Improving the performance of technical services personnel of car enterprises in digital ecosystems

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Abstract. Based on the research, the article discusses the trends in the use of digital technologies and the creation of digital ecosystems in the road transport industry. Transport informatization has created the basis for a transition to a new level of functioning in the context of digital production ecosystems, which focuses personnel’s attention on increasing labor productivity, accelerating interactions with consumers of transport and car maintenance units. However, the digital environment requires automotive personnel to improve existing and create new competencies related to digital literacy, information exchange, and increased communication skills. A digital ecosystem of the engineering and technical service of a car enterprise, a model of personnel competencies (by the example of a controller of the technical condition of vehicles) are proposed.

Key words: digitalization, digital ecosystem, transportation services, vehicle service, personnel, competency model, reliability of personnel.

1. Introduction
The use of digital technologies in transport is a complex system task that significantly affects the development of the transport industry. Considering that the advanced economies, including Russia, are gradually being drawn into the so-called fourth industrial revolution (Industry 4.0), the leadership of many road transport enterprises (RTE) and vehicle service stations (CSS) needs to review development strategies. 4.0” [1] provides for the massive introduction of digital elements and systems, the complete digitization of space, subjects and processes, elaborated digital transformation of all material resources and their integration into digital ecosystems to ensure the production and service level which satisfies consumers. Taking these trends in our country into account on the initiative of the Ministry of Transport, a digital platform of the transport complex is being formed, which will combine services and data arrays and become an ecosystem for all participants in the transport process. The digital platform will establish common standards, rules and regulations for information exchange on vehicles, transport infrastructure, etc. Since the main participants at the primary level in the new forming digital system are transport companies and service stations, they must substantially transform their activities in the light of new requirements caused by digitalization processes in the economy.

The creation of digital ecosystems in transport and service companies is possible only if there are well-established processes in place for obtaining and analyzing information on the achieved
performance indicators based on modern services application and arrangement of effective exchange for the development of management decisions.

To date, a unified understanding of a number of terms of the “digital” economy has not been formed yet, nevertheless, some of them are used by scientists and specialists to explain the digitalization phenomenon. Accordingly, there is a need to cite the most frequently used terms as revised by the author [2]. “A digital (electronic) economy is an economy which characteristic feature is the maximum satisfaction of the needs of all stakeholders through the use of information, including personal one. This is possible through the development of information and communication and financial technologies, as well as the availability of infrastructure, which together provide the opportunity for full interaction in the hybrid world of all economic activity participants: subjects and objects of the process of creation, distribution, exchange and consumption of goods and services”.

“The platform is a digital environment (hardware and software complex) with a set of functions and services that meets the consumer and manufacturer needs, as well as realizes the possibility of direct interaction between them”.

“Digital ecosystem [3] is a representation of the social and technical system in the form of a combination of computer programs with distributed interaction and mutual use of agents for the exchange of knowledge in the evolutionary development”.

2. Problem statement
At present, transport and service enterprises use automated information systems with software tools that allow for personnel, financial and warehouse accounting, processing of transport work documents, accounting of service works (maintenance) and repair (R) works performed, etc. However, the analysis of effectiveness of the information systems use in transport companies has shown that they are outdated, do not take into account and do not process a number of important data, especially indicators of the vehicle technical condition, personnel performance indicators in the maintenance and repair system of vehicles. So, the information is not collected on the reliability of the activities of auto mechanics, controllers of the vehicle technical condition, the principle of continuous monitoring of vehicle technical condition data, especially those that affect road safety are not respected, insufficient attention is paid to accounting of the reliability indicators of equipment. This altogether leads to the fact that the level of road traffic accidents (RTA) remains high due to vehicle malfunctions (according to statistics, up to 4 % of the total number of accidents, according to research estimates – up to 18 %), the costs in the engineering and technical service of a transport enterprise is about 40 % of the cost of transportation. These circumstances pose a problem, primarily in terms of maintaining the rolling stock in working condition, reducing road transport incidents due to technical malfunctions, reaching of optimal costs for transportation and vehicle services. Thus, the creation of a digital ecosystem based on modern digital services for transport enterprises remains an important task which implementation will significantly improve the management of processes to maintain the required level of vehicle performance, provide productive work of personnel, timely accounting and analysis of information on the parameters of activities of the road transport enterprises units.

3. Materials and methods
The range of human activities is continuously changing. New technologies appear, routine work is transferred to technical devices in increasing volume, and personnel is required to be creative, to find new solutions, master new types of activities, willingness to work in a team, etc. All this happens due to the changes in various sectors of the economy of our country, which, together with other advanced economies, is moving to the next level of development of new technologies based on digitalization, artificial intelligence, and cognitive technologies.

