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Integration of geoinformation in transport systems

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Abstract: The purpose of the article is to define and apply modern scientific and practical approaches of geo-information technologies in the organization of cargo transportation using the example of the city of Kharkiv. The main task of transport is to ensure the needs of the population in meeting the needs of their movement and transportation of goods. In the presented study, the issue of integration of geo-information technologies in the process of organization of cargo transportation is solved.

Keywords: freight transportation, geoinformation systems, route, transport, transport infrastructure.

1. Introduction

Currently, scientists are studying the issue of modeling passenger route transport systems. According to the results of their work, separate tasks were solved when considering not only state (regional), but also city, interstate and intercontinental route passenger transport systems.

The authors of the paper [1] dealt with the issue of intelligent planning of urban passenger transport systems , who proposed an approach based on demand modeling of dynamic intelligent planning and route optimization. The solution proposed by the authors in the work allows system operators to make decisions about the dynamic creation of new routes based on requests from passengers. The model is proposed for implementation in Smart City projects. The authors of the paper [2] were also involved in the modeling of routes within the city. In this paper, the scientists proposed a simulation that aims to predict route network schemes taking into account the maximum interaction between bus and railway routes. The authors of the work [3] also dealt with the issue of the need to take into account the coordinated interaction between different types of transport. They invented a solution for the formation of a multimodal transport network, using a multi-criteria routing algorithm for simulation.

In the work, the authors consider the issue of the probability of choosing a route of movement by passengers under the conditions of the availability of a set of options. The model of the probabilistic process of bus service is defined. The authors of the work [4] solved the issue of modeling the total travel time of a passenger in a route network depending on the number of transport nodes and the location of stopping points. Solving issues of improving the efficiency of passenger routes on railway transport is covered in work [5]. The authors of the work [6] model the system states when the technical parameters of the route change.

The authors of the work [7] were engaged in comprehensive consideration of the efficiency of the route passenger transport system. The developed model is based on taking into account different modes of transportation and a multimodal public transport system. The solution of flexible schedule optimization based on the modeling of the flexible size of the car is proposed in the work by the authors. The results of research on modeling demand fluctuations during the transit operation of the bus route were proposed by the authors in the paper [8]. The approach of modeling the demand for trips and its distribution in accordance with the volume restrictions at the zonal level, which are as mandatory as the bandwidth limitations of common links, are presented by the authors in works [9–11].

The authors of the work [12] were engaged in the modeling of passenger transport correspondence with nodes of the transport network. This work is devoted to the forecasting of passenger correspondence using the means of the gravity approach. In the model highlighted by the authors, correspondence is defined taking into account the general economic activity and geographical features of cities.

2. Literature analysis

The purpose of this article is the application of geoinformation systems in the organization of cargo transportation .

In accordance with the set goal, the following tasks are solved:

– to investigate modern approaches to the organization of freight transportation by road transport;

– to investigate approaches and methods of improving urban freight transport systems;

– determine the possibility of using geoinformation systems in transport .

3. Object and subject of research

Object of study - the process of cargo transportation within the city of Kharkiv.

The subject of research there are parameters of transport operation of urban freight transport.

Research methods. The research used: methods of analyzing options for solving the problem using a software approach, systems theory and system analysis for the formalization of transport processes, and analysis of modern scientific approaches to solving research problems, modeling routes.

5. Research results

In the course of working with the geoinformation system, the end user accumulates data on the conditions and nature of transportation with the determination of road network restrictions or the characteristics of cargo absorption by individual nodes. This determines the built routes and the initial conditions for building these routes in the knowledge base for further reuse of this information under similar conditions.

From the point of view of architecture, the development of a geoinformation system, the most popular and competitive option for solving this task is a geoinformation service that will allow users to work through an Internet browser from personal computers, as well as in the form of an application for mobile devices.

The fulfillment of the work objectives requires the availability of digital models of the road network of the city of Kharkiv and the location of vehicle loading and unloading facilities. For this purpose, a search was conducted on the Internet for possible models of the road network. Among the options, a model was chosen, which, unlike the others, is built in an acceptable coordinate system and contains modern information about arcs and nodes of the network. In fig. 1 shows the selected road network.

