

**FaR 2021****International Forum “Freedom and responsibility in pivotal times”****DESIGN AND TESTING OF INTELLIGENT CONTROL SYSTEMS  
AT TRANSPORT ENTERPRISES**

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(c) Rostov State Transport University, 2, Rostovskogo Strelkovogo Polka Narodnogo Opolcheniya Sq.,  
Rostov-on-Don, Russia, visharenko@yandex.ru**Abstract**

In a context of uncertainty and technological constraints in the domestic economy caused by the sanctions imposed on Russia and the pandemic crisis, the role of anti-crisis technological management in ensuring the sustainable development of transport companies is increasing. Free competition is limited to Russian companies, and opportunities for attracting technological and financial resources from foreign markets are reduced. The transport services market experiences a decrease in the income of Russian companies. As part of the strategy of creating intelligent control systems in maritime and railway transport, a phased transition of Russian ships and locomotives to an autonomous control mode is being carried out based on artificial intelligence as the sum of technological solutions that simulate knowledge. Tests conducted and analytical synthesis of their results showed that the advantages of anti-crisis technological management are now more associated with an automatic rather than a remote control format. The low adaptability of projects was affected by risks caused by certain technological constraints. Most projects may be attributed to the format of conducting single experiments, which are not integrated into the system of intelligent control of the transport industry. The development of intelligent control methods and automated technologies will create an engineering algorithm for the mass production of fully unmanned vessels. The use of innovative technologies in Russian maritime and railway transport, which are developing in line with the concept of intelligent control, will ensure the sustainable competitiveness of Russian companies in the international transport market.

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*Keywords:* Transport services market, intelligent control systems, innovative technologies, national economy

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## 1. Introduction

In modern conditions the desire of the Russian economy for information management in accordance with new national objectives makes the tasks of designing and testing intelligent control systems at transport enterprises quite urgent. In the context of limited financial and technological resources, the problem of creating intelligent control systems is solved by the transport industry through the intensified isolation of the Russian market of innovative technologies from world technological developments. The introduction of reorganization and restrictions causes the risks of the isolation economy. Free competition is limited to Russian companies, and opportunities for attracting technological and financial resources from foreign markets are reduced.

The transport services market experiences a decrease in the income of Russian companies, including enterprises of the transport and industrial complex. It is unknown how long the post-crisis economic recovery will last, but modern trends in the development of the transportation market require innovations both in the transportation technology and in the organization of services for consumer companies. Many Russian transport companies striving to stay on the market in difficult conditions are developing new solutions related to the use of intelligent control systems at enterprises by introducing innovative services for interaction with customers and counterparties, automating jobs and using technologies for the robotization of business processes.

The paper aims to identify tools for intelligent control systems technologies for transport companies. These tools serve the basis for a modern information and network infrastructure for the development of the Russian transport industry. The anti-crisis model of intelligent control systems is based on the knowledge and competencies of employees (Stewart, 2007), as well as on the organizational capital of companies and the transport industry as a whole. Today's information and network infrastructure is critical to enable the implementation of an institutional framework for intelligent control.

The main purpose of the study is to theoretically summarize the experience of using innovative technologies of intelligent control in transport that ensure the stability of companies and business security, high-quality customer service, as well as the development of information systems of the risk management system. The theoretical and methodological basis of the study was the classical theory of information management with its modern conceptual directions related to the development of intelligent control systems.

## 2. Problem Statement

The transport services market experiences a decrease in the income of Russian companies, including enterprises of the transport and industrial complex. It is unknown how long the post-crisis economic recovery will last, but modern trends in the development of the transportation market require innovations both in the transportation technology and in the organization of services for consumer companies. Many Russian transport companies striving to stay on the market in difficult conditions are developing new solutions related to the use of intelligent control systems at enterprises by introducing innovative services for interaction with customers and counterparties, automating jobs and using technologies for the robotization of business processes.