The author [2] notes “that with the advent of the Internet, a virtual world is being formed, full of new opportunities. The real and virtual worlds are interconnected and their merger forms a “hybrid” world, characterized by the ability to perform all vital actions in the real world through the virtual one” and that “digitalization is an objective, inevitable process and can not be stopped.”
Based on these concepts, it should be expected that in the near future significant changes will occur in various sectors of the economy, new content will be carried out in management, science, security, and various sectors of the economy.

In this contest, digitalization in the transport sector is gaining momentum: ecosystems are being formed in the market for the transport of goods and passengers, in the organization of road safety, and logistics. Transport experts note that further development of the transport industry is impossible without introduction of digital technologies, self-driving vehicles, artificial intelligence. Digital Transport and Logistics Project which will reflect the best domestic achievements in creating a domestic digital platform and the deployment of information flows on its basis in the transport complex of the country is being developed [4].

The introduction of innovations in transport will require new personnel competencies, especially in terms of the development of digital culture, technologies as part of artificial intelligence, algorithms for interacting with partners and consumers in digital production ecosystems.

Building an ecosystem at the level of a motor transport or vehicle service enterprise and, particularly, a technical engineering service (TES), which maintains the performance of vehicles, involves the inclusion of all structural units and management personnel in this process. Such an ecosystem can be formed as the “TES Digital Ecosystem and Reliability”. However, it should be borne in mind that the ecosystem will consist of two parts: internal and external. Building an internal ecosystem, it is necessary to ensure harmonious interaction with the external ecosystem through the appropriate choice of platform and services.

Fig. 1 shows a diagram of a digital production ecosystem of a vehicle enterprise (CE) with a developed technical engineering service (TES). General change management and the formation of the digital production ecosystem of ATP are carried out by the Director, and at the TES level, by the Chief Engineer (Technical Director). Operational service (OS), human resources department (HR), planning department (PD) and information technology (IT) department provide information to enterprise’s management and communication with external environment. In order to make management and technological processes at the TES level more effective, it is necessary to develop digital tools in the form of programs and databases on a single platform, equip structural units with appropriate services that can function both in the internal and external production ecosystems.

The external digital ecosystem consists of many stakeholders, the main of which are: consumers, suppliers of spare parts and materials, labour market, tax authorities, banks, various forums (conferences, consumer sites, etc.).

The organization of work of a car enterprise TES digital transformation should begin with the creation of a transformation office. Production and technical department (PTD) is quite suitable for this role. At the same time, some employees of production control department (PCD), mechanical department (MD), material and technical supply (MTS) system, maintenance (M) and repair (R) system, and information technology (IT) department (temporarily) on a temporary basis are required.

Transformation office is created to develop a project for the digital transformation of the automotive engineering and engineering service, as a result of which organizational and information technology proposals for business processes based on the capabilities of new digital technologies should be prepared and implemented.

The development of a project, first of all, begins with an analysis of domestic and foreign experience in using digital technologies and an examination of solutions that are acceptable for improving business processes in a car enterprise TES. In this case, of course, changes will be required in operational service (OS) and planning department (PD) of the CE.

On the next phase, it is necessary to make a choice of digital technology that best meets the specifics of business processes in the TES on the basis of expert decisions and is compatible with the services of structural units of a car enterprise.

The next stage should be devoted to the analysis of the current situation in the TES of a car enterprise in such areas as management, organization of technological processes of vehicle maintenance and repair, reflection of processes in the information system, development of personnel competencies.
Figure. 1. TES Digital Ecosystem and Reliability

Such an approach will make it possible to form a roadmap for the implementation of the project, including digitalization of processes to maintain the required operability of vehicles, and improving the competencies of management and production personnel.

Digital transformation of the internal production ecosystem will require digitization of the storage resources of spare parts and materials, updating the fleet of diagnostic and technological equipment and installing chips on them, creating digital profiles of management and production personnel, and developing new competencies. In such a system, reliability indicators are determined for automobiles and for equipment and, which is very important, for personnel.

Digitalization of interactions of the production ecosystem with the external environment will allow the car enterprise to communicate with consumers, suppliers, the labour market and government bodies at a new level.

The implementation of the roadmap will require digitization of information on the performance indicators of all structural units of a car enterprise TES. The most complex are the performance indicators of Maintenance and Repair systems, in which auto mechanics (repair workers) work, using diagnostic and technological equipment to carry out the processes of determining and restoring technical condition of vehicles.

