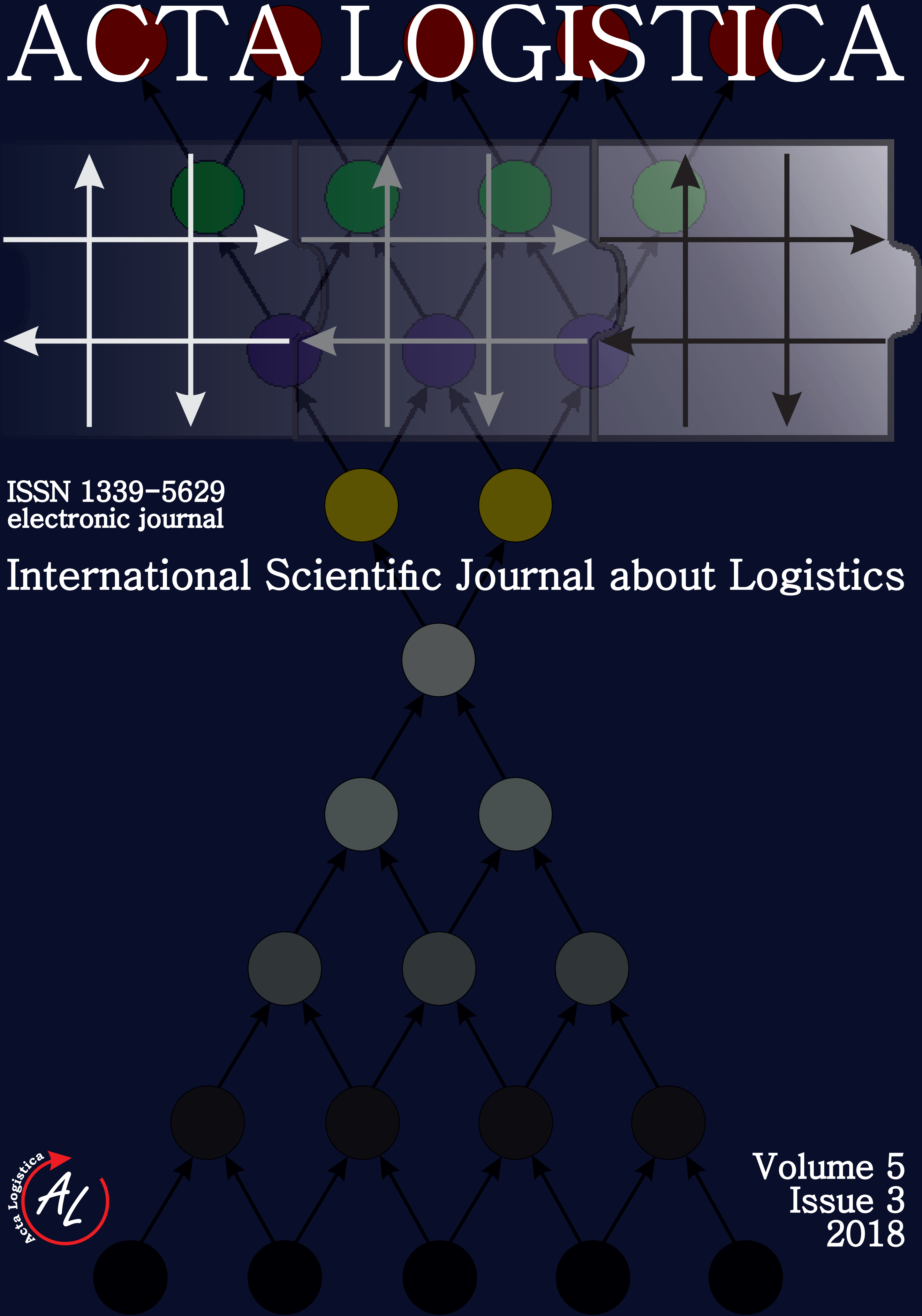
ACTA LOGISTICA



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INCREASE OF EFFICIENCY OF LOGISTICS FLOWS IN SHARING ECONOMY CONDITIONS OF A SPECIFIC COMPANY

Peter Mesarč
Taxify Czech Republic, Vyskočilova 5a, 140 00 Praha 4, Praha, Czech Republic, peter.mesarc@taxify.eu

Keywords: logistics flow, sharing economy, efficiency, logistics

Abstract: The thesis deals with the description of the connection of sharing economy and the logistics flows in business company. At the same time it aims to examine adjustments of logistics flows in practice, in order for them to meet the conditions of sharing economy and increase efficiency. The goal of the thesis is to create a draft of a system of logistics flows, which would increase efficiency of the company and would be more favourable for the company than the current system of product sales. The thesis is divided into three parts. The first part includes list of the most used key concepts and theoretical foundations and paradigms of logistics in connection to sharing economy. The second part makes use of the systematic analysis in order to analyse the three main logistics flows in detail, especially how they influence the current model of product sales to the end-use customers; and lists advantages and disadvantages of the current system. The third part focuses on the possible drafts and adjustments of logistics flows. Gradually, efficiency of flow of material, flow of information and flow of finance is increased. Simultaneously, the proposals for platform for sharing and a micrologistic shared model are drafted.

1 Introduction

In these days it is very hard to think about company, which does not have correct visualisation of logistics flows in logistics schemes of processes. Truly, the logistics is the main key to success, because it can divide all the flows separately and can improve each other. Trends like informatization, application of new selling processes and others are pushing companies to do innovations in their selling channels. One of these trends is sharing economy. So, it is necessary for increasing efficiency, make visualisation of all logistics flows in condition of sharing economy. Conflicts from side of government to providers of sharing economy are pushing transformation of sharing economy into the big corporate companies. Because big companies can guarantee legal form of sharing business. Slovak market are copying the trends from the western market (USA, Great Britain). That is one of the reasons why we can wonder, that one day sharing economy will have a place to work in Slovakia. For sure, this will not be possible without connecting it with logistics and detailed description of its principles, rules and flows.

2 Theoretical analysis of the topic

Sharing economy is the phenomenon that has begun to influence the direction of the whole economy and logistics operations a few years ago. "Top economists have prognosis that sharing will cover more than 50% of market and will have a big influence to the business models [1]." It is necessary to consider if the adaptation to the models of sharing economy is possible, and if it is at the strategic level of the plan also profitable.

2.1 Logistics flows and the sharing economy

In next subheads we will deal with theoretical ideal states of the connection between sharing economy and logistics.

The ideal model of the shared economy presupposes a high level of informatization, the main engine will be the information flow. Most activities take place in the digital environment in minimum time intervals. In the information flow (Figure 1), the main subjects are the producer and the customer. The sales platform works as an online marketplace where it is possible to meet and trade between these two subjects.

However, the question is why producer does not sell products directly to people? The answer to this question may be, given the problem, that the producer does not have a customer database and therefore has no one to offer. While a corporate corporation (a particular firm) has it and can offer many other benefits to this database.

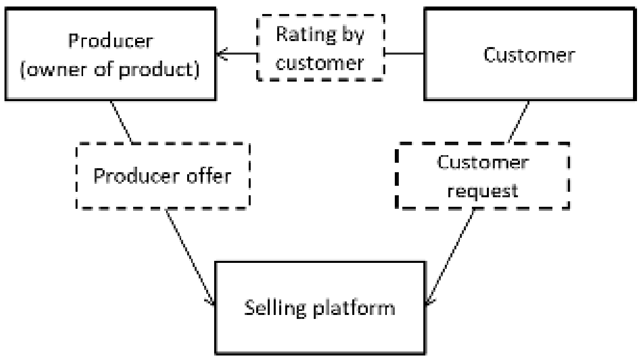

Figure 1 Informational flow and sharing economy [2]

For our thesis, however, the flow of materials is simply a distribution, because it is a business company, not a production company. Even though the flow of material (Figure 2) in the shared economy is illustrated by a relatively simple scheme, it is a complex distribution problem. It is necessary to take into account how the product will be distributed to the customer and how the issue of warehouse management will be addressed. There are a number of types of distribution strategy and their mutual combinations that could be chosen for the given problem.

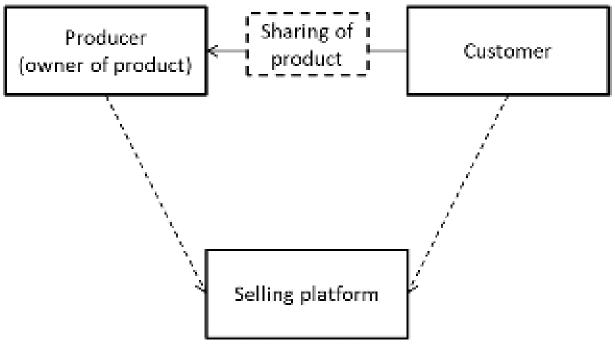

Figure 2 Material flow and sharing economy [2]

The financial calculation of the models of the shared economy is illustrated by a simple scheme (Figure 3). The schema is applied to our specific problem. It is to be imagined that there is a production company on the side of the company that generates a kind of non-commodity product in our case. It is business, so both sides should have their profits from taking a part in model. Customer sends a payment in a digital form that consists of the following components:

• The price of the product determined by the producer (owner) - calculated for the given period, while in the shared economy the principle of micropayments where charges are charged for different variables in different time periods.

• Cost of assembly, claim, bureaucratic load - in an ideal model, the product is sold as a service.

• Fee for connection.

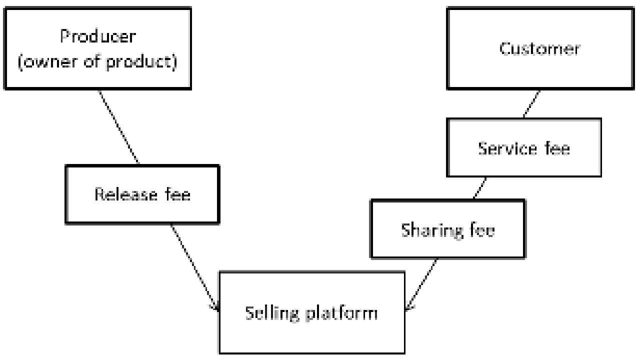

Figure 3 Finance flow and sharing economy [2]

3 Analysis of current state

The type of analysis we have chosen is a system analysis, it is necessary to define the system, the system elements, and the links between the elements of the system [3]. For the purposes of our work, the determination of subjects for system analysis is as follows:

• The system and its subsystems - a product portfolio at different levels

By using system access and one of the main principle, abstraction, we can show the system in the product portfolio. It is a scheme where at first glance are only products divided by categories and types. Simplified say products are offered in certain packages that follow from the point of view of customer satisfaction. At the same time, we can clearly illustrate how the system is winding and where it is influenced by logistical flows.

- Elements - individual products located on the last level of the system.
- Links - logistics flows.
  - Flow of material - physical flow of products from manufacturer, warehouse and storage to one of the sales channels to the customer.
  - Information flow - invoices, information about ownership, product information, it is also possible to include the assistance services that each product includes.
  - Financial flow - commercial and financial models and their application to the market.
  - Flow of humans - the movement of people influencing the overall functioning of the system.

For making an analysis we chose most rented product, which is LED light bulbs.

3.1 *Analysis of material flow*

In case of material flow, there is nothing to change for LED light bulbs. It is without any process without additional value for distribution. It goes directly from warehouses of producers to one of the selling channels and then directly to the customers hands.

So we made analysis of material flow for other products, what we want to share in future. Distribution typology is star, and it is the worst scenario for distribution. You can see it at the Figure 4. And total distance is 1138 km to go.

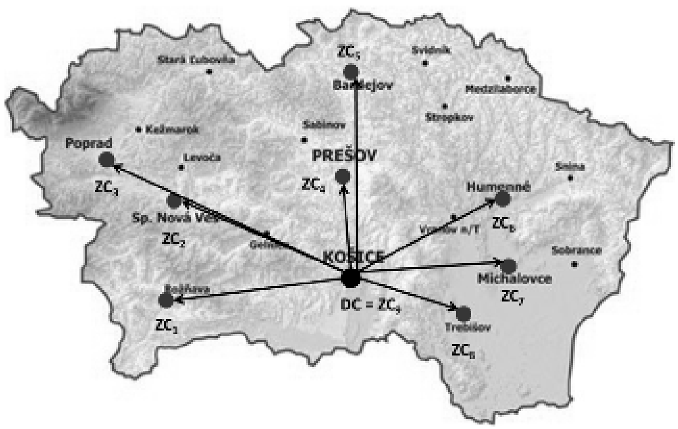

Figure 4 Distribution network - current state

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3.2 *Analysis of material flow*

The most important part of informational flow is ownership. Just ownership of a product defines the differences between the shared economy and other types of business, like renting and others. In the figure (Figure 5), red is a part of the ownership of the manufacturer, the blue part of the property being owned by the company, and green is the possibility of purchasing the product directly by the customer after the specified time. It follows that in the current state, even if the product is at the customer, its owner is still a firm.

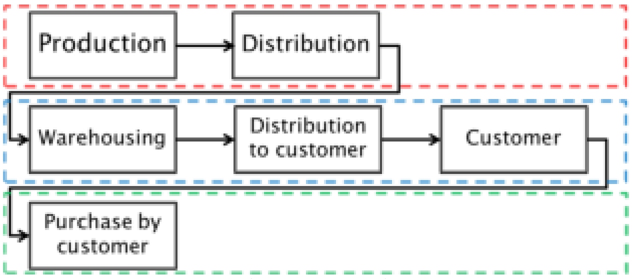

Figure 5 Distribution network - current state

3.3 *Analysis of financial flow*

Financial flow has a characteristic as an operational leasing. It is because of after time of renting is done, customer have an option to purchase a product. Also customer has to pay every month payment for having product at house (Figure 6).

