OPTIMIZATION OF THE LOGISTICS NETWORK OF THE SELECTED ONLINE STORE

Mykhailo Dobroselskyi[1], **Radovan Madleňák**[2]

Abstract: The Internet serves as the main infrastructure for global shopping. For this purpose, the construction of an e-commerce logistics network is the main aspect of a successful existence in the virtual environment.

This paper analyses the logistics system of a company located in Ukraine. The core business of the company is selling diagnostic equipment for cars through an online store. The structure of the company consists of one warehouse and five branches. The company does not have its own fleet for the transportation of products from warehouse to branches or to end customers and it outsources the services of another logistics company.

The main goal of the paper is to optimize the existing logistics system of the product flow between the warehouse, branches and the final buyers of the online store.

At the end of the article, after optimizing the warehouse localization, we received a reduction in shipping costs by 23%. Also, an existing and optimized logistics network is compared in terms of speed and cost of transportation between warehouse, affiliates and end users.

JEL Classification Numbers: L81, L87, L91, **DOI**: 10.12955/cbup.v7.1342

Keywords: online shopping, e-commerce, inventory management, logistics, truck logistics, logistic network design

Introduction

The rapid growth of the Internet and its penetration into the most diverse spheres of social life is one of the main trends not only in the modern world of electronic commerce, but also in the modern world in general. The rapid development of information technology in the past ten years has fundamentally changed the approach to doing business. The emergence of global networks, such as the Internet, has led to a new approach to the organization of commercial activities. The transformations affected both the external forms of business and the internal structure of the companies themselves (Nikolayeva et al., 2013; Bachanova et al., 2009).

The Internet has become both a medium of communication and a market with tens of millions of potential buyers with a fairly high level of income (TNS Interactive, 2002; Drozdziel et al, 2017). In these conditions, commercial organizations with special structure and other management principles are formed. Not surprisingly, electronic communications began to be used in the conclusion of various transactions.

Another mixture involving e-shopping and in-store shopping is to search for a product online, check it out in-store, and finally buy it online. Thus, e-shopping lift the time and space constraints of the shopping process and bring more flexibility, leading ultimately to a fragmentation of the shopping activity in time and space (Farag et al., 2007, Couclelis, 2004; Madlenak, 2015).

Businesses do not stand still, companies compete with each other, looking for new ways to attract customers and sell their products. In a single information space, a trade organization can interact directly with any potential client, no matter where in the world they are located, and receive almost instant information about their decision (Nikolaeva et al., 2013; Ward et al., 2002).

Today, logistics usually means the process of organizing the movement of material and information flows to ensure the achievement of the objectives of the enterprise (Tolmachyov, 2013; Stalmasekova et al., 2017).

The main goal of logistics is to deliver production products to the right place at the right time and place with a minimum cost. There are two ways to organize business processes for delivering goods to customers (Tolmachyov, 2013; Andreev, 2012; Madlenak et al., 2016):

- the formation and maintenance of a business's own delivery service;
- the transfer of business processing to a courier service;

The traditional approach to the organization of delivery is the creation of its service. The undoubted advantage of this approach is the speed of delivery. The main difficulty of this approach to logistics is

[1] University of Žilina, The Faculty of Operation and Economicsof Transport and Communications, Deparment of Communications, Slovak Republic, mykhailo.dobroselskyi@fpedas.uniza.sk
[2] University of Žilina, The Faculty of Operation and Economicsof Transport and Communications, Deparment of Communications, Slovak Republic, radovan.madlenak@fpedas.uniza.sk

the need to spend considerable amounts of time and money on setting up the process of courier delivery. The content of this delivery is not always cost-effective, since the following additional costs arise from (Andreev, 2012; Mikhailuk, 2016):

- a manager's time required to instruct the new qualified employee responsible for the delivery and then the debugging of the delivery business process;
- the maintenance of qualified personnel, preparation of supporting documentation for orders, daily calculation of optimal routes, monitoring the smooth operation of the service;
- financial costs of maintenance (overhead costs, wages, taxes);
- simple couriers and transportation are possible in case of uneven receipt of orders or their absence.

The transfer of the business process of delivery to professional courier services allows online stores to reduce risks and devote more time to the development of sales than logistics. In addition to actual delivery to the final consumer, such companies provide a fairly wide range of services: responsible warehousing of your goods, export of goods from an online store warehouse, cash services, the ability to select narrower delivery intervals, delivery after 19:00, the possibility of issuing goods at issuing points, call centres, tracking goods to their end points, etc (Andreev, 2012; Madlenakova et al., 2016).