Fig. 1. Fragment of the selected road network model.

The received information about the location of the finished product loading warehouse and stores, the unloading location, the location of the vehicle unloading facilities made it possible to build the appropriate layers in the shp format. In fig. 2 shows a fragment of the visualization of the layers of the road network (streets) and stores (Stores).

Fig. 2. A fragment of visualization of the layers of the road network and shops.

The general map document is displayed in ArcMap, as shown in Fig. 3.

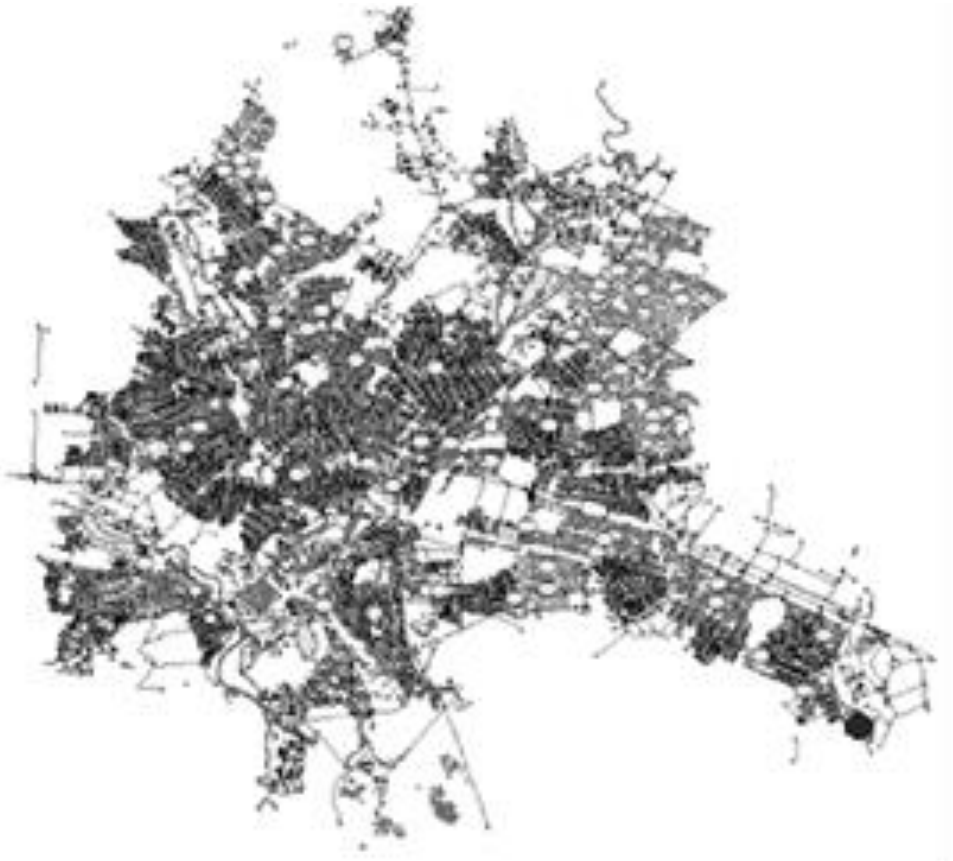

Fig. 3. Visual representation of the road network model with added stores.

The transport route selection analysis layer has been added to the Network Analyst window. Network analysis classes: Orders, Depots, Routes, Depot Visits, Breaks, Route Zones, Route Seed Points, Route Updates (Route Renewals), Specialties (Specialties), Order Pairs (Point Barriers), Line Barriers (Line Barriers) and Polygon Barriers (Polygon Barriers) are empty as indicated on Fig. 4.

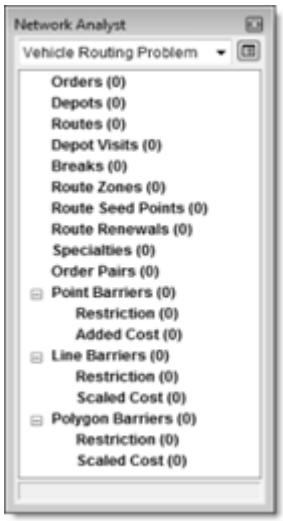

Fig. 4. Classes of network analysis.

