl, 2013 and Destentor.nl, 2013). This is a city in the west of the same province. The company was satisfied with the current employees. Therefore moving far away from the initial location was not appreciated. Another party has also influence in the location decision. The transportation from warehouse to the consumer is outsourced by Wehkamp. This carrier prefers a more central location in the Netherlands. Roughly considering both preferences has led to the decision to locate in Zwolle. It is still close to their current employees and the warehouse is located in a city on the highway instead of 20 kilometers away of it.

In the same year the company Action decided to build a second warehouse (Logistiek.nl, 2013). At that moment the company was only active in the Netherlands. They want to intensify their activities in the Netherlands, but also an international expansion to the neighboring countries. The existing warehouse is located in the province Noord-Holland. A growth in the Netherlands can be caught by an enlargement of the current warehouse, but for the international orientation of the growth will this not be sufficient. The province Noord-Holland is far away from the borders. Therefore they wanted to locate the second distribution center in the Southern province Limburg. The exact location in this province is established by the lobbying of two organizations of which one of them was the government. So this decision was made because of strategic considerations, but also the government has its influence.

In the eastern Netherlands the company Twentepoort Groep decided in 2014 to build a new warehouse a couple a kilometers away from their current one (Logistiek.nl, 2014). The old warehouse became too small and a larger one was needed. The goods of this company have all destinations in Eastern Europe. The current location in Almelo is preferred by the company because of the good accessibility of Eastern Europe. Therefore a location in Wierden, a couple of kilometers from Almelo, is chosen. Furthermore are there plans to open a warehouse in Germany, just over the border in Gildehaus, in order to serve the

German market. In this case the accessibility and again strategic considerations are of importance in the location decision.

Above are just a few examples of location decisions of logistics activities in the Netherlands, especially warehousing. This research will go further into the location of logistics activities. Since logistics is a broad concept, the focus will be on just a segment of logistics, namely warehousing. It will make clear why companies will make a decision for a specific location. Could a neighboring port influence the decision for a location positively? Does the government have an influence in supporting some locations for logistics activities? Are there logistics clusters which have a preference in the location decision? These are a small sample of numerous questions, which can arise with regard to the location of warehousing activities.

Currently there is a lot of research about logistics and more specific the location of it. In this research the indicators for location decisions will be broadly discussed. Those indicators are used in order to research the location of warehousing, to which is done less research. Therefore this literature will contribute to the existing literature by picking out just a part of logistics activities.

To get all these questions into one sentence, the following research question is formulated: What are attractive locations of warehousing in Europe? Splitting up this question into smaller pieces will make this research more understandable. Below the sub questions will be given and thereafter the structure of this research becomes clear.

Research question:

-What are attractive locations of warehousing in Europe?

Sub questions:

-What are determinants of the location of warehousing?

-Where is warehousing overrepresented in Europe?

-How to explain the founded concentrations in Europe?

First of all an explanation of warehousing will be given. Activities of it will be discussed and the market situation will be described. Furthermore the developments within the warehousing industry will be given.

Subsequently existing literature about locations of logistics activities will be discussed. Different views are point of discussion. Researchers have different views on which determinants influence the location decisions. The availability of good infrastructure will realize more efficient transportation of goods. Clusters can also be attractive for logistics activities. Level of wages and real estate costs are examples of costs which can be interesting in the location decision. The mentioned considerations for the location of logistics activities are just a small selection from all determinants.

The empirical part of this research consists of an investigation of the location of warehousing in Europe. To do this empirical research, the Nomenclature of Territorial Units for Statistics will be used. In this way you can see results at smaller regional level. With which determinants this will be done, is described further.

Finally the results will be explained in the analysis. The linkage with the literature has to be made. The reasoning for the choice of a location becomes clear. Furthermore it becomes clear due to which determinant it is. Lastly conclusions will be made, the limitations be discussed and ideas for further research will be given.

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Warehousing

General explanation

Nowadays it is possible to order products at companies at the other side of the world from behind your computer. A couple of days later your package is delivered by a postal service. The development of transport modes, mobile telephones, internet and sophisticated Information and Communication Technology (ICT) has facilitated this. The economy has undergone a globalization process. An improved movement of goods, service and capital has led to the integration of worldwide economies. Therefore you can see that the trade of goods and services has increased last decades (imf.org, 2008).

This trade of goods and services needs supply chains. A supply chain describes how a product moves from raw material to end product. Of course this should be done in the most efficient way in order to be competitive. Many companies are involved in the supply chain, so it is difficult to realize an efficient one. In this research I will focus on a major part of the supply chain namely logistics. According to the Council of Supply Chain Management Professionals (CSCMP) can logistics be defined by: "the process of planning, implementing and controlling the efficient, effective forward and reverse flows and storage of goods, services and related information between the point of origin and the point of consumption in order to meet the customer' requirements" (csmp.org, 2015). This is a comprehensive definition of logistics, which appoints several activities within the logistics sector. If all those logistics activities will be dealt in this research it would not be in detail enough to make efficacious conclusions. Therefore warehousing, one important segment of the logistics sector, gets the attention.

Hundreds of years ago, shipping routes to other continents were explored. This created demand for storage space for the shipped products. Bowen (2008) confirms this initial explanation of a warehouse, which needs manual labor. The wages were low, so it was quite cheap to use manpower (Ashayeri & Gelders, 1985). Furthermore makes Bowen (2008) a distinction between a warehouse and a distribution center. According to him does a distribution center much more, such as cross docking and frequent deliveries, than the traditional warehousing such as storage and manual labor. A distribution center make use of automation and state of the art equipment in order to raise productivity and efficiency. Actually distribution centers are a modern version of warehouses. Therefore distribution centers still belong to the warehousing industry. Only there is given a new name to it, but in essence it is still the same.

Warehousing activities

Above discussion implies that warehousing contains a wide range of activities. Several researchers pointed many activities which are done in a warehouse. According to Gunasekaran et al. (1999) warehousing has six main activities: receiving, transfer, handling, storage, packaging and expediting. They obtained it from several other researches. The transfer is the transportation from the point of receiving to the point of storage, while the handling is the placement of the goods in the racks. Picking the goods from the storage, because it is ordered by a customer, is also called handling. Varila et al. (2007) also mention six activities, they are slightly different from Gunasekaran et al. (1999). They are receiving, put-away, storage, order picking, packaging and shipping. Varila et al. (2007) comprise the activity between receiving and storage as put-away. They are obtained from their own case study and literature. Furthermore they explicitly mention order picking. It is remarkable that shipping is mentioned. Actually this means more than making the goods ready for transport. The differences between both researches are basically because of the goal of the research. Gunasekaran et al. (1999) focused on the efficiency of operations, which requires a more detailed summation of the activities. While Varila et al. (2007) tried to model the costs of warehouse logistics and therefore a broader definition of the activities is allowed.

Aminoff et al. (2002) obtained five primary functions of warehousing, namely receiving, shelving, transfer, picking and shipping by doing observations in warehouses. They also describe secondary functions. Compared to the first two researches here storage is missing. It is hidden in the shelving activity. Furthermore they noticed that the packaging activity is included in shipping. Again the term shipping is used, which also can be seen as a transportation issue which strictly doesn't belong to warehousing itself. Aminoff et al. (2002) had the same subject as Gunasekaran et al. (1999): efficiency of warehouse operations. Therefore their activity formulations are more or less the same, although Aminoff et al. (2002) is more detailed because of defining secondary functions. For this research the secondary functions are too detailed, therefore it will not be discussed. Lim et al. (2013) noticed receiving, put-away, storage, order picking and dispatching as warehousing activities. Those activities are based upon other literature research. This is in line with Varila et al. (2007) except for the last activities. Packaging is lacking and shipping is replaced by dispatching. Lim et al. did a literature research to Radio Frequency Identification (RFID) use in the warehouse. RFID lead to operational efficiency, which means that products go fluently through the warehouse. Packaging has nothing to do with fluently

passing the warehouse, it is a value added activity. Therefore this one lacks in the view of Lim et al. (2013).

Which definition is valuable for this research? First of all receiving is mentioned frequently and is necessary in a warehouse. Subsequently the products have to go the storage by the put-away activity. Gunasekaran et al. (1999) split this activity up into two activities, but in my opinion transport to the racks and placing it in the racks can be captured in one term. Then is the next activity storage. This one is not mentioned explicitly by Aminoff et al. (2002), but it is a traditional activity of warehousing of which an efficient operation of it is still necessary. Subsequently if customers place orders, the goods have to be collected from storage by order picking department. Gunasekaran et al. (1999) called it handling, but it is an elementary part of warehousing, so it is better to mention it explicitly. The right way of order picking can save a lot of time. Customers want customized products, so the products have to be customized via packaging. This value added process has a great importance, it is valuable to notice this activity. Lastly dispatching takes place. The term shipping used by Varila et al. (2007) and Aminoff et al. (2002) is too broad, because it is also associated with transportation. Therefore dispatching is a better classification, because it is about making the goods ready for transportation. All in all the activities are receiving, put-away, storage, order picking, packaging and dispatching.

Now we know what is warehousing about, but what is the role of it in the supply chain? A warehouse is actually just a node in the supply chain, but this is a node which indeed matters. Goods have to go from manufacturers to final customers. In between is place for warehousing. Warehouses ensures that the whole supply chain gains efficiency. Either efficiency in money or efficiency in speed. It creates customer value (Mentzer et al., 2001). Transportation can be done more efficient, by combining goods in a warehouse and deliver it from there to the customer. Storage of the goods can increase the responsiveness towards the customers. Customized packaging can add value for specific customers. So it creates customer value either in efficiency or in value added.

Warehouse types

Warehouse can be divided into several types. Private, public and contract warehouses have distinctive characteristics (Sheehan, 1987). A private warehouse is privately owned. This means that the products handled in the warehouse are from one supplier and that the warehouse is owned by the same supplier. Warehousing is a subdivision of a company. Owning a warehousing yourself, requires a large capital investment. Land, building and also equipment have to be bought. On the other hand the large

investments also lead to tax advantages, because of the depreciations. Flexibility is also higher, because you are not dependent on other parties. Furthermore people working in the warehouse are part of your company. They will do their work with more care, because of the affinity with the company. All in all a private warehouse have high initial costs, a high service level and low variable costs.

A public warehouse is in contrary to a private warehouse not owned by the supplier. A third party owned the warehouse. The products stored in the warehouse are from several suppliers. The third party bears the costs of the capital investments. The supplier only have to pay an amount per square meter or product unit. Actually you only pay for the space you need. Therefore public warehouses are mostly used for short-term. You can benefit from the economies of scale made by the public warehouse, because of the bundling of the volumes of several suppliers in one warehouse. Furthermore you do not bear the risks with regard to labor disputes. So the fixed costs are low or not there and the variable costs are relatively high.

A contract warehouse is a warehouse which is used on the base of a contract between the supplier and a third party. This type is derived from a public warehouse. All the characteristics are the same, except time period of the activities. Everything with regard to costs, risks and responsibilities is captured in a long-term contract. Again there are little or no fixed costs and the variable costs according to a long-term contract are quite high.

Product types

The type of products handled in the warehouse also matters in the location decision. Actually all types of products could be handled in a warehouse. Commodities like bulk cargo need a lot of space, due to the large amounts. Perishable goods have to be stored in a cooled environment. Then you need a refrigerated warehouse. The storage of chemicals involved high safety requirements. Electronics do have a high value and therefore they are sensitive for damage and theft. So actually each products can be handled in a warehouse.

Researchers have made several distinctions between the different types of goods. Lovell et al. (2005) described which stock holding should be used, looking at the product value density (PVD). The PVD is the value of a product divided by the physical weight or size. The results were that a high PVD needs a centralized stock holding. A high PVD means that the holding costs are also quite large, so inventories should be as low as possible in the supply chain, therefore a centralized warehouse is necessary. As a

result of a centralized warehouse the distance to the customer is large, this lead to high transportation costs.

Fisher (1997) classified products in two categories, functional and innovative. A characteristic of a functional good is that it has a predictable demand, while the innovative one has an unpredictable demand. Therefore the warehouses of functional goods can be centralized. The distance to the customer is large. The supply chain of functional products is characterized by the its efficiency and its aim to do it at the lowest possible costs. The innovative goods have to be served via a responsive supply chain, so warehouses should be close to the customer. Responsive means that companies can quickly adapt to the demand of the market. Therefore companies have to be locate close to the market. The distances become smaller and therefore transport costs are lower.

Christopher et al. (2006) elaborated on the findings of Fisher (1997). He combined the demand characteristics, predictable and unpredictable, with the lead time and come up with lean and agile supply chains. The lead time is the time between placing of the order by the customer and the delivery of the order. A predictable demand and a long lead time needs a central warehouse, which are faced with higher transportation costs. While an unpredictable demand and a short lead time needs a regional or national warehouse. The smaller distances lead to lower transportation costs. The other two combinations can use both warehouses and satellite warehouses.

A high variability in demand products requires an agile supply chain, which means that warehousing should be decentralized. On the other hand a low variability in demand needs a lean supply chain. This means that warehousing is centralized (Naylor et al., 1999).

Not all the product types can be handled, otherwise this research becomes unclear due to the variety of results. Therefore is opt to divide the products into two categories which includes many goods. Those categories are functional and innovative products.

Infrastructure types

As mentioned earlier is warehousing a node in the supply chain. Therefore to receive and ship the goods, infrastructure has to be used. Infrastructure can be summarized as the facilities which make it possible for people, information and goods to be transported. In our case it is about goods which have to be transported. Several facilities are available in order to do the transport from point A to B. Road, railway, inland waterway, air infrastructure and pipelines will be shortly discussed (Meyer-Rühle et al., 2008).

The road is a well-known type of infrastructure. It is provided by the government, so everybody can make use of it. You have to pay indirectly for it via taxes or directly via payment of toll. Trucks are making use of this type of infrastructure. Roads are best suited for deliveries to the door, due to an extensive network. Road transportation is a fast mode. Furthermore the flexibility is high, if necessary the route can be changed immediately. Although congestion and driving time restrictions can cause delays.

Railways are used by trains. This infrastructure requires large investments. The companies, which make use of the rails pay a fee to the owner. This is mostly a public one, but it could also be a private one. Rail transportation can handle large volumes over large distances. Due to the dependency on the rail tracks there is a low flexibility in rail transportation. Furthermore cross border transportation can cause delays, because of the different voltages used.

Waterways are basically natural facilities, although with a state of the art technology it is possible to easily dug channels or deepen existing rivers. Therefore this type of infrastructure is not everywhere findable. Inland shipping make use of this type of infrastructure. It can also handle large volumes, therefore this is a cheap transportation mode. On the other hand the speed of the barges is very low. Door to door transportation is hardly possibly with transportation via waterways.

Air transport is done by airplanes. This transport mode is very fast, but it is not suitable for mass products. The batches which have to be transported are small. There is a large global network, although door to door deliveries are impossible. Furthermore the security is high. Nevertheless this type of infrastructure will not be considered in this research. It is a fast, but expensive mode for intercontinental transportations, while this case considers only Europe.

Lastly there are the pipelines. This is not the one with which you come up immediately. These are mainly used for gasses and liquid goods. Therefore predominantly the chemical industry make use of the pipelines. Basically raw materials flow through the pipelines. Warehousing companies in essence don't make products from raw materials. They handle (semi) final products. Therefore I assume that pipelines don't play a significant role in the location decision of warehousing and this one will be ignored.

The three types of infrastructure involved in this research entail two infrastructure nodes. Those are necessary in order to change the cargo from transportation mode. Those are seaports and inland ports.

A port is a location where vessels load and unload their cargo (Stopford, 1997). Therefore a seaport is located at the coast which can be visited by sea going vessels. The port provides quays where the ships can dock to. Formerly the unloading and loading process was done by hand, while it is now an automatically process, because of the invention of the container. Large and expensive cranes pick up the container from the vessels and place them on shore. Not all the cargo is transported by container, there is also liquid or dry bulk. The latter two types of cargo are also loaded and unloaded automatically, via state of the art equipment.

The name inland port implies already its function. It is a port located in the inland. Notteboom & Rodrigue (2005) wrote about the relationship between ports and inland terminals. They found that inland terminals become more and more important for ports. Therefore ports are also involved in the exploitation of inland terminals. But if we look carefully to the fundamentals of inland terminals, it is better to primary classify it to the general determinants. It has in the name the term 'inland', so that refers to an inland location of the terminal away from the port. Furthermore deep-sea vessels can arrive in a port, while inland terminals can only be reached by barge in the case of water transportation.

Developments in warehousing

The technological development, increased labor costs and changed philosophies (Ashayeri & Gelders, 1985) are a couple of examples which lead to a change in the definition of warehousing. The technological development gave companies an alternative for manual labor force, which became expensive due to the increased wages. Improved ICT lead to an automation of the handlings in the warehouse. This ICT for warehousing companies is called Warehouse Management System (WMS). Faber et al. (2002) explains WMS as follows; "It provides, stores and reports the information necessary to efficiently manage the flow of products within a warehouse, from time of receipt to time of shipping".

Initially WMS changed the basic manual handlings. Inventory control had not to be done anymore with writing pad. WMS ensures that this can be done with a computer. WMS needed to evolve further. In order to work as efficient as possible it was required to have real time data about inventories, movements in the warehouse, the receipt and put away of products, order picking and shipping (Min, 2006). Labeling the products with barcodes is a solution for those requirements. However there are limitations to it, because the barcodes en barcode readers cannot process a large amount of data. This limitation is obviated by the rise of RFID (Connolly, 2008 and Wang et al., 2010). Furthermore RFID can read the labels from a larger distance. So it is less time consuming than barcodes.

Those technological developments changed the traditional storage function of a warehouse into a state of the art one. Products can be traced everywhere, this gives a new dimension on the storage of products.

Warehousing philosophies

Besides this technological evolutions in the warehousing sector, there arose new philosophies and concepts last decades. Just In Time (JIT) is such a concept which shed new light on the supply chain, logistics and warehousing. “JIT is a philosophy which aims to bring certainty and smoothness to the flow of material through the supply chain, while reducing the work-in-progress, enabling the lowering of stock and thus reducing the lead time” (Gunasekaran et al., 1999). Because warehousing is an important part of the supply chain, the JIT philosophy affects also the warehousing sector. The inventory in the warehouse is minimized, so besides supplier reliability, optimal communication with suppliers and customers is necessary. The technological improvements, described above, facilitates the optimal communication. Real time data about the products make it possible to control the flow everywhere and every time. So a reduction of the inventory and throughput time is the aim of this philosophy.

