

## WAREHOUSES CONSOLIDATION IN THE LOGISTIC CLUSTERS: FOOD INDUSTRY'S CASE

Navickas V., Baskutis S., Gruzauskas V., Kabasinskas A.\*

**Abstract:** The globalization is affecting the economic development of world. Internet provided a dramatic increase in information and money transaction speed, therefore small markets are also growing rapidly in the international markets. The focus of this paper is on a cluster of companies with logistics intensive activity. This includes mainly logistics services providers, such as transportation companies, warehousemen, third party logistics companies, also distributors, forwarders and retailers, as well. The logistic clusters can be used to provide the competitive advantage for the small markets, however, the main singularities of small market are related to the partial freight distribution problem. Manufacturers tend to buy raw materials in low quantities that may dramatically increase the price per pallet. In the article a methodology proposed by the authors' offers to combine different types of warehouses and transportation methods. A case study was conducted in a small market's food industry that amplifies the possibilities of logistic cluster usage in a food industry. Taking into account the analysed information, it was concluded that warehouses consolidation processes in the logistic clusters can dramatically reduce the cost of food supply chain. Moreover, the implementation of a consolidation warehouse in a logistic cluster can provide environmental and economic benefits, which makes the cluster more attractive. Additionally, the most important factors in food supply chain, such as distribution network of flow from food suppliers to customers combining transportation quantity and ordering size together with controlled temperature conditions by using refrigerated compartments in order to optimize logistic costs, were indicated. As the result, the guidelines to the improvement of warehouses consolidation process in the logistic clusters for the food industry have been developed. In the future partial freight optimization network will be modelled in order to properly evaluate the economical possibilities of logistic cluster usage in the food industry.

**Key words:** supply chain, warehousing, partial freight, logistic cluster

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### Introduction

The technology growth has affected how the firms operate and work within the world economy context. Due to the internet possibilities the globalization of the world has reached new heights. Enterprises which do not understand the effect

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of globalization are losing their competitive advantage. This problem is even more important in the small markets. Therefore, a new approach to the small market competitiveness should be considered. Thus, it is essential to understand why some countries are failing in the market, whereas the others are developing. This can be seen by analysing the manufacturing and logistic performance indexes as well (The World Bank, 2014). These indexes show that small markets tend to perform better in logistics while larger markets are succeeding within manufacturing industry. This can be explained by the experience level of different countries. For example, it would be hard for a small country to compete with Germany, which has decades of experience in the manufacturing area, while the small market is just on the developing stage of the particular manufacturing industry. This also can be applicable to logistics. The main idea of product distribution is not new, however, big data bases, internet, cloud computing drastically changed the level of supply chain management. Therefore, all countries, if comparing them by the experience in supply chain, are rather similar, there is no huge gap between the countries. It depends the markets are innovative or not, however, the competitiveness level is rather similar. However, some countries, e.g. Belgium and Netherlands, have higher logistic performance index than other countries and are positioning themselves as leaders in product distribution. This was a perceptive decision because these countries are based close to the sea waterways, in the middle of West Europe, therefore, they achieve competitive advantage by the geographical position. This is an example how small markets could achieve complete advantage. Therefore, Lithuania has been chosen as a market in which a food industry's cluster case may be analysed. Lithuania is a tactical place to develop food-manufacturing companies (Pekarskiene and Susniene, 2013), because it is in a good geographical position for a distribution centre (Lumiste and Prause, 2011). Despite these facts, many companies cannot compete with the international market and are announcing bankruptcy every year. It was concluded that the largest impact on the total logistic cost has the quantity of the cargo (Baskutis et al., 2015). While transporting a full truck (32 pallets), the pallet price is about 40-48 euros per piece. The transportation of partial cargo may result the price increase per pallet from 80 to 120 euros. This particular research identified that partial freight distribution is a big problem of small markets.

