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IMPROVEMENT OF VEHICLE CARGO HANDLING TO CLEAR – CUSTOMS AT THE UKRAINIAN BORDER

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Abstract. The logistic chain of cargo delivery by international transport is formed. The special-purpose function of the cargo handling to clear customs is determined. The application of Petri's net theory to develop a customs cargo handling model is substantiated. The cargo handling model to clear customs is developed.

Keywords: customs cargo handling, Petri's net theory, logistic chain, international transport, special-purpose function.

Introduction

The competitiveness at the transport market and the integration of the transport system of Ukraine into European organisations stipulate the search of new ways to improve the quality of transport service, minimize the expenditure of the time and resources of the logistic chain members on cargo delivery. The issues of transport technologies improvement, their harmonization with industrial, trade, storehouse and customs technologies, the simplification and improvement of customs procedures, the advancement of the customs control efficiency and the customs clearance of export-import goods traffic to develop synergy are chosen for its topicality (Пономарьова, Столяр 2008).

Last years saw the increase of the application of logistics principles in the systems of cargo delivery by international transport. At the same time the important role is played by effective interaction of all the links of the logistic chain including the customs cargo handling. The competitiveness advancement at the market of international goods transportation has conditioned a need in the allocating of the customs cargo handling as a separate component of a cargo delivery logistic chain.

Main part

The comparative analysis of cargo and vehicle traffic through the border checkpoint of Vilok has been made as of 2009–2011. At present there are three checkpoints on the border between Ukraine and Hungary: Chop, Vilok and Luzhanka. At the time period of 2009–2011 the major part of goods traffic went through Chop and Vilok. At the time specified, 10 835 000 tons of cargo were transported through the checkpoint of Vilok in two directions. The comparative analysis for 2009–2011 has indicated the growth of cargo traffic by 23 %.

The aim of the paper is to develop the model of the customs cargo handling that allows to take the reasoned technological and administrative decisions, change the inlet parameters, apply a long-term planning on the basis of data about the busy schedule of checkpoints, border customs office, customs officers, the capacity of checkpoints, the technical equipment of customs and communication, the types of customs modes, the norms of the time duration of customs cargo handling phases. In addition, it will give a possibility to analyze the time which is necessary for customs procedures according to various types of customs modes (Смехов 1998). The model is developed on the basis of Petri's net theory that allows to research probability processes taking into account faults and queues.

When developing the logistic cargo delivery chain for international transport, it is necessary to find out the major components of the logistic chain. As a result of the analysis of international cargo traffic, the components are as follows:

– motor transport enterprise (MTE). This component is primary intended for information traffic. The component includes a customer and supplier of information traffic. There is a customer because information in terms of needs in transport is delivered from a supplier to MTE. There is a supplier because MTE can provide information to a supplier in terms of the necessary quantity of vehicles, their technical and commercial conditions;

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– supplier (supplier's storehouse). This component is the beginning of the material traffic from a supplier to a customer. The loading of vehicle and the procedures to formalize the process of the preparation of papers to transport goods take place here;

– checkpoint to cross the border of Ukraine. The correspondence between material traffic and information is checked here. Necessary papers to cross the border are formalized;

– checkpoint of a neighboring state. This component has analogous departments as at the checkpoint of the border of Ukraine. The analogous procedures are carried out too;

– customer terminal. This is the last component of the logistic chain. The terminal includes storehouses. The customs department gives an approval to unload the vehicle after all the necessary papers have been checked (Питерсон 1984).

Time for customs inspection depends on the necessary mode of inspection: ecological, phytosanitary, radiological and veterinary. At the same time the status of the checkpoint is important – international or interstate. Legislative acts regulate time for customs inspection depending on both the mode and object of inspection. If we present the process of the customs cargo handling as the model of "a white box", it will have the inlet parameters as follows: volume and kind of cargo (Q_c), a type of the customs mode (K_{mc}), a type of vehicle (A) and frequency of vehicle approach (N_v).

