Modeling methods of technical services for transport operation

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Abstract. The subject of the paper includes modeling methods of a set of technical services for transport operation. The object of the paper covers technical services for transport operation. The purpose of the paper is to develop the methodical basis for technical service system of models used in design and quality assessment of a set of transport services within transport serviceology. The synthesis strategy of a system of models to describe, design and assess the quality of railway transport technical services for further optimization of technical services within the railway transport is proposed. Analysis and synthesis, modeling, system approach, classification methods, comparative analysis, forecasting, design, positioning, standardization, and modeling are used as methods of the study. The scientific novelty of the paper is related to the synthesis strategy of a system of models for design and quality assessment of technical transport services.

1. Introduction

The relevance of the paper is confirmed by the task to increase the quality of technical railway services. To solve this task, it is critical to develop the system of models for design and quality assessment of a set of technical services of transportation equipment.

The purpose of the paper is to develop the methodical basis for technical service system of models used in design and quality assessment of a set of transport services.

The following tasks are solved to achieve the above objective:

- concepts of a set of technical transport services are studied and specified;
- methods to design a set of technical transport services are synthesized;
- techniques of utilizing the models of services during development and assessment of the level of sophistication of services within the railway transport are formed.

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The modern system of technical transport services represents complex, hierarchical, and technological system. Functional decomposition representation may be used to design, analyze, and optimize the developments of this system [1, pp. 184]. Modeling is actively used to ensure and assess the quality of services [2]. The practical task of intellectual transport systems is also important for the development of methodology of transport systems (and their technical services) [3]. Besides, there is a
need to consider the fact that timely and high-quality technical service influences the environmental safety of transport systems [4, pp. 262-267].

Let us accept the technical transport service defined and stipulated by special and technical regulations as a set of services aimed at safety, maintenance, increase in the specified lifetime of all means of transport.

A set of technical transport services shall be understood as a variety of logically interrelated types of technical services provided by service organizations to the customer in a certain sequence (or simultaneously) according to the plan compiled in advance. Such services shall ensure the achievement of a certain technical task (safety and performance of technical means of transport) or tasks related to the increase in economic efficiency of operation of technical means of transport in the course of their use for customer service.

The sets of technical services within any transport perform the following functions:

- operational continuity of technical means of transport for the benefit of movement within the space of goods and their accessories (corrective maintenance of vehicles);
- safety of transport services provided to natural and legal entities (includes all types of equipment maintenance, track repair, security services, etc.);
- maintenance and reliability of infrastructure facilities and the rolling stock within technologically different transport operations at various operational stages of technical means of transport;
- improvement of financial and economic efficiency of carrier companies within the national transport system and the national economy in general.

Technical transport services are aimed to achieve the following objectives:
- to ensure safety of technical means of transport;
- to ensure reliability of technical means of transport;
- to improve environmental compatibility (green transport) of technogenic objects within the national transport system;
- to increase the economic efficiency of carrier companies utilizing technical means of transport;
- to improve certain characteristics (for example, service speed) of technogenic transport within the national transport system;
- to change and improve the design of technical means of transport, etc.

In compliance with GOST 15467-79, the quality of production (goods and services) is understood as the set of product properties defining the ability to satisfy certain needs of customers in accordance with designated purpose. This opens up an opportunity to define the quality of technical transport services as a set of indicators specified in technical regulations, standards and other reference documentation.

The development and application of models of technical transport services may define indicators of provided technical services in terms of quantity and thus create conditions for design, standardization, and marketing of such services, improvement of the degree of objectivity with regard to quality assessment of certain services and a set of services in general by consumers and service providers.

The design of such set (sequence) of technical service models implies a gradual approach to evaluation of indeterminate forms of services, their layout, technologies and characteristics reflecting their quality. The use of this approach allows justifying the consecutive use of certain models to collect more information on the service.

To optimize, assess timeliness and quality of rendered technical services it is suggested to modify the system of models presented in work [5, pp. 228-243].

2. Materials and methods

Let us assume that in each specific case of designing a set of technical services of certain technical means of transport it is possible to make a table of services rendered at the stage (phase) of its operation (table of functions and elements of a technical service system) [1, pp. 185]. One column of this table specifies events in operation (for example, 1-year service life or 15 000 km run time), and the second
column describe types of technical services. This table may be considered as a model of service of a given technical means of transport at all stage of its operation. This is the first element of a set of models of technical service of any vehicle.

The second element of such a set of models is the maintenance plan of a vehicle.

