Optimization of the customs bodies’ communications as an instrument to facilitate transport flows in the Siberian region

D S Fomenko¹,²,³ and R N Shmatkoy²,⁴

¹Siberian Customs Administration, Novosibirsk, Timiryazeva st., 74, 630049; ²Siberian Transport University, Novosibirsk, Dusi Kovalchuk st., 191, 630082.
E-mail: ³doncarlito911@mail.ru, ⁴srn-travel@mail.ru

Abstract. The purpose of this paper is to disclose the mechanism for reproducing the communication optimization model of the customs authorities of the Siberian Customs Administration, which ensures the prompt elimination of contingencies in the operation of software operated by the customs authorities, which in turn will ensure compliance with customs operations and reduce the amount of downtime (delays) of transport funds. Methods of research that will let to achieve this goal are the analysis and experiment of a model for optimizing communications. This paper presents a practical implementation of the model for optimizing communications of the customs authorities of the Siberian Customs Administration, which allows considering an effective approach to eliminating emergency situations in the operation of software and ensuring compliance with the deadlines for customs operations. In connection with the launching of the Siberian Electronic Customs, in the region of activities of which the entire declarative mass of the Siberian region will be concentrated by 2021, the process of implementing a communication model under the conditions of the creation of the Siberian Electronic Customs is being considered. The statistical data of the filed declarations of goods to the customs authorities of the Siberian region for 2016 – 2019 are analyzed. It helps determining the share of the load for each official working with declarations of goods and contingencies.

1. Introduction

In this paper, a mechanism for solving one of the modern fundamental transport problems of the Novosibirsk region is proposed. Previously, the solution to a number of transport problems was reflected in works [1, 2].

Today, the Novosibirsk Region is the largest transport and logistics hub connecting the European and Asian parts of the continent, which ultimately plays a significant role in socio-economic processes.

During the operation of the Unified Automated Information System of the customs authorities (hereinafter referred to as the UAIS CA), the key problem of meeting the deadlines for customs operations with goods declarations by the Siberian customs post and other customs authorities of the Siberian region is the occurrence of emergency situations (hereinafter referred to as the ES) in the form of software failures (failures related to the write-off of funds, a request for the location of the goods, processing of the goods declaration in the process of its registration / release, the appointment of customs search / inspection; requesting documents from the declarant) that impede the uninterrupted functioning of information and communication technologies.
In 2019, the Siberian Customs Administration transferred 161.79 billion rubles to the federal budget (112.21 billion rubles were transferred in 2018). This increase in transfers is due to an increase in the turnover of the Siberian Federal District, the use of innovative customs technologies (including in the field of customs payments), as well as a reduction in the time for customs operations. A significant share of transfers to the federal budget was made by Novosibirsk Customs (17.4%) [3].

Taking into account the scope of customs payments transferred to the federal budget by the Novosibirsk Customs, as well as the available transport and logistics potential of the Novosibirsk Region, the issue of accelerating trade with countries near and far abroad acquires its original significance. Based on the foregoing, there is a need to develop a model for optimizing communications of the customs authorities of the Siberian region, which will optimize the burden on officials of information and technical departments for working with ESs and their automatic identification, which will positively affect the transport industry of the Novosibirsk region and protect against downtime of vehicles.

In foreign works, research is presented in the field of solving problems of the transport industry in the following areas [4 - 10]:

- optimization of the fractal model in the transport industry;
- an algorithm for joint control of vehicles in the absence of infrastructure;
- optimization of transport routes;
- modeling and solving the problem of intermodal freight transportation;
- optimization of discounts in the field of transit traffic using an agent-based model;
- a strategy of flexible and dynamic distribution of road space between different modes of transport.

Thus, the purpose of this study is to reveal the mechanism of functioning of the model for optimizing communications of customs authorities of the Siberian Customs Administration (hereinafter – SCA) using the example of the Siberian Electronic Customs (hereinafter – SEC).

2. E-Customs as an innovative customs authority and analysis of the dynamics of filed declarations for goods
In 2019, the new direction was the introduction, operation and development of a communication system for monitoring customs communications, the main objectives of which are: prevention of ESs; reduction of time for elimination of ESs; minimization of negative consequences from ESs; acceleration of goods and transport flows.

