City's Parameters Influence on Transportation Servicing of Goods

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***Abstract* – Production delivery in the consumption sphere is one of the important trade functions that take place in the commercial companies. Rational management is important in goods distribution processes. Logistics tools are affecting on distribution channel delivery mechanism choice for different regions. The sales channels choice is one of the key decisions for the company.**

The traditional concept of management is not excusing itself. Logistics activities of transportation servicing for various cities in the current market conditions, research not enough. Paper is aimed to improving existing models and approaches to urban transportation servicing of goods carriage.

Key words – logistics channel, material flow, transport planning cities, Automobilization level, retail network.

I. Introduction

The challenge in product's markets is carried out by different aspects. Logistics is no exception, it chose the best way to bring product - material flow from the suppler to client, with minimal price, time and maximum service level.

Increasing demands for transportation services caused by goods range and conditions of their carriage is increasing leads to necessity of improving transportation service approaches to material flows. Lot of markets of these goods makes to search best way to distribute them in different areas.

Choice of LC is influencing on distribution processes efficiency. The LC is linearly ordered characteristics participants that perform logistics operations which bring the MF from one participant to another or to the end user. LC consists of different participant's: manufacturers (seller), consumer (buyer) and logistics agents, storages, services organizations and others. An example of the LC is presented on fig. 1.

Channel's selection directly effects on speed, time, efficiency and safety of products movement during its delivery from producer to final consumer.

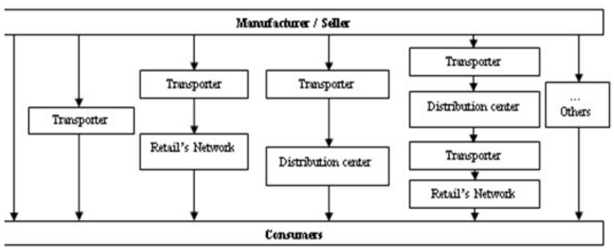

Fig. 1. Material flow's distribution channels scheme [1]

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Existing general methods and models of logistics do not allow us to estimate the impact of a particular region, area or city on MF promotion processes. Therefore, the purpose of the article was chosen precisely evaluate the effect of various city's parameters on urban transportation servicing (TS). For this purpose the following tasks were performed: The city's characteristics analysis; analyzed and substantiated methods of transportation services; analyzed and substantiated methods of transportation planning of cities; Determined the influence of city's parameters on transport processes of goods carriage; Average transportation speed was determined in various Ukrainian cities.

II. City's characteristics analysis

Analysis of the sources of literature defines a large number of options the city, including the main can be considered: city area [2, 3], population [2, 3], city radius [4], Automobilization level [4, 5], the density of the road network [4-6], circuit city transport planning [2-6].

One of the main parameters is the city population [2, 3]. It directly affects the amount of territory planning structure, quantity and quality of life institutions, transport and engineering equipment and others. An important criterion for classification of a settlement to the status of the city is a population that is determined by:

- Small city: up to 10 thousand. - 50 thousand people;
- Medium: 50 - 250 thousand people;
- Big: 250 - 500 thousand people;
- Significant (large): 500 - 1000 thousand people;
- The most significant (the largest): over 1000 thousand people.

The category of the most significant in Ukraine are five cities: Kyiv (2,6 mln. people), Kharkiv (1.47 mln. people) Dnepropetrovsk (1,065 mln. people), Donetsk (1,016 mln. people), Odessa (1.05 mln. people), Lviv (0.9 mln. people).

Analysis of the sources of references defines eight fundamental geometrical schemes covering the diversity of urban planning structures [3-7]. Schematic representation of urban planning structures is presented in Table. 1.

It should be noted that in its pure form all the above schemes street network in modern major cities are small.

The density of the road network of the city is the ratio of the total length of the road network to the area of the city served. Too high density network has drawbacks, such as significant investments in network construction, major maintenance costs and low speed because of frequent traffic intersections. Under the current town-planning regulations mean density of transport networks in cities located within 1.0 - 2.5 km/km^2

The density of main street network in the village as a whole and its individual areas should be taken according to the Table 2 [6]. Value density transport network and walking areas in the city different areas preset in Table 3.