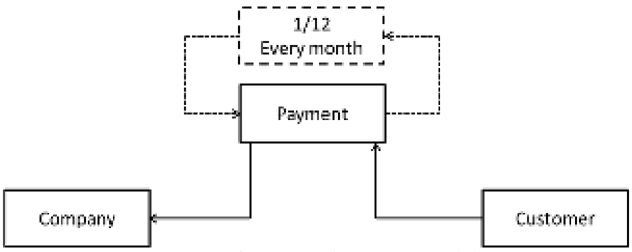

Figure 6 Current business model

Let's talk numbers, if 10% of all customers take product for 12 months it is business turnover 600 000€ and if customer goes for renting light bulb for one year it is business turnover 6€ per year.

3.4 *Summary of analytical part*

Analysis of logistics flows shows deficiencies that may be limiting points for the entire system. Specifically, they were:

- Material flow - star distribution network for other products is least advantageous in terms of time and mileage.
- Information flow - in the environment of the shared economy, the company cannot be the owner of the products that offers them to the customer.
- Financial flow - lease payments have the character of an operating lease, the purchase of the product supports the character of the leasing, and there is no use of product circulation and shortening of the time.
- Unfunded platform that would allow product sharing.

Analysis of logistics flows shows also positive things that are a good prerequisite for applying the principles of a shared economy, namely:

- Material flow - resolved distribution to the product representative.
- Information flow - detailed process-structured activity structure.
- Financial flow - created habit of customers not to own but to sell products.

4 Design part of solution

According to summary of analytical part we should try to design solutions that can increase efficiency of logistics flows. So we made it "per partes" for each logistics flows.

4.1 *Design of material flow*

We allocate new stock via software Allocation v. 2.0 (Figure 8). It is type of consignment stock. Geographically, we see that map is divided in two groups. One is on the north with the centre in Prešov and one is on the south with the centre in Košice. Also software confirm what we see on the map and design new stock in Prešov. Total distance with two stocks and two distributional groups is 634 km to go.

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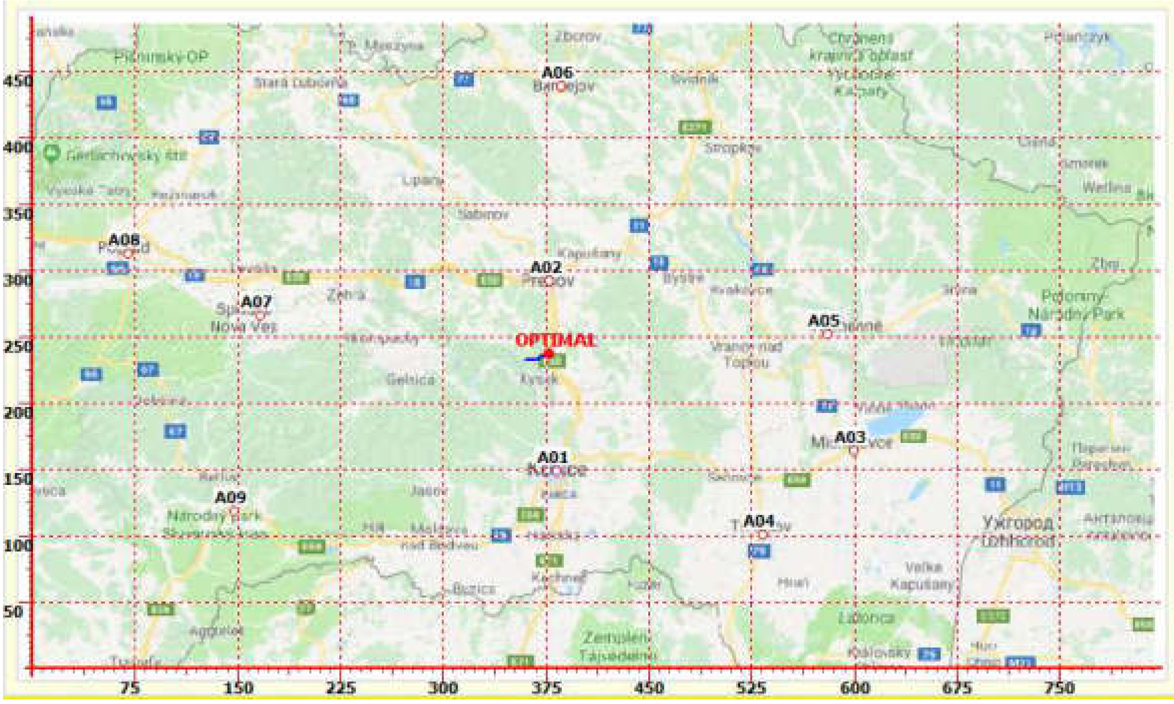

Figure 7 Allocation of new stock

4.2 Design of information flow

In design of a new informational flow, we had to edit the product ownership. In the new information flow (Figure 8), the owner is almost the producer all the time. You can see this as shown in the picture, where the red colour is the ownership of the producer, blue as ownership of the company, and green as the ownership of the customer. In part of warehousing, we want to make consignment stock, so ownership will be one half by producer and one half by company. Part of the purchasing by customer is more like a making relationship with customer.

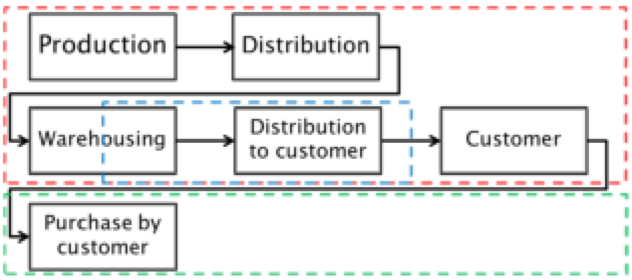

Figure 8 Design of information flow

4.3 Design of financial flow

Sharing economy has two very dominant signs, namely it is (Figure 9):

- Circulation of goods - It is typical to spin products in one cycle, where the products already used can be used again. For product circulation, it is necessary to create an input entity for products that would be used as test products. This step also removes the initial uncertainty of the customer, who may not be convinced of the quality and reliability of the product. Total circulation would be guaranteed by sharing the product for entry testing to customers at a certain price. Such a product would never get into sharing full-fledged products and could produce a profit much higher than full and new products. Schematically, the circulation could be shown as follows [4].
- Shortening time of usage - This includes shortening the time of use of the product, introduction of payment for short periods of time. In the case of long-term sharing, the customer's habit of circumventing the platform arises. For this reason, a short-term share price list should be drawn up when the current price list is rented (sharing). This means shortening the sharing time to the smallest but still acceptable times for the customer [4].

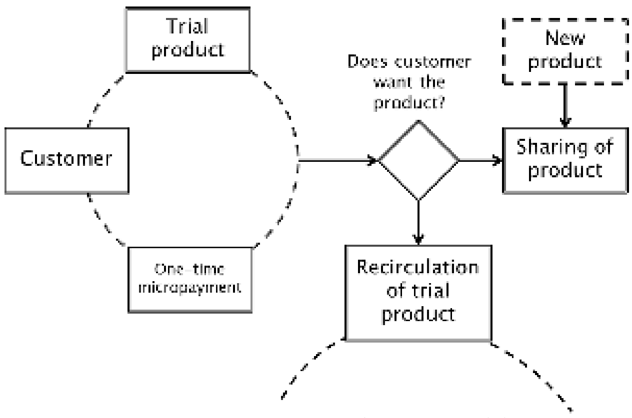

Figure 9 Design of new business model

Let's talk numbers again. If one bulb will be tested for each month, so it means for full year, it should make a business turnover 8.4 € per one bulb. And if we make a calculation very similar like it was in analytical part, additional business turnover for testing a bulb by 10% of customers is 35 000 €.

5 Conclusions

In the material flow we were able to design two distribution groups in the region of Eastern Slovakia with the help of calculations. In the case of the creation of these two distribution groups, the total distance travelled in the Prešov group is 367 km. In the Košice group, this is a typology circle of 267 km. Total savings when using circle-shaped distribution groups is 504 km.

Specifically, we've made a particular company relieve ownership of the product, which reduces the cost of buying and owning products. The company will become an intermediary for energy products without owning just one of the products. In addition to changes in ownership, there was also the need to modify the flow of information using a platform that was not yet created.

In the finance flow, we have been able to increase the turnover of the product's full product load from € 6 to € 8.4 per year, resulting in a 40% increase in turnover per bulb. At the same time, the team created space for creating an additional new turnover of € 35,000 per year.

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EUROPEAN RAILWAY INFRASTRUCTURE: A REVIEW

Lucia Knapcikova
Technical University of Košice, Faculty of Manufacturing Technologies with a seat in Prešov, Department of Industrial Engineering and Informatics, Bayerova 1, 08001 Prešov, Slovak Republic,
lucia.knapcikova@tuke.sk (corresponding author)
Rob Konings
Delft University of Technology, Faculty of Architecture and The Built Environment,
Department OTB - Research for the Built Environment, Julianalaan 134, 2628 BL Delft, The Netherlands,
J.W.Konings@tudelft.nl

Keywords: railway, freight, logistics junction, European Union
Abstract: Presented paper deals with important freight railway infrastructure review in the Europe. The shrinking situation on the road makes companies do to think more and more about alternative ways of transporting goods from remote industrial zones quickly, safely and taking into account an ever more important environmental aspect. The quantity of goods transported in freight transport is increasing every year, which is also reflected in the unfavourable increase in road transport. Road journeys are often used, roads are more prone to wear, and their repair requires significant financial costs each year. Important part of presented paper is focused on the traffic situation that the future of transport will be on the rail. Moving transport from road to rail is also the intention of the European Union, which is declared in the "White Paper on Transport". In addition to other targets, it states that by year 2030 the 30% of road freight over the 300 km should be transferred to other modes of transport such as rail or waterborne transport, and by year 2050 this should represent more than 50% of freight transportation.

1 Introduction

The railway infrastructure in the Europe say about 216,000 km network of active railways in the European Union (EU). The total cost of international train transportation is different in whole Europe [1,2]. It depends on access charges, competition rates, travel time, and economies of scale. Specifically, the significant fixed additional costs associated with the first and last mile (e.g. loading/unloading in terminals) are more evenly distributed at medium and long distances. As a result, the total cost of a tonne-kilometer for rail freight at these distances may be lower than for the carriage of the same goods by road [2]. Promoting more efficient and sustainable modes of transport, and in particular rail freight transport, has been a key part of EU policy over the last 25 years. As early as year 1992, the European Commission (EC) set a shift in the balance between transport modes as one of its main objectives. The European Commission confirmed the importance of refreshing railways infrastructure and formed the objective of maintaining the market share of rail freight in the Member States of Central and Eastern Europe. On the other side, the Commission sets the target of moving up to 30% of the freight travelled by distances exceeding 300 km for other modes of transport, such as rail or water, by 2030 and more than 50% by year 2050 [3].

During the year 2013, the EU revised the previous guidelines on the TEN-T (Trans European Network for Transport, see on the Figure 1) project in order to define a core network of transport infrastructure that incorporates all means of transport, but pays special attention to railways.

In the Regulation No. 913/2010 are defined (among other) three most important rail freight corridors (RFC) through Belgium:

1. *RFC Rhine-Alpine*
   • With direction via Zeebrugge-Antwerp /Amsterdam/ Rotterdam –Duisburg-Basel-Milan-Genoa
2. *RFC North Sea-Mediterranean*
   • With direction via London /Dunkirk/Lille/Liège/Pari s/Amsterdam-Rotterdam-Zeebrugge/Antwerp-Luxembourg-Metz-Dijon-Lyon/Basel-Marseille
3. *RFC North Sea-Baltic*
   • With direction via Wilhelmshaven/Bremerhaven/Ha mburgúAmsterdam/Rotterdam/Antwerp/ Aachen/Berlin – Warsaw-Terespol/Kaunas/Falkenberg-Prague/Wrocław-Katowice [2].