Furthermore the nature of the supply chain had changed. The supply chain changed from supply-push to a demand-pull system (Lasserre, 2004). In the supply-push system products are produced and pushed into the channel by the suppliers. In the demand-pull system is tried to fulfill customer requirements more accurate. Producer adopt their production to the real time demand of the customer. This needs a sophisticated logistics chain. This means less inventories for warehousing companies. Furthermore it forced the warehousing sector to have a high efficiency. The technological improvements are vital in this case in order to create shorter lead times.

Third party logistics providers (3PL) appeared in the logistics industry. Those are external parties, who are specialized in all logistics activities. Outsourcing of the logistics activities, of which warehousing is one of it, to 3PL grew enormously. An important driver for the growth of 3PL is that customer requirements became more specific (Sohail & Sohal, 2003). Furthermore they can generate economies of scale (Bowen, 2008). The varied needs of customers is also visible in the change from a supply-push to a demand-pull system.

The newest trend is the e-commerce. It is very easy to order your products. You didn't have to go to the shopping malls, just turn on your laptop is enough. It is possible to order from everywhere your products. That is at once a new challenge the logistics industry faces. Warehouses must deliver at a more

diversified set of final destinations (Bowen, 2008). Or the network of warehouses should be expanded, in order to get lower outbound distances.

The new philosophies such as JIT and the demand-pull system ensures that the value added activities have gained more importance. Customers want more customized products. The warehousing activity packaging can provide this customized products. Furthermore the rise of e-commerce requires a sophisticated warehousing network. Customers which live far away can order products which have to be delivered quickly.

Warehousing market situation

In order to get an optimal view of the warehousing industry, the market situation will be described. Meyer-Rühle et al. (2008) did research to the logistics sector in Europe. The average profit margin of warehousing over 2000-2006 is 5.53%. It should be noted that this profit margins were slightly lower in 2006 compared to 2000. Compared to other logistics activities is this profit margin moderate. Road and rail transportation had lower average profit margins, laying between 0.05% and 3.13%. Higher average profit margins were found in sea transportation and inland shipping, respectively 6% and 6.5%. Although the margin in sea transportation is somewhat misleading, because brokers are also included. This relatively high profit margin of warehousing compared to other logistic activities let us see that warehousing is more than the traditional storage. Value added activities, such as customization of the products, ensure that profit can be made.

The size of the different costs of warehousing is measured by Meyer-Rühle et al. (2008) as percentage from total warehousing costs. This is done for the countries of the nowadays EU except for Croatia. They calculated the percentage on the basis of company data which they obtained from professional companies. Personnel costs are the largest part. On average it is 40% of the total costs of a warehousing company. The storage equipment costs are 32%. The real estate costs 15% and the energy costs and other costs are respectively 7% and 6%. Cost factors which are in line with the activities of warehousing. So it is reasonable to assume that personnel, storage equipment and real estate costs are the major part of the costs.

The warehousing industry also needs a labor force. Warehousing belongs to a low knowledge intensive service activity (Consoli & Rentocchini, 2015). The same view is devoted to Bowen (2008). According to him provides the warehousing industry many jobs for low skilled people. The warehousing activities were defined as receiving, put-away, storage, order picking, packaging and dispatching. All those

activities can be done by low skilled employees. Besides this blue collar workers, also high skilled white collar workers are necessary in order to handle the state of the art warehousing management systems. But predominantly the low skilled employees are required for the warehousing activities.

Companies which need to do warehousing activities in order to get the right products at the right customers in the right time, can do warehousing by themselves or they can outsource it to third parties. In order to stay focused on your core competencies or because your volumes are too low, you can decide to outsource it to 3PL. In a study done to 3PL is mentioned that 48% of the shippers outsource their warehousing activities (Panalpina, 2013). This number emphasize the upcoming importance of 3PL and therefore outsourcing the activities. Doing the warehousing by yourself, means that warehousing is just a part of all your activities. Outsourcing it to 3PL doesn't mean that warehousing is the only activity of 3PL. 3PL offers more logistics services (Panalpina, 2013). This can be explained by the fact that the different activities have to be coordinated in order to get a product in an efficient way from manufacturer at the final customer.

Whether warehouses focus on efficiency or high quality of the service depends upon which product it handles. Functional products need an efficient handling. While innovative products require a higher quality service.

Some concluding remarks with regard to warehousing will follow. Warehousing takes place within the supply chain and produce customer value through efficiency or value added. The activities in a warehouse are defined as; receiving, put-away, storage, order picking, packaging and dispatching. This broad definition is also caused by recent technological developments and new philosophies. Warehouses can be divided into public, private and contract. All types of products can be handled by warehouses, but in this research only functional and innovative products are involved. The inbound and outbound transportation can be done via several types of infrastructure. In this research road, rail, inland waterway and two infrastructural nodes, seaports and inland ports, will be handled. Warehousing companies have moderate profit margins. The activities require a large amount of low skilled workers. Besides this the warehousing predominantly take place in companies which also do other activities.

Location determinants

Historical location determination

The goal of almost every company is getting a sustainable profit which is as high as possible. Shortly you can say that profit is revenue minus costs. Profit maximization occurs when there is a balance between the high revenues and the low costs.

Above mentioned concept is also the case for the warehousing companies in our research. In the end companies have to make profit, otherwise they are not viable. Although sometimes it can be valuable to offer more qualitative services to the customers, but the costs will be higher then, so they have to pay for it. So besides the cost factors in the location determination, there are also qualitative factors which plays a role. First of all a selection of the determinants will be made, afterwards each determinant will be discussed in detail.

Firstly I will consider a general theory about location and costs. This is in order to show the initial thoughts about the determination of a location. In the 19th century a German economist developed a location theory and called it the Von Thünen model (Von Thünen et al., 1966). This model was based upon an agricultural economy. The main determinants are land costs (land rent) and transportation costs. They are in balance. The main conclusion is that the closer to the city the higher the land costs and the lower the transportation costs. The transportation costs are low, because the distance between the location and the market, in the Von Thünen model is this the city, is small. A drawback is that this theory was conceived approximately two hundred years ago. In that time the economy was completely different. Nowadays there is a large mobility, so it is easier and faster to move over longer distances. Probably this results for a specific product that was formerly located close to the city, nowadays a location further away is also attractive. Although the theory in general sounds clear and later economists elaborate on it.

An economist which proceeds with the findings of Von Thünen et al. (1966) was Weber (1929). Meanwhile the importance of industries has increased, because of the industrial revolution. Therefore another location theory was welcome. Alfred Weber found this theory. The starting point of it was a triangle. One point represents the market were the finished goods have to be sold. The other two points are the raw materials of which the finished goods are made. Somewhere in this triangle there is an optimal point where the land costs and transportation costs are in balance. This balance is mainly depending on the characteristics of the finished goods and raw materials. For example heavy raw

materials will shift the location more to the point of input. Furthermore, this theory can be expanded into a model where the optimal point lays outside the triangle, because of cheap labor. It is evident that this is based on a manufacturing company. Nevertheless you can translate this into a situation with warehousing. There are points of suppliers and customers, with somewhere in between the location of the warehouse. Several location factors will determine the location of that warehouse. Nowadays those theories are still relevant, with even additional determinants.

In the 19th century the concept 'cluster' was already known. Marshall (1890) introduced this concept in the economic world. He described a cluster as a concentration of firms from a particular sector in a specific area. This concentration of firms can realize location advantages. Marshall mentioned three main advantages. Many buyers and suppliers are available within a short distance. In the cluster arises a high specialized labor market. Lastly due to the proximity of the firms there are knowledge spillovers.

Porter (1990) elaborated on the findings of Marshall (1890). He used the theory into the modern economy of the nineties. Besides the interconnected companies within a cluster he took also institutes into account. Porter (1990) wrote about how to create competitive advantages. The emphasis of the creation of competitive advantages laid on proximity of firms. The theory of Marshall was revived by Porter. In order to get competitive advantages companies have to interact with each other. Therefore companies located in a cluster can easily create advantages.

Of the main advantages mentioned by Marshall (1890) are two out of three relevant for this research. Those are the proximity of many buyers and suppliers and the availability of a specialized labor pool. As described earlier warehousing needs predominantly low skilled labor. Low skilled labor is not associated with many knowledge. Therefore it is assumed that knowledge spillovers are not relevant.

Determinant selection

A research done by Hilmola and Lorentz (2011) in Finland and Sweden mentioned fourteen different criteria at operational level, which are divided into five main groups. Those are derived from other literature research. Those five main categories are: costs, accessibility, labor, market and strategic. It is a doubtful classification, because several criteria at operational level can be classified in more main categories. For example labor costs can also be gathered under costs instead of labor. Therefore this main categories will not be used in this research, but the use of the criteria at operational level is still possible. From their survey the three most important criteria come forward. Low distribution costs, a

good accessibility to the road network and the presence of assembly and manufacturing units in close proximity are favored in their survey.

Sosef and Nassiri (2013) used thirteen criteria for their research to warehouse locations in Europe. The determinants are obtained from their own professional expertise. They grouped them into four main categories. Proximity to customers and suppliers, labor and government, real estate and infrastructure are the categories. The labor and government category is about labor availability, wages, government regulations and incentives. Those main categories are more reasonable than the ones of Hilmola and Lorentz (2011), because there can be no discussion to which main category the subcategories should be assigned. The largest differences with the criteria of Hilmola and Lorentz (2011) is that mention governmental and real estate criteria. The importance of the latter is already stressed in the cost structure of warehousing. The top three ranked in the survey of Sosef and Nassiri (2013) is; Proximity to economic networks and strategic transport access, proximity to customers and labor availability and flexibility.

A choice have to be made which determinants will be discussed in further detail. Real estate costs are mentioned by Sosef and Nassiri (2013), furthermore it is an important factor in de cost structure. Transportation costs is not mentioned by Hilmola and Lorentz (2011), although they mention it distribution costs. Besides this distribution to customers is warehousing also dependent on inbound transportation, hence the general term transportation costs is more precise. Personnel costs is in both surveys of Hilmola and Lorentz (2011) and Sosef and Nassiri (2013) mentioned, although not as the most important one. Moreover in the cost structure it takes a prominent role. Hilmola and Lorentz (2011) stress the importance of road accessibility, but there are more types of infrastructure which is explained in the overview of the warehousing activity. Therefore the types of infrastructure mentioned in the introduction will be used. The availability of a labor pool (Sosef and Nassiri, 2013) and proximity of buyers and suppliers (Hilmola and Lorentz, 2011) are two of the three important cluster amenities. Lastly the governmental influence will be explained. In the introduction are holding costs also mentioned, but this one will not be discussed. Holding costs depend upon the product type and therefore not on the location.

All in all the following determinants will be discussed; real estate costs, transportation costs, personnel costs, infrastructure accessibility, labor market, buyers and suppliers and governmental influence.

Determinant explanation

Real estate costs

Real estate costs consist of two parts. These are the costs for buildings and costs for land. A possibility is to own the land, this requires a large capital investment. If a company has too little capital available or they don't want to bear the risks of such an investment, they can opt for leasing the land. A fixed amount per period, lease costs, have to be paid to the lessor. Buildings which stand on the before mentioned land can be financed in the same way as land. Either by doing an investment and owning it by yourself, or by leasing it.

Both option with regard to the ownership construction of the real estate is also applicable to the warehousing industry. Receiving, stocking, labeling, packaging, order picking and shipping the goods need definitely space in the form of land. Furthermore a roof above these activities is also desirable. Therefore real estate is necessary for the warehousing industry. Actually the ownership choice is only of interest for the supplier in case of a private warehouse. The public and contract warehousing is done by third parties, which face the decision to buy or lease. The supplier only pays indirectly the real estate costs via the variable rates per unit.

According to Glasmeier and Kibling (1996) belong real estate costs to the major location determinants of warehousing. On the basis of interviews, they anticipate a reduction in the concentration of warehousing employment in the inner city in favor of rural areas. Technological developments, such as Electronic Data Interchange (EDI), lead to time savings in the transportation. They say that in this new situation it is plausible that warehousing companies will opt for a rural location with cheaper land and labor, despite of the longer transportation time to your customers. Herewith they stress the importance of real estate costs. Although I doubt whether this reasoning is likely. An overview of the costs savings with regard to the real estate costs and the costs increases of the extra transportation is not given.

In a survey done in Europe by Sosef and Nassiri (2013) appears the importance of the role of real estate costs. They identified thirteen criteria and grouped them into four main criteria. Real estate was one of the four main criteria and it was ranked as third. This doesn't stress the importance of real estate. Nevertheless this main criteria can be split up into three more distinctive criteria, namely real estate costs, availability of warehousing and availability of land. We pick out the one it is about in this paragraph, real estate costs, and see that this one is ranked as fourth out of thirteen. It is obvious that real estate costs matters in the location decision in Europe according to this survey. Graham and Sahling

(2004) confirms the importance of real estate costs. In 2004 the European Union (EU) welcomed new members, which were predominantly countries from Eastern Europe. From that moment 3PLs were less interested in the location in Austria, because of the relatively high lease costs

An economic analysis of the logistics sector in the EU is written by Meyer-Rühle et al. (2008). They calculated the share of real estate costs, this includes as well the land costs as the costs of the buildings, as percentage of the total costs of warehousing. In Europe the percentages laid between 11% en 30%. They calculated these numbers with data from different (paid) market reports. Furthermore this report is written for the purpose of the European Commission. So the percentages mentioned are of significant importance to take into account the importance of real estate costs in the location decision.

Transportation costs and infrastructure

Transportation costs

Warehousing takes place in a building and is part of the supply chain. In order to connect the warehouse with other parties in the supply chain transport is necessary. Firstly goods are coming in to the warehouse, this is called inbound transport. Lastly goods went out of the warehouse to their (final) customer. This is the outbound transport. Transportation involves also costs. The truck driver wants salary, fuel have to be bought and there are investments in the equipment. Actually this research is focused on the warehousing part of logistics. Nevertheless transportation should be considered, otherwise the goods will never come in and leave the warehouse.

The importance of transport costs is emphasized by McKinnon (2009). Approximately 40% of total logistics costs is assigned to freight transportation. In several warehouse location problem models the transportation costs are considered as a factor to take into account. Although a notification of how important this factor is, is not given or various scenarios of importance are given. (Lee & Luebbe, 1987 and De la Fuenta & Lozano, 1998).

The strength of this factor in the location decision of warehousing depends on two characteristics. The transportation costs are mainly determined by the distance and type of goods. Whether the distance is large or not, depends on the structure of the supply chain network. Firstly, the distribution can be done by one central distribution center, which is called European Distribution Center (EDC) (Rodrigue & Notteboom, 2010). Efficiency can be made on the inbound transportation. Furthermore there is just one

inventory to manage and there are only costs of one distribution center. On the other hand customers are far away from the EDC, so outbound transportation is relatively expensive and the lead time is high.

Secondly a Regional Distribution Center (RDC) can be chosen for your supply chain network (Rodrigue & Notteboom, 2010). In this network there are multiple RDCs. Those RDCs serve a whole region which is not limited by national borders. The inbound transportation is more complex, because the incoming goods have to go to the multiple RDCs instead of one EDC. Although the RDCs are located closer to the customers. The outbound distances are smaller and therefore cheaper. Furthermore customers can be served faster due to a lower lead time. An extension to the concept of RDC is the National Distribution Center (NDC). This is the case when each country has one or more distribution centers. The outbound distances and the lead time are somewhat smaller than with RDCs.

Lastly there is still the concept which is called Satellite Distribution Center (SDC) (Rodrigue & Notteboom, 2010). The concept is a combination of above mentioned concepts. In this concept there is one central distribution center and multiple satellites. The inbound transportation to the central distribution center can be done efficiently. The satellites can serve the customers quickly, due to the short distance. One drawback is the creation of one extra transport flow, from the central distribution center to the satellites.

Infrastructure

Closely linked to transportation costs is the infrastructure, because doing transportation needs infrastructure. As mentioned before this research will discuss three types of infrastructure. Those are road, railway and inland waterway.

In research to location criteria for warehousing locations in Finland and Sweden (Hilmola & Lorentz, 2011), road connections belong to the top three criteria. Their survey was done in different years, the last year of their survey, 2009, it was even ranked as the most important factor. The importance of roads is also emphasized by Durmus and Turk (2014). They did research in Istanbul, and noticed that in this large city the accessibility of roads is of importance in the location decision for warehousing companies. Furthermore Bowen (2008) stated that highway transportation has an increased influence on the warehousing location. The nowadays time sensitive economy is the reason for this. The use of roads make a quick and responsive service to customers possible. It is likely that warehouses which handle time innovative products will be prioritize road availability more than for example functional

goods warehouses. All in all we can say that road infrastructure is an important determinant in the location decision for warehousing.

In the USA railway accessibility is of less importance than road accessibility (Bowen, 2008). This is caused by the different speed of those modes. Road transportation is much faster than railway transportation. In Eastern Europe railway infrastructure plays a reasonable role, while in Western Europe it didn't (Hilmola & Lorentz, 2011). Several decades ago in Eastern Europe communist systems subsidized the railways, therefore the importance of railways in that former communist countries is more than the Western European countries. Despite this regional observation, the general thoughts about the importance of railway accessibility is the same as Bowen (2008). Railway accessibility is seen as less important than road accessibility. Although with the upcoming intermodal transportation, which needs inland terminals, this will be discussed later on, the importance of railway infrastructure could rise.

The speed of barges is very low, therefore this inland waterway transportation has a long lead time. Door to door transportation is hardly possibly via inland waterways, therefore it seems that this mode of transport is only attractive for inbound transportation. Although research in Belgium (Verhetsel et al., 2015) concludes that locating further away from inland waterways is negatively assessed. It is plausible that due to the natural elements and the characteristics of waterway transport, the importance on the location of warehousing will depend upon the chosen supply chain.

