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## Book

# Innovative development of the road and transport complex: problems and prospects

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Edited by  
Iaroslava Levchenko, Illia Dmytriiev

# INNOVATIVE DEVELOPMENT OF THE ROAD AND TRANSPORT COMPLEX: PROBLEMS AND PROSPECTS

Monograph

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The monograph pays attention to the problems and prospects of innovative development of the road transport complex, as well as highlights the need for scientific developments and practical recommendations for the development of the road transport system as a whole.

The monograph systemises factors of influence upon the transport infrastructure of a region and economic consequences of their realisation, develops a system of management of transport infrastructure and personnel of a motor transport enterprise and offers a methodology of assessment of efficiency of management of personnel of an enterprise. The relevance and timeliness of the use of functional and cost analysis is proved. A strategy for improving machines for earthworks in road construction has been determined. The proposed theoretical, methodological and applied aspects of the development of the road and transport complex are of theoretical and practical interest for scientists, entrepreneurs and state administration bodies.

Figures 55, Tables 40, References 181 items.

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## ABSTRACT

The monograph pays attention to the problems and prospects of innovative development of the road and transport complex. In Ukraine, the road and transport complex is classified as a priority system. And taking into account its key role in the defense of the state, the need to carry out scientific developments and practical recommendations for the development of the road and transport system as a whole is becoming urgent.

Factors affecting the transport infrastructure of the area and the economic consequences of their implementation have been systematized, and a system of management of the transport infrastructure has been developed. The stages of formation and implementation of entrepreneurial strategies, which determine the sustainable innovative development of road and railway transport enterprises, have been developed. The methodical approach to the development of the list of indicators of preventive anti-crisis management of the road enterprise has been improved thanks to the comprehensive consideration of the results of the study of the quantitative and qualitative composition of the indicators of the CVP analysis. The personnel management system of the motor vehicle enterprise has been formed on the basis of a holistic approach, and a methodology for assessing the effectiveness of the enterprise's personnel control was proposed, which helps to identify the weakest points in the existing control system. In order to determine the objects of innovative activity, the urgency and timeliness of the application of functional-cost analysis has been proven. In order to achieve an economic and ecological effect in defined strategy improve cars for earthy road construction works.

The proposed theoretical, methodological and applied aspects of the development of the road and transport complex are of theoretical and practical interest for scientists, entrepreneurs and state administration bodies.

## KEYWORDS

Road and transport system, road transport, railway transport, road construction, transport and logistics services, competences of employees, control, quality of transport services.

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## READERSHIP AND SCOPE OF APPLICATION

The monograph is of practical interest to managers of state and private enterprises from the standpoint of implementing innovative management of enterprises in the road and transport sector, and theoretically to researchers dealing with issues of financial support, innovative management, quality and safety assurance, as well as state administration. In general, the outlined aspects regarding the perspective of the development of the road transport system are of theoretical and practical interest for scientists, entrepreneurs and state administration bodies.

The scientific value of the development of the monograph is methodological and practical recommendations in the field of economics, management and administration both at the level of an individual enterprise and at the national level: psychology of finances of inclusive state educational institutions in the conditions of globalization has been justified; the program for the development of the motor transport infrastructure of the area has been improved; the mechanism of managing the sustainable development of transport enterprises has been outlined, the methodology of preventive anti-crisis management of road enterprises has been proposed; a personnel management system based on a holistic approach has been formed; an algorithm for assessing the effectiveness of control of the company's employees has been proposed; development paths, decision-making systems and marketing management of railway transport enterprises have been highlighted; the mechanism for improving the quality management of cargo transportation by motor vehicles has been improved; it is proposed to achieve a cost-effective result in road construction.

Thanks to the universal approach to development based on the vector of ensuring the development of the road transport system and the relevance of the raised problem among a number of areas of the world, the obtained results can be methodologically useful and practically applied both on the territory of Ukraine and on the territory of other states.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

## INTRODUCTION

The road and transport complex is strategic for every country. Today's road and transport system is quite complex, which provokes its presence in rather difficult conditions. This problem became particularly acute during the period of increasing external and internal challenges, which were provoked by a list of crises. Scientific discussions on the development of an action plan for the restoration and stabilization of the development of the road transport system continue for a long period of time and do not lose their relevance. Transport and its infrastructure (especially road) is an important factor that determines the development and security of each country. Its stable, uninterrupted and effective functioning is the key to the successful interaction of all sectors of the economy, improving the well-being of the population, as well as ensuring the defense capability of the state and its interests. And taking into account its key role in the defense of the state, the need to carry out scientific developments and practical recommendations for the development of the road and transport system as a whole is becoming urgent.

Transport networks and services play a key role in improving the quality of life of the country's citizens and in increasing the opportunities for industrial development. Therefore, the road transport sector is one of the key areas of cooperation between the EU and Ukraine, and in accordance with Article 368 of the Ukraine-EU Association Agreement, the main purpose of such cooperation is to facilitate the restructuring and renewal of the road transport sector of Ukraine and the gradual harmonization of current standards and policies with those existing in the EU.

However, the road and transport sector is underdeveloped, which is the main obstacle to the development of Ukraine's economic activity in the direction of sustainable growth. A comprehensive approach to solving the problem of the development of the road and transport complex can provide its innovative vector of development, therefore the study of the current state and the development of development trends are important tasks of the scientific discussion.



# IMPROVEMENT OF THE QUALITY MANAGEMENT METHODS OF CARGO TRANSPORTATION BY ROAD TRANSPORT

Yuriy Beketov, Iaroslava Levchenko, Igor Britchenko,  
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## ABSTRACT

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Quality occupies a key position in the economic and social strategy of developed countries, and its level is a reliable indicator of the general state of the economy. Quality provides an innovative vector of development and is an integral component of the development of all industries. The level of development of the transport sector, as a component of the road and transport complex, is one of the most important characteristics of the development of modern society – its social orientation. In the transport enterprises of Ukraine, the underestimation of the importance of the comprehensive development of the quality management system has led to an increase in defects in the infrastructure of railways, road, water and air transport, which significantly increases the risk of traffic safety violations. Improvement of quality management systems is one of the most important areas of transport development. The main task of transport is timely, high-quality and complete satisfaction of the needs of the economy and the population in transportation, increasing the economic efficiency of its work. The solution to the problem of effective distribution of goods and improvement of the quality of service to consumers of transport services in market conditions is closely related to the problem of service quality. Only a high level of service quality can ensure a reliable sales market for the services of transport enterprises. A high level of service quality and efficiency should be supported by an appropriate level of material and technical support, including the development of a system of warehouse and container terminals, modern loading and unloading equipment, computerized IT and management tools. Therefore, in the modern conditions of the transformation of Ukrainian society and changes in economic interaction, quality problems caused by the presence of a competitive environment require careful research. Special attention is paid to processing and data processing, the order, cycle and context of each stage of practical application of functional analysis and cost analysis for quality management in the transport industry.

## KEYWORDS

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Transportation quality, transport service, functional-cost analysis, innovative activity, internal reserves, international quality standards.

### 1.1 THEORETICAL FOUNDATIONS OF THE CONCEPT OF QUALITY

Quality belongs to the most capacious, complex and universal categories that have many aspects, features, and, therefore, theoretical approaches to defining the essence.

According to the ISO 9001 International Standard, quality is understood as "the ability of a set of characteristics, implemented and inherent in a product, system or process, to fulfill requirements". The explanations for the term "requirement" indicate that defining words can be used to indicate a specific type of requirement: for example, product requirements, process requirements, consumer requirements, etc. [1].

Conducting an analysis of the existing definitions of the concept of quality, Eduard Minko and Mihail Krichevskiy come to the following definition: "product quality is a set of essential properties, quantified by a system of technical and economic indicators, which distinguish products from other similar purposes, which determine the degree satisfaction of some needs and demand for products in market conditions of creation and use of products at socially necessary costs and prices for these products formed by the market" [2].

According to DST 15467-79, "quality is a set of product properties that determine its suitability to meet certain needs in accordance with its purpose" [3, 4].

It is proposed to understand the quality of service as a set of properties and characteristics of products (services), the level of which is formed by the relationships of all interested parties and allows satisfying different levels of constantly changing needs. Transport services belong to the services that complete and (or) precede the material production process.

The process of transporting cargo and passengers is a product of transport and is measured in ton-kilometers and passenger-kilometers, respectively. In today's conditions, this concept, in our opinion, can only be used as a quantitative indicator for calculating operational costs (fuel, depreciation costs for vehicles, wages, etc.). Transportation of cargo and passengers should be considered the main type of transport services [5].

Transport service is the result of the activity of the transport service provider to satisfy the needs of the passenger, consignor and consignee in transportation in accordance with the established norms and requirements (DST R 51005-96) [3].

The quality of transport services is a set of characteristics of the transport service that determine its ability to satisfy the needs of consumers through the proper and efficient performance of transport services, as well as to meet the established standards and regulations, the terms of the contract or the requirements usually imposed on the transport service.

Quality of service criteria are used to assess the quality of transport services for cargo transportation.

In real life, in the absence of appropriate control over the quality of the provision of transport services in the process of cargo transportation, violations of the cargo transportation process often occur and the following problems arise:

- disruptions in the delivery of goods in time;
- non-fulfillment of the cargo transportation plan;
- cases of cargo loss or theft;
- facts of cargo damage;
- non-compliance with the terms of cargo delivery.

The competitiveness of transport organizations, the rational use of modes of transport and modern cargo delivery schemes, the expansion of foreign trade, etc., directly depend on the quality of transport services. And although, in addition to quality, competitiveness includes price, delivery time, performance, guarantees, service and a number of other components, according to the results of surveys, quality occupies 70 % of the "weight" of all indicators of competitiveness. Thus, in the market economy, much attention is paid to quality problems caused by the existence of a competitive environment. In this regard, the management of the quality of transport services is an urgent need of the hour, since this knowledge is vitally necessary in the conditions of a market economy and fierce competition in the market of transport services.

When considering issues of the quality of transport services and transport services, the following features must be taken into account:

1. The selection of a set of services requires consideration of all possible variants of transport service levels.
2. The client may have several needs, which entails the conformity of the properties and characteristics of the services to several often conflicting requirements at the same time.
3. When concluding a contract, requests and needs of customers are clearly discussed and recorded.
4. In many cases, the client's needs change over time, which necessitates periodic marketing research. Each type of transport service requires serious study and analysis.
5. Customer needs and requests are usually expressed in certain properties with quantitative characteristics of these properties and include such aspects as safety, functional suitability, operational readiness, reliability, economic factors, environmental friendliness, etc.
6. The term "quality" is not used for a quantitative assessment and is not used in an expression that exceeds the degree in a comparative assessment. In such cases, qualitative adjectives are used: "relative quality", "level of quality", "measure of quality".

The ISO 9004:2000 standard "Quality management systems. Guidelines for improving indicators" indicates that the assessment of the effectiveness of the quality system from a financial point of view is important. However, the method of its calculation is still unclear. And this is due, first of all, to the novelty and multifacetedness of the problem, the variety of factors affecting the effectiveness of quality assurance activities.

The result of the creation and implementation of the transport services quality management system is an increase in the efficiency of meeting transport needs, due to the desire to receive high-quality transport services at a minimum price.

Users of transport services now prefer such indicators as compliance with time schedules for the delivery of goods and passengers, responsibility for meeting stipulated needs, reliability of delivery. The fulfillment of these requirements is connected with a sufficiently accurate temporal assessment of the links of the delivery of goods and passengers, that is, with knowledge of the regularities of changes in all their elements and the establishment of specific values. Identifying patterns of links and elements of delivery is the basis for the systematic construction of all possible types of organization of transportation of goods and passengers.

## 1.2 ENSURING THE QUALITY OF TRANSPORTATION SERVICES AS A MODERN CHALLENGE

The theoretical aspect is that in the special scientific industry literature, this issue of assessment and management of the quality of cargo transportation was not given the necessary attention. There are a sufficient number of developments on the quality assessment of passenger transportation on different routes, in different modes, but there are no corresponding methods for cargo transportation, there are only separate developments of different indicators.

Thus, at the present time, there is a need to develop a methodology for assessing and managing the quality of cargo transportation by rolling stock of a motor vehicle enterprise.

The peculiarities of the assessment of the quality of transport services are as follows:

- quality should be assessed in terms of consumer satisfaction (quality indicators should be primarily subordinated to the requirements of the clientele and take their interests into account as much as possible);

- quality should be assessed separately for different groups of consumers (for different groups of consumers, the degree of importance of individual characteristics of the service can vary greatly, so summing up the set of quality indicators into one quantitative value leads to the formation of insufficiently informative quality models);

- when assessing the quality of transport services, it is necessary to determine the degree of satisfaction of consumer requirements, that is, to calculate the level of quality (it is necessary to assess the degree of compliance of services with consumer requirements, which will allow monitoring the approximation of the quality level of transport services to the standard set by consumers);

- assessment of the quality of transport services should be carried out regularly (consumers' needs and expectations may change, which leads to the need for regular reassessment of quality in order to maintain its level);

- when assessing the quality of transport services, it is not necessary to include the cost of services in the list of indicators (the cost of the service does not always reflect its quality, the price is an important indicator of the competitiveness of the service, not its quality);

- when assessing the level of quality of transport services, it is necessary to establish a generalized comprehensive quality indicator (required for an objective generalized assessment of the organization's competitive capabilities, as well as for assessing the effectiveness of measures to improve quality by comparing the received comprehensive quality indicator) [6, 7].

In the work of Nadiia Popova [8], customer requirements for service distribution channels and criteria for assessing their work are defined.

Services are a type of activity aimed at satisfying the corresponding part of the clientele's needs, characterized by the presence of the necessary technological, economic, information and resource support.

Since services are activities, their production and consumption are inseparable from each other. Unlike a product, a service cannot be provided to the consumer until the moment of sale, and it

cannot be produced in stock. Service can be provided only when a service order is received. Therefore, services cannot be stored as goods.

In market conditions, the development of new competitive types of transport services and their improvement is a crucial condition for the activity of every enterprise.

That is why, as a rule, the advantage over competitors is gained by those motor transport companies that, when developing new offers, effectively use the concept of marketing and focus, above all, on the interests of customers.

Customer requirements for service distribution channels:

1. A wide list of services. For example, when choosing a brand of rolling stock, the client should have the maximum possible choice, which allows it to choose a rolling stock for a specific type of cargo.
2. Scope of services. The client must receive the service in the amount it needs.
3. Service performance time. The execution time of the request for service or transportation must satisfy the client.
4. Convenient location. It is important for the client not to waste time looking for the possibility of ordering services. The place of order should be conveniently located in relation to the client.
5. Service. Additional services provided directly by the channel itself play an important role in attracting customers, therefore, the more services, the higher the efficiency of the channel.

Control over the work of service distribution channels is based on the assessment of their activity indicators. Certain criteria must be developed to assess the performance of service distribution channels.

The following characteristics can serve as criteria:

- increase in sales volumes of services;
- customer reviews;
- speed of transfer of the application;
- increase in the number of new engaged clientele;
- increase in the number of regular customers;
- increase in the company's profit;
- increase in informing potential customers about the enterprise.

The results of the checks show whether there is a need to continue cooperation with the intermediary or whether it is necessary to terminate the contract. Comparative characteristics make it possible to identify the best channels, the best channel employees.

Properties of services that can be taken into account when assessing the quality of service:

- the consumer of services quite often participates in the process of providing services;
- the consumer of services does not become their owner;
- the service provision process cannot be tested before payment;
- the service is not tangible, it cannot be viewed or held.

Directions for improving the quality of transport services:

- increasing the technical and technological level of the transportation process;
- increasing the motivation of the company's personnel;

- professional development of personnel of transport and other enterprises;
- introduction and control of compliance with quality standards at the enterprise (end-to-end or selective).

Passenger transportation has its own comprehensive method of managing the quality of passenger transportation by road.

The main indicators of the quality of passenger transportation include:

- comfort of the trip (accumulation of buses and regularity of their movement on the routes);
- time spent by passengers on movement;
- transportation safety [9].

Modern analytical methods must be used to determine reserves for improving the quality of transport services. One of these methods is the functional cost analysis (FCA), with the help of which reserves for increasing the efficiency of the MTE work and the quality of the provision of transport services for each of the transport customers are determined at the same time. Let's consider the stages and order of practical application of this modern method of reserve research.

### 1.3 THE PROCEDURE AND STAGES OF USING FUNCTIONAL-COST ANALYSIS IN THE CONTEXT OF DETERMINING INTERNAL RESERVES

Functional-cost analysis is an effective tool for identifying unused intra-production reserves at enterprises of various branches of production and spheres of activity. The ultimate goal of FCA is to find the most economical options for the organization of production from the point of view of the producer and the consumer.

The algorithm of practical use of FCA consists of the following main stages [10]:

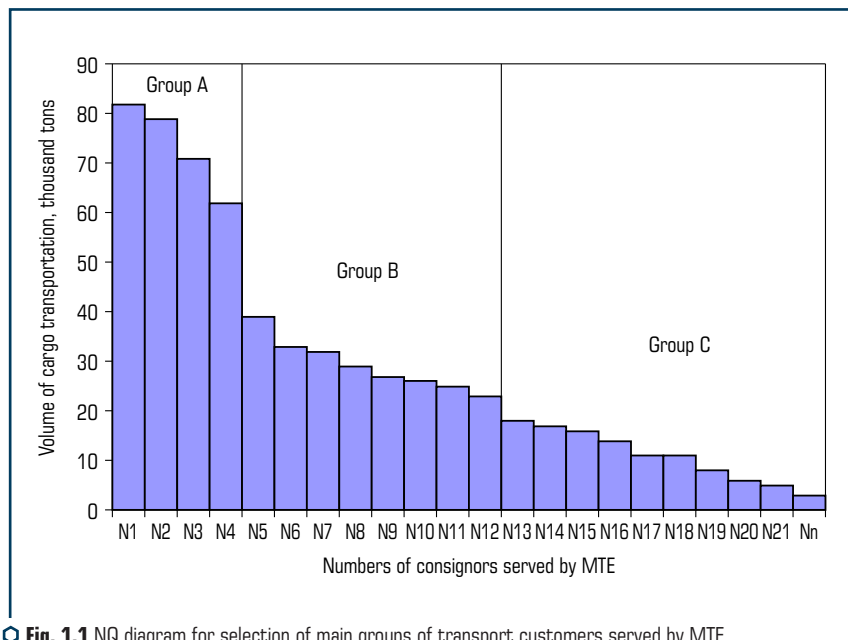
Stage 1. Identification of the main groups of transport customers and their ranking.

The content of the work of this stage is the selection of the main groups of clients according to the level of the volume of transport works (services) in terms of MTE. Various graphic methods are widely used for this:

- "NQ" type diagram (**Fig. 1.1**);
- Lorenz graph (curve of cumulative accumulation of values);
- graphic interpretation of the ABC method and etc.

The initial data necessary for the performance of work at this stage of the analysis should be collected economic information that reflects the activities of MTE for individual clients served.

The "NQ" type diagram is a graph, on the horizontal axis of which are the numbers (names) of all N-customers of vehicles served by the rolling stock, and on the vertical axis – the volume of transported cargo for each customer (shipper) in natural terms (Q – volume of cargo transportation) or in value terms (D is the amount of revenue from cargo transportation). All clientele served should be placed from left to right according to the degree of decrease in the volume of transported goods.



**Fig. 1.1** NQ diagram for selection of main groups of transport customers served by MTE

Source: author's development

The data analysis allows to identify three main groups of transport customers served by MTE rolling stock:

- group A is the most important clientele with the largest volume of cargo transportation. Their number is small (15–20 % of the total number of customers), but they occupy the main positions in the production program of the operation of rolling stock of MTE (45–50 % of the volume of cargo transportation);
- group B is an average group in terms of importance, including 25–30 % of the total number of shippers. In the structure of the volume of transportation, their share is about 30–35 %;
- group C is a clientele that is not of great importance. It makes up 45–50 % of the positions of the production program, and it accounts for 20–25 % of the volume of transportation.

According to the principle of selection of the leading link, the objects selected in groups A and B as the most important should be the objects of further study. Let's consider them as the main clientele served.

Stage 2. Analysis of production costs and the efficiency of MTE work in servicing each customer.

Costs are identified and indicators of the efficiency of the use of rolling stock in the transport service of each of the main customers are calculated. The purpose of such an analysis is to obtain reliable information about the level of profitability of services provided by MTE.

The indicator of the profitability of transportation is used as an assessment criterion:

$$R_{tr_i} = \frac{P_{tr_i}}{D_{tr_i}} 100 \%, \quad (1.1)$$

where  $P_{tr}$  – profit received by MTE from transportation of goods to the  $i$ -th transport customer, thousand UAH;  $D_{tr}$  – revenues of MTE from transportation of goods to the  $i$ -th customer, thousand UAH.

After the calculations are completed, a bar chart is built, on which the main contractual clientele is placed horizontally, and the level of profitability of transportation is placed vertically. In this diagram, all motor vehicle customers belonging to groups A and B are ranked from left to right in order of decreasing profitability.

The obtained results characterize only one side of the efficiency of motor vehicle production – from the point of view of MTE itself. Therefore, this analysis should be supplemented with other studies that will allow assessing the production activity of motor carriers from the perspective of the clientele served.

Stage 3. Analysis of the functionality of the performance of transport services (works).

One of the most important tasks (functions) of MTE is timely, complete and high-quality transport service to the clientele. Therefore, the purpose of this stage of the FCA is to determine the level of functionality (quality) of the performance of works and services for each of the transport customers that formed groups A and B.

The level of functionality of transport service can be expressed in different ways. In this case, it is suggested to use the functionality coefficient calculated for each and every consignor:

$$K_{f_i} = 1 - \frac{F_{fines_i} + L_{A_i} + S_{G_i}}{D_{tr_i}}, \quad (1.2)$$

where  $F_{fines_i}$  – the amount of fines issued by the MTE clientele for untimely cargo transportation, thousand UAH;  $L_{A_i}$  – losses of consignors in connection with traffic accidents caused by the fault of MTE drivers, thousand UAH;  $S_{G_i}$  – the amount of shortages, losses and theft of goods during their transportation, thousand UAH.

Graphically obtained results should be presented in the form of a bar chart. The level of transport service functionality is marked on its vertical axis  $K_{f_i}$ , and the serial numbers of transport customers are indicated on the horizontal axis, and, as in the previous cases, the clientele is placed on the graph from left to right as the functionality coefficient decreases.

Stage 4. Selection of objects of innovative activity.

To determine the objects of innovative activity, a correlation table is built (**Fig. 1.2**).

In it, the number of rows and the number of columns is equal to the number of main consignors in groups A and B. The numbers of customers are recorded horizontally in the correlation table as the level of profitability of cargo transportation decreases, and the numbers of customers are indicated vertically as the functionality coefficient decreases.



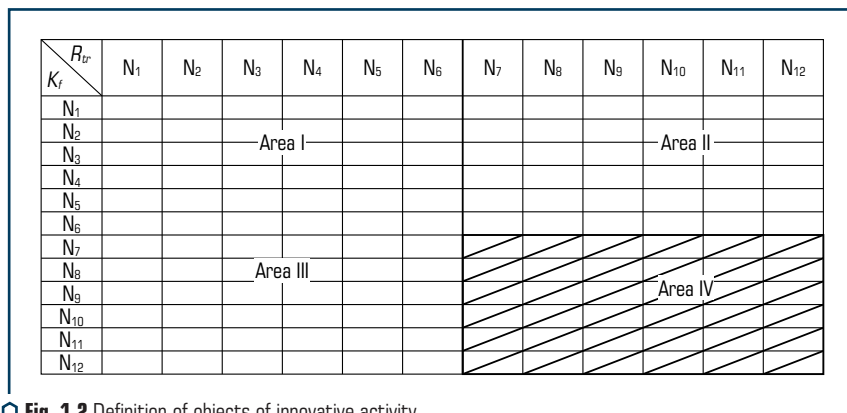


Fig. 1.2 Definition of objects of innovative activity  
Source: author's development

With the help of a correlation table, the entire main contract clientele of MTE is divided into four areas:

- area I – it includes customers with the highest level of both transportation profitability and functionality;
- area II – motor vehicle customers who have achieved a high level of functionality (quality) of transport service, but there is a low level of efficiency in the use of rolling stock, i.e. profitability;
- area III – customers with a high level of profitability of cargo transportation and a low level of functionality of transport services;
- area IV – those customers of motor transport, in which the lowest level of both the efficiency of the transport process and the functionality of the transport service is observed during the reporting period;
- the last group of enterprises are motor vehicle customers and are objects of innovative activity; for each of the enterprises, it is necessary to propose measures to increase the efficiency of the use of rolling stock and increase the quality of transport service.

## 1.4 EXPERIMENTAL RESEARCH AND DEFINITION OF OBJECTS OF INNOVATIVE ACTIVITY

The use of functional-cost analysis makes it possible to form three groups of customers: group A includes 4 customers with a total volume of transportation of 293.5 thousand tons, group B – 8 customers with a volume of transportation of 233.5 thousand tons, and group C – 9 customers for 94.1 thousand tons. In accordance with the principle of selection of the leading link, the objects selected in groups A and B as the most important should be the objects of further study. Let's consider them as the main clientele served.

The initial data of the study are presented in **Table 1.1**.

● **Table 1.1** Initial data on MTE operation

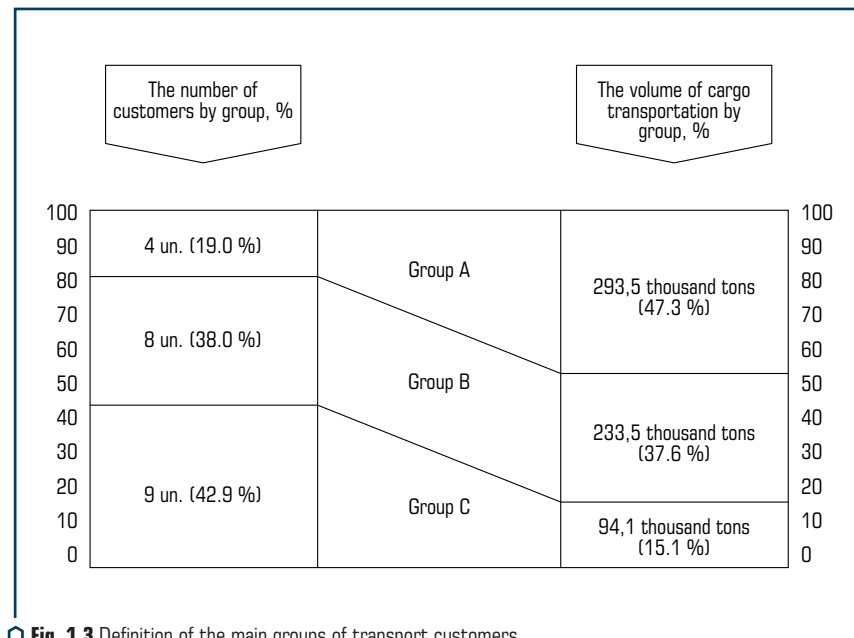
No.	Name of the customer	Volume of cargo transportation, thousand tons	Transportation profitability indicator, $R_p$ , %	Coefficient of functionality, $K_f$
1	"Fozzy" hypermarket (Fozzy)	70	35	0.98
2	SAN InBev Ukraine	79	33	0.95
3	Lactalis Ukraine	62	31	0.88
4	Philip Morris Ukraine	82.5	30	0.97
5	Danone	38.5	28.5	0.9
6	ATB market	33	26.5	0.95
7	PJSC Pivdenspetsbud	26	24.7	0.89
8	Synergy LLC	28	22.3	0.81
9	LLC Balakliya slate plant	27	19.4	0.86
10	Elektrovazhmash, plant	29	18.3	0.78
11	Vykont Ltd	24.5	16.8	0.78
12	LLC Metinvest SMC	32	15	0.85
13	LLC Comex	18.3	15	0.68
14	AB Metal	18	10.3	0.7
15	Art factory "Mechanics"	16	9.8	0.72
16	Kharkiv ZhBI plant	15	7.5	0.69
17	ZhBK "Promstroy"	10	6.9	0.73
18	Plant ZhBK-15	12	5.2	0.71
19	SE "Malyshev Plant"	8,9	4.8	0.65
20	Vladar	7.6	5.3	0.66
21	Red October	6.8	6.8	0.67

A graphic interpretation of the results of the first stage of the FCA is shown in **Fig. 1.3**.

The graphic interpretation of the results of the work of the second and third stages is shown in **Fig. 1.4, 1.5**.

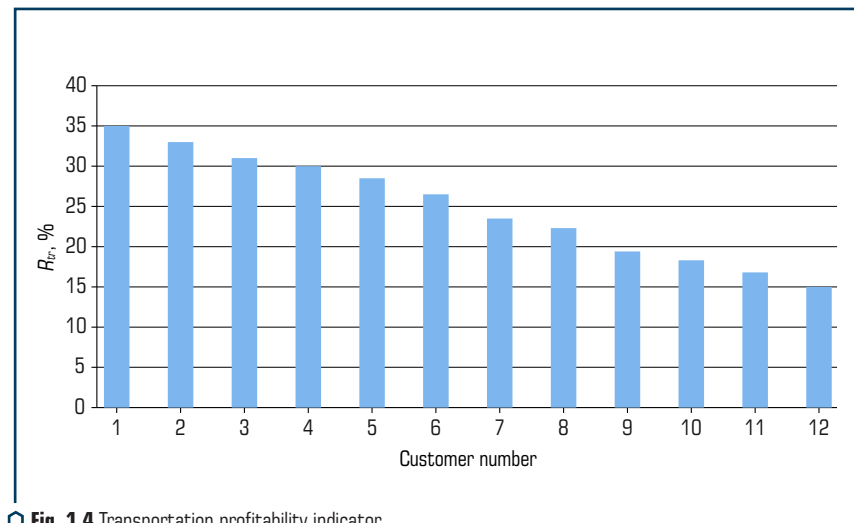
The correlation matrix, which is built at the fourth stage of practical application of FCA based on the results of our research, has the following form (**Fig. 1.6**).

Transport service customers entered the I area, 1 customer in the II area, 1 customer in the III area, and 5 customers in the IV area.



**Fig. 1.3** Definition of the main groups of transport customers

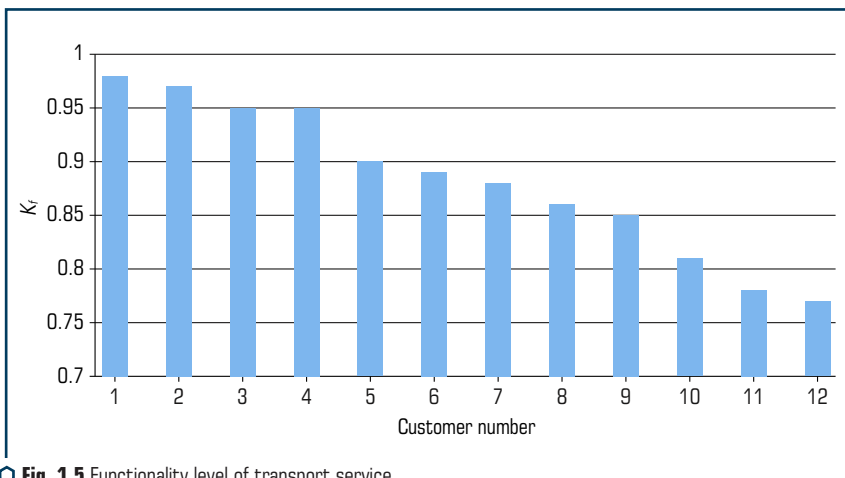
Source: author's development



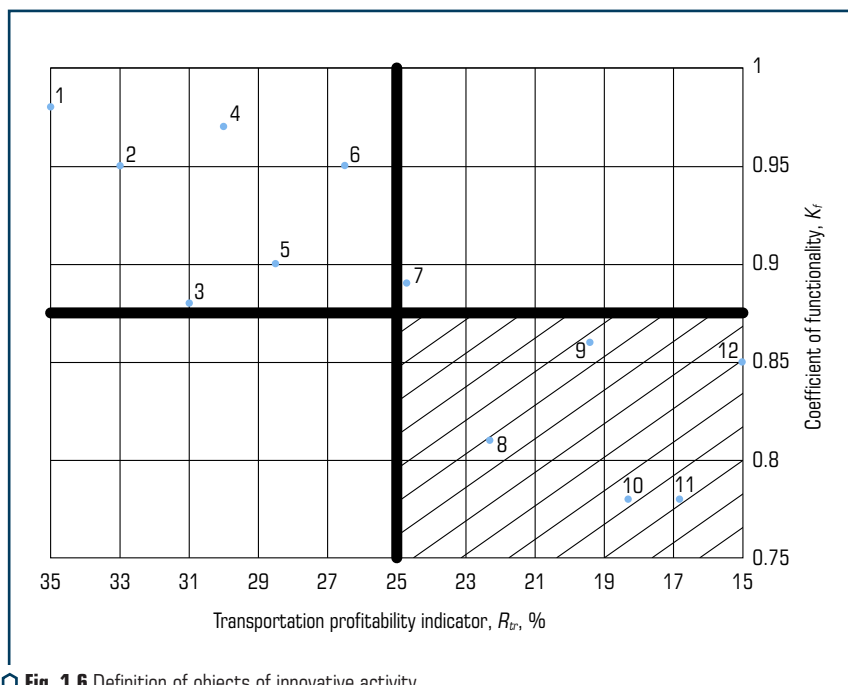
**Fig. 1.4** Transportation profitability indicator

Source: author's development

# 1 IMPROVEMENT OF THE QUALITY MANAGEMENT METHODS OF CARGO TRANSPORTATION BY ROAD TRANSPORT



**Fig. 1.5** Functionality level of transport service  
Source: author's development



**Fig. 1.6** Definition of objects of innovative activity  
Source: author's development

Special attention is given to those customers of transport services with the lowest profitability index and the level of functionality of transport service, that is, they have the lowest level of both the efficiency of the transport process and the functionality of transport service. Therefore, the motor transport company should pay attention to the customers who got to the IV area, namely, according to this experimental study, three customers under number 8–12, which MTE can lose.

## 1.5 DISCUSSION OF THE RESULTS OF IMPROVING METHODS OF MANAGING THE QUALITY OF GOODS TRANSPORTATION BY MOTOR VEHICLES

The problem of solving the quality of transport services for the population, organizations and enterprises of Ukraine is very urgent. Indicators of the quality of passenger and cargo transportation are the most important, which characterize the competitiveness of modern motor transport enterprises and firms, but in modern conditions, the managers of most MTEs do not pay due attention to these indicators, there are no practical recommendations and methodological developments for assessing and managing the quality of cargo transportation for MTEs that work in market conditions. Improving the quality of transport services is the most promising way to ensure the competitiveness of enterprises.

The analysis of literary sources on the topic of the study shows the fact that until now there is no unified approach among scientists to the development of a comprehensive system of assessment and management of the quality of the provision of transport services by means of road transport, there is no unified approach to the system of indicators for assessing the quality of cargo transportation.

One of the newest methods of managing the work reserves of modern MTEs operating in market conditions is the functional-cost analysis. The advantage of this method is that as a result of its practical application in the course of conducting research, it is possible to simultaneously assess the effectiveness of the provision of transport services for each of the customers, as well as to assess the level of quality of cargo transportation for each of them.

The practical application of FCA in the course of experimental studies made it possible to develop recommendations that enable the management of MTE to identify objects of innovative activity, which include specific shippers, where a low level of both the efficiency of the transport process and the quality of the provision of transport services is observed, and to develop specific measures.

