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Computer aid decision-making in inland navigation

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Abstract

The article discusses the problem of computer aided decision making processes in inland waterway transport. Inland waterway transport is of minor importance in the Polish transport system. One of the reason for this is the difficulty in making decisions about transportation. This is due to the high variability of navigational conditions on Polish waterways, thus the low reliability of this mode of transport. This does not change the fact that the inland waterway transport of bulk goods, oversized and hazardous materials is the most efficient and least burdensome means of transport. For this reason, one should aim to increase the share of freight with the use of inland vessels. The paper indicates the possibility of supporting decision making processes in the organization of inland waterways transportation. For shippers or other persons organizing transport of goods, various issues can be important: the cost of transportation, delivery or handling method. Often, due to the lack of appropriate tools transportation is directed to the cars. Access to appropriate computer programs that calculate of the some parameters for the carriage or optimization criteria, may increase the use of inland waterway transport, and consequently a reduction in external and social costs, associated with carriage of cargo. The paper describes the possibilities.

Introduction

In Europe inland waterway transport is used for the carriage of 7.3% (the so-called Old Fifteen countries) [1] of all loads. In Poland, this share varies around 0.3%. Such a low share of inland waterway transport is due to the unsatisfactory state of Polish waterways. Due to the changing conditions of navigation, is difficult to predict the duration of carriage. In addition, there are little loading ports which connect inland waterways with other transport systems. That is why the transport capacities of Polish rivers are not fully utilized.

Currently, primarily for flood control, more and more pressure is put on investments related to water management. Programs co-financed by the European Union are increasingly being associated with the improvement or construction of new hydrotechnic structures what allows to believe in the improvement of navigation conditions on Polish inland waterways.

The Polish transport policy includes in its plans also the increase of use of inland waterways. Inland navigation consumes energy at the lowest level in the transport industry, and thus the direct costs are the lowest. External costs and related social costs of inland transport are also the lowest of all modes of transport. It can therefore be expected to increase share of inland waterway transport in the freight in Poland.

For many years, there has been the development of information system the ever – increasing computational of processors and the increasing flow of information. These results in a dynamic development tools widely understood computer support.

Computers make it easier designing, accounting, calculating, forecasting, and more. In many cases, using appropriate criteria and algorithms indicate the best (with a particular point of view) solutions for selected problems.

Often, computer programs are used as an aid in decision-making processes by: identifying errors,

the calculation of the defined indicators, the probability of a repetition of the undesirable situation etc.

Computer aided transport is quite common. Navigation systems are available for individual drivers. Shippers use the programs to determine the transport routes and travel time predictions, taking congestion into account. Modern warehouses use applications helping to locate the stored goods. With the use of the programs one can predict the transport capacities of the carrier, or a particular transport network.

Computers can also be involved in decision-making at an earlier stage. They help to decide whether to accept the cargo, whether it would be delivered on time, and what mode of transport would be the most advantageous. Other computer programs improve the safety of road users. There are also support algorithms, such as: fleet management, automate certain processes, optimize the parametersaccording to specific criteria. And all of this, in order to increase the competitiveness of the carrier, lower its costs. These applications perform certain tasks and calculations, and provide relevant information to a person whose job is to make a decision. It can therefore be concluded that indirectly participate in decision-making.

Due to the marginal utility of inland navigation, it remains under-invested not only in terms of infrastructure and transport. There are also highly developed logistics systems that support this branch, which do not work in Poland. In road transport, competition and the increasing traffic on the roads (including congestion) forced the development of transport logistics tools. Systematically the computer aid systems start to appear on the railway. It is natural, that there is a need for this type of tools adapted to inland waterways.

Further on, programs to support inland navigation and its safety will be presented. More information will be given to a program which helps to minimize fuel consumption by inland vessels and thus – minimizing transport costs.

Decision-making processes

At the same time, with the development of Internet, the availability of information dynamically increases. This is due to the increases the complexity of information management systems. It is also more difficulte to make decisions too, because the criteria are made more complex.

The base for decision support system is to create a model of decision-making. The process of decision-making can be divided into four phases:

1. Processing of primary information.
2. Analysis of the information.
3. The solution of the problem.
4. Making the decision.

In transportation systems, the most important problems connected to decision-making is the task of the transport. They can be divided into:

1. Determining conditions of the order.
2. Transportation planning.
3. Loading.
4. Transportation.
5. Unloading.

Each of these sub-tasks requires taking many current decisions. The exploitation of a technical object – here: inland vessel, requires consideration of preserving the efficiency (standby) of the ship, the work of preparing to transport and implementing the process itself.

Factors influencing decisions are:

– properties and characteristics of the vessel;
– conditions on the waterway;
– weather conditions;
– decision-making criteria.

