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APPLICATION OF SOCIALLY-ORIENTED AND LEGAL INNOVATIVE PRACTICES IN THE URBAN TRANSPORT FLOW LOGISTICS AND TOURISM

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ABSTRACT

The relevance of the study is determined by the public interest in logistic support of urban transport flows and tourism. The aim of the article is to determine the best innovative practices of providing transport and tourist flows by different urban transport modes, and also to identify prospects for their use in conditions of domestic markets. The study found that according to the German experience as one of the best practices, the priority of the development should be given to the rail transport as a key component of urban transport and logistics infrastructure, including the tourism sector. It was determined that the integrated urban intelligent transport system includes the traffic management system, the public transport management system, the parking management system and the logistics flow management system, considering the impact of tourism. The regularities of the influence of factors on the dynamics of urban transport flows were determined based on a critical analysis of a number of specific cases. The prospects for the development of rural areas adjacent to such cities were determined, given the development of transport and logistics infrastructure of the country. The materials of the study can be useful for employees of the transport and logistics sector and the sphere of tourist services, researchers, graduate students, doctoral students, and government officials.

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INTRODUCTION

The rapid expansion of cities requires the implementation of modern approaches to the development of their transport infrastructure. This is manifested primarily in the implementation of intelligent transport systems in cities. The city's integrated intelligent transport system should consist of a traffic management system, a public transport management system, a parking management system, and a logistics flow management system. The state and municipal authorities of most countries of the world are interested in the development of the tourism sector but now this issue contradicts the quarantine measures due to the spread of COVID-19 worldwide. The tourism sector, which has suffered the most from these restrictions, is gradually recovering and needs to find

the most innovative socially oriented and legal practices that would accelerate this process. The tourism is inextricably linked to urban logistics, and therefore, the effective logistic support of urban transport flows will include the management of tourist flows. In their study Porta *et al.* (2006) proposed a number of models for different cases of urban street networks. The authors conducted a comparative study of some structural properties of double graphs, looking for significant similarity and recurrence between clusters of different cases, which is an interesting scientific achievement.

The adaptive approach proposed by Daganzo (2007) to control in order to improve urban mobility and reduce congestion, was a new view, which was characterized by the implementation of monitoring and control of aggregate traffic congestion at the district level. The ease of using the dynamic models proposed by the author and the need for observational initial data should be considered a significant advantage over other similar tools. In the study by Geroliminis and Daganzo (2008), the authors found that in a large urban area there is a macroscopic fundamental diagram that directly links the space-mean flow, density and speed, and that there is a fixed relationship between space-mean flows across the network. To assess urban flows, data from minibuses with GPS support were used. Continuing his research, N. Geroliminis concludes that the analytical theories of studying the relations between network structure and the macroscopic fundamental diagram for urban areas proposed earlier do not consider the influence of turns, and therefore, are not optimal (Geroliminis and Boyacı, 2012). The approaches proposed in the paper allowed to consider the variability for different cities and signal structures, which, in our opinion, is a key theoretical and practical development. Evaluation of the implementation of freight traffic management system was conducted by Bo *et al* (2019).

Investigating undirected unweighted network road models, Guo and Lu (2016) proposed two modeling methods based on complex network theory and data trajectory filtering. The authors also proved the partial randomness of the development of urban traffic. Virtual logistics management, logistics 4.0 approach (Galkin *et al*., 2019), scenario modeling the technological scheme of delivery (Galkin *et al*., 2020) are promising areas of research. Intelligent transport systems often face the problem of congestion and require the development of the most applied mathematical apparatus that would consider the impact of different solutions on the traffic flow of cities. A heuristic approach should be a basic one to improving congestion modeling (Zambrano-Martinez *et al*., 2017). It is worth noting that only some sections of the streets fall under the general vehicle flow theory, ensuring adequacy by quadratic regression, while other categories are typical in other cases (Zambrano-Martinez *et al*., 2018). A more detailed analysis of the road network may include the proposed by Zhao *et al*. (2017) system for measuring the centralization of the network, considering its topological characteristics and geometric properties.