TABLE 1

DESCRIPTION OF THE TOWN PLANNING AGENCIES [4]

Name of scheme	Description	Coefficient	Source
free	The entire network consists of narrow crooked streets with variable width carriageway. For cities in Ukraine, this scheme is not applicable	-	[12-16]
radial	Complicated connections between peripheral regions, causing significant rerun and overload city center	>>1	[12, 13, 15, 16]
radial-ring	Has two fundamentally different types of highways - radial and ring	1,05 – 1,1	[12-16]
triangular	There is no clearly defined central core and the possibility of even distribution of transportation throughout the city	1,4-1,5	[12-16]
rectangular	It includes chord and diagonal streets, punched in the existing building on the busiest destinations	1,2-1,3	[12-14, 16]
hexagonal	The basis of the scheme is a combination of hexagons, excluded the formation of complex assemblies crossings on highways	-	[12, 13]

TABLE 2

DENSITY STREET NETWORK BACKBONE [4]

Groups of cities	The average density of main street network in the city, km / km^2	Including areas of cities		
		central	average	peripheral
The largest	2,0-2,5	4,0	2,2	1,4
large	1,8-2,1	3,4	1,6	1,2
Big	1,6-1,8	2,2	1,4	1,1
Medium	1,4-1,6	1,6	1,2	1,0
Small city	1,0-1,2	1,2	1,0	0,7

TABLE 3

TERRITORIAL DENSITY OF URBAN TRANSPORT NETWORK [4]

Qualitative characteristic density of the transport network	The density of urban transport network			
	In the city	In the city center	In the middle zone	At the periphery
Very small	Less than 1.6	Less than 3.0	Less than 1,6	Less than 1,35
Small	1,6-2,2	3,0-3,5	1,6-2,5	1,35-2,0
Moderate	2,2-2,75	3,5-4,0	2,5-3,5	2,0-2,42
Dense	2,75-3,25	4,0-5,0	3,5-4,5	2,42-2,75
Very dense	3,25-3,7	5,0-6,0	4,5-5,0	2,75-3,15
Extremely dense	Over 3.7	Over 6,0	Over 5,0	Over 3,15

The city area is the area bounded by the city limits, measured in square units. Area of the city, according to studies, affects the rate of dislocation density of consumers, and thus the distance between adjacent points.

According to the definition of the area, the city radius is the distance from the city center to the specified anywhere in the city. The radius of the city largely influences the speed connections. In this regard, is the value recommended speeds depending on the radius of the city [8].

TS are inextricably linked with the principles of urban planning and forecasting.

Solving problems TS can be obtained considering the parameters of the city. Therefore, it is possible to trace the influence of city planning structure parameters of LC.

III. Methods of transportation service

At the heart of the management of MF is processing information (technological, technical, economic) that aggregate information about the functioning of various objects that can capture, transfer, convert and use to perform management functions such as planning, accounting, analysis, management and others.

Given the fact that traffic volumes are directly related to the volume of material flows, determine the value of the last calculation in the horizon [7, 8, 9]. Average turnover time of vehicles is determined by:

$$\overline{T}_r^v = \frac{\bar{l}_m}{V_t^v} + t_{li} + t_{uli} \qquad (1)$$

where $\bar{l}_m$ - The average route length in km; V_t^v - Technical vehicle speed in km / h.; t_{li} - Down time under load, h.; t_{uli} - Idle time during unloading to service retailers, h.

Adaptability streets of network to the requirements of modern urban traffic misalignment coefficient estimated - the ratio of the actual length of the path between two points to the length of the line between them [3]. Coefficient misalignment of RN calculated by the formula:

$$R = \frac{\sum_{i=1}^{n} l_{road}}{\sum_{i=1}^{n} l_{air}} \qquad (2)$$

where l_{road} - The length between the points of roads, km; l_{air} - length between points "over the air", km; n - The number of plots.

It should be mentioned the approach takes into account the density of participants as retail network (RN) equidistant between them.

IV. Methods and models of City’s transportation planning

Analysis of TS is procedure for the production, study and decision-making in the research process and the formation of a transport customer service, which allows a simple turn complex.

Systematic analysis of the activity of the motor company is to select the main elements of the structure and functions of the management system. It allows you to create a mathematical model which is a tool location and describe the behavior of elements of the enterprise.

The formation of traffic is a result of the operation of transport systems biggest cities [9]. The transport flows consist of a set of correspondence of vehicles sold in the same ways, forming patterns which, subject to certain rules and can be formalized.

The need to understand patterns of transportation caused by the use of mathematical models in modeling traffic flows. In practice, modeling of traffic, there are several different approaches to the description of regularities of their formation.

Patterns of traffic formation based on a macroscopic approach found reflection in [10-14]. This approach is based on the fact that the relationship between the characteristics of the traffic flow can be established on the basis of experimental data, the analysis of boundary conditions and physical analogies [14].

