PREPARING DATA ON TRANSPORTATION NETWORK WITHIN TRANSPORT OPTIMIZATION SYSTEM

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Abstract

Works upon computer systems for agricultural goods transport management require, among others, an appropriate preparing the data on transportation network within transport optimization system. Such transportation network is very complicated and contains a variety of detailed information on purchase centers, to which cereals are supplied by farmers; stores, to which purchased cereal is transported; and transportation means that take part in a transport of purchased cereals. Since 80's decade of the 20th century, works upon the optimization of agricultural goods transport process have been performed at The Department of Agricultural Machines and Devices, University of Life Sciences in Lublin. That time, many transportation systems based on various optimization methods were worked out. Particular versions were written in different programming languages, subsequent versions of data processing procedures were worked out, and different methods (more and more advanced) for computer map of the area were applied. All data referring to centers the goods are received from, and supplied to, upon the transportation means should be entered into the database in such a way that the software could use them during calculations. The software perfectly facilitates the process of data input. In a simple and clear way, it ensures the accessibility to particular files as well as movements among them. Its role is to generate files used subsequently to calculations in optimization software.

Keywords: *transport, agriculture, system, optimization, data preparation*

1. Introduction

The increase of agricultural production towarowości makes that any farm involuntarily becomes a transportation enterprise. Such thesis is confirmed by numerous domestic and foreign studies, according to which the share of costs borne for agricultural production reaches 30-40% of total capital-consumption, 60-70% of production processes mechanization, and 40-50% of energetic inputs borne for agricultural production [1, 6, 8]. Transportation works are included into almost all operations made in a farm and they make up about a half of total labor inputs [3]. Transport in an agriculture is not only transportation of machines, tools, production means, agricultural goods - transportation of loads within the farm also makes up a great percentage: various works associated with feed supplying, feed preparation, waste removing, appropriate storage of agricultural goods, etc. Utilization of technical and organizational opportunities in agriculture to make transport improved requires quite versatile considering the needs, their proportions and existing and predicted conditions for their meeting [4]. The agricultural transport has many traits that considerably affect the costs of agricultural production. It is due to variety of loading and reloading points.

The transportation of large loads and great percentage of transportation works in total labor inputs per production unit is another issue. Meteorological conditions that have influence on surface variability and on different working condition, are also important. Inner farm transport is realized at short distances and is very important, because it makes up 75% of transportation works made within the farm. In farms that are not productively directed, low utilization of transportation

means influences on large maintenance costs. It results from a single direction of majority of transports, short time of transports in total transportation period, and incomplete utilization of transportation mean carrier, namely at shifting volume materials. Depending on production direction and economics, the farm may have its own transportation means or rent them outside. In farms involved in fruit or vegetable production, the farm's transportation self-service is preferred. Produced goods have to be quickly transported to receivers at different daytimes, at different amounts, and the owner should have own transportation means with permanents and unlimited access. The cereal producer, if has the opportunity of using transportation means rented at satisfying price, may be based on them rented from transportation enterprise or borrowed from the neighbors instead of making field works with his own devices.

Achieving the success by a farm or enterprise cooperating with agriculture requires, among others, proper solution of transportation issues that have great influence on financial results of these economic units. One direction consists in utilizing modern transportation means, in which modern constructional solutions decreasing the exploitation costs are applied [5], while another is improving the work organization. Connections among large number of factors affecting the transport of goods in an agriculture makes a complicated system that, if has to be efficiently managed, requires computer systems for transport optimization [7]. Quality and time of data achievement as well as the way of their processing is one of the principal conditions determining the efficiency of decision making associated with the improvement of up-to-date functioning transportation solutions. It particularly refers to issues associated with operative planning the transport realized by agricultural goods producers, agricultural and food processing plants, and specialized units providing the transportation services.

2. The aim of study

Transport is very important for any farm activity as well as for enterprises involved in production and processing of agricultural goods. In order to get a success on a market, a good produced by a farm and processed by processing plant has to meet particular requirements. Besides high quality and nice interesting wrapping, an attractive price is very important. To make price competitive against other similar products, shifting excessive costs resulting from a bad production organization should be avoided. Transport of agricultural goods is the important link of production process chain. Reducing the costs for transport may be achieved by applying computer systems optimizing the transportation works in agriculture. Such systems require an appropriate data preparation.

The aim of present study was to create software that would prepare data for optimizing calculations. The application will aim at generating files that would be used for calculations in optimization software.