Fig. 2 shows the “TES Digital Ecosystem and Reliability” scheme, which allows to improve the interaction of Maintenance and Repair systems with the units of a car enterprise.

In the proposed scheme, the role of production and technical department (PTD) is increasing, which is additionally entrusted with the functions of coordinating the work of the TES structural divisions, receiving from them relevant digital information, processing it and presenting it to the chief engineer in a structured form to make management decisions. The controllers of vehicles technical condition transmit information through their mobile services to the PCD, which is processed and transmitted digitally to the PTD. After performing technological operations, the auto mechanics of the Maintenance and Repair systems also transmit information about the work for each vehicle that has undergone maintenance or repair through their mobile services. Data from the equipment chips comes to PTD automatically and is processed in real time. All departments (MD, MTS, PCD) that carry out their activities as part of the TES transmit certain information to the PTD. Thus, valid data is daily received by the TES management and is checked and communicated digitally to the enterprise’s
General Manager referring major issues. If the achieved results are within the planned values, then operational regulation of production processes is not performed, otherwise the place of failure in the enterprise’s system is determined and current management decisions are made to correct the situation. Particular attention is required to apply the competency model of management and operational personnel to work in digital ecosystems.

The competency model of a specialist is a combination of key competencies with specific results of their application, which allows them to successfully perform labor functions. Key competencies represent the specialists’ competencies which are the most important for the enterprise at a certain stage of its development.

The competency model (on the example of a controller of the technical condition of vehicles) can be represented by the following set of key competencies:

- ability to use digital technologies for work organization on preparation, calibrating, monitoring of readiness and use of technical diagnostics, measuring instruments, additional technological equipment;
- ability to perform maintenance of diagnostic devices, measuring instruments, technological equipment;

Figure. 2. Scheme of interaction between PTD and the maintenance and repair system with the units of a car enterprise as part of the “TES Digital Ecosystem and Reliability” model
• ability to perform work on measuring, checking and analyzing the parameters of the technical condition of vehicles;
• ability to make decisions on the conformity of the technical condition of vehicles with requirements of traffic safety;
• ability to develop and digitize organizational and technological documentation for monitoring the technical condition of vehicles;
• ability to control and analyze the process of monitoring the technical condition of vehicles, the work of personnel to perform labor functions;
• ability to work in the digital ecosystem for recording, storing and updating data on vehicle monitoring and the operability of technical diagnostics, measuring instruments, and additional technological equipment.

4. Discussion of the results
The creation of digital production ecosystems in transport and vehicle services enterprises is possible using existing and developed digital platforms and services for transport, investments in the development of new competencies of management and operational personnel, new forms of information flow management in the Maintenance and Repair system and structural units of car enterprises. Previously, the authors [5] considered the possibilities of applying advanced information technologies in transport systems and justified not only the need for digitalization of management and technological processes, but also proposed models and algorithms that would increase the efficiency of personnel, reduce material and labor costs for vehicle operation. At the same time, the basic principles necessary for setting information systems for CE are formulated: “document revision, usage of common database by all units, automation of engineering decisions based on expert systems, implementation of information exchange between CE units through a computer network, real time information system operation, use of rolling stock control systems”. These principles are in good agreement with the modern digital economy. However, they affect only the inner part of the CE ecosystem, and insufficient attention has been paid to the important part of the digital interaction with the external environment. The author [6] reasonably points out the technical capabilities available for car enterprises to electronically identify objects, transmit information based on automation-equipped working places (AWP), implement information technologies when organizing a supply chain.

The studies highlighted in [5, 6] confirm the fact that increasing the efficiency of car enterprises and their units can be achieved by expanding their functions in the provision and use of services in digital format, electronic processing of information on business process results, and analytics based on the use of artificial intelligence, connecting new consumers involved in the digital space.

The practical implementation of the elements of the digital production ecosystem of car enterprises has shown that the time for interaction with consumers on organizing the transportation of goods and passengers, servicing and repairing vehicles at service stations is significantly reduced. The amount of information processed automatically increases 5–6 times, and the time to receive analytical data and make management decisions decreases 3–4 times.

The direction of further research is seen in improving mathematical models and algorithmization of reliability value of management and production personnel [7] and units of the car enterprise, its technical engineering service in order to bring values into a format convenient for digitalization, and to increase the share of optimization tasks in the digital production ecosystem.

5. Conclusion
Thus, one of the main factors that can improve the efficiency of transport and vehicle service enterprises and their technical services is the creation of digital production ecosystems at enterprises. This should be promoted by the developed and proposed TES Digital Ecosystem and Reliability digitalization concept, updated personnel competency models, which are preferable for working in the new digital environment.
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