That all elements of the supply chain are influencing each other in order to come to an optimal one, can also be seen with the transportation costs. The distance which should be covered is dependent on the distribution network. Furthermore different product types affect the design of the distribution network, which subsequently has an influence on the transportation costs. The same applies for the nature of demand. The infrastructure is closely linked to the transportation costs. The existence of infrastructure is an important condition to do transportation. Furthermore a bad infrastructure can cause delays, which increase the transportation costs. Therefore also the quality of the infrastructure matters. As mentioned is transportation actually another activity within the supply chain, but still a necessary one for warehousing. To keep the difference between both activities and to stay as close as possible to the warehousing is opt to continue this research with the determinant infrastructure. Compared to previous location determinant, real estate costs, the transportation costs and thus infrastructure seems to have a greater impact on the location decision of warehousing.

Wages

Running a company involves the presence of employees, unless you have a sole proprietorship or your companies is fully robotized. As described earlier the automation in the warehousing is also developing. This didn't mean that in the whole industry the employees are replaced by robots. The warehousing industry still made use of human resources.

The work of the employees in the warehousing industry has to do with receiving, stocking, labeling, packaging, order picking and shipping the products. Whether or not with the assistance of technological equipment. The costs of employees are the wages.

According to Meyer-Rühle et al. (2008) is the share of personnel costs very different within Europe. This share falls between 10%-60%. On average 35% of the total warehousing costs is personnel cost. This variation emphasizes the importance of wages. It definitely makes sense whether your personnel costs are 10% or 60%. It is plausible that in case of a low automated warehouse a location within a low labor costs region will be more attractive.

The importance of the level of wages in the location decision of warehousing is measured in Europe. Sosef and Nassiri (2013) did a survey under stakeholders in the logistics industry and they found that the level of wages is ranked as sixth out of thirteen. Compared to the high percentages in the cost structure, is this a somewhat disappointed ranking. You would expect with a high share of personnel costs it will be assessed with a ranking at the top three. The reasoning for this stays unclear, probably later on it can be explained by other determinants.

In comparison with the transportation costs, the personnel costs takes the same share in the costs structure. Therefore it seems to be that they have the same influence. With regard the real estate costs, the personnel costs are ranked as less important, despite of the higher share in the costs structure. Perhaps it has to do with the influence of supply chain structure on the determinant. A responsive supply chain means more warehouses, thus more real estate costs. On the other hand a logical reasoning would be that these additional warehouses also need employees. So the total costs of the employees also increases.

Port

As mentioned earlier is a seaport an infrastructural node. It connects two modes of transport. Besides this initial function, another one can be assigned to the port. It attracts several economic activities.

There are indeed a lot of raw materials, semi-finished products and finished products available. This makes it attractive to handle the products in the port region. Additionally ports are nowadays seen as a regional cluster of the economic activities instead of a node in the transport chain (De Langen 2004).

Clustering in the port region is nowadays a well-known concept. Rivera et al. (2014) did research to the logistics clusters in the USA, with an emphasis on inland logistics clusters. Although they allege the relevance of ports in this subject. This is not especially for the logistics sector, but for all port activity, including the economic activities related to the port. They say that it is likely that cooperation and concentration of the activities within the port will increase. This is in line with the new competition for supply chains.

Mangan et al. (2008) elaborated on the logistics part of the concentration of economic activities. They introduced the concept of port centric logistics. The increasing importance of supply chains promotes the role of port centric logistics. At the port the ships will be unloaded, the containers are still there. So it is a possibility to do the logistics of those containers at the port. The containers are emptied and the products will be labeled and repacked if necessary. Doing this in the port instead of inland, it can be much more efficient for the whole supply chain. Different products can be bundled and then transported to their semifinal or final destination. Furthermore you do not have to suffer from restrictions such as a maximum weight for road transport and there is less transportation of empty containers (Mangan et al., 2008).

A large hinterland with many customers increased the attractiveness of a port for logistics companies. Research in Asia concludes that a good nautical accessibility and a large hinterland encourages logistics companies to locate in the port of Busan (Theys et al. 2010).

Compared to the other determinants it seems that the port has the same influence as the infrastructure determinants. It is also an infrastructural node. Furthermore the literature is confirming the importance of a port in the location decision of warehousing.

Inland terminals

An inland terminal is a node in a supply chain where cargo can change from mode of transport. This could be for example a place for warehousing, cargo comes in large volumes and can be customized close to the inland terminal. Van den Heuvel et al. (2013) did research logistics and thus warehousing and the inland port as a location. More specifically they did research to the location dynamics of logistics

establishments. In principle they looked at the location decisions in relation to spatial clustering. In order to get results they focused on the province North-Brabant in the Netherlands. With regard to the inland terminals they found that it attracts logistics employment. The reason why this area attracts logistics employment is that logistics establishments often move to areas with inland terminals compared to the ones which lack inland terminals.

In global supply chains are terminals important nodes. The relationship of two types of terminals is assessed by Rodrigue & Notteboom (2009). They stated that the hinterland terminals became popular last fifteen years. There was one remarkable conclusion which is of interest for this research. Vertical integration in the supply chain facilitates the existence of logistics activities in the proximity of the hinterland terminals. The vertical integration of the supply chain means also that inland terminals are often used. This means that there arise nodes in the supply chain which needs logistics, thus warehouses. Therefore many logistics zones in different European countries arose close to the inland terminals.

The importance of inland ports is the same as for ports. The reasoning behind it is also the same.

Specialized labor market

A large and specialized labor pool is an incentive to locate your company in a cluster. The availability of a large amount of personnel, who preferably meets your requirements, is necessary in order to be competitive and ready for the future. If you locate in a cluster you can gain the benefits of an easy access towards workers. Furthermore, this pool of workers has specific skills which are required in particular sector. It is not only the easy access but also the specialization of the labor pool, which makes co-location attractive (Ellison, 2010).

Besides the positive externalities mentioned above, there are also negative associations with respect to a labor pool. An easy access for employers implies also that employees can switch easily between companies. There is a risk that employees bring over confidential information to their new employers. On the other hand they can learn a lot from each other, which will increase the skills level of the employees. Therefore as long as the benefits are higher than the costs it is attractive to locate in within a cluster (Combes and Duranton, 2006).

According to Consoli & Rentocchini (2015) and Bowen (2008) is warehousing a low knowledge intensive sector. Having experience in low knowledge intensive work is also a specialization. Therefore being

located close to a low knowledge intensive labor pool is interesting for warehousing companies. Although due to its low knowledge character the influence of locating close to a low skilled labor pool is small.

Buyers and suppliers

The last of the three major agglomeration economies mentioned by Marshall (1890) is the advantage of the proximity of many buyers and suppliers. This is related to the input as well as the output market. Firstly the input side of a cluster will be considered. Companies with similar or additional activities which are located in a cluster can join their forces in order to purchase their raw materials or inputs cheaper. Economies of scale arise. With regard to the logistics sector is this somewhat more complex than for manufacturing companies. Although there are opportunities to cooperate and to create advantages. For example companies can arranges together the transport to the logistics cluster. The inbound transport costs are reduced and the companies are more competitive.

The mutual transport costs can also be reduced in a cluster. The distances between companies in a cluster a much smaller than if they are scattered through a country. An assembling company located close to their transporting company is with respect to the costs ways more attractive.

The outbound logistics can also be done jointly. They can cooperate in order to create economies of scale in the outbound logistics. Although this is less plausible because of the confidential information about your customers which will be available for your competitors. On the other hand there are regions which are unprofitable to serve. If several companies have that problem, they can join the transport and make the freight transport to that specific region profitable.

So if there is a large pool of buyers in a close proximity, the outbound distances will be low. On the other hand the increased mobility of and the technological developments provides also fast and reliable deliveries for customers living further away from the warehouse. Therefore the influence of the proximity of a population on the location decision for warehousing is expected to be small.

Governmental influence

The government plays an important role in the national and global economy. Although they can behave in different ways. They can play a role as an active government, who wants to intervene as much as possible in the economy. On the other side of the spectrum is the passive government, who aspire a free

market economy. Looking at the subject in this research, will they have an influence on the location determination of the logistics sector?

We go back to the case about the company Action (Logistiek.nl, 2013) which is mentioned in the introduction. The existing distribution center became too small, therefore an additional had to be built. The next step in this process is to find a location for the new one. One of the factors which played a role was the government. The Ministry of Economic Affairs had an active lobby in order to convince the company to locate in the middle of the province Limburg. For a particular region it is very attractive that such companies locate in their region. In this case 6,000 jobs will arise and therefore it is of interest for politics to work on it to ensure that it will come to your region. However it is not clear how much influence the lobby had. Mostly the lobby activities do not take place in front of the public. Somewhere behind the scenes there are a lot of conversations and discussions. It creates some cloudiness surround this type of convincing. The company Action didn't say anything about it. They only say some general words that it was a process where different factors made sure that this was the optimal decision. Above mentioned practice is based on just newspaper articles. The scientific relevance is more difficult to describe. The stakeholders in such cases remain silent and vague about the lobbying of governments. Therefore it lacks the scientific argumentation.

The lobbying process discussed above is actually not a general one. Here the government tries to influence the decision making process. While the most well-known lobbying process is that united groups of people with the same objective tries to influence the government in order to make a valuable decision for them.

So far are only the government influences for specific companies or groups discussed. The government can also influence the location decision in general. Although there is some overlap with the section before, because there is the infrastructure already discussed. Hong (2007) found that government has its influence on the location decision of logistics firms. In the Chinese case they adopted policies which were favorable for logistics companies, especially the foreign companies. Policies you can think of are tax reduction and the allocation of land for logistics purposes in the free trade zones.

Porter (2000) ascertains that the traditional influence of the government declines. A global economy combined with a great mobility of people and goods leads to a diminishing role of the location of the activities. Therefore a diminishing role of the government in this location process. On the other hand Porter (2000) sees that clusters are of more important in the contemporary economy. So there is still a

governmental influence, although it is focused on the clusters. The roles which are mentioned by Porter (2000) are facilitating growth and upgrading the clusters.

It is difficult to measure the governmental influence in the location decision of warehousing, this would in itself. Therefore there is acknowledged that there probably is an governmental influence, but it will not be incorporated in the empirical part of the research due to its complexity.

Overview

Above all location determinants are explained. In order to make some expectations, all determinants are compared and weighted on the basis of above explanation. Figure 1 shows shortly the expected importance of each determinant.

Determinant	Importance
Real estate costs	++
Wages	++
Low educated labor force	+
Population	+
Road density	++++
Railway density	++
Inland waterway density	++
Road infrastructure quality	++++
Railway infrastructure quality	++
Port infrastructure quality	++
Seaport distance	+++
Inland port distance	+++

Figure 1 The expected importance of each determinant. + means slightly important, ++ means moderately important, +++ means important and ++++ means very important.

All the determinants are discussed. Here follows a short summary what they mean for the different types of goods, which is also visible in figure 2. Functional goods have a predictable demand, therefore a high efficiency is necessary in order to be competitive. Therefore low costs are desired in the supply chain for functional goods. So Real estate costs and low wages are important for predictable goods and unimportant for innovative goods. A low educated labor force has the same importance for both types of goods. Innovative goods needs a responsive supply chain with warehouses close to the customers,

therefore the proximity of a population is important for innovative goods and unimportant for functional goods. Since functional goods can afford a long lead time the importance of infrastructure is as follows ranked from important to unimportant; inland waterway, railway and road. Innovative goods needs a fast delivery, therefore the importance of infrastructure is as follows ranked from important to unimportant; road, railway and inland waterway. The proximity of a seaport is for functional goods important and for innovative goods unimportant. This is because the supply chain structure of functional goods is typically with an EDC, which is characterized by the presence of one distribution centre. The inland port distance is important for innovative goods because those goods needs typically an RDC, where warehouses are also inland located close to the customers.

Determinant	**Functional goods**	**Innovative goods**
Real estate costs	important	unimportant
Wages	important	unimportant
Low educated labor force	neutral	neutral
Population	unimpotant	important
Road density	unimpotant	important
Railway density	neutral	neutral
Inland waterway density	important	unimportant
Road infrastructure quality	unimportant	important
Railway infrastructure quality	neutral	neutral
Port infrastructure quality	important	unimportant
Seaport distance	important	unimportant
Inland port distance	unimportant	important

Figure 2 Determinant importance for the different product types

Data and methodology

Methodology

Before the analysis of the overrepresentation of warehousing in Europe can be given, the methodology and the data collection have to be explained. First of all an explanation of the methodology will be given. Then the overrepresentation of warehousing will be showed. Subsequently each determinant will be

mapped. Those maps will be made with software of QGIS. Thereafter the determinants will be one by one discussed and compared with the findings about the overrepresentation. Lastly the best warehousing locations according to this research will be addressed on the basis of a weighting of the determinants. The weighting is account for the possible interacting determinants. Furthermore this weighting is based on the different types of goods. As mentioned earlier in the literature review, those are functional and innovative goods. The importance of the determinants for those goods is also already given in the literature review in figure 2 and on the basis of this importance is the weighting determined.

General data explanation

The data collection have to be explained. First of all the countries have to be selected. A clear way to do this, is to take the countries of the European Union (EU). The EU covers a large part of Europe. Nowadays the EU consists of twenty eight countries. The base year for the data collection is 2012, but the EU keeps on expanding. Croatia acceded in 2013, therefore this country will be ignored. Malta is also ignored in this research, due to the lack of reliable data. Therefore twenty six countries will be part of the case (see Appendix A). The choice for EU countries means that Switzerland, Norway, Iceland, a couple of Balkan countries and some Eastern European countries are ignored. The data of the ignored countries is not accurate. So to get a representative and reliable view of warehousing in Europe, it is sufficient to take the EU countries.

It is possible to look at different levels to those countries. With the Nomenclature of Territorial Units for Statistics (NUTS) four different levels (0, 1, 2 and 3) can be distinguished. NUTS0 is the less detailed, this is at country level, while NUTS3 is the most detailed. A high detailed level is desired in order to make reasonable conclusions. Although data availability is low at NUTS3 level. Therefore is opt for an analysis at NUTS2 level, the data is available and it gives still results at local regions. Spain, Portugal and France still have a couple of overseas regions, because of their marginal role and for simplicity they are ignored. It are the following regions; Ceuta, Mellila, Canarias, Região Autónoma dos Açores, Região Autónoma da Madeira, Guadeloupe, Martinique, Guyana and Réunion.

This research is focused on warehousing, therefore only data for this activity is obtained. The Nomenclature statistique des Activités économiques dans la Communauté Européene (NACE) is the statistical classification of economic activities in the European Community. More specifically the NACE 2 rev. is used which is the last update since 2008. The category H is transportation and storage, within

those categories there are subcategories. The subcategory H52 contains the activities relevant for this research namely warehousing and supporting activities for transportation.

The comparison of the overrepresentation with the determinants, which will be done in the analysis, is done via a table. The regions are divided in regions with a high and a low location quotient. A high location quotient means a location quotient of 1 or more and a low location quotient means a location quotient less than 1. The determinant is also divided into high and low. It is assessed as high if the value of a specific region is larger than the median. It is assessed as low if the value of a specific region is lower than the median. Subsequently the amount of regions with a high determinant value are divided by the number of regions with a high location quotient, this results in a percentage. This is also done for the other combinations of the location quotient and determinant. The interpretation of the percentages is given in figure 3

Sign	Percentage	Explanation
--	<25%	Small presence of the determinant
-	≥25% and <50%	Determinant is present in small minority of the regions
+	≥50% and <75%	Determinant is present in small majority of the regions
++	≥75%	Large presence of the determinant

Figure 3 Explanation of the signs

Overrepresentation of warehousing

In order to get the overrepresentation of warehousing in Europe, the location quotient will be used. This technique shows the regional concentration of warehousing compared to all EU countries. The data for this location quotient is obtained from Eurostat. The formula of the location quotient is given in figure 4.

After filling the formula with numbers a location quotient will come out of it. To illustrate how this formula should be interpreted an example will be given. If the location quotient of a region is 2, then is warehousing 2 times more concentrated in that region compared to the EU. In that region is there an overrepresentation of warehousing. A region with an overrepresentation of warehousing, this means that the location quotient is larger than 1, is highlighted with bold borders in the figures.

$$\frac{number\ of\ people\ employed\ in\ H52\ in\ a\ specific\ region\ /\ number\ of\ people\ employed\ in\ a\ specific\ region}{number\ of\ people\ employed\ in\ H52\ in\ EU\ /\ number\ of\ people\ employed\ in\ EU}$$

Figure 4 Formula of the location quotient for warehousing

The data of the number of people employed in H52 in a specific region is from 2012, but there were some missing values. The data of Nuts2 regions Brandenburg, Etelä Suomi, Åland, Champagne-Ardenne, Picardie, Nord - Pas-de-Calais, Lorraine, Alsace, Franche Comté, Rhône-Alpes, Auvergne, Languedoc-Roussilon, Corse, Lietuva is from 2010, while the data of the three regions Luxembourg, Tees Valley and Durham and Northumberland and Tyne and Wear is from 2011. The data of Groningen and Drenthe lacks. Nuts1 region Noord-Nederland consists of Groningen, Drenthe and Friesland (NL) and that data was still available. The missing data of both regions is obtained by subtracting the number of Friesland (NL) from Noord-Nederland and subsequently divide it by two. Due to a boundary shift between Leipzig and Chemnitz is this data from 2010 based upon NUTS version of 2006.

The number of people employed of a specific region gives no missing values for 2012. For the before mentioned regions with data from 2010 and 2011 is also data from 2010 and 2011 used for the number of people employed, in order to get reliable location quotients.

The number of people employed in H52 in EU and the number of people employed is the sum of the specific regions.