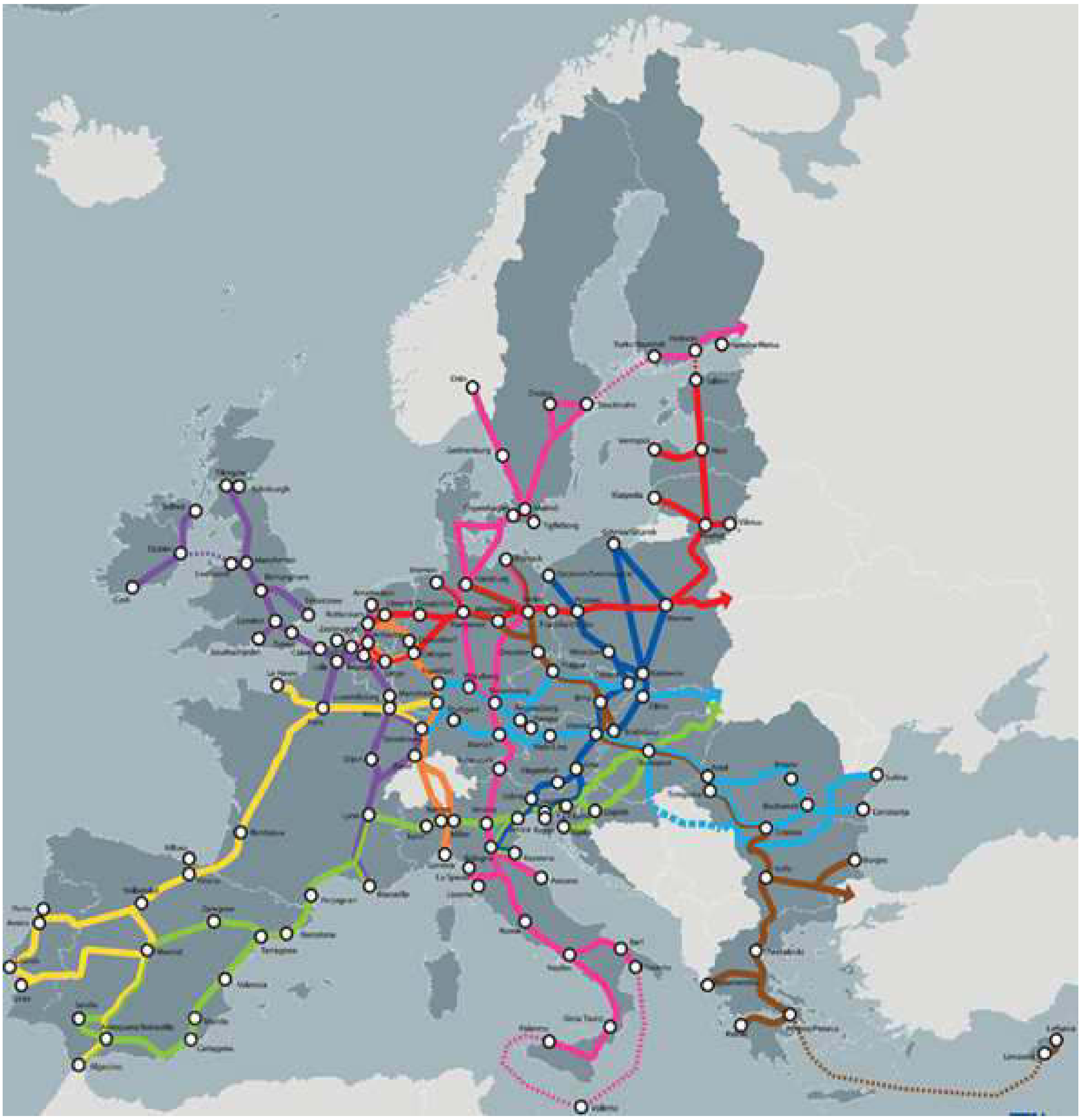

Figure 1 Trans-European transport network [2]

Legend to the Figure 1:
Dark blue line- Corridor "Baltic-Adriatic",
Red line- Corridor "North Sea- Baltic",
Green line- Corridor "Mediterranean",
Brown line- Corridor "Orient-East- Med",
Pink line- Corridor "Scandinavian- Mediterranean",
Orange line- Corridor "Rhine-Alpine",
Yellow line- Corridor"Atlantic",
Violet line- Corridor "North Sea- Mediterranean",
Sky blue line- Corridor "Rhine-Danube".

The formation of new industrial areas in China and Russia offers new and interesting challenges for logistics companies. An effective solution to cover the long distances that goods have to overcome to the destination station, the transport of sensitive, special or oversized goods, is an ideal transportation by rail. By the year 2015, the number of China-European international trains has risen by more than 100% annually. In the past year alone, 2000 trains across the Polish-Belarusian border and transhipment terminals were transported in China-Europe route in two directions. Undoubtedly, the situation in Ukraine has also been extremely hard on the current state. Generally, the transit time from China to Europe according to the selected mode of transport:

- Air transport 3-7 days,
- Maritime transport 28-38 days,

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- Rail transport 14-22 days.

A part from railway undertakings that hold a licence and a safety certificate, other applicants (shippers, freight forwarders, etc.) can also apply for capacity on the corridors (Fig. 2) [4].

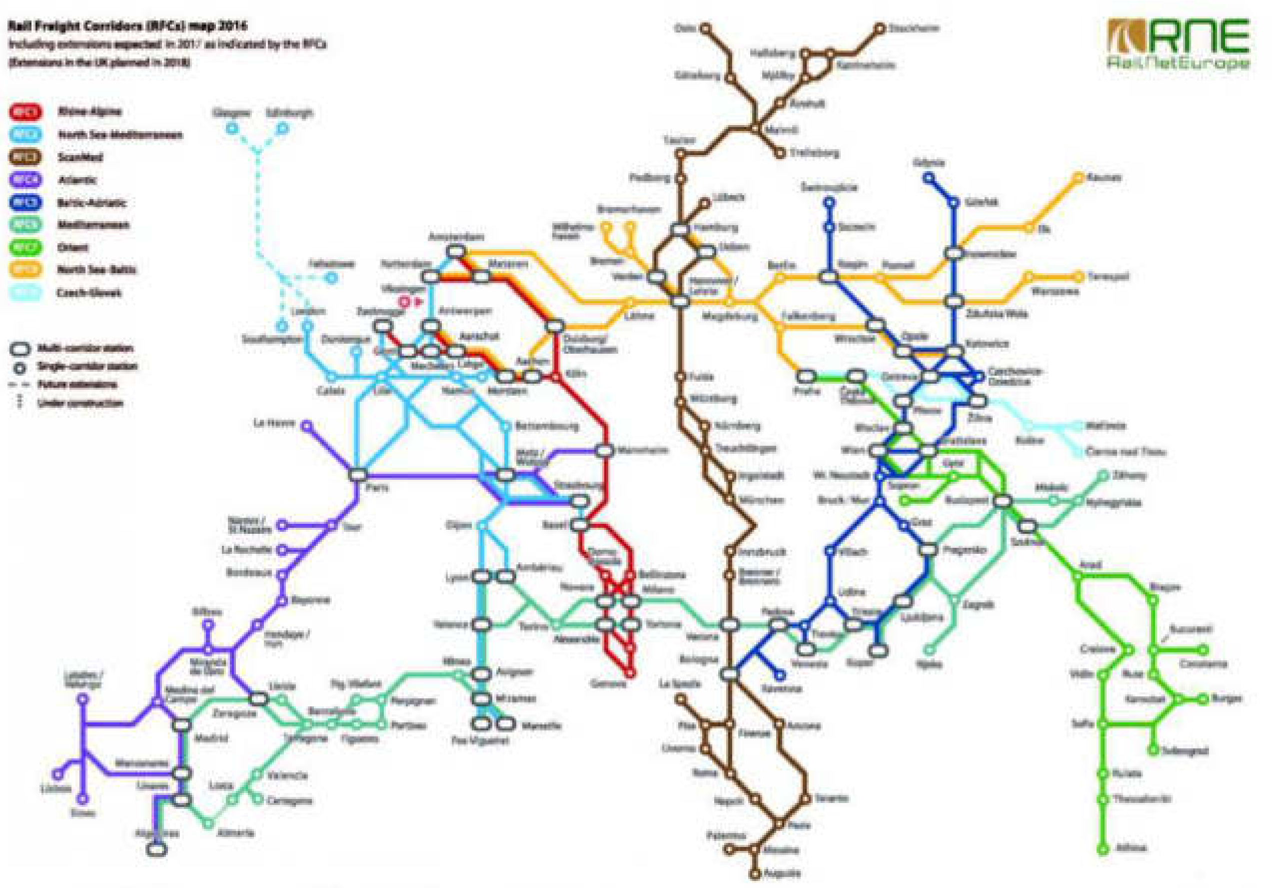

Figure 2 Rail freight corridors map (y. 2016) [3]

Legend to the Figure 2:
RFC- Rail Freight Corridor,
RFC1- Corridor “Rhine-Alpine”,
RFC2- Corridor “North Sea- Mediterranean”,
RFC3- Corridor “Scandinavian- Mediterranean”,
RFC4- Corridor “Atlantic”,
RFC5-Corridor “Baltic-Adriatic”,
RFC6-Corridor “Mediterranean”,
RFC7-Corridor “Orient”,
RFC8-Corridor “North Sea- Baltic”,
RFC9- Corridor “Czech-Slovak”.

To strengthen the competitiveness of rail freight transport should the rail network to meet the needs of the freight sector. It is generally accepted, in particular:

- to allow easy crossing of borders because of rail freight is more competitive at medium and long distances (what in Europe generally means the transport of goods between different EU Member States)
- to provide good connections to-from different freight producers and support the development of multi-modal logistical platforms,
- to provide infrastructure and facilities for cargo transportation,
- to support rail-road transport if needed or combined transport),
- to allow longer trains to reduce unit costs per tonne of transported goods [2].

2 Freight railway infrastructure in European Union

On a global scale, the distribution of railways is uneven, for several reasons. The first is that, from a technical point of view, the railways must be fairly flat terrain and mostly at the level of the surrounding terrain. Secondly, railways are being built in places with higher density of occupation and increased levels of economic activity so they are economically feasible. The competition of other types of transport also affects distribution of railway networks. In places where there is a well-developed road or air transport, it is difficult to keep rail transport in a dominant position.

The poor performance of rail transport in terms of volume and share of modes of transport in the EU does not help the average service speed of freight trains [2,5]. In a nutshell, expensive trains travel slowly, and their speed has not increased significantly in the last decade. Every day, thousands of goods are shipped across the EU to factories, warehouses and customers. Rail transport is in direct competition with road haulage, like freight transports. In other words, transporters choose transport modes based on commercial criteria rather than on the political priorities of the EU [6].

According to International Railways Association, the total length of railways was at the end of 2015, 1 039 230 kilometres. The area of North and South America was the largest with the 37%, the second largest of the total length of railways in the world was Europe with the 26%.

In the European Union, the regulation requests the member state to establish international market-oriented Rail Freight Corridors (RFC) to meet next challenges [7]:

- cooperation between infrastructure managers and infrastructure development,
- building the right balance between freight and passenger railway traffic along the Rail Freight Corridors (RFC),
- giving adequate capacity and priority for freight in hand in hand with market needs,
- intermodality between rail and other transport modes,
- integrating terminals into the corridor management and development [7].

2.1 Infrastructure efficiency of freight railway funding by European Commission

Transport requirements constantly require optimization of transport links, efficient use of means of transport, transport routes and smoothness and transport safety. The issue of traffic accidents, whether on road or road rail transport is a socio-economic problem in all spheres of human activity. Today's, the high-quality services of railway undertakings and carriers in general and for the competitiveness of rail freight, say that the infrastructure manager must not only renovate and modernize the railway network to meet the specific needs of rail freight but also regularly maintain it [5]. Despite the business plans and indicative rail infrastructure development strategies identified by infrastructure managers, railways more frequently used by freight trains and limited passenger transport are generally closed and speeds are limited. This has an impact on the performance of the rest of the rail network in terms of the volume of goods transported, including those that could potentially benefit from EU funds, since their ability to transport goods from the place of production to the consumer centres is limited. The inadequate priority given by infrastructure managers for the maintenance of railways that use more frequent freight trains is the result of prioritizing passenger transport routes that are politically more sensitive and, in some cases, the low profits generated by rail freight [6,7].

The provision of railway services is multidimensional. In economic terms the railway company is a multi-product firm. It is a very capital intensive business, economies of scale and density can be relevant and some natural monopoly characteristics are present. In most contexts and on most continents, a competitive railway market is not a straightforward concept [8].

2.2 Financial support of freight railway infrastructure by European Commission

The government, the users of the railway network or the users of railway services and the economic regulator, these are three most important parts of railway funding [8]. Funding support provided by the EU's financial assistance is mainly focused on the construction of new railway lines or the renewal and upgrading of existing lines, which usually involves speeding up and redress or adapting to interoperability requirements. Except for line projects used exclusively by passenger trains (in general, high-speed lines) or in rare cases, trains used only by freight trains for investment in railway infrastructure benefit both modes [6,8]. To a lesser extent, investment in rail rolling stock is also supported by the EU budget, several non-infrastructure measures to support the implementation of EU rail policy and research projects focus mainly on the construction of new railway lines or the renewal and upgrading of existing lines, which usually includes increase speed and axle wagon load or adaptation to interoperability railways requirements.

3 Statistical results of freight rail transport across the European states

They serve the industry and consumers every day, and there is an endeavour to provide them with technical and technological innovations, but focusing on this is not enough.

The following Table 1 describes a statistical data processing of the volume of freight rail transport that has been monitored and processed from 2006 to 2015.

Developing implementation studies and strategic approaches in the long run also need to be addressed. As one of the few countries, Finland has set up a comprehensive strategic plan for the transport of hazardous costs for the period up to 2015, which deals not only with the state but also with the challenges and new trends that are useful as a source of inspiration for other countries, including Slovakia. In this country, there is a particular unit.

The institutions are responsible for this hazardous goods transport strategy and also responsible for preparing the necessary legal framework [9]. It focuses on improving and developing supervision and management, education and services.