The main goal of the paper is to optimize the existing logistics system for the transportation of goods between a warehouse, branches and end-users of an online store. The result of this paper is to reduce the transportation costs.

The methodology

To achieve the goal, we analysed the current system of delivery of goods from a warehouse to affiliates and calculated the amount of shipping costs at the current turnover of the goods. With the help of the FLP methods which uses the Tabu Search algorithm (Erdoğan, 2017a), we have identified a new optimal warehouse location and realised calculations of transportation costs when we changed the location of the warehouse. By using the VRP methods which uses the Large Neighbourhood Search algorithm (Erdoğan, 2017b), we designed a present routing system (outsourced by the courier service) between the warehouse and the branches and proposed a future routing system (with a business's own car fleet). On the basis of calculated transportation costs, we could formulate a final decision about the optimal routing system of the company.

Tabu Search is a Global Optimization algorithm and a Metaheuristic or Meta-strategy for controlling an embedded heuristic technique. Tabu Search is a parent for a large family of derivative approaches that introduce memory structures in Metaheuristics, such as Reactive Tabu Search and Parallel Tabu Search. The objective for the Tabu Search algorithm is to constrain an embedded heuristic from returning to recently visited areas of the search space, referred to as cycling. The strategy of the approach is to maintain a short-term memory of the specific changes of recent moves within the search space and preventing future moves from undoing those changes. Additional intermediate-term memory structures may be introduced to bias moves toward promising areas of the search space, as well as longer-term memory structures that promote a general diversity in the search across the search space (Brownlee, 2015).

A. Change location of the warehouse – optimised logistic network

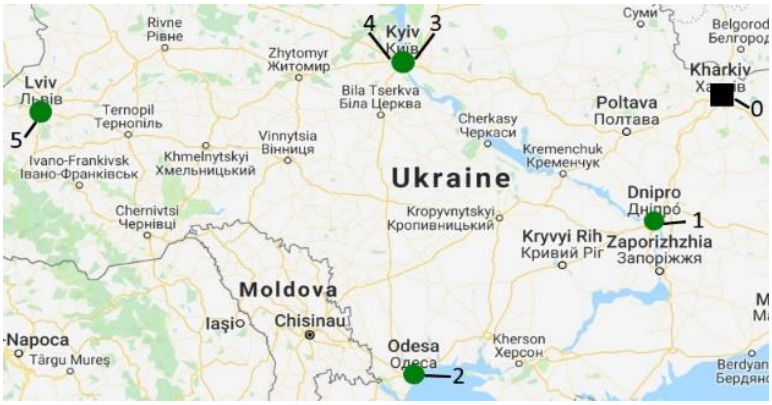
From our point of view, the location of the main warehouse is strategically unprofitable, as the distance between it and the branches is quite large, takes longer for shipments to arrive and has more delivery costs. Therefore, we considered to find a new position for warehouse. For that reason, we used the Tabu Search algorithm (Figure 2). In Table 2, for example, the input data is shown for calculating the localization for optimal storage and the result of the calculation.

According the optimisation process. the new best place for the warehouse became the city of Kiev.

After finding a new location for the warehouse. we can calculate how the cost of transportation services will change. The conditions remain the same (the same logistic company and the same turnover of the products) as was in previous version of system (Table 3).

When we compare the present prices for transportation and the optimised version of the logistic network. we find that the delivery services costs decreased by 23%.

Figure 1. The organisation of the main warehouse and branches (0 - main warehouse in Kharkiv, 1 - Dnipro, 2 - Odessa, 3, 4 - Kiev, 5 - Lvov).



Source: Author

Table 1. Price list of transportation services.