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## 2

ROAD TRANSPORT INFRASTRUCTURE DEVELOPMENT PROGRAM  
OF THE REGION: IMPROVEMENT OF MAIN AREAS

Oleksandr Mordovtsev, Marian Tripak,  
Iaroslava Levchenko, Oksana Dmytriieva, Igor Britchenko

## ABSTRACT

As evidenced by the research results of Chapter 1, the practical component of financial relations in the conditions of recovery and post-war transformation processes, high variability of the environment requires the maximum involvement of every member of society in the functioning of the financial system and the accumulation of the financial potential of Ukraine. Road transport infrastructure is a powerful lever, therefore the search for ways to improve the main directions of its development program is a priority vector. Insufficient provision of the transport infrastructure with the resources necessary for its functioning leads to a decrease in the efficiency of its development, and the unbalanced development of modern types of transport in conditions of limited resources. The role of transport infrastructure in the system of socio-economic development of the region is determined. A detailed author's definition of the term "transport infrastructure of the region" is provided. Factors influencing the transport infrastructure of the region and the economic consequences of their implementation are systemized. The supporting subsystems of the motor transport infrastructure were studied, and on this basis the definition of the category "motor transport infrastructure" was given. A management system for the region's motor vehicle infrastructure has been developed. The stages of the formation of the program for increasing the efficiency of the development of motor transport infrastructure have been determined. Variations regarding the formation of the basic principles of the program for increasing the efficiency of the development of the motor transport infrastructure of the region re analyzed. Ways of improving directions for increasing the efficiency of managing the development of motor vehicle infrastructure at the state, regional and local levels are proposed and substantiated.

## KEYWORDS

Transport infrastructure of the region, motor transport infrastructure, development program, socio-economic development, management system.

## 2.1 PROBLEMS ON THE ROAD TO THE DEVELOPMENT OF MOTOR TRANSPORT INFRASTRUCTURE

Transport and transport infrastructure, which provides the conditions for its operation, is one of the system-forming branches of the economy of the regions, which ensures their territorial integrity and the unity of the economic space, and therefore the development of transport infrastructure

is a necessary condition for the implementation of an innovative model of economic growth and improving the quality of life of the population of the regions. The lagging behind the development of the transport infrastructure from the needs of the national economy branches of the regions in the field of freight transportation restrains the development of the economy of the region as a whole.

At the same time, it should be noted that insufficient provision of the transport infrastructure with the necessary resources for its functioning leads to a decrease in the efficiency of its development, and the unbalanced development of modern types of transport in conditions of limited resources (often these resources are investment resources) leads to an irrational ratio in the transport balance of the region. The solution to this problem depends on overcoming the problem of spatial differentiation of the country's regions, as well as the overall development of the national transport services market [1]. The developed methods do not fully take into account the assessment principles that characterize the parameters of the transport infrastructure; the proposed indicators cannot always be calculated on the basis of published statistical reports; there is no single methodical approach to assessing the effectiveness of the development of the transport infrastructure of the region; efficiency is assessed mainly through indicators reflecting the results of its activity; compliance of the motor transport infrastructure with the needs of the region in the implementation of transport and economic connections is not taken into account. Therefore, the solution of these problems is currently an actual direction of research in the complex of socio-economic development of the region.

## 2.2 FEATURES OF THE FORMATION AND DEVELOPMENT OF MOTOR TRANSPORT INFRASTRUCTURE

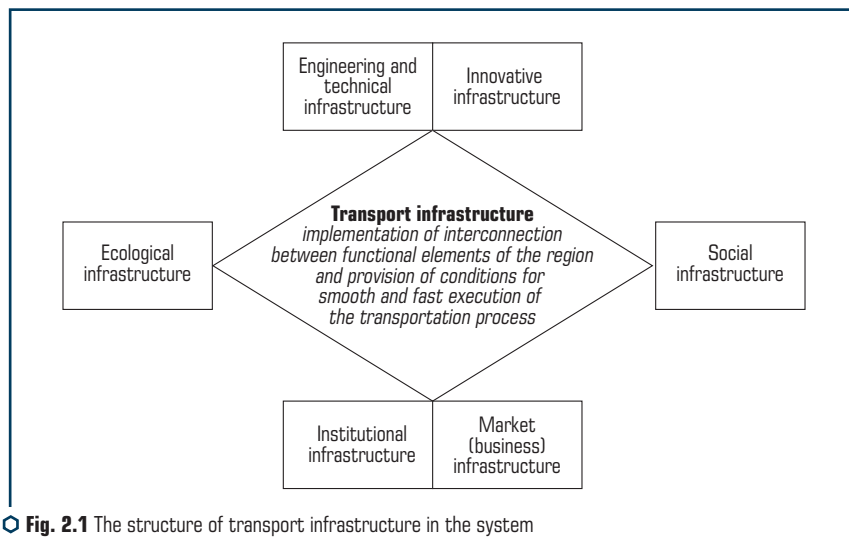
Unlike other branches of the economy, transport is a necessary condition for regional production – the region can successfully develop without raw materials, but without the presence of a transport complex, the main component of which is transport infrastructure, its socio-economic development is practically impossible. The presence of transport flows in the region implies a developed transport infrastructure, which makes it possible to fully ensure their development with the use of modern technologies. Transport infrastructure is aimed at ensuring transportation needs of the economy and the population of a separate territory, reliable internal and interregional trade in accordance with the requirements of national economic and environmental security, planned and proportional development of land, water and air. routes, regional transport security, as well as mobilization readiness for transportation in emergency situations [2].

Scientific works [2, 3] proved that the transport infrastructure is a separate consolidated element of the regional infrastructure, the key overall function of which can be considered the implementation of regional and interregional transport and economic connections (**Fig. 2.1**).

The lack of an effective transport infrastructure causes loss of products in the process of its movement both by elements of the infrastructure of the region and outside its borders, restrains the development of branches of the national economy and social relations, as well as social



development of the region, which proves the decisive role of the transport infrastructure in the implementation of the processes of reproduction of the region.

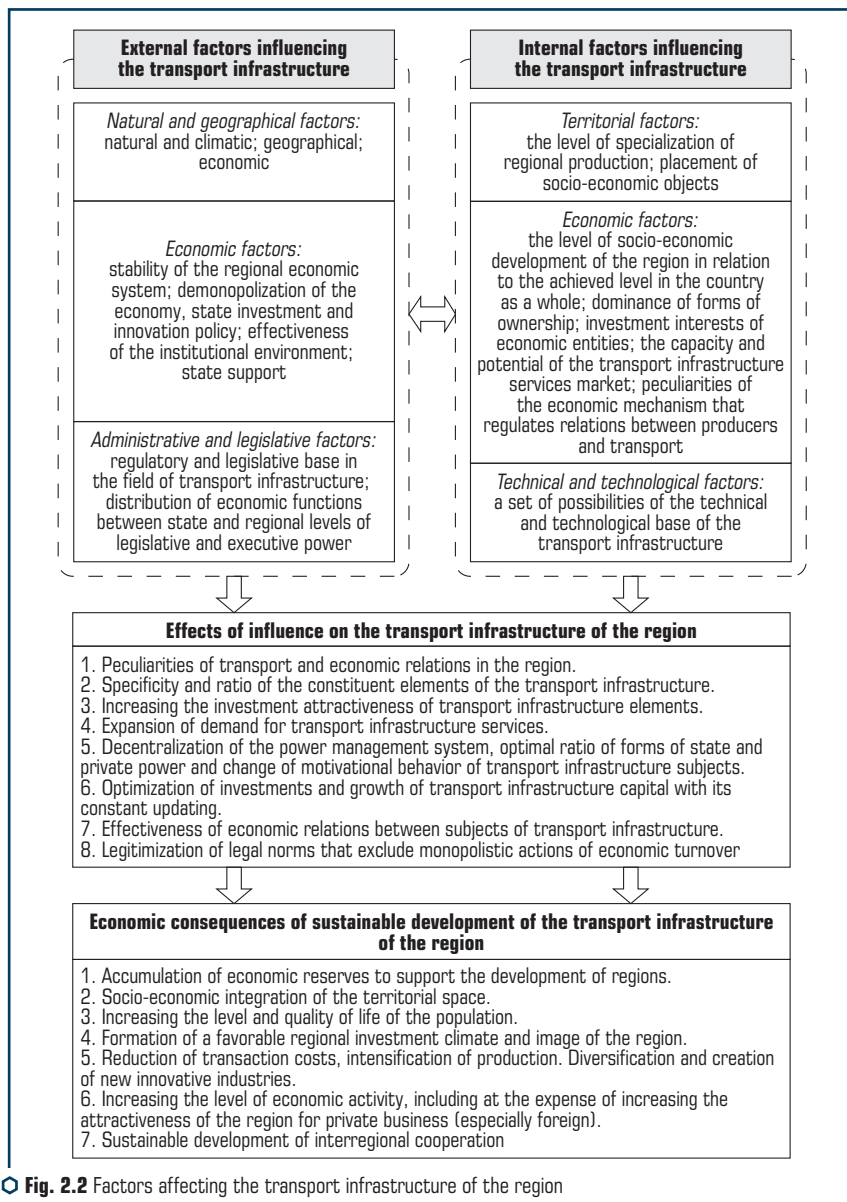


**Fig. 2.1** The structure of transport infrastructure in the system of socio-economic development of the region  
*Source: systematized by the author based on [2, 3]*

Based on the above-described processes, own experience and researched scientific sources [1–5], it can be concluded that the transport infrastructure of the region is a specific (special) type of infrastructure complex that has a special region-forming character, which is expressed in the ability of the transport infrastructure to ensure the territorial integrity of the region and create conditions for its socio-economic development by performing the functions entrusted to it to ensure transport and economic connections between different territories and territorial-administrative entities. Such an interpretation of this category in our study will allow a more in-depth assessment of the efficiency of development and the compliance of the transport infrastructure with the needs in the implementation of transport and economic connections of both a separate region and the country as a whole.

It can be argued that the nature of the development of transport infrastructure and its functional features are determined based on the specifics of the region, the commonality of regional socio-economic interests under the influence of many different factors. Depending on the goals of the study, a different set of factors of the efficiency of the development of transport infrastructure is substantiated, which are expediently classified according to the scope of action into external ones arising at the level of the macroeconomic system and internal ones arising at the level of regional transport infrastructure (**Fig. 2.2**) [6–8].

## 2 ROAD TRANSPORT INFRASTRUCTURE DEVELOPMENT PROGRAM OF THE REGION: IMPROVEMENT OF MAIN AREAS



**Fig. 2.2** Factors affecting the transport infrastructure of the region and the economic consequences of their implementation

Source: developed by the author based on [6–8]

From **Fig. 2.2**, it turns out that internal factors are subjective and directly affect the efficiency of transport infrastructure, so these factors can be defined as infrastructure-forming. External factors are objective and have an indirect effect on the efficiency of functioning not only of transport infrastructure, but also of other types of regional infrastructure, so they can be defined as conditions created in the economy for the formation of regional infrastructure.

Thus, the effectiveness of the development of the transport infrastructure of a specific territory is determined by the influence of infrastructure-forming factors and the conditions created in the economy for its formation and at the same time is one of the determining factors of the level of socio-economic development of the region. It is worth noting that the influence of transport infrastructure on regional development under the influence of these factors can be both strengthened and weakened, and therefore their study allows not only to determine their role, specificity and direction of influence, but also to assess the economic consequences of the effectiveness of regional transport infrastructure development [6]. The experience of the world's leading countries shows that the creation of a developed transport infrastructure contributes to the effective use of the resource, economic and social potential of territories through the effective implementation of transport and economic connections [7].

Motor transport infrastructure is assigned the most important state task – along with other types of transport infrastructure, it is designed to form a unified transport complex of the country, to meet the country's needs in the implementation of transport and economic connections. Currently, the road transport infrastructure occupies one of the leading places in the transport and infrastructure complex of Ukraine – in 2022, road transport will account for more than 42 % of all transported passengers and approximately 30.0 % of cargo (note that in pre-war times, the specific weight of transport road transport was much more – more than 50 % of passenger transportation and 75 % of cargo transportation) [8, 9].

It should be noted that the main task of the motor transport infrastructure is to meet the needs of the economic system in the implementation of transport and economic connections. So, the motor transport infrastructure is a multidimensional system, and each of its subsystems is a set of elements that provide various aspects of the transport process. Studies have shown that the entire set of elements of the motor transport infrastructure can be conventionally divided into four functional subsystems based on the feature of provision (**Fig. 2.3**).

Thus, on the basis of the researched in **Fig. 2.3** of support subsystems and the above definition of the concept of "transport infrastructure", it is possible to make an author's definition of the category "motor transport infrastructure", namely, it is a set of interconnected structural elements that provide transportation and related processes that perform the tasks assigned to this type infrastructural complex functions to create conditions for the implementation of transport and economic connections at the local, regional and state levels.

It is worth agreeing with the opinion of transport infrastructure researchers [1, 3, 5–8, 10, 11] that the most important problem of the effective development of the transport infrastructure in Ukraine and its regions is the unsatisfactory transport and operational condition, a high degree

of wear and tear and non-compliance with modern technical requirements the existing network of public highways and artificial structures on them, as well as structures and service equipment of automobile carriers.

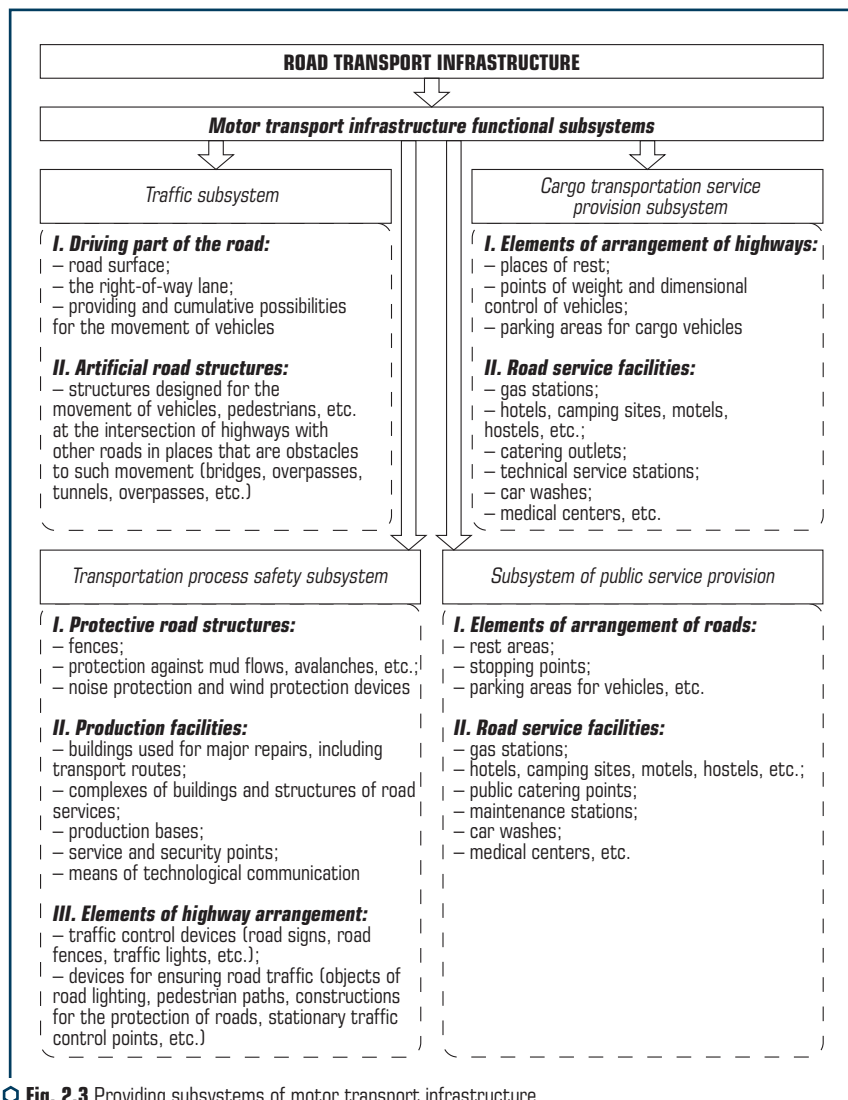


Fig. 2.3 Providing subsystems of motor transport infrastructure  
Source: built by the author based on [10, 11]

The problems listed above create a threat of slowing down the economic growth and social development of the regions of Ukraine, and therefore, without their solution, it is impossible to achieve radical positive changes in the socio-economic situation of the country.

Solving these problems requires an assessment of the provision of the motor transport infrastructure with the necessary functional subsystems, the efficiency of its development and compliance with the needs of the region in the implementation of transport and economic connections and the mobility of the population. For this purpose, it is expedient to form a system of management of the transport infrastructure of the region.

### 2.3 SYSTEM OF MANAGEMENT OF MOTOR TRANSPORT INFRASTRUCTURE OF THE REGION

As discussed above, the transport infrastructure plays a dual role in the socio-economic development of the region, it is rightfully considered a key factor in the formation of both economic and social space. Such a special position of this type of infrastructure complex in the region is explained by the fact that the motor transport infrastructure provides the needs of the region in the implementation of transport and economic connections.

Therefore, ensuring a high level of adaptability of the motor transport infrastructure to the dynamic conditions of the development of the regional environment and meeting the existing needs of the region in the implementation of transport and economic connections requires the need for its qualitative and quantitative assessment, which is one of the main elements of the management system of the motor transport infrastructure of the region. It is worth noting that such an assessment should be carried out in order to determine the possibilities of forming an effective motor transport infrastructure in accordance with the needs of the region in the implementation of transport and economic connections using the existing intra-regional reserves. Based on this, let's consider it expedient to form a system for managing the transport infrastructure of the region, which consists of:

- login to the system, which collects all available retrospective information on the state and problems of the region's motor transport infrastructure;
- five interconnected subsystems, which are the core and main driving force of the developed system;
- exit from the system, where the expected results of the system functioning are presented;
- feedback, which is the main mechanism for correcting the effects of retrospective data and subsystems of the formed system by the region's motor transport infrastructure (**Fig. 2.4**).

As can be seen from **Fig. 2.4**, the logical result of the operation of the system of managing the road transport infrastructure of the region is the development of a program to increase the efficiency of the development of the road transport infrastructure in accordance with the needs of the region. The ultimate goal of road transport infrastructure development is to meet the needs of the region in the implementation of transport and economic connections at the expense of more complete provision of infrastructure elements. Therefore, the formation of a program for increasing

the efficiency of the development of road transport infrastructure should be carried out not only for those regions where this infrastructure does not meet the needs of the region due to the low supply of its infrastructure elements (the first case), but also for regions with an effectively developed road and transport infrastructure (the second case), as well as for regions where the level of provision of structural elements exceeds the needs of the region in the implementation of transport and economic connections (the third case).

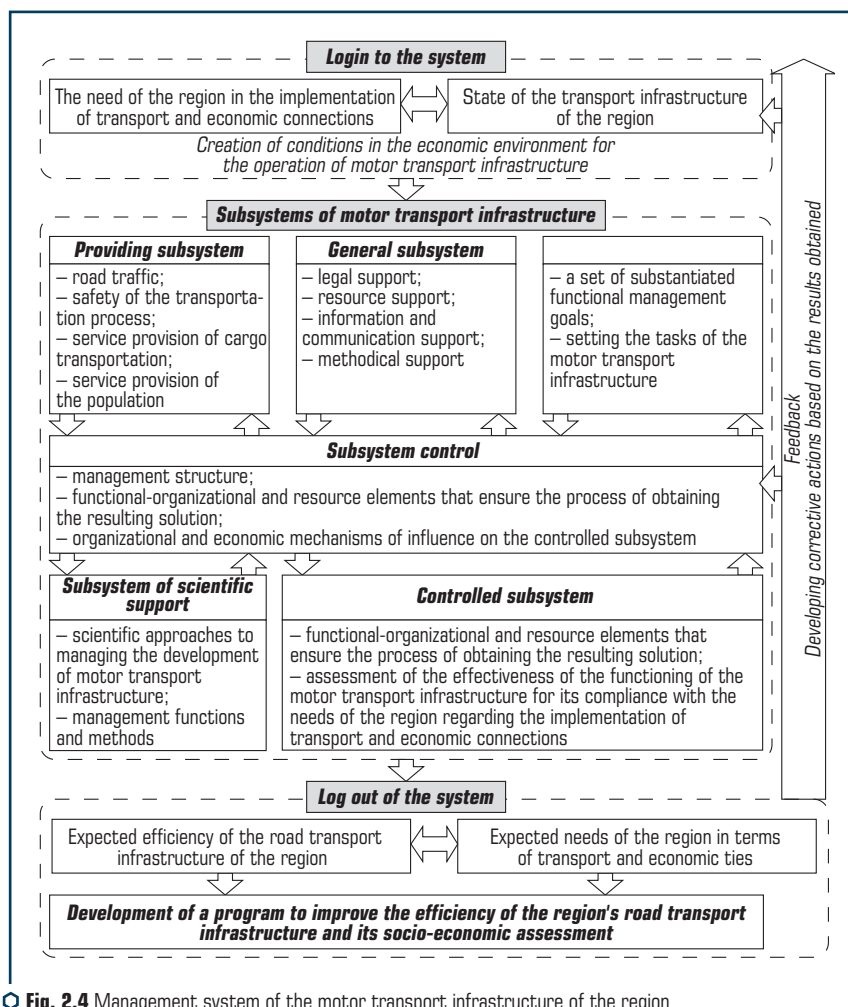


Fig. 2.4 Management system of the motor transport infrastructure of the region  
Source: developed by the author

From this, it is possible to draw general conclusions that the measures of the program should be aimed at:

- in the first case, to increase the efficiency of the development of the motor transport infrastructure in terms of compliance with the needs of the region in the implementation of complex transport and economic connections;
- in the second case, to achieve sustainable compliance of the motor transport infrastructure with the needs of the region in the implementation of complex transport and economic connections;
- in the third case, to support sustainable socio-economic transport infrastructure of the region.

For all the cases described above, the formation of a program for increasing the efficiency of the development of motor transport infrastructure should consist of the following stages, namely:

Stage 1. Identification of elements of the structural components of the motor transport infrastructure to meet the needs of the region in the implementation of complex transport and economic connections. For the successful implementation of this stage of the program, it is advisable to divide it into the following components, in particular:

- ranking of individual indicators of provision of motor transport infrastructure with infrastructural elements according to the deviation from the average regional value;
- identification of infrastructural elements that do not meet the needs of the region in the implementation of complex transport and economic connections based on the result of their ranking.

Stage 2. Elucidation of factors that have a negative impact on the provision of motor transport infrastructure with elements of structural components.

Stage 3. Development of ways to increase the efficiency of the development of motor transport infrastructure (the main stage of program development, the effective implementation of which will allow achieving sustainable socio-economic growth of the region in the field of motor transport infrastructure).

Stage 4. Selection of priority directions for increasing the efficiency of the development of motor transport infrastructure.

Stage 5. Processing and adjusting the performance criteria of the program's measures, which are aimed at increasing the efficiency of the development of motor transport infrastructure, using feedback.

Thus, it can be concluded that the formation of the program is carried out taking into account the level of provision of the necessary infrastructure elements and compliance with the needs of the region in the implementation of complex transport and economic connections in order to eliminate a possible imbalance between them. At the same time, the region's need to implement complex transport and economic connections provides an opportunity to have different options for forming a program to increase the efficiency of the development of motor transport infrastructure, taking into account the level of its provision with elements of functional subsystems and compliance with the needs of the region in the implementation of transport and economic connections (**Table 2.1**).

● **Table 2.1** Variations regarding the formation of the basic principles of the program to increase the efficiency of the development of the motor transport infrastructure of the region

<b>No.</b>	<b>Correspondence of the motor transport infrastructure to the needs of the region</b>	<b>Variations in the formation and implementation of the program</b>
I	Available reserves for the use of motor transport infrastructure for the needs of the region in the implementation of complex transport and economic connections	<ul style="list-style-type: none"> <li>– support for effective socio-economic development of the region's motor transport infrastructure;</li> <li>– achieving a more sustainable compliance of the motor transport infrastructure with the needs of the region in the implementation of complex transport and economic connections</li> </ul>
II	Road transport infrastructure meets the needs of the region in the implementation of complex transport and economic connections	<ul style="list-style-type: none"> <li>– achievement of a more stable compliance of the motor transport infrastructure with the needs of the region in the implementation of complex transport and economic connections;</li> <li>– increasing the efficiency of the development of motor transport infrastructure and bringing its characteristics to a level that meets the needs of the region</li> </ul>
III	Road transport infrastructure does not meet the needs of the region in the implementation of complex transport and economic connections and restrains their development	<ul style="list-style-type: none"> <li>– achievement of a more stable compliance of the motor transport infrastructure with the needs of the region in the implementation of complex transport and economic connections;</li> <li>– increasing the efficiency of the development of motor transport infrastructure and bringing its characteristics to the level that meets the needs of the region</li> </ul>

*Source: developed by the author*

It should be noted that the conducted studies of the implementation of various programs of regional and local development [12, 13], including those aimed at increasing the efficiency of the development of motor transport infrastructure, indicate significant shortcomings that do not allow optimal use of financial and economic, resource and organizational and management potential of regions regarding their implementation. This is primarily due to the incorrect allocation of strategic priorities in the structure of programs, which does not allow to effectively solve the tasks of regional socio-economic development. In this regard, let's consider it expedient to investigate and develop ways of improving the directions of increasing the efficiency of the development of motor transport infrastructure.

## **2.4 IMPROVEMENT OF DIRECTIONS FOR INCREASING THE EFFICIENCY OF MANAGEMENT OF THE DEVELOPMENT OF MOTOR TRANSPORT INFRASTRUCTURE**

In the conditions of the modern dynamic socio-economic situation in Ukraine, researching the problems and prospects of introducing innovative models and management methods into the motor transport infrastructure of the regions is an urgent task, since the process of forming its unified system is very urgent complex and does not meet the modern parameters of the development of the entire infrastructure system of the national economy. In the previous chapter of this study,



the author's vision for the formation of the management system of the motor transport infrastructure of the region is proposed, the final result of which is a program for increasing the efficiency of the motor transport infrastructure development. It was also proved that the main stage of the construction of this program is the development and improvement of directions for increasing the efficiency of management of the development of motor transport infrastructure. For this purpose, it is expedient to form a system complex of general economic tasks regarding the determination of directions for the development of the motor transport infrastructure of the regional economy, in particular:

- complex construction of infrastructure in the regions;
- observance of the regional balance of interests of all subjects of the motor vehicle market, smoothing of spatial differentiation;
- ensuring public-private partnership, technical and technological improvement;
- formation of a set of measures regarding the institutional and cluster attractiveness of the region.

To solve these problems, it is advisable to divide the development and improvement of directions for improving the management of the development of motor vehicle infrastructure into three components, in particular, state-regional, regional, and regional-local [14]:

#### **I. State-regional component.**

In scientific literature and in practice, it has been proven that state influence is fundamental, in particular:

- the state is always present in the economy and it should not depart from it;
- the degree of state participation depends on the set and volume of functions. which are recognized;
- practical policy cannot be based entirely on any one doctrine, because circumstances arise in life that objectively make it expedient for the state to perform various sets of functions and vary their scope;
- the choice of the optimal level of state participation in the economy must take into account a number of factors, including the conditions and stage of the country's development, its position in relation to other countries, the peculiarities of national culture and institutions, the degree of uncertainty of the current situation, other force majeure circumstances (military operations, epidemics, etc.).

Thus, it is possible to clearly position the following directions for increasing the efficiency of management of the development of motor vehicle infrastructure in this component, namely:

1. Modernization of the regulatory and institutional framework at the state level. It should be noted that the improvement of the legal system is a continuous process. However, the main drawback of this improvement of the legislation is the lack of a system of consistency between individual provisions of the Civil Code and normative interpretations in other administrative documents. It should also be noted that the legal registration or granting of legal status lags far behind in the field of improving the regulatory and legal framework for the adaptation of scientific and technical, technological improvements in socio-economic relations in the development of infrastructure

in general, and in motor vehicles in particular. This especially applies to everyday norms and rules of human behavior, groups of people on transport when using innovative facilities and communications, which are sometimes not directly protected in the legal aspect, and indirect legal protection under current legal acts is ineffective. Therefore, it is necessary to emphasize the importance of the next direction of improvement.

2. Ensuring comprehensive safety and stability of the motor vehicle system. Comprehensive security involves not only the legal side of the issue, but also a simple formalization of the rules of use, as well as the formation of a system or its modernization, continuous professional development of the personnel employed in transport or motor transport communications.

3. Increasing the competitiveness of the state motor transport system. It can be achieved through the formation and constant growth of technical and technological and service potential. Traditionally, competitiveness in the motor transport industry is considered as the compliance of the transport service with the requirements of the market situation in terms of technical, technological, economic and other characteristics that determine its difference and superiority from the services of other carriers [15]. This direction is important from the point of view of reducing the cost of transportation due to the involvement of additional paid services. This creates prerequisites for the profitable operation of transport organizations, provides additional employment at transport enterprises, etc. [15].

4. Overcoming limitations of socio-economic development. This direction can be developed at the expense of infrastructure investments, which are designed to solve the problem of excessive wear and tear of fixed assets, modernization of the fixed capital of motor vehicle enterprises and organizations of the regional economy, as well as to be included in the system of co-financing of entrepreneurial initiatives and state programs for the modernization of motor vehicle infrastructure and the introduction of resource-saving technologies into its operation.

5. Development of motor vehicle complexes and their integration into the world transport system.

6. Expansion of the capacity of the transport network at the state and regional level.

7. Implementation of transit export-import potential through a complex of investment measures aimed at the development of international transport corridors.

8. Creation of financing programs for the reconstruction and construction of new buildings and structures of motor transport infrastructure of national and regional importance.

9. Formation and distribution of innovative logistics technologies that increase the quality and availability of motor transport services.

10. Formation of a grid network of national highways, which is a long and costly process, which is implemented only under the conditions of the presence of autonomous, targeted and stable sources of funding for the road industry. Currently, in the modern conditions of Ukraine, it can be implemented only in the post-war period.

11. Formation of a complex state-regional system of tariff regulation in the motor transport system.

12. Formation of state rules regarding the use of land plots for the creation of new facilities and communications of the region's motor transport system.

## **II. Regional component.**

This component includes a number of directions that are characteristic of certain regions in their dominant development, that is, they have certain motor vehicle specifics or complex characteristics based on natural and geographical parameters.

Modern socio-economic policy of the state, according to many scientists and specialists, dictates such conditions of development, under which the center of gravity of economic policy should be shifted from external sources of development to internal ones, the main of which in the long term is the increase of the reproductive potential of regions and cities through development territory and development of human potential [16]. The basis of such "regionally oriented development" should be the modernization of infrastructure – the fundamental layer of regional and urban systems, which creates resource prerequisites for economic growth [16].

Thus, it is possible to establish a circle of directions for improving the development of the motor transport infrastructure of the regional economy, namely:

1. Introduction of new equipment and technologies in the road transportation market.
2. Update of the motor vehicle fleet (passenger, cargo).
3. Support in the development of the competitive sector of private operator services in the region's motor transport system.
4. Development of the supporting transport network in the regions.
5. Organization of high-speed movement of passenger and cargo vehicles on priority routes of the network due to the construction of modern high-quality roads and infrastructural facilities of the regions.
6. Implementation of large infrastructural regional projects involving investments (including foreign ones).
7. Regional arrangement of directions of international motor transport corridors and their branches.
8. Reconstruction and construction of cluster-type regional motor transport infrastructure.
9. Achieving the optimality of the indicator of "humanity" of the regional motor transport system, i.e. 3 to 1 in relation to the ratio of passenger-kilometers to ton-kilometers (it is considered the optimal norm of this indicator for large developed countries [17]).
10. Elimination of regional "lobbying" and corruption connections (schemes) in the development and implementation of various motor transport projects.
11. Formation and development of institutional organizations and structures that regulate motor transport policy and provide broad services to the population.
12. Development and implementation of plans and implementation programs to increase the capacity of the supporting transport network of the region.
13. Construction of regional programs for leveling the causes and consequences of traffic accidents.
14. Formation of a network of nodal distribution centers to create conditions for increasing the competitiveness of cargo delivery from the sender to the consignee, including reduction of delivery time, reduction of transportation costs, reduction of risks, control of cargo movement along the entire path.

15. Formation of a system of high-tech projects for the development of regional motor transport hubs.

16. Development of the concept of development of regional motor transport infrastructure for passenger transport of general use.

### **III. Regional and local component.**

The main pool of problems of motor transport infrastructure with all the various strategic results of state development programs is implemented, first of all, at the local level. It should be noted that this implementation goes in two directions, in particular: either the project of national significance is adapted to the territorial specifics of a specific local community, or the advantages of the local territory allow the implementation of motor transport infrastructure projects, which in turn brings a positive effect both for the region and for the entire nation economy of Ukraine. In any case, all infrastructural transport projects and modernization phenomena in this area are part of the tasks of city authorities [18].

The importance of understanding the role of local management of transport infrastructure is due to objective reasons that determine the relationship between the socio-economic sphere of human activity and the management of motor transport provision of this activity in the local territorial formation.

In the implementation of the infrastructure policy at the regional level, the main attention was paid to the measures of technical modernization and re-equipment of the industry, and not to institutional transformations. However, the depth of the problems of the formation of socio-economic relations in the motor vehicle sector between its participants is quite significant and cannot always be fully resolved.

Whatever measures are taken by the regional authorities aimed at creating a functional motor vehicle environment, these actions are leveled by changes in the socio-economic environment of a specific territory of the region, the transformation of economic and industrial relations, as well as the socio-economic mechanisms and control levers operating at the local level [19].

Therefore, it is necessary to highlight and most effectively solve the following areas of development of the motor transport infrastructure, characteristic for the local level, namely:

1. Modernization and development of municipally owned motor vehicle infrastructure.
2. Ensuring stable, reliable and accessible communication links with socially important objects and other territories of the region in local territories.
3. Provision of modern information, communication and technical equipment of city transport hubs.
4. Update of morally and physically outdated equipment and technologies of motor transport infrastructure at the local level.
5. Elimination of cross-subsidization in the implementation of local motor transport projects, which creates the basis for the emergence of corrupt and fraudulent schemes for the outflow of financial and other resources.
6. Formation and development of innovative nodal transport platforms and loading and unloading complexes.
7. Development of the information and communication concept of local transport policy and its coverage in mass media.

8. Implementation of concession relations or public-private partnership at the local level.

9. Formation of the local concept of service of state and regional motor transport communications as a factor of increasing the employment of the local population and smoothing spatial differentiation [20].

10. Formation of urban traffic junctions and engineering systems of life support of the population.

11. Wide implementation of electronic and index informatization at the objects of motor transport infrastructure.

Summarizing all of the above research, it should be noted that the differentiation of directions for improving the development of motor vehicle infrastructure at the state, regional and local levels with their socio-economic detailing by objects of influence, as well as the broad integration of each program will allow to adaptively and rationally develop a unified system of managing the motor vehicle infrastructure of the region and timely and fully implement and implement the directions of socio-economic development substantiated in the work.

## 2.5 DISCUSSION OF THE RESULTS OF THE IMPROVEMENT PROGRAM FOR THE DEVELOPMENT OF THE MOTOR TRANSPORT INFRASTRUCTURE OF THE REGION

In the course of a comprehensive study of the actual problem of finding ways to improve the main parameters of the region's motor transport infrastructure development program, the following scientific, methodological and practical results were obtained, namely:

- a clarified author's definition of the term "transport infrastructure of the region" is provided – it is a specific (special) type of infrastructure complex that has a special region-forming character, which is expressed in the ability of transport infrastructure to ensure the territorial integrity of the region and create conditions for its socio-economic development by fulfilling the tasks assigned to it functions to ensure transport and economic connections between different territories and territorial-administrative entities;

- systematized factors of influence on the transport infrastructure of the region and the economic consequences of their implementation – this made it possible to prove that the effectiveness of the development of the transport infrastructure of a specific territory is determined by the influence of infrastructure-forming factors and the conditions created in the economy for its formation and at the same time is one of the determining factors of the level of socio-economic development of the region in general;

- a system of managing the motor transport infrastructure of the region was developed, the logical result of which is the formation of a program for increasing the efficiency of the development of the motor transport infrastructure in accordance with the needs of the region;

- the stages of the formation of the program for increasing the efficiency of the development of motor transport infrastructure are determined and a generalized conclusion is made that the implementation of this program is carried out taking into account the level of provision of the

necessary infrastructure elements and compliance with the needs of the region in the implementation of complex transport and economic connections in order to eliminate a possible imbalance between them;

– the ways of improving directions for increasing the efficiency of managing the development of motor transport infrastructure at the state, regional and local levels are proposed and substantiated.