Studies by Wang *et al*. (2018) regarding the distribution of demand for urban traffic show that during peak hours at different intersections and roads there is heterogeneity, but there is a correlation between peak hourly flows and daily flows. The authors proposed the model of connection between the structure and functions of urban roads, which is a very interesting development that should be implemented in practice. In general, the use of systematic traffic management is one of the key innovative tools for logistic support of urban transport flows. These studies are interesting precisely because of the application of information solutions in solving the problem of estimating traffic flows of cities. In a study by Lu *et al*. (2018), the authors proposed an innovative approach to identifying tools improving traffic in the city. Moreover, the spatial correlation of traffic in the city's road networks was revealed. In the large-scale scientific research of Zhang *et al*. (2021), the authors constructed a spatial network of traffic flows, highlighting the cold and hot spots between them. The study divided traffic flow networks into communities by centralization and density. In our opinion, this study allowed the nature of urban traffic flows to be better understood.

METHODOLOGICAL FRAMEWORK

When optimizing transport and logistics flows in cities, it is necessary to balance the interests of society and business. Society is interested in ensuring a comfortable standard of living for individuals associated with ensuring transport accessibility, food and environmental safety. In turn, urban delivery for transport and logistics companies is extremely important. The main delays often occur here and significant financial costs are incurred. The importance for the logistics business on the "last mile" delivery section requires the

implementation of modern solutions while minimizing costs, which is beneficial for public interests, since, in particular, the movement of heavy vehicles in cities is minimized, and a better adaptation to customer requests is provided, as parts of society. Within the scientific work of Lu *et al*. (2014), the authors proposed a two-parameter dynamic model of the community for building social networks on the criteria of communication speed and exchange rate. An interesting achievement should be the experimental proof by the authors that the networks created by the proposed model can significantly and qualitatively reproduce the networks of social contacts.

Any socially oriented innovative practices are inextricably linked with the possibility of their implementation, and for this, in particular, it is necessary to adequately assess the educational level of the population. The feasibility of applying a systematic approach to diagnosing the level of education of people should be determined and the results of diagnosing the educational level of the city should be evaluated in the context of the information society formation (Martynovych *et al*., 2019). Mobility during traveling, especially in large cities, is becoming an important factor in the quality assessment of the tourist product by consumers. According to Albalate and Bel (2010), the intensity of tourism is a factor that increases the demand for urban public transport and causes its development, but also causes problems for urban residents associated with limited supply and congestion. Other researchers agree with this, in particular Hącia (2019), who notes the need for research aimed at solving these problems by developing effective tools.

Yang et al. (2019), found that air transport has a greater impact on two-way tourist flows than rail, and the effects of transport connections and intermodal transport competition directly depend on the total distance of departure-destination. An interesting regularity was found by Gutiérrez and Miravet (2016). They identified that although tourists who arrived by plane and had a profile according to which they used public transport the least, used it the most, and those tourists who arrived in their own car used it even when it was obviously more convenient to use public transport. Therefore, the tourist profile becomes in some cases non-priority for consideration, and the most important thing is whether they use their own car. The tourism sector is affected by a number of legal acts and regulations relating to transport, accommodation, food provision, consumer protection, e-commerce, development of recreation and tourism facilities in general. Standards of quality of living and food set for specific types of locations have a significant impact.

The key normative and legal documents regulating tourist services within the EU are the following: Directive (EU) 2015/2302 on package travel and linked travel arrangements and Directive 2011/83/EU of the European Parliament and of the Council on consumer rights, as well as Regulation (EC) Fairness in platform-to-business relations Platform-to-business trading practices (EU, 2021). The research of Russo *et al*. (2021) is devoted to determining the optimal method of designing urban courier and express delivery logistics centers. The mathematical apparatus for the authors was a model of linear optimization on the criterion of maximizing utility with optimal distribution of capacities of the common infrastructure of the subjects of the courier and express delivery market. Mechanisms supporting collection-and-delivery points as a sustainable innovation in urban logistics, implementing current market proposals have been the subject of research by Altuntaş and Aktepe (2021). Herewith, the authors rightly emphasize that collection-and-delivery points should become solutions that must be supplemented by other logistics services in order to expand the offer and for their better implementation.

The use of software to optimize the urban logistics is also becoming an integral part of the application of innovative practices. Šourek (2021) devoted their research to these problems. The author uses computing software and modeling tools to solve a wide range of planning problems and optimization processes in urban logistics. The proposed solutions are especially effective in modeling typical urban logistics processes, where an exceptionally high level of reliability of results is achieved. The study of Gardrat (2021) is focused on the development of preconditions for formation of the concept that synthesizes the expansion of urban logistics and other dynamics of localization, a key factor determining the mobility of goods. The work of İmre *et al.* (2021) is devoted to a comprehensive study of the factors influencing the introduction of electric freight vehicles in urban freight fleets. The authors, in particular, identified significant problems with the reliability of information on the proposed tools. During the study the methods of expert analysis, probability theory, methods of formalization and generalization,

statistical analysis, etc. were used.