Many manufacturers buy raw material or distribute their products by smaller quantities. Because small markets have a low frequency of freight and small quantities, the lead-time and cost for the distribution can increase dramatically, therefore, it is essential to provide the economy of scale to the small markets as well. On the other hand, the economy of scale concept can also increase the cost per unit; therefore, by combining particular size of cargo small markets have a possibility to compete with large markets in the sector of logistics. This problem has been analysed before by the authors (Navickas et al., 2015). It was offered to use clustering process to combine similar working enterprises and to distribute their products together. This method will provide better competitive advantage

and also will stimulate the formation of industrial and innovation clusters in the future. A proper implementation of the logistic clusters can be done by combining different types of warehouses and different transportation types. A methodology should be proposed, which can help to combine several types of warehouses with different types of transportation.

### **Background and Literature Review**

The implementation of the logistic clustering process can ensure proper competitiveness level; however, it is essential to understand all the problems that may occur and to evaluate the economic efficiency level. Supply chain of the whole system is one of the most crucial areas of evaluation. It is important properly to combine the partial freight with the planning of routing; only then proper competitiveness can be achieved. Day et al. (2015) argue that the supply chain management has a high impact on the financial gain. The research considered supply chain management's coordinated sourcing, collaboration management and performance assessment and offered a methodology to evaluate the strategy for the routing. Huang et al. (2015) analysed the financial aspect of logistic and suggested a model for strategic transport planning involving a network wide intermodal transport system. Food distribution network in Sweden was analysed by Bosona et al. (2013). Authors proposed the performance of a distribution centre by evaluating different scenarios regarding the travelled distance. It was illustrated the importance to combine the whole supply chain together and use different types of transportation for cost efficiency. However, these works did not consider the temperature importance to the food supply chain.

Other aspect of the proper combination is the computability issue of different transportation methods and warehousing. The food industry can use various transportation possibilities. The most common ones in Europe is land transportation, mainly truck. This method is widely used because the food industry requires temperature control and to maintain the products quality level. Another way of the distribution possibilities is commonly used sea transportation. However, this is more used with large quantities and with products that has a higher validity date. A similar transportation method which can be used for larger quantities is train transport. The railway distribution process can be effective in some cases. This paper analyses the situation with a central warehouse. In Europe the rail Baltica will be opened in recent years, therefore, the logistic infrastructure must be adapted to the possibilities coming ahead (Keinanen and Paajanen, 2013). Therefore, the computability issue is a large problem that needs to be considered when conducting a decision support methodology. A research regarding this problem has been made.

Freight transport optimization model that simultaneously incorporates infrastructure, hub-based service network structures and the various design objectives of multiple actors was investigated by Zhang (2013). Proposed model was tested with real-life data and identified that by incorporating multiple types

of policies in freight transport system can achieve better cost efficiency. Properly combined partial freight food distribution technologies are used in the model.

The cost effective technologies are being used worldwide, however, practically none of the models considers the temperature requirements, what is essential for the food industry. Therefore, it is important to use specific technologies for temperature transportation and warehousing. Flexible partitions for temperature zones is one of the technologies, that can help maintain proper competitiveness level. These partitions are used to divide the transportation area in several parts. Another technology example is double decker, where several floors for transportation cargo are used. Folding wall is a new technology that helps a closed box trailer to load cargo even faster. This is specially developed to load from the side. Thermography is used to track the temperature for the whole trip. If necessary, there is a possibility to print out a thermograph for detail visualization for the transportation process. These technologies can help achieve better cost effective network by combining partial cargo, at the same time require a more complex management system.