3. Material and Methods

Data collected in a form of files are from purchase centers and cereal stores of Cereal Works (CW) in Zamość. The activity area of the enterprise is completely the same as former Zamość region. The CW had 50 purchase centers on that area, where wheat, barley, rye, triticale, oats, and their mixtures, as well as rapeseed was purchased. Particular purchase centers had different storage areas, purchased different cereal amounts, had different devices for unloading the supplies and loading material onto different vehicles transporting purchased cereals to stores, which affected the receiving and loading abilities of those centers. Purchased grains were transported to 25 stores where particular cereal types were stored. Part of these stores was equipped in different-efficiency lines for grain drying. Part of the cereal was supplied to the stores directly from large producers (omitting the purchase centers) in a form of so-called *three-tone lots*. The data structure was excessively expanded, because besides describing and localizing particular purchase centers and

stores, all information on transportation means used for transporting purchased batch between purchase centers and stores had to be written down.

Ford and Fulkerson's theory was applied to work out the model and to make optimization of such complex information problem. A graph describing the mass flow within transportation network for cereal purchase was construed (Fig. 1).

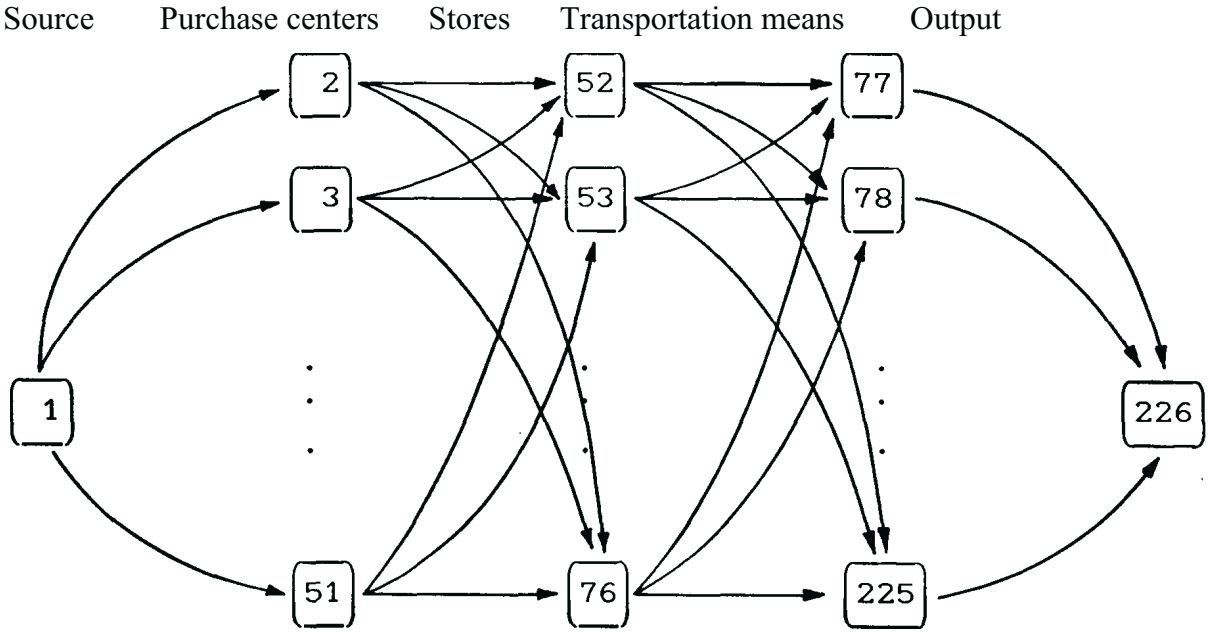

Fig. 1.Graph describing the structure of transportation network for cereal purchase

Above graph describes the mass flow between the source and the output. The source is node No 1, while the output is node No 226. Particular nodes are grouped in node categories. Nodes 2 - 51 belong to purchase centers category - there are 50 nodes and each describes particular purchase center. Other category describes stores - 25, and transportation means - there are 149 different-type transportation means; every node refers to a particular truck. Such created graph is a basis for making the analysis of mass flow among all nodes at particular categories, and in consequence, for finding the optimum solution describing the flow with the minimum costs, for instance.