RESULTS

In general, the largest share of land transport falls on countries with fast-growing and developing economies. A similar trend is observed in urban transport and it tends to increase. At the same time, the greatest efforts to reduce the impact of emissions are made by developed countries, especially the United States and the European Union, while in countries with fast-growing and developing economies, this problem is not systematically addressed. A significant problem is the slow pace of technical progress, because it is road transport that contributes the largest share of emissions from freight transport and the use of older vehicles plays an extremely negative role (ITF, 2021). The active use of electric vehicles instead of motorcycles in the organization of postal deliveries in a number of Korean cities can be considered successful innovative practices. Cost-benefit analysis showed that the benefits of using electric vehicles exceeded costs by 243%, delivery time decreased by 6%, and the mileage of the electric vehicle was 20% less than that of a motorcycle. Delivery services in London, Los Angeles and Hong Kong are also testing similar projects. The results are quite ambiguous, although the advantages of electric vehicles in deliveries are noted in all studies (ITF, 2019).

In the context of the COVID-19 pandemic, the processes of digitalization and e-commerce, regionalization of trade, use of more reliable and proven supply chains, accelerating the introduction of existing technologies and business models become vital for market participants (ITF, 2021). Also, the regionalization of supply chains and the strengthening of the importance of local urban deliveries, especially the “last mile”, are intensifying. The latter will also have impacts for international trade, which is to some extent localized. The ITF freight model fully evaluates freight activity in all regions of the world. At the same time, its content is comprehensive – urban, domestic, suburban and international transportation, it considers 27 types of goods for all major modes of transport (ITF, 2020). This model, first proposed in 2015, is periodically updated and supplemented with new modules. This tool can be considered a inclusive solution to the problem, which includes the logistic support of urban transport flows.

Management of urban transport flows is an extremely complex problem and involves solving a whole set of individual tasks. In particular, it is necessary to determine the principles of urban transport flows’ formation. The principles and patterns of transport flow management are given below. As noted earlier, the tourism sector has a direct impact on urban logistics, and tourist flows are an integral part of urban transport flows. The development of tourism contributes to the development of urban transport and logistics infrastructure. Without considering the impact of tourist flows, it is impossible to qualitatively assess the level of satisfaction of the urban population with public transport services. Tourism itself is a large intersectoral complex that can become a significant driver of both the city’s economy and national economy. For the transport flow of a side street, two types of obstacles are mainly considered: unregulated transport flow of the main street and traffic lights. Currently, traffic lights with different operating principles are used, ranging from traffic lights with a fixed duration of red and green signals to very complex devices that respond to the presence of moving vehicles.

Pedestrians, even if they accumulate a lot, can simultaneously move all together when appropriate conditions allow it, while vehicles must wait in line. Considering pedestrians, single vehicles are also meant, since their delay is not related to the delay of other vehicles. Therefore, the results applicable to pedestrians will also apply to vehicles if the transport flow on the side street is quite rare, allowing neglecting the queuing possibility. The usual service device of a classical queuing system is sensitive in the sense that it starts to act if a new requirement arrives in the system and the previous requirement service is completed. The presence of this requirement would suggest that the waiting time is equal to zero for those requirements at the time of receipt of which the system is free. However, for the case of street intersections, this assumption is not true. At the time of car arrival, there may be no queue, and yet the car will have to wait. If the passage permitting process is considered as a maintenance process, the service device is insensitive until vehicles arrive on the side street and from time to time allows passage regardless of the need for it.