In terms of the use of the electronic form for declaring goods and the use of electronic documents when creating a unified network of electronic customs and electronic declaration centers, the functioning of customs authorities depends on the state of information and technical support for the activities of customs authorities, ensuring uninterrupted operation of software, data transmission channels and computer equipment at all levels of customs.

The Center for Electronic Declaration is a specialized customs authority whose competence is limited to customs operations in respect of goods declared exclusively in electronic form and is authorized to perform only documentary control, which eliminates the need for a personal presence of a participant in foreign economic activity, and also reduces the time for customs operations declaration of goods.

The Federal Customs Service of the Russian Federation (hereinafter - the FCS of Russia) carries out systematic work on the development of software tools aimed at implementing centralized information processing, ensuring the necessary level of performance and fault tolerance, as well as optimizing software tools to reduce the total amount of fault tolerance.

In this study, statistical analysis is subject to the activities of customs authorities in Siberia, including Siberian e-customs.
By order of the Federal Customs Service of Russia dated 07.05.2019 No. 764 “On the Creation of the Siberian Electronic Customs”, from 15.08.2019 the SEC was created, which is subordinate to SCA. SEC is an innovative customs authority that uses technology for the remote release of goods (through UAIS CA).

The main goals of creating the SEC are:

- optimization of customs administration; reduction of costs of participants in foreign economic activity;
- improving the investment climate and accelerating the movement of goods across the customs border of the Eurasian Economic Union;
- Assistance in realizing the acceleration of traffic flow in the Siberian region.

In order to reflect the declaration array and study the dynamics of the submitted declarations for goods in the Siberian region, table 1 shows the statistics on the number of declarations for goods submitted to the customs authorities of SCA in electronic form for the years 2016 – 2019 (data was taken from the official site of the Siberian Customs Administration [11].

| Number of filed declarations for goods | 2016     | 2017     | 2018     | 2019     |
|----------------------------------------|----------|----------|----------|----------|
|                                        | 300,590  | 348,504  | 371,543  | 394,717  |

As can be seen from the table above, the number of declarations for goods submitted to the customs authorities of the Siberian region is growing rapidly every year, which is a consequence of the growth in trade and demand for transport services in the Siberian region.

At the moment, the region where SCA operates includes Altai, Irkutsk, Kemerovo, Krasnoyarsk, Novosibirsk, Omsk, Tomsk, Tyva, Khakass and Siberian electronic customs. As of 2020, electronic declaration centers authorized to perform customs operations with electronic declarations of goods are located in the region where Irkutsk, Novosibirsk, Omsk, Tomsk and Siberian electronic customs operate.

Dynamics of filed declarations for goods to the customs authorities of the Siberian region for 2016 - 2019 reflected in figure 1.

**Figure 1.** Dynamics of filing declarations for goods with the customs authorities of the Siberian region for 2016 – 2019.

By 2021, the entire declaration massif of the Siberian region will be concentrated in the SEC. It should be noted that in the SCA region of operation, the customs, in which customs operations related to: opening and closing of the customs procedure of customs transit; control over the activities of temporary storage of goods; actual customs control of goods and various types of vehicles transported within the Siberian region will be performed, will continue to function.
The Siberian customs post began to carry out customs operations and carry out customs control in respect of declarations for goods from September 2019.

The structure of the Siberian Customs Post (Center for Electronic Declaration (hereinafter - the CED) is presented as follows:

- Head of the Siberian Customs Post (CED) and his deputy;
- 37 federal state civil servants (hereinafter – FSCS) engaged in customs operations related to the receipt and registration of declarations for goods, the implementation of customs control and release of goods.

By 2021, it is planned to increase the number of staff units to 124 FSCS, since, as mentioned earlier, the entire declaration array will be concentrated at the Siberian Customs Post (CED).

The structure of the Siberian Electronic Customs includes a department for round-the-clock technical support of information systems, information technologies and means of their support (hereinafter - NTSIS), the staff of which is 7 FSCS. By 2021, the staffing of the NTSIS will increase to 16 FSCS.