### **3. Research Questions**

The paper aims to identify tools for intelligent control systems technologies for transport companies. These tools serve the basis for a modern information and network infrastructure for the development of the Russian transport industry. The anti-crisis model of intelligent control systems is based on the knowledge and competencies of employees, as well as on the organizational capital of companies and the transport industry as a whole. Today's information and network infrastructure is critical to enable the implementation of an institutional framework for intelligent control.

### **4. Purpose of the Study**

The main purpose of the study is to theoretically summarize the experience of using innovative technologies of intelligent control in transport that ensure the stability of companies and business security, high-quality customer service, as well as the development of information systems of the risk management system. The theoretical and methodological basis of the study was the classical theory of information management with its modern conceptual directions related to the development of intelligent control systems.

### **5. Research Methods**

The study was conducted using the following open and verifiable sources: 2015–2021 publications included in the Scopus and Web of Science, as well as publications included in the RSCI, which cover the issues of information management, intelligent systems for managing the development of transport, digital economy and cognitive technologies. Within the framework of the study, the following methods were used: institutional analysis, graphic modeling, risk-oriented approach, philosophy of economy and anti-crisis management.

The prerequisites for the development of the methodological base of the study were the directions and tools for the development of intelligent control and information management systems (Albekov et al., 2017). The following categories were particularly important during the study: information-network management, intellectual capital, intelligent control systems, information management, competency-based approach and cognitive competencies. The modern level of digitalization of transport systems management processes does not meet the tasks of creating intelligent control systems. The development of innovative programs requires new technological approaches and solutions adapted against successful practices by industry companies.

### **6. Findings**

Intelligent business management systems arose on the basis of a competency-based approach and cognitive management methods. Cognitive methods were distinguished on the basis of the concept of a competency-based approach, which arose in the English scientific literature in 1984, when Raven (2008) presented the categorical meaning of defining the concept of “competence” as a phenomenon based on a large number of components, some of which belong to the cognitive sphere.

The competency-based approach in the company management system determines the ability to perform professional tasks, solve problems and evaluate the results in terms of the stated objectives. The competency-based approach represents the proven, tested and then digested information that a person, group of people or organization has. Based on the study of Stewart (2007), it can be concluded that knowledge and skills are a fundamental category of the competence. Professional competencies should be created by practical experience and already formed competencies of a specialist. Based on the study of Stewart (2007), it can be concluded that knowledge is a fundamental category of the competence. Practical knowledge forms the basis for the algorithmization of practical activities, methods and results of practical actions that form the intellectual capital of a modern company (Andreeva et al., 2019a).

The set of professional and cognitive knowledge is implemented in practice through the formation of skills and abilities of employees, the development of intellectual thinking. It is these factors that specialists pay attention to during training and retraining programs (Andreeva et al., 2015).

In modern conditions the desire of the Russian economy for information management in accordance with new national objectives makes the tasks of designing and testing intelligent control systems at transport enterprises quite urgent. In the context of limited financial and technological resources, the problem of creating intelligent control systems is solved by the transport industry through the intensified isolation of the Russian market of innovative technologies from world technological developments. The introduction of reorganization and restrictions causes the risks of the isolation economy. Free competition is limited to Russian companies, and opportunities for attracting technological and financial resources from foreign markets are reduced (Alexandrova & Andreeva, 2020; Mirgorodskaya et al., 2018).

The modern transport services market experiences an unstable situation related to the decrease in the transition to the stage of recovery growth of the Russian economy, which occurs in the context of the ongoing pandemic crisis and increased sanctions by the United States and the European Union. This means a reduction in the services of transport companies due to the restriction or blocking of supplies to many countries of the world market. It is difficult to say how long the post-crisis economic recovery will last, but modern trends in the development of the transportation market require innovations both in the transportation technology and in the organization of services for consumer companies. Innovation-driven Russian transport companies striving to remain competitive in the market in such difficult conditions are developing related to the use of intelligent control systems at enterprises by introducing innovative services for interaction with customers and counterparties, automating jobs and using technologies for the robotization of business processes. Robotics has become more in demand in conditions of remote work and lack of qualified personnel (Andreeva et al., 2018).