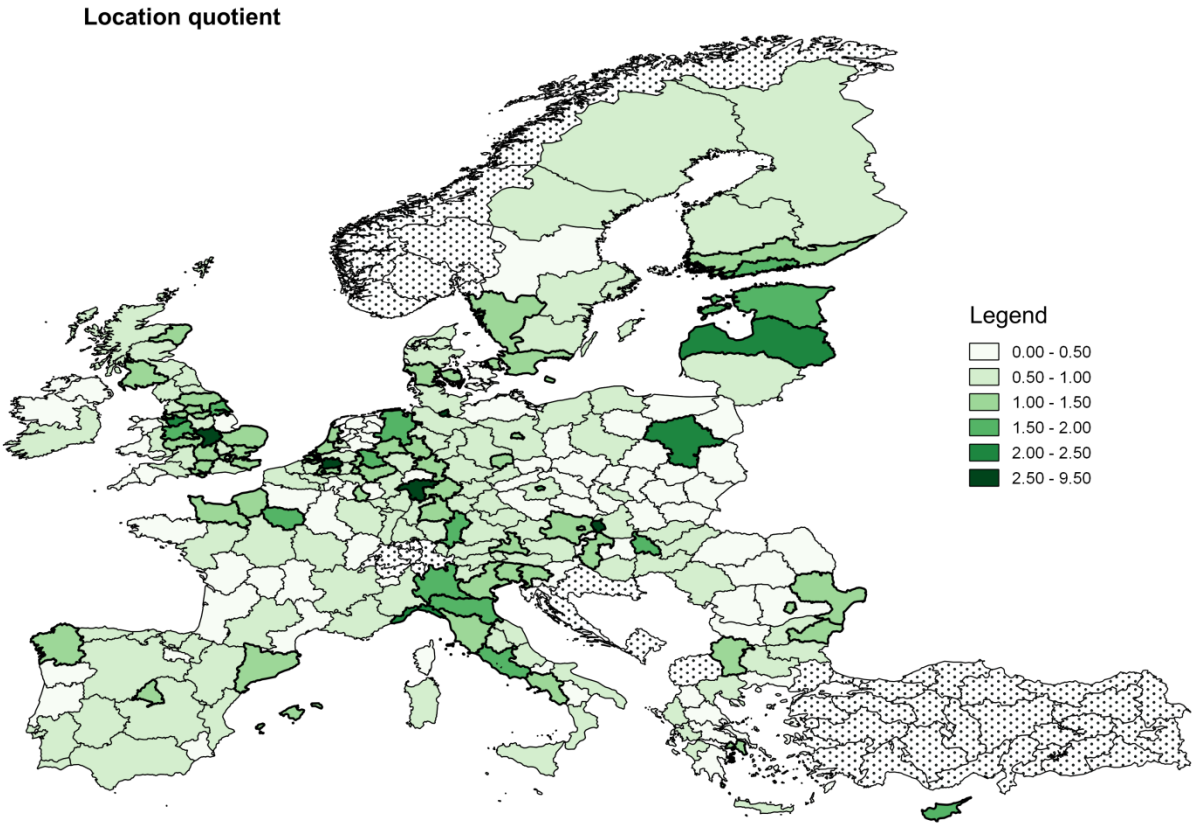

Figure 5 Warehousing location quotient ”Source: Eurostat; own calculations”

Real estate costs

The rents for warehousing buildings are difficult to obtain. Most sources are not freely available and if they are available the information is not extensive. Although Crushman & Wakefield has several rents available. For seventy-six cities they have the prime rents available. The assumption is made that the rents for a specific city is the same as in the nuts2 region to which that city belongs. There are still many missing values, but it is possible to make some general statements about this determinant. Although in order to rank the region with a score for their determinant values, those missing values have to be solved. The missing values had to be replaced by assumed values. Therefore is opt to choose the values of neighboring regions. If the neighboring region also has a missing value, the value of a region in close proximity is assumed to be the value for that specific region.

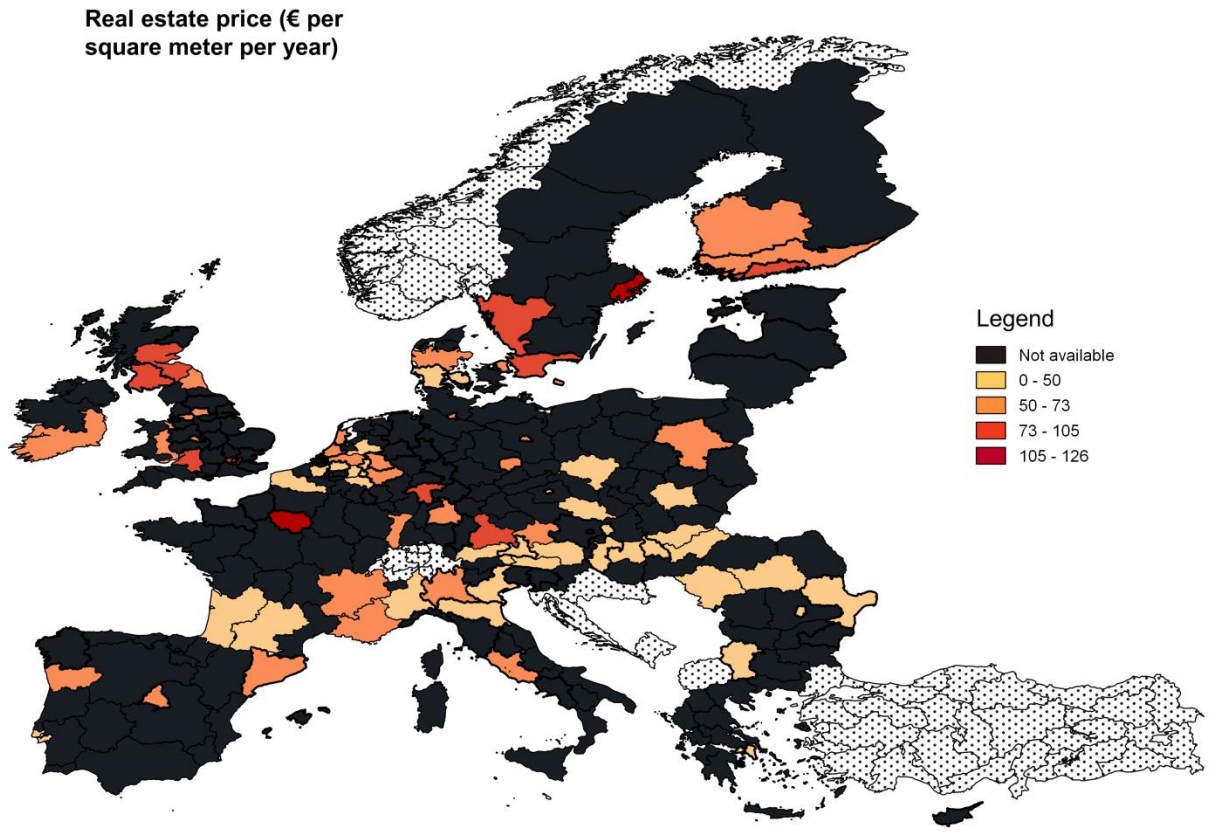

Figure 6 Warehousing real estate price ”Source: Crushman & Wakefield”

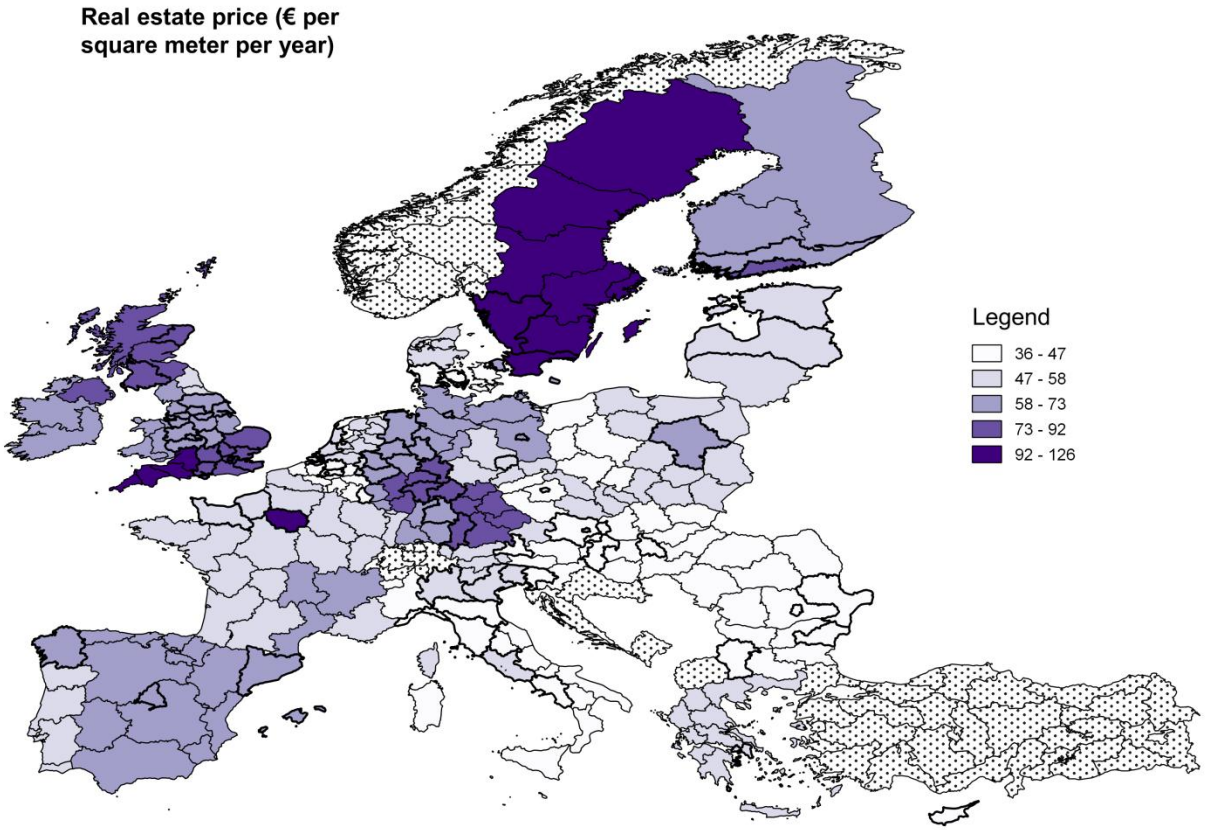

Figure 7 Extrapolated warehousing real estate price "Source: Crushman & Wakefield; own calculations"

Wages

The data of the wages are obtained from the four-yearly Labor Costs Survey which can be found at Eurostat. The most recent one is from 2012, so that one is used for this research. Only enterprises with more than ten employees are involved in the surveys. It gives the wage per hour in euros for category H52. Furthermore it is also regional data at Nuts1 level. Therefore it is assumed that the Nuts2 regions which belong to a Nuts1 region have the same wage level as that Nuts1 region.

For a couple of countries this data is missing. Those are Cyprus, Czech Republic, Denmark, Estonia, Finland, Ireland, Lithuania, Luxembourg, Slovenia and Slovakia. At nuts0 level there is data available with the same conditions as the data at Nuts1 level. It is assumed that the wages in those countries are equal in the corresponding Nuts2 regions.

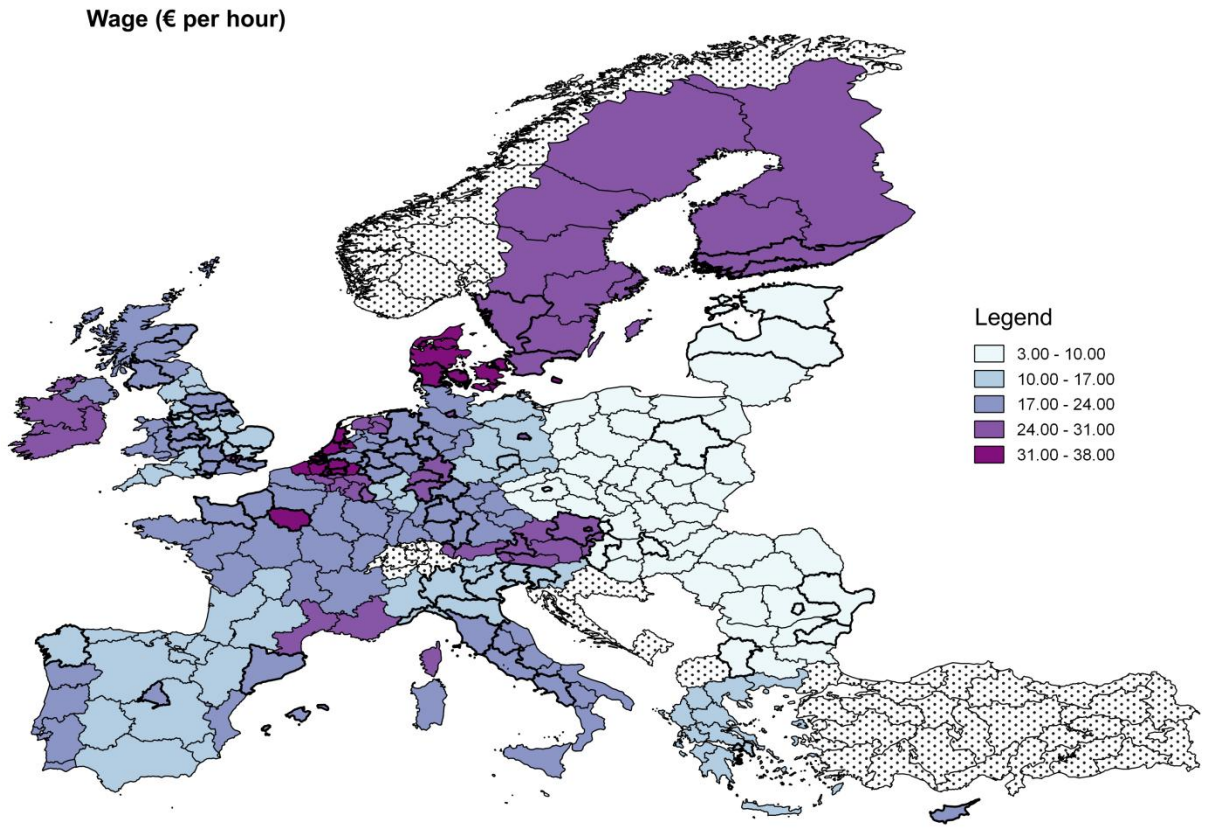

Figure 8 Wage per hour in the warehousing industry "Source: Eurostat; own calculations"

Low educated labor force

The economically active people, as well as the employed ones as the unemployed ones, is the labor force. Eurostat has this data at Nuts2 level for the year 2012. Furthermore there are no missing values. The labor force is corrected for the surface of the region, by dividing it by the amount of square kilometers of the region, because a large region can house a greater labor force than a small one.

Furthermore the education level is used to determine where the low skilled labor force is located. The International Standard Classification of Education (ISCE) classified the education level. They distinguish nine levels of education. Those nine levels are distributed over three categories: Lower secondary education attainment (low education), upper secondary education attainment (medium education) and tertiary education attainment (high education). Since warehousing predominantly needs low skilled labor, both lower and upper secondary education attainment category is used for the data collection. The population of which the education level is noticed are 25-64 years old and is about 2012. Furthermore the results should be interpreted as a percentage.

Lastly the founded labor force per square kilometer is multiplied with the percentage low educated people. This results in a low educated labor force per square kilometer.

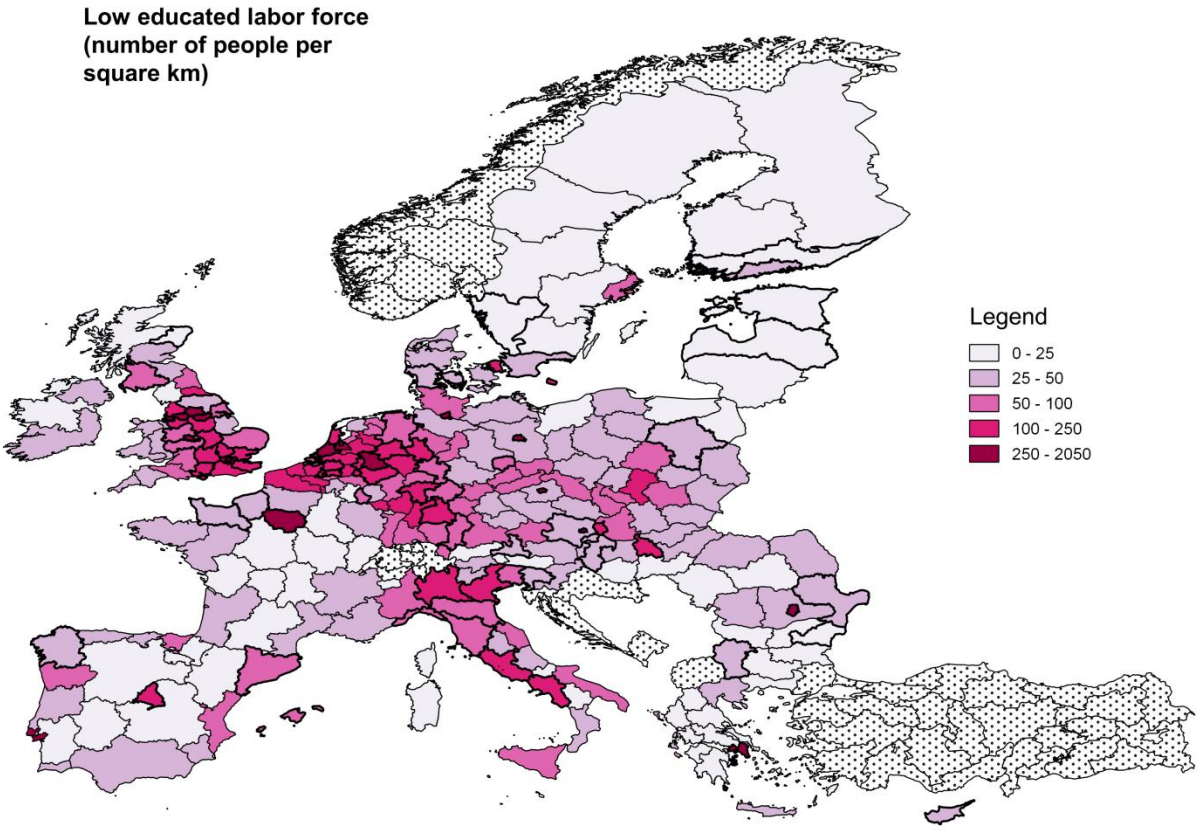

Figure 9 Labor force "Source: Eurostat"

Population

This determinant represents the population. It differs not that much with the labor pool, except the children and retired people. It is obtained from Eurostat for the year 2012. Again there are no missing values. In a region with a great surface more people can live than in a region with a small surface. Therefore the population is divided by the square kilometers of the region.