The decision criteria are the most complex and difficult parts to clearly assess. Several criteria are often assumed which are frequently in conflict. It is therefore necessary to determine the most important criteria and allowable ranges of others.

In the transport systems the most leading criterion is to minimize the cost. Another key is to deliver the load as soon as possible, or within a specified time.

Computer applications used in inland navigation

The specificity of Polish navigational conditions prevailing on inland waterways requires the use of solutions unusual or unnecessary in other parts of Europe. But there are many computer applications used in the European Union, that are or can be implemented to our terms and conditions.

An example of such program is e.g. RIS. It is used primarily to improve the safety of inland vessels. The implementation of this system regulates the EU Directive. The program is implemented in all waterways of international class (class IV and higher), that have a connection with the European system of inland waterways. With built-in maps of the waterways and data collected by the terrestrial infrastructure, one can check in the system, where the ship is, where and with what cargo flows. It is also possible to watch the traffic and navigation conditions on the selected section of the waterway [2].

Another type of application is SEABLEET. It is used as a complement to the new generation of computerized engine and was developed by Volvo Penta Europe Office. It allows to determine the position of the vessel throughout Europe, and to monitor any signals coming from the engine (not only the fuel, but the engine speed, oil temperature, etc.). It does not require installing additional sensors or processors in the engine or vessel. It was created by the company UNI-Net Poland. The result is the first Volvo Penta remote system of monitoring parameters of ships' engines. Data monitored in this way are available to members of the crew staying on board, but also for the fleet owner, owner of the cargo, the recipient and the sender. In addition, it is important to provide the data to a service which by knowing the parameters, without going on board will be able to recommend a review or a repair. Currently, the system is installed on a BISON pusher-tug, owned by OTLogistics and traveling on German waterways. The example of programs data are shown on figure 1.

Many companies are also creating applications that support control center. In Poland, where even the biggest ship-owners have small amounts of the fleet it is managed in a non-automated units. Slowly, however, departs from this, and more often computer programs are used. One of them, based on the calculation of the capacity of the Odra Waterway, is presented in [3]. This application allows

Fig. 1. Screen of SEAFLEET

Fig. 2. The mail window of application [3]

to plan routes, bulk, and to determine the rate of capacity utilization of the waterway. The main window of the application is shown in the figure 2.

Competition from other modes of transport also requires the use of more and newer technologies to operate the fleet and to forecast service. In Polish conditions, the most difficult to estimate is the probability of the hydrotechnical conditions – whether it will allow to transport cargo. A method of calculating the probability of the desired depth is shown in [4]. Based on the operating data, assuming the duration of the cruise, the probability of realizing the carriage can be calculated.

Regardless of the mode of transport, it is increasingly important to minimize fuel consumption. This is due to environmental – minimizing emissions of pollutants, but also because of the large share of fuel costs in the total cost of carriage. The algorithm for calculating the fuel consumption of inland vessels, depending on the prevailing conditions of navigation is presented below.

Fuel consumption in varying conditions of navigation

The basic hydrotechnical parameter is the depth of a waterway. In the canalised sections is constant. The hydrotechnical building helps to maintained the level of water. Exceptions are only the periods of drought or flood.

Problematic are fluctuations of the transit depth of rivers. For this reason, when taking into account transport on not-canalized sections, transport costs become a secondary issue for ship-owners. Sometimes the carriage is feasible at all.

The suitable conditions for a safe transportation are mainly the depth of transit dipping fleet plus safety margin imposed by the manager of the waterway. The draught of barges operated in Poland may be from 0.7 m to 2.2 m, depending on loading.

Larger draft of barge also increases the amount of goods carried. For this reason, dipping inland vessels as much as possible is more profitable.

The ratio: draught of ship to a depth of the waterway has a very large impact on the resistance of swimming and, consequently, on fuel consumption. The issue of fuel consumption depending on the vessel resistance has been described in [5]. The once loaded ship maintains its immersion throughout the cruise, that indicates that only the fluctuations in the depth of a waterway are changing resistance of swimming. Vessel propulsion system has the task of overcoming the resistance to motion, therefore, the depth of the waterway directly impacting on the labor parameters of the ships' propulsion system.

On the figure 3, there is presented an algorithm. It is a simplified algorithm of a board computer controller, which is designed to control the operating parameters of the propulsion system, based on the set criteria. One of them is to minimize fuel consumption by inland vessels. For this purpose it is necessary to monitor the operating parameters of the propulsion system and the depth of the waterway. While knowing an extent of loading the immersion of ship in known. The depth of a waterway significantly alters the movement resistance, so for this condition the labor parameters of propulsion system should be determined.

The algorithm describes the principle of the application collects data on the ship, and in particular the propulsion system and computed optimal performance of the propulsion system, monitored on an ongoing basis for the depth of the waterway.