Store locations will be added to the Order network analysis class (Orders). Orders can be submitted as orders to be filled, as each store orders a certain amount of product from a distribution center (warehouse). Elements of the "Orders" class will eventually be stops on the transport route.

Store locations have already been added as a "BranhesKharkiv" feature layer to the map document. The attributes of the "Branches Kharkiv" layer contain information about the total weight

of the goods (in kilograms) that each branch needs, the time when the delivery should be made and the unloading time (in minutes) in each branch. Unloading time is the time required to unload the goods. These branch point characteristics will be added to the analysis layer as an order.

Using the additional Network Analyst module, we will calculate the required routes. The results of route modeling are shown in fig. 5, 6 and 7.

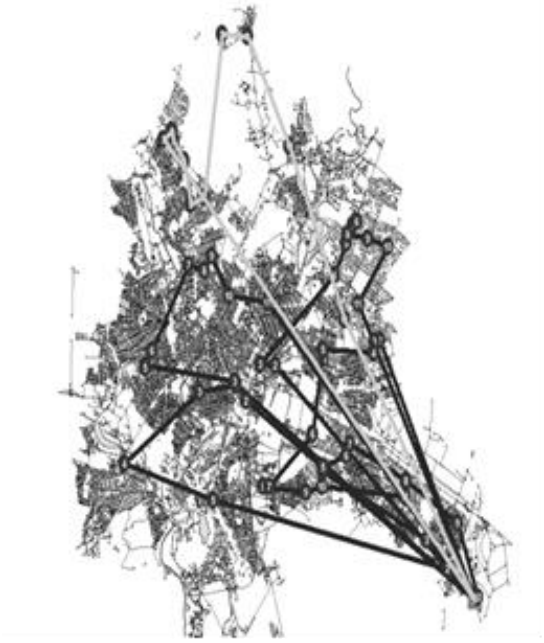

Fig. 5. Scheme of route No. 1.

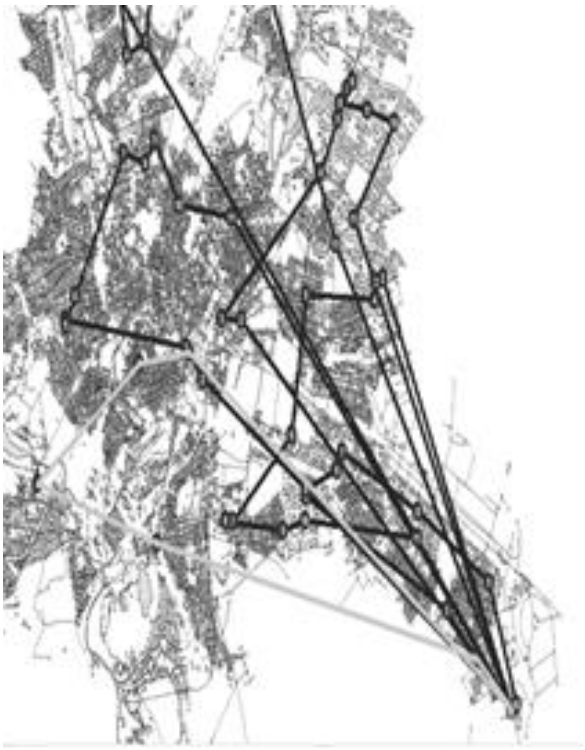

Fig. 6. Scheme of route No. 6.