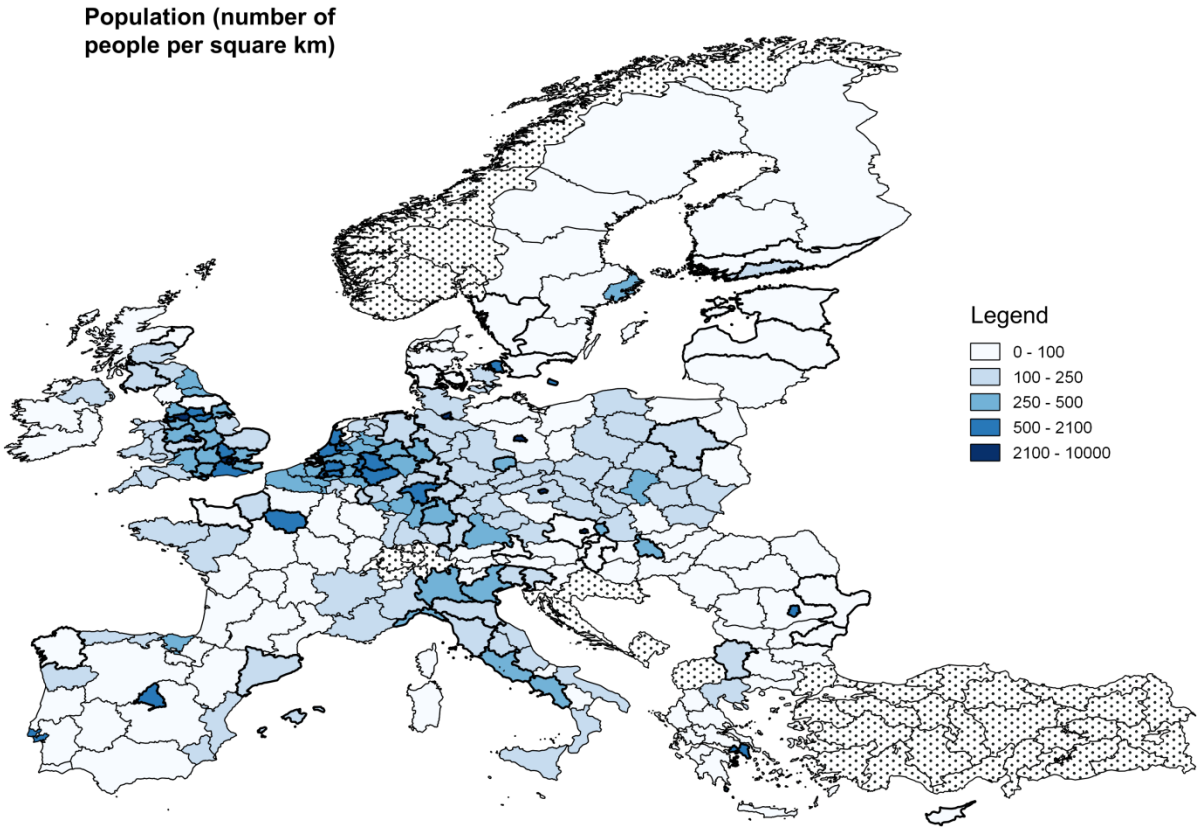

Figure 10 Population which are (potential) customers "Source: Eurostat"

Road density

The data about the amount of roads in a Nuts2 region are obtained from Eurostat. It are not all paved roads, it contains only the motorways measured in kilometers. The data of regions of which no data was available in 2012, is selected from other years. Of thirty eight regions is the data from the years 2008-2011. The most recent data of the Portuguese regions was from 2004 and the Greek regions from 1996. Although this data of Greece and Portugal is from years ago, is still decided to use it, because there are not that much changes in the amount of motorways and it is better to have some data than no data.

Drawing reliable conclusions from the amount of motorways is not possible, because in a greater region there is more space to build motorways. Therefore the amount of motorways is divided by the surface of a region. The surface per region is also given by Eurostat and measured in 1,000 square kilometers.

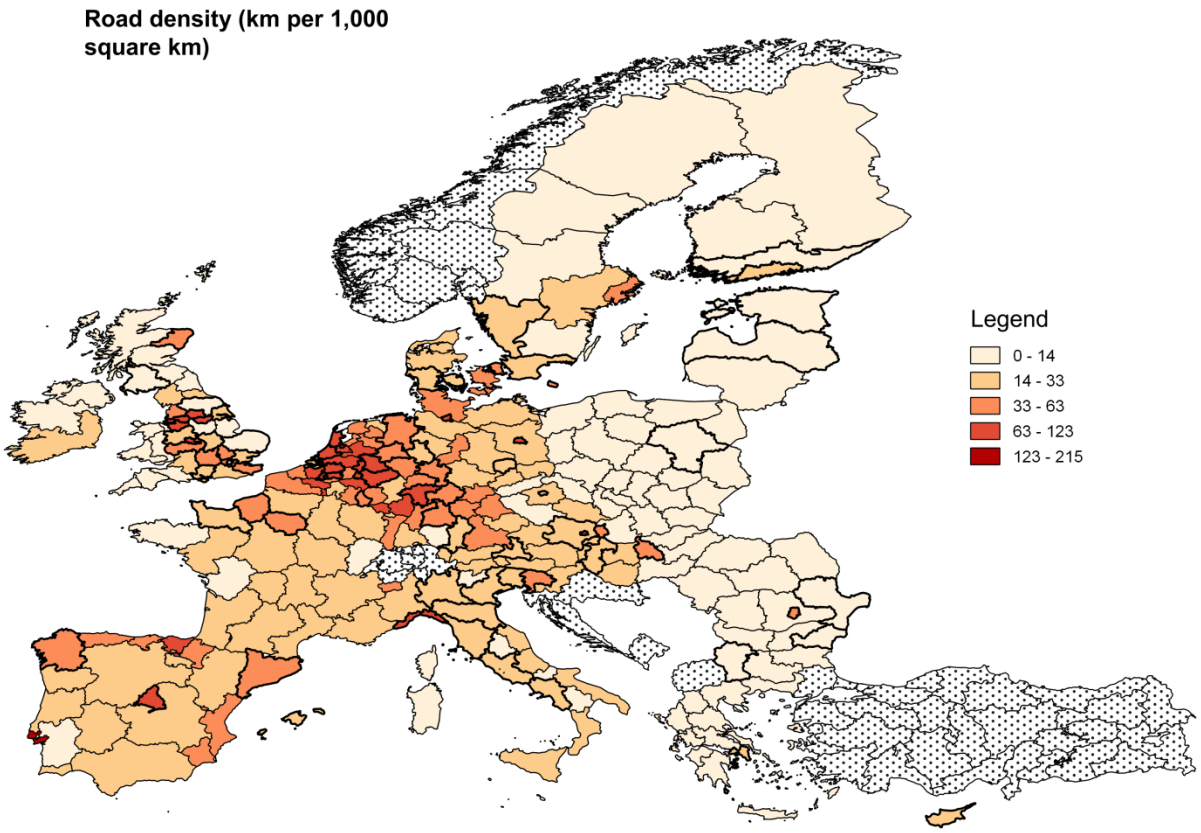

Figure 11 Amount of roads relative to the area surface "Source: Eurostat; own calculations"

Railway density

The length of railways per region is available at Eurostat. It is also measured in kilometers. From twelve regions is the data obtained from the years 2008 and 2011. The data of all the regions in Austria is from 1997, this was the most recent year with available data. Twenty nine out of thirty eight German regions, Denmark, Ireland, Slovenia and the United Kingdom except Northern Ireland have no data available at Nuts2 level. There is still data at Nuts1 level. Therefore is assumed that the amount of railways is equally divided over the corresponding Nuts2 regions. Furthermore the length of the railways is divided by the surface of a region. This is again in order to draw reliable conclusions.

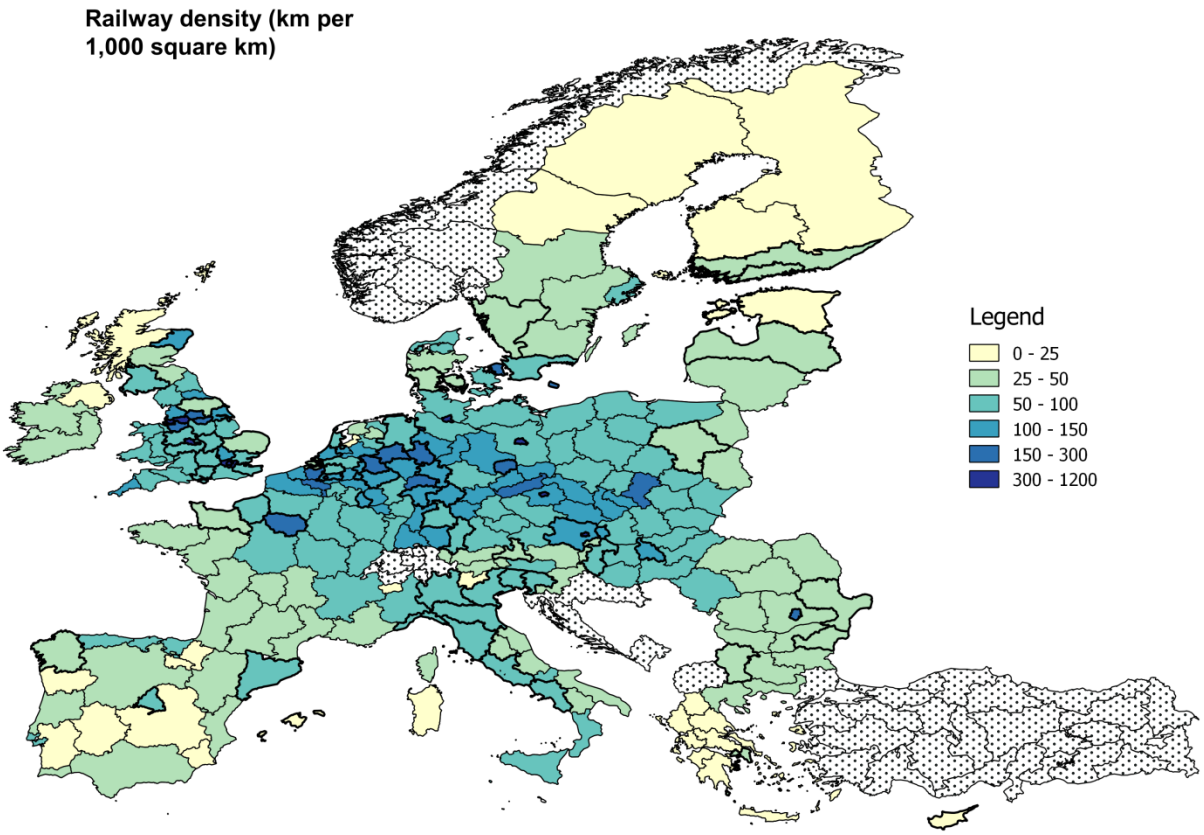

Figure 12 Amount of railways relative to the are surface "Source: Eurostat; own calculations"

Inland waterway density

The length of inland waterways is obtained from two sources from Eurostat. Navigable rivers and navigable canals are the source. The former contains the natural waterways open for navigation and the latter contains the waterways primary built for navigation. It is measured in kilometers. The data of Belgium is from 1994. It is data from two decades ago, but is assumed that it is still reliable data. The data of twenty nine out of thirty eight German regions, Austria and the United Kingdom is extrapolated from the Nuts1 regions. The assumption is made that the length of inland waterways is equally distributed over the corresponding Nuts2 regions. The data from Poland and Italy is extrapolated from the Nuts0 level. It is assumed that the length of inland waterways is equally distributed over the Nuts2 regions of those countries. From several countries there was no data available at Eurostat. Those are Denmark, Greece, Spain, Ireland, Latvia, Portugal and Slovenia. This data is collected via other sources. Greece, Portugal, Spain is obtained from United Nations Economic Commission for Europe (UNECE). The source of Latvia and Ireland is De Agostini Geografia. From the length of inland waterways of Ireland is

assumed that it is equally distributed over the both Nuts2 regions. For Denmark and Slovenia is the Central Intelligence Agency used. Again is for Denmark assumed that the length is equally distributed over the five Nuts2 regions. This source says for Slovenia that there is some transport on the Drava River, but it doesn't mention any length. Further research makes clear that this rivers is only accessible for small boats (Brittanica, 2015). Therefore the assumption is made that there are no inland waterways in Slovenia.

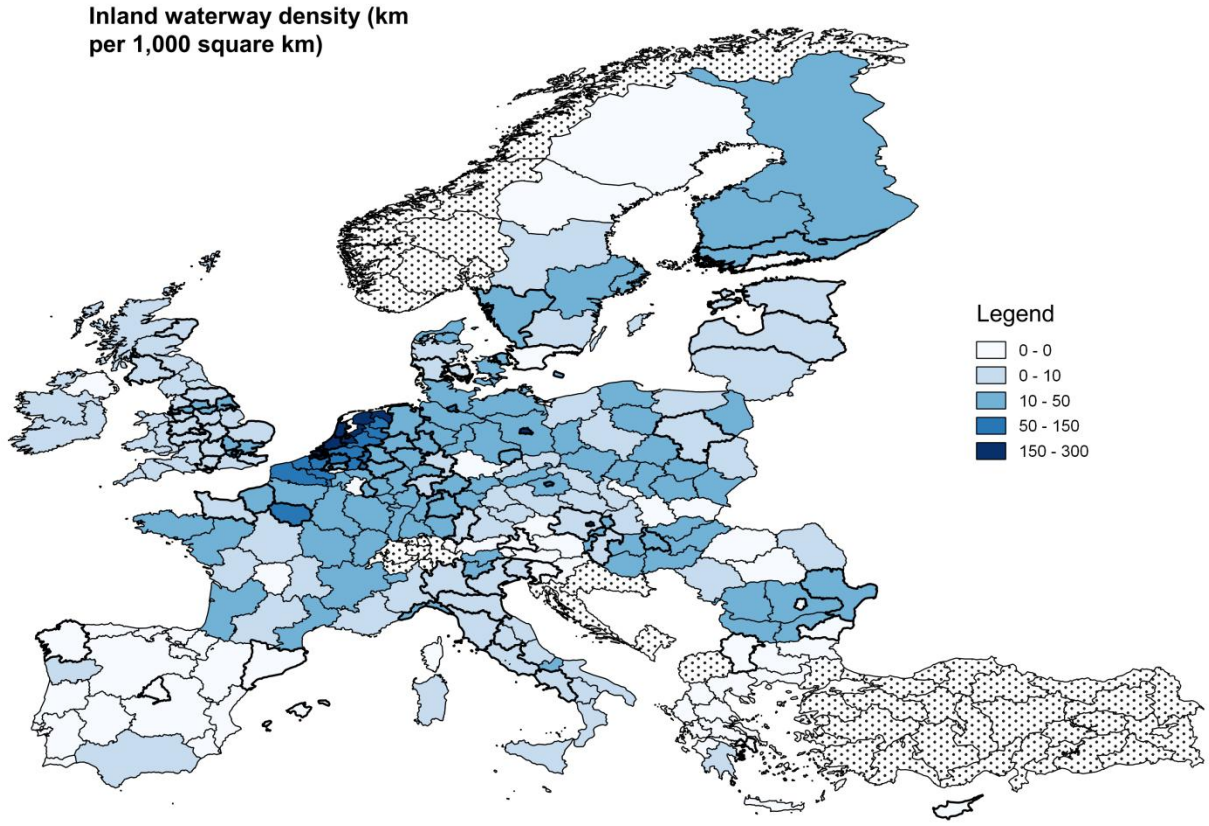

Figure 13 Amount of inland waterways relative to the are surface "Source: Eurostat; De Agostini; Central Intelligence Agency; UNECE"

Infrastructure quality

Besides the quantity of infrastructure, the quality of it does also matter. The World Economic Forum published a report about the Global Competitiveness 2012-2013. This report contains also data about the quality of infrastructure. The data is collected via surveys. In this survey the quality of roads, railroads and ports had to be rated at a scale of 1 to 7. Where 1 is extremely underdeveloped and 7 is well developed and efficient according to international standards. The landlocked countries have to

assess the port infrastructure at a scale 1 (extremely inaccessible) to 7 (extremely accessible). This data is only available at country level, therefore the assumption is made that the quality of the infrastructure of a country is equal in the corresponding Nuts2 regions.