Statistics of issued declarations for goods by the Siberian customs post is given in table 2 [8].

| Number of declarations issued by Siberian Electronic Customs | September 2019 | October 2019 | November 2019 | December 2019 | January 2020 | February 2020 |
|------------------------------------------------------------|----------------|--------------|---------------|---------------|---------------|---------------|
| In automatic mode                                           | 300            | 2 237        | 5 139         | 9 076         | 4 212         | 10 342        |

The dynamics of filed declarations for goods at the Siberian customs post of the Siberian Electronic Customs for September - December 2019 are shown in Figure 2.

Based on the statistics above, the officials of the Siberian customs post accepted 9076 declarations for goods for the period from September 1, 2019 to December 31, 2019. In the period from 01.01.2020 to 02.29.2020, officials of the Siberian customs post accepted 10342 declarations for goods, which is 13.9% higher than for the past four months of 2019.

Due to the rapid growth of the declarations of goods submitted to the Siberian customs post of the Siberian Electronic Customs, an increase in the number of ESs is inevitable, therefore, the number of vehicle downtime will increase, which will entail an increase in transport costs of participants in foreign economic activity. In connection with the above, there is a need to develop a model for optimizing communications of customs authorities of the Siberian region.
3. Practical implementation of the model for optimizing communications of customs authorities of the Siberian region using the example of the Siberian Electronic Customs

In order to reveal the mechanism of the model for optimizing communications of the customs authorities of the Siberian region, it is necessary to calculate the load on each official of the customs authority and determine the intensity of work to eliminate emergency situations by officials of the NTSIS with the current staffing level.

The average number of accepted declarations for goods by an official of the customs body is - 5 (10342 number of declarations accepted / 59 number of days / 37 number of staff units). Given the concentration of the declaration array in the region where the Siberian Electronic Customs operates, by 2021, the number of declarations for goods submitted will undoubtedly grow as well as the growth of traffic in the Siberian region. Therefore, with each year the burden on customs officials to register, conduct customs control and issue customs declarations during the operation of software systems will increase.

When the number of full-time NTSIS units has been established by a legal act of the FCS of Russia, it is possible to more accurately calculate the intensity of work to eliminate ESs by the following formula:

$$\lambda(t) = \frac{Q}{T * N}$$

The number of filed declarations for goods at the Siberian customs post will be taken for January - February 2020 - 10,342 (Q); goods declaration registration time - 60 minutes (the term is determined by paragraph 2 of Article 111 of the Customs Code of the Eurasian Economic Union - T); number of registered ESs – 180 (N). The intensity of the work to eliminate the ES will be about 1 hour. At the same time, the right of the Eurasian Economic Union establishes a deadline for the release of goods - 4 hours. In the event of a failure in the software, the time taken to make a decision on the release of the goods may increase to 5 hours or more (depending on the time of work with the goods declaration). In case of a rapid increase in the flow of declarations for goods, more time will be spent on the implementation of the elimination of ESs, which will ultimately lead to a massive delay in the release of goods and additional transport and other costs for participants in foreign economic activity.

Within this study, a mechanism was proposed for reproducing the work of the communications monitoring system of the customs authorities of the Siberian region during the implementation of the search process for the best solution to the issue related to the urgent elimination of emerging ESs.

The process of reproducing the work of the software is as follows:

- identification of the ES (the formation by an official who revealed a malfunction of the software of the application with a description of the reason for the impossibility of eliminating the malfunction and its registration / automatic detection of the malfunction due to a data processing failure in the software and its fixation in the monitoring software);
- determination of the complexity of the malfunction (at the level of customs, regional customs administration and at the federal level);
- making management decision.

These processes have a certain sequence of operations and are characterized by their number - j. The processes are displayed by the Ki components (i = 1, 2, 3) (1 - identification; 2 - assessment; 3 - elimination), which are executed in parallel.

As a result of elementary operations of the software (EOij) is performed on the time interval tij. For the above Ki components, there is an own definition of “local time” ti. In a real system, time intervals change simultaneously (parallel operation), however, the nature of these changes is different and is determined by the sequence of time intervals \{rij\}.

These events are described as follows:
- C11 - software malfunction detection;
C12 - automatic formation of the application, which displays information about the impossibility of a specific operation;

C13 - determination of the degree of complexity of the failure (not critical, critical, extremely critical);

C14 - making a decision to eliminate the ES.