The next aspect is warehousing. Warehousing is important to implement together with the distribution system. The warehouses types may differ depending on the situation. The main types of warehouses are: central warehouse, consolidation warehouses, a port and a warehouse prepared for the railway. The main problem of warehousing selection is determining the correct location, at the same time considering the combination of warehouses. Consolidation warehouses can be used to gather partial freight and ensure distribution around the region. This may lead to cost effective strategies. Shqair et al. (2014) analysed the effect of warehouse efficiency related on the distance travelled to the warehouse. The research designed a stochastic model for proper site selection. The study identified that having one cross aisle only and using a class-based storage policy it is possible to decrease the travelled distance, thus increasing the economic efficiency. However, this analysis did not takes in to account the partial cargo distribution problem. Warehouses position depends on the general distance between the suppliers, therefore by including the combination of several supplier cargo collections, the optimal location may differ. The other problem, that needs to be taken into consideration while planning partial cargo distribution system, is related to the design and management of the warehouse. The partial cargo may require smaller spaces with more flexible temperature control. On the other hand, small quantity may increase the overall information flow.

Accorsi et al. (2014) suggested a decision support system for the design and management of the warehouse system. Heuristic methods and algorithms were used to analyse critical warehouses issues, such as order picking process, which is responsible for 55 % of the overall costs in a distribution centre. Created decision support system helped to maintain better material handling system and so to increase the economic efficiency. The paper describes the process of cargo

distribution inside the warehouse, but does not take into consideration very small quantities that may be an issue in small markets.

One of the essential aspects of warehousing is computability of different transportation types and optimal warehouse positioning. Almost the same problem, as considered in this paper, was analysed by Huang et al. (2015). Their research presents an integrated model for site selection and space determination for warehouse in a two-stage network. The products are shipped from part suppliers to warehouses, where they are stored for an uncertain time and then delivered to assembly plants. Designed model helps to minimize the total inbound and outbound transportation cost and warehousing operation cost. However, this particular method is not specialized for the food industry that needs a very short warehousing time for products and partial freight distribution.

Since clustering is the grouping of similar objects, it is important to understand the benefits and issues that may arise in the clustering process. The clusters are used to optimize the information flow, provide higher economic efficiency and to share the experience and knowledge between the members of the cluster. Nie and Sun (2015) analysed the industrial world wide cluster development and identified that in today's globalized economy these kinds of clusters are developing rapidly for competitiveness purpose. Magdalena (2011) has taken the clustering process and identified a new concept that is called clustering the clusters. The authors identified collaboration in the Europe with focus on the Visegrad Group of countries.

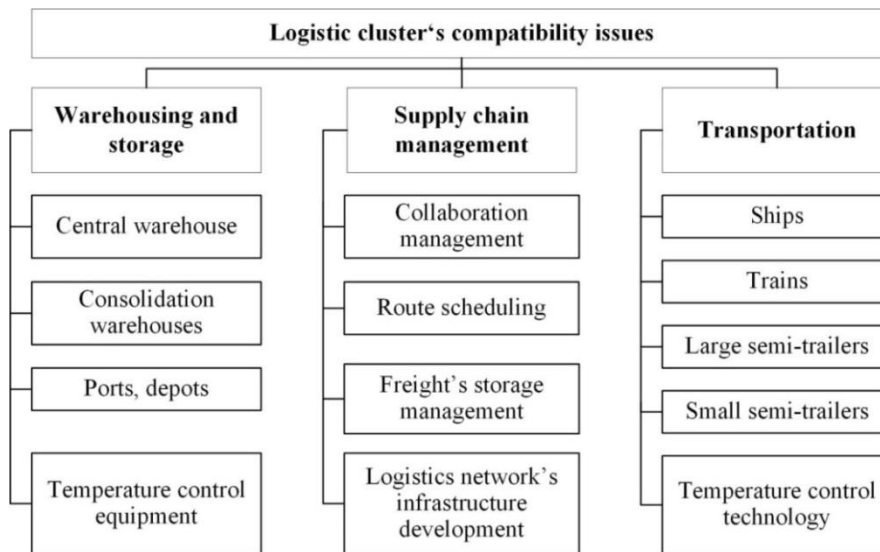
The specialized markets linked with the logistics clusters. First and foremost logistics clusters are clusters of service industry. Logistics clusters create a large number of jobs. They require sincere participation of all parties in the supply chain, including manufacturers, distributors, suppliers and end users. Logistics clusters motivate the development of new logistics services, such as network design, planning, consulting and information technology services. In order properly implement the logistic cluster, a methodology for selecting the warehouse quantity and location needs have been analysed. For this purpose a small market's food industry's case is considered.

