Advanced technologies of international cargo correspondence in railway transport

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Abstract. The technologies of formation of transportation documents and preliminary informing in the international traffic are the primary directions of improvement of information technologies of interstate transfer points both for the information systems of state control and regulation and for the information systems of the subjects of transportation services. In the railway transport system of the Russian Federation the model of formation of transportation documents and preliminary information has a number of distinctive features from the existing model of the world practice. The article analyzes and determines the possibility of development and interaction of information systems of state authorities, owners and consumers of transport services in a single information space, methods of their consolidation and integration into international transport corridors. Automation of technological operations on processing of transport documents and preliminary informing by creation and introduction of innovative developments in the field of management of process of technological interaction of participants of transport - providing services is considered. The automated system of processing of transportation documents for imported cargo with barcoding and the automated system of informing cargo owners about the approaching expiration date of the phytosanitary certificate are presented and proposed for use at the interstate junction points. The proposed information systems improve and optimize these technologies, accelerate trade turnover and ensure the implementation of projects for the development of a common information space in the segment of international traffic and the development of transport international relations in general. The systems have undergone states registration.

1. Introduction
The active development of international trade and industrial relations requires the search for new, more qualitative developments in the digital economy of the Russian Federation [1]. One of the ways to improve it is to increase the efficiency of the existing economy through the automation of technologies and processes of processing information data. The development of this segment is a priority for the railway transport, since the majority of cargo correspondence on the domestic and international markets of transport services falls on its share [2]. The universal development and implementation of automation of the technology of formation of transport documents and preliminary information in international traffic are the primary directions of improvement of information technologies of interstate docking points, both for information systems (IT - systems) of state control and regulation, and for IT - systems of subjects of transport services [3]. In the railway transport...
system of the Russian Federation, the model of formation of transport documents and preliminary information has a number of distinctive features from the existing model of world practice [4]. Studies show that in the modern information space of the country’s transport system there is no interaction and data exchange between the information systems of the transport control bodies providing the complex and information systems of the subjects of transport services. Implementation of the project on creation of information support of cargo correspondence in international transport corridors is at the initial stage of development. Analysis of the work of interstate junctions shows that with the increase in the volume of export cargo transportation, the number of delayed trains and wagons with export cargo increases proportionally for such reasons as waiting for processing of transportation documents and waiting for the formation of transportation documents. In addition, there is a negative growth rate of unhitched wagons at border transfer stations (BTS) due to the expired validity of the phytosanitary certificate (PSC) for export cargo, discrepancies in the information about the goods in the shipping documents and the lack of shipping documents [3,4]. The solution to these problems can be found through the implementation of the concept and projects of the digital economy, methods of consolidation of IT systems and their integration into international transport corridors (Fig. 1). The aim of the work is to improve document management and preliminary information (PI) technologies in the organization of transportation of foreign trade cargoes by creating and implementing innovative developments in the field of managing the process of technological interaction between participants of transport services.

Fig. 1. Structure of reasons for delays of export cargoes on the IJP and ways to eliminate these reasons

In this paper, the authors propose a new effective way of development and implementation of the information resource of the railway transport system in the field of international communications. The IT system for processing of transport documents for imported goods with the use of barcoding (AC barcode) and IT system for informing cargo owners about the approaching expiration date of the phytosanitary certificate (AC KSDFS) are presented and proposed for use at the MSSP IT [5,6].

The main purpose of creation of the presented IT-systems is realization of the project of development of digital economy in space of creation of a uniform information field of a transport complex of the country:

– systems of accounting, processing and analysis of statistical information of the single transport complex;
– systems of analysis and planning of correspondence of export cargoes;
– systems of interaction of subjects of management of transport branch and subjects of transport services;
– systems of electronic document flow and preliminary informing of market users in the segment of transport services.

Achieving the goal is possible by solving the following tasks:

Ensuring transparency of statistical data.
Ensuring information consolidation and integration of producers of goods, transport companies and consumers of transport services on the basis of and using information resources of railway transport.

3) Ensuring automation of the processing of transport documents and preliminary information on imported and exported goods and their preliminary translation from the language of the transmitting party into the language of the receiving party.

4. Introduction of automated bar-coding technology for identification of import and export documents.

5. Introduction of automated IP technology.

6. Formation of a database for storing documents in foreign and Russian languages (translations).

7. Creation of an automated system to search for documents for imported and exported goods with the possibility of feedback from the shipper and correction of errors in design.

8. Introduction of changes in the existing technology of work, personnel training and support of the system operation.

Creation of conditions allowing to realize the listed problems promote formation of system of optimization of expenses at transportation of cargoes in the international communication, the account, processing of the information data of a transport complex and modeling of variants of interaction of controls and subjects of transport services in a uniform information field [7].