The problem of finding directions for the development of the transport infrastructure of the region is outlined in this chapter, so the next chapter 3 will be devoted directly to the mechanism of managing the development of transport enterprises.

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## THEORETICAL FOUNDATION OF THE COMPONENT MECHANISM OF SUSTAINABLE DEVELOPMENT MANAGEMENT OF TRANSPORT ENTERPRISES

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### ABSTRACT

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For effective adaptation to the rapidly changing conditions of the external environment and the implementation of economic activity, a necessary condition for the effective management of sustainable development is theoretical research into the mechanism of its provision according to the vector of innovation. Within the framework of this chapter, a systematic approach to the formation and implementation of the strategy of sustainable innovative development of transport enterprises is outlined, which allows determining the main methods and tools used in order to improve the efficiency of the enterprise's functioning, both in the current period and in the future. At the same time, it is important to note that the strategy of sustainable development includes two main directions – the mechanism of enterprise restructuring to achieve long-term sustainable development and the management policy of short-term sustainable development of enterprises. Methodological approaches have been developed to determine the mechanism of sustainable innovative development, which is a set of subsystems and elements that regulate the process of managing the innovative activity of the enterprise.

It is substantiated that one of the most important conditions for the functioning of the mechanism of sustainable innovative development of the enterprise is the formation of the necessary volume of financial resources. In case of limited access to financial resources of developed countries, the main source is the company's own resources. This made it necessary to develop a methodology for the formation of funds for targeted financing, which, based on the characteristics of innovative transformations, are determined by the characteristics of internal investment and venture funds.

### KEYWORDS

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Sustainable development, innovative development, restructuring, development strategy, systemic approach.

### 3.1 PECULIARITIES OF THE SYSTEM APPROACH TO THE FORMATION OF THE STRATEGY OF SUSTAINABLE INNOVATIVE DEVELOPMENT OF TRANSPORT ENTERPRISES

The functioning of a transport enterprise in the conditions of a market economy and the implementation of innovative programs is influenced by various factors of the external and internal environment. In this regard, its sustainable development involves an adequate response to



these indignations by forming a management system based on the development and implementation of an effective strategy with mechanisms embedded in it that ensure the given sustainability.

One of the conditions that determine the relevance of developing a strategy for the sustainable development of an enterprise is the transition to a new stage of the life cycle, since each of the stages is characterized by the level of investment and innovation activity, directions and forms of activity, features of the formation and distribution of resources. Thus, the strategy being developed allows the enterprise to adapt its activities in advance to future changes in the possibilities of its sustainable economic development.

In addition, an important condition that determines the relevance of developing a sustainable development strategy is a change in the goals of the company's financial and economic activity, since their implementation requires a change in the range of manufactured goods, works and services, the introduction of new technologies, the development of new sales markets, etc. As a result of this, the investment activity of the enterprise and the diversification of the forms of its activity, which should have a predictable nature, which is ensured by the necessary level of stability, significantly increase.

The process of strategic management is characterized by certain features, the main ones, according to some experts, are:

- a) the impossibility of a detailed description of the objects of analysis, according to which weakly structured tasks prevail;
- b) a high degree of uncertainty of obtaining results in the process of implementing strategic decisions;
- c) a large number of uncontrolled and partially controlled variables;
- d) lack of previous, clearly defined criteria for solving certain types of tasks and clarification of criteria in the process of solving them;
- e) the high labor intensity of this process, which requires significant costs and the involvement of highly qualified specialists [1].

This specificity is also characteristic of the process of ensuring sustainable development and should be taken into account when implementing systemic changes based on the functioning of the sustainable development management mechanism.

Considering various ways of ensuring the sustainable development of enterprises, the following are distinguished:

- an evolutionary strategy characterized by gradual, planned and stable development;
- a revolutionary strategy, characterized by a leap-like growth of the main indicators of the enterprise, which ensures the transition from one qualitative state of the system to another;
- a survival strategy implemented in the event of a crisis situation and aimed at adapting to deteriorating environmental conditions in order to preserve the enterprise's potential [2].

When implementing a strategy of sustainable innovative development, the company must decide on the target tasks and the content of this process, while three approaches can be distinguished here:

- 1) adaptive, which is considered as a set of measures to bring the company's operating conditions into line with changing market conditions;

2) systemic, which is a complex and interconnected change in structures with the aim of ensuring the stability of the enterprise in new conditions;

3) structural, which is defined as structural restructuring with the aim of ensuring effective distribution and use of enterprise resources through reorganization or liquidation of structural units, as well as absorption of other enterprises to increase investment attractiveness and competitiveness.

The implementation of each of the above approaches involves the activation of innovative activities, since the search for new technologies, forms of internal organization, as well as ways of implementing external relations, markets and products is a source of sustainable economic development.

The development of a strategy for the sustainable development of an enterprise at the modern innovative stage of economic transformation is based on the methodological principles of the concept of strategic management. This concept reflects the strategic positioning of the enterprise, presented in the system of principles and goals of its operation, the mechanism of interaction between the subject and the object of management, as well as the nature of the relationship between the elements of the economic and organizational structure and the forms of their adaptation to the changing conditions of the external and internal environment.

Strategic management was formed through the development of the strategic planning methodology, which is its essential basis, instead, it is based, first of all, on the clear identification of the objects of this management, among which the following main groups are usually distinguished: the enterprise as a whole; strategic economic zone; strategic economic unit. In this regard, in relation to the management of the strategy of sustainable development, it is important to develop such a management system that would ensure the coverage of all groups of objects.

In our opinion, the essential characteristics of a company's sustainable development strategy in the light of the strategic management paradigm are:

1) the strategy of sustainable development is one of the types of functional strategies of the enterprise;

2) in the system of functional strategies, the strategy of sustainable development should occupy a prominent place, since it defines and integrates the activities of all divisions in the process of forming and implementing the system of enterprise strategies, primarily functional strategies;

3) the strategy of sustainable development covers all the main areas of activity and relations of the enterprise, which follows, first of all, from the content of strategic management, the most important function of which is the formation of this strategy;

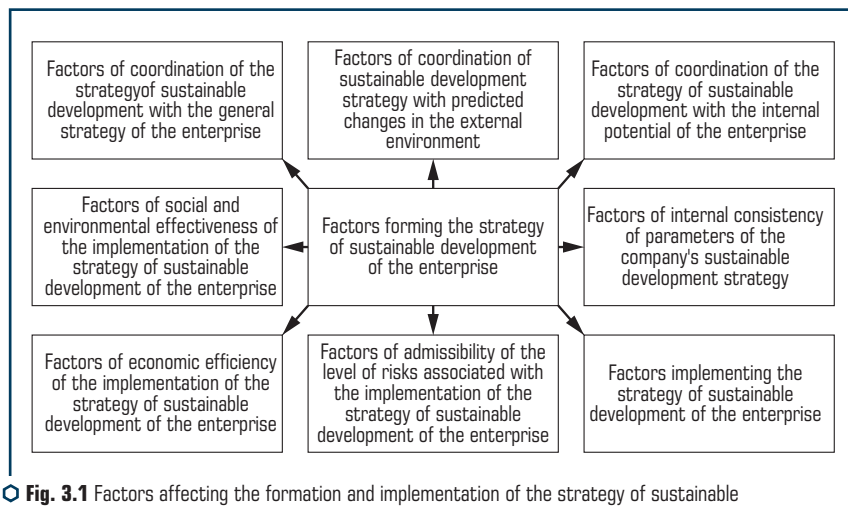
4) the process of developing a sustainable development strategy determines the need for the formation of specific goals for the long-term sustainable development of the enterprise;

5) the process of forming a sustainable development strategy determines the choice of effective directions for achieving the set goal, that is, it is ensured by the search and assessment of alternative options for possible strategic solutions and their selection according to the criterion of sustainability;

6) the strategy of sustainable development is designed to take into account the changes occurring in the external environment during the development of the enterprise, and to respond adequately to these changes, which is an important quality of any strategy;

7) adaptation of the strategy of sustainable development to the changing conditions of the external environment is ensured, first of all, by the effective use of the mechanism of sustainable development, focused on increasing the sustainability potential of the enterprise and the directions of resource use.

Let's present the main factors that, in our opinion, form the strategy of sustainable development of transport enterprises in the conditions of structural restructuring on an innovative basis (**Fig. 3.1**).



**Fig. 3.1** Factors affecting the formation and implementation of the strategy of sustainable innovative development of the transport enterprise  
Source: author's development

The implementation of the sustainable development strategy forms the basis of the development of long-term and short-term management policies for sustainable innovative development of the enterprise.

The mechanism of sustainable development plays the role of an impulse that activates the elements of the enterprise's structure, and functions through the development and implementation of an appropriate strategy based on a systemic approach, which is the study of objects as a system.

The system approach is a methodological direction of research, the basis of which is the consideration of the object as a whole set of elements in a set of relations and connections between them. The systematic approach to the development of the enterprise's sustainable development strategy is characterized by the observance of methodological principles:

1. The principle of purposefulness, i.e. determination of strategy goals, taking into account the construction of a tree of goals.
2. The principle of heredity, characterized by the regularity of transmission of dominant and recessive traits at separate stages from the current strategy to the newly implemented one.

3. The principle of priority of quality, i.e., the practice of strategy implementation shows that the most effective value for the enterprise is the priority of the quality of development, strategy implementation and management decisions.

4. The principle of optimality, which characterizes the degree of satisfaction of the requirements for the implementation of the strategy to achieve the planned goals, which ensure the best use of its potential.

5. The principle of reliability, which in turn is determined by such characteristics as uninterrupted functioning, preservation of system parameters during the planned period of time, stability of the system in the process of strategy implementation, etc.

The assessment of the developed sustainable development strategy allows to answer the question whether this strategy will lead the company to achieve its sustainable development goals under the conditions of changes in external and internal environmental factors. In our opinion, this assessment should be based on the use of such parameters as:

1) consistency of the company's sustainable development strategy with the mission and corporate strategy of the transport company;

2) consistency of the company's sustainable development strategy with predicted changes in factors generated by the environment;

3) consistency of the company's sustainable development strategy with the level of its internal potential;

4) internal balance of the main parameters of the company's sustainable development strategy;

5) degree of implementation of the developed sustainable development strategy;

6) acceptability of the level of commercial risks associated with the implementation of the company's sustainable development strategy;

7) level of economic efficiency of the implementation of the company's sustainable development strategy.

In the system of strategic management, the most important stage is the management of the implementation of the developed strategy of sustainable development of the enterprise. The main task here is to create the necessary prerequisites and conditions at the enterprise for achieving the ultimate strategic goals of its modernization and sustainable development. This process is characterized by the following main features:

a) the management of the implementation of the sustainable development strategy is aimed not so much at the mandatory implementation of all strategic decisions, but at the achievement of the main goal – the sustainable development of the enterprise;

b) the successful implementation of the enterprise's sustainable development strategy allows to obtain an additional effect, since at this stage there is an opportunity to eliminate mistakes made at the stage of its development;

c) at this stage, there is a shift in the emphasis of strategic management, since the main management efforts take on the character of direct actions;

d) in the process of implementing the strategy of sustainable development, an important prerequisite for success is the construction of effective communication links and a system of motivation of personnel related to this process.

Thus, it can be noted that the systematic approach to the formation and implementation of the strategy of sustainable innovative development of transport enterprises allows to determine the main methods and tools used in order to increase the efficiency of the enterprise's functioning, both in the current period and in the future. At the same time, it is important to note that the strategy of sustainable development includes two main directions – the mechanism of enterprise restructuring to achieve long-term sustainable development and the management policy of short-term sustainable development of enterprises, which must be considered in more detail.

### 3.2 DEVELOPMENT OF A MECHANISM FOR RESTRUCTURING THE TRANSPORT ENTERPRISE TO ACHIEVE LONG-TERM SUSTAINABLE DEVELOPMENT

The long-term sustainable development of transport enterprises is largely determined by their level of competitiveness, which largely depends on the existing potential, which, in turn, is ensured by the activation of investment and innovation activities, since the search for new technologies, forms of internal organization, methods of external relations, markets and logistics connections is a source of economic development [3].

The main direction for the majority of transport enterprises of Ukraine, which creates conditions for sustainable development, is the restructuring mechanism aimed at the activation of innovative activities.

Restructuring determines the most important characteristic features of the innovation process, the main of which are novelty, the direction of changing the current state and the introduction of innovations.

Forecasting the restructuring of the enterprise requires a clear understanding of the goals, tasks, implementation mechanism and determination of the amount of necessary resources. In this, the majority of authors [4, 5] investigating the problems of corporate transformations agree that the strategic goals of restructuring are to increase the value of equity capital and ensure long-term sustainable development due to the effective use of resources and the introduction of innovations. At the same time, the main tasks of restructuring, from the point of view of these authors, are:

- optimization of the organizational and functional structures, as well as the management system of the enterprise in accordance with the strategic goals of its development;
- reengineering of business processes, primarily commercial and financial activities, with the aim of improving indicators;
- optimization of the quantitative and qualitative composition of personnel.

In addition to the listed tasks, a number of specialists [6] are considering such things as modernization and technical rearmament of the existing production base of the enterprise based on the intro-

duction of innovative technologies, reorganization of the management system and the use of human resources, a qualitative change in relations with consumers and the creation of a new client group.

It can be noted that the priority goal of restructuring is to increase the value of the enterprise's capital based on increasing its potential due to innovative activity by ensuring sustainable development and increasing the efficiency of operation. Moreover, in the process of restructuring, the following tasks must be solved: increasing the competitiveness of the enterprise in a strategic perspective; increasing its adaptive properties to the changing market environment.

In this regard, the following main reasons for restructuring can be named:

- a) significant changes occurring in the external environment and negatively affecting current and prospective sustainability;
- b) formation of new strategic areas of enterprise development;
- c) impossibility of achieving the set goal by other means, etc.

For greater effectiveness of the restructuring management process, it is important to define the subject, mechanism and methods of the intended transformations, that is, the restructuring complex. It should be noted that the subject of the restructuring complex is the basic subsystems of the enterprise's functioning, and the restructuring management mechanism is a set of used tools, methods, models, regulations and principles that ensure effective management of these transformations. Moreover, the management mechanism is the most active part of the restructuring complex, which provides a decisive influence on the factors affecting the effectiveness of the process [6].

The restructuring process is carried out in a certain sequence, which can be characterized as follows.

At the first stage, a comprehensive assessment of the enterprise is carried out, including diagnostics of all directions, functions and subsystems of the enterprise. Diagnostics is necessary to identify problems of enterprise development, identify strengths and weaknesses in financial and economic activity, and consider opportunities and threats to functioning. At the same time, in the process of conducting the assessment, a diagnosis of the implementation of the current development strategy is made, the trends occurring in the external environment are analyzed, the financial condition, investment and innovative attractiveness and other aspects of the activity are studied.

At the second stage, taking into account the data obtained in the process of the conducted assessment, the need for restructuring is substantiated, as well as the forecast results of the activity as a result of its implementation and without the implementation of these transformations are compared.

At the third stage, the project is directly developed and the direction of the planned restructuring is agreed, and at this stage, several alternative options are formed taking into account possible changes in the environment and the level of risk of transformation, including the selection of the optimal one. In addition, in the process of project development, strategic goals are formed, qualitative and quantitative parameters of the project are determined, taking into account resource limitations.

At the fourth stage, the necessary resources (personnel, financial, material, technical, etc.) are formed in order to successfully implement the planned activities.

At the fifth stage, the measures of the restructuring project are implemented, that is, the transformation of the basic subsystems of the enterprise is carried out based on the use of motivation and controlling mechanisms in compliance with the necessary proportions that ensure the given stability.

At the sixth stage, the results of the transformations are analyzed on the basis of the monitoring system, and in case of significant deviations of the actual indicators from the target parameters, the company's development strategy is adjusted.

Solving the formulated problems requires consideration and determination of the conceptual provisions of the management system of restructuring processes in the development and implementation of the company's sustainable development strategy.

The sustainable development of the enterprise is determined, first of all, by ensuring economic growth and the formation of higher potential based on innovative activity, in connection with which, in the process of transformations, there is a violation of the balance of subsystems, therefore, the formation of a mechanism that ensures the stability of functioning at a new level of development is of great importance.

In our opinion, the methodological basis of the management system of the restructuring mechanism, aimed at ensuring strategic sustainability, is the following provisions:

1) radical changes that determine the level of development of the enterprise, aimed at the transition of the system to a different qualitative state, which is carried out in the conditions of changes in the interaction of the internal structure, technologies and processes with the external environment. The transition of the enterprise to a qualitatively new state creates the prerequisites for the emergence of promising directions of development, additional competitive advantages, changes in the enterprise's position on the market, an increase in the level of operational efficiency and the provision of sustainable long-term development;

2) radical changes carried out at the enterprise determine the need to significantly shorten the period of reaching such a state that ensures a new level of development, while the marginal reduction of the restructuring period allows for a shorter period of time to ensure a stable state of the enterprise, at the same time, accelerated development leads to an increase in cost implementation of works, as they are implemented in a forced mode [7];

3) a significant transformation of the company's activity involves the complexity of the planned changes, while the complexity of the changes expresses a systematic approach to the implementation of transformations, which includes: the formation of a single development strategy based on the coordination and harmonious combination of the main vectors of the projected transformations; complex transformation of the basic subsystems of the enterprise, which allows to reduce the degree of their inconsistency at a new level; unification of measures carried out with the aim of spreading the positive results obtained in individual segments to the entire system; strengthening competitive advantages by transforming the weaknesses of the company's current activities;

4) radical changes in the development of the enterprise cause the need to increase the level of adaptation to changes in the environment in the process of restructuring, that is, if an adequate reaction to changes in the external environment does not occur, then this will lead to a decrease

in the potential of the development of the enterprise, a loss of competitiveness, an increase in the imbalance between the existing state of the system and requirements of the external environment;

5) the restructuring carried out for the enterprise places increased demands on the management system of innovative transformations, that is, in the process of radical changes, it is also necessary to maintain the current functioning at the required level, which leads to an increase in the volume of controlling influences and requires increased manageability;

6) the development of the enterprise through the implementation of restructuring involves the formation of a new development inertia in the perspective direction of the enterprise's functioning, which affects the process of transformation, the achievement of strategic goals and ensuring its sustainability;

7) qualitatively new transformations of the enterprise provide for the maximum concentration of all resources in order to reduce the terms of restructuring as much as possible and ensure its comprehensive implementation.

Accordingly, it can be noted that in order to ensure the necessary level of sustainability during the implementation of restructuring processes, it is necessary to achieve a sufficient margin of financial strength of the enterprise operating in conditions of uncertainty and increased risk generated by the influence of environmental factors and social policy.

The process of intensive innovative development is largely determined by radical strategic changes that form a higher level of development and is the main object of management in the process of enterprise restructuring, in connection with which an important methodological problem is the determination of the interdependence of development processes and the action of the restructuring mechanism. At the same time, it should be noted that the restructuring process is primarily aimed at increasing the development potential, as well as increasing the efficiency and market value of the enterprise, and the most significant, in our opinion, is the management of the enterprise's development potential.

The potential of the enterprise determines the scope of the stock of opportunities for development and includes the following main components:

- a) production potential that ensures the necessary rates of economic growth;
- b) financial potential, which creates prerequisites for ensuring the necessary margin of financial stability;
- c) investment potential, which ensures the implementation of investment projects aimed at increasing the level of technological potential;
- d) innovative potential, which determines the company's prospects and capabilities for the development and implementation of modern, cutting-edge technologies and products;
- e) marketing potential, which makes it possible to strengthen and expand the company's position on the market and reflects the strategic level of competitiveness;
- f) labor potential, which characterizes the capabilities of the company's personnel to master new functions, as well as increase the volume and quality of performed work;
- g) other types of potential of the enterprise, which determine development opportunities.



Potential management is aimed, first of all, at the transformation of the existing potential of current functioning, the formation of a mechanism for the accumulation of potential for prospective development and the realization of potential for the purpose of comprehensive innovative transformation, in turn, the growth of potentials is ensured by the implementation of reengineering and modernization.

Determining balanced proportions and ratios, which allow to ensure a given degree of sustainability of the enterprise, is possible through the development of relevant norms, standards and ratios, while the sustainable development of the enterprise is a complex concept that responds to the influence of each production component, resulting in the emergence of an unstable state of the enterprise in the process development is associated with a violation of established economic proportions and relations.

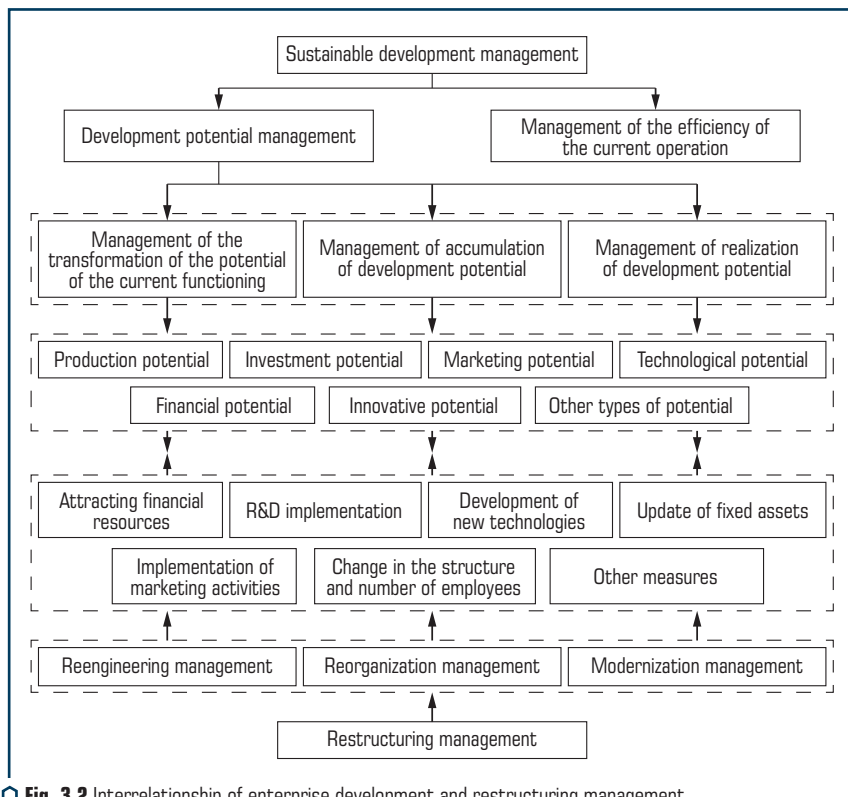
Important problems are the development and implementation of a management strategy for each type of enterprise potential and their totality. It should also be noted that potential management is primarily aimed at transforming the potential of current functioning, forming a mechanism for accumulating potential for prospective development and realizing potential with the aim of comprehensive transformation, while the growth of potential is ensured by reengineering, reorganization and modernization.

The system of interconnection of management of sustainable development and restructuring is determined by the transformation of development potential (**Fig. 3.2**).

The management of the sustainable development of the enterprise on the basis of restructuring is based on certain principles and criteria for the implementation of forecasted measures, and the specificity of the study of these elements is the need for methodological substantiation of the construction of restructuring processes and the main directions of their analysis. This depends on the fact that the sustainable innovative development of enterprises appears as a complex and multifaceted process, carried out under the conditions of uncertainty of the influence of the external environment, and accounting for this circumstance requires a systematic approach from management.

The management of strategic innovative development determines the state and position of the enterprise in the future, ensuring the consistency, systematicity and predictability of the transformation of this economic system [8]. In this regard, the management of the sustainable development of the enterprise is a set of principles, criteria, methods and methods aimed at implementing changes that ensure the optimal trajectory of the enterprise's development in the conditions of changes in the external environment.

The method of forming a system of methods of corrective influences on the transformation process to ensure the sustainability of development is necessary due to the fact that changes in the external and internal environment generate risks of possible deviation from the planned development trajectory. Management of the system of methods of corrective effects has a certain specificity, which consists in the fact that it is necessary to clearly determine the state of the enterprise in accordance with sustainability criteria and compare the obtained data with forecast parameters, and in case of exceeding the permissible values, the deviation data serve as the object of influence of correction methods.



**Fig. 3.2** Interrelationship of enterprise development and restructuring management  
 Source: author's development

Having considered the methodological aspects of transformations carried out at enterprises within the framework of the strategy, it is necessary to characterize the methodology of managing organizational and economic transformations in the process of enterprise development.

### 3.3 FORMATION OF THE POLICY OF SUSTAINABLE DEVELOPMENT OF TRANSPORT ENTERPRISES IN THE SHORT TERM

Ensuring the sustainable development of transport enterprises in the short term is largely related to an effective system of managing economic resources, primarily working capital, while the system of organization and management of economic resources of enterprises of the transport complex is largely determined by the peculiarities of their functioning.

Transport appears as an independent branch of the economy, uniting enterprises of various orientations. At the same time, the sustainability of such enterprises is characterized by a set of indicators that reflect the processes of formation and effective use of available resources.

The conducted studies showed that the economic, technical, and technological features of transport enterprises are of the most importance for studying the economic sustainability of transport enterprises. The conducted survey of managers of transport enterprises showed that entrepreneurial activity is limited by economic factors that determine the economic sustainability of enterprises in the short term. In this regard, the sustainable functioning of enterprises under the conditions of a market economy requires the development of an appropriate policy of sustainable development, taking into account the full and effective use of available resources.

Assessing economic stability, counterparties and owners have the opportunity to substantiate management decisions in the field of current activity, to assess the level of efficiency in the process of formation and distribution of economic resources, that is, to develop an economic policy adequate to the existing conditions, taking into account what to determine the main parameters of the sustainable development of the enterprise.

The analysis of the methodological directions of the organization and management of economic resources shows that, in relation to transport enterprises, the economic policy includes:

- a) development of the concept of management of economic resources, which should ensure an optimal combination of the level of profitability and commercial risks;
- b) justification of the main directions of the use of economic resources in the current and strategic periods, taking into account changes in the macroeconomic and regional situation, with the aim of ensuring economic growth by achieving a stable state.

The formation of sustainable development policy in the short term includes the management of stocks, money and flows.

The main goal of stock management is to create such a quantity that, on the one hand, would be sufficient for the smooth operation of the enterprise, and on the other hand, would minimize the total costs of their maintenance. According to the definition of Ihor Blank, "inventory management policy is part of the company's current asset management policy, which consists in optimizing the overall size and structure of inventories of commodity and material values, minimizing the costs of their maintenance and ensuring effective control over their movement" [9].

Management of the process of formation and sale of stocks acts as the main subsystem of management of the operating cycle and determines the characteristics of the dynamics of the cycle, as well as the degree of its deviation from the steady state. At the same time, the main directions in the inventory management system to ensure sustainable development are:

- a) analysis of stocks for the current period;
- b) optimization of the warehouse stock of the level of inventories of goods and material values;
- c) determination of the optimal system for placing orders with suppliers;
- d) formation of the value of the insurance reserve, which ensures the necessary efficiency in the process of carrying out production and economic activities.

The need to manage monetary assets is determined by the following factors: monetary assets and flows serve almost all types of economic activity of the economic system; management of cash flows and assets creates an opportunity to ensure economic stability at the enterprise in the long term; rational formation of cash assets and flows allows to reduce the enterprise's need for loan capital; effective management of cash assets and flows ensures the acceleration of the turnover of the enterprise's capital, increases its liquidity and reduces the risk of insolvency.

The main goal of monetary asset management is to ensure the constant solvency of the enterprise, which is why in practice monetary asset management is quite often equated with solvency management (or liquidity management). Therefore, an important task of management in the process of managing monetary assets is to create conditions for the effective use of temporarily free funds, as well as their investment balance.

Effective money management largely depends on the organization of management and the abilities of managers who, in order to achieve sustainable development, use the following methods:

- 1) synchronization of cash flows, which ensures, on the basis of high accuracy of forecasts, the combination of cash receipts with cash payments, reducing the current account balance to a minimum;

- 2) the use of funds on the road, which is the difference between the balance of funds reflected in the company's current account and the balance according to bank documents;

- 3) acceleration of cash receipts, in its practice, the enterprise allows considering several methods that can be used to accelerate calculations;

- 4) control of payments, since effective results can be achieved under the condition of management, and both income and expenses.

To maintain economic sustainability, the enterprise needs to forecast the conditions for its preservation and determine the values of various forecasted parameters, while choosing one of three parameters (net working capital, need for working capital or funds). Accordingly, forecasting the values of other variables depends on the value of the selected parameter, and in the process of managing monetary assets and flows, the following methods of forecasting the economic sustainability of the enterprise are used:

- 1) extrapolation methods, which are based on the assumption of the existence of a direct relationship between net working capital (or short-term cyclical need for financing) and the volume of services provided;

- 2) the method of terms of turnover, the purpose of which is to determine the financial needs generated by the business cycle;

- 3) budgeting of funds, which is the development of a plan of cash receipts and payments of the enterprise for all types of its activities;

- 4) planning of income from economic activity based on the plan of monthly provided services.

One of the tasks of money management is the creation of opportunities for the formation of the necessary amount of cash income and the investment of their surplus for the purpose of obtaining profit, fulfilling payment obligations and insurance in case of unforeseen situations.

The optimization of the average balance of the company's monetary assets is ensured on the basis of the calculation of their required amount in the forecast period according to the following elements:

- a) optimization of the current balance is carried out based on the volume of future payments from all types of activities;
- b) the need for an insurance balance is determined based on the amount of their current balance and the coefficient of variation of the receipt of funds for certain periods of the previous year;
- c) the need for investment balance is predicted based on the financial capabilities of the enterprise after ensuring the need for other types of cash balances;
- d) the need for a compensatory balance is forecasted in the amount determined by the banking service agreement.

In this, the total volume of the average balance of funds in the forecast period is calculated by summing up all the calculated needs in individual types.

In the domestic practice and the practice of foreign countries, the mechanism for ensuring sustainability is based on the application of various models for determining the average balance of monetary assets, while the Baumol model, the Miller-Orr model, etc. are used to a greater extent. At the same time, these models of optimizing cash balances to ensure the sustainable development of transport enterprises are quite difficult to use in the domestic practice of management systems due to the lack of current assets, the underdevelopment of the market for short-term financial instruments and other factors that make it difficult for enterprises to form optimal cash balances.

The most important prerequisite for the optimization of cash flows is the study of the factors affecting their formation (**Table 3.1**).

◆ **Table 3.1** Factors determining the formation of cash flows of a transport enterprise

External factors	Internal factors
Change in the commodity market situation	Stage of the life cycle of the enterprise
Change in the financial market situation	Duration of the operating cycle
Taxation level of enterprises	Seasonality of production and sale of products
Practice consisting of lending to suppliers and buyers of products	Urgency of implementing investment programs
Payment forms used by enterprises	Applied depreciation policy of the enterprise
Availability of loan funds	Operating leverage ratio

Since most transport companies are faced with a shortage of funds, they should strive, on the one hand, to accelerate the attraction of monetary assets, and on the other hand, to slow down the payment of funds to acceptable volumes and terms (**Table 3.2**).

● **Table 3.2** Measures used by the enterprise in case of shortage of funds

<b>To accelerate the mobilization of funds</b>	<b>To slow down the turnover of money</b>
<ol style="list-style-type: none"> <li>1. Increasing the volume of price discounts in the case of using cash payment during the provision of services.</li> <li>2. Receiving partial and full prepayment for the services provided.</li> <li>3. Shortening the terms of providing commercial credit to buyers of services.</li> <li>4. Acceleration of collection of overdue receivables.</li> <li>5. Application of modern forms of refinancing receivables (factoring, forfeiting, accounting of promissory notes, etc.).</li> <li>6. Sale (leasing) of unused fixed assets</li> </ol>	<ol style="list-style-type: none"> <li>1. Extending the term of the commodity credit for purchased services.</li> <li>2. Restructuring of short-term credits and loans into long-term ones.</li> <li>3. Application of leasing operations for implementation of investment projects.</li> <li>4. Reduction of the amount of fixed costs of the enterprise</li> </ol>

In the presence of excess cash flow, it is advisable to use methods aimed at increasing its investment activity, including:

- a) acceleration of the implementation of real investment projects;
- b) long-term repayment of credits and loans;
- c) carrying out diversification of economic activity;
- d) formation of a portfolio of financial assets.

Based on the results of the mentioned directions, the following tasks can be determined, the solution of which is necessary for the implementation of the strategic directions of the development of transport enterprises:

- 1) maximization of the enterprise's profit for the development and expansion of the enterprise;
- 2) formation of a mechanism for effective management of economic resources to achieve strategic goals of the enterprise, adequate to modern market conditions, and search for ways to achieve them;
- 3) optimization of the used assets in order to achieve the required level of liquidity, solvency, creditworthiness and economic balance, which allow to reach the necessary rates of economic development;
- 4) optimization of the capital structure to reduce the level of entrepreneurial risks and minimize the cost of financial resources involved;
- 5) improvement of the price policy to increase the volume of services provided and ensure the financial strength of the transport enterprise;
- 6) application of modern innovative technologies to reduce costs, increase competitiveness and quality of provided services.

One of the most important conditions for the functioning of the mechanism of sustainable innovative development of the enterprise is the formation of the necessary volume of financial resources. In case of limited access to financial resources of developed countries, the main source is the company's own resources. This made it necessary to develop a methodology for the formation of funds for targeted financing, which, based on the characteristics of innovative transformations, are determined by the characteristics of internal investment and venture funds.

### 3.4 DISCUSSION OF THE RESULTS OF THE MANAGEMENT MECHANISM FOR THE SUSTAINABLE DEVELOPMENT OF TRANSPORT ENTERPRISES

Adequate response of management structures of economic entities to market challenges is carried out with the help of the implementation of a set of entrepreneurial strategies with embedded resources of an organizational and managerial nature. In this regard, methodological approaches and economic tools for the formation of a complex of entrepreneurial strategies of economic systems, which ensure their sustainable innovative development, have been developed.

The definition was formulated, the levels were identified, and the stages of formation and implementation of entrepreneurial strategies, which determine the sustainable innovative development of enterprises, were developed.

To ensure the long-term stability of the enterprise, it is necessary to increase its strategic potential, which is carried out as a result of reinvestment, restructuring, diversification. This strategy acts as a tool of the management system of the transport enterprise and is implemented on the basis of the development of various policies that determine the directions of innovative management of the economic entity [10]. At the same time, a scheme for managing the sustainable development of transport enterprises is proposed, which can be used to model the intra-company process of managing the sustainable development of enterprises.

The implementation of the strategy and, accordingly, various types of sustainable development policies form the basis of the use of the appropriate mechanism. In this regard, methodological approaches have been developed to determine the mechanism of sustainable innovative development, which is a set of subsystems and elements that regulate the process of managing the innovative activities of the enterprise.

The next stage of research should be the substantiation of indicators of sustainable development, to which the next chapter 4 will be devoted from the standpoint of preventive anti-crisis management.