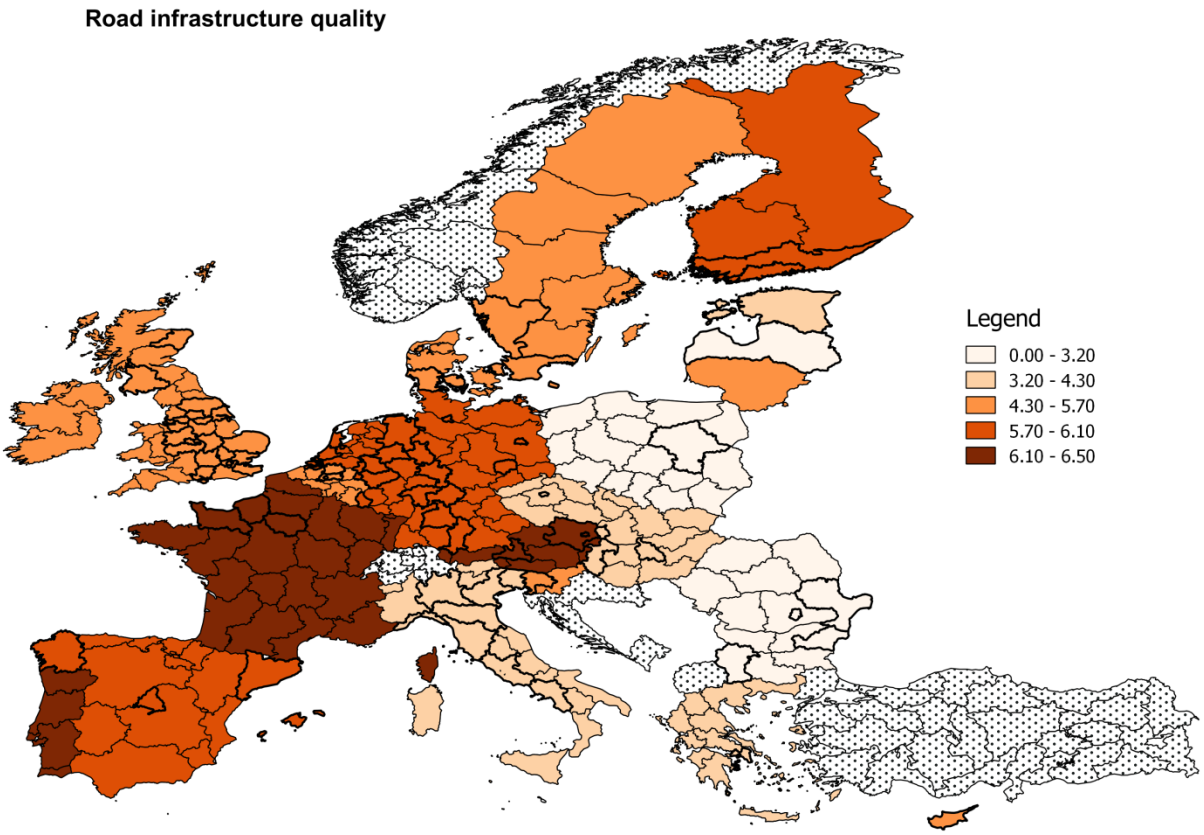

Figure 14 Quality of the roads ”Source: World Economic Forum”

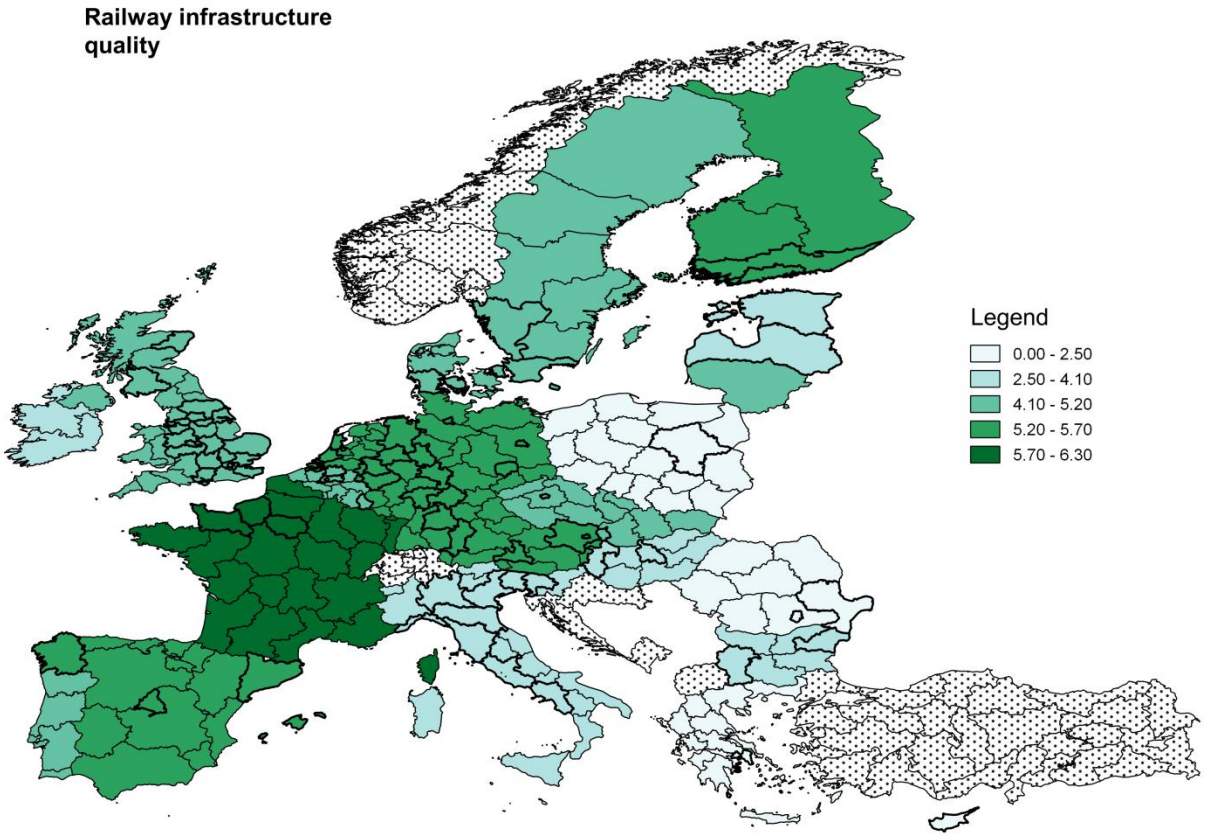

Figure 15 Quality of the railways ”Source: World Economic Forum”

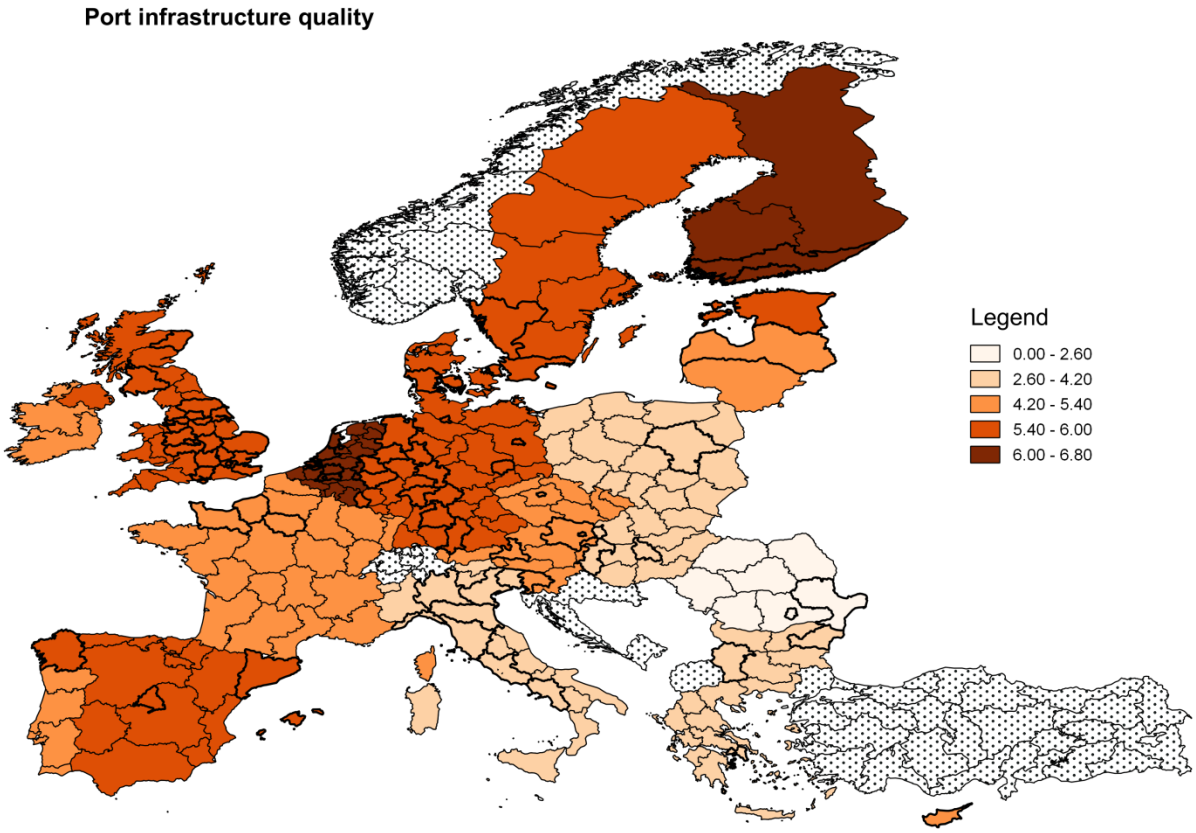

Figure 16 Quality of the port infrastructure "Source: World Economic Forum"

Seaport distance

Before the proximity of ports can be measured, the available ports have to make clear. Eurostat has a shape file with ports in Europe which can be used for QGIS. It contains seaports and inland ports, furthermore small ports with recreational purposes are involved. First the seaports must be separated from the inland ports. A port is noticed as seaport if it is located in a coastal region. A coastal region is a Nuts3 region which borders on the sea. There are six exceptions on this determination. First Hamburg is located in a non-coastal region, but it is well known as an important seaport (e.g. Hamburg Le Havre range). Therefore this port is noticed as a seaport. In Sweden there are five ports, Vänersborg, Trollhätan, Lidköping, Hällekis and Otterbäcken, which are located in a coastal region, but it they are seen as an inland port. These ports are located on the shores of a lake, hence this exception.

There are many ports available, also ports with recreational purposes. Therefore the ports are selected on the basis of the amount of cargo they handle per year. Eurostat gives those numbers, which are

expressed in thousand tons per year. The seventy-five ports with the highest cargo handling are chosen to be relevant for this research (see Appendix B).

The central point of each Nuts2 level is taken. With the help of the distance matrix of QGIS the distance from the central point to the nearest port is measured. This gives the proximity of a port per Nuts2 region.

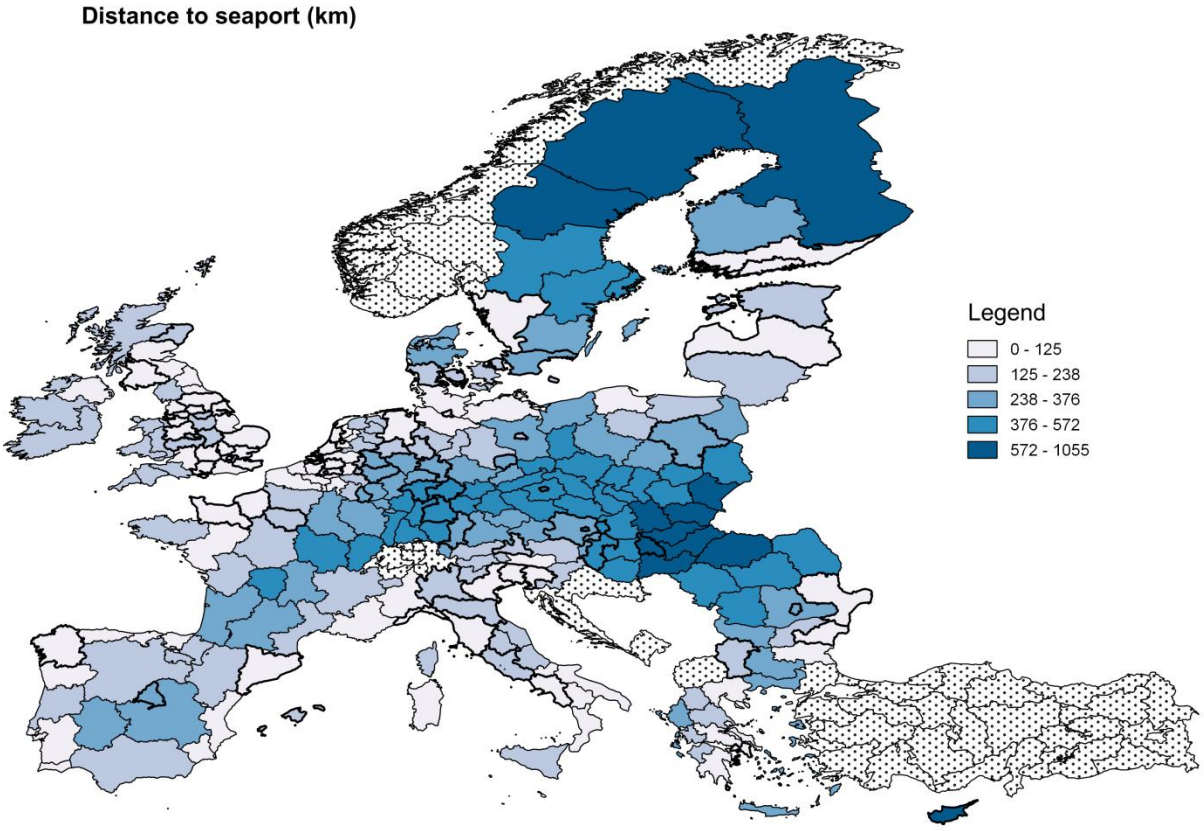

Figure 17 Distance from each region to the nearest seaport "Source: Eurostat; own calculations"

Inland port distance

The inland ports come from two sources. First of all the non-coastal areas, including the exceptions, of above mentioned source are used. This source shows actually only the inland ports of the Netherlands, Belgium and Germany, while for example along the Danube River also inland ports are located. Therefore a second source, the European Federation of Inland Ports (EFIP) is used. This gives in total one hundred thirty five inland ports (see Appendix C).

Again the central points of each Nuts2 regions is taken. The distance matrix of QGIS calculated the distance from the central point to the nearest inland port. This is how the proximity of inland ports is determined.

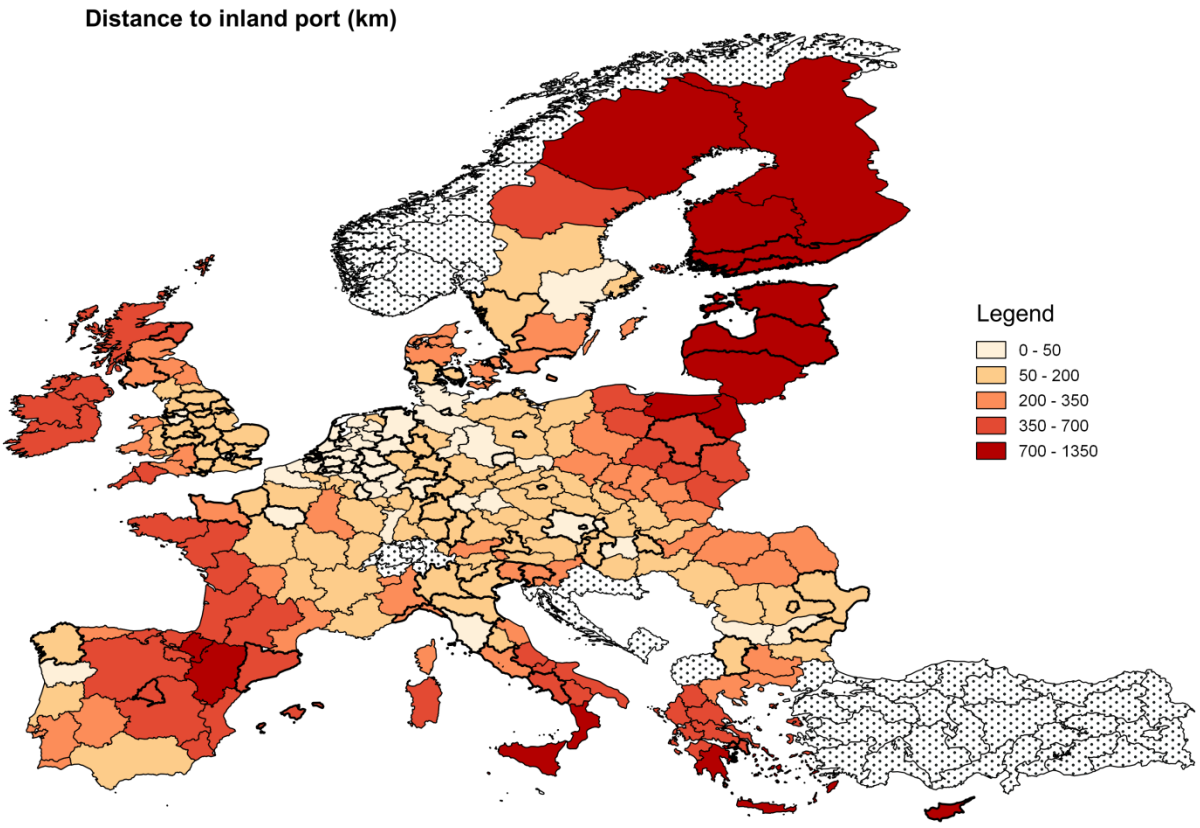

Figure 18 Distance from each region to the nearest inland port "Source: Eurostat; own calculations"

Analysis

First of all the map of the location quotients in the EU will be analyzed. It makes clear where warehousing is overrepresented. Thereafter each determinant will be analyzed on the basis of the figures showed before. Extraordinary findings will be highlighted. Lastly a ranking of the best warehousing location according to this determinants will be given for different types of products.

Location quotient

According to figure 5 is in the well known "Blue Banana" an overrepresentation of warehousing visible. The "Blue Banana" is the banana shaped area from London to Milan. This area contains a lot of economic activity and a major part of the European population lives in this area (Hospers, 2003). In case of overrepresentation of warehousing the "Blue Banana" can be stretched to the north and the south. In the north to region of Manchester and in the south to central Italy where Rome is located.

Besides this stretched "Blue Banana" there are other regions where warehousing is overrepresented. The north-east Baltic Sea region and around the Gulf of Finland presence of warehousing is also noticeable. Furthermore in the regions which border on the Black Sea a small overrepresentation is visible. In central Europe in the regions around Wien, Bratislava and Budapest is an increased concentration of warehousing. Lastly in South-East Scandinavia, North-West France and the regions of Barcelona and Madrid is warehousing also overrepresented.

The regions with an overrepresentation are roughly sketched, but to which extent is it overrepresented? Figure 19 gives the top ten of regions with the highest overrepresentation of warehousing. Bremen is the region with the highest overrepresentation. Warehousing is 9.4 times more concentrated in Bremen than in the EU. Brussels and Bratislava come after Bremen, which are respectively 6.2 and 5.9 times more concentrated than the EU.