City	Price for 1 pallet (EUR)	Price per month (1 pallet 9 times per month to 5 affiliate = 45 pallets) (EUR)
Kharkov, UA	Main warehouse	Main warehouse
Dnipro, UA	30	270
Odessa, UA	35	315
Kiev1, UA	35	315
Kiev2, UA	35	315
Lvov, UA	47	420
Total EUR	182	1635

Source: Author

Table 2. Input data and results of the FLP method

1.Locations	Number of locations	6
2.Costs and Coverage	Distance computation	Driving distances (km)
	Route type	Fastest / Car
	Cost per unit distance	0.135
	Service distance limit	560
	Coverage distance limit	560
3.Solution	Number of facilities	1
	Objective	Minimize total cost
	All facilities must be located?	Yes

Location ID	Name	Address	Latitude (y)	Longitude (x)	Demand	May be a facility?	Capacity	Setup cost
1	Location 1	Kharkiv	49.964145	36.240428	1	Yes	6	0
2	Location 2	Dnipro	48.407617	35.031447	1	Yes	6	0
3	Location 3	Odessa	46.469494	30.721367	1	Yes	6	0
4	Location 4	Kyiv1	50.412097	30.516674	1	Yes	6	0
5	Location 5	Kyiv2	50.442979	30.647289	1	Yes	6	0
6	Location 6	Lviv	49.842188	23.979669	1	Yes	6	0

The result of calculation

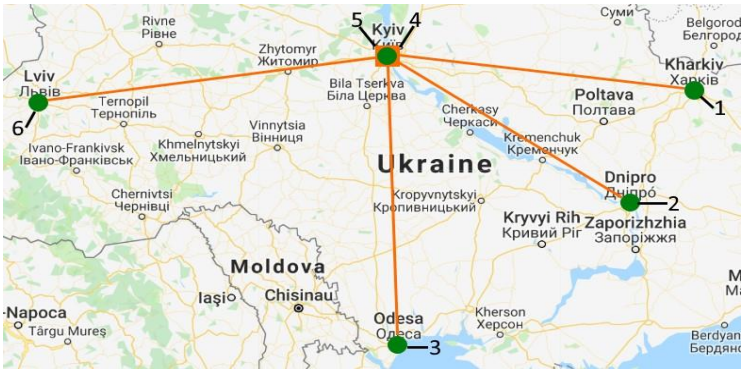
Facility 1	Facility location	Capacity	Demand allocated	Demand covered	Cost incurred
	Location 4	6.00	6.00	6.00	263.38
Locations served	Location name	Distance	Demand	Covered	Cost
1	Location 4	0.00	1.00	1.00	0.00
2	Location 1	476.48	1.00	1.00	64.32
3	Location 2	446.42	1.00	1.00	60.27
4	Location 3	469.35	1.00	1.00	63.36
5	Location 5	12.82	1.00	1.00	1.73
6	Location 6	545.87	1.00	1.00	73.69

Source: Author

A. A change in the way goods are transported

Another way to improve the existing logistic network is to change how the goods between the warehouse and branches are transported. We considered the version of the logistic network where the online store provides the transportation with its own vehicle. In Table 4 we can see the input data for calculating the optimal route for the transportation of goods through one's own transport with a capacity of 10 pallets and the result of the calculation.

Figure 2. Optimal location of the warehouse (5 - warehouse; 4 - Kyiv; 1 - Kharkiv; 2 - Dnipro; 3 - Odessa; 6 - Lviv).



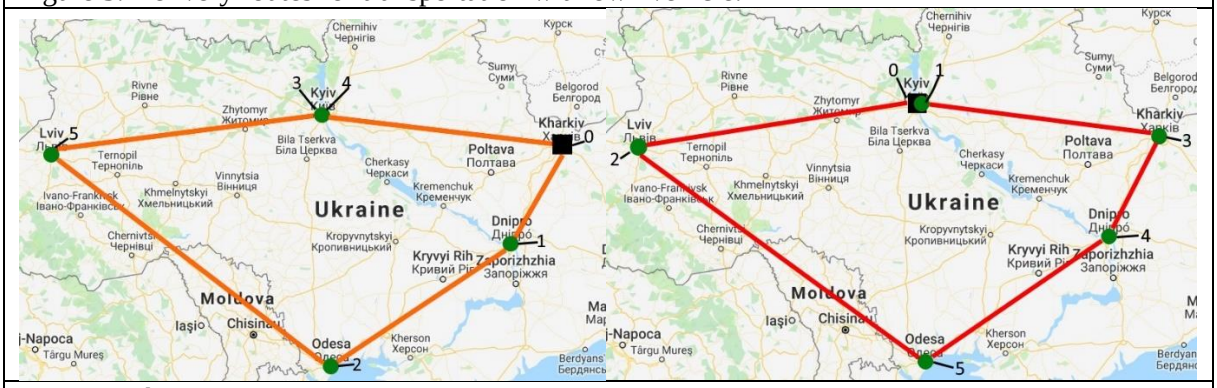
Source: Author

Table 3. Prices list for transportation services.