Depending on the purpose of research can be used a variety of methods for determining the speed of traffic. In general, all methods can be divided into full-scale and modeling techniques.

The method of field research [15] is to obtain actual speed in a given space and within a specified period. This method is to conduct direct observations. Determining the speed of transportation can be done by modeling methods [12, 15, 16].

It should be noted that the benefits of field observations of traffic speed is their high accuracy, ease of use. The disadvantages are the complexity and high cost of material survey, especially when using special technical means and vehicles [15]. The use of this group of methods is possible on stage to collect the necessary statistical information. For example, when developing traffic models. However, given the material and technical possibilities, preference should be given direct counsel against transport network and the implementation of control gauging's when traveling in a car without special equipment.

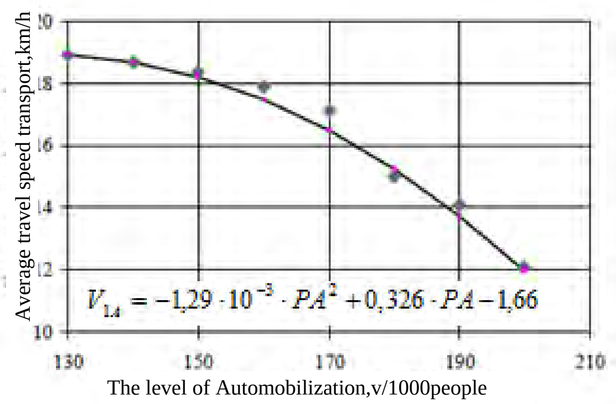


Fig. 2. Dependence of average travel speed network the level of Automobilization [17]

The second group of methods for determining the speed of traffic is to use traffic models. To establish a connection between the various pairs of the main characteristics of transport stream can be used [14, 16]:

- Experimental data and built on them functions;
- Conclusions reached in the analysis of boundary conditions;
- Physical analogy.

At this time developed several approaches to determining the speed of traffic in terms of urban transport networks. One of the approaches developed by C. Robinson [15], based on the assumption that the total impact of regulated and unregulated intersections, edge effects reduces the capacity of city streets by about 50%. In this approach, the dependence of traffic on its intensity has the form:

$$V = 55{,}82 - 6{,}92 \cdot 10^{-5} \cdot N_{1n}^2 , \qquad (3)$$

where N_{1n} – traffic, which accounts for an average of one lane city street, cars / hour.

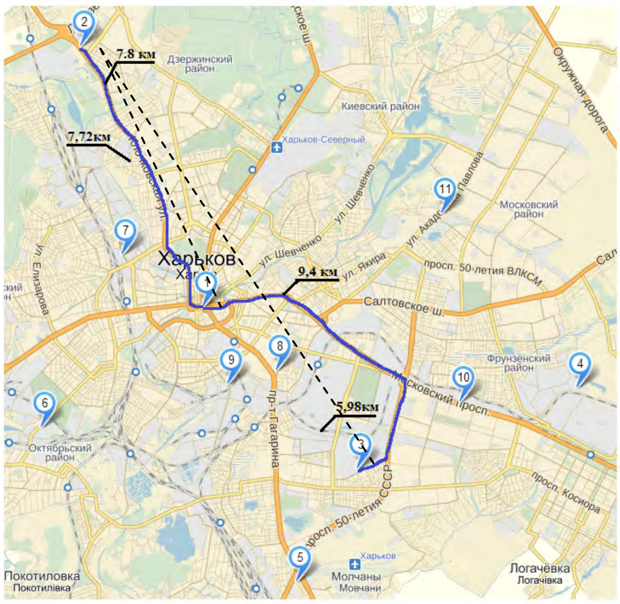
Model Eq. (3) is suitable for use in urban transport networks. But it is designed to determine the speed only a limited category of city streets - where free flow speed not exceeding 60 km/h. As imagined, this model will give significant errors in determining the speed of traffic on the streets of large (70-80 km / h) and low (30-40 km / h) speed of free movement. Univariate models of change in network [16].

Presented regression models change the speed of traffic in urban areas are adequate and suitable for use in solving problems increase the efficiency of transportation systems significant and largest cities. This proposed model is most appropriate for further calculations

V. Determination of city's parameters influence on average transportation speed

For the calculation of road network outline misalignment N sites (we have 10) measurement by determining the start and end points of the site. These points are located directly on the road.