2. Methods of construction and structure of IT systems

The reliability of IT systems depends on the principles of governance in the areas of coordination, monitoring and exchange, and data management [8]. This area is within the scope of the activities of the transport complex management bodies. The quality and direction of information flows of IT systems depend on the users - subjects of transport services. In general, both the former and the latter are IT systems integrators, which provide system information consolidation and integration in the organization of transportation of foreign trade goods, the method of formation of information and technological and using the mechanism of automation of functional IT systems with self-determination and maintenance. At construction of IT - systems of AC barcode and AC KSDFS, methods of identification, transformation, coding, accounting, analysis and protection of information flows were applied [8]. The mechanisms of modeling of variants of perfection and interaction of controls and subjects of a transport complex (fig. 2) were used.

Using methodological principles of formation of adaptive systems with self-maintenance the volume of information flow at the input (ΣP_i) in IT systems is determined:

$$\sum P_i = \{ P_{1i}, P_{2i}, P_{3i} \},$$  \quad (1)

the volume of information flow (ΣP_e) at the exit from IT systems looks like:

$$\sum P_e = \{ P_{1e}, P_{2e}, P_{3e} \},$$  \quad (2)

the preferred information flow conversion function (ΣP_d) is as follows:
When creating the IT-barcode AC systems and AC KSDFS systems, it is assumed that the purpose of the information space unity function is to create a predictive model of the mechanism that represents the maximum value of the target function, or preferred for system integrators of information data for a period of time \((T_{ij})\). As a result, the solution at the initial given forecast \((X)\), on the set of mechanisms \((Q_x)\), is defined as follows:

\[
Q_x = \sum X = \left\{ X, P_{in}, P_{en}, P_{ijn}, T \right\},
\]

Thus, the target function of the synthesis of self-contained systems in a single information space is to ensure the development of all system integrators, without exception, included in the model of the market of transport services in international traffic, and to maintain a transportation process that will ensure maximum performance of the target function with a variety of preferred options.

Fig. 2 shows the scheme of transmission, transformation, coding of accounting and analysis of information flows in AC barcode and AC KSDFS systems

The structure of IT systems. The structure of AC barcode - code and AC KSDFS includes the Server (WEB-server, application server), database server, personal computers of IT-systems users. The server of systems is intended for installation of the software realising functionality of AC a barcode, AC KSDFS. Database server is designed to install software that implements the functionality of the system of traffic safety management, placement and storage of IT-systems data [9]. Personal computers of users are designed to provide a user interface for access to IT systems. Server components of the System (WEB-server, application server, database server) provide the possibility of scaling in the event of increased load when connecting additional users and / or expanding the functionality of IT - systems. Components are implemented on the basis of industrial software. The software is documented and provides the necessary and sufficient for the implementation of basic functions set of subsystems dedicated to the functional and technological principle. The software provides a user interface in Russian and other languages (by decision) and has the property of extensibility of functionality [10,11].
IT systems function in a single information space on the basis of a single database and reference information systems. Data exchange is carried out in accordance with the approved data exchange regulations [10,11].

According to the functions and the level of tasks solved by users, for each IT workplace - barcode AC systems, AC KSDFS provide the following access rights:
– the consignor's workstation for inputting primary documents for import and export cargoes;
– an interpreter's workstation to ensure control over electronic document translations;
– specialist workstation for efficient processing of freight trains, with access to transportation documents and the possibility of correcting electronic documents;
– the system administrator's workstation, which allows to add and improve IT systems, change and supplement regulatory and reference information to form a database.

AC barcode - a barcode and AC KSDFS represent an information, software and hardware complex, which is based on standard technical means and software and hardware platform used in JSCo "Russian Railways".

Reliability of IT systems. IT systems remain operational and provide restoration of their functions in case of the following emergency situations [11]:
– power failure;
– malfunction of IT systems software;
– violation of the technical means complex operability.

Reliability of IT-systems operation is provided at the expense:
– data integrity control;
– provision of backup copying of information data;
– organization of hot backup of information data on logical and individual physical media (software/hardware RAID) levels [12];
– localization of program codes components of their configuration and results of work in separate catalogues on corresponding servers;
– use of own means of protection of standard software for data protection and access control;
– use of certified computer facilities;
– connection of technical means to uninterruptible power supplies to protect equipment and data from power failures [11,12].

3. Results
Results of AC barcode development - code and AC KSDFS are issued in the form of computer programs, a set of technical documentation, user's instructions and methodical materials in the volume necessary for implementation and use. IT systems are designed to work in the information space of JSCo "Russian Railways", railways of participants of international communications and interested government agencies of the Russian Federation. Access is provided both by the subjects of transport services and by the employees of the transport complex management bodies (border and customs services and other federal supervisory services) [13,14]. The work of IT systems is based on the principle of displaying the required accompanying documents for export and import cargoes through the WEB interface at the workplace of users. Data exchange is carried out in accordance with the approved regulations. The software is placed on the server and does not require installation of additional software on the user's workstations. The software and data storage are located on the server. The software is implemented on the personal computers, united by standard means of communication via the Internet [15]. IT systems are built on the principle of displaying screen forms at the workplace with the possibility of adding files in electronic form, further work with transportation documents, adding language translations, and displaying the required information [15].