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## 4

**PREVENTIVE ANTI-CRISIS MANAGEMENT OF ROAD ENTERPRISES  
IN CONDITIONS OF SUSTAINABLE DEVELOPMENT**

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Inna Shevchenko, Valentyna Nesterenko, Igor Britchenko

**ABSTRACT**

Chapter 3 of this monograph discussed sustainable development and its management mechanisms. In continuation of the development of the direction of sustainable development, this chapter will discuss the justification of its indicators. Clarifying the results of the research of existing approaches to considering the features of the modern world showed that as a key tool of anti-crisis management, it is still advisable to use continuous CVP analysis. Therefore, the basis for the formation of indicators of preventive anti-crisis management of enterprises of Ukraine in conditions of sustainable development in the VUCA-, DEST-, BANI-, RUPT-, TUNA-world are the indicators calculated during the implementation of operational analysis. The work improved the methodical approach to the development of a system of indicators of preventive anti-crisis management of the enterprise based on the implementation of a set of actions, which ensures a justified choice of indicators of effective management of the enterprise due to the comprehensive consideration of the results of the study of the quantitative and qualitative composition of the CVP analysis indicators; the specifics of the industry in which the enterprise operates and the distribution of responsibility for each selected indicator. Approbation of the methodical approach for road enterprises of Ukraine allowed, firstly, to improve the list of indicators of operational analysis, which allows not only to fulfill all the main tasks of CVP analysis, but also new ones that arise in the conditions of sustainable development of society, and secondly, to substantiate the list of indicators preventive anti-crisis management of modern road enterprises, which corresponds to the principles and essence of controlling. The presented research results can be useful to specialists who are interested in effective enterprise management in the conditions of sustainable development in the VUCA-, DEST-, BANI-, RUPT-, TUNA-world.

**KEYWORDS**

VUCA-, DEST-, BANI-, RUPT-, TUNA-world, sustainable development, unstable world, indicators of preventive anti-crisis management, controlled indicators, CVP analysis.

#### **4.1 FEATURES OF ANTI-CRISIS MANAGEMENT OF ROAD ENTERPRISES IN CONDITIONS OF SUSTAINABLE DEVELOPMENT IN THE VUCA WORLD**

Modern enterprises operate in a rapidly changing world, largely due to the technological changes brought about by the "digital age". These changes create opportunities, but also cause

uncertainties, complexities, risks, etc. In such conditions, enterprises must be able to predict the future by developing scenarios of events that may occur and options for effective work in future situations [1] while simultaneously ensuring the preventive nature of their anti-crisis management. Thus, the implementation of preventive anti-crisis management is extremely urgent. In turn, for Ukrainian enterprises, as was revealed in previous studies, it becomes urgent to solve the task of independent organization of effective work in the conditions of sustainable development in the VUCA-world (including the pandemic) without any hope for significant support from the state [2].

Since February 24, 2022, Ukraine has experienced a treacherous and unpredictable military invasion by Russia. In work [3] it is noted that according to the data of the Kyiv School of Economics (Project for the collection, assessment and analysis of information on the material losses of Ukraine from the war with Russia, 2022), as of the beginning of July 2022, the losses of the Ukrainian economy from damage to the physical infrastructure since the beginning of hostilities amounted to about 600 billion USD, including 103.9 billion USD in case of complete destruction of objects. At the same time, the consequences of the attack on Ukraine for the world GDP in 2022 will amount to at least  $-1\%$  growth, or 1 trillion USD [3].

All components of the multi-component mechanism of the road and transport complex of Ukraine suffered losses. In particular, since the beginning of the full-scale war in Ukraine, 305 artificial structures have been destroyed, and 24,000 km of highways need to be cleared, repaired or completely rebuilt. It will take approximately 3–4 years to restore the destroyed infrastructure, while basic things are planned to be restored in 1–1.5 years. The authors share the opinion [4] that while active hostilities are underway, it is very difficult to determine the speed of restoration of damaged highways. As highways and man-made structures continue to collapse, there is a need for demining. Therefore, it takes time for road infrastructure to become a priority. In turn, there is a possibility of active international financial and technical assistance in restoring the destroyed infrastructure [4]. Therefore, the possibility of obtaining financial assistance for road enterprises exists, but this not only does not cancel the need for independent organization of effective work in conditions of sustainable development in the VUCA-world, but above all requires it.

Today, it is expedient for road enterprises to manage the process of road works, which, taking into account their specific features, will: firstly, predict the future state of events through scenario planning of events and actions that ensure effective development of the enterprise, including preventive crisis management; secondly, to meet modern economic conditions; thirdly, to promote sustainable development; fourth, to ensure transparent, timely and high-quality execution of road works with minimal possible risks and costs.

The use during planning, organization, motivation and control of the enterprise's work of performance indicators of its activity, which will allow the implementation of formulated requirements, will provide road enterprises with the implementation of effective preventive anti-crisis management at the operational level of management.

## 4.2 INDICATORS OF CVP-ANALYSIS AS A BASIS FOR THE FORMATION OF INDICATORS OF PREVENTIVE ANTI-CRISIS MANAGEMENT OF ROAD ENTERPRISES OF UKRAINE IN CONDITIONS OF SUSTAINABLE DEVELOPMENT IN AN UNSTABLE WORLD

In previous studies, the modern business environment was characterized by two main features: the sustainable development of all countries of the world through the fulfillment of the seventeen Sustainable Development Goals (SDGs) and the VUCA-world. The expediency of using CVP analysis on a continuous basis as a key tool of anti-crisis management of a modern enterprise was also substantiated. For its implementation, the theoretical and methodological foundations of CVP analysis were deepened and improved by ensuring their compliance with the principles of sustainable development of the enterprise, organization and the possibility of implementing VUCA-solutions acting on anticipation [2]. In this context, continuous CVP analysis (cost-volume-profit relationship analysis, operational analysis, break-even analysis, margin analysis, cost-output-profit analysis) is considered as a tool for managing the process of achieving operational goals of the enterprise through continuous systematic improvement of the enterprise's work on the basis of systematic tracking and study of the dependence between changes in the volume of activity, total revenues from the sale of products, costs and profit. Continuous provides a weekly CVP analysis based on planned and actual indicators, which will significantly facilitate the process of managing the enterprise in conditions of sustainable development in the VUCA-world. Thus, it is the indicators of CVP analysis should be considered as a basis for the formation of indicators of preventive anti-crisis management of road enterprises of Ukraine in the conditions of sustainable development in the VUCA-world, therefore it is necessary to determine the quantitative and qualitative composition of their list.

It should be noted that there are other views on the list of features of the environment in which enterprises operate. Today, five approaches to considering the characteristics of the modern business environment can be distinguished [2, 5–10]:

- Volatility, Uncertainty, Complexity and Ambiguity – **VUCA-world** [2, 5, 6]. The essence of each characteristic is given in [2];
- Disorder (disorder – a world full of unexpected changes), Egocentrism (egocentrism – focused on personal interests and goals), Suppression (suppression – refusal to divulge or publish) and Turbulence (turbulence – manifested by conflict, confusion over which there is no control, on in contrast to the VUCA-world, where the focus is on controlling goals) – **DEST-world** [7];
- Brittle (brittle – illusory strength, it has become even more difficult to find support, everything that seemed strong yesterday can crumble today), Anxious (anxious – every choice seems potentially catastrophic, anxiety permeates life, many teams are immersed in hustle and bustle, increasingly employees complain about burnout), Nonlinear (nonlinear – many logical connections do not work; it is possible to make minimal efforts and get a breakthrough, or it is possible to work for a long time and get practically zero results; those who have built a culture of experimentation in their company win more and more often; everything is more difficult those who are used to living by plans) and Incomprehensible (incomprehensible – an incomprehensible and sometimes senseless world, lack of meaning

in the answers found) – **BANI-world** [5, 8]. The concept of "BANI" was developed by J. Cascio (Jamaica Cascio) in 2018 to work with a chaotic future, as a way to better understand and respond to rapid global disruptions and the current state of the world [8]. BANI-model is now increasingly used throughout the world. Successful work according to this model involves the use of scenario planning;

– Rapid (fast, rapid – a world full of rapid unexpected changes), Unpredictable (unpredictable – events are almost or impossible to predict, their sudden nature), Paradoxical (paradoxical – unexpected, strange, contrary to common ideas, not in accordance with natural expectations) and Tangled (tangled – manifests itself through confusion, over which there is usually no control or the exercise of control is difficult) – **RUPT-world**. The concept of "RUPT" is used by the Center for Creative Leadership in the USA as a publicized "VUCA" model, which was created for use by the American military [5];

– Turbulent (turbulent – messy world, i.e. full of unexpected changes), Uncertain (uncertain – lack of information to predict consequences and plan necessary actions), Novel (new, unusual, newly introduced – events that have not happened before, unusual events, events, created as a result of the intellectual activity of people) and Ambiguous (ambiguous – the ambiguity of the interpretation of certain events – in those cases when they can be interpreted in two ways) – **TUNA-world**. This concept is used by Oxford University's Executive Education program instead of the generally accepted VUCA. This program is award-winning. For successful functioning in the TUNA world, it is suggested [9, 10] to use the Oxford Scenario Planning Approach (OSPA), which was developed by three authors, including Rafael Ramirez [5, 10, 11]. In their work, Rafael Ramirez and Angela Wilkinson [10] note that the main emphasis in OSPA is on supporting the cycle of predictable understanding, which allows clarifying strategic choices and determining the best options for functioning [10].

Today, the majority consider the concept of VUCA as generally accepted, and at the World Economic Forum in Davos in the report dated 18.01.2023 "How 7 directors of digital technologies navigate in an unstable world", the VUCA approach is used [6]. But in a fast-paced world that is constantly changing predictably and increasingly unpredictably, this is not a constant either. On the website "VUCA-WORLD" [5], when comparing VUCA-, BANI-, RUPT- and TUNA-approaches, it is noted that "we enjoy a growing community that is sailing with us on the waves of VUCA and sailing with the wind of VUCA, BANI, RUPT and TUNA". It is appropriate to consider these approaches as an additional perspective on the consideration of the features of the world, which is moving forward and does not mean "exceptions to the rules" [5]. In the work, the researcher agrees that [5] "in any case, the problem is the same: the external environment changes quickly and unpredictably, putting companies and their stakeholders in front of what worked yesterday, will not work tomorrow and the day after tomorrow. That's why it is necessary to answer and a willingness to think anew!". A comparative analysis of existing approaches to considering the characteristics of the modern environment showed that, firstly, common to all approaches is that it is unstable, unpredictable, fast (**Fig. 4.1**), and secondly, the appropriateness of using scenario planning methods in approaches that arose in the last decade. In such conditions, it is necessary to use management tools that will ensure transparency, predictability of activity and efficiency of use of available resources, which is exactly what continuous CVP analysis of planned and actual current activities of the enterprise is.

The name of the characteristics of the world according to different approaches				
VUCA-world	DEST-world	BANI-world	RUPT-world	TUNA-world
Volatility	Disorder	Brittle	Rapid	Turbulent
Uncertainty	Egocentrism	Anxious	Unpredictable	Uncertain
Complexity	Suppression	Nonlinear	Paradoxical	Novel
Ambiguity	Turbulence	Incomprehensible	Tangled	Ambiguous
		Characteristics that can be considered as a group of synonyms for a noun. Color defines groups of synonyms		

**Fig. 4.1** Characteristics of the world according to different approaches\*

*\*Own view, created as a result of a comparative analysis of the approaches described in works [5–10]*

Thus, clarifying the features of the modern business environment confirmed the expediency of using the latter as a key tool of anti-crisis management of the road enterprise in conditions of sustainable development in an unstable world. Therefore, it is the indicators CVP analysis should be considered as a basis for the formation of indicators of preventive anti-crisis management by modern road enterprises of Ukraine.

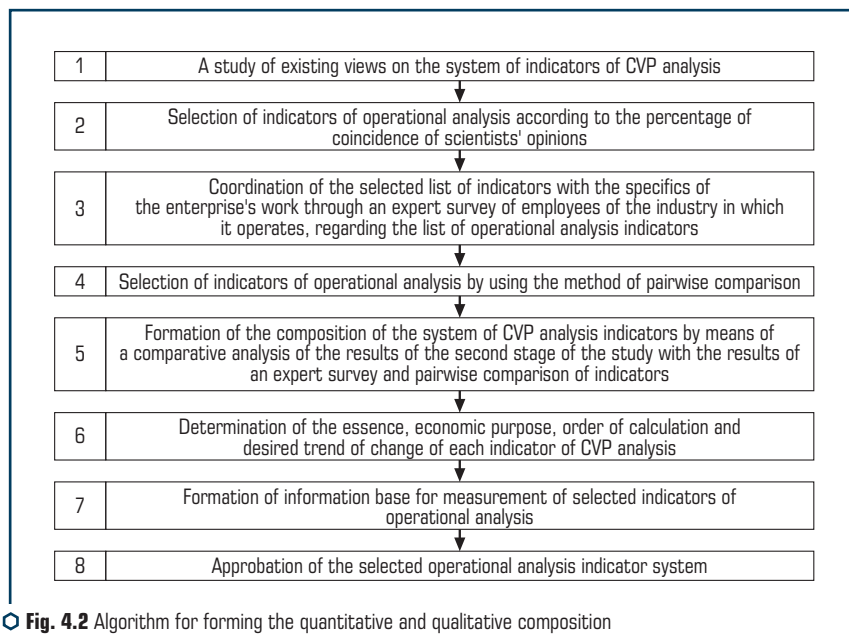
The relevance of the use of operational analysis is also evidenced by the large number of publications published over the past three years and appearing now. These publications deal with certain aspects of the methodological foundations of practical application CVP analysis. Some scientists offer a refined CVP MODEL – an analysis that takes into account the features of the modern unstable world [11, 12], a change in the cost structure [13], multi-product production [14] and others. Many scientists use operational analysis to study the activities of certain enterprises with the help of operational analysis, using a certain list of its indicators of different quantitative and qualitative composition, for example, work [14, 15].

Therefore, in the future, in order to form indicators of preventive anti-crisis management of road enterprises, it is first necessary to make a justified choice of the list of CVP INDICATORS – analysis by quantitative and qualitative composition. At the same time, the indicators should ensure the organization of the work of the road enterprise in accordance with the principles of sustainable development of the enterprise [2] and provide the opportunity to implement actions aimed at getting ahead.

### 4.3 JUSTIFICATION OF THE LIST OF INDICATORS OF OPERATIONAL ANALYSIS OF ROAD ENTERPRISES

In the paper [16], a justified selection of profit management indicators of road enterprises was carried out according to the developed research algorithm with a description of all methodical

approaches to the implementation of each stage. As indicators of profit management, the authors considered indicators of CVP analysis. The methodical approach allows for the formation of a system of indicators for the operational analysis of an enterprise in a certain industry by taking into account its specific features, as well as the opinions of leading specialists in this industry and scientists in the field of enterprise profit management. Later, the selected list of indicators was refined according to the requirements of the time [17]. According to practical experience, the approach was refined in order to take into account the specifics of the work and the requirements of the enterprise where CVP analysis will be carried out. Another stage was added – the selection of indicators using the pairwise comparison method. A pairwise comparison is proposed to be carried out by the deputy in charge of economics, or the financial director or the chief economist. Thus, the improved algorithm for selecting CVP analysis indicators is presented in **Fig. 4.2**.



**Fig. 4.2** Algorithm for forming the quantitative and qualitative composition of CVP analysis indicators of the enterprise's activity

*Source: author's development*

At the fourth stage, operational analysis indicators are selected by using the pairwise comparison method. This stage is not mandatory and is carried out if necessary for a specific enterprise. To form an information base for measuring selected indicators, the company's accounting data are used, which are processed using the method of statistical analysis of accounting

accounts [2]. The implementation of other stages is described in works [16, 17]. Thus, the proposed methodological approach (**Fig. 4.2**) makes it possible to substantiate the composition of CVP analysis indicators taking into account the peculiarities of the functioning of a certain industry and the coordination of the opinions of leading specialists both in the field of profit management and in a certain industry at the level of the entire industry and one enterprise at which will be analyzed.

In modern economic literature, there are many views on the composition of the system of CVP analysis indicators of the enterprise, therefore, there is no unified opinion on the qualitative and quantitative composition of the system of indicators of the operational analysis of the enterprise [16, 17].

As a result of the research, it was found that some indicators are considered by scientists under different names, although their essence is the same, for example, marginal income, marginal profit, coverage amount and gross result; break-even point, break-even point, critical point and equilibrium volume of operating activity and others. All such indicators during the study were considered identical [16, 17]. In work [17], a comparative analysis of 18 approaches to considering the quantitative and qualitative composition of CVP analysis indicators was carried out – the results of the analysis are shown in Table 4. The quantitative composition of the system of indicators varies from three to ten, on average the number is seven indicators. In the paper, these research results are somewhat updated by the developments of other scientists over the past three years (**Table 4.1**).

A comparative analysis of approaches regarding the composition of CVP analysis indicators of the enterprise's activity (**Table 4.1**) showed that there is no unity of opinion regarding the quantitative and qualitative composition of the CVP analysis indicators of the enterprise's activity.

The quantitative composition of the system of indicators varies from three to eleven, on average, the authors allocate seven indicators. After clarifying the comparative analysis of the existing approaches (**Table 4.2**), the percentages of agreement of scientists' opinions on some indicators changed slightly – the percentage of use of the break-even point decreased (from 100 % to 90.5 %), the coefficient of marginal income, the margin of financial strength, in turn, the applicability increased such indicators as: break-even sales by almost 5 %, operating leverage by 4 % and marginal income by 3 %.

At the same time, the qualitative composition of indicators that have a percentage of coincidence of more than 50 % has not changed. These are the following indicators: break-even point, marginal revenue, marginal revenue ratio, margin of financial strength, operating leverage, break-even, and specific marginal revenue (coverage rate). But, since currently in the conditions of a modern socially oriented economy, focusing on consumer needs is relevant, it will be appropriate to add to the selected set of CVP analysis indicators: the consumer satisfaction index and the consumer engagement index [17], and the consumer constancy index. The proposed composition needs a more detailed justification according to the proposed algorithm (**Fig. 4.2**).

#### 4 PREVENTIVE ANTI-CRISIS MANAGEMENT OF ROAD ENTERPRISES IN CONDITIONS OF SUSTAINABLE DEVELOPMENT

● **Table 4.1** Comparative analysis of approaches to the quantitative and qualitative composition of the CVP analysis indicators of the enterprise's activity

Indicator	Percentage of coincidence [17]	Literary source number			Total match percentage
		[14]	[15]	[18]	
Breakeven point	100.00			+	90.48
Marginal income	77.78	+	+	+	80.95
The coefficient of marginal income	72.22	+		+	71.43
Stock of financial strength	72.22	+		+	71.43
Operating lever	72.22	+	+	+	76.19
Profitability of implementation	66.67	+	+	+	71.43
Specific marginal revenue	66.67		+	+	66.67
The volume of product sales to obtain the target profit	44.44			+	42.86
Security zone	44.44			+	42.86
Power reserve coefficient	38.89	+	+	+	47.62
Power of operating leverage	38.89				33.33
The point of closing the enterprise	16.67				14.29
Financial leverage	11.11			+	14.29
Break -even price	11.11				9.52
Price coefficient	5.56				4.76
Net operating profit	5.56				4.76
Target volume of implementation	5.56				4.76
Assortment policy of the enterprise	5.56				4.76
Customer satisfaction index	5.56				4.76
Customer Engagement Index	5.56				4.76
Total number of indicators	–	6	5	11	–

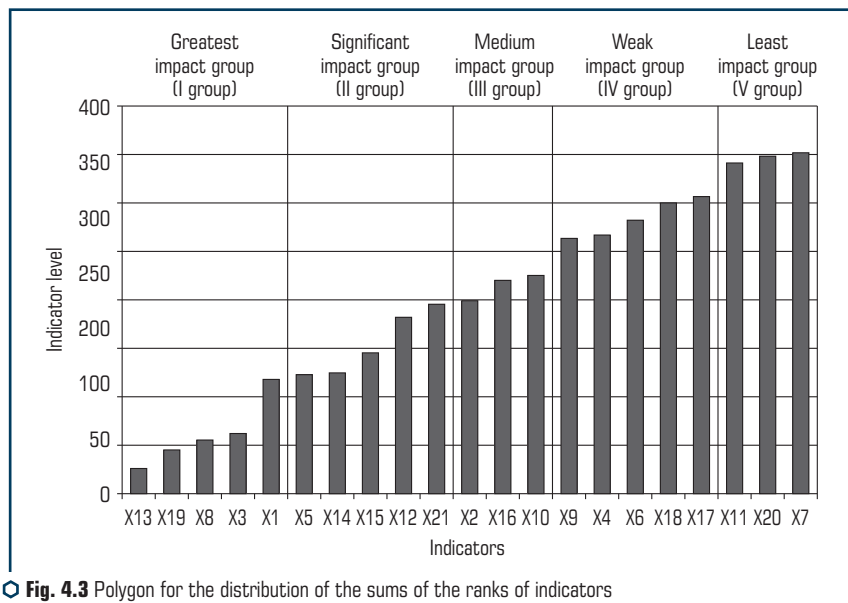
"+" – this indicator is considered as a component of the list of CVP analysis indicators

● **Table 4.2** Assessment of the probability of the results of the expert survey

Number of interviewed specialists, m	Number of factors, n	The sum of squared deviations, S	Concordance coefficient, W	Pearson's test, $\chi$	
				calculated	tabular
18	21	216172	0.87	362.6	156



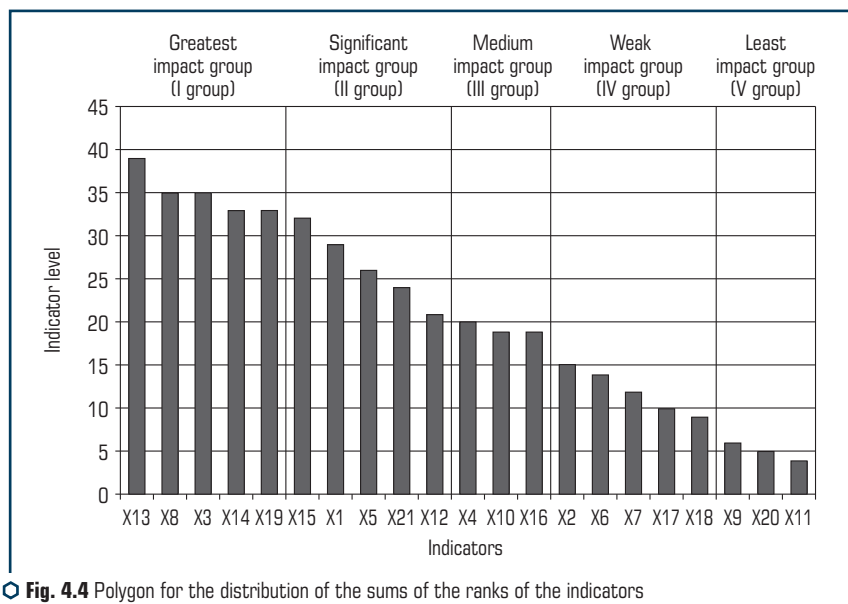
The enterprise always operates in a certain industry, which has its own characteristics, which must be taken into account when making management decisions, and therefore also when justifying the list of operational analysis indicators. The specifics of the industry are best known by specialists who work in it. The study is devoted to enterprises of the road industry. The latter is a component of the coordinated road and transport complex, which is the basis of the development of the country as a whole. A group of 18 experts was created according to two methodical approaches to selecting the number of experts [16, 17]. The expert competence coefficient was 0.82. Each specialist was given a developed questionnaire, in which it was suggested to rank the indicators according to their strength in relation to the results of the work of road organizations. The list of investigated indicators included: X1 – specific marginal income; X2 – safety zone; X3 – break-even implementation; X4 – point of closing the enterprise; X5 – consumer satisfaction index; X6 – coefficient of operating leverage; X7 – effectiveness of financial leverage; X8 – marginal income; X9 – break-even point; X10 – power of the operating lever; X11 – financial leverage; X12 – operating lever; X13 – consumer engagement index; X14 – reserve of financial strength; X15 – safety factor; X16 – margin of safety; X17 – target volume of production; X18 – break-even price; X19 – coefficient of marginal income; X20 – price coefficient; X21 – index of consumer constancy. It was proposed to give rank 1 to the most important indicator, 21 to the least important. Based on the results of the questionnaire, a polygon was built for the distribution of the sums of the ranks of the CVP analysis indicators (**Fig. 4.3**).



**Fig. 4.3** Polygon for the distribution of the sums of the ranks of indicators of the operational analysis of the activities of road enterprises  
Source: author's development

The assessment of the reliability of the obtained results according to the concordance coefficient and Pearson's criterion shows that the experts' opinions are in agreement by 87 %, and according to the Pearson's criterion it is not random (**Table 4.2**).

In the work, a pairwise comparison of the questionnaire indicators was carried out by the chief economist of the road organization of the Kharkiv region of Ukraine, where it was planned to use the selected indicators. On the basis of the obtained results, a histogram and a polygon of the distribution of the sums of the ranks of the CVP analysis indicators of the activity at this enterprise were constructed (**Fig. 4.4**).



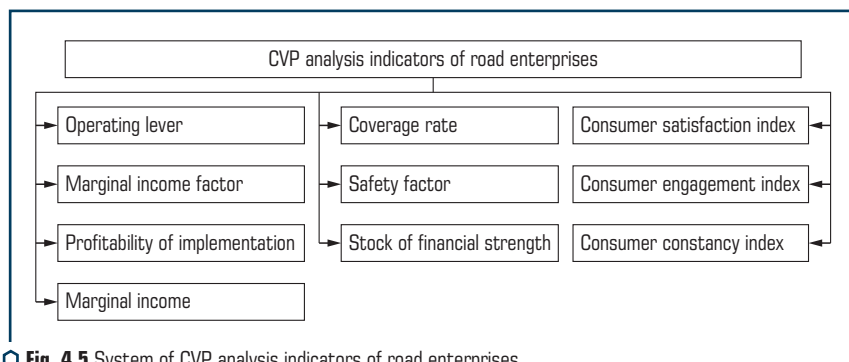
**Fig. 4.4** Polygon for the distribution of the sums of the ranks of the indicators of the operational analysis of the road organization

Source: author's development

Thus, according to polygons for the distribution of the sums of the ranks of the indicators of the operational analysis of the company's activity based on a pairwise comparison and an expert survey (**Fig. 4.3, 4.4**), it is advisable to include ten indicators that form groups of the greatest influence and significant influence (**Fig. 4.5**).

An expert survey and a pairwise comparison of indicators made it possible to clarify their list, the number of indicators remained unchanged, their qualitative composition changed somewhat. Due to the fact that road enterprises perform several types of work at the same time, the use of the break-even point, measured in natural units, as an indicator is quite complicated, and experts consider it sufficient to calculate only the break-even point of implementation. The riskiness of

the decisions made, which in the conditions of an unstable world is important. In the future, to enable management decisions to be made on the basis of the chosen system of indicators, the essence, calculation procedure and desired trend of change of each indicator were determined. The results are presented in **Table 4.3**.



**Fig. 4.5** System of CVP analysis indicators of road enterprises  
Source: author's development

**Table 4.3** Indicators of CVP analysis of road enterprises

Indicator	Designations	Measurement unit	Calculation formula <sup>a</sup>	The essence of the indicator	Desired change
1	2	3	4	5	6
Marginal income factor	$K_{sh}$	shares per unit, %	$1 - \frac{V_{CUA}}{P}$	Shows the increase in profit in relative terms when the income increases by 1 UAH	growth
Profitability of implementation	PI	money unit	$\frac{C_{CONST}}{C_R}$	Income equal to total expenses	fall
Marginal income	MI	money unit	$I - V_C$	Part of the income that remains for covering fixed costs and generating profit	growth
Coverage rate	$C_r$	money unit/national unit	$P - V_{CUA}$	It characterizes the increase in profit from the performance of every 1 m <sup>2</sup> of work	growth
Stock of financial strength	Sfs	money unit	$I - I_{TB}$	Shows how close the actual income is to the critical one	growth
Safety factor	MTB	shares per unit, %	$1 - \frac{I_{TB}}{I}$	It is a measure of the risk of unprofitable work, the larger its value, the less likely that the company will suffer losses in the event of a decrease in volume	growth

#### 4 PREVENTIVE ANTI-CRISIS MANAGEMENT OF ROAD ENTERPRISES IN CONDITIONS OF SUSTAINABLE DEVELOPMENT

● **Continuation of Table 4.3**

1	2	3	4	5	6
Operating lever	COL	shares per unit, %	$\frac{I_{CONST}}{I_{TOT}}$	It characterizes the degree of use of fixed costs: the greater this indicator, the greater the impact on profit provided by a change in sales volume	optimal ratio
Consumer satisfaction index	CSI	shares per unit, %	$\frac{C_P}{C} \cdot 100 \%$	Assessment of the level of consumer satisfaction after interaction with the enterprise	growth
Consumer engagement index	CEI	shares per unit, %	$\frac{C_N}{C} \cdot 100 \%$	Shows how many new customers the company managed to attract during a certain period	growth
Consumer constancy index	CCI	shares per unit, %	$\frac{C_{POST}}{C} \cdot 100 \%$	Shows how many regular customers the company managed to retain over a certain period	growth

*\*Conventional designations:  $I$  – income from the sale of products without VAT, money unit;  $V_c$  – variable costs, money unit;  $V_{cub}$  – variable costs per unit of activity, money unit;  $C_{const}$  – constant costs, money unit;  $P$  – price of a unit of activity, money unit;  $C$  – total number of clients (customers);  $C_p$  – the number of positive reviews from customers who purchased the product, units;  $C_n$  – the number of new customers, units;  $C_{post}$  – the number of consumers who made more than five orders, units*

To form the information base for measuring the selected indicators, the accounting data of the road organization were used, which were processed using the method of statistical analysis of accounting accounts [2]. On the basis of the received data, a CVP analysis of the activity of the road organization of Ukraine was carried out five years before the start of hostilities in the country (Table 4.4).

● **Table 4.4** Calculation of CVP indicators – analysis of the activity of the road organization of Ukraine

Indicator	Value by year by year				
	2017	2018	2019	2020	2021
Marginal income factor, share unit	0.300	0.300	0.300	0.300	0.260
Profitability of implementation, thousand UAH	3968.03	7717.77	8974.53	13976.50	17839.44
Marginal income, thousand UAH	1154.01	2332.83	2797.56	4003.35	5452.95
Coverage rate, UAH	22.75	34.03	13.80	21.11	26.19
Stock of financial strength, thousand UAH	–121.33	58.33	350.67	–632.00	3133.46
Safety factor, fraction of units	–0.03	0.01	0.04	–0.05	0.15
Operating leverage, shares per unit	0.31	0.30	0.29	0.31	0.23
Consumer satisfaction index, %	73.33	72.00	90.91	84.00	100.00
Consumer engagement index, %	31.82	27.78	25.00	23.81	27.27
Consumer constancy index, %	23.33	28.00	31.82	28.00	31.82

It was revealed that a negative trend is observed for all indicators of profit management, i.e. the results of operations have become worse, the reason for which was the unstable state of the volume of work performed (dynamics of the margin of safety ratio) and the growth of the company's costs (the value of the operating leverage). Based on the analysis, recommendations are offered to improve the efficiency of work.

In this way, the methodical approach to forming a list of indicators of CVP analysis of the company's activity was further developed. The approach includes the sequence of actions necessary for the formation of the list and proposed methodical approaches to their implementation. It allows the formation of indicators of the operational analysis of an enterprise of a certain industry by taking into account its specifics, as well as the opinions of leading experts in this industry and the latest scientific and practical developments in the field of enterprise profit management, taking into account, if necessary, the specific features of the functioning of an individual enterprise. The proposed methodical approach is universal and can be used to form a reasonable list of CVP analysis indicators of the road enterprise (**Fig. 4.5, Table 4.3**). It allows not only to carry out all the main tasks of operational analysis, but also new ones arising in the conditions of sustainable development in an unstable world. Using this list during management will enable the road company to work ahead of schedule, creating scenarios for future ongoing activities. The determined composition takes into account the peculiarities of the functioning of the road industry and does not contradict the opinions of leading specialists both in the field of profit management and in road management at the level of the industry and individual enterprises. In the road organization, it is advisable to carry out CVP analysis by types of activities, by orders (projects) and by the organization as a whole.

#### 4.4 JUSTIFICATION OF THE LIST OF INDICATORS OF PREVENTIVE ANTI-CRISIS MANAGEMENT OF A MODERN ROAD ENTERPRISE

Preventive anti-crisis management involves management that allows to prevent a crisis situation by ensuring break-even activity in the future with continuous control and coordination of current activities to achieve break-even activity, which consists in maintaining the established value of the reserve of financial strength. It is possible to realize this thanks to the implementation of activities according to the principles of controlling with the use of operational controlling tools, namely the formation of a list of controllable indicators of effective management of the enterprise during the organization of budgeting as a management technology. The term "monitorable indicators" provides for the definition of officials who monitor their implementation. The main levels of formation of the list of controlled indicators should be structural units of the enterprise, whose managers are able to influence them [19]. By preventive anti-crisis management indicators (PAMI) it is proposed to understand controlled indicators of effective management of the enterprise, which is the starting point for calculating the selected CVP analysis indicators of the enterprise's activity (**Table 4.4**) and are functionally independent of each other (4.1):

$$PAMI = \{V_{cua}, C_{const}, P, LC, E, C, C_p, C_n, C_{post}\}, \quad (4.1)$$

where  $V_{cua}$  – variable costs per unit of activity, money unit;  $C_{const}$  – constant costs, money unit;  $P$  – price of a unit of activity, money unit;  $LC$  – logistics costs, money unit;  $x$  – volume of activity, nature unit;  $C$  – total number of clients (customers), units;  $C_p$  – the number of positive reviews from customers who purchased the product, units;  $C_n$  – the number of new customers, units;  $C_{post}$  – the number of consumers who made more than five orders, units.

These nine indicators correspond to the general principles of forming a system of controlled indicators [19]. It is proposed to distribute responsibility with the help of the developed Mark Razu, professor, Doctor of Economics, distribution matrix of administrative tasks (DMAT), used in project management. The DMAT matrix is a table in which the names of positions, divisions and services are located, as well as the tasks performed by these divisions, services, etc. are listed [20]. In a specific case, the PAMI tasks. The conditional sign indicates the relationship of each service unit or a specific employee to the performance of the planned indicator. When using responsibility matrices, it is necessary to be guided by the expediency of using certain symbols. The complexity of the responsibility matrix should correspond to the complexity of the tasks to be solved. The DMAT matrix uses symbols that reflect the three principle objects of each job performance [19]: making decisions about work; work management; performance of work and its technical and informational maintenance. The rules for filling the DMAT matrix with symbols are described in detail in the works of the developer Mark Razu, professor, Doctor of Economics.

Thus, in order to substantiate the list of indicators of preventive anti-crisis management of a modern road enterprise, it is advisable to add two more stages to the developed algorithm for the formation of quantitative and qualitative CVP analysis indicators of the enterprise's activity (**Fig. 4.2**):

- formation of the list of indicators that is the starting point for calculating the selected CVP analysis indicators of the company's activity and are functionally independent of each other;
- formation of a list of the controlled PPAU of the enterprise based on the construction of a matrix for the distribution of administrative management tasks.

Approbation of the added stages was carried out for road industry enterprises. A fragment of the DMAT symbolic matrix of controlled indicators of the road organization of Ukraine is presented in **Table 4.5**.

◆ **Table 4.5** Fragment of the DMAT symbolic matrix of controlled indicators of the road organization in Ukraine

No.	PAMI name	Officials and structural divisions			
		Director	Chief Accountant	...	Economist
1	Logistics costs	!K	PT	...	T
2	Scope of activity	JAPOHAKT	RPOHAT		T
	...	...	...	...	...
9	Number of new customers	JAPOHAKT	T	...	T

In addition to the developed apparatus for depicting various types of participation in the performance of work, the DMAT matrix has another advantage: the possibility of transitioning from the symbolic designation of responsibility to numerical and using the obtained indicators in the analysis and design of organizational solutions. This transition is carried out through a table of pairwise comparison of types of responsibility marked with symbols [19]. A fragment of such a table is presented in **Table 4.6**.