City	Price for 1 pallet (EUR)	Price per month (Kharkov) (EUR)	Price per month (Kiev) (EUR)
Kharkov. UA	35	315	0
Dnipro. UA	35	315	270
Odessa. UA	35	315	315
Kiev 1. UA	warehouse	warehouse	315
Kiev 2. UA	0	0	315
Lvov. UA	35	315	420
Total EUR	140	1260	1635

Source: Author

Figure 3. Delivery routes for transportation with own vehicle.



Source: Author.

We calculated and analysed at which turnover of goods per month using one's own transportation will be advantageous for the online store. To do this. we chose two cars. The first type can carry up to 10 pallets at a time - the Mitsubishi Canter. the fuel consumption of this car costs 0.135 cents / km. The second type of car is designed to carry up to 30 pallets - SCANIA P-340. the fuel consumption of this car will be 0.233 cents / km. By using the Large Neighbourhood Search algorithm. we found the delivery route of goods between the warehouse and the affiliates (Figure 3). This route takes 2510 km (The distance of the route is the same for the present (warehouse in Kharkov) and the optimised (warehouse in Kiev) version of logistic network - Figure 3).

Table 4. Input data and results of the VRP method.

1.Locations			Number of depots			1	
			Number of customers			5	
2.Distances			Distance / duration computation			Driving distances (km)	
			Route type			Fastest	
			Average vehicle speed			60	
3.Vehicles			Number of vehicle types			1	
4.Solution			Vehicles must return to the depot?			Yes	
Location ID	Name	Address	Latitude (y)	Longitude (x)	Time window start	Time window end	Must be visited?
0	Depot	Kharkiv	50.412097	30.516674	08:00	19:59	Starting location
1	Customer 1	Dnipro	50.442979	30.647289	08:00	19:59	Must be visited
2	Customer 2	Odessa	49.964145	36.240428	08:00	19:59	Must be visited
3	Customer 3	Kyiv1	48.407617	35.031447	08:00	19:59	Must be visited
4	Customer 4	Kyiv2	46.469494	30.721367	08:00	19:59	Must be visited
5	Customer 5	Lviv	49.842188	23.979669	08:00	19:59	Must be visited

The result of calculation

Vehicle:	V1	Stops:	6	Net profit:	340	
Stop count	Location name	Distance travelled	Driving time	Arrival time	Departure time	Working time
0	Depot	0.00	0:00		08:00	0:00
1	Customer 1	470.49	6:21	14:21	14:21	6:21
2	Customer 2	481.70	6:42	14:42	14:42	6:42
3	Customer 3	1027.56	14:17	22:17	22:17	14:17
4	Customer 4	1828.32	25:27	09:27	09:27	25:27
5	Customer 5	2283.20	32:12	16:12	16:12	32:12
6	Depot	2510.29	34:59	18:59		34:59

Source: Author.

When we found the optimal delivery route (solution with the business's own car). we calculated the cost of transportation for this version. In the Table 5 we are comparing the operation costs of the present logistic network (Kharkov) with the operation costs of the optimised logistic network (Kiev).

Table 5. Price list of transportation services.

City	**5 pallets for 1 time**	**5 pallets for 1 time**	**Own car up to 10 pallets**	**Own car from 10 to 30 pallets**
	Main warehouse in Kharkov	**Main warehouse in Kiev**	**Road 2510 km**	**Road 2510 km**
Kharkov. UA	0	315	337	583
Dnipro. UA	270	315		
Odessa. UA	315	315		
Kiev1. UA	315	0		
Kiev2. UA	315	0		
Lvov. UA	420	315		
Total EUR per month	1635	1260	3035	5250

Source: Author.

From the date in Table 5 we can calculate and compare the total cost of delivery depending on the number of pallets (Table 6).