The external factors of influence are as follows: checkpoint capacity (P_c), quantity of traffic lanes (n_{tl}), technical means of the customs control and communication available at the checkpoint (I_c) to obtain information about car theft, drugs and weapons smuggling, quantity of personnel of the checkpoint with possible changes (N_{pc}). The outlet is time to carry out the customs procedures when using various types of the customs modes (T_{mc}).

The internal components of the system are as follows:

– the process of the sending of automobiles to the consignor;

– the process of loading;

– an approach to the internal customs;

– the process of the preparation of documents at the internal customs;

– an approach to the customs checkpoint;

– the process of the waiting for the customs procedures;

– the process of the customs inspection;

– the process of the customs clearance;

– an approach to the customs of destination;

– delivery of cargo to the consignee (Котов 1984).

The condition of effective customs cargo handling is to minimize the time to handle cargo at the customs

$$T_{cd} = \sum_{i=1}^{m} T_{cd_i} \to \min , \qquad (1)$$

where: T_{cd} – time to handle cargo at the customs during the i phase, hours; m – quantity of phases.

The time to handle cargo at the customs during the i phase is determined by the function:

$$T_{cd_i} = \sum_{j=1}^{n} T_{w_j} + \sum_{j=1}^{n} T_{p_j} \to \min , \qquad (2)$$

where: T_{w_j} – time of waiting the performance of the j technological operation to handle cargo at the customs during the i phase, hours; n – quantity of the operations that are performed in the phase or quantity of waitings for operations to be performed.

During the customs cargo handling in addition to technological operations (productive activity) there are some interoperational periods of downtime that are available while waiting for operations to begin under various conditions and circumstances. Thus, time while waiting for performance of the j technological operation to handle cargo at the customs in the i phase can be provided as follows:

$$T_w = t_w^{ic} + t_w^{nVQA} + t_w^{cp} + t_w^{cd} , \qquad (3)$$

where: t_w^{ic} – time to wait for the customs clearance at the internal customs, hours; t_w^{nVQA} – time of waiting while in a vehicle queue on the approach to the checkpoint, hours; t t_w^{cp} – time of the waiting of the customs procedures at the checkpoint (customs inspection, customs clearance and the other customs procedures), hours; t_w^{cd} – time of waiting for cargo clearance at the customs of destination, hours.

Time to perform the j technological operation in terms of the customs cargo handling during the i phase can be calculated by using the equation as follows:

$$T_w = T^{ic} + T^{nVQA} + T_a^{cp} + T^{ncd} + T^{cd} , \qquad (4)$$

where: T^{ic} – time to perform the customs clearance at the internal customs, hours; T^{nVQA} – time for vehicles to approach the checkpoint, hours; T_a^{cp} – time to perform the customs procedures at the checkpoint (customs inspection, customs clearance etc.), hours; T^{ncd} – time for vehicle to the customs of destination, hours; T^{cd} – time to clear goods at the customs of destination, hours.

To describe the system of the customs cargo handling as a system of interacting models that describe the iteration process of a gradual approach to an optimum decision, Petri's net theory is efficient.

The mathematical definitions of Petri's net allows to study the dynamics of the functioning of a system under research and its behavior under various initial conditions. When using formal methods, the analysis of the properties of Petri's net allows to investigate the system operation in dynamics and get the most important characteristics of technological processes. In addition, the formalization of the customs cargo handling with the help of Petri's nets is a rather obvious, simple and quick procedure. Unlike Petri's nets, some traditional approaches to model the technological processes on transport do not allow the person, who is making a decision, to get a ready-made managerial deci-

sion. They offer the optimum parameters of the technological elements (operations) of given processes only without taking into account any expectations (Petri 1962).