Rank	Nuts ID	Region	Location quotient
1	DE50	Bremen	9.36
2	BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	6.25
3	SK01	Bratislavský kraj	5.90
4	DE71	Darmstadt	3.95
5	DE60	Hamburg	3.69
6	UKF2	Leicestershire, Rutland and Northamptonshire	2.55
7	BE21	Prov. Antwerpen	2.54
8	ITC3	Liguria	2.47
9	LV00	Latvija	2.37
10	PL12	Mazowieckie	2.05

Figure 19 Ten regions with the highest overrepresentation of warehousing "Source: Own calculations"

Real estate costs

Considering the literature it is expected that this determinant is moderately important, see figure 1. This means that this determinant is relevant, but it is not the most important one. Therefore it is expected that a small majority of the regions with a high location quotient also assessed as low real estate costs regions.

The real estate costs for warehousing are showed in figure 6. The most expensive region is Stockholm, here you pay €125,80 per square meter. This one is followed by Île de France, a square meter warehouse costs €120,-. Higher costs means lower profits, therefore it is interesting to know where the real estate costs are low. In two Belgian regions you find the lowest real estate costs. Those are Province Limburg (BE) and Province Liège, both are located in Eastern Belgium. Here you pay €36,- per square meter.

The presence of low real estate costs in regions with a high location quotient can be seen in figure 20. A small minority of the regions with an overrepresentation of warehousing have also low real estate costs. Therefore it seems this determinant has a small influence on the location of warehousing.

Actually the findings are not the same as the expectations. Where a small majority of regions with a high location quotient combined with low real estate costs was expected, is a small minority found. Probably it has to do with the missing values of this determinant. On the other hand real estate prices are generated by supply and demand. So if there the demand for warehousing is large, the price of it will also increase. That can be a plausible explanation of the difference between the expectation and the findings.

	Real estate costs high	Real estate costs low
Location quotient high	+	-
Location quotient low	-	+

Figure 20 location quotient versus real estate costs

Wage

In figure 1 can be seen that the determinant wage is classified as moderately important. In the literature is this determinant considered as an important one, but not the most important. The expectation is that a small majority of the regions with a high location quotient, will also be classified as a region with low wages.

The wage for people working in the warehousing sector is shown in figure 8. Scandinavia, Ireland and the Benelux have a high level of wages. Île de France is the most expensive region, where employers pay their employees €38,- per hour. Subsequently comes Denmark, here €35,04 per hour is paid. They are followed by Brussels where employees earn €34,- per hour. Compared to the location quotients this high level seems not to be a problem for warehousing companies to locate in the Benelux. Nevertheless warehousing in Ireland and Scandinavia is underrepresented, so the high wages can be an obstacle to locate there. In Eastern Europe the wages are extremely low. In Western Romania are the wages at the lowest level, namely €3,- per hour. In Eastern Hungary and North and East Bulgaria are the wage levels also extremely low with €4,- per hour.

In Eastern Europe there are several regions where warehousing is overrepresented: the Baltic regions, regions which border on the Black Sea and regions around the large cities. Therefore a low wage might be favorable for companies to locate there, but it is also dependent on other variables otherwise in whole Eastern Europe should be an overrepresentation of warehousing. Nevertheless figure 21 makes clear that a small minority of the regions with a high location quotient also have low wages.

The findings don't meet the expectations. Although the difference is not that large. A small minority of the regions with a high location quotient also have low wages, while it was expected that this was a small majority. Possibly this difference can be caused by the technological changes over the years. More automation needs less personnel, so the cost of human resources are less important.

	Wage high	Wage low
Location quotient high	+	-
Location quotient low	-	+

Figure 21 location quotient versus wages

Low educated labor force

In figure 1 can be seen that the low educated labor force is slightly important. In the literature this determinant is not of large importance. Therefore it is expected that a small minority of the regions with a high location quotient also have a large low educated labor force.

In figure 9 the low educated labor force per square kilometer can be seen. In the "Blue Banana" are the densities high. The densest region is Inner London, this is a small area with a large labor force which results in a high density. There is a low educated labor force of 2,013 people per square kilometer. The

second one is Brussels, just like London an urban region, here you can find 1,790 people per square kilometer. Vienna is the third one. This is again an urban region with a low educated labor force of 1,474 people per square kilometer.

Compared to the overrepresentation of warehousing it seems that this is in line. Regions with high density of the low educated labor force have also an overrepresentation of warehousing. In figure 22 this is confirmed. It is visible that a large presence of the regions with a high location quotient also have a high density of the low educated labor force.

The findings are not in line with the expectations. It was expected that a small minority of the regions with an overrepresentation of warehousing also have a high density of the low educated labor force. Although a large majority is found. Therefore it seems that adequate human resources are probably underestimated in the literature.

	High density of a low educated labor force high	Low density of a low Educated labor force low
Location quotient high	++	--
Location quotient low	-	+

Figure 22 location quotient versus low educated labor force

Population

The population determinant is considered as slightly important in figure 1. The literature stated that this determinant has a small importance. This is probably caused by the increased mobility, so it has become easier to serve people far away. Therefore it is expected that a small minority of the regions with a high location quotient also have a high population.

In figure 10 is the population per square kilometer showed. This figure is comparable with figure 9 with the low educated labor force. The densities are only somewhat higher in figure 9, because the population includes children and retired people and the population is not corrected for the level of education. Inner London, Brussels and Vienna have the highest densities. Those are respectively 9,951, 7201 and 4137 people per square kilometer. Two Swedish regions, Övre Norrland and Mellersta Norrland, have the lowest densities, respectively 3 and 5 people per square kilometer.

According to figure 23 is the presence of a high population in regions with a high location quotient large. It seems that having many customers in close proximity is of influence on the location decision of warehousing.

The expectations and the findings don't match. The expectation was that a small minority of the regions with an overrepresentation of warehousing also have a high population. While there is found that a large majority of the regions with a high location quotient also have a high population. Customers probably wants fast deliveries, so a responsive supply chain is necessary, which needs warehouses close to the customers.

	Population high	Population low
Location quotient high	++	--
Location quotient low	-	+

Figure 23 location quotient versus population

Density of roads

In figure 1 is showed that the road density is very important. This is because of the speed of the mode of transport which make use of this type of infrastructure is very high, which is nowadays important in logistics according to the literature. Therefore it is expected that regions with a high location quotient also have a large majority of a high road density.

The density of roads per region in kilometer per 1,000 square kilometer is shown in figure 11. In the North-West Europe is the density at the highest level. Surprisingly it is the region Lisboa which has the highest road density with 214 kilometer per 1,000 square kilometer. This is due to the urban character of this region combined with a small surface. Broad ring roads are common in large cities and divide this by a small surface than you get a high density. Bremen, Düsseldorf, Utrecht, Hamburg, Zuid-Holland, Wien, Greater Manchester and Limburg (NL) complete the top ten with a density between 96 and 179 km per 1,000 square km. The lowest densities are found in Eastern Europe, it lays between 0 and 13 kilometer per 1,000 square kilometer.

Figure 24 shows that a small majority of the regions with a high location quotient also have a high road density. Therefore it seems to be a relevant determinant in the location choice, because most regions with a high density are in the Northern part of the "Blue Banana", which have a high overrepresentation of warehousing.

It was expected that a very large majority of the regions with a high location quotient also have a high road density. The findings are that this is just a small majority. So the expectation don't exactly meet the findings. A plausible reasoning for this can be that large cities dominating the top of the road density, because they have ring roads and their surface of an urban region is relatively small. Then you get high densities. Congestion problems in large cities can cause the findings of a small majority.

	Road density high	Road density low
Location quotient high	+	-
Location quotient low	-	+

Figure 24 location quotient versus road density

Density of railways

The railway density is moderately important, which can be seen in figure 1. Because of the slow speed in comparison with road transportation and it is not able to deliver door to door, the importance of this determinant is expected to be much lower than the road density. Therefore the expectation is that a small majority of the regions with an overrepresentation of warehousing also have a high railway density.

In figure 12 is the density of the railways in km per 1,000 square km shown. Actually from west to east in the middle of Europe is the railways density as highest. The top seven of regions with the highest densities are all urban regions with a small surface. The densities of those regions vary from 434 to 1187 kilometer per square kilometer. Compared to the overrepresentation of warehousing it has similarities, so it seems that this determinant is of influence on the location of warehousing. In the corners of the EU, Southwest Europe, Southeast Europe and the Northern regions of Scandinavia, are barely any railways available. The density is between 0 and 25 km per 1,000 square km.

In figure 25 can be seen that a small majority of the regions with a high location quotient also have a high railway density. Therefore it is likely that companies prefer locating in regions with a high railway density.

The expectations are similar to the findings. A small majority of the regions with a high location quotient also have a high railway density. Although this transport mode is not able to realize door to door deliveries, for long distances it is still a cheap substitute of road transportation.

	Railway density high	Railway density low
Location quotient high	+	-
Location quotient low	-	+

Figure 25 location quotient versus railway density

Density inland waterways

In figure 1 can be found that the density of inland waterways are moderately important. That this determinant is not viewed as important as the road density is again caused by the speed of the transportation mode. Furthermore inland waterways have a strong natural character. This means that a region is strongly dependent on the nature. Therefore it is expected that a small majority of the regions with a high location quotient also have a high inland waterway density.

The inland waterway density in kilometer per 1,000 square kilometer is given in figure 13. In West-Europe the highest densities are visible. Zuid-Holland has the highest density namely 272 kilometers inland waterways per 1,000 square kilometer. This region is followed by three other Dutch regions. Several regions don't have any inland waterways due to the natural character of it.

Figure 26 shows the presence of inland waterway densities for the regions with a low and high location quotient. Similar to the road and railway density have a small majority of the regions with a high location quotient also a high inland waterway density.

The findings are in line with the expectations. There was expected that a small majority of the regions with a high location quotient also have a high inland waterway density. The results show a also a small majority of it. That it is just a small majority has possibly to do with the slow speed of the barges. Therefore it is only favorable to use this type for products with a long lead time.

	Inland waterway density high	Inland waterway density low
Location quotient high	+	-
Location quotient low	-	+

Figure 26 location quotient versus inland waterway density

Road infrastructure quality

The expectations of the quality are the same as the quantitative part. In figure 1 is noticed that road infrastructure is very important. Therefore it is expected that a large majority of the regions with a high location quotient also have a high road quality.

In figure 14 the quality of the roads is shown. This figure makes clear that in Western Europe the quality of roads is much higher than in Eastern Europe. France gets the highest ranking 6.5 out of 7. They are followed by Portugal and Austria with respectively 6.4 and 6.3 out of 7. The lowest rankings can be found in Eastern Europe in Romania and Bulgaria, with a ranking of 1.9 and a 2.5 out of 7.

According to figure 27 have a small minority of the regions with a high location quotient also a high road quality. Therefore it seems that the influence of this determinant is limited in the location decision for warehousing.

The expectation of the qualitative part of road infrastructure don't match with the findings. There was found that just a small minority of the regions with a high location quotient also have a high road quality, while there was expected that it was a large majority. It seems that the quality of roads is of less importance for companies to decide to locate the warehouse somewhere.

	Road quality high	Road quality low
Location quotient high	-	+
Location quotient low	-	+

Figure 27 location quotient versus road quality

Railway infrastructure quality

In figure 1 is the importance of railway infrastructure quality showed. Again is this importance the same as the quantitative part of the railway infrastructure. Therefore the expectation is that a small majority of the regions with an overrepresentation of warehousing also have a high railway infrastructure.

The quality of the railways is shown in figure 15. It has the same pattern as the quality of the roads. France is assessed as the country with the highest quality with a score of 6.3 out of 7. The Netherlands, Germany Finland and Spain are commonly the second best with a score of 5.7 out of 7. Cyprus is ranked at the last place with a score of 0, because in this country there are no railways. Thereafter Romania and Poland are ranked as countries with the worst railway infrastructure quality. They scored respectively 2.2 and 2.4 out of 7.

Again it seems that this determinant can have an influence on the location decision of warehousing. Figure 28 shows that a small minority of the regions with a high location quotient also have a high railway quality.

The findings don't match with the expectations. It was expected that a small majority of the regions with a high location quotient also have a high railway quality. While there is found that a small minority of the regions with a high location quotient also have a high railway quality. Therefore it seems that the quality is of less importance in the location decision.

	Railway quality high	Railway quality low
Location quotient high	-	+
Location quotient low	-	+

Figure 28 location quotient versus railway quality

Port infrastructure quality

The port infrastructure quality is moderately important according to figure 1. Again is this the same as the qualitative part of the determinant. Therefore it is expected that a small majority of the regions with a high location quotient also have a high port infrastructure quality.

Figure 16 shows the quality of port infrastructure. North West Europe has the highest port quality. This is not strange because of the existence of the well-known Hamburg-Le Havre range. Furthermore Finland is a remarkable finding. Probably this has to do with their dependency of the port, because over land it is hard to reach this country via a short and fast route. The Netherlands have the highest quality with a score of 6.8 out of 7. Belgium and Finland are the second best with a score of 6.3 out of 7. Again is in Eastern Europe the quality of this type of infrastructure low. Romania scores a 2.6 out of 7, while Poland scores a 3.5 out of 7.

In Figure 29 can be seen that a small minority of the regions with a high location quotient also have a high port infrastructure quality.

The findings are not the same as the expectations. The expectation was that a small majority of the regions with a high location quotient also have a high port quality, while a small minority was found. In line with the road and railway quality is the port quality also of less importance in the location decision.

	Port quality high	Port quality low
Location quotient high	-	+
Location quotient low	-	+

Figure 29 location quotient versus port quality

Seaport distance

The proximity of a seaport is important, see figure 1. It is not the most important determinant according to the literature, but it has a considerable importance. Therefore a majority of the regions with a high location quotient also have a high seaport proximity.

The distance of each region to a seaport can be found in figure 17. It is clear that the coastal regions have short distances to the port. The shortest distance can be found in the region Hamburg, namely 5 kilometers. This regions is followed by Haute-Normandie and Zuid-Holland with a distance of respectively 7 and 9 kilometers. On the other hand the inner land region are further away from a seaport. The region Cyprus is the farthest away from a seaport with 1,055 kilometers. This seems to be strange, because Cyprus is an island surrounded by the Mediterranean Sea. As mentioned in the data collection, there is opt to consider only the ports with the highest cargo handling numbers. It included none of the ports in Cyprus. The second farthest away is Övre Norrland in Sweden. The nearest seaport is at 958 kilometers. This region is followed by Észak-Alföld in Hungary at a distance of 798 kilometers from the nearest seaport.

Figure 30 shows that a small majority of the regions with a overrepresentation of warehousing also have a low seaport distance. It is very likely that companies prefer regions close to a seaport.

The expectations are not exactly in line with the findings. It was expected that a majority of the regions with a high location quotient also have a low seaport distance, but a small majority is found. Despite of this small difference it seems that this determinant is of importance. It is likely that a short inbound transportation is desired, probably to reduce inbound transportation costs.

	Seaport distance high	Seaport distance low
Location quotient high	-	+
Location quotient low	+	-

Figure 30 location quotient versus seaport distance

Inland port distance

In figure 1 is showed that the proximity of an inland port is important. Several researches stated the attractiveness of inland ports for warehousing. Therefore the expectation is that a majority of the regions with an overrepresentation of warehousing also have a high inland port proximity.

Figure 18 shows the distance of each region to an inland port. From Western Europe through central Europe to the Black Sea region are the distances to an inland port at the lowest level. The regions of Bremen and Brussels have the lowest distance, namely 2 kilometers. After those comes Greater Manchester with a distance of 5 kilometers. The regions Pohjois- ja Itä-Suomi, Cyprus and Eesti, are the farthest away from an inland terminal. The distances are respectively 1,337, 1,219 and 1,034 kilometers.

The overrepresentation of warehousing can also be found in regions where the distance to an inland port is short. So this determinant has a quite strong influence on the location of warehousing. This is confirmed by figure 31. A small majority of the regions with a high location quotient have also a low inland port distance.

The expectation and the findings shows a small difference. The expectation was that a majority of the regions with a high location quotient also have a low inland port distance, but just a small majority was found. This is a small difference, but it is still likely that this determinant is of influence on the location decision for warehousing. Location close to an inland port is possibly to reduce inbound transportation costs. Goods are customized close to the inland port, so outbound costs will be higher. Probably those the latter costs are seen as value added.

	Inland port distance high	Inland port distance low
Location quotient high	-	+
Location quotient low	+	-

Figure 31 location quotient versus inland port distance

Preferable warehousing locations

With the help of the determinants a ranking can be made of the most preferable warehousing location. First, for all the regions the values of the determinants have to be converted to a 0-100 scale. For the determinants real estate costs, wage, seaport distance and inland port distance is a low value associated as good. Therefore the inverse has to be taken. A summation of the scores of each determinant will give a total score. Although different types of products requires different logistics. The importance of the determinants is not the same. A weight will be allocated to each determinant for both functional and innovative products. The weighting is determined on the basis of the factors making the difference between functional and innovative products (Appendix D). An example of the calculation of the score is given in Appendix E.

Figure 32 shows the top ten ranking of regions which are most favorable for the warehousing of functional products. The Provence Zuid-Holland in the Netherlands is the most favorable location. This region gets a high score for eleven determinants out of thirteen. For the remainder two determinants the score is lower. The wages and the real estate costs are high in this region. Furthermore it is remarkable that eight regions from the top ten are Belgium German or Dutch regions. Several seaports are located close to this regions, which reduce inbound costs. In general the infrastructure is in those regions of high quality and in multiples present. Furthermore it lays in the "Blue Banana", which means that a large hinterland of customers is nearby. In Appendix F a map is given with the scores of all regions for functional goods.

NUTS ID	Region	Total Score
NL33	Zuid-Holland	58.27
DE60	Hamburg	55.12
BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	53.40
DE30	Berlin	51.10
NL31	Utrecht	50.42
NL23	Flevoland	50.00
DE50	Bremen	49.82
NL32	Noord-Holland	49.65
AT13	Wien	49.36
UKI1	Inner London	48.13

Figure 32 Top ten of regions for warehousing of functional goods "Source: Own calculations"

The top ten ranking for the warehousing of innovative products can be found in figure 33. The region of Brussels in Belgium is most preferable. Ten determinants out of thirteen gets a high score for Brussels, while three determinants scored low. Those are the wages, road and rail infrastructure quality. All regions in the top ten are located in West-Europe. They are predominantly located close to the customers in order to respond quickly to their requirements. The outbound costs are therefore lower. Furthermore the road density is very high in those regions. In Appendix G is a map given with the scores of all regions for innovative goods.