The development of innovative products based on intelligent control systems is being carried out by Russian Railways Technologies and Robin, and the first Russian marketplace of robotic software solutions is being created. Marketplace should become an integrator of innovative companies in the transport and services market. The marketplace is designed on the basis of the intelligent control project “Cloud factory of software robots”. The development of the marketplace as a center for robotics will allow the market participants taking advantage of its developments. This innovative project is created on the technical basis for software robots. The intelligent technical modeling system is designed on the basis of four products, such as Robin Studio, Robin Robot, Robin Orchestrator, Robin Cloud Factory (Klevoshin, 2021).

The Studio product is a tool for software robots using a visual designer. The robot accumulates a test script base for robotics, which ensures the operation of a software robot on a standard computer. Orchestrator allows managing the entire manufacturing automation process. As part of the Cloud Factory product, the counterparties will be able to receive the indicated technologies according to a specialized technical program.

Similar systems work effectively in foreign countries both in the form of individual projects and in partnership with certain companies. The launch of the platform will solve a range of innovative problems for the development of transport companies. Marketplace as an innovative platform will ensure the rapid growth of robotics. However, not all business processes work according to unified schemes (Vovchenko et al., 2019). The surge in the development of information and network technologies and artificial intelligence creates the basis for big data processing and interaction with customers.

The modern information and network infrastructure, which is based on the knowledge and competencies of employees, as well as on the organizational capital of companies and the industry, serves the basis for the development of intelligent control systems. Today's information and network infrastructure is critical to enable the implementation of an institutional framework for intelligent control. The availability of institutional practices for managing the intellectual and organizational capital of industry companies allows for load testing of automation and robotization programs. An important condition for testing is the availability of tools for automated secure access based on the identification methods.