To develop an adequate mathematical model, Petri's net theory allows to evaluate the parameters as follows:

– system's possibility to execute all the technological operations (customs procedures);

– level of the effectiveness of the subsystems' separate phases functioning, the subsystems and the system in general;

– availability of potential technological drawbacks in the phases, subsystems and systems;

– availability of the expectations of technological operations and above norm downtime in the phases, subsystems and systems;

– possibility to simplify (to enlarge) systems to operate without malfunctions.

Petri's nets can formally be presented as follows

$$PN = \left(P, T, F, W, M_0\right), \tag{5}$$

where: $P = (p_1, p_2, \ldots, p_m)$ – final quantity of positions; $T = (t_1, t_2, \ldots, t_n)$ – final quantity of transitions; F – multiple arcs (stream relationship).

$$F \subseteq \left(P \times T\right) \cup \left(T \times P\right), \tag{6}$$

where $W : F \rightarrow (1, 2, 3, \ldots)$ – weight function; $M_0 : F \rightarrow (0, 1, 2, 3, \ldots)$ – initial marking.

The process of the cativation of transitions can formally be presented as follows

$$\forall pi \in P, M(P) - F(Pi, Ti) \geq 0. \tag{7}$$

The enlarged model of Petri's nets, which describes the process of the customs is shown in (Petri 1962). The system of the parallel operations of the customs clearance and control is given in details.

In the model the positions of P1-P25 reflect the intermediate states of system and each transition (T1-T13) shows the functioning of the phases of the customs cargo handling. The system of the parallel operations of the customs clearance and control is considered here.

In the model the positions of P1-P25 reflect the intermediate states of system and each transition (T1-T13) shows the functioning of the phases of the customs cargo handling.

Model of the process of the customs processing of loads

The model has the markings as follows: P1, P2, P3 – quantity of automobiles that are ready to set up to carriers; P4 – quantity of automobiles that the consignor has to load them; P5, P6, P7 – quantity of cargo the consignor has to transport on international routes; P8 – quantity of free loadings for loading-unloading mechanisms that the consignor has; P9 – quantity of loaded automobiles that are ready to depart; P10 – quantity of cargo at the internal customs; P11 – quantity of automobiles that have had the customs clearance at the internal customs; P12 – quantity of automobiles that are ready to have the customs procedures; P13 – quantity of automobiles that are ready to have the customs inspection; P14 – quantity of automobiles that are ready to have the customs clearance; P15 – work of the customs authorities during the customs inspection; P16 – work of the customs authorities during the customs clearance; P17 – the procedure of the customs inspection is over; P18 – the procedure of the customs clearance is over; P19 – quantity of vacant customs officers to have the customs inspection to do; P20 – quantity of vacant customs officers to have the customs clearance to do; P21 – quantity of automobiles which have reached the customs of their destination; P22 – quantity of automobiles that have had the customs clearance; P23, P24, P25 – quantity of automobiles that have reached their consignees.

The markings of the transitions in the model are as follows: T1 – intensity of the arrival of automobiles from the carrier; T2 – time period of loading at the consignor; T3 – time period of delivery to the internal customs; T4 – functioning of the internal customs; T5 – time to approach the checkpoint; T6 – (transition - switch) distribution to perform the customs operations (procedures); T7 – time for the customs authorities to approach the automobile to cany out the customs inspection; T8 – time for the customs authorities to approach the automobile to carry out the customs clearance; T9 – idle time under customs inspection; T10 – idle time under customs clearance; T1l – time to approach to the customs of destination; T12 – time to clear customs; T13 – time period to deliver cargo to the consignee.

Conclusion

The customs cargo handling model is developed for the checkpoint of Vilok. The model on the basiss of Petri's net theory give a possibility to take into account the expectations as the checkpoint on the Ukrainian border operates with different intensity and goods traffic through the customs of the border customs office is uneven there are queues at checkpoints and time losses. It enables us to model, analyze and prognosticate the customs operation on the basis of norms that are quickly calculated for every object under control rather than use average and technological norms.

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