Table 1 Volume of freight rail transport in the Europe (statistical datas between y.2016-2015)[10]*

GEO/TIME	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
European Union (28 countries)	100.4	100.9	98.8	91.5	94	92.6	90.7	91.6	90.4	90.1
Belgium	98.9	94.1	86.7	78.6	79.5	75.6	75.3	76.3	73.8	72.5
Bulgaria	92	89.7	92.8	110.6	118.4	117.3	132.7	144.1	144.8	159.6
Czech Republic	106.1	97.9	98.1	89.8	99.7	103	98.4	103.9	100.9	101.8
Denmark	88.1	85.8	81	74.1	67.6	72.4	73.1	70.7	70	65.7
Germany (until 1990 former territory of the FRG)	102.9	104	102.5	95.7	96.7	95.1	91.4	91.5	90.7	90.1
Estonia	87.9	75.9	71.9	71.5	75.9	70.2	60.3	58.3	50.7	49
Ireland	91.6	95.7	91.5	64.4	59.2	54.8	54.6	50	48.8	39.2
Greece	134.6	107.6	111.8	114.9	126.9	96.2	104.6	98.3	99.6	102.5
Spain	99.3	102.1	94.9	85.1	84.9	84.7	84.1	82.8	83.4	86.5
France	100.3	101.5	95.5	82.6	83.7	84.7	79	78.2	75.4	70.7
Croatia	105.6	104.8	110	100	98.1	96.2	95.8	98.8	101.2	110
Italy	88.3	84.3	85	81.7	84.2	70.1	63.9	66	62.1	61.5
Cyprus	80	78.8	82.5	61.9	68.9	59.5	58.5	44	37.9	39
Latvia	87.5	90.9	95.6	93.8	100.8	114.5	111.7	103.5	103.7	102.4
Lithuania	101.9	102.4	101.3	100.2	109.2	114.8	113.6	115.8	119.4	112.2
Luxembourg	96	96.4	89.6	86.5	87.1	85.4	77	79.9	83.6	74
Hungary	112.7	126.7	125.2	125.5	124.8	124.2	124.8	129	129.3	127.1
Malta	98.2	94.4	91.4	93.7	90.5	89.3	87	83.2	76.9	71.5
Netherlands	96.3	92.7	91	83.6	91.8	89.6	87.3	89.6	89.1	84.8
Austria	103.9	99.2	93.3	80.8	82.6	80.6	74.9	71.8	73.1	71.7
Poland	105.9	111.5	113.1	113.6	122.7	121.7	124.3	134.9	131.7	131.2
Portugal	103.4	104.1	88.7	83.4	81.2	85.1	80.8	89.8	85.5	77.9
Romania	98.2	94.4	83.8	64.1	59.5	58.8	61.9	63.6	61.7	66.1
Slovenia	102.7	107.5	118.7	114.4	124.4	129	127.1	130.8	131.2	138.9
Slovakia	92.7	98	97.3	92.3	91	91.4	90.4	92.3	93.2	93.4
Finland	94.3	88.6	91.3	87.3	90.8	81.7	79.5	78.2	76.6	76.3
Sweden	98.6	97.8	100.7	90.1	91.6	89.4	83.2	80.7	91.3	86.1
United Kingdom	100	100.1	95	86.9	88.8	92.4	94	87	82.2	88.1
Norway	103.6	101.3	106.8	98.4	103.6	100.5	101.6	105.1	104.9	109.4
Switzerland	100.7	97.2	85.9	79.6	79.2	80.3	76.1	76.6	77.4	75.2
Former Yugoslav Republic of Macedonia	110.2	131.1	118.7	79.7	81.5	72.6	64.4	62.3	:	:

**Source: Database-Eurostat-European Commision*

Today's social, functional logistics chain is a basic requirement for the profitability of growing industrial sectors. Therefore, successful transport is considered to be based on the current market demand, which requires cooperation through the administrative sector. According to Eurostat data, the collection presented on the graph below, is based on the Regulation (EC) 91/2003 of the European Parliament and of the Council of 16 December 2002 on Rail transport statistics. Data displayed in Figure 3 cover the rail transport of goods which relate rail goods transport in the Member States on its national territory.

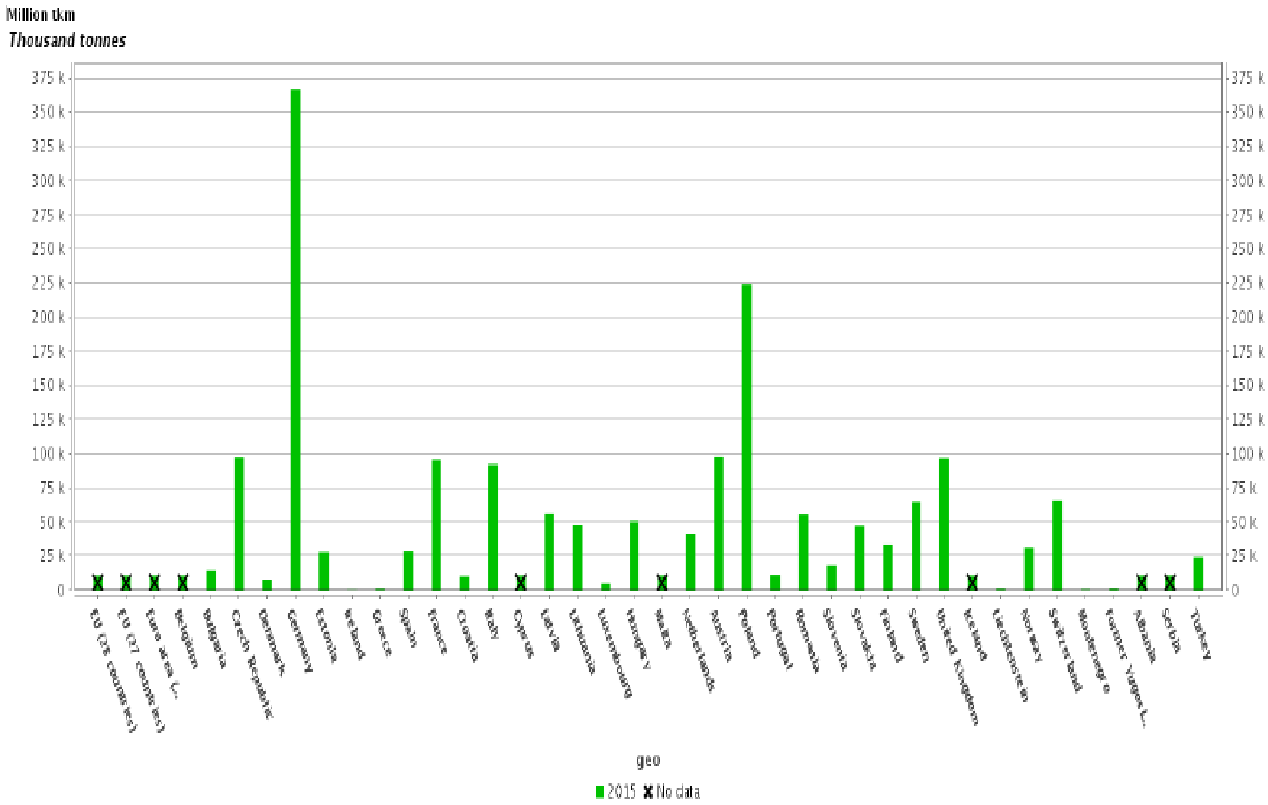

Figure 3 Goods transport by rail in the Europe [10]

Member States may exclude railway undertakings which operate entirely or mainly within industrial and similar installations, including harbours. They are not covered in above mentioned statistics.

Monitoring of freight rail transportation can be accessed from the point of view:

- Safety, which has a first share in all activities related to the transport of dangerous goods.
- Emphasis is placed on prevention, training, education and carefully focused information it is important that the freight transportation is feasible in the business sector.
- In order to ensure transport as profitable and logistically efficient, emphasis is put on the quality and conditions of infrastructure, also on transport safety and on careful management and supervision.

4 Conclusions

In view of a much broader societal perspective there is the relative good environmental performance of freight rail transportation as mitigation of climate change is concerned, although freight rail transportation has lost it favourable performance regarding air quality at the cost of road transport. Today´s global trend is, where legislation has forced the truck industry to significantly reduce emissions.

A large proportion of the freight transportation takes places by rail. This is much safer than by truck, because these types of transport often have to travel through urban areas in order to reach their destination.

According the problematic presented in this paper we can say the most important advantages of freight railway infrastructure:

- independence of roads traffic density,
- possibility of transporting dangerous goods,
- large capacity of the wagon load,
- minimum weather dependency,
- minimum wagon´s and locomotive´s failure

When we want to choose the most suitable mode of transportation we take into account:

- cost of transport
- ability to create networks
- railway safety
- environment protection

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http://www.lessthanwagonload.eu

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FACILITY LOCATION MODEL WITH INVENTORY TRANSPORTATION AND MANAGEMENT COSTS

Shaira-Tatiana Sánchez-Sierra
Universidad Popular Autónoma del Estado de Puebla A.C., 17 Sur 901, Barrio de Santiago, 72410, Puebla, Mexico, shairatatiana.sanchez@upaep.edu.mx
Santiago-Omar Caballero-Morales
Universidad Popular Autónoma del Estado de Puebla A.C., 17 Sur 901, Barrio de Santiago, 72410, Puebla, Mexico, santiagoomar.caballero@upaep.mx (corresponding author)
Diana Sánchez-Partida
Universidad Popular Autónoma del Estado de Puebla A.C., 17 Sur 901, Barrio de Santiago, 72410, Puebla, Mexico, diana.sanchez@upaep.mx
Jose-Luis Martínez-Flores
Universidad Popular Autónoma del Estado de Puebla A.C., 17 Sur 901, Barrio de Santiago, 72410, Puebla, Mexico, joseluis.martinez01@upaep.mx

Keywords: supply chain networks, model, facility location problem, inventory management
Abstract: This work is focused on the integration of the standard EOQ (Economic Order Quantity) model within the facility location decision model. This is proposed to extend on the facility location task which is usually performed based on just the overall demand of the customer locations to be served. If the inventory costs are considered within the demand supply process, these may affect the overall transportation costs as these are not linearly dependent of the demand. As such, the extended model considers, besides the distances, performance and capacity of the vehicles, the order quantities and the period in which they should be fulfilled. This model was tested with a reference instance of 200 suppliers and one distribution centre. The distances were estimated by considering the geographical locations of all elements in the network and the spherical model of the Earth's surface to obtain the metric in kilometres. As analysed, by considering the inventory costs within the facility location model, it can lead to refine the location to obtain long-term savings in transportation.

1 Introduction

Several efforts have been performed to improve supply chain operations, developing practical tools and instruments that have contributed to company competitiveness and also for researchers who seek to provide real and useful results. This has involved the use of mathematical decision models for the optimization of resources. Among these models, some have contributed to the design of distribution networks by integrating the modelling of real factors such as demography data, times, capacities, speeds, and restrictions. The importance of solving problems related to distribution networks lies in the fact that all services and products require them for an efficient delivery to customers and industries. Thus, mechanisms to reduce delivery and production times, improve quality and reduce waste, are frequently sought.

Recently, research has been focused on the integration of location and inventory decisions in a single framework, with the motivation that integration can bring substantial cost savings. Integrated supply chain network design involves several core components among which facility location and inventory management are the main components [1]. The benefit of the integration depends on the relative size of the facility location costs and inventory management costs. Since traditionally facility location decisions are made before the inventory policy is decided, the benefit of integration increases as inventory costs increase [2].

In this work we describe an integrated inventory-facility location model to minimize distance, transportation and inventory management costs. For this, the proposed model considers vehicle-dependent fuel consumption costs and management-dependent inventory costs to adjust the demand of each customer to be gathered by a distribution centre.

The paper is structured as follows: in Section 2 the technical background and research from the literature is presented. Then, the justification of the research is discussed in Section 3. In Sections 4 and 5 the development of the integrated distribution-inventory model and the results on the test instance are presented and discussed. Finally, the conclusions are presented in Section 6.

Nowadays it is very important that a plant or facility, independently of its qualification or size, has a strategic location according to its supplies and customers. In general, its resources must be as close as possible for the purpose of avoiding setbacks that generate high repair costs, so that the raw material arrives on time. In general, the location of a plant is strategic for its success, and the employees must have the appropriate infrastructure and means of transportation.

No less important is the subject of inventories. It is almost as important as the investment decision itself, since it is fundamental for the development of a company. It is a strong economic investment that will remain on hold or with little movement. For this reason, good management and planning of inventories is of vital importance to avoid financial problems in the future. Hence, it is the area where bad planning can impact the most.

This is why in this work we considered the unification of these contexts. If each one separately contributes to the improvement and optimization of resources, a unified model can lead to more significant improvements. Thus, the intention is to verify that the financial impact, the optimization of resources (in this case fuel) and the distance between the distribution centre and the customers, are key factors for the adequate economic management.

The main objective of this work is to find the strategic location of a new plant with the intention of minimizing the distances respect to its suppliers. This can lead to savings in transportation costs by decreasing fuel consumption for each location, properly planning inventory levels and avoiding additional costs by determining the exact amounts in the established times to prevent unnecessary transfers.

2 State of the art

2.1 *Facility location problem*

Alfred Weber, a German economist, developed one of the earliest approaches to determine the location of manufacturing industries [3]. The facility location problem (FLP) was introduced by him in the early 20th century. This model is focused on determining the location of a warehouse in the two-dimensional plane with customers located across the plane [4]. This location must minimize the total distance from the warehouse to n customers located at different points. Weber assumed that the warehouse could be located anywhere in the plane. Hence, this objective function can be formulated as [4]:

$$\boldsymbol{min} \textstyle\sum_{i=1}^{n} \boldsymbol{d}(\boldsymbol{x}, \boldsymbol{x}_i)\boldsymbol{w}_i, \boldsymbol{s.t.x} \in \mathbb{R}^2 \quad (1)$$

Where $x \in \mathbb{R}^2$ is the warehouse or plant location, $x_i \in \mathbb{R}^2$ are the locations of the n customer points (hence, $i = 1, \ldots, n$), and w_i a weight associated to the customer point i (commonly, this weight is used to provide a priority for a given point).

This problem has received much attention in the literature and industry. Researches have been performed to complement this model with more variables. Weber considers a uniform plain where it is always possible to go directly from one point to any other at a given rate. In this two-dimensional space, the market site, the location of "localised" resources, and the spatial distribution of labor are regarded as given [5]. The Theory of Location has adopted a unilateral approach to define the locational optimum. While the "minimum cost" concentrates on the spatial variation of costs by paying little attention to demand as a primary locational force, the approximation of the market area overes-timates demand at the expense of cost variations [6].