Based on the foregoing, there is a need to determine the following points in time:

\( t_{11} \) - moment of detection of a malfunction in the software. This indicator should include the time interval allotted for the automatic generation of an application (or manually by an official). The interval can be from 1 to 10 minutes;

\( t_{12} \) - the time interval for determining the degree of complexity of the failure from 5 to 15 minutes;

\( t_{13} \) - the period of time intended to carry out work to eliminate the failure (depending on the degree of complexity, for example, from 30 to 180 minutes);

\( t_{14} \) - the moment of elimination of the emergency situation (also depends on the degree of complexity of the failure, for example, from 5 to 30 minutes).

During operation \( K_i \) (identification, assessment, elimination) four events occur sequentially (C11, C12, C13, C14), corresponding to four points in time \( t_i \) (t11, t12, t13, t14). Between these moments of time the component \( K_i \) four elementary operations are performed (EO11, EO12, EO13, EO14) during corresponding time intervals (t11, t12, t13, t14). Replacing objects EOij carried out in the following sequence \{EO1j\}, \( j=1,2,3,4 \) ([EO11], [EO12], [EO13], [EO14]) [12].

Component K2 sequentially performs three elementary operations \{EO1j\} \( j=1,2,3 \) ([EO11], [EO12], [EO13]), respectively for three time intervals \{t2j\}, \( j=1,2,3 \), displaying in a simulation model \{EO2j\}, \( j=1,2,3 \) ([EO21], [EO22], [EO23]).

K3 performs three consecutive operations \{EO3j\}, \( j=1,2,3 \), displayed in the simulation model by three elementary operations \{EO3j\}, \( j=1,2,3 \) ([EO31], [EO32], [EO33]).

It should be noted that each displayed elementary operation EOij described by the corresponding algorithm \( A_{ij} \) and implemented in the model by the corresponding module \( M_{ij} \), in this connection, this module in the considered model implements the simulation process in the execution of the algorithm \( A_{ij} \) at constant \( t_i \), and also converts the time coordinate \( t_i \) for the amount \( \tau_{ij} \) [13, 14].

Modeling of operations implemented by the communications monitoring system of the customs authorities of the Siberian region is presented in Figure 3.

![Figure 3. Modeling operations implemented by a communications monitoring system.](image)

The implementation process of the monitoring system of communications of the customs authorities of the Siberian region consists of a sequence of works to identify the actual state of the system and assess the elimination of ES.

In the process of working with the "AIST-M" software, one of the officials of the Siberian customs post had a failure in the form of impossibility to write off customs payments in respect of declared goods. Until the end of the release of goods is no more than 30 minutes. An automated system for monitoring communications in case of independent detection of a failure fixes a malfunction and automatically generates a request for elimination of the ES and sends it to the 24-hour technical support department of the Siberian Electronic Customs in less than a minute without creating an application by an official user of a software tool without manually generating an application. If the application was manually generated in a separate software tool, this application for the elimination of
the ES would be received by the round-the-clock technical support department no earlier than 10 minutes later. To automatically generate an application for the elimination of ES, it is necessary to provide the software of the customs authorities with appropriate software.

The next step is to determine the complexity of the ES by the officials of the 24-hour technical support department. In our case, a malfunction of the software was detected at the customs level and one official and NTSIS were able to resolve the identified malfunction on their own. In case of ES at the regional level, NTSIS officials generate and send a report to a higher customs authority for joint work to eliminate the identified malfunctions.

4. Conclusion
Having studied the principle of implementing the model for optimizing communications in the customs bodies of the Siberian Customs Administration, including the Siberian Electronic Customs, the following conclusions should be made.

1. Due to the expected concentration of the declaration array in the region where the Siberian Customs Post of the Siberian Electronic Customs operates, as well as with an increase in the burden on customs officials (according to the statistical information presented in this study), the issue of the effectiveness of eliminating the emergency situations is important, since one of the most priority tasks set before the customs authorities - the acceleration of trade through the customs border of the Eurasian Economic Union, as well as the acceleration of transport flow in the Siberian region - are being solved.

2. Siberian Electronic Customs is an innovative customs authority in the region where the Siberian Customs Post operates, whose competence is to perform customs operations with respect to goods declared exclusively in electronic form. The main objective of the Siberian customs post is to reduce the time it takes to complete customs operations when declaring goods.

3. The process of implementing the communications monitoring system of the customs authorities of the Siberian region consists in the accelerated identification of emergency situations, determining its complexity and making an effective management decision.