NUTS ID	Description	Total Score
BE10	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	68.96
UKI1	Inner London	63.21
DE50	Bremen	60.00
DE30	Berlin	55.57
AT13	Wien	54.98
DE60	Hamburg	48.65
UKD3	Greater Manchester	45.74
NL33	Zuid-Holland	43.34
UKG3	West Midlands	42.71
DEA1	Düsseldorf	42.69

Figure 33 Top ten of regions for warehousing of innovative products ”Source: Own calculations”

Conclusion

Several researches bring in many determinants in order to choose a warehousing location. A selection of those are chosen to consider in this research. Those are real estate costs, wage, low educated labor force, population, road density, railway density, inland waterway density, road infrastructure quality, railway infrastructure quality, port infrastructure quality, seaport distance and inland port distance. Furthermore in the literature is also the governmental influence discussed. Due to the immeasurability of it, is decided to keep it in mind, but don´t make conclusions out of it.

Subsequently the data is collected to obtain the location quotients of warehousing in Europe. In general we can conclude that warehousing is overrepresented in the extended "Blue Banana". With extended "Blue Banana" is meant that as well in the North as in the South the "Blue Banana" is somewhat enlarged. Furthermore around the Gulf of Finland and in the Northern Baltic States is warehousing overrepresented. The region of Bremen in Germany is the one with the highest location quotient. In this region warehousing is 9.4 times more concentrated than in the EU. Second and third are respectively Brussels and Bratislava.

The importance of the determinants vary. The most important ones are the distance to the seaports and inland ports. Probably play the inbound transportation costs an important role. Furthermore is the infrastructure as well quantitative as qualitative seen as important. A good and extensive infrastructure facilitates a quick and reliable delivery.

Lastly are the most preferable location are determined on the basis of the determinant values. This is done for two types of goods, namely functional and innovative goods. For functional goods is the region Zuid-Holland assessed as most preferable. A location close to a seaport with a large and high quality infrastructure. Brussels is the most preferred region for innovative goods. A location with a large hinterland of customers in close proximity. Furthermore has it a high dense road network, which facilitates a quick and responsive delivery.

All in all it seems that Western Europe is still the most attractive for warehousing companies, because of all the benefits like a large hinterland and an extensive and high quality infrastructure.

Discussion

This research also knows his limitations. First of all there is mentioned that the types of goods matter in the location decision of warehousing. In this research are only two types of goods discussed. A better way would be to have a more precise and extensive distinction between the products. The amount of different types will be much larger, therefore the research will also be enlarged. Furthermore are there limitations on the data collection. The real estate costs are difficult to obtain because you have to pay for it, therefore this determinant noticed many missing values. The Nuts2 level at which this research is done is not the most detailed one. Nuts3 level is the most detailed. Probably by doing this research at Nuts3 level, you would really see the local overrepresentation of warehousing. Moreover the assessment of the most preferred region for warehousing on the basis of the determinants is sensitive to the weighting of the determinants. Furthermore there can be an interaction between the determinants.

There are also recommendations for further research. In order to measure the importance of the determinants a research can be done to a statistical model. With that model also the preferred locations can be obtained. Furthermore is it a possibility to pick out a couple of countries and do this research at

for example a Nuts3 level. Lastly a field research also belongs to the possibilities. A research on the basis of the thoughts of the companies themselves, measured by surveys, can also be interesting.

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Appendices

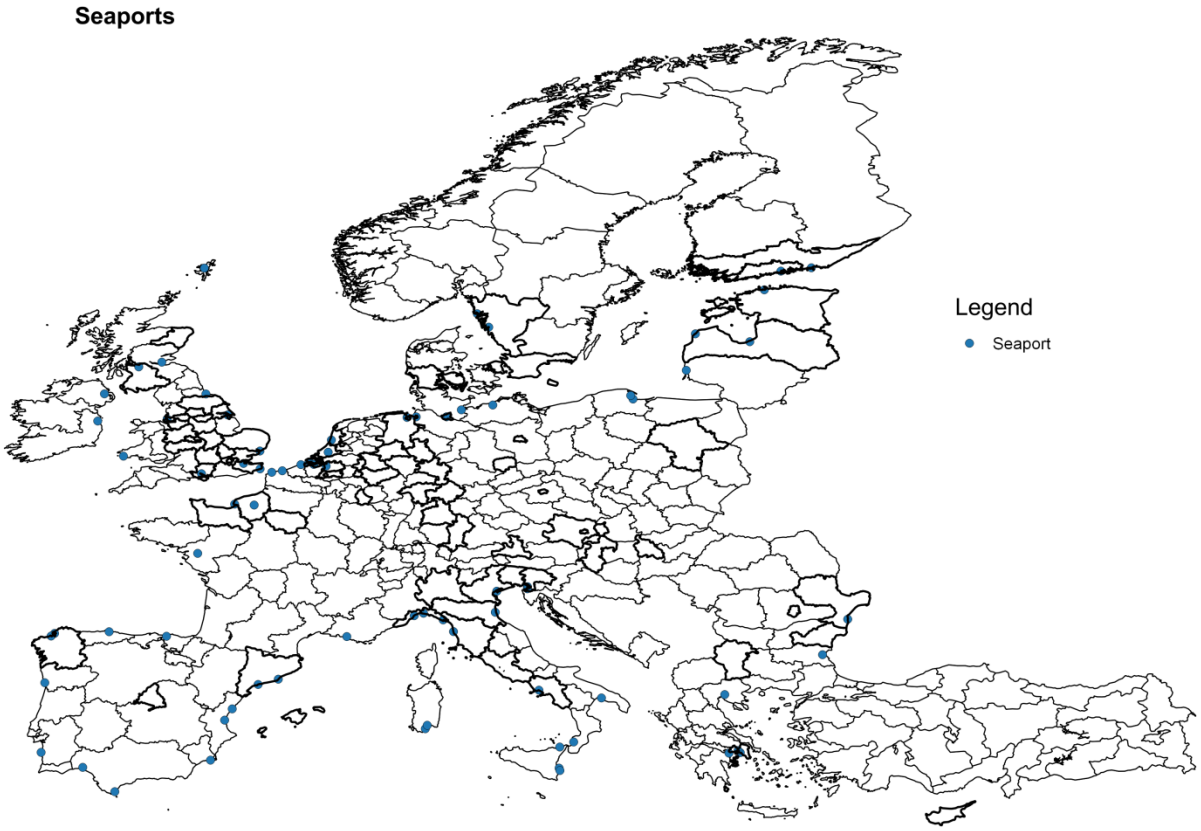
Appendix A

List of countries used in this research.

Austria	Germany	Poland
Belgium	Greece	Portugal
Bulgaria	Hungary	Romania
Cyprus	Ireland	Slovakia
Czech Republic	Italy	Slovenia
Denmark	Latvia	Spain
Estonia	Lithunia	Sweden
Finland	Luxembourg	United Kingdom
France	Netherlands	

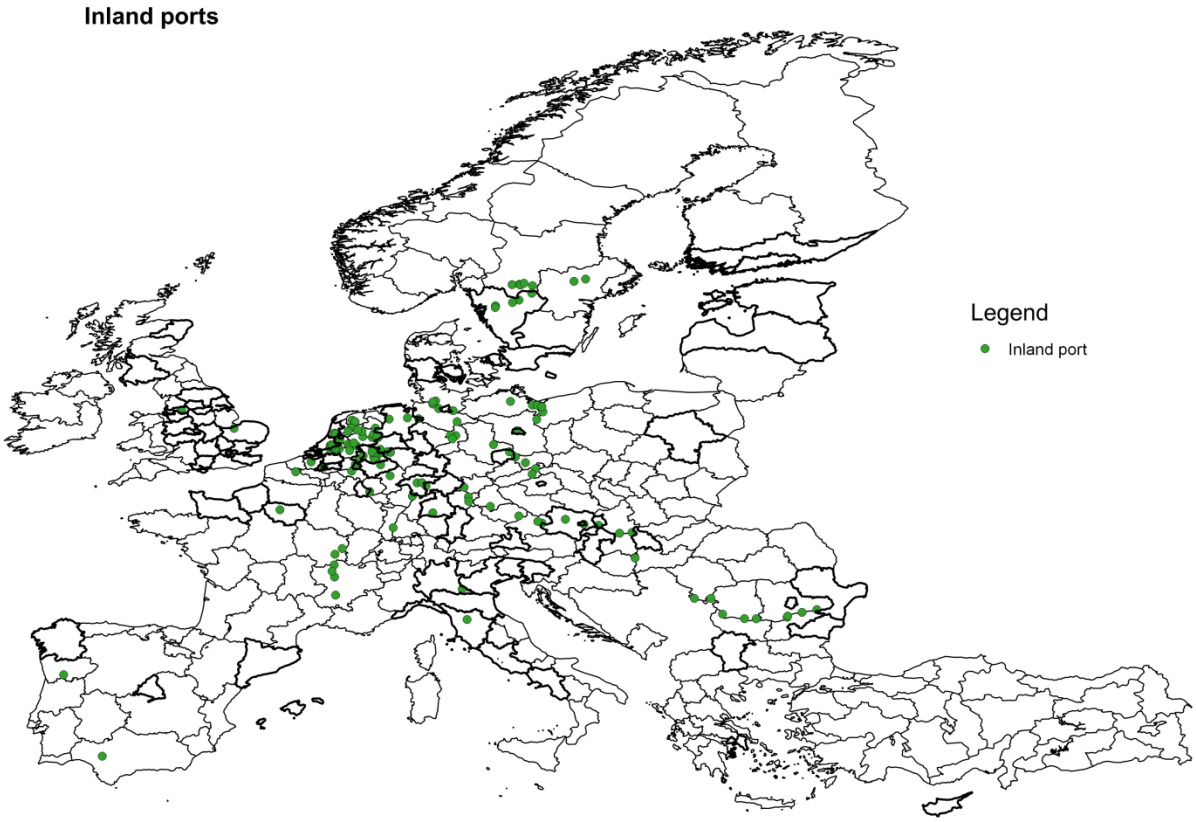
Appendix B

Map of seaports used in this research.



Appendix C

Map of inland ports used in this research.



Appendix D

Weighting in order to get a score for the different types of products. In this table are the rounded numbers given in order to increase readability. The calculations are all done with unrounded numbers.

Determinant	**Functional products**	**Innovative products**
Real estate costs	0.13	0.03
Wages	0.13	0.03
Low educated labor force*	0.03	0.13
Population	0.03	0.13
Road density	0.03	0.13
Railway density	0.08	0.08
Inland waterway density	0.13	0.03
Quality of roads	0.03	0.13
Quality of railways	0.08	0.08
Quality of ports	0.13	0.03
Seaport distance	0.13	0.03
Inland port distance	0.03	0.13

*The low educated labor force is for both functional and innovative products viewed as neutral in figure 2. Due to the fact that the weights of each product type have to sum up to 1, this weighting is somewhat different compared to figure 2.

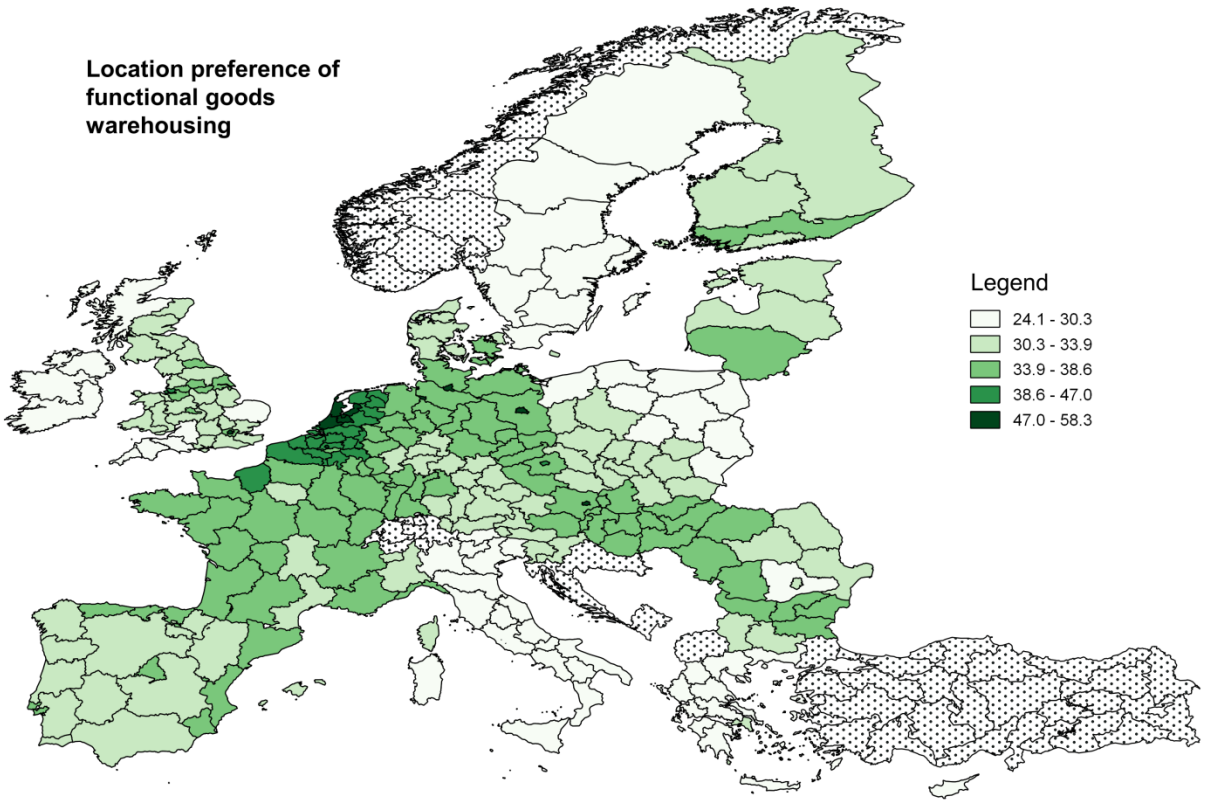
Appendix E

An example of the calculation of the score of region Zuid-Holland.

	Conversion to 0-100 scale			*Muliplication of Value at 0-100 scale and Weight*		
	Determinant value	**Value at 0-100 scale**		**Weight**		**Score**
Real estate rent	58.00	62.07		0.13		8.28
wage per hour	30.00	10.00		0.13		1.33
Low educated labor force	357.44	17.76		0.03		0.59
population	1039.17	10.44		0.03		0.35
Road per housand sq km	105.89	49.28		0.03		1.64
Railway per thousand sq km	127.83	10.78		0.08		0.90
Inland waterway per thousand sq km	271.76	100.00		0.13		13.33
Quality of roads	6.00	92.31		0.03		3.08
Quality of railroads	5.70	90.48		0.08		7.54
Quality of ports	6.80	100.00		0.13		13.33
Seaport distance	8.56	56.81		0.13		7.57
Inland port distance	22.38	9.74		0.03		0.32
Total score						**58.27**

Appendix F

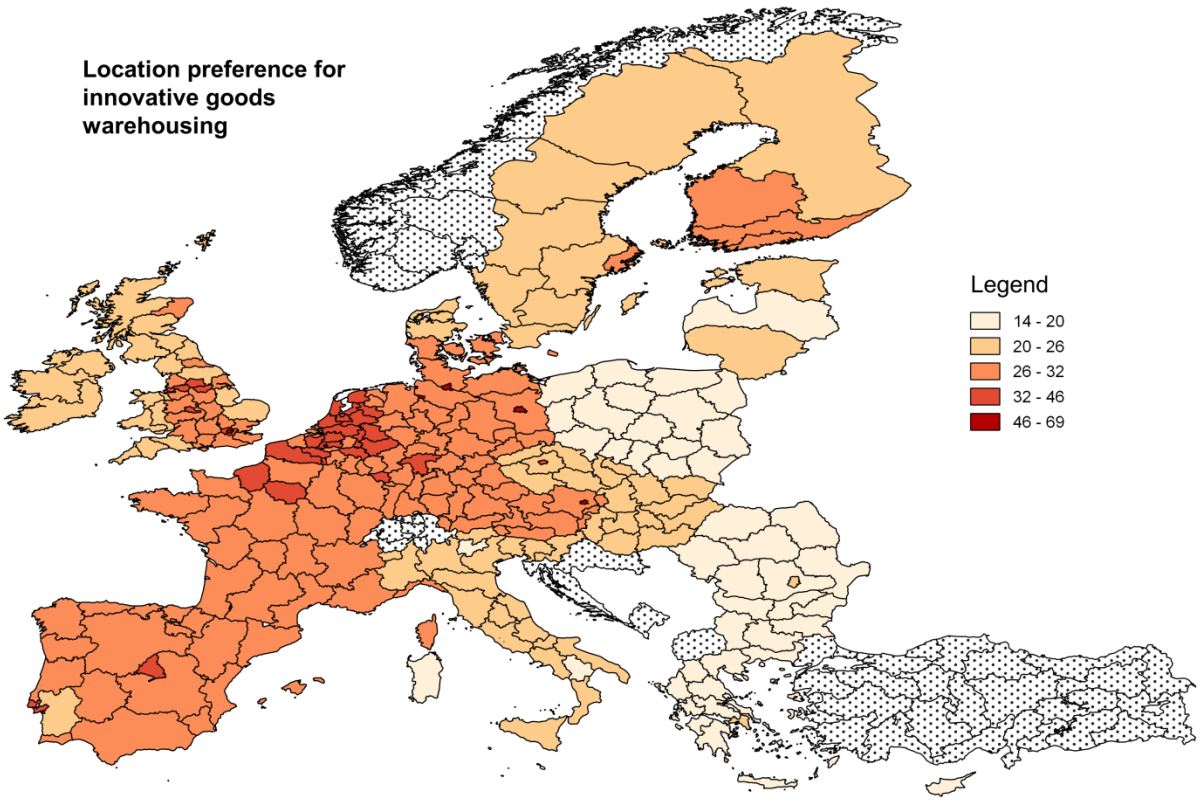
Map of the scores per region for functional goods warehousing.



”Source: Own calculations”

Appendix G

Map of the scores per region for innovative goods warehousing.



”Source: Own calculations”