If at a certain moment only one object is passed through, then the turnstile can be considered an insensitive service device; in the case when several objects are simultaneously passing, a traffic light can be considered such a device, but with regard to an unregulated

transport flow of the main street will be such a "device". Also, there is a need to remember about the importance of urban logistics planning, in particular through the traffic light system. Along with the use of modern methods for solving this problem, it involves solving a number of theoretical problems in the framework of determining the patterns of factor influence on the dynamics of transport flows in large cities, to which this study is devoted. To determine the patterns of factor, influence on the dynamics of transport flows, the following cases were considered. The authors revealed that in the queuing theory, the obstruction of free movement is considered as service, and delay duration is called as service duration. However, these concepts can be directly applied only to a small range of issues related to the traffic flow theory. Transport delays at intersections can hardly be considered as a service process. From the point of view of probability theory, the explanation for this simple fact is that the duration of the service is not necessarily random variables distributed according to the same law, and they will definitely not have known distribution densities. Especially absurd is exponential distribution of the service duration. The point is that vehicles begin to move randomly, and go only at the moment when certain conditions are met. In most cases, the arrival process of delayed objects (on a side street) is Poisson. Either vehicles or pedestrians can be considered as delayed objects depending on the possibility of forming a queue. Scheme for determining the patterns of the influence factor on the dynamics of traffic flows is presented on Figure 1.

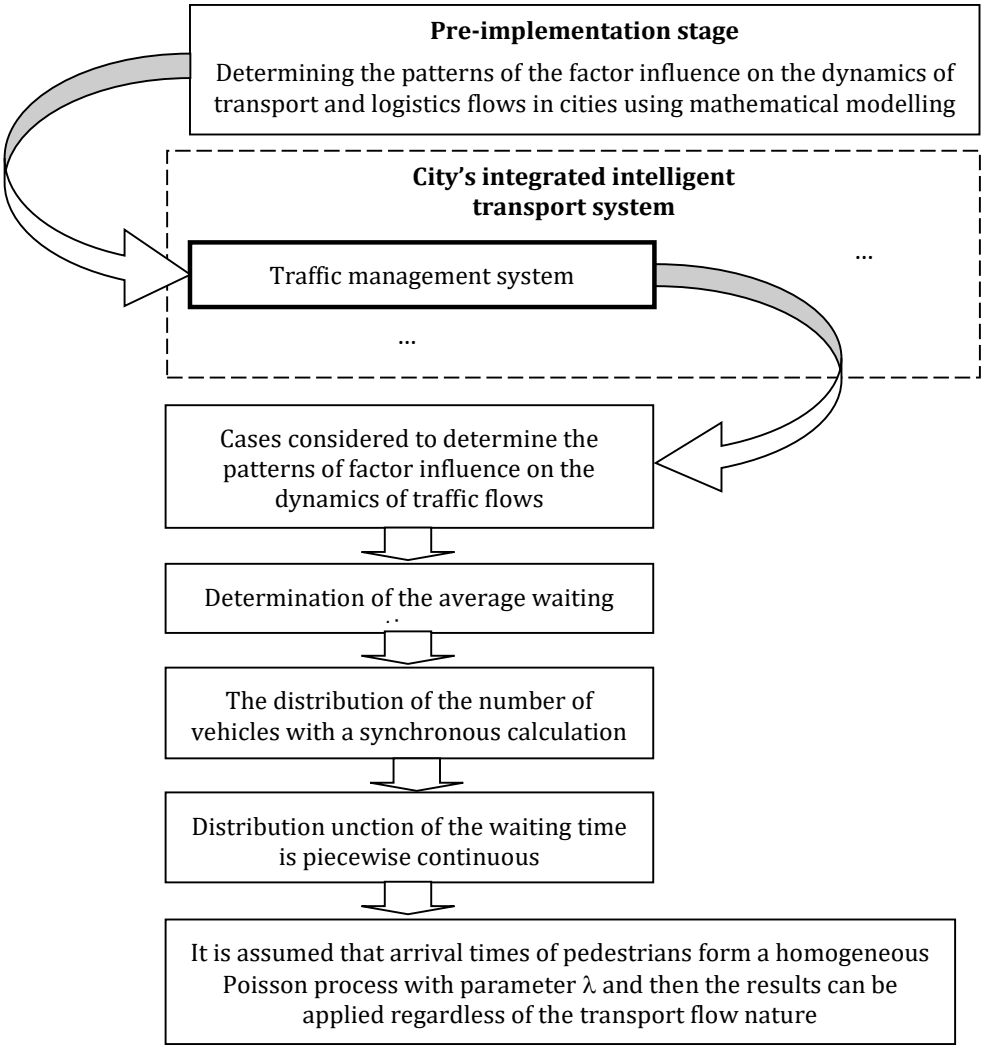

Figure 1. Scheme for determining the patterns of factor influence on the dynamics of traffic flows.