Despite the long history of the single-facility location problem, there still appears to be much to say about it as evidenced by several recently published articles on this topic [7]. For example, Jamalian & Salahi [8] considered the multi-facility Weber location problem (MFWP) with uncertain location of demand points and transportation cost parameters. Uno et al. [9] considered the Weber location problem with weights including both uncertainty and vagueness. By representing its weights as fuzzy random variables, it was extended to a fuzzy random weighted Weber problem, and then formulated as a fuzzy random programming problem. On the other hand, Murat et al. [10] developed an efficient exact "shooting" algorithm with capacity acquisition problem and dense demand.

As presented, this is a very interesting and extensive research topic, and many researchers have tried to find the solution for so many associated variables supported by this model. Hence, it is important to note that an "optimal" location for any plant, or house, or city, or company, always is influenced by many factors, and some of them are explored in this work.

2.2 *Economic Order Quantity (EOQ)*

When Ford W. Harris published his short three-page article in the Economic Order Quantity model in 1913, he likely did not foresee that it would still be discussed and used 100 years later [11]. Technically, his model determines manufacturing quantities that minimize inventory-associated costs [12].

The EOQ (Economic Order Quantity) proposes an inventory planning based on policies that will achieve an optimal investment. Many inventory planning models are available and basically all of them try to answer the following two questions [13]:

- How much to order?
- When to order?

The corresponding model of Harris is formulated as:

$$\boldsymbol{Q} = \sqrt{\frac{\boldsymbol{2DCo}}{\boldsymbol{Ch}}} \quad (2)$$

Where Co is the standard ordering cost, D is the total demand per unit of time (through-out a planning horizon), Ch is the holding cost per unit of product, and Q the periodic lot size that minimizes the inventory costs within the planning horizon [14]. The fol-lowing formulation estimates the total inventory costs associated to a lot quantity Q where each unit has a cost C:

$$\boldsymbol{TC} = \left(\frac{\boldsymbol{D}}{\boldsymbol{Q}}\right)\boldsymbol{Co} + \left(\frac{\boldsymbol{Q}}{\boldsymbol{2}}\right)\boldsymbol{Ch} + \boldsymbol{DC} \quad (3)$$

Eq. (2) and Eq. (3) have been extended in different forms to model the diverse contexts of the inventory supply strategies. Rossi et al. [15] proposed an approach that regulates the processing of different items by a shared resource according to a control model based on an ordering policy that combines the EOQ with a policy based on minimum and maximum inventory levels (min–max policy). Another interesting study about the EOQ model is the one reported by Dobson et al. [16] that proposed the inventory management decision model for a retailer selling a single perishable good in a deterministic setting. This model considered into account the consumers' assessment of quality over the lifetime of the products and assumed that the demand rate was a linearly decreasing function of the age of the products.

As presented, this model can have many scenarios and variables, and these will continue to grow as the industrial and inventory policies become more complex.

2.3 *Arch length on the sphere*

In order to find the distance between the plant or distribution centre *(i)* and its customers or suppliers *(j)*, we used the following mathematical formulation:

$$d_{ij} = R\, Arcos(sin\varphi_i sin\varphi_j + cos\varphi_i cos\varphi_j cos(\lambda_i + \lambda_j)) \qquad (4)$$

Where (φ_i, λ_i) and (φ_j, λ_j) are the geographical latitude and longitude in radians of two points on the sphere, and R is the sphere radius (see Figure 1). If distances on the spherical Earth are to be estimated, then R = 6371 km.

The spherical model allowed the estimation of a more suitable distance metric in contrast to the Euclidean distance. This is because the spherical model is more similar to the Earth's true form than the flat form assumed by the Euclidean model. Nevertheless, it is important to mention that the truer form of the Earth's surface is defined as a geoid, which can be better modelled by an ellipsoid.

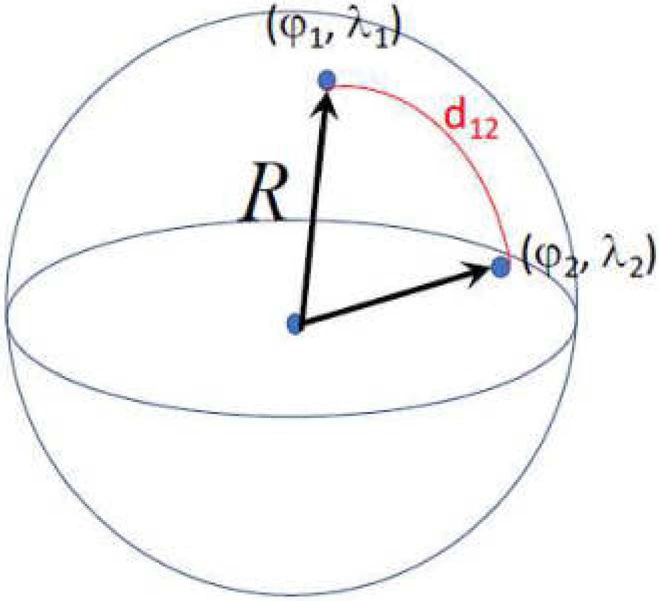

Figure 1 Spherical model of the Earth: Arc length between two points on the surface

2.4 *Non-linear programming*

In mathematics and software engineering, non-linear programming is defined as the process of solving an optimization problem where the objective function to be maximised or minimised, and / or some of its constraints (restrictions) are non-linear. Currently, many software tools are available for optimization of problems with this characteristic (i.e., Microsoft's Solver, and LINDO). Due to the nature of Eq. (4), the proposed facility location model is a non-linear problem.

3 Development of the model and test instance

To begin with, the development of the model, first we begin by knowing its assumptions:

- Location of a single new plant.
- 200 suppliers are considered for the new plant with locations around the Mexican Republic.
- The Facility Location Problem was considered with discrete data (i.e., each data is different and independent from the other).
- Initially, only distance and demand are considered with no other urban and infrastructure factors.
- Based on the previous assumption, the global coordinates of the main locations are determined.

- Each supplier provides a unique product with different characteristics and prices than the other suppliers.
- 6 different types of vehicles are handled for the 200 suppliers, with different fuel efficiency per kilometre.
- Each supplier has one of the six types of vehicles previously considered.
- The weight of the lot never exceeds the vehicle capacity.

After knowing all of these assumptions, the second step was to determine the geographical locations of the 200 points around the Mexican Republic. The geographical coordinates of these locations (in degrees) were converted into decimal coordinates for the estimation of Eq. (4). Then, the third step consisted on determining the demand for each location (except for the distribution centre), including quantity of pieces, weight in kilograms (by unit product) and unit prices. This is a regular and stable demand forecasted for a planning horizon of 10 years with an annual increment of 5.0%.

In the fourth step we determined the characteristics of each vehicle. Table 1 presents this information.

Table 1 Characteristics and performance of each vehicle (own work from data available in [17])

Vehicle Type *k*	Maximum Capacity (kg)	Diesel Efficiency (km/litre)
V1	17000	9
V2	28000	6
V3	31000	6
V4	27000	4.5
V5	25000	2.5
V6	48000	2.5

To have a complete calculation, the actual fuel price was included to obtain the efficiency for each travelled kilometre. From [18] the cost of \$18.87 per litre was determined. Once the diesel cost per litre is obtained, a cost per travelled kilometre CV_k is estimated for each vehicle *k* as follows:

$$CV_k = 18.87\ \$/lt \times (1/Diesel\ Efficiency\ in\ km/lt\ of\ vehicle\ V_k) \quad (5)$$

In example, for vehicle V_3, the cost per travelled kilometre is $CV_3 = 18.87 \times (1/6) = \$3.145/km$. With this metric for CV_k, the fifth step consist on determining the distance in kilometres between the distribution centre and each customer or supplier location by means of Eq. (4). Note that by multiplying Eq. (4) by Eq. (5) a "distance cost" between two locations can be estimated (if the vehicle returns to the supplier after delivery at the distribution centre, then it is assumed that the distance cost is performed twice).

How many times the distance cost will take place depends of the quantity of inventory lots to be delivered at the distribution centre through a planning horizon. This is estimated by means of the EOQ policy as:

$$n = \frac{D}{Q} \quad (6)$$

With all of these calculations, we can define an "inventory transportation cost", which is the very important metric to complement the objective function of the Weber model. The integrated objective function of the extended Weber model then can be expressed as:

$$min \sum_{i=1}^{n} 2d(x, x_i)CV_K nQ_i \quad (7)$$

In the next section, the implication of this updated objective function is analysed and discussed.

4 Analisys of results

Figure 2 presents the location of the suppliers and the distribution centre considering just the basic model described by Eq. (1). The location was determined with the Solver tool. Observe how the distribution of locations fit the geographical shape of the Mexican Republic. This visualization was obtained by a code developed with the programming platform Octave.

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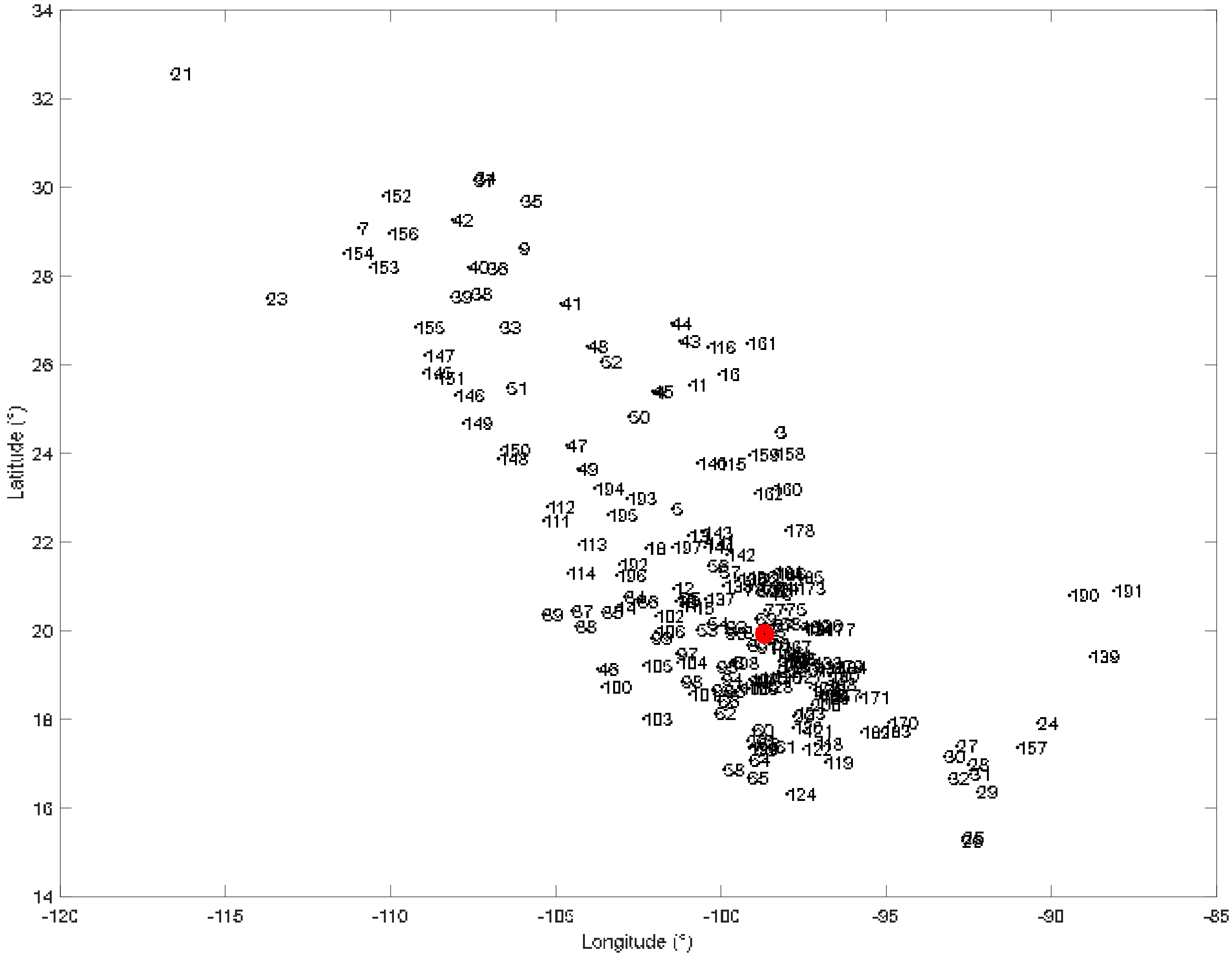

Figure 2 Locations of the suppliers and the plant or distribution centre

Minimization of the basic objective function led to determine the geographical coordinate -99º, 20º as the optimal location for the plant obtained by Eq. (1). Specifically, the location is near the city of Mexico as presented in Figure 3.

Then, we proceeded to re-estimate the location of the plant with the extended model described by Eq. (7). This led to a revised location which was determined at the coordinate -98.68º, 19.91º. Table 2 presents the comparison of economic results for supplier #30 with the standard and revised locations while Figure 4 presents the distance between both plants.

As presented, in both cases distance is minimised, however the economic implications are different. The extended model led to a 10-year transportation cost associated to the revised location for the plant of $1,283,199.00. In contrast to the location estimated with the standard facility location model, this represents a saving of $1,340,911.93 - $1,283,199.00 = $57,712.93.