● **Table 4.6** Pairwise comparison table

Symbols	!	R	JA	P	O	H	A	K	T	Σ	V, %
!	1	2	1	1	1	1	2	1	0	10	12.3
...	...	...	...	...	...	...	...	...	...	...	...
T	2	2	1	1	1	2	2	2	1	14	17.3
Σ	8	15	7	6	5	13	11	12	4	81	100.0

According to the rules and principles of building the DMAT matrix, there were indicators that were selected as controlled, and they were assigned to the structural units of the enterprise using the DMAT matrix. After that, an assessment of the performance of the planned controlled indicators was carried out, a fragment of the results is provided in **Table 4.7**.

● **Table 4.7** Table of pairwise comparison of labor intensity of controlled indicators

No.	PAMI name	1	2	3	4	5	6	7	8	9	Σ	W, %
1	Logistics costs	1	0	0	1	1	0	0	0	1	4	4.9
2	Scope of activity	2	1	1	2	2	0	0	1	2	11	13.6
...	...	...	...	...	...	...	...	...	...	...	...	...
9	Number of new customers	1	0	1	1	2	0	0	0	1	6	7.4
Σ		14	7	8	12	15	2	4	7	12	81	100.0

As a result, it was found that the most labor-intensive indicators are variable costs per unit of activity, the total number of customers, the price of a unit of the volume of activity, the volume of activity. Next, the character matrix is converted into a numerical one. This can be done using Microsoft Excel. For convenience, the calculated final values can be presented as a percentage, i.e., divide the labor intensity of work execution and loading of structural units by the total number of points and multiply by 100. A fragment of the obtained results is shown in **Table 4.8**.

As a result of compiling the DMAT matrix, it was found that the most labor-intensive indicators are variable costs per unit of activity (23.3 %) and volume of activity (16.9 %). The least labor-intensive are logistics costs (2.8 %). The obtained data can be used to determine the internal cost of activity of structural units. Including, it is possible to translate the obtained values into

monetary indicators. The matrix of the distribution of administrative tasks of management is not only a matrix of responsibility, which allows to visually depict the system of responsibility of structural units and executors for the performance of work on the project, but is also a full-fledged tool for organizational analysis and design.

● **Table 4.8** Fragment of the numerical matrix of DMAT controlled indicators of the road organization in Ukraine

No.	PAMI name	Director	Chief Engineer	...	Economist	<i>C</i>	<i>S</i> , %
1	Logistics costs	97.5	103.6	...	85.4	542.6	2.8
2	Scope of activity	1140.1	905.3	...	234.7	3219.0	16.9
...	...	...	...	...	...	...	...
9	Number of new customers	621.9	128.0		128.0	1518.1	8.0
<i>S</i>		3478.1	5974.7	...	1493.7	19076.4	100.0
<i>S</i> , %		18.2 %	31.3 %	...	7.8 %	100.0 %	19076.4

*Conventional designations: C – estimated labor intensity of the performed work; S – assessment of the labor intensity of all operations performed by a specific position, structural unit*

Thus, the methodical approach to the development of the PAMI list by the enterprise on the basis of the use of the proposed set of actions for the formation of the composition of the system of controlled indicators of effective management of the enterprise, which provides a reasoned choice by conducting a study of existing approaches to the composition of performance indicators, taking into account the specifics of the industry in which it operates, received further development enterprise and the use of the DMAT matrix for the distribution of responsibilities, which is a full-fledged tool for organizational analysis and planning.

#### **4.5 DISCUSSION OF THE RESULTS OF THE METHODOLOGY OF PREVENTIVE ANTI-CRISIS MANAGEMENT OF ROAD ENTERPRISES**

As a result of the conducted research, the following results were obtained:

- expediency of using indicators of operational analysis is justified as a basis for forming indicators of preventive anti-crisis management of road enterprises of Ukraine in conditions of sustainable development in the VUCA-, DEST-, BANI-, RUPT-, TUNA-world. Continuous CVP analysis of planned and actual current activities of the enterprise will ensure transparency, predictability of activities and efficiency of use of available resources;
- the methodical approach to forming a list of CVP analysis indicators of the road enterprise's activity was further developed by coordinating the opinions of leading specialists both in the field of profit management and in the industry in which the enterprise operates, as well as taking into account, if necessary, the specifics of the latter's work. The proposed methodical approach is



universal and can be used to form a justified list of CVP analysis indicators of the enterprise's activity in any branch of economy;

– the qualitative composition of the CVP analysis indicators of the road enterprise has been improved, it is formed by ten indicators that allow not only to carry out all the main tasks of the CVP analysis, but also new ones that arise in the conditions of a socially-oriented economy and an unstable external environment. With the help of the formed system of CVP analysis indicators, road enterprises will be able to constantly monitor the dynamics of indicators and respond to negative changes in a timely manner, predicting them or creating positive changes;

– the methodical approach to the development of the list of indicators of preventive anti-crisis management of the enterprise has been improved due to the comprehensive consideration of the results of the study of the quantitative and qualitative composition of CVP analysis indicators; the specifics of the industry in which the enterprise operates and the distribution of responsibility for each selected controlled indicator with the calculation of the labor intensity of its implementation. Approval of the proposed approach made it possible to form a PAMI list by road enterprises of Ukraine.

The application of the obtained results in the activity of road enterprises of the road and transport complex of Ukraine will prevent a crisis thanks to the formation of an opportunity to work ahead of schedule, creating scenarios of future current activities taking into account the requirement of continuous improvement of work and carrying out transparent implementation of their implementation with rational use of resources. All this contributes to the fulfillment of the following Sustainable Development Goals: overcoming poverty; decent jobs and economic growth.

It is worth noting that in none of the four sections of the monograph the language was devoted to the human factor. Therefore, in the next Chapter 5, in order to fill this gap, attention will be paid to the personnel management system.

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# PERSONNEL MANAGEMENT SYSTEM BASED ON A HOLISTIC APPROACH: FORMATION AND DEVELOPMENT IN THE CONTEXT OF ENSURING INNOVATIVE DEVELOPMENT OF MOTOR TRANSPORT ENTERPRISES

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## ABSTRACT

In the market economy, important changes are taking place in the management of the organization (enterprise), the role of the human factor, the value and importance of working with personnel is increasing. The primary importance in the competitive struggle is occupied by the employee – the "working man", its human, social and intellectual potential. In this regard, personnel management becomes the predominant type of activity against the management of other objects, the basis of the organization's management system. Personnel management activities permeate all processes of the company's functioning, are implemented in all subsystems (functional and target – we are talking about operational activities for personnel assessment, motivation of employees to perform certain tasks, etc.).

Practice shows that the implementation of functions and procedures related to personnel selection, their assessment, career planning, reserve training, etc. separately does not give the desired result, since the connection with the organization's strategy and the focus on achieving the main goals are not fully ensured. Therefore, the formation of an effective personnel management system at the enterprise, which meets the conditions of operation, is able to ensure the achievement of the set goals and quickly adapt to changes in the external environment, is of great importance. Therefore, there is a need for the formation of such a personnel management system of the organization, which would ensure the implementation of the strategic goals of the enterprise as effectively as possible; corresponded to the state of the external and internal environment; the possibility of flexibility in the implementation of functions and management methods, etc.

## KEYWORDS

Personnel, human factor, integrity, holistic approach, personnel management, strategy.

## 5.1 PERSONNEL MANAGEMENT: ANALYTICAL AND METHODOLOGICAL FOUNDATIONS

In modern literature and practical activity, a sufficiently large number of studies have been conducted regarding the methods of forming the personnel management system, its "embeddedness" in the general structure of enterprise management. In modern studies, attention is paid to the search for new approaches to the formation and functioning of the personnel management system.

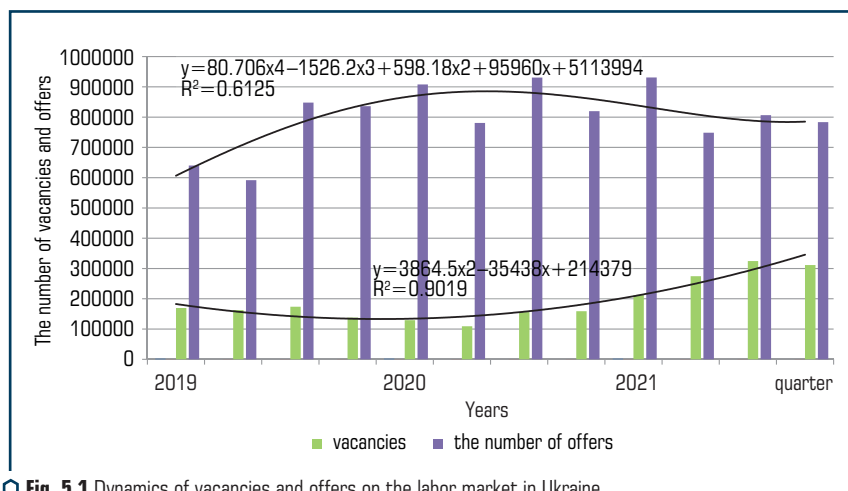
Many studies that have a practical orientation are primarily related to the quantitative assessment of the need for workers in various industries and types of economic activity, analysis of vacancies and the need for strategic planning of training of specialists, etc.

The dynamics of supply and demand on the labor market in Ukraine (**Fig. 5.1**) shows that supply exceeds supply in all periods of the studied population (quarters for the years 2019–2021). So, in 2020, in the 1<sup>st</sup> and 2<sup>nd</sup> quarters, such an excess was 7 times. Then the situation improved somewhat and in 2021 it decreased from 4 times in the first quarter to 2 times. The transport sector accounts for 11 % of the need for personnel from the total number of vacancies. The study of the trends of these indicators shows that there is a polynomial relationship, which allows to calculate forecast changes according to the corresponding equations (marked in **Fig. 5.1**).

As for 2022 (the period of hostilities on the territory of Ukraine), the number of vacancies (as of September 30, 2022) averages 87.18 thousand, which is 13.4 thousand or 18.15 % more than in the previous month (as of August 30, 2022). The average number of posted resumes is 464.22 thousand and 487.94 thousand, respectively, which indicates a decrease of 23.72 thousand, or 4.86 %. Again, the number of offers exceeds the number of vacancies by 6 times.

The results of a comparative analysis of the main labor indicators in Ukraine as a whole in comparison with the transport sector are shown in **Table 5.1**.

According to the **Table 5.1**, it should be noted an unstable trend regarding the employment of workers, both in Ukraine as a whole and in the transport sector. So, in 2013, the number of employed workers was 7,406,494, and in 2016, it was 5,801,140 people – a negative trend of reducing the number of employed people in the economy. Starting from 2017 to 2021, there is a slight positive trend towards an increase in the number of employed persons.



**Fig. 5.1** Dynamics of vacancies and offers on the labor market in Ukraine  
Source: author's development

● **Table 5.1** Comparative analysis of labor indicators (based on official statistics)

Indicator	Years								
	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of employed workers – Ukraine	7406.5	6298.5	5889.7	5801.1	5812.9	5959.5	6407.5	6366.1	6391.7
by section H*	911.5	762.3	776.5	765.2	764.2	762.3	758.1	729.4	710.0
Chain growth rates (Ukraine on), %	–	–15.0	–6.5	–1.5	0.2	2.5	7.5	–0.6	0.4
Chain growth rates by section H, %	–	–16.4	1.9	–1.5	–0.1	–0.2	–0.6	–3.8	–2.7
Personnel costs, billion UAH – Ukraine	378.2	354.4	392.6	434.8	569.9	727.1	901.2	990.6	1169.8
by section N	51.4	45.0	54.8	62.3	82.3	106.4	123.4	122.9	137.5
Chain growth rates (Ukraine on), %	–	–6.3	10.8	10.7	31.1	27.6	23.9	9.9	18.1
Chain growth rates by section H, %	–	–12.5	21.8	13.7	32.1	29.3	16.0	–0.4	11.9

Note. \* includes data from section H "Transport, warehousing, postal and courier activities"

In the transport sector, a negative trend in the number of employed persons is observed for almost the entire considered period. The rate of reduction in 2014 is the most important – (–16.4 %). The reason for this is the war in Donbas, the annexation of Crimea, the unstable socio-economic and political situation in Ukraine.

An important indicator that characterizes the effectiveness of personnel management is the ratio of profit from a certain type of activity and the corresponding personnel costs, that is, the profitability of the total personnel costs (**Fig. 5.2**).

In general, according to economic indicators in Ukraine, there is a slight reduction in the profitability of aggregate costs (from 8.5 % in 2012, a gradual reduction to 0.8 % in 2020). As for enterprises in the transport sector, an unstable situation is observed here: from 2012 to 2014, a negative trend took place (in 2014, the lowest value of this indicator was recorded (–68.3 %), from 2014 to 2016, a positive trend was observed to increase in the rate of profitability, from 2016 to 2018 – a decrease again. Starting from 2018, a positive trend is noted, 8.9 % was recorded in 2020. It has the following equation for this trend:

$$R=22.123t-47.016, \text{ the reliability of the approximation } R^2=0.7721.$$

Analyzing the growth rates of labor productivity in comparison with the growth rates of personnel costs (Fig. 5.3), it is possible to draw a conclusion about the positive trend in the functioning of transport industry enterprises. In recent years (2019 and 2020), the growth rate of labor productivity exceeds the growth rate of wages.

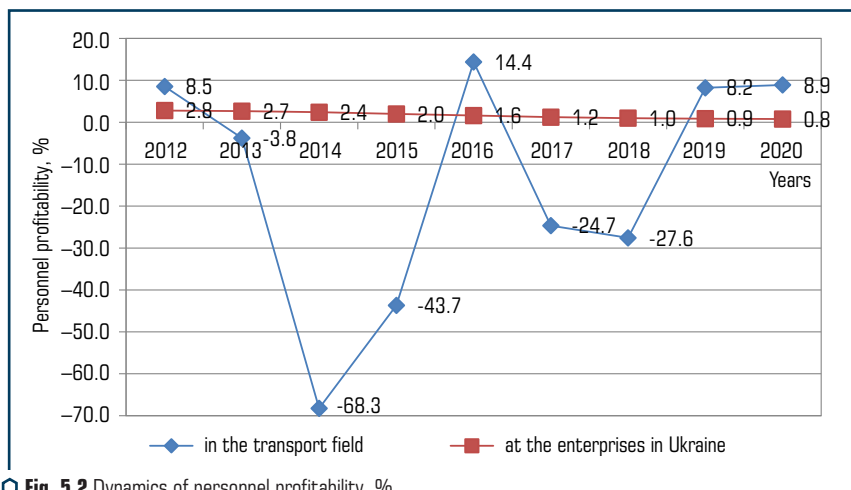


Fig. 5.2 Dynamics of personnel profitability, %

Source: author's development

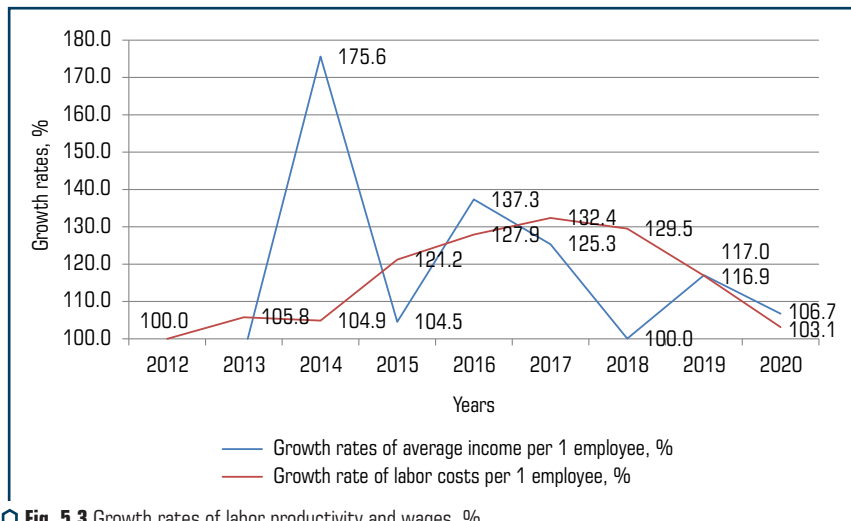


Fig. 5.3 Growth rates of labor productivity and wages, %

Source: author's development

However, in 2022, military actions changed the situation with the functioning and development of transport enterprises. The number of enterprises that have completely stopped their activities has almost halved compared to the beginning of hostilities (from 32 % to 17 %). However, 60 % of enterprises operate below the pre-war level of employment, almost 23 % – more than twice. The port infrastructure is practically paralyzed (sea ports of Berdiansk, Mariupol, Skadovsk, Kherson are closed until control over the territories is restored, and the work of Mykolaiv and Odesa ports is blocked). At the same time, railway and road connections are being restored, and new transportation routes are being introduced.

The conducted analysis proves the necessity of forming a personnel management system as an integral component of enterprise management and is a vital condition for its functioning.

Theoretical studies of the personnel management system mainly relate to the definition of its components, features of formation in modern economic conditions, construction methods in a competitive market environment, etc.

In the most common approach, the personnel management system is considered as a subsystem of the general enterprise management system, which is aimed at the involvement and effective use of existing employees and is based on the performance of specific functions distributed among the personnel of the management apparatus [1]; subsystem of managing the enterprise as a whole, which has a purpose, content and a certain mechanism. The purpose of the personnel management system is determined by the mission of the enterprise [2] or as "an ordered set of interconnected elements that differ in functional goals, act autonomously, but are aimed at achieving a common goal" [3]; separately emphasized in the definitions of the personnel management system and its goals – "the personnel management system of the enterprise is a set of goals, tasks and main directions of activity, personnel policy of the enterprise, as well as various types, methods and the corresponding management mechanism, aimed at increasing labor productivity and quality personnel work" [4].

These definitions focus on the fact that the personnel management system implements certain functions aimed at achieving a certain goal and is part of the overall management system.

In the scientific and educational literature, various approaches to the formation of a personnel management system are considered: functional [2, 5, 6]; systemic [3, 7, 8]; process [1, 9].

The first approach involves the functional division of labor in the field of personnel management. According to management theory, namely general management functions "analysis → planning → organization → motivation → control", specific functions of personnel management are distinguished.

In work [2], the most simplified approach to the selection of types of functional activity in personnel management is given: the process of hiring employees, development; individual goals, assessment and motivation of personnel.

The most complete list of such functions is given in the work of Liudmyla Poshelyuzhnaia [6]. These are the following types of functions: personnel analysis and planning; recruitment and hiring of personnel; personnel assessment; organization of training and professional development of personnel; attestation and personnel rotation; personnel motivation; accounting of company



employees; organization of labor relations at the enterprise; creation of working conditions; social development and social partnership; legal and information support of the personnel management process.

At the same time, there is a certain combination of the functions themselves and the provision of the personnel management process, as well as the directions of development of the system itself – social development and social partnership.

When using the system approach, the personnel management system is perceived as a set of different subsystems. At the same time, different types of subsystems are distinguished. For example, the authors of the work [8], based on the understanding of the system of managerial work as a set of goals, forms and methods of effective personnel management, justify the presence of three subsystems. The first is a subsystem of personnel analysis, planning and forecasting aimed at creating facilities and management structures, calculating the need for personnel of the required profession, specialty and qualification. The second subsystem includes the subsystem of selection, placement, assessment and continuous training of personnel, which are considered as a guarantee of the quality of the formed objects of the personnel management structure, as well as effective stimulation. And, the third subsystem is the rationality of personnel use.

It should be noted that this is the simplest and most widespread approach to the allocation of personnel management subsystems. However, this selection of subsystems is quite extensive; there are no subsystems for personnel motivation and personnel accounting.

The approach to the organization of functional subsystems of the company's personnel management system is also quite widespread [9]: subsystem of labor relations; working conditions subsystem; personnel accounting subsystem; personnel planning and forecasting subsystem; personnel development and training subsystem; work stimulation subsystem; creation of the necessary social infrastructure; selection and application of organizational management structures.

A more detailed description of the types of subsystems is contained in the work of Dmytro Korsakov [10], namely, nine such subsystems are provided: C1 – subsystem of personnel analysis and planning; C2 – subsystem of recruitment and personnel accounting; C3 – personnel motivation subsystem; C4 – personnel assessment subsystem; C5 – personnel development management subsystem; C6 – subsystem of creation of working conditions; C7 – information support subsystem of the personnel management system; C8 – subsystem of the development of the organizational management structure; C9 – subsystem of legal support.

A similar list of subsystems of the modern personnel management system is given in [11]: strategic planning; management of social and sustainable development, legal support, subsystem of development of organizational structure and management culture; managing labor relations and ensuring normal working conditions; general and line management; information support and marketing; personnel development management; personnel administration and recruiting activities and personnel accounting; management of stimulation and motivation of personnel.

In our opinion, such an organization of the system is sufficiently complete and practically feasible. The presented list of subsystems of the personnel management system and their content are

universal, as they are aimed at large organizations with broad financial capabilities. But there is a mixing of subsystems of personnel management, which provide for the implementation of functions on a permanent basis, and subsystems of the development of this work, namely C8 and the subsystem of the development of organizational structure and management culture. Also, in our opinion, a separate place should be occupied by subsystems related to ensuring the functioning of the personnel management system (C7, C9) and information support and marketing, etc.

The general drawback of functional and systemic approaches to the formation of a personnel management system is the lack of mapping of the relationship between functional blocks or subsystems, the order of implementation of management functions is not determined.

Considering the functions of personnel management as a series of interdependent continuous actions is assumed by the process approach. The personnel management system is presented as a relationship of processes united in three blocks: "launch", "processes", "release". "Launching" involves hiring, selection, negotiations, concluding a contract. The "processes" block includes training, training, working conditions, medical care, conflict prevention and resolution, termination of employment. And the "output" block is perceived as the output of the system and provides for the execution of work.

When applying a process approach to personnel management, it is necessary to take into account that this process is not localized within one unit, it is implemented in different units of the organization, it is end-to-end.

Studies of existing approaches to personnel management systems show that when they are formed, there is no interconnection with the organization's management system, its strategy, the goals of the main activity; in some cases, the object of management is not defined: an individual is an employee, a group of employees; the team in general. All this requires improvement of the personnel management system of the organization.

## **5.2 PERSONNEL MANAGEMENT FROM THE POSITION OF A HOLISTIC APPROACH**

The focus of personnel management on ensuring the strategic goals of the enterprise ensures the use of a holistic approach. In the most general case, the term "holism" comes from the Greek "ὅλος" and means "whole", "make whole".

Regarding the application of holism in management, this is a new approach. Theoretical and methodological aspects of holistic management have just begun to take shape. At the same time, the object for the application of a holistic approach is tasks that cannot be effectively solved using traditional management methods. The authors [12, 13] call the following the main differences of holistic management: prioritizing the involvement of all participants in the development and implementation of management decisions; absence of the need to detail the system, but its perception as a whole, despite any level of complexity and the presence of differences in individual components; maintaining feedback; reducing the distance in the relationship between management personnel and

other groups of employees of the enterprise; decentralization; taking into account the influence of macro- and microenvironmental factors.

Despite the fact that the holistic approach is quite new, there is some development and research in the direction of its application in personnel management.

Holistic personnel management is considered as a general approach to the management of human resources in accordance with the strategic vectors of the company's activity, which is closely related to the strategic management of the enterprise. This approach is an effective way to ensure system performance by considering human resource management (HRM) from a more holistic and balanced perspective, including organizational climate, culture, etc. [14]. From the point of view of the authors of the work [15] the HRM model should ensure the achievement of multifunctional goals of the organization, as well as the achievement of individual goals of each individual employee, take into account the impact of the organization on the external and internal environment. A holistic approach to HR [16] also includes, along with traditional elements of personnel management (HR philosophy, strategy, HR processes, which include formal procedures and methods used to implement strategic plans and policies), the implementation of the concept of individual resources of employees from the point of view great time pressure, work overload, professional stress and the threat of burnout.

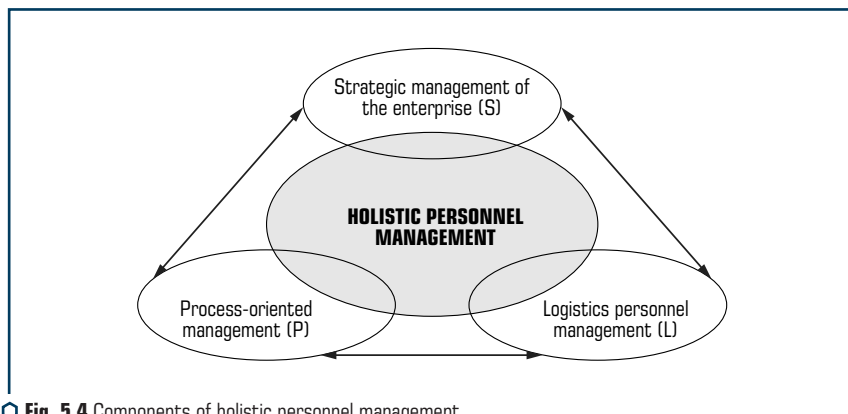
The paper [17] examines the basics of holistic personnel management and emphasizes the fact that "a feature of the holistic approach to personnel management is the integration (technical, technological, informational, methodological and economic) of individual subsystems into a single system that provides end-to-end management of all types of flows: labor, material, financial, informational, service, marketing and sales". In the opinion of these authors, with which one should fully agree, the application of a holistic approach to the management of the organization's labor resources should be considered through the prism of the general logistics rule "7R": required personnel (right personnel) in the necessary amount (right quantity) and qualifications (right qualification), which are needed by the structural divisions of the organization (right structural divisions of the organization) at the right time (right time) and place (right place) with the specified level of expenses (right cost).

The formation of the company's personnel management system based on a holistic approach is related to the creation of a single system taking into account common features, determining the mutual compatibility of possible subsystems and their coordination mechanisms.

Holistic personnel management, in our opinion, includes a holistic view and signs of the implementation of three components: strategic enterprise management, process-oriented management and logistical personnel management (**Fig. 5.4**).

Strategic management determines how the organization will function and develop, a list of management actions to achieve the desired state, set goals in the long term. Employees should be perceived as the basis of the enterprise, its main value and source of competitiveness.

Strategic management is dominant, and process-oriented and logistical personnel management are derivatives, created to ensure the achievement of strategic goals of the enterprise.



**Fig. 5.4** Components of holistic personnel management  
*Source: author's development*

Process-oriented management is a purposeful activity that allows the enterprise to increase the value of products for consumers, as well as the level of its profitability by focusing on processes and approaches to their internal organization.

Process-oriented personnel management leads to the simplification of multi-level hierarchical organizational structures, which ensures a greater orientation of the organization to the consumer. By reducing the hierarchical levels of the organizational structure, the process approach makes it possible to simplify the exchange of information between different units; eliminate the isolation of units and officials, consider personnel management activities not statically, but dynamically, when the activity in the system must be constantly improved on the basis of appropriate measurements and analysis, focus on the interaction of units and officials, which makes it possible to eliminate "night fields", i.e. areas of activity falling out of the influence of the system.

Logistics management of personnel is considered by us as a process or activity that is subject to defined goals, is carried out in a logical sequence, can be organized at the strategic and tactical levels, is carried out continuously and includes planning, organization, implementation and control of personnel movement; at the tactical level, it includes the process of optimization and rationalization of personnel flows in order to coordinate them with other logistics flows and increase the efficiency of providing and using the company's personnel.

The main tasks of logistics personnel management are to provide the enterprise with the necessary personnel at the required time, in the required quantity and in the required place with costs beneficial for the enterprise.

Holistic personnel management combines these components and provides orientation of the system to the appropriate strategy of the enterprise, the ability to adapt the system to changes in the external environment, the development of horizontal connections that ensure effective interaction of employees and units; cooperation.

In terms of the general theory of systems and their formalization, a personnel management system built on the basis of a holistic approach can be represented as an intersection of three sets of strategic ( $S$ ), process-oriented ( $P$ ), and logistical personnel management ( $L$ ), respectively:

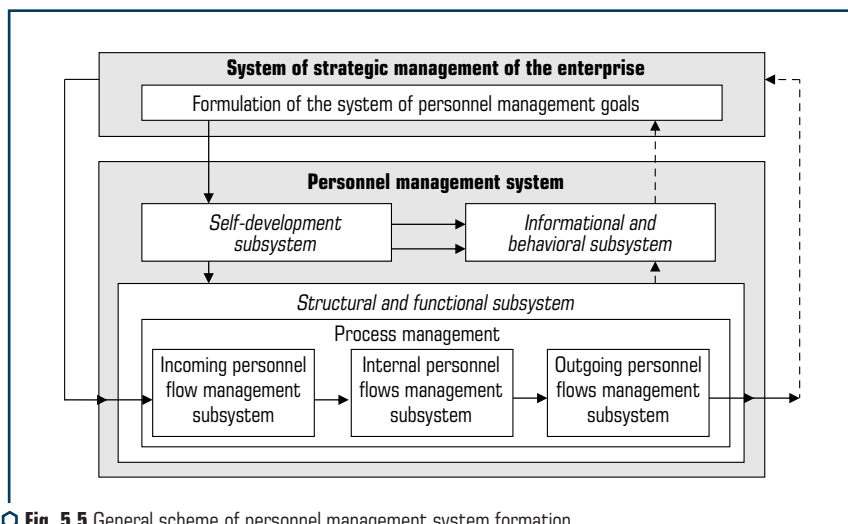
$$S \cap P \cap L = \{D | D \in S \text{ and } D \in P \text{ and } D \in L\},$$

where  $D$  are the elements characterizing the combined features of holistic personnel management;

$$D = \{T, X, U, W, Y, G, h, j\},$$

where  $T$  – a set of time points;  $X$  – a set of possible input influences,  $X = \{x: T \rightarrow \Omega\}$ ;  $\Omega$  – a set of instantaneous values of input influences;  $U$  – a set of states or internal characteristics of the system;  $Y$  – a set of instantaneous values of output signals;  $G$  – a set of initial values,  $G = \{\gamma: T \rightarrow Y\}$ ;  $\eta$  – output display,  $\{\eta: T \times U \rightarrow Y\}$ ;  $\varphi$  – a state transition function,  $\{\varphi: T \times U \times Kh \rightarrow U\}$ .

According to the holistic approach, it is proposed to present the personnel management system as a set of sequentially combined elements (**Fig. 5.5**).



**Fig. 5.5** General scheme of personnel management system formation  
Source: author's development

It is advisable to integrate the strategic management system of the organization into the process management system as one of the top-level processes. For this, a single system of strategic goals is created, and each internal strategic goal and indicator of its achievement must be attributed to a certain process of the system. The identified goals must comply with the SMART principle,

first of all, relate to certain time intervals (Time-based) and be simple, clear (specific), measurable (measurable), agreed upon and focused on specific actions (Attainable), realistic (realistic).

The personnel management system can be represented as a set of structural-functional, informational-behavioral subsystems and self-development subsystem.

The information-behavioral subsystem includes the management ideology and value system of the organization, employee interests and behavioral norms, information support of the management system; subsystem of self-development – changes in the external environment that lead to changes in the management ideology of the organization and the emergence of self-development stimulators. The structural and functional subsystem reflects the connections between the elements of the management entity and implements process management.

The specific content of the structural-functional subsystem is determined by the content of the object in personnel management.

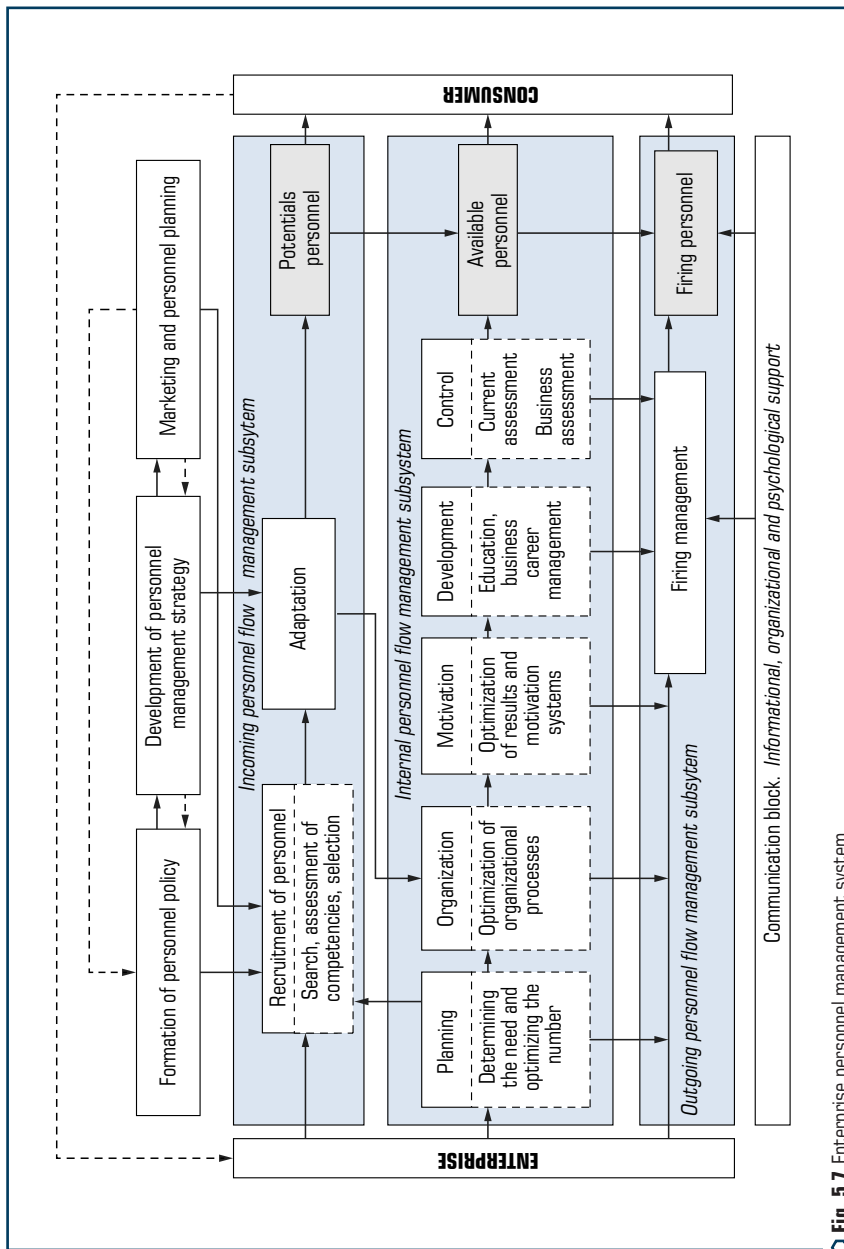
To describe the object in personnel management and its formalization, let's use the canonical model – the representation of the object in the form of "entrance", "black box" and "exit". As "input" it is appropriate to consider the needs and motives of the employee, related to the possibility of their satisfaction in this organization, and "output" – the achieved results (work performed, its significance, involvement in the production process, etc.), that is, significant in the organization, and to an individual employee. In addition, taking into account the logistics approach, the formation of the system should be based on the following principle: the organization is a supplier, and working people are consumers (**Fig. 5.6**).

Having worked during the working day, the employee leaves the organization with its intelligence, which is not material capital. It is an invisible resource that belongs to the employee and can bring success to the organization. Logistics personnel management considers employees not just as a labor force that receives wages, but as an intellectual potential in which the organization is also interested, as in the external consumer. From this point of view, the employee is its client (internal consumer).

In our opinion, it is expedient to present the structural and functional subsystem as part of three subsystems: management of incoming personnel flows, internal personnel flows, and management of outgoing personnel flows (**Fig. 5.7**).