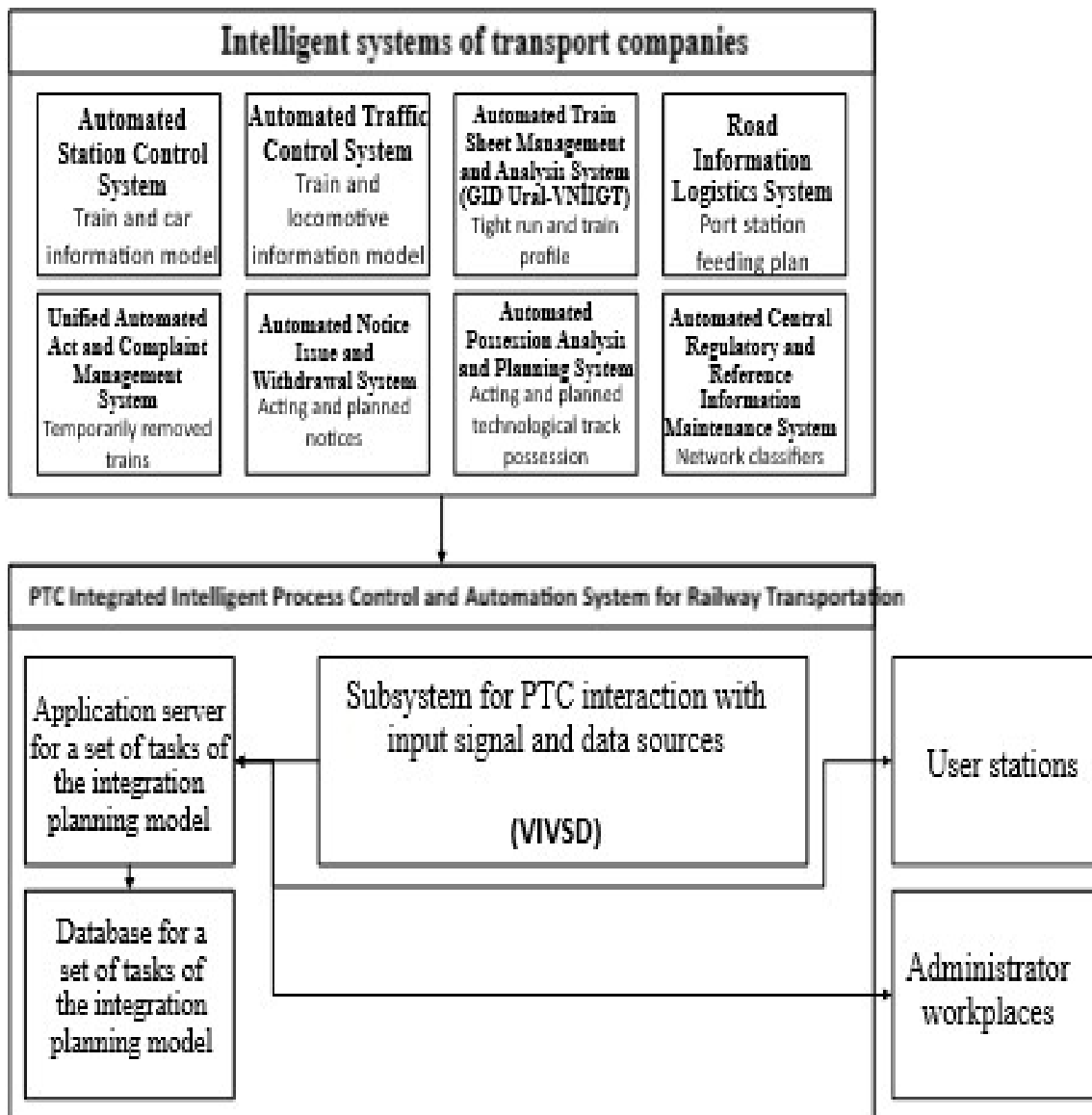
A new condition for the successful development of tools for modeling intelligent transport systems for business management is the presence of a variable multi-unit strategy aimed at improving the sustainability of the industry and finding tools for financing the intelligent development of transport companies (Andreeva & Shevchik, 2017). In the context of imputed restrictions on business growth, transport company risk managers use the first and second level information database based on the cascading of indicators ranked after the analytical study (Andreeva & Shevchik, 2020; Buryakov et al., 2020).

The autonomous management systems will allow ship owners reducing costs and increasing the financial stability of companies. The modernization of the organizational and technological management system will keep costs down, for example, by reducing the number of crew members. The transport and service systems need specialists with a quite wide range of competencies. If specialists have insufficient experience, then additional risks are formed for freight carriers, forwarding and logistics companies. The share of freight traffic registered using digital services has increased almost 2 times since the beginning of 2021 (Andreeva et al., 2019b). From the beginning of 2021, Russian Railways Freight Transportation began to use electronic trading platforms for online ordering of services, including such tools as export and transit transportation, provision of rolling stock, loading and unloading and terminal work. Innovative services have found high demand among economic agents operating in the spot market. This service is highly desired if it is necessary to pay exactly at a certain time in order to get cars for transporting urgent cargo. For example, during the pandemic crisis the Business Lines Group of Companies put a number of digital services into operation: change of data in online orders by phone, possibility to track the movement of a car with address delivery on a map, ability to quickly contact a manager by a video call.

Engineering technologies were introduced into cargo insurance processes, which made it possible to automate the insurance process. This allowed speeding up the processing of insurance operations and

reducing the time to settle the losses. Insurance payments and proceeds in case of violation of the cargo delivery period began to be paid automatically, which significantly increased the level of confidence between the counterparties of the transport services market.

The use of new information technology solutions increased the speed of operations and the quality of services. For example, after the introduction of QR coding at its largest Domodedovo terminal, the Baikal-Service transport company increased the speed of cargo processing by 3 times. With the introduction of the new technology the goods delivery at warehouses became faster, while the service time of one customer at the checkout was significantly reduced. Electronic payments reduced the service time for one client to a few minutes. When servicing customers through the express delivery service center, the transport company increases its profitability and forms a loyal customer base. The development of intelligent control systems in the Russian transport industry is consistent and technological. The conceptual diagram of the intelligent control system of a transport company is shown in Figure 01.