The third element of a set (architecture) of models of a technical service system is a specific description of every service. The specific description of the overhaul schedule for the railway rolling stock may be as follows: “Overhaul repair of the railway rolling stock includes complete disassembly, cleaning and washing of the rolling stock items (electric locomotives, diesel locomotives, railroad cars, etc.), repair or replacement of their main parts; complete replacement of all worn parts and pieces, elimination of revealed defects with further assembly, alignment and adjustment of equipment within the railway rolling stock”.

The fourth, more extended and detailed structural element of a set of models is the description of a technical service via the maintenance flow chart. The flow chart of the overhaul plan of any item within the railway rolling stock may include the following: overhaul plan and flow charts; repair report and request as per schedule; statement and acceptance of the rolling stock for overhaul repair in maintenance shops (maintenance depot); cleaning and washing of the rolling stock items, inspection, assessment of wear degree and diagnostics of wear reasons; dismantling, cleaning and washing of pieces of the rolling stock equipment; repair and/or replacement of base components of the rolling stock equipment; complete replacement of all worn-out units and nodes; elimination of revealed defects within the rolling stock equipment; assembly of the rolling stock equipment; adjustment of the rolling stock equipment; functional and safety test of the rolling stock equipment after overhaul repairs; transfer of the rolling stock equipment to the customer (operating organization) with the act of acceptance of performed technical services; report and cost estimate of overhaul repairs; presentation of billing documents for payment and report on performed overhaul repair of an object (unit) of the rolling stock to the operating organization.

The fifth structural element of this set of models is the description of structure and properties of a service at four levels (four-tier service model). It shall be noted that the famous marketing three-tier model of goods (services) was supplemented by the fourth (strategic and environmental) level in work [6, pp. 83-87].

The four-tier service model of overhaul repair of the railway rolling stock includes the following structural elements. The first level is the main benefit: extension of the operating phase of the railway rolling stock life cycle. The second level – real service: repair intensity (average number of replaced elements and items); availability of overhaul repairs of the railway rolling stock in a given region; time between overhauls (or hours in service); reliability of the railway transport during time between overhauls; maintainability: average cost of repair of a railway transport, etc. The third level (support service) characterizes the following: availability or lack of a possibility of overhaul repair of the railway rolling stock against a credit; availability or lack of guarantee period on the performed overhaul repair of the railway rolling stock; availability of repair insurance, etc. The fourth level – strategic, environmental and social-economic level reflecting the opportunity resulting from overhaul repair: extension of the railway rolling stock life cycle; reduction of mineral and labor costs for railway transport engineering to ensure transport support of social and economic processes; reduction of environmental damage potential, etc.

3. Results and Discussion

The proposed set of models of technical transport services contains a table with the list of technical transport services for the entire operation period, which shall be performed according to a certain plan of technical transport services. It also includes some descriptive models of each technical transport service, corresponding (to these descriptive models) set of flow charts of all types of repairs (technical services), relevant four-tier models of each technical transport service.
The given set of models does not only ensure gradual increase of information on overhaul repair of vehicles within the assigned period of service, but also describes a set of technical transport services for the entire operation period from various perspectives.

The table with the list of technical transport services for the entire operation period makes it possible to define the whole structure of a set of technical transport services for the specified lifetime. This table allows designing a technical service plan, planning spare-parts output and forecasting the operating cost of technical means of transport.

The plan of certain technical transport services allows creating a logical sequence of services taking into account some factors (for example, run time) and duration of certain types of services.

The set of descriptive models of each technical transport service allows defining the content and implication of a certain technical service and can form the basis for cost estimate regarding a particular transport service.

The set of repair flow charts (technical services) defines the technology and algorithm of each service.

The four-tier service model represents hierarchically defined set of quality indicators of each technical service. The corresponding four-tier models of each technical transport service can be useful in design or analysis, as well as quality assessment of services on the basis of four-tier service model. The following algorithm may be applied when utilizing this model to improve the quality of services: four-tier model of technical transport service is formed; for each level of the model and each property of such service the rating scale is suggested to determine the quality level of this service against its particular property (for instance, according to a ten-point scale); each property indicator of a certain service is assessed by expertise; competitive advantages and drawbacks of a specific characteristic of a service, which shall be improved to increase its quality are defined; possible alternatives for property improvement (quality assessment) of services to the level of indicators not lower than those of competitors and/or design indicators of service properties are suggested; using formal (for example, efficiency/cost ratio) and/or informal criteria the optimal quality improvement method is defined; optimum alternative for property improvement of technical transport services is implemented.

4. Conclusions
The paper presents the synthesis strategy for a set of technical transport service models, which will be useful in design, positioning, assessment of competitiveness and cost efficiency of technical transport services. This set of models includes the table (list) of technical transport services for the entire operation period. It also presents a repair plan, a set of descriptive models of technical transport services, a corresponding set of repairs flow charts (technical services), synthesis of four-tier models of each technical transport service.

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