Provider	Exit	Process	Entrance	Consumer
Organization	People's needs (workers) Organization of meeting needs	"Black Box"	Significance of work Reward-based performance Engagement (separation of powers) Mentoring	Workers

**Fig. 5.6** The principle of personnel management system formation  
Source: author's development



**Fig. 5.7** Enterprise personnel management system  
Source: author's development

The main differences of the proposed personnel management system (**Fig. 5.7**) are: firstly, personnel flows should be considered from the enterprise as a supplier of work to the consumer (potential or existing personnel or personnel being laid off); secondly, the main management functions (planning, organization, development, motivation and control of personnel) are used when determining the content of the system; thirdly, the element "information, organizational and psychological support" is included in the components of the system; fourthly, take into account that the optimization of personnel flows is based on a certain set of initial provisions: the personnel system is considered as a complex system that has a number of subsystems; each subsystem has its own criterion of optimality, which reflects its internal (immanent) interests; the functioning of the structure is a process of interaction of these subsystems.

Taking into account management tasks, management ideology and development strategy, a personnel policy is formed and a personnel management strategy is developed, that is, a general direction of work, a course of action to strengthen and preserve the competitiveness of the organization with the help of its employees. On this basis, personnel planning is carried out, organizational and technical measures are developed for the selection and reception of personnel, their development, motivation, assessment and communication. The subsystem of management of incoming personnel flows includes personnel recruitment and adaptation. In turn, when implementing personnel recruitment, it is necessary to search for personnel, assess competencies, and select personnel.

The search for personnel is carried out using the following sources: from the mass media (the use of media space ensures maximum "coverage" of possible applicants and relatively small financial costs. Informational, organizational and psychological support reflects the issue of social and psychological support for personnel management, the implementation of various sociological and psychological procedures in the practice of personnel work at the stage of personnel search and selection. Such procedures should include consultations with a specialist (psychologist) and its participation in interviews, the attachment of a mentor for the adaptation period, the organization of interviews in convenient conditions, etc. This helps to overcome the psychological burden that arise in the course of work, carries out coordination and implementation of decisions that allow avoiding conflicts and stresses.

The internal personnel flow management subsystem includes the performance of the following personnel management functions: planning, organization, motivation, development and control.

At the planning stage, the main attention in the personnel logistics system should be given to determining and optimizing the number of personnel. The actions of the enterprise to optimize the number of personnel are reduced to the following: reduction of employees or their recruitment from the outside; functional adaptation of own employees to changing conditions of production through the use of non-standard working hours; organizational transfers of employees; retraining and professional development; personnel leasing (temporary hiring of labor through relevant organizations).

Optimizing the number of personnel in case of structural inconsistency is carried out by the following method: relocation of employees at workplaces after their retraining; changes of workplaces at the initiative of the administration or the employees themselves; preservation of workers in the event of their underutilization.



The main role of informational, organizational and psychological support in the management of internal personnel flows is to convey the necessary information to the existing personnel about the actions (measures) that the enterprise performs (implements) in relation to its existing personnel, which, in turn, should contribute to retention personnel.

The subsystem of management of outgoing personnel flows provides management of dismissal.

Before starting to lay off employees, it is necessary to use a number of less drastic methods, namely: suspend the recruitment of new employees for jobs that are vacated due to natural turnover of personnel, and fill these positions with your own employees, whose positions need to be reduced. As a rule, such a company is accompanied by retraining of personnel, which is also a temporary way of reducing the intra-organizational labor supply. The enterprise can send its employees to a long period of training with a break from production; transfer of some employees to part-time work, especially in industries with seasonal fluctuations in demand (transport, agriculture, tourism). This will allow to retain qualified employees; voluntary dismissal. Management should encourage voluntary redundancy through a one-time payment and facilitate the search for a new job. The communication unit provides connections between all subsystems.

The practical implementation of the proposed personnel management system of the enterprise involves substantiation of the most expedient variant of its organizational structure. Solving this task is related to the specifics of the enterprise in the relevant industry and the specifics of the management approaches used.

In the enterprises of the road and transport complex, including motor transport enterprises (MTE), linear and functional management structures are mainly used. At the same time, the functions and decision-making rights are entrusted to the linear management units, and to the functional subdivisions – methodical guidance in the preparation and implementation of decisions on the management of MTE activities. Among the MTE services, the main (operational) service – the service of transportation organization; auxiliary (management of car maintenance and repair processes) – technical service; service for maintenance of production – service of the chief mechanic and energy; service of ancillary works (cleaning of premises, territory, etc.). MTE management services include the planning and economic department, the marketing department, the personnel department, etc.

The conducted studies show that within the existing organizational structure of MTE, several options for creating a personnel management system (PMS) can be identified and considered:

- 1) identify the PMS with the personnel department;
- 2) create a PMS on the basis of the personnel department, the planning and economic department and others, which are engaged in the implementation of individual functions of personnel management;
- 3) create a section of strategic personnel management, which is engaged in the implementation and development of personnel management functions in a strategic aspect, and the implementation of these functions in the current work will be entrusted to line managers.

Each of the options has its advantages and disadvantages. Thus, the first option does not require costs for the formation of a new system, redistribution of functions, etc., but does not

ensure the availability and performance of coordinating functions in personnel management, implies low efficiency of these works. PMS on the basis of personnel department, planning and economic department and others engaged in the implementation of individual personnel management functions (the second option) has a high level of coordinating personnel management functions, but requires costs for the formation of a new system, redistribution of functions, etc. The advantage of the third option is the use of the concept of dual or shared responsibility, according to which both line managers and personnel management specialists are responsible for the implementation of the main task – increasing the efficiency of the use of human resources.

To assess the given options, it is advisable to apply the method of prioritization (**Fig. 5.8**).

As criteria for comparing variants of the organizational structure of personnel management, it is proposed to use the following: the effectiveness of the organizational structure, the completeness of the implemented functions of personnel management, social standards and the possibility of MTE implementation. Block 1 is responsible for entering information on the functioning of the personnel management system (the number of organizational options is specified, their content is determined, parameters characterizing the effectiveness of the relevant organization are established). On the basis of the presented information in block 2, objects of pairwise comparison are determined. As objects of comparison, separate versions of the PMS act. It is assumed that  $t$  objects  $A_1, A_2, \dots, A_t$  are compared in pairs by each of  $n$  experts. Then the number of possible pairs for comparison is  $s = t(t-1)/2$ , which is determined in block 3.

Experts express their judgments in the form of pairwise comparisons without quantitative assessment of the degree of superiority in each pair of objects.

The calculated ratio coefficient ( $K_p$ ) is determined by the formula (block 4):

$$K_p = \frac{A_i^{\max}}{A_j^{\min}},$$

where  $A_i^{\max}$ ,  $A_j^{\min}$  is the object with the maximum and minimum importance rating, respectively. As a result, a system of paired comparisons based on a given feature is formed.

The determined values of the coefficients  $X_{ij}$  are the basis for forming a matrix of pairwise comparisons of processes  $A = [X(i, j)]$  – block 5 and 6.

Data processing of the received matrices is performed in block 7 in the following sequence:

- the iterative power of the first order is determined by summing the values of the matrix by row ( $P_i(1) = \sum X_{ij}$ );
- the iterative force of the second order ( $P_i(2) = \sum X_{ij} \cdot P_j(1)$ ) is calculated:

$$p_{s(k)}^{\text{rel}(2)} = \frac{1}{\sum_{s(k)=1}^{S(m)} \sum_{g=1}^G b_{gs(k)} p_g^{\text{rel}(1)}} B p^{\text{rel}(1)},$$

where  $B = \|b_{gs(k)}\|$  is the matrices of comparisons of variants of the organization of the SMP;

$$- \rho^{rel(1)} = \frac{\sum_g b_{gs(k)}}{\sum_{s(k)} \sum_g b_{gs(k)}} - \text{the iterated power of the first order by } s(k)\text{-th comparison indicator;}$$

– determination of the normalized iterative power of the  $i$ -th variant ( $P_i = P_i(2) / \sum P_i(2)$ ).

The value of the normalized iterative power indicates the degree of importance of the corresponding option of the personnel management system. According to the received priority values, the options are ranked in order from more important to less important in block 8, however, they can be accepted for further calculations only if the matrix is transitive and there are no equality relations in it. The check of the set condition takes place in block 9. In this case, two options are possible. If the condition is fulfilled, conclusions are made about the degree of manifestation of the assessed feature in the processes, and the importance values are transferred to block 14. In the opposite case, the ratio coefficients need to be recalculated, based on which the priority values of the comparison objects are adjusted.

Block 10 provides for the calculation of the actual ratio coefficient ( $K_r$ ) based on the actual priority data. At the same time, it is necessary to check the consistency of the actual ratio with the calculated ratio (block 11). If the value of these coefficients is equal, then the problem is considered solved and information about the importance of the PMS options is transferred to block 12. In the opposite case, the value characterizing the increase in the coefficient  $X_j$  needs to be adjusted according to the formula:

$$y' = y \frac{K_r}{K_f}.$$

Block 12 is responsible for the recalculation of this coefficient. Based on the adjusted system of priorities, block 13 forms a matrix with a non-transitive system of comparisons  $A' = [X(i, j)']$ . The determination of the adjusted values of priorities takes place in block 14, and the values of the adjusted normalized iterative power of processes ( $P^i$ ) are accepted for further calculations (block 15).

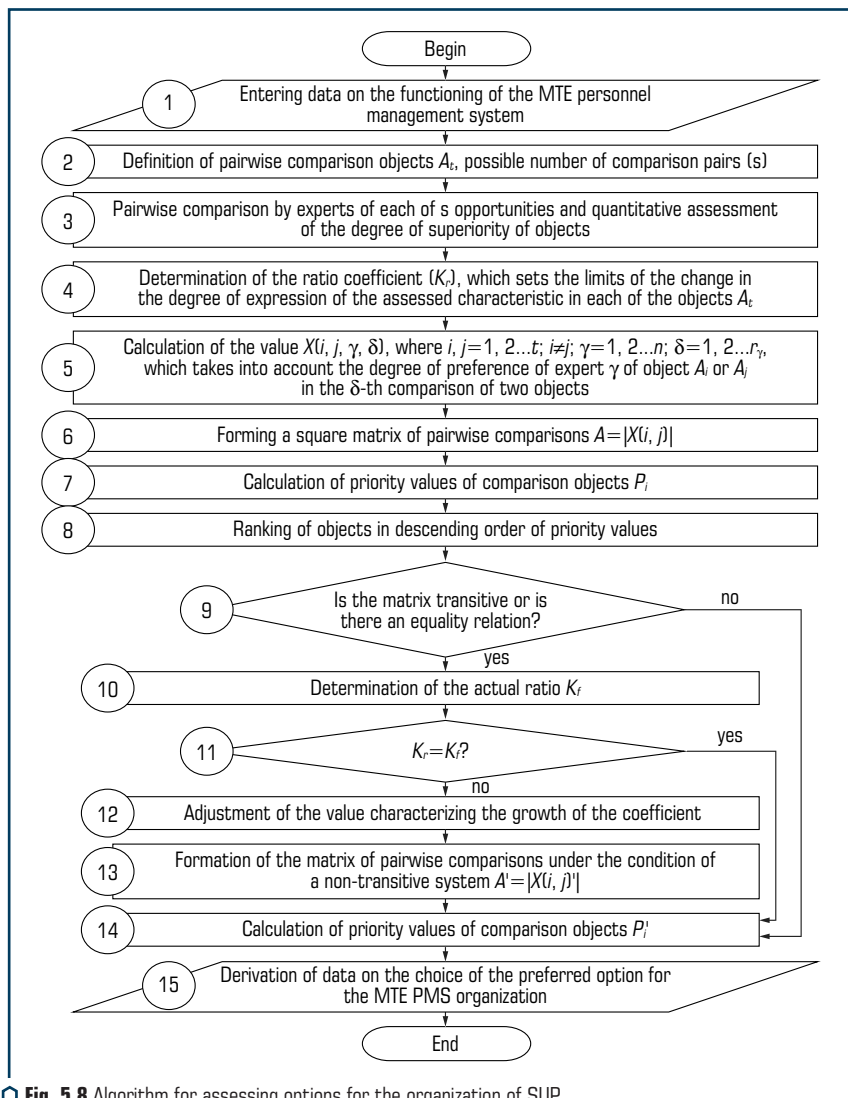
Absolute priorities regarding the proposed options:

$$\rho_{s(k)} = \sum_{s(k)} \rho_{s(k)}^{rel(2)} \alpha_{s(k)},$$

where  $\rho_{s(k)}^{rel(2)}$  – the normalized iterated force of the second order according to  $s(k)$  variant of the PMS organization;  $\alpha_{s(k)}$  – the significance of the criteria for the comparison of options according to  $s(k)$  option of organization of MTE PMS.

The results of the comparison of options for the organization of the personnel management system according to the criteria: the effectiveness of the organizational structure, the completeness of the implemented personnel management functions, social standards and the possibility of implementation in MTE are presented in **Table 5.2**.

Comparison of criteria among themselves takes place according to the same algorithm with the aim of obtaining their specific significance. On the basis of the obtained results, let's determine the complex priorities of the options for the PMS organization (**Table 5.3**).



**Fig. 5.8** Algorithm for assessing options for the organization of SUP  
Source: author's development

● **Table 5.2** Matrix of comparisons of options for the organization of MTE PMS according to the criterion – effectiveness of the organizational structure

Variant of PMS organization	V-1	V-2	V-3	And the generated force is of the first order $\rho^{rel(1)}$	Relative priority of the first order $b_{gs}\rho^{rel(1)}$	Normalized and applied force of the second order $\rho^{rel(2)}$	Relative priority of the second order $\rho_s$
The criterion is the effectiveness of the organizational structure							
I. V-1	1.0	0.5	0.5	2.0	0.22	5.5	0.22
V-2	1.5	1.0	0.5	3.0	0.33	8.0	0.32
V-3	1.5	1.5	1.0	4.0	0.44	11.5	0.46
II. Sum				9	1.00	25.0	1.00
The criterion is the realization of our functions and personnel management							
III. V-1	1.0	0.5	0.5	2.0	0.22	5.5	0.22
V-2	1.5	1.0	0.5	3.0	0.33	8.0	0.32
V-3	1.5	1.5	1.0	4.0	0.44	11.5	0.46
IV. Sum				9	1.00	25.0	1.00
The criterion is social and social and standard							
V. V-1	1.0	1.5	0.5	3.0	0.33	8.0	0.32
V-2	0.5	1.0	0.5	2.0	0.22	5.5	0.22
V-3	1.5	1.5	1.0	4.0	0.44	11.5	0.46
VI. Sum				9.0	1.00	25.0	1.00
The criterion is the possibility of implementation							
VII. V-1	1.0	1.5	1.5	4.0	0.44	11.5	0.46
V-2	0.5	1.0	0.5	2.0	0.22	5.5	0.22
V-3	0.5	1.5	1.0	3.0	0.33	8.0	0.32
VIII. Sum				9.0	1.00	25.0	1.00

● **Table 5.3** Determination of comprehensive priorities according to the MTE PMS organization options

Criteria for choosing options for the PMS organization	Specific significance of selection criteria	IX. Variant of PMS organization			Complex priority according to the options for the PMS organization		
		V-1	X. V-2	V-3	XI. V-1	A. V-2	V-3
XII. C-1	0.22	0.22	0.32	0.46	0.048	0.070	0.101
C-2	0.22	0.22	0.32	0.46	0.048	0.070	0.101
C-3	0.22	0.32	0.22	0.46	0.070	0.048	0.101
C-4	0.35	0.46	0.22	0.32	0.161	0.077	0.112
Sum	1.00	—	—	—	0.328	0.266	0.416

Based on the obtained results, the third option of the organizational structure of the personnel management system, which involves the formation of a strategic personnel management section, the directions of which will be the coordination and implementation of personnel management functions in a strategic aspect, is the most expedient according to the greatest value of the complex priority.

### **5.3 DISCUSSION OF THE RESULTS OF THE FORMATION OF THE MTE PERSONNEL MANAGEMENT SYSTEM BASED ON A HOLISTIC APPROACH**

Ensuring the competitiveness and stability of the organization depends on the implementation of effective strategies related, first of all, to the implementation of socially responsible business. This requires constant maintenance of the balance between the economic and social efficiency of the enterprise. This is of particular importance for MTE, which is gradually trying to ensure a decent level of wages for hired labor, social packages, etc. In these conditions, the most important element is the personnel.

It is necessary to form a holistic approach to personnel management, which will ensure the ability of the organization to achieve its goals through the best use of available resources, the MTE adaptability to the external environment, and the implementation of sustainability principles.

The application of a holistic approach to personnel management will allow to agree and effectively coordinate the implementation of organizational strategies, tasks of process-oriented management and logistics management of MTE.

A personnel management system was formed based on a holistic approach as a set of three subsystems: management of incoming, internal and outgoing personnel flows. The main differences of this system are: personnel flows are considered from the enterprise as a supplier of work to the consumer (potential or existing personnel or personnel being dismissed); implementation of all main management functions (planning, organization, development, motivation and personnel control) is provided for; the element "information, organizational and psychological support" is included in the components of the system.

It is taken into account that the optimization of personnel flows is based on a certain set of initial provisions: the personnel system is considered as a complex system that has a number of subsystems; each subsystem has its own criterion of optimality, which reflects its internal (immanent) interests; the functioning of the structure is a process of interaction of these subsystems.

However, for the organization to achieve its goals, control is one of the main functions of management in general and personnel in particular.

Since this function is not disclosed in this chapter of the monograph, the next chapter 6 will be devoted to the solution of this vector.

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## 6

ASSESSMENT OF THE EFFICIENCY OF WORK CONTROL  
OF THE EMPLOYEES OF THE MOTOR TRANSPORT ENTERPRISE

Larysa Achkasova, Illia Dmytriiev, Inna Shevchenko

**ABSTRACT**

The control function is one of the main functions of management and ensures that the organization achieves its goals. This is a cost-effective function, so the question of assessing the effectiveness of control performance is relevant. The category of efficiency is complex and multifaceted, this explains the influence of many factors on the effectiveness of control. The purpose of the chapter is to develop a methodology for assessing the effectiveness of monitoring the work of the company's employees.

The system of criteria for effective control was further developed by supplementing the existing system with other criteria taking into account the basic principles of effective control. In addition, the method of assessing the effectiveness of control has been further developed, which, unlike the existing ones, has a complex nature and takes into account the specifics of the work of various groups of personnel of the motor vehicle enterprise: the personnel of the control apparatus, drivers and repair workers.

The resulting technique allows enterprises to increase the level of efficiency of their activities, profit and competitiveness due to the optimization of the control function and increase its effectiveness, to identify the weakest points in the existing control system and to develop measures for their improvement.

**KEYWORDS**

Control, control effectiveness, control effectiveness criteria, control principles, control effectiveness model, hierarchy analysis method, radar method, functional-cost analysis, cluster analysis.

**6.1 PREREQUISITES FOR ASSESSING THE EFFECTIVENESS OF EMPLOYEE CONTROL**

In modern companies, where hired personnel work, the problem of their effective and full-time work often arises. There are several reasons for this phenomenon, one of them being the inefficiency of the control of the personnel's work by managers or its absence. The control function ensures that the organization achieves its goals. In the personnel management system, it is a mechanism for ensuring the implementation of plans, preservation and development of the personnel potential of the organization, effective interaction in the system of social partnership.

Any control system is expensive, but in some cases these costs are justified, and in others – not. That is, there is a need to determine the expediency of spending on the control system. That is why there is a question in assessing the effectiveness of control.

At the present time, not only is there no perfect system for assessing the effectiveness of monitoring the work of the personnel of the motor vehicle enterprise, but there is also no substantiated system of criteria for such an assessment.

There is no comprehensive methodology for determining the criteria and the significance of each of them for assessing the effectiveness of control for different groups of workers.

Examining the definitions of different authors, it is possible to conclude that control in various scientific studies is considered in the following aspects:

- as a function of the management system [1, 2];
- as a system of observation, comparison, verification and analysis of the functioning of the managed object with the aim of detecting deviations from the accepted standards [3–5];
- as a set of measures carried out by controlling bodies to check economic transactions [6];
- as a tool for reducing various risks [5];
- as a process that ensures the organization achieves its goals [2];
- as an integral part of the regulation system [7, 8];
- as a form of feedback, with the help of which the control system receives the necessary information about the actual state of the controlled object and the execution of management decisions [8].

All these approaches are certainly correct, as the control system is distinguished by its complexity and multifaceted tasks facing it. In our opinion, the essence of control is that with its help the control system can receive information about the actual state of the control object and respond in a timely manner to negative deviations in order to achieve the organization's goals.

The purpose of control is not so much to collect information, establish norms and standards and identify deviations, but to fulfill the tasks set before the organization. For effective control, it is necessary that the goal of the organization is more important than the used control means [9]. In addition, control should correspond to the type of activity that is controlled and objectively assess what is important for the organization.

To a large extent, the effectiveness of control is determined by the development of principles, instructions, rules, as well as criteria for assessing indicators that measure individual aspects of activity. It is important to develop an algorithm for conducting control operations, training and selecting personnel capable of conducting them [10]. Therefore, in order to assess the effectiveness of control, a list of criteria that would characterize this category must be substantiated, and an approach to assessing the effectiveness of control should be developed.

## 6.2 JUSTIFICATION OF THE CRITERIA OF EFFECTIVE CONTROL

The substantiation of the criteria for effective control is an integral part of control at the motor transport enterprise. Criteria are requirements for assessing phenomena, objects, people, etc.

The algorithm shown in **Fig. 6.1** was used to develop criteria for effective control.

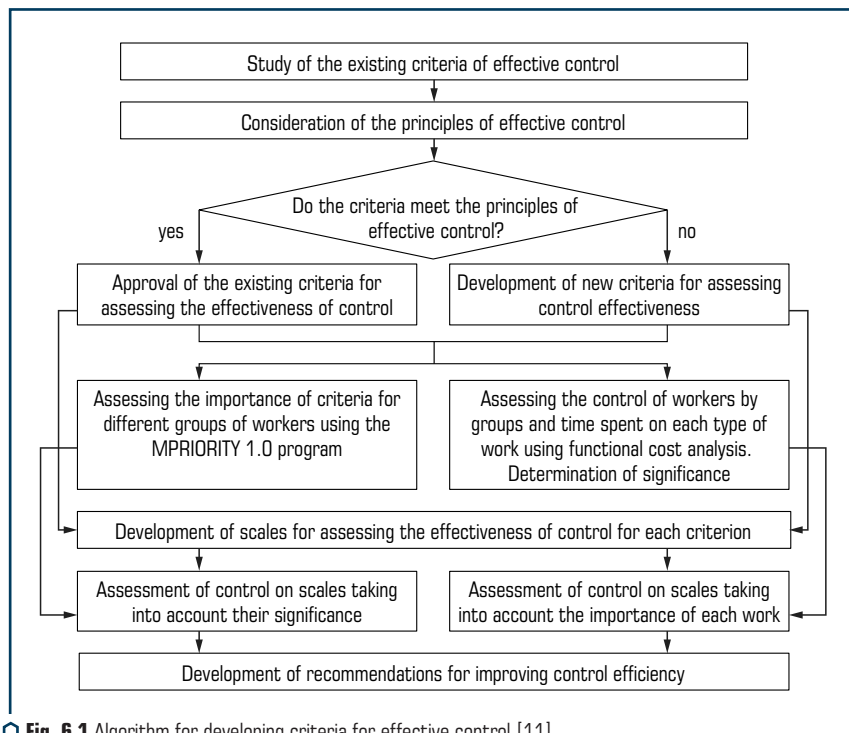


Fig. 6.1 Algorithm for developing criteria for effective control [11]

Source: author's development

The effectiveness of control involves determining the degree of expediency of its implementation, which consists in comparing the usefulness of control (avoidance of costs associated with deficiencies in the future) and costs of control (costs for material support of control and personnel, as well as costs for eliminating deviations).

Control measures affect the company's personnel in different ways. On the one hand, they stimulate the improvement of the quality of work, create a sense of satisfaction, and stimulate the acquisition of knowledge [12]. On the other hand, control measures cause demotivation of mistrust, atypical behavior of the person being checked and other negative manifestations. That is why control measures should be carried out in such a way as not to cause a defensive reaction in the persons being checked.

In order to form an effective system of control of the company's employees, it is necessary to adhere to the criteria for the organization of control processes. Which include:

- effectiveness of control;
- effect of influence on people;

- performance of control tasks;
- limits of control (limitation of control) [13].

One of the main criteria is the performance of control tasks. The results of control can be the detection of deviations and overlaps in the implementation of projects, the elimination of deviations, the correction of standards and plans, relative to the change in the conditions of the enterprise, as well as the achievement of the effect of experience based on the analysis of the causes of deficiencies [14].

Based on the fact that we are talking about monitoring the work of personnel, the development of criteria should take into account the criteria used to assess personnel (an example of such criteria is given in **Table 6.1**).

● **Table 6.1** Criteria used for personnel assessment

<b>Indexes</b>	<b>Criterion</b>
Quantitative indicators	Labor productivity, sales volume in pieces, kilograms, meters, etc.; revenue, the number of signed contracts, processed documents, responses to advertisements
Quality of work	The number of errors when filling out forms, information and other documents, printing papers, the number of claims (complaints) from customers, losses from poorly executed or rejected work
Individual characteristics of the employee	Personal qualities (personal maturity, sociability, emotional stability, etc.); peculiarities of work behavior (relations with clients, discipline, helping employees, etc.); business qualities (independence, responsibility, initiative, etc.)

Performance measurement criteria can be expressed as:

- by results – for example, productivity, the number of new customers, the volume of products produced, the volume of sales, services provided on time, the number of employees who have met the requirements of the work profile (competencies), etc.;
- finance – indicators such as return on invested capital, profit before deduction of interest, taxes, depreciation, gross income;
- time – for example, the time to close the vacancy, the speed of response to the received order (the time period between the receipt and execution of the order), the solution of the task within the set deadline, the period from the beginning of the development of the product to its release on the market, delivery time, etc.;
- ratio – for example, the ratio of the volume of sales to the number of personnel, the personnel turnover rate, the rate of loss of working time, etc. [15].

The concept of control effectiveness is closely related to the concept of its effectiveness, since the final result, that is, the set of objective consequences of control, is the main criterion for determining its effectiveness [16]. It is not possible to draw conclusions about the results of control without determining the consequences that affected the content of the activity of the controlled object. The effectiveness criterion is related to the control effectiveness criterion.

The latter reflects the positive impact of control on the subject of control and the ability of the subject of control to ensure full and timely implementation of instructions, recommendations and requirements by the subject of control [16, 17].

With the help of control, the economy of the activity of the motor vehicle enterprise is achieved, which is a prerequisite for the implementation of the efficiency of this activity. Achieving efficiency through the link of the control system is impossible without ensuring economy [9, 18]. In general, the conclusion regarding the effectiveness of the control system is a subjective opinion that arises as a result of the assessment of control elements and the degree of their effective functioning. Therefore, it is important to carry out the assessment with the involvement of a group of experts and taking into account the results of the assessment of individual control elements.

The ratio of the result (effect) to the costs that ensured its receipt is a definition of efficiency. It reveals the nature of the cause-and-effect relationships of production and shows at what cost the result was achieved. This explains the fact that efficiency is mainly characterized by relative indicators, which are calculated on the basis of result parameters and cost parameters.

The effect expresses the result, the consequence of certain actions. It can be measured in material, social, monetary terms. Therefore, such control is effective, the result of which corresponds to the expected while minimizing the costs of its implementation and acceptable risks.

The basis of the creation of all control systems should be the effectiveness of control, which includes: fulfillment of obligations; prevention of deficiencies; determining the expediency of control costs. At the same time, the main aspects should be: reduction of costs associated with the detection and elimination of deviations as a result of control; reduction of control costs; reduction of costs for personnel and equipment involved in the control process.

In order for control to be able to use its true task, to be effective, it must possess certain criteria, which in turn must fully comply with the principles of effective control.

Liana Skibitska and Oleksandr Skibitskiy [19] propose to highlight the following criteria for effective control: strategic orientation, which involves the analysis of key issues of the company's activity, rather than focusing on non-principled shortcomings of the work; orientation to the result consists in subordinating all controlling actions to the desired goals and expected results of the enterprise's activity; compliance with the case consists in objective measurement and assessment of what is really important and what corresponds to the type of activity of the enterprise; the timeliness of control consists in the possibility of eliminating deviations before they become significant; the flexibility and simplicity of control consists in its adaptation to the variability of the internal and external environment and the application of simple control methods; the economics of control is that the cost of control should not exceed the profit from it.

A comparison of the proposed control assessment criteria with the principles showed that not all principles are covered by this system of criteria, therefore it is proposed to include a number of criteria in the system of control effectiveness assessment criteria, this list is given in **Table 6.2**.

● **Table 6.2** Compliance of the criteria with the principles of effective control

Criteria	Principles										
	Strategic direction	Orientation on results	Relevance to the case	Timeliness and flexibility	Economic control	Compliance with qualification standards	Connection with the planning process	Dissemination of control over all personnel	Continuity and regularity	Focus on processes	Transparency
Existing criteria											
Compliance with the nature of the process being controlled			+								+
Economy					+						
Orientation on results		+									
Presence of a clear strategic direction	+						+			+	
Timeliness and flexibility				+							
The proposed criteria to enter into the existing system assessment criteria											
Engagement to monitoring of employees								+			
Continuity and regularity of implementation									+		
Reward for achieving standards											
Degree of transparency										+	
											+

Thus, using the **Table 6.2** a more complete list of criteria for effective control was formed, which includes 9 criteria. The resulting list of criteria for assessing the effectiveness of control will allow for a comprehensive, comprehensive and objective assessment. This will bring the company closer to achieving its goals. The resulting system of criteria requires determining the significance of each of them in the overall system, taking into account the specifics of the work of each category of the company's personnel and the development of assessment scales.

Several methods were used to assess the effectiveness of the company's personnel control based on data on the work of one of Kharkiv's motor transport companies.

Many factors affect the effectiveness of the company's personnel control, but these factors are unequal and affect the effectiveness in different ways.

With the help of the method of analysis of hierarchies, the significance of the criteria for assessing the effectiveness of control was determined: compliance with the nature of the control process; economy; result orientation; the presence of a clear strategic orientation; timeliness and flexibility; the degree of involvement in the control of employees; degree of continuity and regularity of conduct; reward for achieving standards; degree of transparency. The MPRIORITY 1.0 program was used in the calculations.

The significance of the criteria was assessed from the point of view of different categories of workers. The results of the significance of the criteria were later used to calculate the weighted scores.

Similar results were obtained for other groups of employees. Basically, the priorities of the groups differ among themselves, which is explained by the different specifics of the work.

In addition, the final result was obtained, which showed that the most important criterion in general for ATP for all categories of workers is the reward for achieving standards (0.2819), the least important is the degree of involvement in the control of employees (0.0452).

Then, using the scaling method, the appropriateness scales for each criterion were determined (the scales are shown in **Tables 6.3–6.11**).

◆ **Table 6.3** Scale of compliance with the nature of the control process (K1)

Characteristics of the criterion	Rating
It clearly corresponds to the nature of the controlling process	5
Mostly corresponds, but there are minor inconsistencies	4
Levels of conformity and non-conformity coincide	3
Inconsistencies in the nature of the controlling process are much more numerous than those of the nature of the control process	2
It does not correspond to the nature of the controlling process at all	1

◆ **Table 6.4** Scale of compliance with the "economical" criterion (K2)

The value of the profitability indicator, %	Rating
81–100	5
61–80	4
46–60	3
21–45	2
0–20	1

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● **Table 6.5** Scale of compliance with the "result orientation" criterion (K3)

<b>The value of the income indicator in thousand hryvnias/year</b>	<b>Rating</b>
More than 10,000 thousand UAH	5
From 3,000 to 10,000 thousand UAH	4
From 1,000 to 3,000 thousand UAH	3
From 500 to 1,000 thousand UAH	2
Up to 500 thousand UAH	1

● **Table 6.6** Scale of compliance with the criterion "the presence of a clear strategic orientation" (K4)

<b>Characteristics of the criterion</b>	<b>Rating</b>
There is a clear strategic orientation	5
The strategic orientation is not entirely clear	4
The strategic orientation is poorly and vaguely defined	3
There is almost no strategic orientation	2
There is no strategic direction at all	1

● **Table 6.7** Scale of compliance with the criterion "timeliness and flexibility" (K5)

<b>Characteristics of the criterion</b>	<b>Rating</b>
Control is simple, and the assessment process adequately corresponds to the phenomenon under control	5
Control is simple, but assessments are not quite timely	4
Control of medium difficulty, assessment is not quite on time	3
Control of medium difficulty, assessment is not regulated	2
Control is very difficult, assessments are not regulated	1

● **Table 6.8** Scale of compliance with the criterion "degree of involvement in employee control" (K6)

<b>Characteristics of the criterion</b>	<b>Rating</b>
The level of engagement is very high	5
The degree of engagement is above average	4
The degree of involvement is average	3
The degree of engagement is below average	2
The degree of engagement is very low	1



● **Table 6.9** Scale of compliance with the criterion "degree of continuity and regularity of conduct" (K7)

Characteristics of the criterion	Rating
The scheduled time of return and the signature in the dispatch log match	5
The driver was no more than 5–10 minutes late	4
The driver was 10–15 minutes late	3
The driver was 15–30 minutes late	2
The driver returned very late: more than 30 minutes	1

The criterion "reward for achieving standards" is proposed to be calculated as the ratio of the number of bonuses issued to the number of workers whose work results are subject to bonuses in percentage.

● **Table 6.10** Scale of compliance with the criterion "reward for achieving the standard" (K8)

Criterion value %	Rating
81–100	5
61–80	4
46–60	3
21–45	2
0–20	1

● **Table 6.11** Scale of compliance with the "degree of transparency" criterion (K9)

Characteristics of the criterion	Rating
Information on all results of control measures is fully available	5
Information about the results of the work is partially classified	4
About 50 % of information about performance is available	3
Information on the results of control measures for an individual employee (department) is partially available	2
Information about the results of control measures is closed	1

Of the nine criteria, the value of three can be obtained with the help of calculations and, using the appropriate scale, determine the rating. These are the criteria of economy, orientation to the result and reward for achievements. The rest of the criteria need to be assessed by experts (managers and other experienced workers of the enterprise). Such an assessment was carried out and the average score for each criterion was determined.

The next step is to determine the weighted assessment, which takes into account the importance of the criteria for each group of employees. The result of the calculation is given in **Table 6.12**.

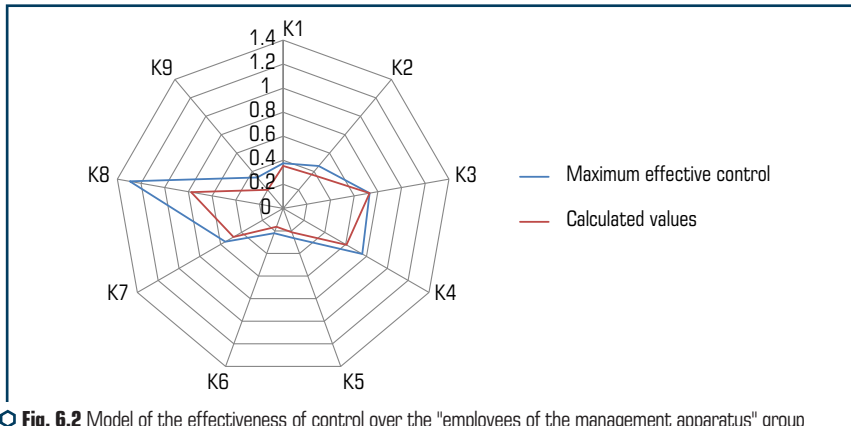
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● **Table 6.12** Results of assessment of criteria for each group of workers

Criterion	Score in points			Significance			Final assessment		
	Y	D	R	Y	D	R	Y	D	R
Compliance with the nature of the control process (K1)	4.7	5	3.7	0.075	0.069	0.133	0.353	0.345	0.492
Economy (K2)	4	4	4	0.092	0.134	0.096	0.368	0.536	0.384
Orientation to the result (K3)	5	5	5	0.146	0.212	0.085	0.73	1.06	0.425
Presence of a clear strategic orientation (K4)	4	4.3	3.7	0.152	0.12	0.079	0.608	0.516	0.292
Timeliness and flexibility (K5)	4	4.3	4	0.053	0.042	0.1	0.212	0.181	0.4
The degree of involvement in the control of employees (K6)	3.7	4.3	3.7	0.044	0.017	0.062	0.163	0.073	0.299
Degree of continuity and regularity of conduct (K7)	4.3	4	4	0.111	0.045	0.051	0.477	0.18	0.204
Reward for achieving standards (K8)	3	3	3	0.259	0.276	0.331	0.777	0.828	0.993
Degree of transparency (K9)	3	3	3.7	0.067	0.086	0.062	0.201	0.258	0.229
Result	–	–	–	–	–	–	3.889	3.977	3.718

Note: A – employees of the management apparatus of the enterprise; D – drivers; R – repair workers

Using the radar method, control efficiency models for each group of employees were built (Fig. 6.2–6.4).