The input data for the AC barcode is the AC barcode:
– Selection of operation mode (subject receiving cargo, subject transmitting cargo, translator);
– Selection of transportation documents;
– accompanying documentation (list of electronic documents);
– accompanying documentation (work with translation).

The output data of the AC barcode are:
– output of forms of electronic documents;
– Barcode - the code of the consignment (it allows one to read the data and search for the accompanying information, including translation into the user's language), examples of AC barcode visualization - the code is shown in Fig. 3, 4.

![Barcode AC]

**Fig. 3.** Example of the screen form for inputting the operating mode in the IT - AC system barcode

```
|| Accompanying documentation

Mode selection
• Receiving/disposing party
• Translator
• Russian side

Barcode AC
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![Barcode AC]

**Fig. 4.** Example of a screen form for displaying electronic shipping documents on an export cargo consignment in IT - AC barcode system

IT system AS KSDFS provides preliminary informing of cargo owners about the end of the FSS validity period and improves the process of processing of initial incoming information on the export cargo. The algorithm of this process is that with the help of the information resource of the global network "Internet", the consignor, as a system integrator, receives a notification in the PI mode about the period of validity of the FCC with the indication of the reason and the guilty in this subject of the transport complex. A link is sent with the notification containing the form of an electronic application to form the FSS again. The integrator sends the newly formed electronic application form to the relevant supervisory authorities for reissuance. As a result, having preliminary information, the accompanying documents for export cargo are reissued in advance, except for the restarting of the process at the MSME. The IT system functionality is being developed in stages:
– collection of statistical data;
– accounting and processing of statistical data;
– computer analysis of information data;
– visual display of the analyzed data;
– Formation of managerial and corrective decisions;
– user notification.

Examples of visualization of KSDFS AC are shown in Fig. 5, 6.

![Control Term of the Phytosanitary Certificate](image1)

**Fig. 5.** Example of the screen form of request for the analyzed information about overdue FSS in IT - KSDFS AC system

![Screen form for notifying the consignor of the FSS expiration date](image2)

**Fig. 6.** Example of a screen form for notifying the consignor of the FSS expiration date in the IT system of the KSDFS AC

Thus, the developed IT systems provide the unification of information statistical data from other systems working in a single information space that provides the possibility of filling them with
the necessary flow of information, which creates the conditions for adaptation and self-maintenance of the transport production process. IT - barcode AC systems and KSDFS AC were registered with the Federal Service for Intellectual Property of the Russian Federation.

4. Discussion

The IT systems presented by the authors allow for implementation:

– preliminary translation of electronic documents into the language of users, as well as creation of conditions for even loading of translators;

– preliminary informing transport service providers about the status of accompanying transport documents;

– Possibility of using electronic documents on consignments of export and import cargoes by the state management bodies of the transport complex and subdivisions of JSCo "Russian Railways" to speed up the technological process of their processing, reception and transfer;

– Assigning a unique bar code to copies of electronic transportation documents, i.e., a code that ensures identification of the cargo throughout its delivery;

– automation of the process of preparation of accompanying documents for imported cargo, prompt search for any document and its translation;

– Preservation of electronic documents in the database, protection from distortion;

– visualization of the task for the employees of IHR;

– forecasting and planning of the processing of transportation documents for the forthcoming period;

– generation of barcodes and search for transportation documents in information systems by barcode;

– adaptation of the technological process to changing internal and external conditions;

– maintenance of the main technological process for processing electronic transportation documents in international traffic.

Calculation parameters show that when using the IT - barcode AC systems and KSDFS AC, the prerequisites for excluding unproductive technological periods from the single technological process, such as waiting for processing of transportation documents for export and import cargoes, waiting for the formation of transportation documents, are created at the MSSP [16]. Preliminary information on the state of accompanying documents excludes the idle time of cargoes and rolling stock at border crossing points and approaches to them [16].

5. Conclusion

Widespread introduction and further development of the proposed IT systems will make it possible to accelerate the implementation of projects to create information support for freight correspondence in international transport corridors and to improve the unified information space of the Russian Federation. The application of these software products will ensure the formation of foreign trade relations with the consolidating interaction in the space of international communications.

The obtained results due to automation of technologies and processes of information data processing increase the efficiency of the existing economy, customer focus and improve the digital economy of the country.

The issue of further development of the IT potential of the AS barcode and AS KSDFS systems reinforced by the information flow, accounting and analysis of statistical data sent to the personalized complex of information transport services, is the subject of future research.

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