In general, the optimization task may be formulated as follows [2]:

X - space of solutions (decisions) with properties dependent on the task type,

Y - space of solutions (decisions) evaluation with properties dependent on the task type,

$f : X \rightarrow Y$ - purpose function (criterion).

Moreover, there are distinguished:

Ω - set of permissible solutions ($\Omega \subset X$),

K - set of evaluations of permissible solutions, such that:

$$K=\{y \in Y : y = f(x), x \in \Omega\}, \tag{1}$$

D - dominating relation ($D \subset Y \times Y$) for defining the preferences within set Y, which means to determine when element $y' \in Y$ is „better" than element $y'' \in Y$,

K* - set of „the best" estimations in a reference to dominating relations D ($K^* \subset K$),

Ω^* - set of „the best" solutions:

$$\Omega^*=\{x \in \Omega : f(x) \in K^*\}, \tag{2}$$

that is called the set of optimum solutions.

It is said that optimization task is formulated when there are given Ω, f, D as well as determining of the set Ω* or its some elements is required.
The task is called single-criterion one, when:

$$X = E^n, Y = R, f : E^n \rightarrow R, \tag{3}$$

D - relation of "≥" type within real numbers set R,
E^n - Euclidean n-dimensional space.

The task is called multi-criterion one, when:

$$X = E^n, Y = E^m, f = (f_1, f_2, \ldots f_m) : E^n \rightarrow E^m, m \geq 2, \tag{4}$$

D - relation (most often of the order) in space E^m.

4. Results

The software serves for data preparing to optimization calculations. The software is executed with the file *ProgramPD*. After appearance the form (Fig. 2), data on stores and purchase centers can be taken from the file or manually input. To enter data from the file, button Otwórz on the form (Fig. 2) should be pressed. Following window will appear, where file *Dprzewoz.pas* should be selected by clicking Otwórz. The file will be automatically executed. It can be viewed by clicking the Edycja danych (Fig. 3). Then, window with names of purchase centers and stores will appear. In the case of purchase centers, there are columns: capacity, receiving and reloading abilities, mean purchase, and three-tone lots, while in the case of stores, there are following columns: capacity, receiving and drying abilities. In both cases, there is a possibility to edit data. Following step consists in selecting Oblicz**.** Button Otwórz should be re-entered then (Fig. 2).