For Kharkiv city was scheduled for the following 10 lots, similar to sections 1-2 and 1-3, centered in paragraph 1 Fig. 3.



where

- l -length between points on road
- l -length between points "over the air"

Fig. 3. Scheme of points for the calculation of road network for misalignment c. Kharkiv

It calculated the distance roads and "over the air" between the center and all areas. Similarly, it was planned and calculated the distance between the points for the three retailers of the city. For c. Kharkiv factor misalignment road network for RN 1 is:

$$R = \frac{72,1}{58,5} = 1,23.$$

For m c. Kyiv, c. Lviv and c. Dnepropetrovsk Calculation misalignment road networks perform similarly c. Kharkiv. The calculation results are summarized in the Table 4.

According to the obtained coefficient misalignment road network and Table 4 may identify each city planning scheme.

Thus, c. Kharkiv and c. Kyiv with a rectangular-diagonal scheme planning, and c. Lviv and c. Dnepropetrovsk – rectangular.

The closer this ratio is to unity, the better the draft transport network. Table 5 degree is misalignment network depending on the value coefficient.

TABLE 4

RESULTS OF CALCULATIONS FOR DIFFERENT COEFFICIENTS MISALIGNMENT RETAIL NETWORK [4]

Name of the City	Number s / n	Name of RN	Coefficient of misalignment	The average value of coefficient of misalignment	Number of participants RN
Kharkiv	1	household goods 1	1,23	1,2	10
	2	ATB	1,15		10
	3	ProStor	1,15		10
	4	Foxtrot	1,26		7
Kyiv	1	household goods 2	1,44	1,3	10
	2	ATB	1,29		10
	3	ProStor	1,28		8
	4	Foxtrot	1,36		9
Dnipropetrovsk	1	household goods 3	1,63	1,5	10
	2	ATB	1,55		10
	3	ProStor	1,48		10
	4	Foxtrot	1,47		5
Lviv	1	household goods 4	1,38	1,4	10
	2	household goods 5	1,45		10

To determine the average distance between two adjacent points on dependence Eq. (4). In the case of uneven distribution of dependence have the following form:

$$\bar{l}_d = \frac{\sqrt{\lambda_d^{-1}}}{R} \cdot \delta, \qquad (4)$$

where R - misalignment coefficient of the road network; λ_d - density deployment consumers, defined as: δ - dispersion, which in this case describes the deviation from the average in terms of length and is given by:

$$\delta = \frac{\sqrt{\sum (\bar{l}^{air} - l^{air\text{в}}_{actual})^2}}{n} \cdot 100\%, \qquad (5)$$

where $\bar{l}^{air}$ - the average value of length between points "over the air" km; l^{airr}_{actual} - the actual value of length between points "over the air", km.

TABLE 5

DEGREE OF MISALIGNMENT NETWORK [4]

Coefficient	Degree of misalignment network
Over 1.3	exceptionally high
1,25-1,3	very high
1,2-1,25	high
1,15-1,2	moderate
1,1-1,15	small
1,1	very small

The density of retail network in the city determined by the relationship:

$$\lambda_d = \frac{N_r}{S_m} \qquad (6)$$

where S_m - district service area (city square).

TABLE 6

RESULTS OF CALCULATION UNEVEN DISTRIBUTION OF PARTICIPANTS FOR VARIOUS RETAIL NETWORK

Name of the City	Number s / n	Name of RN	Coefficient of irregularity	The average value of irregularity coefficient	Number of participants RN
Kharkiv	1	household goods 1	0,46	0,5	10
	2	ATB	0,51		10
	3	ProStor	0,48		10
	4	Foxtrot	0,56		7
Kyiv	1	household goods 2	0,56	0,69	10
	2	ATB	0,79		10
	3	ProStor	0,72		8
	4	Foxtrot	0,69		9
Dnipropetrovsk	1	household goods 3	0,41	0,34	10
	2	ATB	0,29		10
	3	ProStor	0,32		10
	4	Foxtrot	0,35		5
Lviv	1	household goods 4	0,8	0,85	10
	2	household goods 5	0,89		10