This software will optimize the workload for officials of the round-the-clock technical support department of the Siberian Electronic Customs with the help of automatic contingency management, which ultimately will accelerate goods turnover across the customs border of the Eurasian Economic Union and reduce transportation costs (including the payment of penalties).

The automatic detection of emergencies by the software provided in this paper is aimed at accelerating commodity circulation with the countries of near and far abroad by optimizing the load on each official of the control department of round-the-clock technical support of both the Siberian electronic customs and other customs authorities of the Siberian region to eliminate malfunctions software tools. Ultimately, the rapid identification of emergency situations will speed up the process of eliminating them, reduce the number of forced vehicle downtime and the costs of participants in customs legal relations.

References
[1] Abramov A D, Becher S A, Popkov A L 2018 Optimization of technical training processes for the staff of car repair activities through the development and implementation of software Bulletin of SSURE No 4 P 42 - 49
[2] Burdyak P S, Sivitsky D A 2019 Optimization of the operation of the railway stations based on the use of a rolling stock control pattern Bulletin of SSURE 3 31-38
[3] Gorodnichev M, Marsova E, Gematudinov R, Dzhabrailov K 2020 Technical vision for monitoring and diagnostic of the road surface quality in the smart city programs E3S Web of Conferences 164 03013 DOI: 10.1051/e3sconf/202016403013
[4] Abbassi A, Ahmed El hilali A, Boukachour J 2019 Robust optimisation of the intermodal freight transport problem Modeling and solving with an efficient hybrid approach. Journal of Computational Science Vol 30 pp 127 - 142 https://doi.org/10.1016/j.jocs.2018.12.001
[5] Enoch L, Ashraf Uz Zaman Patwary, Wei Huang, Hong K Lo 2020 Transit interchange discount optimization using an agent-based simulation model Procedia Computer Science Vol 170 pp 702 - 707 https://doi.org/10.1016/j.procs.2020.03.168

[6] Flötteröd G 2017 A search acceleration method for optimization problems with transport simulation constraints Transportation Research Part B: Methodological Vol 98 pp 239 – 260 https://doi.org/10.1016/j.trb.2016.12.009

[7] Haitao H, Menendez M, Ilgin Gulér S 2018 Analytical evaluation of flexible-sharing strategies on multimodal arterials Transportation Research Part A: Policy and Practice Vol 114 Part B pp 364 – 379 https://doi.org/10.1016/j.tra.2018.01.038

[8] Pegon P, Santambrogio F, Qinglan X 2019 A fractal shape optimization problem in branched transport Journal de Mathématiques Pures et Appliquées Vol 123 pp 244 - 269 https://doi.org/10.1016/j.matpur.2018.06.007

[9] Hacizade U, Kaya I. 2018 Based Traveling Salesman Problem Solution and its Application to Transport Routes optimization. IFAC-Papers OnLine Vol 51 pp 620 - 625 https://doi.org/10.1016/j.ifacol.2018.11.224.

[10] Zheng Y, Lisheng J, Linlin G, Keyong L, Yan W, Faji W 2016 Development of a Distributed Cooperative Vehicles Control Algorithm Based on V2V Communication. Procedia Engineering Vol 137 P 649 – 658 https://doi.org/10.1016/j.proeng.2016.01.302

[11] Ilyukhin A V, Marsov V I, Marsova E V, Syetina T A, Dzhabrailov K A 2019 Improving the efficiency of frozen soils excavation using high-frequency vibration IOP Conference Series: Materials Science and Engineering 643 012102 doi:10.1088/1757-899X/643/1/012102

[12] Lipatova N G 2014 Tools for formalizing customs control processes and a mechanism for their imitation in modeling Bulletin of the Russian Customs Academy No 2 pp 58 - 65

[13] Fomenko D S, Shmatkov R N 2019 The model of optimization of communications of customs authorities of the Siberian region Issues of defense technology Scientific and technical journal Technical means of countering terrorism No 135 - 136 pp 12 - 17

[14] Fomenko D, Shmatkov R 2019 Optimization of a communication model of customs bodies. 012195 10.1088/1755-1315/403/1/012195. IOP Conference Series: Earth and Environmental Science (Don State Technical University, Russian Federation) Vol 403