The transport flow of the main street can be characterized by the distribution of intervals between

sequential vehicles (including initial interval distribution) and the presence of a stop sign. The arrival of the delayed car should not depend on the transport flow of the main street. It is assumed that a stop sign prohibits the rapid crossing of an intersection and therefore eliminates speed differences for vehicles on a side street. Delayed vehicles differ only in acceleration. The system of converting streets to one-way traffic has proved to be an extremely effective mechanism for reducing the number of traffic jams in cities. This contributed to an increase in the average vehicle speed and congestion reduction. This mechanism is especially promising for the central part of large cities, in particular side streets, along with traffic restrictions. A sufficient difficulty in assessing the impact of tourist flows and urban transport and logistics infrastructure is seasonal nature of the former.

As a rule, a significant number of tourists from resort cities fall on peak periods, while in low season the number of tourists is insignificant. Considering this issue requires the creation of a flexible system of logistic support of urban transport flows. Prerequisites for its creation in terms of tourism development are given in Figure 2.

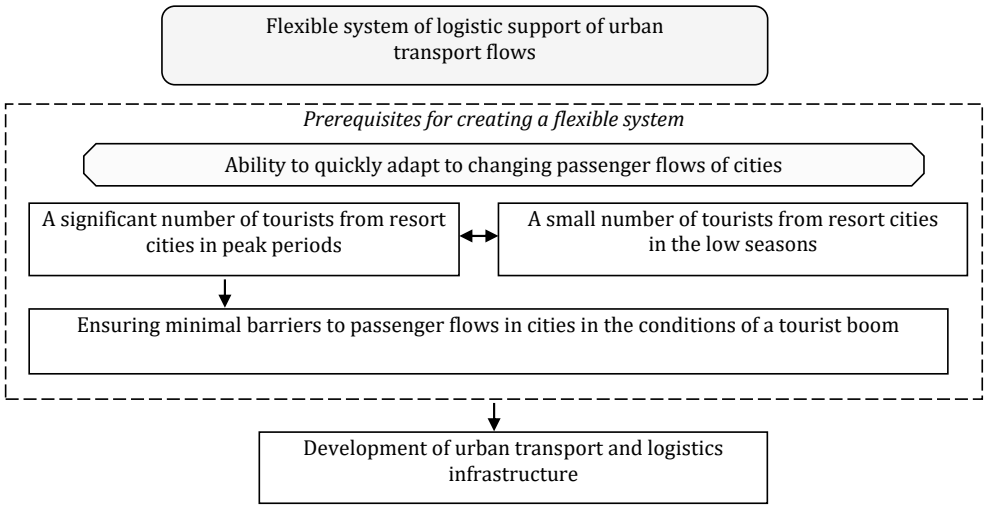

Figure 2. Prerequisites for creating a flexible system of logistic support of urban transport flows considering tourism development

Intelligent urban transport systems are formed without considering the described features of urban transport flow management, and this is completely incorrect, as a qualitative theoretical justification will take full consideration of the characteristics of specific components of urban transport systems. In general, if we consider the cities closest to the most optimal transport systems, they usually have a light rail. It is relevant both for passenger and for freight transportations. The use of this railway is also possible to service tourist flows that are seasonal. A significant advantage of the city light rail is the ability to quickly adapt to changing passenger flows of cities, which is especially relevant for resorts with dynamically changing passenger flows, which in peak periods are complemented by a significant number of tourists. Also, an effectively integrated city light rail is able to provide minimal barriers to urban passenger flows in the conditions of a tourist boom. This is especially relevant given the need to maintain a high level of mobility of the permanent urban population during this period.

DISCUSSION

A serious point of discussion is the extent to which the interests of participants in the transport and logistics sector of the city and their priority should be considered. In addition, it is necessary to determine the prospects for the development of rural areas adjacent to such cities, given the development of transport and logistics infrastructure of the country. In our opinion, the public interests of the country, cities and villages should be the most important ones, and they should take precedence over the interests of individual participants in transport and logistics markets, including tourism sector. The society is interested in the development of urban transport and logistics infrastructure to increase its own

mobility, which determines the development of technological support of urban transport, ease of connection and integration of urban and suburban modes of transport, including airports. Suburban modes of transport are becoming an important part of ensuring the movement of labor to cities and must develop on a par with urban transport, and in full integration with it. But tourist flows should be a quality addition to sustainable urban transport flows and the convenience of their movement in cities should be the basis for ensuring their mobility. A key success indicator of the tourism sector for the city, and the country is the satisfaction of tourists with the service level and transport and logistic support provided, considering the amount of money spent. That is why cities are trying to attract the most solvent tourists who want to get a better and more comprehensive product, while minimizing their impact on urban infrastructure. This can be achieved by creating more innovative transport and tourism facilities, namely hotels, entertainment complexes, shops, including transport hubs such as airports, ports, railway and bus stations. Rural areas adjacent to large cities can get significant opportunities for the development in terms of expanding transport and logistics infrastructure to their boundaries in order to intensify domestic tourism, as well as the relocation of some urban residents to a "greener" environment, Figure 3.

