MATHEMATICAL SIMULATION OF TRANSSHIPMENT PROCESS MANAGEMENT WITHIN A SEA PORT

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Transport nodes play central role in freight traffic. In spite of construction of new Russian port transshipment facilities the demand for them isn't satisfied (for instance in international trade only 70% of demand is met). Thereupon there is a need to increase the efficiency of transport nodes particularly by optimization of management of transshipment and port facilities on the basis of modern information and computer technology.

Transshipment processes as an object of simulation permit to solve a wide range of management tasks. Random character of processes within infrastructures of a sea port makes management models stochastic and permits to consider them as models of queueing process [1, 3, 4].

The Murmansk transport system comprises railway, sea, road and aviation companies.

And the main problem of efficient interaction of all the actors of freight processing in Murmansk transport node is the absence of regional or seaport logistics hub. That explains the proposal to create a comprehensive information system with a subsystem of transshipment management. The subsystem should assess the costs of transshipment using economic criterion of total cost of freight traffic.

Every similar transport center has subsystems of moorages, terminals, railway and road loading facilities. The proposed graph model describes these subsystems of loading-unloading as graph points K = {K1, K2,.., KN} (N = 1… 17) and directions of freightage as arcs E = {E12, E21, …, E17, E71}.

While the number of ships and railway cars as well as the time of their arrival are known, the presence of free reloaders and storehouses is a random number.

Therefore the description and simulation of transshipment processes in a transport node can be made through graph model and mathematical chance model.

The problem of optimization of management of transshipment can be described as follows. There is a certain number of loading/unloading points, the similar quantity of vehicles and of freight flows within the same system. It is necessary to plan a route for every freight flow and for every vehicle in order to ensure minimum transportation costs and to reduce time of processing of vehicles [1, 5].

An expression permits to define prices of all routes of vehicles within a transportation node. Minimization of costs is achieved taking into account some restrictions: that every vehicle is within the permanent route and that it can't move more freight than its payload is. There are also time restrictions.

The following quality indices were taken into consideration:

– continuous/uninterrupted process of freightage;
– speed of freight delivery;
– level of goods' safety etc.

The above rates, once achieved, are within the range between 0 and 1 for each kind of transport. The software Simulink of Matlab simulates the whole graph model that has three sub models: way 1, way 2 и way 3 (subsystem elements). The use of the keys allows to select the routes. Adder/subtractor units sum up the costs of transshipment operations adjusted for transit.

The simulation resulted in approximation of costs of transshipment and vehicle operations, transit rates which are shown at the Web-site of Murmansk sea commercial port.

The described approaches towards mathematical model of a transport node in the form of graph model and its matrix analog help to optimize different variants of transshipment of freight within sea transport traffic center. By using a model created under Simulink it is possible to assess costs of transshipment by different vehicles and methods and to optimize the whole process of transshipment on the basis of economic criterion of total costs of freightage.

Key words: sea port, transport node model, port services, transshipment, information technology, methods of control.

REFERENCES

1. Berezhnaya E. E., Berezhnoy V. I. Mathematical methods of modelling of economic systems [*Matematicheskiye metody modelirovaniya economicheskih system*]. Textbook. 2d ed. Moscow, Financy i statistica publ, 2006. 432 p.

2. Lazarev N. F. Transshipment processes in sea ports. Processing and maintenance of ships. [*Peregruzochnye protsessy v morskih portah. Obrabotka I obsluzhivanie sudov*]. Moscow, Transport publ, 1987. 197 p.

3. Chan Thi Hyong, Shurshev V. F. Engineering of mathematical model of the solution of problems of optimization of transshipment processes in a sea port [*Razrabotka matemeticheskoy modeli dlia resheniya zadach optimizatsii upravleniya peregruzochnymi protsessami morskogo porta*]. Vestnik of Astrakhan State Technical University. Series management, computer, engineering, informatics. 2011, No.1, pp. 83–88.

4. Prohorenkov A. M., Istratov R. A. Engineering of an information structure of a port within transport node [*Razrabotka informatsionnoy structury porta v sostave transportnogo uzla*]. SWorld Selected works. Proceedings of international scientific and practical conference on Modern problems and decision in science, transport, industry and training 2011. Vol 1, No.4. Odessa, Chernomorie publ, 2011. 94 p., pp. 85–94.

5. Prohorenkov A. M., Istratov R. A. Freight traffic management of a sea port within transport node [*Upravlenie gruzopotokami morskogo porta, vhodiaschego v sostav transportnogo uzla*]. Proceedings of international scientific and technical conference on Science and education 2012. Murmansk, Murmansk State Technical University publ., 2012, pp. 923–927.

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