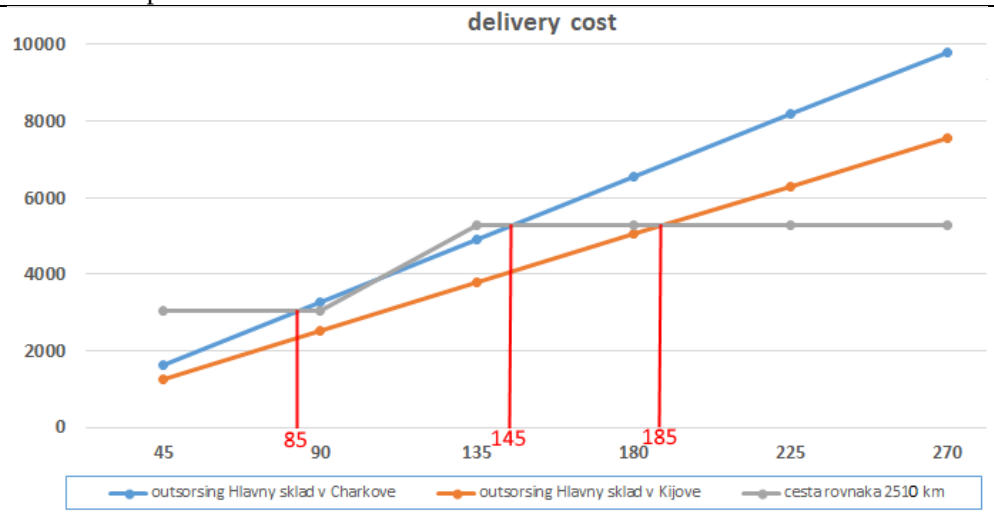
According the data from the Figure 4 we found that when the number of transported pallets exceeds 85 pieces per month (warehouse is located in Kharkov). the transportation costs of the outsourcing logistic service are equal to the transportation costs of using one's own vehicle. If the warehouse will move to Kiev. the transportation cost of the outsourcing logistic service will be equal to the transportation cost of the own vehicle use exactly when the number of transported pallets will be more than 185 per month (Figure 4).

Table 6. Comparison of costs depending on the number of pallets.

Number of pallets/month	Cost (EUR) of services for the month (warehouse in Kharkov)	Cost (EUR) of services for the month (warehouse in Kiev)	Cost (EUR) of services for the month (own car)
45	1635	1260	3035
90	3270	2520	3035
135	4905	3780	5250
180	6540	5040	5250
225	8175	6300	5250
270	9810	7560	5250

Source: Author

Figure 4. Comparison of costs. depending on the number of transported pallets. location of warehouse and transportation mode.



Source: Author.

Conclusions

After analysing the existing logistic network system. we arrived at the following conclusions:

In order to optimize the existing logistics network system. it is possible to change the localisation of the warehouse from Kharkov to Kiev. This will reduce the cost for transportation services provided by the outsourced logistic company by 23%.

If the warehouse is based in Kharkov. when the number of transported pallets exceeds 85 pallets per month. the transportation costs by the outsourced logistic company is approximately equal to the transportation costs of using one's own vehicle. If. for example. the number of transported pallets will be higher than 145 per month. it will be better to use one's own vehicle for transportation than the outsourced logistic company.

If the warehouse will be moved to Kiev and the number of transported pallets will be higher than 185 per month. it would be more profitable for the online store to use their own vehicle for transportation than the outsourced logistic company.

Ultimately. it depends on the final decision of company management what they will do in the future. We recommend to them:

- In the first phase to move the warehouse from Kharkov to Kiev. it will bring them benefits instantly through a reduction in transportation cost from the outsourced logistic company.
- In the second phase. they could think about providing transportation their own way. They could purchase their own vehicle (truck) for the transportation of goods from their warehouse to the regional branches. This decision is dependent on the future demand for the products of the online store. If the company will expect an increase in demand for their products. then they can buy their own vehicle and save on transportation cost compared to using the outsourced logistic company.

In future research. we are planning to carry out more detailed economic calculations of the own vehicle transportation costs. including all aspects of the operational cost (for example: servicing the vehicle. amortization. driver's salary. etc.). Also. we will focus on calculating the optimal delivery time that will consider the open hours of branches and the driving time of the vehicle.

Acknowledgements

This paper was developed under the support of project: VEGA 1/0721/18 the research of economic impacts of visual smog on transport using methods of neuroscience.

References

Andreyev. A. (2012). Prodayem virtual'no. dostavlyayem real'no! Logistika Internet-magazinov [We sell virtually. we deliver really! Logistics online stores.]. Logistika. (11). 14-15. from https://elibrary.ru/item.asp?id=18244848

Bachanova. P.. Corejova. T.. & Rostasova. M. (2009). The green issues of postal industry in Europe. Cers 2009 - 3rd Central European Conference in Regional Science. International Conference Proceedings - Young Scientists Articles. 901-905.