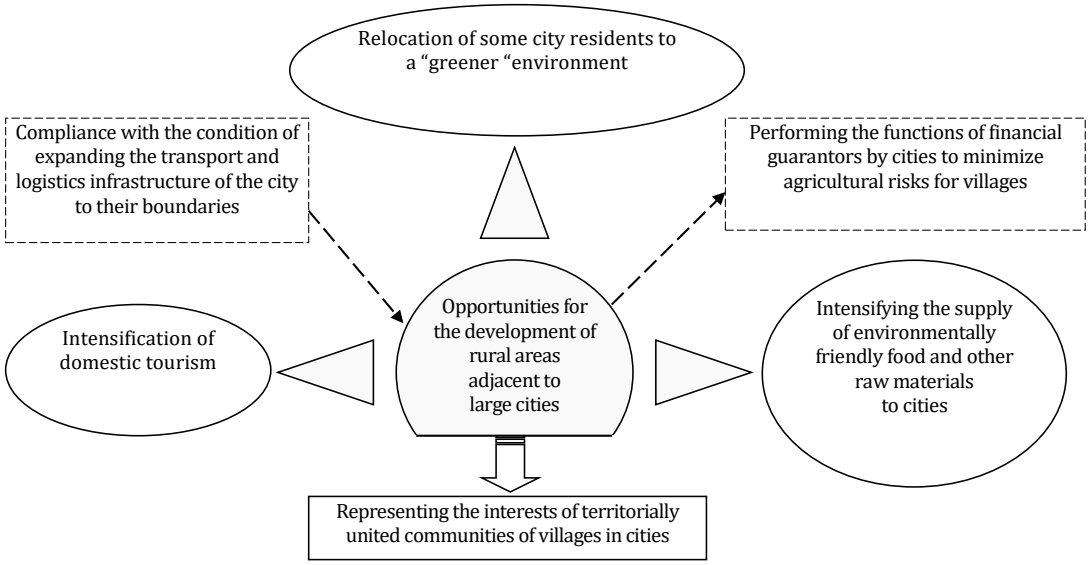

Figure 3. Opportunities for the development of rural areas adjacent to large cities in terms of expanding transport and logistics infrastructure.

Moreover, rural areas can intensify their own efforts to supply environmentally friendly food and other raw materials to cities, representing the interests of territorially united rural communities. Cities, for their part, can act as financial guarantors to minimize agricultural risks for crop-related villages, as well as to guide the dissemination of agricultural knowledge and management principles in cities.

CONCLUSIONS

Determining the possibility of applying socially-oriented innovative practices in the logistic support of basic urban transport and tourist flows requires a comprehensive study. To solve the set goal at the first stage, the scientific works of the world's leading scientists were critically analyzed. A number of developments that were theoretical and practical in nature allowed to consider the variability for different cities and signal structures in the system of urban traffic light traffic, proved the partial randomness of urban traffic development, and the importance of tourism for urban logistics. It was also determined that the development of the most applied mathematical apparatus should be carried out, which would consider the impact of different solutions on the transport flow of cities, also a spatial correlation of traffic in the city roads was revealed, and the need for systematic traffic management was proved, which is one of the key

innovative tools for logistic support of basic urban transport and tourist flows. Integrated logistics centers are identified as a main component of innovative urban logistics management, including the city light railway as one of the elements which can be a relevant issue for both freight and passenger flows.

The study identified the principles of formation of urban transport flows, including tourist flows. In particular, it has been found that in queuing theory, free movement is considered a service, and the duration of the delay is called the service duration, while the service duration is not necessarily random variables distributed by the same law, and they do not have known distribution densities. The prospects for the development of rural areas adjacent to cities were identified, which should become suppliers of environmentally friendly food and other raw materials to cities, receiving financial guarantees from cities to minimize agricultural risks and disseminating agricultural knowledge and management principles in cities.

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