For calculations, the thrust characteristics of the vessel, the driving characteristics and the characteristics of the fuel consumption are required. These data can be entered directly, or by providing specific parameters on the basis of which the characteristics are calculated using approximate formulas.

It is also necessary to select the section of the waterway, on which the ship will move and define the conditions of navigation. The sections, where navigation conditions are known, algorithm immediately indicates optimal operating parameters of propulsion system, for the free-flowing sections, the calculations will be carried out during the operation.

There is also possibility to indicate the optimization criterion. This can be a particular vessel speed or minimum fuel consumption. The practice shows that maximizing swimming speed is pointless, because the increase of speed above the critical value is associated with a drastic increase in fuel consumption, which is not cost-effective.

The presented algorithm assumes the possibility of connecting it with the propulsion system of inland vessel, so it constitutes an integral part. This is only possible in the new generation engines that would have an additional driver. This would allow for automatic control of the parameters of the propulsion system. Current correction of operating parameters of the propulsion system when changing the depth of the waterway would lead to the minimization of fuel consumption.

Application of the shown algorithm exclude human participation in decision-making. Nevertheless it can be consider as supporting the decision-

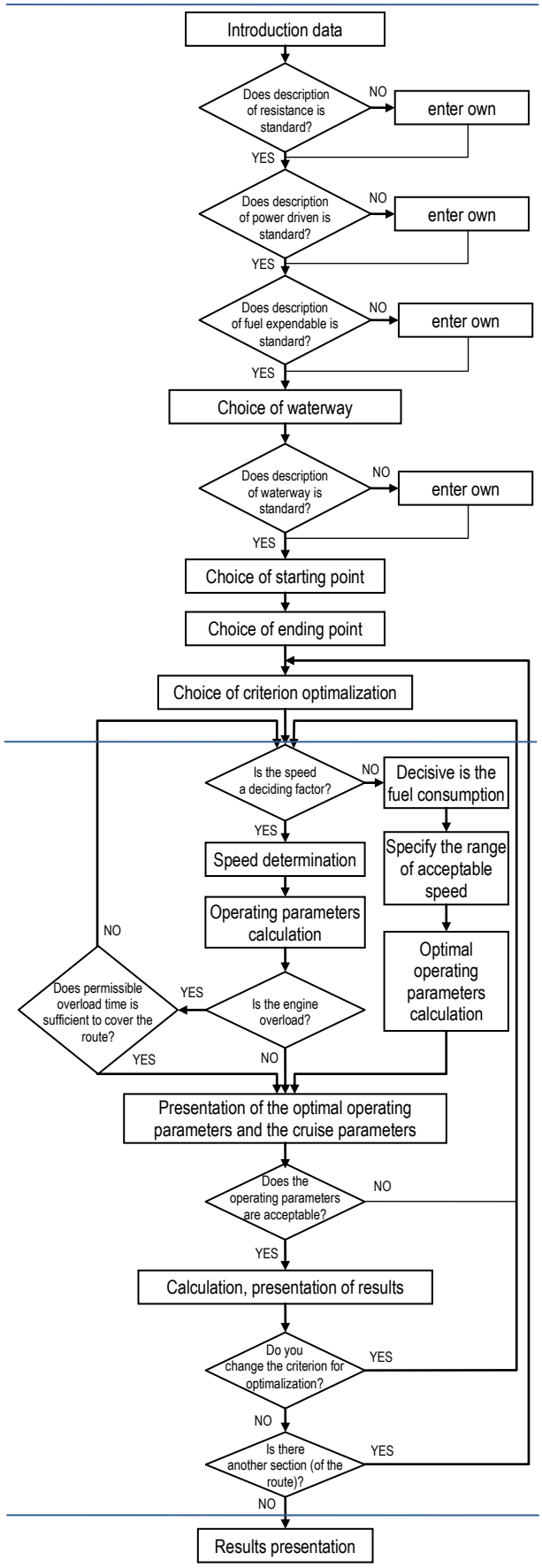

Fig. 3. A simplified algorithm of a board computer controller, controlling the operating parameters of the propulsion system

-making process, while it is possible to use it as a semi-automatic. The part of it can be turned off to control parameters of the drive system in the traditional way, just looking at suggested parameters.

Conclusions

Tools indicated in the paper and other similar, are becoming increasingly important due to the increasing importance attached to the effective use of time. In the transportation sector, timeliness and predictability are important factors. Optimization the cost allow to increase competitiveness in relation to other companies.

The strategic decisions taken by the company, are very important but not without significance are small solutions used even at the lowest levels. For this reason, computer-aided decision-making is growing very rapidly and it appears in all areas of business management, and fleet management.

The presented algorithm adjusting engine operating parameters to the navigation conditions on the waterway, opens up new opportunities to shipowners and manufacturers of marine engines designed for inland waterway transport in Poland.

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