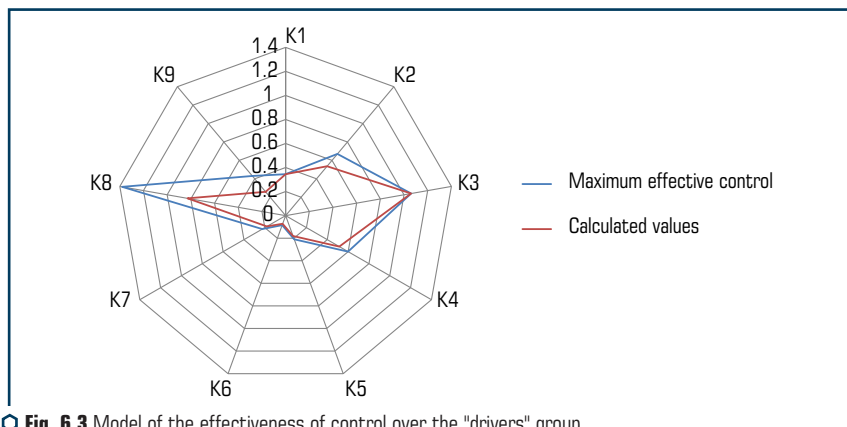
● **Fig. 6.2** Model of the effectiveness of control over the "employees of the management apparatus" group  
Source: author's development

**Fig. 6.2** shows that the values of criteria K1 and K3 correspond to the maximum value of control efficiency, criteria K2, K5 and K6 are very close to the maximum value. The remaining criteria

require appropriate improvement of the control system for workers of the management apparatus. Particular attention should be paid to criterion K8 – reward for achieving standards.

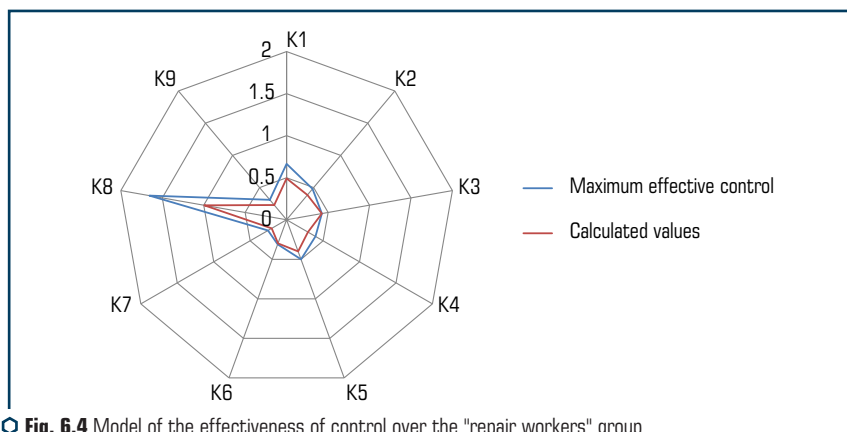
The control effectiveness model for the group of "driver" employees is shown in **Fig. 6.3**.

**Fig. 6.3** shows that criteria K1, K3, K5, K6 and K7 correspond to the maximum value of control efficiency, criterion K4 is located closest to the maximum value, and criteria K2, K8 and K9 need improvement in the existing control system of workers of the "drivers" group. Particular attention should be paid to criterion K8.



**Fig. 6.3** Model of the effectiveness of control over the "drivers" group  
Source: author's development

The control effectiveness model for the group of workers "repair workers" is shown in **Fig. 6.4**.



**Fig. 6.4** Model of the effectiveness of control over the "repair workers" group  
Source: author's development

In this model, criteria K3, K6 and K7 correspond to the maximum value. The model needs improvement due to the remaining criteria.

In order to make a final conclusion about the effectiveness of the control systems of workers of different groups of the enterprise, it is possible to build a comparative table (**Table 6.13**) and develop recommendations.

● **Table 6.13** Comparative table of conformity of control efficiency criteria to the maximum value

Criterion	Groups of workers			Result
	Y	D	R	
Compliance with the nature of the control process (K1)	+	+	+, -	Very good
Economy (K2)	+, -	-	+, -	Satisfactorily
Orientation to the result (K3)	+	+	+	Perfectly
Presence of a clear strategic orientation (K4)	-	+, -	+, -	Satisfactorily
Timeliness and flexibility (K5)	+, -	+	+, -	Fine
Degree of involvement in the control of employees (K6)	+, -	+	+	Very good
Degree of continuity and regularity of conduct (K7)	-	+	+	Satisfactorily
Reward for achieving standards (K8)	-, -	-, -	-, -	Unsatisfactorily
Degree of transparency (K9)	-	-	+, -	Badly

As the **Table 6.13** shows, the primary task of the enterprise's control system is to improve the material incentive systems of all groups of enterprise employees. Considerable weight should be given to ensuring the transparency of control results with the help of an informational component. Such aspects of the control system as cost-effectiveness, the presence of a clear strategic direction, and the degree of continuity and regularity of control also require improvement.

In order to assess the time spent on the work, the work instructions of the workers were used to determine the list of works that are performed in one or another position. 3 categories of the company's personnel were taken into account: specialists (manager of the operation department), drivers and repair workers. Next, for each work, the essence of the previous, current and final control was determined, and with the help of an expert survey, the time spent was determined.

A fragment of the received data for the personnel of the technical and operational department of the motor vehicle enterprise is given in **Table 6.14**.

The relevant list of control works by its types and possible time expenditure is compiled for other categories of personnel.

The main sources of cost reduction are: elimination of unnecessary work; elimination of harmful works; combination of auxiliary works; finding solutions in which the same material medium of work would perform several works; reduction of excess consumer properties for which there is no real need.

● **Table 6.14** Composition of works by types of control and time spent on their execution

<b>Work in progress</b>	<b>Preliminary control</b>	<b>Current control</b>	<b>Final control</b>	<b>Spending time</b>	
1.1 Development of rational systems and planning of transportation, organization of movement of rolling stock	1.1.1 Study of the quantity and frequency of the quality of orders for the previous 3 years. Study of rolling stock of ATP and their transport capacities	1.1.2 Development of route sheets. Checking the availability of: transportation planning systems; timetables and traffic schedules. Verification of compliance of the fact with the plan	1.1.3 Checking customer satisfaction using a telephone survey. Verification of compliance with the route specified in the route sheet	7 days	2 days every week
1.2 Ensuring the implementation and functioning of advanced systems of dispatching control of car traffic	1.2.1 Checking the availability of advanced dispatch control systems and personnel who could manage them at the ATP	1.2.2 Checking the functioning of dispatching equipment	1.2.3 Checking the effectiveness of the dispatch control system	3 days	1 day every week
1.3 Full, timely, comfortable and safe transportation of passengers and cargo	1.3.1 Market demand analysis. Determining customer wishes (using questionnaires)	1.3.2 Checking the technical condition of cars. Checking the conditions of transportation	1.3.3 Conducting customer satisfaction surveys	4 days	1 day every week
1.4 Organization of effective use of rolling stock and its profitable operation	1.4.1 Verification of compliance of rolling stock, type of cargo and customer wishes, analysis of operating conditions, justification of choice	1.4.2 Checking the compliance of the actual use of rolling stock with the planned	1.4.3 Comparison of all costs and profits from the use of PC at the end of each month	10 days	2 days every week
1.5 Creation of conditions for highly productive work of maintenance service employees	1.5.1 Studying the wishes of workers with the help of a survey. Comparison of the existing conditions with the desired ones and recognition of correspondences. Checking the availability of the conditions creation plan	1.5.2 Checking compliance with conditions	1.5.3 Checking the quality of work performance by comparing the obtained results with the planned ones	1 day	1 day every week
1.6 Generalization of advanced driving methods and advanced work experiences	1.6.1 Checking the availability of specialists at the enterprise who have advanced work methods. Checking the availability of professional development plans	1.6.2 Verification of the implementation of employee training plans	1.6.3 Review of all costs and benefits of implementing best practices for work and driving at the end of each month	2 days	2 days every week
1.7 Systematic implementation of educational work with drivers and dispatchers	1.7.1 Checking the availability of the educational work schedule	1.7.2 Carrying out educational work and checking the attendance of workers at meetings	1.7.3 Checking whether all the prescribed points have been met by means of accident reporting	1 day	4 days 1 day

## 6 ASSESSMENT OF THE EFFICIENCY OF WORK CONTROL OF THE EMPLOYEES OF THE MOTOR TRANSPORT ENTERPRISE

Next, using the **Table 6.14**, the time needed to perform each function per year was calculated, assuming that there are 23 working days of 8 hours per month.

Another important point in FCA is determining the significance of works. For this, a survey of experts from among the company's employees was conducted. The results of the significance of works by types of control are given in **Table 6.15**.

● **Table 6.15** Significance of works by types of control

No. of works	Significance by types of controls		
	Previous	Current	Final
1.1	0.3	0.45	0.25
1.2	0.25	0.3	0.45
1.3	0.4	0.35	0.3
1.4	0.25	0.35	0.4
1.5	0.5	0.2	0.3
1.6	0.3	0.35	0.35
1.7	0.2	0.55	0.25
2.1	0.25	0.45	0.3
2.2	0.2	0.55	0.25
2.3	0.25	0.5	0.25
2.4	0.35	0.4	0.25
2.5	0.15	0.6	0.25
2.6	0.2	0.5	0.3
2.7	0.25	0.45	0.3
2.8	0.35	0.35	0.3
2.9	0.25	0.35	0.4
2.10	0.25	0.45	0.3
2.11	0.3	0.35	0.35
3.1	0.25	0.35	0.4
3.2	0.33	0.33	0.34
3.3	0.2	0.4	0.4
3.4	0.35	0.4	0.25
3.5	0.2	0.35	0.45
3.6	0.45	–	0.55
3.7	0.25	0.4	0.35

Works are listed by numbers. Works starting with the number 1 correspond to control works for employees of the technical and operational department of the enterprise. Works starting with the number 2 – for drivers, and with the number 3 – for repair workers.

Using the **Table 6.15** it was determined which of the works are the most important, for this three different experts assessed the works using a 5-point scale, which is presented in **Table 6.16**, a fragment of the calculation results will be presented in the form of a **Table 6.17**.

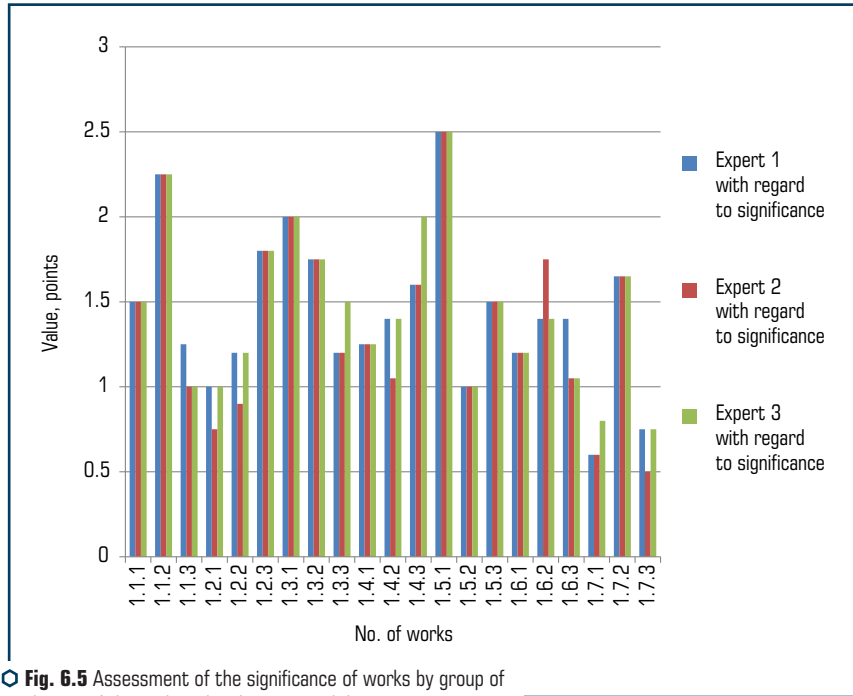
● **Table 6.16** Assessment scale of performed works

Points	Value
5	Work is necessary
4	Work is important, but not always
3	Work is important, but sometimes it is not necessary at all
2	Work is not very important
1	The work is almost not important, you cannot do it

● **Table 6.17** The results of assessment of works by experts

No. of works	Assessments			Significance	Importance with regard to significance
	Expert 1	Expert 2	Expert 3		
1.1.1	5	5	5	0.3	4.5
1.1.2	5	5	5	0.45	6.75
1.1.3	5	4	4	0.25	3.25
1.2.1	4	3	4	0.25	2.75
1.2.2	4	3	4	0.3	3.3
1.2.3	4	4	4	0.45	5.4
1.3.1	5	5	5	0.4	6
1.3.2	5	5	5	0.35	5.25
1.3.3	4	4	5	0.3	3.9
1.4.1	5	5	5	0.25	3.75
1.4.1	4	3	4	0.35	3.85
1.4.3	4	4	5	0.4	5.2
1.5.1	5	5	5	0.5	7.5
1.5.2	5	5	5	0.2	3
1.5.3	5	5	5	0.3	4.5
1.6.1	4	4	4	0.3	3.6
1.6.2	4	5	4	0.35	4.55
1.6.3	4	3	3	0.35	3.5
1.7.1	3	3	4	0.2	2
1.7.2	3	3	3	0.55	4.95
1.7.3	3	2	3	0.25	2

This is more clearly presented in **Fig. 6.5**.



**Fig. 6.5** Assessment of the significance of works by group of employees of the technical and operational department  
*Source: author's development*

In **Fig. 6.5**, it can be seen that the least important works of the technical and operational department are: checking the quality of the schedule of educational works (1.7.1) and checking whether all the prescribed points have been fulfilled by means of accident reporting (1.7.3).

In order to reduce time spent, it is recommended to exclude or combine these works with others (depending on whether the company needs them).

Having considered all the works performed at the enterprise, the task is to group them, thereby reducing the time spent on their implementation. For this, let's use cluster analysis.

Cluster analysis allows to classify observations or objects into homogeneous groups called clusters.

Classification is carried out with the help of numerous computational procedures on the research objects. As a result of calculations, groups of very similar objects are formed. This type of analysis allows classifying objects by several features at the same time. By objects, let's understand the work performed at the enterprise by the technical and operational department, drivers and repair workers, without assigning them to three types of control: preliminary, current and final.



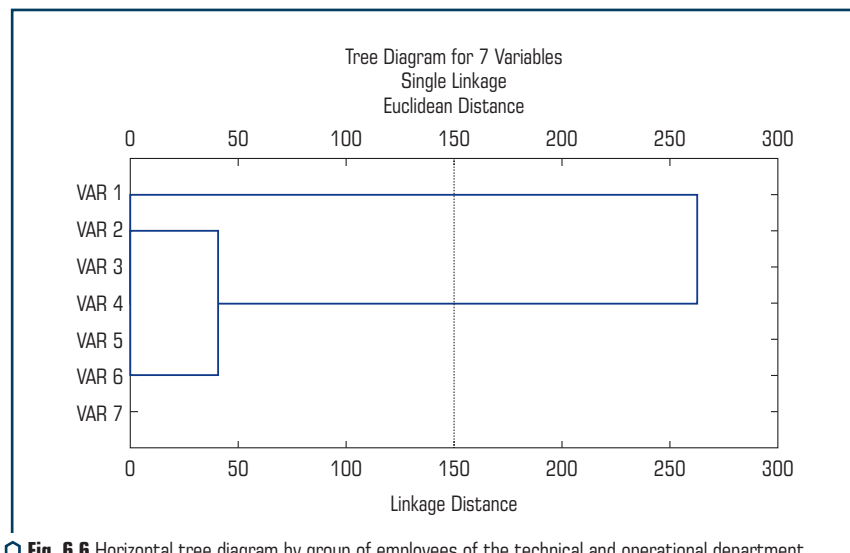
Works in clusters will be grouped according to two features: duration and importance. The combination of indicators will be carried out for similar tasks and for closer values of these indicators.

To build clusters, let's consider the work performed by different groups of workers (**Table 6.18**). STATISTIKA program was used to build clusters (**Fig. 6.6**).

**Fig. 6.6** shows that two clusters were formed for the group of employees of the technical and operational department, the first cluster included the following works: 1.2, 1.3, 1.4, 1.5, 1.6. Later, work 1.1 was combined with it. The cluster analysis showed that work 1.7 (systematically conducts educational work with drivers and the dispatcher) is not included in the clusters, so it is suggested to combine it with work 1.6 (generalization of advanced driving methods and advanced work practices).

● **Table 6.18** Criteria for the group of employees of the technical and operational department

Work number	Duration hours	Importance
1.1	136	14.5
1.2	64	11.45
1.3	72	15.15
1.4	160	12.8
1.5	56	15.0
1.6	88	11.65
1.7	48	8.95



● **Fig. 6.6** Horizontal tree diagram by group of employees of the technical and operational department  
Source: author's development

Thus, the proposed method makes it possible to identify reserves, with the help of which it is necessary to prove the expediency of these costs or to find specific solutions for their elimination or reduction.

### 6.3 DISCUSSION OF THE RESULTS AND ASSESSMENT OF THE EFFECTIVENESS OF THE CONTROL OF THE MOTOR VEHICLE ENTERPRISE EMPLOYEES

Competitive struggle requires an established control system from the enterprise. Control of the company's personnel is the most important task [20]. It helps ensure the achievement of goals due to discipline, accumulation of efforts, revealing the potential of employees and timely detection of deviations from norms and standards. The proposed method of assessing the effectiveness of the control of the personnel of the motor vehicle enterprise helps to identify the weakest points in the existing control system. This technique takes into account the peculiarities of control for different groups of employees and the importance of assessment criteria. It is complex in nature and helps to find ways to improve the company's control system. In addition, the proposed method of assessing costs for the implementation of the company's personnel control function helps to identify the least significant works in the existing control system and thereby contributes to the simplification of the system itself, reducing the costs of its support and increasing the efficiency of the company's activities.

It is also worth noting that the road and transport complex includes a large number of components. In the following sections, attention will be focused on the development of railway transport.

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# STRATEGIC PRIORITIES FOR THE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES IN THE CONTEXT OF ENSURING THEIR DIGITAL TRANSFORMATION

Olena Kirdina, Iryna Tokmakova, Myroslava Korin, Illia Dmytriiev

## ABSTRACT

Global trends in the development of the world transport complex indicate that digitization is the key tool for the transformation of its business models and service provision system today. Technologies of the Internet of Things, artificial intelligence, big data, memory on a neural network, unmanned transport, Blockchain, automated processes using robotic systems allow not only to organize the work of enterprises in a qualitatively new way, but also to change the system of relations with stakeholders, ensuring the formation of a system values in accordance with the needs of modern consumers.

The successful future of domestic railway transport enterprises depends on the level and progressiveness of implemented digital technologies, which will allow optimizing operational activities in the industry, increasing the effectiveness and efficiency of management actions, and qualitatively improving the level of customer service. These circumstances indicate the expediency of considering the scientific and applied problem of determining strategic priorities for ensuring the digital transformation of railway transport enterprises in the dynamic conditions of their operation.

## KEYWORDS

Digitalization, transformation, railway transport, digital development, innovative progress.

## 7.1 DIGITIZATION AS A KEY TOOL FOR THE DEVELOPMENT OF THE TRANSPORT COMPLEX

Digitization is a key tool for the development of the transport complex today. Digitization includes the processes by which digital technologies and information are used by railway companies to change their organizational models, improve efficiency and create new values. From companies, digitalization requires a customer-oriented business strategy and major organizational changes. So, for example, the use of digital modeling technologies or VIM technologies makes it possible to transform the process of designing, building and operating railway infrastructure by creating an opportunity to model the infrastructure object virtually, without spending time on making its prototype. Big data technologies, which allow monitoring their parameters and managing maintenance processes in real time, also create huge opportunities for maintaining infrastructure and rolling stock in a technically sound condition. The use of data array technologies makes it possible to move to a new system of managing the condition of railway infrastructure objects and rolling stock,

namely to manage their life cycle, thereby ensuring the improvement of the effectiveness of repair measures and the optimization of costs for their implementation.

In the field of providing services to passengers, digital technologies make it possible to introduce new service quality standards based on the principles of interoperability, omnichannel and customer orientation. The use of Blockchain technology due to the creation of cross-corporate applications allows not only to identify passengers, reliably track the location of cargo, train or passenger, form smart contacts and purchase tickets, but also to develop progressive loyalty programs for customers, thereby supporting effective communication with consumers of transport services. In addition, a significant potential for the formation of an adaptive customer relationship management system is created by mobile applications that allow the implementation of a wide range of virtual services, starting with trip planning and ending with the support of the individual safety of each passenger [1].

The implementation of platform solutions is also observed in the field of personnel management of railway transport enterprises, which, as evidenced by the experience of European railway companies, allow not only to effectively manage the processes of adaptation, training and stimulation of employees, but also to implement an effective policy to support the company's HR branding. The most promising technological directions in the field of transport, which include:

5G technologies: devices to detect errors in received information or to prevent them; a transmission control procedure, for example, a channel level control procedure; means of synchronization; systems of automatic repetition, for example, the van Duuren system; services specially adapted for wireless communication networks in which location information is used [2].

Connected (connected) transport: closed television systems in which the signal is not used for broadcasting; computer systems based on specific computational models; structural elements – means of cooling.

Big data: electrical or hydraulic circuits designed specifically for vehicles to transmit signals between vehicle systems or subsystems; a transmission control procedure, for example, a channel level control procedure; special purpose aircraft; means or devices for reading or recognizing printed or written characters, or for recognizing images, for example, fingerprints; in determining or calculating movement parameters used in the traffic control system of a road vehicle – driving style or mode [3].

Let's consider the prerequisites, opportunities and risks that form in the environment of the functioning of railway transport enterprises under the influence of digital transformation processes.

## **7.2 THE OPERATING ENVIRONMENT OF RAILWAY TRANSPORT ENTERPRISES: PREREQUISITES, OPPORTUNITIES AND RISKS**

The first precondition of the external level, which caused significant challenges for the digital transformation of domestic business structures "Development and transition of the world economy to the Age of Industry 4.0". In the conditions of the formation of the information society in various sectors of the economy, a huge amount of various data is created and accumulated [4].

In industry and business, the flow of information necessary for enterprise management is constantly growing. If in the past the most important factor of competitiveness and value creation for enterprises was the state of cost management and the quality of products (services), today and in the future, along with the physical product itself, the data obtained from digital marketing and smart analytics are gaining more and more value.

In order to transition to intelligent management of business processes, optimize the use of labor force and increase the efficiency of business, Ukrainian business structures need to move to the widest implementation of the Concept of the "Fourth Industrial Revolution" (English "Industry 4.0") as soon as possible, making the most of its opportunities [5].

The project of the "Digital Agenda-2010" Concept, developed by specialists of the PA "High Tech Office" [6], is an initiative on the issue of digitalization of the economy. In the mentioned draft concept, the authors propose a forced scenario of digitization of the country, the key strategy of which is to work with the internal market, and the leading initiatives should be the formation of the subjects of the digital space of business, the state and citizens, motivation and the need to use new digital technologies.

The strategy offers an accelerated path, and the main tools that allow for a reactive breakthrough, according to the authors, should be the tools of the economic mechanism with the use of tax and customs policy tools for the introduction of special import duties on equipment and technologies intended for the development of the digital sphere, which would make it possible to reduce the cost digital means of software, equipment; implementation of lending tools for digitization of business and production projects; funding through the creation of special funds for joint investment, venture investment, which would provide financial stimulation for the development of the digital technology sector, improve the investment climate in the country and create prerequisites for attracting foreign investment in the digital technology sector [7].

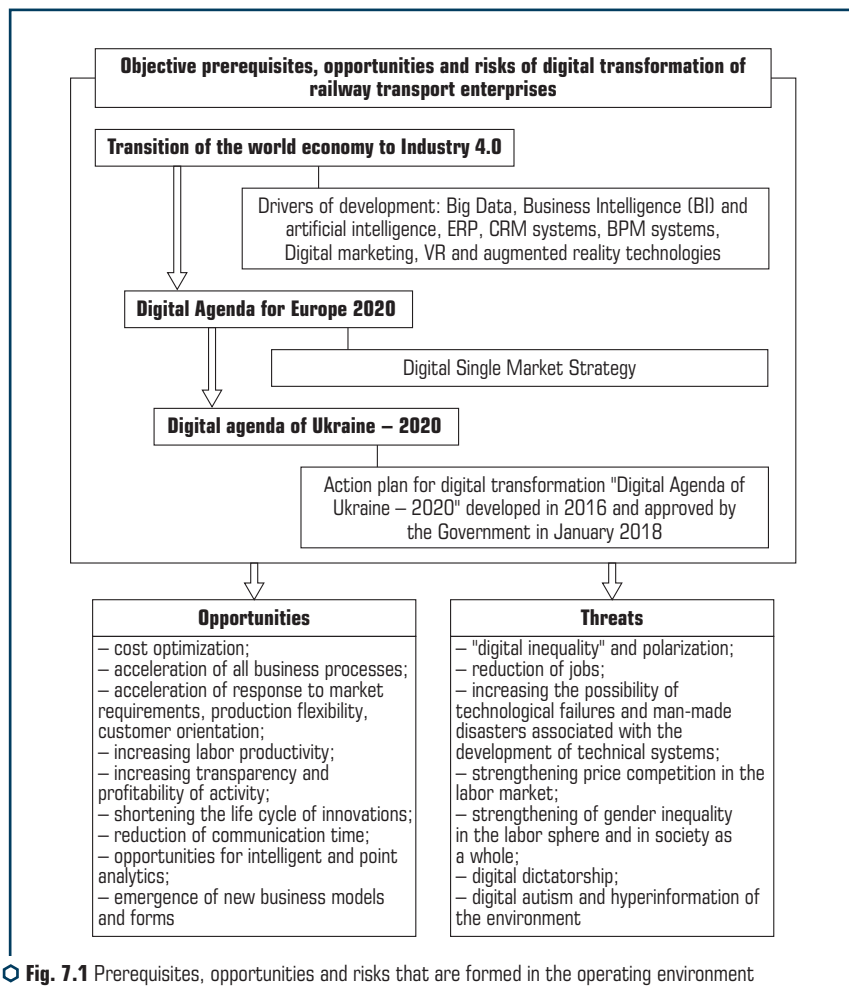
Prerequisites, opportunities and risks that form in the environment of the functioning of railway transport enterprises under the influence of digital transformation processes are presented in **Fig. 7.1**.

Digitization of the world economy creates a number of opportunities and threats in the process of digital growth of enterprises, including railway transport enterprises.

World experience proves that the processes of digitalization of industries, enterprises, including railway transport enterprises, have three defining characteristics, which are expressed in the development of cooperation, intelligence and the innovation production system. Instead of reactively carrying out fragmented vertical digitalization, most economically developed countries choose a strategy of continuous joint transformation. As industries strive to go digital, they increasingly rely on platforms, sharing mechanisms, and artificial intelligence. This, in turn, involves the development of open and joint innovation systems, equipped with all the necessary elements and resources and functioning in a favorable institutional environment.

The digital transformation process is long-term and includes five stages: pilot, local expansion, replication, operations management, optimization and innovation. Among the majority of enterprises that have chosen the path of digital transformation, more than 70 % are currently in the

"local expansion" and "replication" stages, while only 3.9 % have reached the "optimization and innovation" stage. As world practice proves, the processes of digital transformation of large enterprises are long-term and large-scale from the point of view of the use of investments [8].



**Fig. 7.1** Prerequisites, opportunities and risks that are formed in the operating environment of railway transport enterprises under the influence of digital transformation processes  
Source: author's development

When choosing a digital transformation strategy, it is extremely important to achieve changes in such areas of the company's activity as informativeness, culture, organization, methodology, model.

Changes in the field of informativeness should take place through, firstly, the introduction of progressive software tools and technologies, and, secondly, focusing on the needs of the market, developing the ability to sense these needs in real time and promptly respond to them in order to create value for customers and users [9].

It is possible and necessary to lay a solid foundation for digitalization and continue to enrich and optimize options for using digital solutions by implementing digital objects, processes and rules.

Therefore, digitalization processes require the implementation of significant changes in the company and require the latter to be receptive to the introduction of digital innovations. The latter depends on the level of digital maturity of the company and its ability to support and implement transformations.

Corresponding requirements are also being put forward to railway transport enterprises that have embarked on the path of digital transformation. Undoubtedly, the ability of railway transport enterprises to successfully carry out digital reforms and create a digital image of the industry depends on their ability to perceive various types of digital innovations. Since the perception of digital changes depends on the prerequisites formed in the industry for the implementation of digital transformations, let's consider it appropriate to assess the level of digital maturity of railway transport enterprises.

Based on scientific views [10–14] regarding the content of digital maturity of companies, the last category will be defined as the readiness of the enterprises of the industry for transformations due to the introduction of digital innovations.

To assess the level of digital maturity, let's use the direct assessment method (score method), which was carried out with the involvement of 25 experts – specialists and employees of railway transport enterprises. The latter were asked to complete a questionnaire and assess their vision of the level of digital maturity of the industry.

The assessment is proposed to be carried out on the basis of the determination of such indicators as:

- existence of a clearly defined digital transformation strategy (K1);
- level of implementation of new business processes (K2);
- availability of a change management system (K3);
- availability of an internal communications system that ensures clear communication of digitalization goals to employees (K4);
- availability of a personnel motivation system that guides employees to support digital transformations (K5);
- availability of a corporate training system that adapts to the strategic goals of digitization (K6);
- availability of direct communication channels with consumers of transport and logistics services (K7);
- level of digitization of transport services: availability of new digital products and services (K8);
- availability of investments for the purchase of digital solutions (K9);
- level of development of technological partnership with suppliers of digital innovations (K10);
- availability of end-to-end information systems to support key business processes (K11).



The conducted survey of experts regarding the rank of each indicator, who assigned the latter ranks in the range from 1 to 11, allows to establish the importance of each individual indicator and calculate the general value of the level of digital maturity of railway transport enterprises.

**Table 7.1** shows the results of the expert survey and the established values of the specific weight of each indicator.

To find out the specific weight of a partial indicator, let's use the formula:

$$S_{wK_j} = \frac{\sum A_{Kj}}{\sum (\bar{A} - \sum A_{Kj})^2}, \quad (7.1)$$

where  $\sum A_{Kj}$  – the sum of ranks assigned by experts to the  $j$ -th indicator;  $\sum (\bar{A} - \sum A_{Kj})^2$  – the total sum of ranks determined by experts for all partial indicators.

Let's determine the Kendall concordance coefficient, which will allow to establish the quality of the results of expert assessment and talk about the level of agreement of the opinions of the involved experts [15]:

$$W = \frac{S}{\frac{1}{12} \cdot m^2 \cdot (n^3 - n) - m \cdot \sum_{j=1}^m T_j}, \quad (7.2)$$

$$T_j = \sum_{k=1}^{H_j} (h_k^3 - h_k), \quad (7.3)$$

$$S = \sum_{i=1}^n \left( \sum_{j=1}^m r_{ij} - \bar{r} \right)^2, \quad (7.4)$$

$$\bar{r} = \frac{1}{n} \cdot \sum_{i=1}^n r_i, \quad (7.5)$$

where  $T_j$  – the indicator of connected (same) ranks in the  $j$ -th ranking;  $H_j$  – the number of groups of connected ranks in the  $j$ -th ranking;  $h_k$  – the number of connected ranks in the  $k$ -th group of connected ranks with the  $j$ -th expert;  $n$  – number of objects;  $m$  – number of experts;  $r_{ij}$  – the rank assigned by the  $j$ -th expert to the  $i$ -th object;  $\bar{r}$  – the average rank.

To interpret the results of the calculation of the concordance coefficient, let's use a well-known rating scale, where the values of the concordance coefficient in the range of 0.4–0.5, at which the quality of the assessment is satisfactory, and in the range of 0.7–0.8 is high.

**Table 7.2** presents data on the ranks of partial indicators provided by each of the involved experts.

Using the provided assessment, the concordance coefficient was calculated, which indicates a satisfactory level of consistency of experts' opinions, as it is 0.55 and, accordingly, indicates the importance of these partial indicators in the process of assessing the level of digital maturity of railway transport enterprises.