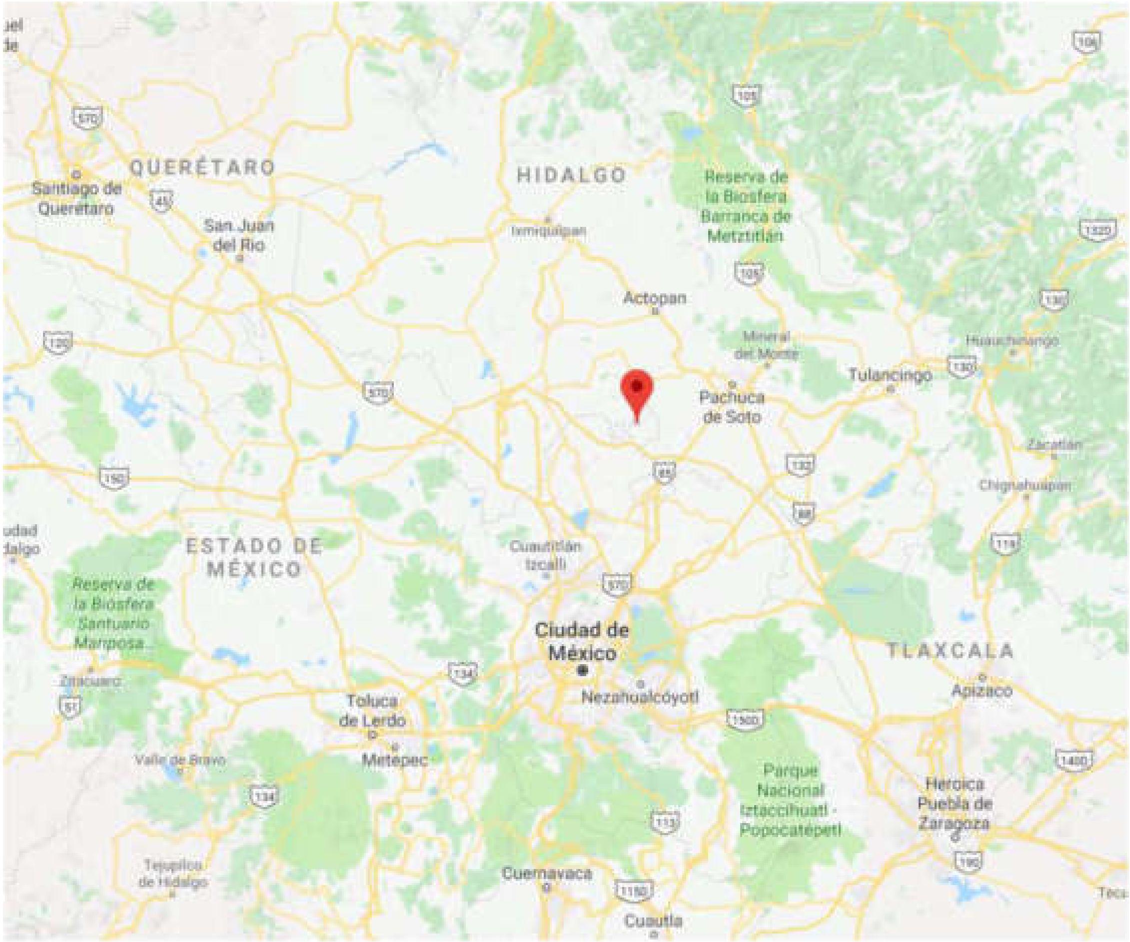

Figure 3 Location of the plant as determined by Eq. (1)

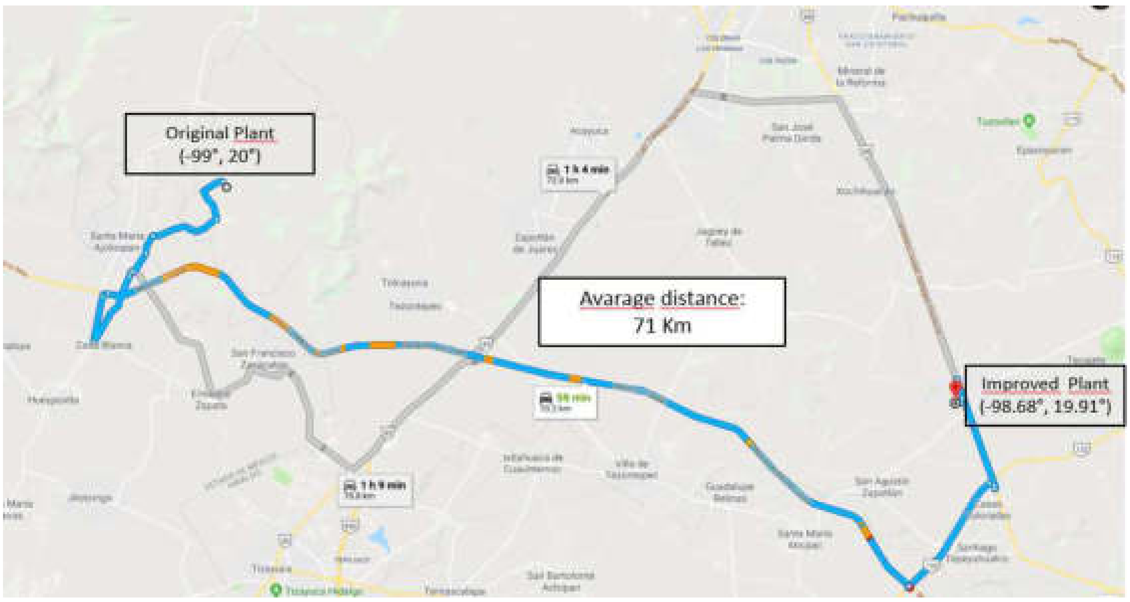

Figure 4 Functional location plants determined by Eq. (1) and Eq. (7)

Table 2. Comparison of results: standard facility location vs. extended model for supplier #30 (own work)

Concept	**Coordinates (Eq. (1)) -99º, 20º**	**Revised Coordinates (Eq. (7)) -98.68º, 19.92º**
Annual demand (USD)	$93,816.80	
Unit cost (USD)	$553.00	
Annual demand (Units) = Annual demand (USD)/ Unit cost (USD)	$170	
Total demand (10 years) with 5% annual increase	2,241	
Unit weight (kg)	4	
Vehicle	V_1	
Vehicle's capacity (kg)	25,000	
Vehicle's performance (km / lt)	2.5	
Diesel cost per litre (USD)	$0.96	
Cost per kilometre	$0.38	
Holding cost (Ch)	$82.95	
Order cost (Co)	$991.00	
Lot size (Q_{30})	231	
Total weight of the lot Q_{30} (kg)	925.51	
Cost of lot Q (USD)	$127,951.41	
Number of orders with the 10 year-period (n=D/Q)	10	
Distance to plant (km)	**779.267**	**745.727**
Distance cost to plant (USD)	**$299.24**	**$286.36**
Transportation cost (Eq. (7) with *i*=30 and k=1)	**$1,340,911.93**	**$1,283,199.00**

An important issue regarding these costs is that the future cost variation and increase of the gasoline are not considered. Hence, savings can be more significant when considering these factors.

5 Conclusion and future works

How important would be the management of inventory if the company belongs to the pharmaceutical industry? If the plant produces medicines with different elements from a set of suppliers, effective delivery of these elements is crucial for the production process. Also, costs associated to delivery of raw material, distribution of the final products, and inventory costs, are crucial to keep competitiveness and good quality products. As discussed in this work, having an appropriate integrated model can lead to significant economic savings. These can be used to reinvest strategically in some other aspects of the supply chain.

Of course, within these costs there are many more factors. However, the proposed model can be the guideline to extend on a more comprehensive approach to optimize transportation within the economic aspects of inventory management. As an example, strategies for safety stock, variable delivery time and dynamic reorder point, can be considered to improve the planning of materials.

Similarly, in terms of transport, the structure of the roads, the size of the vehicles, the size of the orders, the dimensions, the payment of tolls, the maintenance of equipment, etc., influence the determination of operative costs. Thus, this work can be extended to include many more variables to optimize more resources of the supply chain. The following extensions are considered for future work:

- Consider variable demand and uncertainty within the delivery time.
- Consider a different inventory model with uncertain demand (i.e., periodic or continuous review model) as the base inventory strategy.
- Integrate variable costs within the planning horizon as a decision variable.

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A LOGISTICS SYSTEM IN MANAGEMENT OF FLOWS IN THE AREA OF AGRIBUSINESS

Maria Nowicka-Skowron
Czestochowa University of Technology, Czestochowa, al. Armii Krajowej 19B, Poland , maria.nowicka-skowron@wz.pcz.pl
Joanna Nowakowska-Grunt
Czestochowa University of Technology, Czestochowa, al. Armii Krajowej 19B, Poland , joanna.nowakowska-grunt@wz.pcz.pl (corresponding author)
Anna Brzozowska
Czestochowa University of Technology, Czestochowa, al. Armii Krajowej 36B, Poland , anna.brzozowska@wz.pcz.pl

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Abstract: Today, the subject of management in Polish agribusiness needs to be looked at in a more comprehensive way. With Poland's accession to the European Union, it is necessary to implement the solutions defined by the Common Agricultural Policy in agribusiness, whereas entrepreneurs from rural areas need to give more attention to issues connected with logistics and the process of management. This papers considers the problems of logistics management in the area of agribusiness. It has been pointed out that new paradigms that continuously appear in this area pose a huge challenge both for theoreticians and practitioners. Aiming to achieve a synergy effect and added value for activities that involve movement processes in agribusiness, both decision-makers and those managing farms and rural areas should consider and implement the right principles and solutions that will allow them to achieve this goal.

1 Introduction

Agriculture is the main source of livelihood for most inhabitants of rural areas. Changes in agriculture driven by the obligation to implement the solutions defined by the EU Common Agricultural Policy [1] in Polish agribusiness and changes in using the potential of rural areas for economic growth and employment provide a huge chance for the development of these areas. Particularly valuable can be augmentation of logistic functions through transferring specific activities to specialised entities, e.g. in storage of agricultural products. Such solutions allow farms to avoid high costs connected with storage of raw materials and products, and generate new jobs. Thus, intermediation in the area of logistics may contribute to combating the phenomenon of peripheralization of rural areas. It should be stressed that there is a growing trend in pursuing education among young people in rural areas, which in turn leads to a gradual change in the occupational structure in rural areas [2-4]. Thus, the new professional groups that emerged from the process of transformation represent a potential for the field of logistics.

2 Research aim and methodology

This paper attempts to find an answer to the questions concerning the demand for managerial activities in logistics of rural areas. Performed observations allow us to state that the process of management, given microeconomic factors of the development of agricultural entrepreneurs who employ different strategies to diversify their activity, needs such support. The fundamental issue is whether given the lack of competitiveness in the agribusiness sector, which relies on various forms of sectoral support, agrilogistics will have a chance for effective development. Having said that, it is also important to pay attention to the solutions that can optimise flows in the dynamic model of the logistics system in rural areas.

2.1 *Integrated logistics system of rural areas*

When considering logistic conditions in the development of Polish agribusiness, it is worth highlighting the systemic approach to logistics processes, which should be based on interrelationship among the different areas [5]. From the very first stage, i.e. already in the process of planning, these areas should combine into a whole to enable in the future integrated logistics activities, which are based on optimal management of processes on a farm, and subsequently in the whole logistic chain.

Agricultural enterprises rely on logistics solutions in their activities. Nowadays, there is no need to store means of production for a long time, as they are widely available, and service providers usually use their own transport. However, it is possible to lower total production costs through optimal solutions in this area, e.g. by creating a base and defining key principles governing physical flows so that they can approach perfection [6]. This requires agricultural entrepreneurs to develop new principles and attitudes as well as abilities to dynamically adapt to changes in the logistics system (as illustrated in Figure 1) so that their enterprises can function effectively. The necessary costs connected with such activities should be estimated based on a detailed analysis of logistics infrastructure [7].

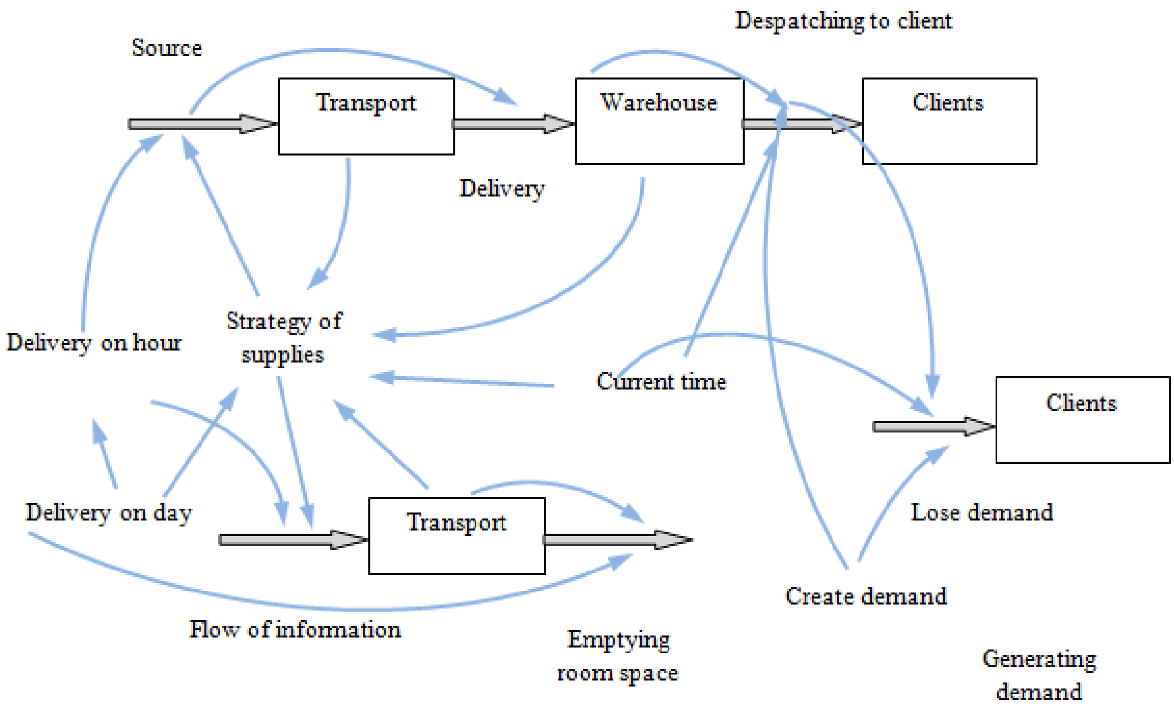

Figure 1 Dynamic model of a logistics system [8]

The dynamic model of the logistics system in agricultural enterprises is an integrated system of activities which is supported by specialist scientific knowledge on strategic and logistics [9] management and involves all processes of production and distribution [10]. It allows farms to efficiently function in a market economy. By viewing and analysing logistic processes in rural areas in a comprehensive way, we can identify business models in such areas that have an impact on the type of competitive advantage. Enterprises in the sector of agribusiness possess skills which underlie the strategy they use, which are helpful both in agribusiness and agrilogistics [3].