**Figure 1.** Conceptual diagram of intelligent systems of transport companies

The introduction of intelligent systems on Russian ships and railway transport will reduce costs, for example, associated with shifts, the number of people and the number of shifts themselves. For large ship owners this constitutes substantial costs for production activities. A draft federal law on the autonomous fleet and technical regulation norms was prepared for the development of innovative systems. It includes documents of the Federal Agency for Maritime and River Transport of Russia and the Russian Maritime Register of Shipping. The provisions of the shipping register have already been published, while other regulatory documents are being developed. Within the framework of existing international conventions, the maritime administration develops its institutional and legal mechanism for their adaptation and introduces specific rules for the innovative development of companies.

Automatic ship control, which determined the content of “autonomous navigation” until 2016, corresponded to the concept of “unmanned navigation”. Later, the International Maritime Organization (IMO) as the regulator of the shipping market established a new generally accepted terminology. Currently, the category “maritime autonomous vessels” is used to characterize the transport of large ships, and “unmanned” are terminologically defined as small vessels that are not included in the regulatory format of the International Maritime Organization.

In December 2020, the Morspetservice shipping company signed an agreement with Kronstadt Technologies to equip 10 cargo and passenger ships with autonomous navigation systems. A package of documents is also being developed for signing an agreement between Kronstadt Technologies and SeaEnergy, which is part of the MT Group. The subject of the agreement is related to the equipment of 10 dry cargo vessels with autonomous systems. Signed agreements will be institutionalized after the decision of the Government of the Russian Federation on legalizing autonomous navigation in our country. Consequently, Russian maritime transport is beginning to introduce intelligent control technologies.

According to expert information, the estimated cost of installing the system and its annual support is 40 million rubles per one vessel. For the domestic navy such amount of expenses for an intelligent control system seems quite substantial. At the same time, the modernization of the organizational and technological management system will reduce costs, for example, by reducing the number of crew members. The introduction of such systems on Russian ships with large crews will definitely reduce major costs. The goal of the modern Russian project, which is formed on the basis of the construction of intelligent control systems in the transport industry, is to ensure the wide use of autonomous navigation technologies.

Tests conducted and analytical synthesis of their results showed that the advantages of anti-crisis technological management are now more associated with an automatic rather than a remote control format. The low adaptability of projects was affected by risks caused by certain technological restrictions. Thus, the tests revealed that the existing marine satellite communication channels do not yet have high adaptability.

## **7. Conclusion**

Modern technologies allow developing and implementing innovative projects aimed at the development of autonomous navigation technologies. At the same time, most of these projects may be attributed to the format of conducting single experiments, which are not integrated into the system of intelligent control of the transport industry.

The program of intelligent control of the transport industry includes developments related to the use of innovative methods for the delivery of goods and passengers. On the one hand, the use of autonomous ships allows not only reducing the costs of companies, but also improving the safety of navigation, and eliminating the factor of human errors during operation. The development of intelligent control methods and automated technologies will create an engineering algorithm for the mass production of fully unmanned vessels. At the same time, the use of innovative technologies in Russian maritime and railway transport, which are developing in line with the concept of intelligent control, will ensure the sustainable competitiveness of Russian companies in the international transportation market.

During freight transportation, the QR code payment technology is available at the delivery points. If before the crisis the customers of transport companies paid for orders at the time of receipt, then in the second half of 2020 contactless payment of goods became the most commonly used method. The introduction and expansion of new technological solutions increased the need for information and service centers to store large amounts of data. BigData methods are now widely used in the transport industry. The BI system allows speeding up the analysis and verification of the hypothesis, and using the corresponding solutions in marketing, sales, financial transactions.

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