According to Table 6 can conclude that within a city of irregularity coefficient did not differ significantly, which confirmed the existence of irregularity placement participants of RN. Further calculations of the average distance between two adjacent points using the dependence Eq. (5). For the city of Kharkov in the number of participants of retail network N_r =15 shall have the following meanings:

$$\delta = \frac{27,64}{55} = 0,5025 \cdot 100 = 50,25\%;$$

$$\lambda_d = \frac{15}{350} = 0,042;$$

$$\overline{l_d} = \frac{\sqrt{0,042^{-1}}}{1,2} \cdot 0,5 = 2,01 \text{ km};$$

Similarly perform the calculation for other cities. For the city of Kyiv will have the following values:

$$\delta = \frac{37,95}{55} = 0,69 \cdot 100 = 69\%;$$

$$\lambda_d = \frac{15}{840} = 0,017;$$

$$\overline{l_d} = \frac{\sqrt{0,017^{-1}}}{1,3} \cdot 0,69 = 3,97 \text{ km};$$

For the city of Dnepropetrovsk will have the following values:

$$\delta = \frac{18,74}{55} = 0,34 \cdot 100 = 34\%;$$

$$\lambda_d = \frac{15}{405} = 0,037;$$

$$\overline{l_d} = \frac{\sqrt{0,037^{-1}}}{1,5} \cdot 0,34 = 1,17 \text{ km};$$

For city of c. Lviv will have the following values:

$$\delta = \frac{46,75}{55} = 0,85 \cdot 100 = 85\%;$$

$$\lambda_d = \frac{15}{190} = 0,078;$$

$$\overline{l_d} = \frac{\sqrt{0,078^{-1}}}{1,4} \cdot 0,85 = 2,16 \text{ km}.$$

The data will be used in subsequent calculations to determine turnover time. Increasing of length of the route leads to an increase in the turnover time.

VI. Finding and results of speed calculations for different city's

According to statistics to the Automobilization level and specific density of the transport network for the cities of Kharkiv, Kyiv, Dnipropetrovsk and Lviv reduced to the Table 7.

TABLE 7

VALUES OF AUTOMOBILIZATION AND SPECIFIC DENSITY OF TRANSPORT NETWORKS FOR CITIES

City's Name	Indicators	
	The level of Automobilization, v/1000 people	Specific density of the transport network, km^2/ km^2 10^2
Kharkiv	143	1,97
Kyiv	200	1,5
Dnipropetrovsk	171	2,1
Lviv	187	1,8

According to Table 3 and Table 7 density values obtained for each characteristic quality of the city transport network density for Kharkiv - small, Kyiv - very small for Dnipropetrovsk and Lviv is also small.

Average travel speed network, depending on the specific density for cities [17] will be equal to:

$$V_{Kharkiv} = 17,4 \cdot 1,97 - 1,62 \cdot 1,97^2 - 10,56 = = 17,4 \textit{km/h.};$$

$$V_{Kyiv} = 17,4 \cdot 1,5 - 1,62 \cdot 1,5^2 - 10,56 = 11,8 \text{ km/h.};$$

$$V_{Lviv} = 17,4 \cdot 1,8 - 1,62 \cdot 1,8^2 - 10,56 = 15,5 \text{ km/h.};$$

$$V_{Dnipropetrovsk} = 17,4 \cdot 2,1 - 1,62 \cdot 2,1^2 - 10,56 = = 18,8 \textit{km/h.}$$

Average travel speed network depending on Automobilization level for cities [19] will be equal to:

$$V_{Kharkiv} = -1,29 \cdot 10^{-3} + 143^2 + 0,326 \cdot 143 - 1,66 = = 18,57 \textit{km/h.};$$

$$V_{Kyiv} = -1,29 \cdot 10^{-3} + 200^2 + 0,326 \cdot 200 - 1,66 = = 11,9 \textit{km/h.};$$

$$V_{Lviv} = -1,29 \cdot 10^{-3} + 187^2 + 0,326 \cdot 187 - 1,66 = = 14,2 \textit{ km/h.};$$

$$V_{Dnipropetrovsk} = -1,29 \cdot 10^{-3} + 171^2 + 0,326 \cdot 171 - -1,66 = 16,36 \textit{ km/h.}$$

The values of the cities' network speed depending on the specific density of the transport network and depending on the Automobilization level not significantly different, so the results can be used for calculation the required the turnover time (1) and the number of vehicles for a specific city.

Conclusion

As a result of research had found influence of city's parameters (Automobilization level, density of the transport network, degree of misalignment network) on elements of urban transportation servicing process (average transportation speed of vehicle and the length of the route). Calculations have shown that an increase in the Automobilization level and traffic misalignment coefficient increases turnaround time, increasing the density of the road network on the contrary decreases turnaround time.

Further research should focus on further investigation of the influence of the city's parameters on logistics technology choice in them.

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