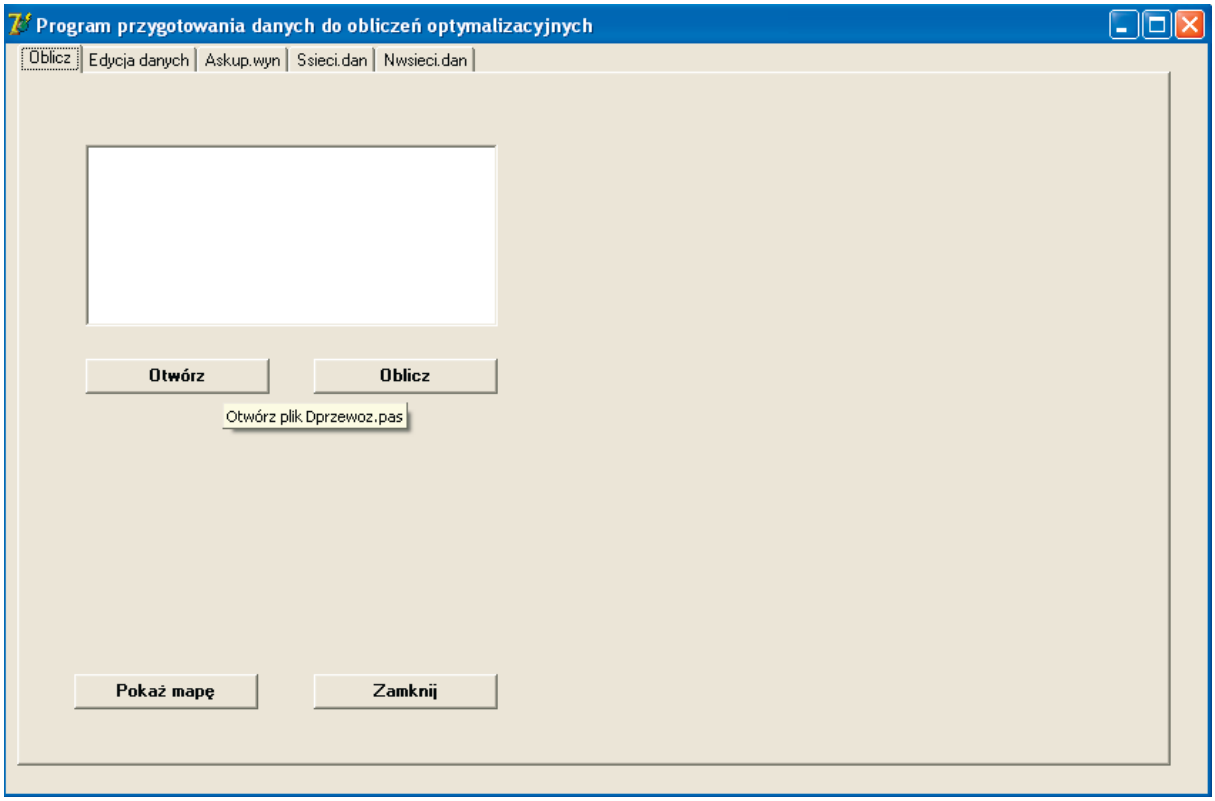

Fig. 2. Form for data input from the file

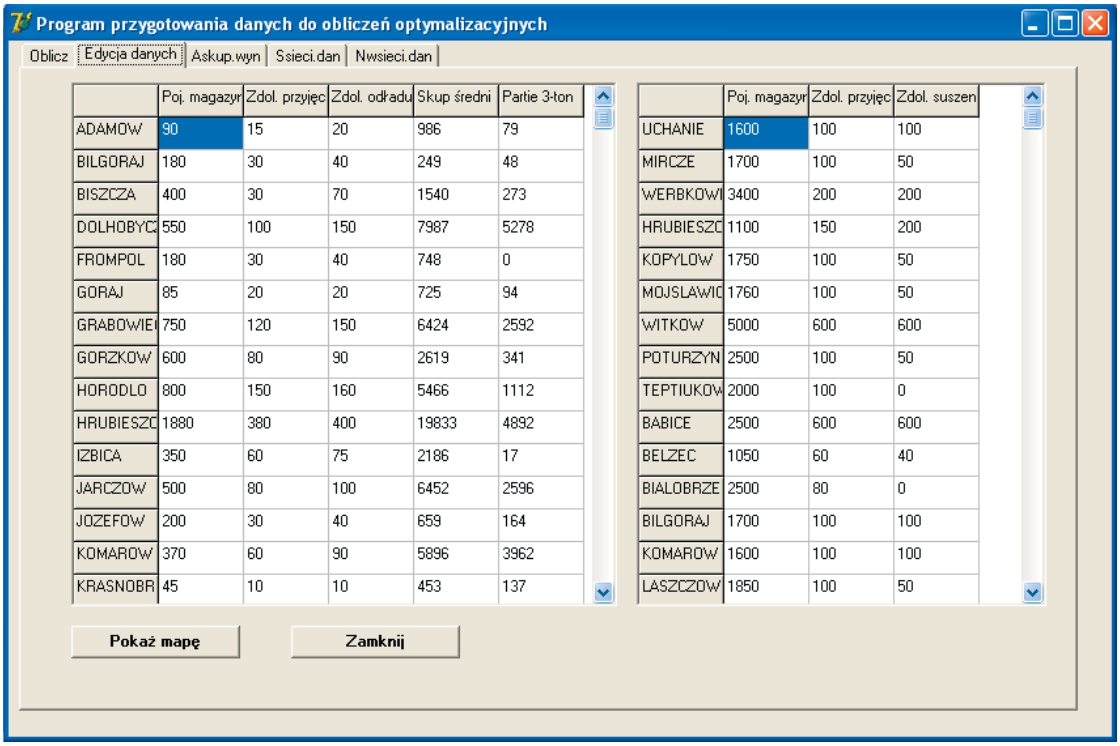

Fig. 3. Form for manual data input

Then, the software will automatically generate files *Askup.wyn, Ssieci.dan, Nwsieci.dan.* It will be done when subsequent bookmarks are selected. When bookmark Askup.wyn is selected, a form from Fig. 2 will appear. Data on purchase centers and stores, that were input in Edycja danych, will be generated. In addition, information on the number of purchase centers, stores, and transportation means will be given. At the same time, all those data will be written in a file possible to be used in optimization software.