Brownlee. J. (2015). Tabu Search. (Clever Algorithms: Nature-Inspired Programming Recipes). from http://www.cleveralgorithms.com/nature-inspired/stochastic/tabu_search.html

Couclelis. H. (2004). Pizza over the Internet: E-commerce. the fragmentation of activity and the tyranny of the region. Entrepreneurship & Regional Development 16. 41–54.

Drozdziel. P.. Winska. M.. Madlenak. R.. & Szumski. P. (2017). Optimization of the position of the local distribution centre of the regional post logistics network. Transport Problems. 12(3). 43-50. doi:10.20858/tp.2017.12.3.4

Erdoğan G. (2017a); FLP Spreadsheet Solver. Retrieved from http://people.bath.ac.uk/ge277/index.php/flp-spreadsheet-solver/

Erdoğan G. (2017b); VRP Spreadsheet Solver. Retrieved from http://people.bath.ac.uk/ge277/index.php/vrp-spreadsheet-solver/

Farag. S.. Schwanen. T.. Dijst. M.. & Faber. J. (2007). Shopping online and/or in-store? A structural equation model of the relationships between e-shopping and in-store shopping. Transportation Research Part A: Policy and Practice. 41(2). 125-141.

Magomedov. A. M. (2013). Transportnaya podsistema v logisticheskoy sisteme regiona. Upravleniye ekonomicheskimi sistemami: elektronnnyy nauchnyy zhurnal. (11 (59)).

Madlenak. R.. Madlenakova. L.. & Stefunko. J. (2015). The variant approach to the optimization of the postal transportation network in the conditions of the Slovak republic. Transport and Telecommunication Journal. 16(3). 237-245. doi:10.1515/ttj-2015-0022

Madlenak. R.. Madlenakova. L.. Stefunko. J.. & Keil. R. (2016). Multiple approaches of solving allocation problems on postal transportation network in conditions of large countries. Transport and Telecommunication Journal. 17(3). 222-230. doi:10.1515/ttj-2016-0020

Madlenakova. L.. Matuskova. M.. & Hrudkay. K. (2016). Intermodal Transport Terminals as Part of the Postal Transportation Network. 20th International Scientific Conference on Transport Means 2016. Juodkrante. LITHUANIA.

Mikhaylyuk. M. V. (2016). Tsepi postavok i internet-logistika v usloviyakh mnogokanal'nogo razvitiya riteyla.[Supply chains and Internet logistics in the conditions of multichannel retail development] Simvol nauki. (12-1) from https://cyberleninka.ru/article/n/tsepi-postavok-i-internet-logistika-v-usloviyah-mnogokanalnogo-razvitiya-riteyla

Nikolayeva. I. P.. Lezhnev. YU. V. (2013). Problemy razvitiya elektronnoy torgovli. [Problems of development of electronic commerce] Izvestiya Volgogradskogo gosudarstvennogo tekhnicheskogo universiteta. (11). 62-74. from https://elibrary.ru/item.asp?id=19419355

Stalmasekova. N.. Genzorova. T.. Corejova. T.. & Gasperova. L. (2017). The impact of using the digital environment in transport. 12th International Scientific Conference of Young Scientists on Sustainable. Modern and Safe Transport. 192. 231-236. doi:10.1016/j.proeng.2017.06.040

TNS Interactive (2002); Global e-Commerce Report 2002. http://www.tnsofres.com/ger2002/ (accessed 5.7.2004);

Tolmachev O. V. (2013). Logistika tovarodvizheniya [Logistics of distribution of goods]: uchebnoye elektronnoye tekstovoye izdaniye / O. V. Tolmachev ; nauchnyy redaktor N. M. Tret'yakova ; Ural'skiy federal'nyy universitet imeni pervogo Prezidenta Rossii B. N. Yel'tsina. Institut «Vysshaya shkola ekonomiki i menedzhmenta». Departament NOTS «INZHEK». Kafedra ekonomiki prirodopol'zovaniya. — Yekaterinburg. 2013. — 360 s. — from http://hdl.handle.net/10995/28157.

Ward. M.R.. Morganosky. M. (2002); Consumer acquisition of product information and subsequent purchase channel decisions M.R. Baye (Ed.). Advances in Applied Microeconomics: The Economics of the Internet and E-Commerce. Elsevier Science. Amsterdam