Activities in the area of agrilogistics concentrate on enhancement of flows and their optimisation in current conditions. They also involve improvement in the aspect of relations with basic processes that take place in rural areas. Gradual partial and descriptive identification of these relations enables optimisation of basic processes and creation of new logistic concepts [11,12].

The discussion above shows that the dynamic logistics model in the systemic approach in the area of agribusiness supports decision-making processes and involves new directions of development.

3 Elements of logistic support in enterprises from the agribusiness sector

A logistic process is inseparably connected with multifaceted management that defines standards and strategies of action as well as processes of movement in various environments [13] and warehousing, taking into account the costs of such operations [14]. Processes that guarantee all the resources that are required to execute a basic task can be referred to as logistic processes [15]. In a market economy, every process of meeting the needs involves a flow of goods and resources or transporting a customer, or a combination of such transfers. When such flows take place in an integrated way, in compliance with the concept of logistics as part of optimised logistics systems [3], their execution is economically efficient. Appropriate support in utilising microeconomic factors is indispensable in every activity, both business and other, and the quality, cost and time it takes to complete a basic task is determined by efficiency of the management of these processes [15]. The factors driving the development of agricultural enterprises mainly include efficiency of management and professionalism as well as entrepreneurship and innovativeness [16] of the managerial staff, i.e. farmers themselves and their nearest environment. Any business and non-business activity requires knowledge on management and logistics activity, which delivers certain objectives through available technical, infrastructural, organisational and legal means using appropriate techniques, methods and people. Thus, a system of logistic support involves all logistic means and processes which determine the execution of the above-mentioned tasks [17]. It enables the use of specific techniques and methods to achieve the objective, i.e. to deliver, in an integrated way, appropriate resources to basic processes [15]. Adopting the system of logistic support in a broader scale of the activity undertaken in agribusiness, it is important to specify the basic tasks of a logistic process which supports satisfaction of the needs at a gmina level [3]. It involves tasks aiming to meet consumer needs of individual farms and provide access to mass consumption services, as well as processes connected with the needs reported by local producers [18]. The current development of rural areas and modernisation of farms raise questions about a gradual modernisation of agricultural equipment and optimisation of the methods. The lack of harmony between the two above-mentioned areas of activity applies to factors that theoretically facilitate the development of agricultural production. However, good effects can be achieved through development of external logistics services focused on key agricultural products in a given area, especially through development of local and regional initiatives in the area of agribusiness [3].

An important role may be played by a coherent network of logistics centres focused on agricultural products for farms which are dynamically developing in the direction of intensive farming. The traditional purchase forms are no longer attractive, especially for a potential customer, and the investments in the development of a farm, without a potential additional logistics support, are becoming insufficient.

3.1 Strategies for diversification of activity in agribusiness

Agriculture is no exception to the fast economic and social changes that take place in today's world. Both gmina and individual farmers need to adapt to the current conditions of functioning in a highly competitive environment [19], employing solutions from the areas of management, logistics, marketing and knowledge management [20] to ensure optimal development of their enterprises [21]. Nowadays, farms are perceived as enterprises which have to consider managerial aspects in their marketing activity, such as product development, proper pricing policy, selection of distribution channels and promotion tools [22]. Thus, it is necessary to search for the best competencies in logistics, based on both their agricultural and non-agricultural activity, in the area of microeconomic factors in the development of agricultural enterprises (Table 1).

Table 1 Average score for factors in the different groups of respondents [23]

Factor	Multi-skilling	Horizontal diversification	Vertical diversification	Parallel diversification
Competencies, knowledge and qualifications of the owner-manager	5.96	5.39	5.63	5.60
Amount of own financial capital	4.65	4.09	4.42	4.67
Amount of own physical capital	4.39	4.61	4.68	5.07
Applied technologies	5.70	5.61	5.68	5.87
Available housing resources	5.17	5.35	4.79	4.87
Organisational factors (e.g. distribution of tasks and responsibilities)	5.78	5.78	6.05	5.67
Location of the activity	5.78	6.13	6.74	7.00
Environmental conditions	5.30	4.87	5.47	5.93
State of technical infrastructure	5.09	5.04	5.79	5.73
Access to the Internet	5.87	5.96	6.63	6.27
Access to qualified employees on the local labour market	5.74	5.00	5.26	5.13
Extend to which the local authorities are favourably inclined towards rural entrepreneurs	5.04	5.09	5.16	5.80

Extend to which the local community is favourably inclined towards rural entrepreneurs	4.91	5.13	5.11	5.80
Availability of business environment institutions	5.17	5.22	4.84	5.07
Level of market competition intensity	4.65	4.26	4.84	5.33
Number of customers within the reach of the activity	5.70	5.13	5.95	6.20
Access to target recipients of services and products	5.83	5.13	6.32	6.27

The empirical studies on multi-skilling and diversification [23] found out that:

1. The lowest level of positive assessments was received by the group of horizontally diversified entrepreneurs. The lower level of assessments concerns: competencies, knowledge, qualifications of the manager, amount of own capital, innovativeness, infrastructure, competitiveness. Higher scores were received by housing resources and availability of business environment institutions.
2. Within the group of multi-skilled respondents, lower scores were received by the amount of own capital, location, access to the Internet and relationships with the local authorities. Higher scores concerned: own competencies, knowledge, qualifications and availability of employees on the local labour market.
3. The vertical diversification group scored below average in availability of local resources and business environment institutions. A positive assessment within this group was received by organisation, development of technical and logistic infrastructure and access to the Internet.
4. The group of developing entrepreneurs received higher scores in the amount of own capital, innovativeness, location, environmental conditions, relationships with the local authorities and competitiveness. Only the organisation received the lowest score.

It should be stressed that the assessments presented here are findings of studies covering the activity of entrepreneurs engaged mainly in agribusiness.

In each of the factors listed here, both in small agricultural enterprises and international agrarian corporations, managers implement various strategies. The assignment criterion has an impact on the area of influence of the individual tasks executed as part of physical flows [24].

4 Summary and conclusions

The discussion about the essence of and possibilities created by the implementation of the idea of logistic support for the development of rural areas, as presented in this paper, indicates the interrelation between these two systems. Rural areas generate huge demand for logistic processes that support the flows of goods. At the same time, it is in these areas that most of these processes are performed due to their dominant share in the territory of the country. The quality of the infrastructure in rural areas allows logistic processes to be executed regardless of the place of residence of their recipients (in the country or the city). Thus, there is a need for a deep analysis of the system of flows in the agribusiness sector, where a range of optimisation possibilities exists. Searching for the synergy of logistics operations may lead to identification of a coherent system for monitoring of logistic support, and to an increase in the effectiveness of flows in rural areas.

Competitiveness and constant presence on the market require a farm, just like any other enterprise, to adjust the production to the current needs, invest in its development, continuously improve the quality of products and modernise itself. A farmer entrepreneur should be able to predict and meet consumer needs. Management of agricultural enterprises is specific in character, as the decision-making concerns not only the issues of production and investment, but also inspiration of activities that rely on management and logistics solutions. Therefore, the concept of management in rural areas and on farms should be viewed in terms of the possibilities of integrating it with the area of management, logistics and assignment of a farm. This approach means a full consolidation of the principle and processes of logistic management in rural areas and on farms at every level of operational, strategic and normative management. A farmer, who manages an agricultural enterprise, usually not only wishes to derive financial benefits from his/her work, but is also highly motivated and wants to feel satisfied with day-to-day life, which conforms with the assumptions of the behavioural school of management. The multifaceted character of the problem of economic cooperation in view of the processes of globalisation imposes high requirements on logistic functions that support such cooperation. It is likely that an integrated environment of economic activity management will be ultimately built [25,26]. Economic activity is closely connected with the environment, which comprises all the elements of the economic, political and social world. Not so long ago, economic entities perceived their environment as a static reality, and the events taking place in it were easy to predict. However, the last thirty years have seen processes in the political, social and economic world that completely changed the view of the conditions of economic activity. These changes also affected agribusiness as a sphere of the implementation of logistic principles and solutions to develop a system of the flow of goods and information on agricultural and food markets. This activity, focused on the development of farms, is reflected in the issues connected with agrilogistics.

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THE INFLUENCE OF TRUST ON REDUCTION OF COOPERATION RISK IN LOGISTICS

Tomasz Malkus
Cracow University of Economics, Department of Management Processes , 31-510 Cracow ul. Rakowicka 27, malkust@uek.krakow.pl

Keywords: cooperation, logistics service, risk factor, trust, response to risk
Abstract: The influence of logistics on competitive advantage of cooperating parties, as well as risk associated with changing operating conditions increase the importance of trust, that partner works for mutual benefits, even if detailed regulations regarding the response to changes in the environment are not included in contract. The objective of paper is to present the role of trust in reduction of risk of logistics cooperation between principal and provider of logistics service. Typology of main risk factors, characteristics of trust between companies, as well as role of trust in different types of cooperation relationships are taken into consideration.

1 Introduction

The influence of logistics on competitive advantage of cooperating parties, as well as risk associated with changing operating conditions increase the importance of trust, that partner works for mutual benefits, even if detailed regulations regarding the response to changes in the environment are not included in contract. Under the influence of behavior of parties and actions taken trust between cooperating units may increase over time. In the case of unfavorable, opportunistic actions, trust can be reduced or even eliminated.

The objective of paper is to present the role of trust in reduction of logistics cooperation risk between principal and provider of logistics service. Typology of main risk factors, characteristics of trust between companies, as well as role of trust in different types of cooperation relationships are taken into consideration. The content of paper is prepared on the basis of theoretical considerations and results of empirical research instead of results presented in literature, as well as on own considerations and empirical experience of author. *(The publication was financed from the resources allocated to the Management Faculty of Cracow University of Economics, under the grant for the maintenance of the research potential).*

2 Risk of logistics cooperation

Considering description of risk in logistics cooperation it should be noted, that such a risk is multidimensional. Different types of risk are characterized by different components. There are factors that can be controlled and other, uncontrolled. In addition, the way of determining this risk is to a large extent subjective. Risk of cooperation is usually perceived negatively, and the main manifestation of its occurrence is the non-performance or unsatisfactory performance of service provider [1-7].

Description of risk of cooperation with specialized vendor of logistics services can be done by presentation of typologies of major risk factors, generally divided in two groups: external factors – appearing in the environment of cooperation and internal factors – dependent on principal (recipient of service) and service provider (including also the relationship between main vendor of service and its subcontractors). External factors are related in particular to law, politics and the economy, but also natural elements and events that affect joint activity of recipient and vendor. Internal conditions of cooperation risk concern especially parties' behavior and relationships between them. Such conditions can be identified using transaction costs theory [8,9], theory of incomplete contract [10] as well as agency theory [11], developed on the basis of transaction costs theory. As a starting point of description of risk of logistics cooperation, major risk factors and examples of negative scenarios, dependent on provider and principal should be highlighted (Table 1).

Table 1 Risk factors dependent on principal and provider principal and vendor of logistics service in logistics cooperation [12]

Risk factor	Negative scenarios influenced by factor
Opportunism of logistics service provider	Differences appearing in comparison of offer of service provider and its actual ability to perform the requested tasks, disruptions in risk communication between principal and provider, excessive dependence on provider, conflicts between parties (resulting with involvement of court), loss of control over performance of service ordered.
Asymmetry of information between	Risk communication between cooperating partners, differences between

principal and service provider	provider's offer and its actual ability to carry out services ordered, insufficient knowledge of principal about the quality of provider's performance, problems related to cooperation management (especially coordination of this cooperation with the service provider).
Insufficient experience of principal concerning cooperation with service provider	Misunderstanding in the area of mutual expectations, difficulties in determination of expected effects of cooperation, excessive dependence on service provider, problems related to cooperation management (especially coordination of this cooperation with the service provider), conflicts between parties (resulting in interference by the courts), loss of principal's control over activity performed by provider.
Lack of specific obligations of principal's employees to update information about service market	Lack of knowledge concerning changes of offers, as well as new offers on service market, excessive costs of obtaining expected quality of service provided (if there are units on the market that offer similar quality at a lower price).
Difference in perception of risk by cooperating parties	Problems concerning risk communication between partners.
Assets specificity (often related also to the limited availability of offers of service units on the market)	Excessive dependence on service provider.
Cause and effect relationships between activities of principal and service provider	Long period of coordinating activities, joint problem solving and mutual adjustment.
Insufficient mechanisms to control the activity of service provider by principal	Loss of principal's control over activity performed by service provider.
Insufficient involvement of service provider in improvement of cooperation	Insufficient development of activity of principal.