Figure 1 summarizes our analysis and provides the possible configuration of logistic cluster's compatibility issues for the small market's food industry.

### **Food Industry's Logistic Cluster Case**

As an example of a small market, Lithuania has been chosen, because it is positioned in a logistic collider, has high educated employees and relatively low cost labour force. The logistic infrastructure in Lithuania is well developed. Klaipeda has a port and there are several highways that connect the country with the other Baltic States, Scandinavia and East Europe.

Due to rail Baltica there is also a plan to connect Baltic region with Western Europe, therefore the logistic infrastructure will be expanded and possibilities to combine different types of transportation will be possible.



**Figure 1. Logistic cluster's compatibility issues for the food industry market**

The case study of chosen country is done theoretically and a logistic cluster concept is discussed and adapted to a food industry. A food industry has been chosen for several reasons. The first one is because the food industry has the most complex supply chain. It has short lead-time and temperature dependent cargo transportation. In addition, there is a trend to demand high quality and fresh food. Because of the growing population, globalization and customer demand for high quality and variety, the distribution possibilities are essential for the competitive advantage. Some products of the food industry are from the fast moving consumer goods market and this market is one of the most competitive. Specialist interview was conducted in the food industry's supply chain and various loading, unloading addresses were gathered from the Lithuania's food manufacturers. These addresses mainly consisted of raw materials import from Western Europe. All the products are different, requiring frozen temperature (-18 C°), chilled temperature (+6 C°) or none-temperature, also the products have different expiration dates. The food industry's model can be used for other industries as well.

Figure 2 illustrates the advantages of using the consolidation warehouses.

The main point is that warehouses may distribute cargo to suppliers, manufactures and distributors. This concept may seem just as third-party logistics provider (3PL) business model, however, it is different from the managerial perspective. A 3PL company's goal is to obtain profit; therefore, all the transportation costs would have a margin that would approximately increase the total logistic costs by 15%.

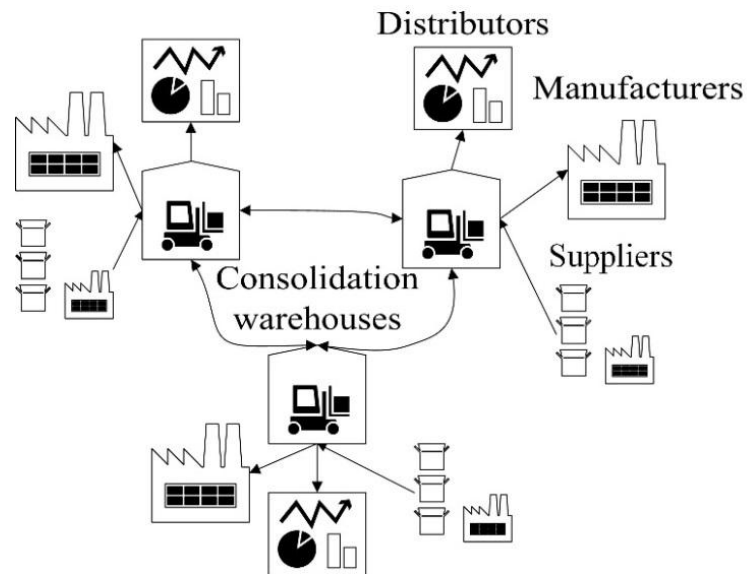


Figure 2. Visualization of logistic cluster possibilities

Due to the cluster all concerned companies can collaborate, share costs, cargo and responsibility. The cluster will help to avoid partial freight distribution problems and distribute only full trucks, moreover, the margin that was taken by the 3PL provider, can be used to manage the cluster. A complex logistic cluster can be formed and controlled by a special artificial intelligence algorithm, GPS models and radio-frequency identification tags. The suppliers of raw materials are spread across the Europe – United Kingdom (UK), Germany, Belgium, and Netherlands mainly. By using the gathered expert's information about their supply chain preliminary warehouses locations were chosen (Figure 3).