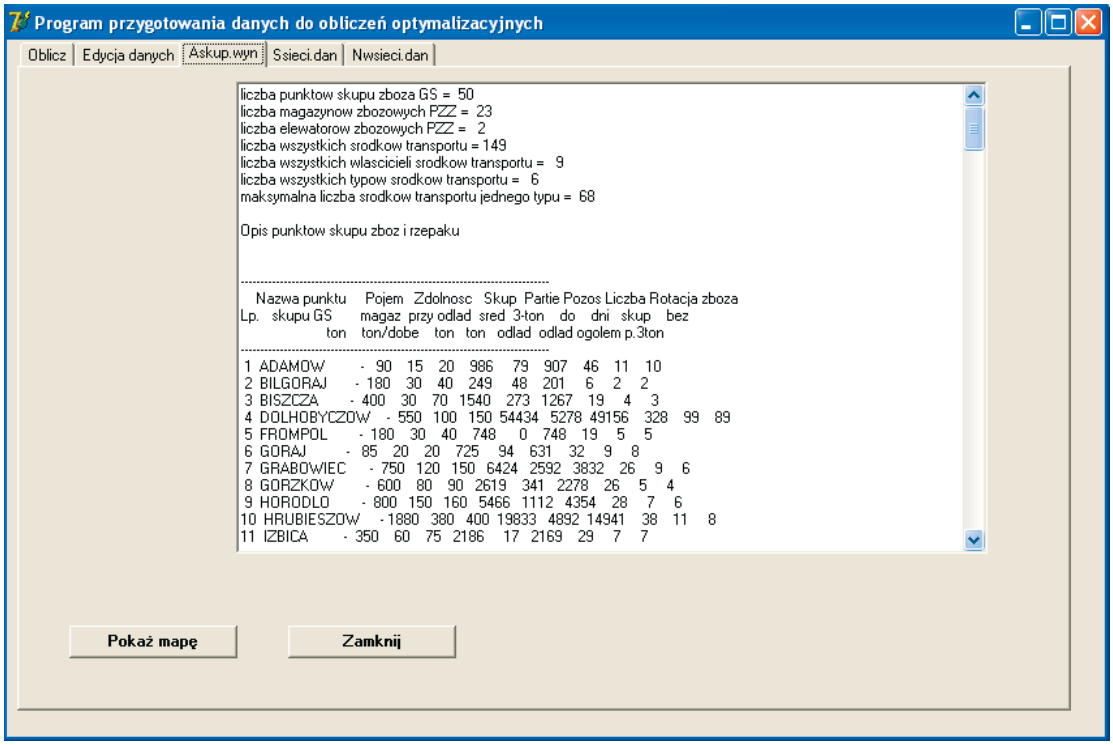

Fig. 5. Form with purchase centers and stores

The subsequent step is to select bookmark Ssieci.dan, where structure of transportation network is presented. There is information on distances between purchase centers and stores, stores capacities, and capacities of transportation means and on owners of those means.

5. Discussion

The paper consists in creating the software for preparing the data on transport network for optimizing works of transportation means shifting agricultural goods. The software verification was made using data from purchase centers and cereal stores in former Zamość region. The user can easily input and edit values of a store capacities, receiving, reloading, and drying abilities as well as levels of mean purchase. These data are listed in columns where, besides the name of purchase center or store, there are cells making possible to enter data. After writing necessary data, the software will automatically generate files that can be used in further calculations. Contents of the following files may be viewed in particular bookmarks. The application was created in Borland Delhi ver. 7 programming language.

- The software can be applied both for helping and managing the transport network as well as creating new transportation solutions.
- The application makes possible to solve problems associated with transport and purchase of many agricultural goods as well as other ones.

6. Summary

Since 80's of the 20th century, works upon the optimization of agricultural goods transport process have been performed at The Department of Agricultural Machines and Devices, University of Life Sciences in Lublin. That time, many transportation systems based on various optimization methods were worked out. Particular versions were written in different programming languages, subsequent versions of data processing procedures were worked out, and different methods (more and more advanced) for computer map of the area were applied. However, one of the most difficult works to do at preparing particular transportation systems was preparing data on transport network. All data referring to centers the goods are received from, and supplied to, upon the transportation means should be entered into the database in such a way that the software could use them during calculations. The paper presents the software for preparing data to optimization calculations. The software perfectly facilitates the process of data input. In a simple and clear way, it ensures the accessibility to particular files as well as movements among them. It is intended as a versatile software that should be possible to use in various transportation optimization systems based on different optimization methods.

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