The specificity of factors in the area of logistics cooperation is reflected by attitudes of suppliers and recipients of principal, concerning the activity of service provider who takes over the flow of supply for principal and distribution of its products to recipients. Under these conditions, the image of principal created by its suppliers and recipients is influenced mostly on activity carried out by logistics service provider.

Considerations regarding external risk factors of logistic cooperation can be initiated with universal (independent of types of service provided) problem of adverse behavior of service provider related to the influence of other principals cooperating with such provider.

Taking into account characteristics of business of different clients cooperating with provider, even clients of provider competing with considered principal, it is important to pay attention to possible disloyalty of such provider, which can be reflected by:

- provision of information about market achievements to competitors, under the pressure of other principals on service provider,
- copying solutions related to flow of goods, developed with considered principal in cooperation with its competitors,
- informal agreement between service provider and selected client (principal), resulting in limitation of access for other clients to services provided (especially important in the conditions of high specificity of assets in cooperation).

Together with factors presented above, resulting from characteristics of relationship between service provider and its principal as well as between principals, there are other factors in the environment of cooperation (Table 2).

Table 2 Risk factors in the environment of logistics cooperation [12]

Risk factor	Examples of scenarios
Technical and technological development	Affects the improvement of logistics activities, but also other areas of the company's operations, related to logistics, as for example development of IT tools supporting enterprise resource management.

Changes in regulations of law, regarding the field of activity, being the subject of cooperation	Solutions related to traffic, road, rail, air and sea transport, disposal of waste, secondary raw materials, transport and storage of hazardous materials.
Changes of legal regulations, international agreements and conventions	Agreements concerning: documentation of international road transport of good – CMR (convention concerning the international standard of consignment note in road transport), treatment of specific types of goods in transport – ADR (carriage of dangerous goods by road).
Changes of customer preferences	Change in the size of demand, changes of expectations regarding the ranges and types of services offered.
Development of logistics service market	Introduction of new service providers to the market, development of offers of existing providers, mergers of enterprises, in order to increase competitive strength.
Changes of road and rail infrastructure	Extension of transport routes, related delays, compared to the assumptions of plans before the period of repair started.
Changes in the organization of market of considered service	Transformation of enterprises, operating in the area of railway transport (in Poland).
Changes of conditions on air transport market	New connections, new airports.

It should be emphasized, that none of parties to the cooperation has any influence on factors included in Table 2. Ways to deal with such risk factors may be reflected in the contract between principal and service provider by including so-called emergency plans. Such plans are applied in the face of changes that may occur in the environment, including possibility of renegotiating terms of cooperation between parties.

Taking into account considered risk factors and related scenarios it should be noted, that consequences of each scenario for client, as well as for service provider are subsequently defined and response options for each individual risk factor are determined. As a result, mechanisms for reaction to risk factors are designed [3,7].

In the discussion on the implementation of described actions in response to risk attention should be payed on costs of actions, as well as on costs of appearance of each risk factor. Actions should be taken in response to important risk factors in case of high probability of their occurrence.

3 The problem of trust in cooperation

In general description of trust, based on sociology it can be understood as assumption made about the uncertain future actions of other people. It consists of beliefs and their expression in the form of actions of the person who trusts [13]. This assumption is adopted in the belief that other members of community is characterized by fair and cooperative behavior, based on shared standards [14].

In considerations regarding trust in cooperation, significant importance is attributed to shaping the conditions for development of trust in cooperating relationship. The transaction (treated individually) can be treated as the basis for creating such a relationship. A distinction is made between cooperation based on separate transactions and a relational exchange, evolving over time, in which each subsequent transaction is considered and evaluated from the point of view of the past and the future of cooperation [15-18]. Interest in cooperation relationship as the object of scientific study has grown along with development of concept of relationship marketing [19] as well as with spread of relational paradigm in management science [20], which was developed as network paradigm [21,22].

The ability of trust development is the indication, that trust is of dynamic nature. In the model approach, development of trust can reflect its three levels: trust based on calculation, knowledge-based trust and trust based on identification [23]. On the level of trust, based on calculation, the calculation of costs and benefits from the relationship plays a crucial role. The next level (knowledge-based trust) is achieved thanks to regular contacts between partners, obtaining information and predictability of the other party's behavior. The highest level of trust in model it is trust based on identification. It concerns identifying with intentions and expectations of partner. It can be developed when partners know each other, predict their behavior, but also expect continuation of trust [24]. It should be added, that cooperation includes also individual transactions carried out by Internet platforms in which parties don't know each other before beginning of transaction, and don't expect closer relationship after completing the transaction. Reliance on characteristics, abilities, strength of vendor play major role in such conditions [25,26]. According to presentation of levels of trust mentioned earlier it seems, that in such situation also trust based on calculation can occur.

In considerations concerning the meaning and conditions of development of trust in enterprises' activity it is important to highlight several dimensions of description and analysis of trust in cooperation relationships. Contractual dimension concerns the belief that partner will act for mutual benefits, even if there, are arrangements not reflected in contract. Dimension of trust in competences is related to expectation, that exchange partner will implement commitments undertaken in accordance with requirements in terms of quality of performance. Third dimension concerns trust in goodwill of partner. [18,27]. Presented aspects show the overall picture of trust in cooperation. They can be treated as a reflection of the development of trust, along with the development of the scope of cooperation and the extension of its duration. Therefore, depending on assumptions, concerning objectives of cooperation and its duration, the significance of individual dimensions of trust may change. In cooperation with service provider, performing short-term simple supporting tasks for client, the contractual aspect of trust may be most important. If parties cooperate taking joint investments for mutual benefits, apart from the dimensions of trust mentioned so far issues of goodwill, initiative and commitment to develope the cooperation, even beyond regulations of the contract play also an important role [28].

Emphasizing the importance of trust in development and maintenance of cooperation it should be noted, that trust is distinguished among key factors affecting the stability of relationship. This stability can be defined as a reflection of a stable, mutual attitude, that fosters relationship within a fixed period [27]. It goes beyond the positive evaluation of the partner in cooperation, based on current benefits and costs related to the relationship. It involves taking account of mentioned long-term orientation and willingness of each party to short-term sacrifices in the way to achieve long-term, mutual benefits [15].

4 Influence of trust on reduction of risk in cooperation with logistics service provider

Trust as mechanism for risk reduction, replacing or supplementing requirements of coordination and control of partner usually develops with learning of activitiy and achievements of this unit. Applied organizational, procedural solutions and adopted ways of behavior in relationships with other companies, which are perceived as a confirmation of credibility, accelerate the development of trust in such an entity. Such factors influence also the scope of regulations, regarding coordination and control of cooperation. Certificates and accreditations issued by independent entities can be treated as confirmation of reliability, as well as mechanism of reputation [29,30]. If reputation cannot be verified in considered company information is obtained from other parties cooperating with such company. The reputation is reflected in recommendations issued for such partner.

Trust always involves risk. Adoption of bet on the result of activity (as a sign of trust) can be understood only in the conditions of awareness of the possibility of alternative results. Treating trust as a risk consists in omitting the main point regarding trust: it opens the door to positive results that would be impossible without it. [30].

Defining the role of trust in reduction of risk of logistics cooperation, one can assign trust level to different types of cooperation, level of risk of each relationship as well as the importance of trust in its reduction. It is listed in Table 3. The cooperation relationships are diversified, especially from the point of view of scope of cooperation, related connection between vendor and recipient, susceptibility to abuses and interruption of cooperation and the need to control performance of vendor.

Table 3 Influence of trust on risk depending on types of cooperation [1,18,23-27]

Level of trust	Basic terms of cooperation	Status of transaction costs and risk sources
Reliance on character, abilities, strength of vendor, including, appearance of trust based mainly on calculation (concerning costs and profits of cooperation)	– incidental transactions, carried out using online platforms (for transport, storage), – parties to transaction often don't know each other (before beginning of transaction), – usually low value of single transaction, – ease of determination and comparison of service value, – wide access to service vendors meeting recipient's requirements.	– wide access to information about provider, – no need to exchange information concerning further cooperation between parties, – no need to invest in specific assets for transaction, – lack of profitability of opportunistic attitudes of vendors, – low level of external risk, importance of internal risk factors influencing cooperation, – small influence of contractual trust on reduction of transaction risk.
Trust based mainly on calculation	– low cost of determining the value of service (known requirements for the carriage of goods, fixed route, well-known storage conditions, requirements for forwarding activities),	– wide access to information about provider, – no need to exchange information concerning further cooperation between parties, – no need to invest in specific assets for transaction,

	– low value of transaction for recipient, – wide access to service vendors meeting recipient's requirements, – similar bargaining power of parties, – cooperation not treated as a source of competitive advantage.	– lack of profitability of opportunistic attitudes of vendors, – importance of internal risk factors influencing cooperation, higher level of external risk, – small significance of contractual trust in reduction of transaction risk.
Trust based mainly on knowledge about the partner	– higher sensitivity of cooperation to interference and interruption, – relates often to a greater level of integration of logistics activities with service vendor, – there is a need to use behavior monitoring tools to protect partners, – relationship monitoring tools allow to assign costs (to be paid) to the party with opportunistic attitude, – relationship with such a form of trust can be a source of competitive advantage, but only in the conditions of differentiating skills and abilities of monitoring.	– limitations and high costs of access to information, – need to invest in specific equipment/infrastructure (specialized trucks, trailers, equipment for loading and unloading), – costs of opportunistic behavior can be high (due to the tools used to influence behavior), – greater importance of contract incompleteness, – significant impact of internal and external risk factors on cooperation, – increased role of trust in reducing the risk of cooperation, especially the risk related to concluding a contract and ongoing operations under a contract, – high importance of contractual and competence trust, need for trust in the goodwill of partner.
Trust based on identification with partner (with its activity, image)	– associated often with a high level of integration of logistics activities and joint development strategy, – long period of previous cooperation (partners know each other), – lack of emphasis on the use of monitoring mechanisms – trust results from principles of cooperation used by both parties, – parties want to maintain credibility, regardless of whether the cooperation is sensitive to interference, – parties rely on each other, – high level of commitment – cooperation is a source of competitive advantage.	– mutual information transfer is the basis for establishment and implementation of cooperation, – high specticity of assets, used in cooperation, – frequent investments of both parties in assets used in cooperation, – avoiding opportunistic behavior (effects of such behavior are very expensive, can result with further problems on the market), – high level of contract incompleteness, – higher level of external risk, internal risk is reduced, – high impact of trust in reduction of cooperation risk, – importance of trust in contractual and competence aspects, as well as importance of trust in goodwill of partner.

It is worth noting, that also distrust associated with the resignation from the need to trust other party is treated as a rational tool to avoid risky situations. In conditions of undertaking actions inconsistent with expectations of trusting party its trust may be irrational. In any case, the social system, created by representatives of cooperating companies is more or less endowed with external mechanisms in the form of legal and social sanctions to enforce the general principles according to which expectations towards others are taken in accordance with the law [31].

Considering presented impact of trust on reduction of risks and uncertainties associated with entering into cooperation it is worth paying attention to the situation in which one of parties to cooperation may reduce or even lose trust. Risk-reduction mechanism based on trust is ineffective in this context. The party, that lost trust in partner may strive to complete cooperation. However, this is possible primarily in the context of low specificity of assets used in cooperation, often associated with the lack of integration of cooperating activities and the small impact of partner change on the performance of the party breaking cooperation. In the case of previous long-term partnership cooperation, based on the high specificity of infrastructure and equipment used in joint operations, but also in the conditions of high dependence on provider, related to difficulty of obtaining resources from another party, a quick solution may be too expensive and even impossible.

In the conditions of a high level of integration of activities of cooperating parties it is important to react quickly and take corrective actions, usually related to regulations agreed in the contract, enabling renegotiation of the contract terms, increase the level of cooperation monitoring, temporary or permanent limitation partner's influence on the activity of party, that lost trust in partner. It should also be noted that usually rebuilding trust is a process that lasts longer than the initial development of trust when starting cooperation.

5 Summary and conclusions

The content presented in this article was prepared primarily on the basis of presented in the literature theoretical considerations and results of empirical research concerning trust in cooperation and its impact on the reduction of risk and uncertainty in cooperation relationship. Own reflections as well as practical experience of author were also used.

Issues included in the article are treated as most important to provide a comprehensive picture of the impact of trust on risk of cooperation. In practice, the diversity of problems related to shaping trust and its impact on reducing the risk of cooperation can be significantly greater. It may be related to much greater diversity of forms of cooperation, compared to those presented in Table 3. Principles of cooperation, mutual obligations and rights taken in response to risk may also be different, depending on changes of risk factors. It is also worth paying attention to diversity of organizational tendency to trust, influenced by individual attitudes of employees of cooperating companies, responsible for results of cooperation in future.

An important limitation of cooperation may also be a loss of confidence, especially as a result of partner's actions, which although not intended to harm the other side, but the effects of these actions have been interpreted in such a way. It may not be possible to restore previous trust. Consequences concern reduction of level of integration in cooperation. In case of lack of such opportunities, there is a possibility to strive introducing changes to contract, that would more effectively protect injured party.

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