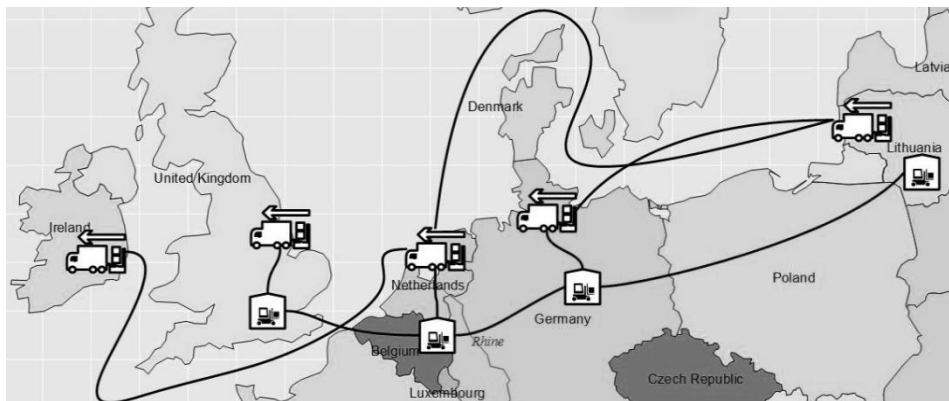


Figure 3. East-West Europe supply chain route

An important factor in the development of logistics clusters is the natural environment, largely geographical location. During a logistic cluster implementation various possibilities of warehouses needs were analysed. In this case, it is possible to use a central warehouse (for railway and distribution purpose), consolidation warehouse (for gathering cargo) and a port (for sea transportation). Some types of food products may use sea transportation, e.g., spices, sauces, pasta etc. These types of products may require temperature only during specific weather conditions, like winter (-20 C<sup>o</sup>) or hot summers (+30 C<sup>o</sup>). The ports are positioned in Ireland, UK, Netherlands, Germany and Lithuania. A central warehouse is positioned in the centre of Germany and Lithuania. Germany's warehouse is close to the rail Baltic and may be used to transport high quantities of products. Temperature required products might also be transported by this type of transportation. The main problem is that only large quantities of products may be transported by a railway. However, this is the reason why logistic clusters are offered to implement. The last type of warehouses is consolidation warehouses, which are located in UK, Belgium and Lithuania. These warehouses are used to gather and distribute partial freight. In Germany, Belgium and UK the cargo are gathered around the region, then loaded to full trucks and delivered to Lithuania consolidation warehouse, where the cargo is distributed around the region. Moreover, because Lithuania is in a logistic collider, the cargo may go through transit and then may be send to other regions. By using this case, it is possible to conclude, that different warehouses and transportation type's combination can provide proper competitive advantage. This type of logistic cluster may be implemented not only in the food industry. The main issue is to choose proper warehouse locations. Therefore, a warehouses localization model is still under investigation.

### **Conclusions and Future Research**

The authors conducted methodology offers a way to efficiency use different types of warehouses inside the logistic network. The method also considers the transportation possibilities with land, train and sea. Air transportation is not used regularly in the food industry. This conducted methodology can be used in other industries as well. The combination of several types of warehouses and their usage as a consolidation warehouse, where partial freight is distributed across the region may lead to competitive advantage in various industries – especially in the fast moving consumer goods industry. The research indicated that clusters in food distribution network together with different warehouses and transportation type's combination with controlled temperature conditions can substantially reduce total logistic costs. The analysis of data received from the companies of food industry showed that due to above mentioned factors the transportation price per pallet can decrease up to 4 times. The development of logistic clusters with effective distribution network is good for industry promotion whereas logistic clusters create a large number of jobs.