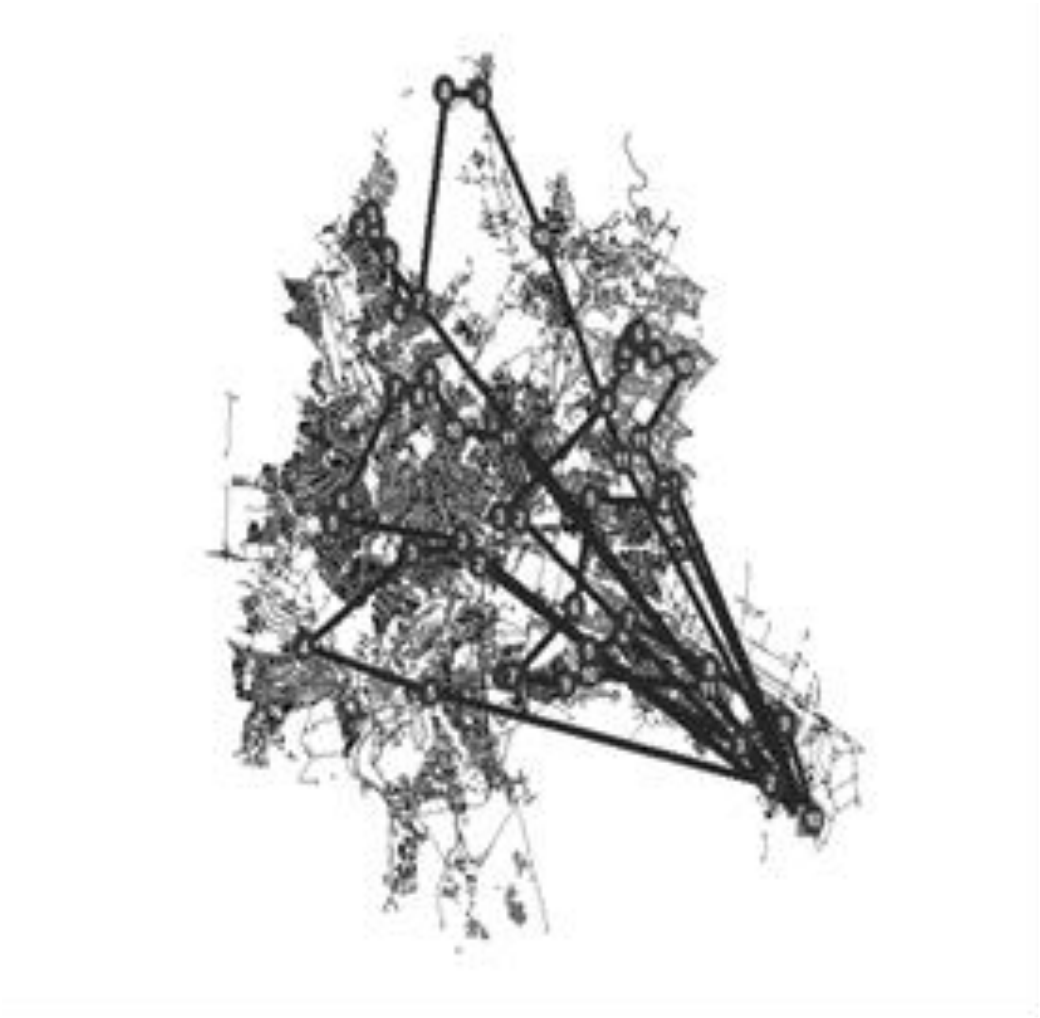

Fig. 7. General scheme of calculated routes.

ESRY software , namely ArcMap in network analysis tasks. The conditions for ensuring the analysis of engineering networks on the example of the transportation network of the city of Kharkiv have been established. The issue of a comprehensive approach to the issue of compliance with the requirements of the basic characteristics of the simulated transportation process has been resolved. The Location Analysis Properties section of the Load locations dialog box allows you to specify which attributes of the Branches object class contain values that will be used by the ArcGIS Network Analyst add-on when solving the transport route selection problem. The ArcGIS Network Analyst plug-in attempts to automatically bind location analysis properties for a new transport routing task layer based on the configuration file.

6. Conclusions

Compliance with the requirements regarding driving time, deviations from traffic schedules, finding the optimal distribution of transport work between vehicles, the maximum time of delivery of products to end consumers from the manufacturer, and minimizing the total mileage of the transporter's company's vehicles are ensured.

Simultaneous consideration of the specified requirements as limiting factors when modeling transport routes comprehensively takes into account not only the socio-economic requirements of the present, but also reduces the environmental burden on the city of Kharkiv.

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