The optimal warehouse quantity and location by using computational models and numerical experiments is under investigation. This approach should be supported by implementing partial freight collection possibilities. The open issue is that logistics clusters are complex systems, so advanced heuristic, clustering and artificial intelligence methods needs to be implemented in to the model. The model will be promoted to further point out relevant quality perspectives and its contribution for consolidation warehouses to logistic clusters. Further investigations will be concentrated on data collection in order to identify the validity of the model and the directions of logistics clusters evolution.

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### KONSOLIDACJA MAGAZYNÓW W KLASTRACH LOGISTYCZNYCH: PRZYPADK PRZEMYSŁU SPOŻYWCZEGO

**Streszczenie:** Tematem niniejszego artykułu jest klastr firm aktywnych logistycznie. Dotyczy to przede wszystkim dostawców usług logistycznych, takich jak firmy transportowe, magazynierów, innych logistycznych firm, jak również dystrybutorów, spedytorów i detalistów. Klastry logistyczne mogą być wykorzystywane w celu zapewnienia przewagi konkurencyjnej małych rynków. Przedstawiona w artykule metodologia zaproponowana przez autorów oferuje połączenie różnych rodzajów magazynów i metod transportu. Studium przypadku przeprowadzone zostało w obszarze małego rynku przemysłu spożywczego wzmacniającego możliwości wykorzystania klastra logistycznego w przemyśle spożywczym. Analiza przypadku wykazała, że procesy konsolidacyjne w magazynach klastrów logistycznych mogą bardzo znacznie obniżyć koszty łańcucha dostaw żywności. Ponadto realizacja magazynu konsolidacyjnego w klastrze logistycznym może przynieść korzyści gospodarcze i środowiskowe, co czyni klastr bardziej atrakcyjnym. Dodatkowo wskazane zostały najważniejsze czynniki w łańcuchu dostaw żywności, takie jak sieci dystrybucji przepływu od dostawców żywności do klientów łączące wielkość transportu oraz zamówień z kontrolowanymi warunkami termicznymi przy wykorzystaniu komór chłodniczych w celu optymalizacji kosztów logistycznych. W rezultacie opracowane zostały, wytyczne do poprawy procesu konsolidacji magazynów w klastrach logistycznych dla przemysłu spożywczego.

**Słowa kluczowe:** łańcuch dostaw, magazynowanie, częściowy fracht, klastr logistyczny

#### 物流集群中的倉庫合併：食品工業案例

**摘要：**全球化正在影響世界的經濟發展。互聯網提供了信息和貨幣交易速度的急劇增加，因此小型市場在國際市場上也快速增長。本文的重點是一組具有物流密集型活動的公司。這主要包括物流服務提供商，如運輸公司，倉庫，第三方物流公司，分銷商，代理商和零售商。物流集群可以用於為小市場提供競爭優勢，然而，小市場的主要奇異性與部分貨運分配問題相關。製造商傾向於以低數量購買原材料，這可能顯著增加每個托盤的價格。在文章中，作者提出的方法提出結合不同類型的倉庫和運輸方法。在小市場的食品工業中進行了一個案例研究，這放大了食品行業中物流集群使用的可能性。考慮到分析的信息，得出結論，物流集群中的倉庫整合過程可以大大降低食品供應鏈的成本。此外，在物流集群中實施合併倉庫可以提供環境和經濟利益，這使得集群更具吸引力。此外，食品供應鏈中最重要因素，如從食品供應商到客戶的流量分配網絡，結合運輸數量和訂購尺寸以及通過使用冷藏室控制溫度條件，以優化物流成本。結果，制定了在食品工業物流集群中改進倉庫整合過程的指南。在未來，將對部分貨運優化網絡進行建模，以便正確評估食品行業中物流集群使用的經濟可能性。

**關鍵詞：**供應鏈，倉儲，部分貨運，物流集群