**7 STRATEGIC PRIORITIES FOR THE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES IN THE CONTEXT OF ENSURING THEIR DIGITAL TRANSFORMATION**

● **Table 7.1** Ranking of partial indicators for assessing the level of digital maturity of railway transport enterprises

Expert	Ranks by partial indicators										
	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11
1	2	3	3	5	6	7	8	9	10	11	11
1	8	6	5	7	9	9	7	9	9	9	6
2	7	6	5	6	9	9	9	9	9	9	7
3	9	6	4	7	9	9	9	8	9	9	7
4	9	6	5	6	9	8	8	8	8	8	6
5	9	6	5	8	9	9	7	7	8	8	6
6	7	5	5	6	9	9	8	7	8	8	5
7	8	5	4	5	9	9	9	7	10	9	7
8	8	5	5	5	8	9	9	8	8	7	6
9	8	5	4	6	8	8	9	8	8	10	6
10	9	7	4	7	9	10	8	8	10	9	6
11	9	7	6	5	9	10	7	8	9	9	5
12	9	6	5	7	9	9	7	8	9	9	6
13	9	6	5	6	8	9	8	9	9	8	6
14	9	6	5	5	9	10	9	9	9	7	6
15	9	6	5	6	9	9	8	7	10	9	5
16	8	6	5	6	8	10	7	9	8	9	6
17	8	5	4	6	9	10	8	9	9	8	7
18	9	5	5	6	9	10	8	9	9	9	6
19	9	5	6	6	9	8	8	8	10	9	6
20	9	5	5	5	9	9	8	8	10	8	6
21	8	6	5	6	8	10	8	9	9	7	5
22	8	6	4	6	9	9	8	9	9	7	5
23	9	5	5	5	9	10	9	8	9	9	6
24	9	6	5	6	9	9	7	7	9	9	6
25	9	5	5	5	8	9	8	8	4	9	5
Sum of ranks	213	142	121	149	219	230	201	204	219	212	148
$\sum A_{K_i}$											
Average sum of ranks	187.09	232.27	232.27	232.27	232.27	232.27	232.27	232.27	232.27	232.27	232.27
$\sum (\bar{A} - \sum A_{K_i})^2$											
Deviation from average sum of ranks	25.91	-90.27	-111.27	-83.27	-13.27	-2.27	-31.27	-28.27	-13.27	-20.27	-84.27
The square of the deviation	671	8149	12381	6934	176	5	978	799	176	411	7101
$\sum (\bar{A} - \sum A_{K_i})^2$											
The specific gravity of the indicator $S_{wK_i}$	0.10	0.07	0.06	0.07	0.11	0.11	0.10	0.10	0.11	0.10	0.07

● **Table 7.2** Calculation of consistency of experts' assessments

Expert ratings ( $K$ )	Number of people ( $n$ )	The product of the variant by the frequency ( $\sum K_i = nK$ )	Average score ( $\bar{K} = \frac{\sum K_i}{\sum n}$ )	Deviation of options from the average ( $K - \bar{K}$ )	Squares of deviation ( $(K - \bar{K})^2$ )	Product squared deviations per frequency ( $(K - \bar{K})^2 \times n$ )	Mean square deviation $G = \sqrt{\frac{\sum (K - \bar{K})^2 \times n}{\sum n}}$	$K$ variation, % $K_v = \frac{G \times 100}{\bar{K}}$
1	2	3	4	5	6	7	8	9
<b>K1</b>	4	4		-1.68	2.82	11.29		
1	8	16		-0.68	0.46	3.70		
2	7	21		0.32	0.10	0.72		
3	4	16		1.32	1.74	6.97		
4	2	10		2.32	5.38	10.76		
5	25	67	2.68			33.44	1.16	43.15
<i>In total</i>								
<b>K2</b>	4	4		-1.32	1.74	6.97		
1	9	18		-0.32	0.10	0.92		
2	12	36		0.68	0.46	5.55		
3	0	0		1.68	2.82	0.00		
4		0		2.68	7.18	0.00		
5	25	58	2.32			13.44	0.73	31.60
<i>In total</i>								
<b>K3</b>	4	4		-1.68	2.82	11.29		
1	4	8		-0.68	0.46	1.85		
2	13	39		0.32	0.10	1.33		
3	4	16		1.32	1.74	6.97		
4	0	0		2.32	5.38	0.00		
5	25	67	2.68			21.44	0.93	34.55
<i>In total</i>	4	4		-1.68	2.82	11.29		
<b>K4</b>								
1	2	2		-1.36	1.85	3.70		
2	14	28		-0.36	0.13	1.81		
3	7	21		0.64	0.41	2.87		
4	2	8		1.64	2.69	5.38		
5	0	0		2.64	6.97	0.00		
<i>In total</i>	25	59	2.36			13.76	0.74	31.44

**7 STRATEGIC PRIORITIES FOR THE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES IN THE CONTEXT  
OF ENSURING THEIR DIGITAL TRANSFORMATION**

● **Continuation of Table 7.2**

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
<b>K5</b>								
1	3	3		−1.68	2.82	8.47		
2	6	12		−0.68	0.46	2.77		
3	12	36		0.32	0.10	1.23		
4	4	16		1.32	1.74	6.97		
5	0	0		2.32	5.38	0.00		
<i>In total</i>	25	67	2.68			19.44	0.88	32.90
<b>K6</b>								
1	2	2		−1.64	2.69	5.38		
2	8	16		−0.64	0.41	3.28		
3	13	39		0.36	0.13	1.68		
4	1	4		1.36	1.85	1.85		
5	1	5		2.36	5.57	5.57		
<i>In total</i>	25	66	2.64			17.76	0.84	31.93
<b>K7</b>								
1	7	7		−1.28	1.64	11.47		
2	9	18		−0.28	0.08	0.71		
3	5	15		0.72	0.52	2.59		
4	3	12		1.72	2.96	8.88		
5	1	5		2.72	7.40	7.40		
<i>In total</i>	25	57	2.28			31.04	1.11	48.87
<b>K8</b>								
1	5	5		−1.68	2.82	14.11		
2	6	12		−0.68	0.46	2.77		
3	7	21		0.32	0.10	0.72		
4	6	24		1.32	1.74	10.45		
5	1	5		2.32	5.38	5.38		
<i>In total</i>	25	67	2.68			33.44	1.16	43.15
<b>K9</b>								
1	0	0		−1.64	2.69	0.00		
2	15	30		−0.64	0.41	6.14		
3	4	12		0.36	0.13	0.52		
4	6	24		1.36	1.85	11.10		
5	0	0		2.36	5.57	0.00		
<i>In total</i>	25	66	2.64			17.76	0.84	31.93

● Continuation of Table 7.2

1	2	3	4	5	6	7	8	9
<b>K10</b>								
1	4	4		–1.68	2.82	11.29		
2	7	14		–0.68	0.46	3.24		
3	8	24		0.32	0.10	0.82		
4	5	20		1.32	1.74	8.71		
5	1	5		2.32	5.38	5.38		
<i>In total</i>	25	67	2.68			29.44	1.09	40.49
<b>K11</b>								
1	7	7		–1.32	1.74	12.20		
2	7	14		–0.32	0.10	0.72		
3	8	24		0.68	0.46	3.70		
4	2	8		1.68	2.82	5.64		
5	1	5		2.68	7.18	7.18		
<i>In total</i>	25	58	2.32			29.44	1.09	46.77

In order to say whether the level of digital maturity of railway transport enterprises is acceptable or not, a scale of interpretation of the values of the generalizing indicator has been developed, which provides for the following gradation: the level of digital maturity will be considered high for assessments of 5 points, sufficient – for assessments of 4 points, satisfactory – 3 points, unsatisfactory – 2 points, and critical – 1 point.

**Table 7.2** shows the results of the calculation of the level of agreement of experts' opinions, which allow to speak about the homogeneity of this population, because the value of the coefficient of options for each indicator is within the norm, that is, no more than 33 %. Based on the importance of the partial indicators and the results of the point assessment, let's establish the level of digital maturity of railway transport enterprises based on a defined system of partial indicators that reflect the level of ability and readiness of the enterprises of the industry to implement digital transformations, by calculating the appropriate generalizing indicator:

$$DM_{RTE} = \sum DM_{RTE_{K_i}} \cdot E_{vK_i}, \quad (7.6)$$

where  $DM_{RTE}$  – a general indicator of the level of digital maturity of railway transport enterprises;  
 $DM_{RTE_{K_i}}$  – the level of digital maturity for each partial indicator through the comparison of the maximum possible and actual values;

$$DM_{RTE_{K_i}} = \frac{\sum K_i}{A}. \quad (7.7)$$

## 7 STRATEGIC PRIORITIES FOR THE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES IN THE CONTEXT OF ENSURING THEIR DIGITAL TRANSFORMATION

The calculation of the general indicator of the level of digital maturity of railway transport enterprises, which is given in **Table 7.3**, allows to assert the digital immaturity of railway transport enterprises, that is, their unwillingness to implement digital transformations.

● **Table 7.3** Determination of the level of digital maturity of railway transport enterprises

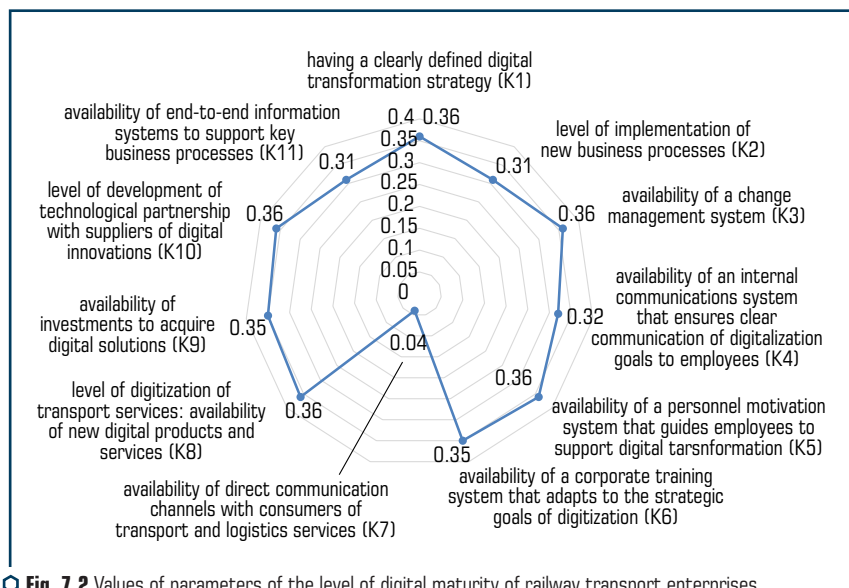
Indicator	Specific weight, %	Average sum of ranks	Actual value of the characteristics and	Assessment of the level of digital maturity by each indicator	General indicator of the level of digital maturity of RTE
Having a clearly defined digital transformation strategy (K1)	10	187.09	67	0.36	<b>0.32</b>
Level of implementation of new business processes (K2)	7	187.09	58	0.31	
Availability of a change management system (K3)	6	187.09	67	0.36	
Availability of an internal communications system that ensures clear communication of digitalization goals to employees (K4)	7	187.09	59	0.32	
Availability of a personnel motivation system that guides employees to support digital transformations (K5)	11	187.09	67	0.36	
Availability of a corporate training system that adapts to the strategic goals of digitization (K6)	11	187.09	66	0.35	
Availability of direct communication channels with consumers of transport and logistics services (K7)	10	187.09	7	0.04	
Level of digitization of transport services: availability of new digital products and services (K8)	10	187.09	67	0.36	
Availability of investments for the purchase of digital solutions (K9)	11	187.09	66	0.35	
Level of development of technological partnership with suppliers of digital innovations (K10)	10	187.09	67	0.36	
Availability of end-to-end information systems to support key business processes (K11)	7	187.09	58	0.31	

To interpret the values of the general indicator of the level of digital maturity of railway transport enterprises, let's use the following scale:

– 0.2–0.39 – critical – the level of digital maturity does not correspond to the trends of digitalization of railway transport, it is necessary to take measures to ensure the digital development of enterprises in the industry;

- 0.4–0.59 – unsatisfactory – the level of digital maturity in most parameters does not correspond to the trends of digitalization of railway transport;
- 0.6–0.69 – average – the level of digital maturity does not fully correspond to the trends of digitalization of railway transport;
- 0.7–1 – high level – railway transport enterprises have a sufficient level of digital maturity to ensure their own digital development.

Unwillingness to implement digital technologies is indicated by low values for such assessment parameters as the presence of direct communication channels with consumers of transport and logistics services, the presence of end-to-end information systems to support key business processes, the level of implementation of new business processes, the presence of an internal communications system that ensures clearly communicating the goals of digitization to employees. It is worth noting that all parameters for assessing the level of digital maturity of railway transport enterprises are at a critical level, since they do not exceed the value of 0.36 (**Fig. 7.2**), which means that in order to achieve success in digital reforms, it is necessary to form an effective digital transformation strategy, which would determine the goals, tasks and tools for ensuring the digital development of enterprises in the railway industry.



**Fig. 7.2** Values of parameters of the level of digital maturity of railway transport enterprises  
Source: author's development

So, it is possible to say that despite the targeted orientation of the Industry Development Strategy on the implementation of digital transformations, currently the measures of railway

transport enterprises in this direction are limited to the implementation of individual software products aimed at expanding the online platform of consumer service.

Unfortunately, the slowdown in the processes of digital transformation of the industry is due to the action of a number of negative factors taking place in the environment of railway transport enterprises.

Firstly, the lack of clearly established standards for the use of digital technologies in railway transport and the presence of numerous legislative gaps in the field of intellectual property rights are holding back the process of digital transformation. The lack of a clearly defined strategy for their digital transformation does not contribute to the acceleration of digital changes at the enterprises of the industry [15, 16].

Secondly, the political and economic situation in the country does not contribute to the implementation of digital changes in the industry. Protracted military actions for the sovereignty of our state and a difficult economic situation as a result of the destruction and shutdown of a significant number of industrial productions do not allow the Government to financially support projects of digital transformation of railway transport enterprises [17].

Thirdly, due to the significant cost of projects of digital transformation of railway transport enterprises and the high risk of their failure in wartime conditions, investors are not interested in allocating funds for the implementation of digital technologies at railway transport enterprises.

Fourthly, significant resistance of employees to changes in the traditional forms of fulfilling their obligations remains. The low level of awareness of employees and a misunderstanding of the content of digital transformation complicate the implementation of digital technologies at enterprises of the industry, etc. [18].

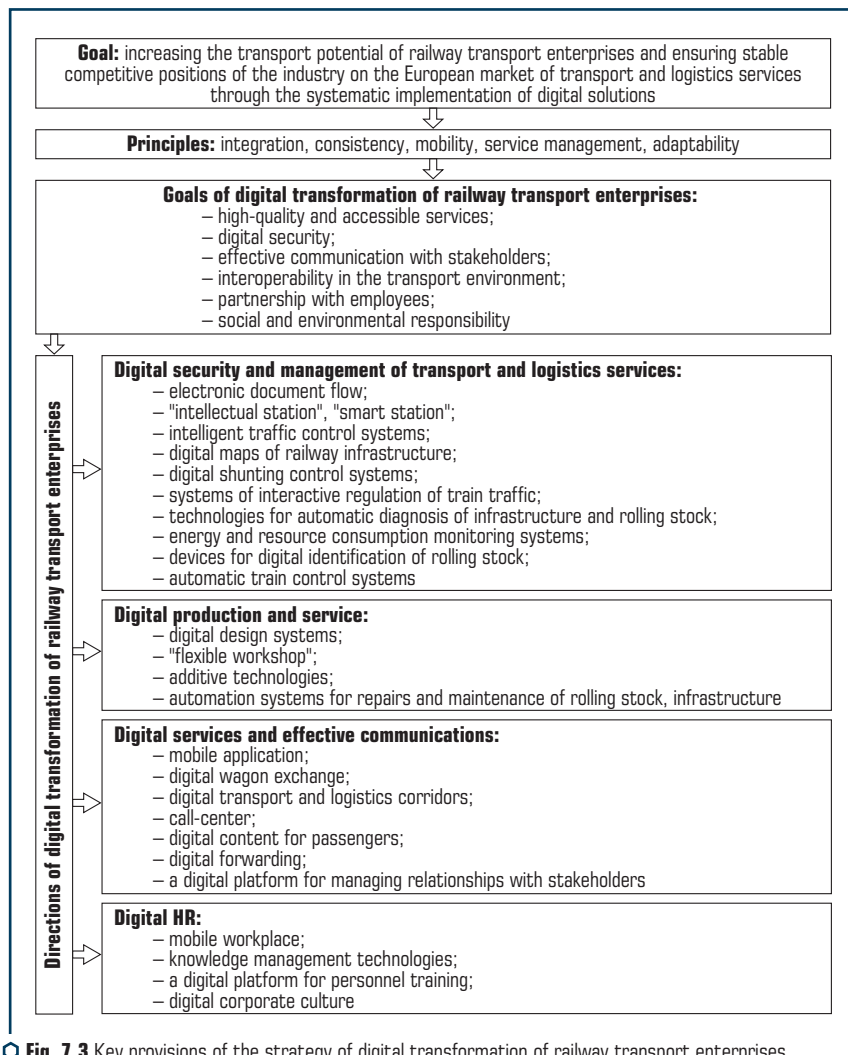
Taking into account the above, in order to level the impact and accelerate the implementation of digital changes at railway transport enterprises, there is a need to develop a strategy for their digital transformation, which would reflect the goals, key directions and tools for the implementation of digital transformations in the industry.

### 7.3 DISCUSSION OF THE RESULTS OF THE DEVELOPMENT PRIORITIES OF RAILWAY TRANSPORT ENTERPRISES IN THE CONTEXT OF ENSURING THEIR DIGITAL TRANSFORMATION

To achieve the targets of the digital transformation of railway transport enterprises, it is necessary to comprehensively implement digital innovations and implement projects in the areas of digital security and management of transport and logistics services, digital production and service, digital services and effective communications, digital HR [19].

The key provisions of the strategy of digital transformation of railway transport enterprises are presented in **Fig. 7.3**.





**Fig. 7.3** Key provisions of the strategy of digital transformation of railway transport enterprises  
Source: development of the authors

To achieve digital security and management of transport and logistics services, it is necessary to:

- implement electronic document flow, ensure the creation of an "intelligent station", "smart stations", implement intelligent traffic management systems, digital maps of the railway infrastructure, digital shunting management systems, systems for interactive regulation of train traffic, technologies

for automatic diagnosis of the state of infrastructure and rolling stock, energy and resource consumption monitoring systems, devices for digital identification of rolling stock, as well as automatic train control systems, etc.;

– it is possible and necessary to form digital production and provide digital service by implementing a digital design system, additive technologies, a system for automating repairs and maintenance of rolling stock, infrastructure, as well as a "flexible shop" system. Implementing digital services and maintaining effective communications with stakeholders is possible through use mobile applications, the creation of a digital wagon exchange, digital transport and logistics corridors, the expansion of all-center capabilities, the introduction of digital content for passengers, digital forwarding services, as well as the creation of a digital platform for managing communications with stakeholders;

– increase the loyalty of employees and improve communications with them, it is necessary to implement digital HR tools, namely to ensure the creation of mobile workplaces, a digital platform for personnel training, digital corporate culture, as well as knowledge management technology, etc. [20].

It is worth noting that the implementation of the digital transformation strategy of railway transport enterprises is impossible without a decision-making support system, which will be the subject of the next Chapter 8.

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## ABSTRACT

The transformation of the global environment, accompanied by a change in the operating environment of enterprises under the influence of digitalization processes, has a significant impact on the activities of railway transport enterprises. For more than a dozen years now, they have been operating under the conditions of the implementation of reforms and systematic underfunding of the processes of updating the technical and technological base. Due to the lack of investment and the low level of innovative activity, the enterprises of the industry are currently experiencing a state of technological crisis, which is manifested in the critical state of technological objects and rolling stock that are key to the transport process [1]. According to experts' estimates, the annual investment need of railway transport enterprises is about 35 billion UAH. Currently, the industry's capital investment needs are met by 25–30 % [2]. Due to a systemic violation of the reproduction mechanism of the technological base, the latter is being exploited at the critical limit. Such a situation with the state of the technological base of railway transport enterprises indicates that the mechanism of innovation reproduction of funds is currently broken in the industry and the priorities of the innovation policy have not been chosen correctly [3]. In the conditions of the digital revolution, which leads to a significant increase in competition in the market of transport and logistics services, in the coming years, railway transport enterprises must implement radical changes in all the main technological and business processes through the systematic introduction of technological and organizational innovations.

## KEYWORDS

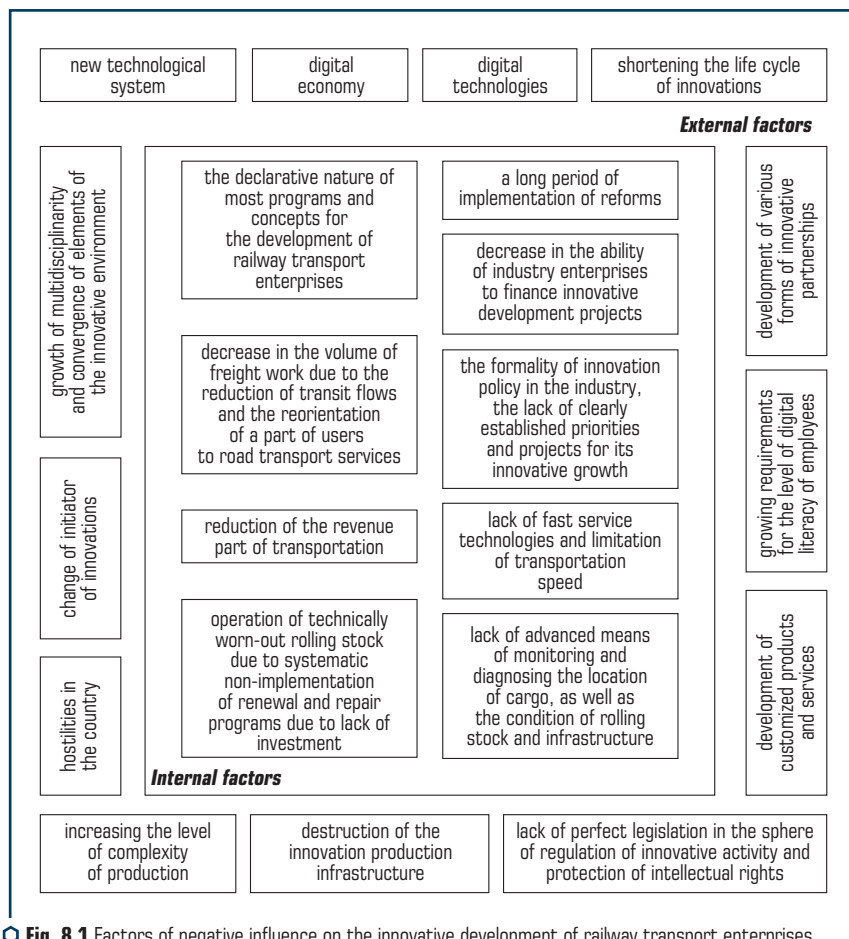
Goal setting, innovative development strategy, transport infrastructure, strategic goals, foresight, public administration.

## 8.1 ENVIRONMENT FOR INNOVATIVE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES

Taking into account the fact that railway transport enterprises function as an open system and have established connections with the external environment, let's focus primarily on its research (**Fig. 8.1**).

The external environment for the implementation of projects of innovative development of railway transport enterprises is currently extremely turbulent. First, dynamic changes are caused by the transition to a new technological system and the development of the digital economy.

Digital technologies have significantly accelerated economic processes and led to confrontation between market entities. Digital technologies caused extremely significant transformations in the field of innovative activity, leading to a significant reduction of the life cycle of innovation due to the optimization of the procedure for creating, modeling and developing a prototype.



**Fig. 8.1** Factors of negative influence on the innovative development of railway transport enterprises  
Source: author's development (formed on the basis of [1–4])

Features of the digital transformation of domestic enterprises are studied in detail in the works of Volodymyr Dykan, Myroslava Korin, Hanna Obruch, Iryna Tokmakova, Viktoriia Ovchynnikova, Serhii Pankratov, Pavlo Denysenko, Oleksandr Kubatko, Olena Shkarupa, Anton Yaremenko [4–9].

The analysis of the results obtained by scientists allowed to come to the conclusion that under the influence of digitalization, the innovative activity of railway transport enterprises has also undergone changes: technological solutions have appeared that significantly optimize technological processes in the industry.

In addition, digital technologies allowed railway transport enterprises to become a full participant in the process of creating innovations due to the formation of effective communication channels within the framework of the creation of innovative and technological cooperation mechanisms. Today, in the world of railway enterprises, they are active participants in the innovation process, not only dictating to manufacturers the needs for innovations, but also independently developing innovations for the needs of railway transport.

Secondly, the transformation of the innovation environment that is taking place today is caused not only by the increase in the number of scientific developments and research, the emergence of digital technologies, but also by a change in the initiator of innovations. As research will allow, a significant part of innovative developments today have the status of "consumer" because they arose from the initiative not of the manufacturer, but of the consumer of its products.

Thirdly, the modern innovation environment is characterized by the growth of various types of innovative partnerships based on the combination of the potential of innovative companies and individual industries. Strategic partnerships between railway transport operators and large manufacturers of products for the needs of railways are developing quite actively in Europe and are used as a strategic tool to support industry development projects.

Fourthly, due to the growing level of use of digital technologies in the activities of economic entities, including railway transport enterprises, systematic training of employees in the field of using digital innovations is carried out to support the efficiency of the innovation process. In fact, as in other areas, in the field of innovation there is also an increase in requirements for the level of digital literacy of employees, which led to the transformation of the system of their education and training.

Fifth, the rapid development of customized products and services led to an increase in the level of complexity of production, and also caused an increase in multidisciplinary and the convergence of all elements of the innovation environment.

In addition to the fact that the external innovative environment of the enterprises of the industry is transformed, the nature and strength of the influence of external factors are also changing. In particular, projects of innovative development of railway transport enterprises are blocked by the processes currently taking place in the country. This is, first of all, military actions, which entail the destruction of not only the railway infrastructure, but also the infrastructure for the production of innovations, destabilize economic processes, causing a mass stoppage of production, and, accordingly, a decrease in the resource provision of economic stability in the country.

The lack of perfect legislation in the sphere of regulation of innovative activity and protection of intellectual rights inhibits innovation processes at railway transport enterprises. Also, the activity of the existing innovative infrastructure in the country should be recognized as not entirely effective, most of which functions according to the residual principle, without creating significant

developments and innovations for the country. The state policy in the field of innovation support has an equally negative impact on the state of the innovation environment of railway transport enterprises: despite the determination of state innovation priorities, most innovative projects are currently financed according to the residual principle [10].

The internal environment of ensuring the innovative development of railway transport enterprises is characterized by the presence of a number of disincentive factors that indirectly affect the effectiveness of the innovative activities of the enterprises of the industry. These factors are represented by the key issues that have become the cornerstone for enterprises in the industry, namely:

- the declarative nature of most programs and concepts for the development of railway transport enterprises, including those that establish industry priorities in the field of innovative activity;
- the long term of implementation of reforms, which have been of a formal nature for many years, and currently remain unfinished;
- a drop in the volume of freight work due to the reduction of transit flows and the reorientation of some users to road transport services;
- a reduction in the revenue part of transportation and, as a result, a decrease in the ability of industry enterprises to finance innovative development projects;
- uncertainty and formality of innovation policy in the industry, lack of clearly established priorities and projects for its innovative growth;
- operation of technically worn-out rolling stock due to systematic non-implementation of renewal and repair programs due to lack of investment;
- lack of fast service technologies and limitation of transportation speed in a significant part of service areas due to the timely failure to carry out scheduled and preventive repairs of infrastructure facilities and signaling;
- lack of advanced means of monitoring and diagnosing the location of cargo, as well as the state of rolling stock and infrastructure, etc. [11].

So, summarizing in general, it is worth pointing out that currently the environment for the implementation of projects of innovative development of railway transport enterprises is characterized by a high level of instability, which is caused by high external dangers and risks, primarily those that exist at the state level, as well as the presence of systemic functioning problems railway transport enterprises.

## 8.2 STRATEGIC DIRECTIONS OF IMPLEMENTATION OF INNOVATIVE PROJECTS AT RAILWAY TRANSPORT ENTERPRISES

Based on the above, it is worth pointing out that in the near future, in order to maintain their own competitiveness and preserve the existing potential, railway transport enterprises must fundamentally change all technological and business processes by replacing rolling stock with

more modern models, and introducing progressive technological complexes, intelligent systems traffic management and other organizational and technological innovations. At the same time, as the experience of European railways proves, without reforming approaches to the organization of railway transport management with an orientation towards the growth of innovative activity of industry enterprises, without the formation of conditions that ensure the creation and use of effective innovations, the national security of the country appears to be under threat. In accordance with this, strategic directions for the implementation of innovative projects at railway transport enterprises should be identified, which correspond to the global trend of the transformation of railways and will ensure innovative modernization of domestic enterprises of the railway industry (**Table 8.1**).

The key direction of the implementation of innovative projects should be the direction of ensuring digital modernization and the introduction of digital technologies. Most of the innovative projects in this direction should relate to the development of such modern digital technologies as the Internet of Things, "big data", distributed registers (blockchain), artificial intelligence technologies, virtual and augmented reality technologies, new data transmission technologies. A platform approach to the formation of new services for consumers should also be applied, which is based on the creation of digital platforms in the key areas of activity of enterprises in the industry, including the field of development and use of innovations [12].

The priorities of infrastructure development should include the creation of intelligent stations, which provide for the introduction of innovative systems of automation and mechanization of station processes, as well as infrastructure for means of robotization of warehouse processing processes at sorting stations, which will allow the transition to unmanned technologies, increase the throughput of sorting stations due to robotics maintenance processes in the reception park, reduce the impact of the human factor on the technological process, speed up the processing of warehouses.

For the practical implementation of the projects listed above to ensure the innovative development of railway transport enterprises, it is expedient to organize the cooperation of industry enterprises with specialized enterprises by forming an engineering center. The latter should specialize in the development of innovations for the enterprises of the industry due to the combination of their innovation and production potential with the country's leading manufacturers, namely:

- creation of high-speed rolling stock for the transportation of passengers and cargo;
  - development of electric trains with the 4th level of automation;
  - creating a line of low-complexity hybrid electric trains serving mixed passenger services;
  - creation of hybrid models of diesel locomotives for work on shunting and removal work;
  - implementation of systems for collecting, processing, and storing coordinate information about infrastructure objects and rolling stock of railway transport, including a high-precision coordinate system and a spatial data base of digital track models;
  - development of other new types of rolling stock;
  - development of passenger information and entertainment systems, etc.
-



**INNOVATIVE DEVELOPMENT OF THE ROAD AND TRANSPORT COMPLEX:  
PROBLEMS AND PROSPECTS**

● **Table 8.1** Priority projects of innovative development of railway transport enterprises

<b>A group of projects</b>	<b>Content</b>	<b>Type of innovations created</b>	<b>Effect</b>
Digital modernization and implementation of digital technologies	Mastering digital technologies, creating digital platforms in key areas of activity	Procedural	Ensuring innovative development, transformation of the business model and industry processes
Automatic control of rolling stock	Automation of management processes and diagnostics of the technical condition of rolling stock	Process, organizational	Increasing the efficiency of operational activity, optimizing costs for the main activity, increasing labor productivity
Renewal of rolling stock	Introduction of modern models of locomotives operating on alternative types of fuel, creation of "smart locomotives" with the use of intelligent control systems, locomotives with increased average daily productivity, increased mileage between repairs, structures, creation of digital models of rolling stock with functions of predictive forecasting of technical condition	Procedural	Improvement of operational characteristics of rolling stock, reduction of life cycle costs, improvement of safety, reliability and environmental friendliness of transportation, growth of indicators of transportation activity
Development of high-speed traffic	Construction of separate high-speed tracks designed for passenger traffic, introduction of modern electric trains and systems for automatic monitoring of traffic parameters, construction of an effective data exchange system between various participants in the transportation process	Grocery	Increasing the level of customer loyalty, attracting additional passenger traffic
Development of services for consumers of transport services	Expanding sales tools, improving application functionality, creating digital relationship management platforms	Food, advertising	Improving the quality of services, customer orientation, provision of new digital services
Modernization of railway infrastructure	Creation of a digital model with functions of predictive analytics of implementation technologies of interval regulation of train movement, "virtual clutch" technology, innovative track designs, technologies and technical means of major track repairs, rail grinding and milling technologies, creation of intelligent stations	Process, organizational	Reduction of costs related to repairs and maintenance (including indirect costs from downtime), reducing the number of unscheduled repairs, improving transportation safety and labor productivity
Development of strategic partnerships	Organization of cooperation between industry enterprises and specialized enterprises through the creation of an engineering center	Organizational	To reduce the import dependence of industry enterprises, to organize the localization of production of innovative rolling stock and its components

Its creation will make it possible to reduce the import dependence of enterprises in the industry, organize the localization of the production of innovative rolling stock and its components, reduce the duration of work on the development of the concept, development of technical documentation, R&D, creation of prototypes, conducting all kinds of tests of new equipment, and also ensure the accelerated implementation of progressive projects and solutions and, accordingly, additional efficiency due to life cycle cost savings implemented by innovations.

Therefore, the need to transform railway transport enterprises into an innovative European-level company is recognized today both at the highest level of state management and at the level of individual structural divisions. This manifests itself not only in the form of political declarations and heated discussions, but already in certain, not always consistent and often unsubstantiated decisions made at the industry level. Despite the fact that currently the state does not invest enough funds in the implementation of projects of innovative development of railway transport enterprises, quite often the decisions made at the level of the management of the railway industry and aimed at the implementation of innovative achievements are not effective enough. In any case, management actions in the field of innovation activity would be more effective, which would be based on scientific studies of patterns and institutional forms of innovation activity management [13]. Until now, the theory and best practices of innovation management have accumulated enough arguments in favor of the fact that the technological and production component in innovative development is far from the most important. The real transformation of railway transport enterprises into an innovative company is impossible without increasing the efficiency of management of innovative projects without increasing innovativeness. After all, the currently existing practice of implementing innovation policy at railway transport enterprises clearly demonstrates that the effectiveness of innovative activity is restrained, or better said – undermined, by a chronic disease – not a successful choice of management tools for innovative development projects of enterprises in the industry.

### 8.3 CONSIDERATIONS REGARDING THE IMPROVEMENT OF THE MANAGEMENT PROCEDURE OF PROJECTS OF INNOVATIVE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES

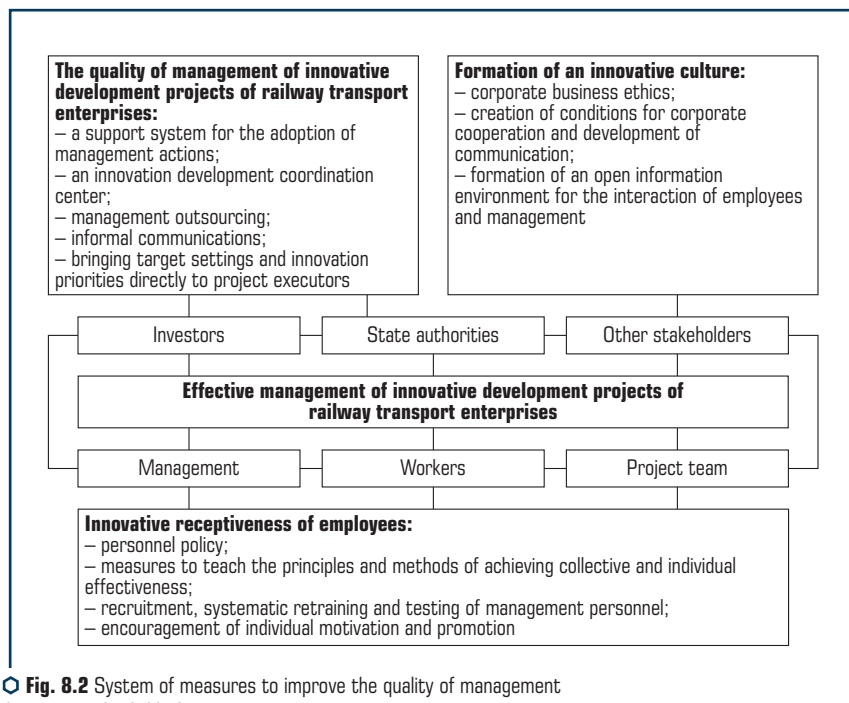
The main goal of innovative transformations at railway transport enterprises is to ensure their proactive development as the basis of financial stability and competitiveness in the market of transport and logistics services. Undoubtedly, innovative development should be based on the structural restructuring of the management system of innovative activities at railway transport enterprises, as well as technological updating of their production base due to the introduction of modern innovative technologies.

That is why today it is extremely important to take measures to improve the management procedure of innovative development projects of railway enterprises, since the stable future of the industry depends on their effectiveness.

Taking into account the fact that currently there is a low efficiency of the current innovation policy and the effectiveness of the projects selected for the implementation of innovation development,

a comprehensive system of management of innovation projects should be formed at the enterprises of the industry, taking into account industry transformations and innovation priorities within the framework of the next stages:

1. Establishment of bottlenecks, obstacles and directions for improvement of the management system of projects of innovative development of railway transport enterprises. Studies prove that to increase the efficiency of the management system of innovative projects at railway transport enterprises, it is necessary to implement measures to improve the quality of management decisions in the field of innovative activity. These measures should be directed not only to the development of the competencies of the management personnel, but also to the formation in the minds of employees of the importance of innovative changes for the enterprises of the industry, the development of innovative partnerships, and the formation of an innovative culture (**Fig. 8.2**).



**Fig. 8.2** System of measures to improve the quality of management decisions in the field of innovative activity

Source: author's development

In particular, in order to improve the coordination and quality of management actions in the process of implementing innovative development projects of railway transport enterprises, it is advisable to implement a support system for the adoption of management actions, to create

innovation development coordination centers, which will allow a clear demarcation of powers and responsibilities between project group participants, as well as to ensure a balance of interests all stakeholders. It will also allow to implement management outsourcing, develop informal communications, and ensure delivery of target attitudes and innovation priorities directly to project executors. The formation of an innovative culture should take place through the support of corporate business ethics, the creation of conditions for corporate cooperation and the development of communication, the formation of an open information environment for the interaction of employees and management (**Fig. 8.2**).

For the development of innovative receptivity of employees, namely employees' awareness of the importance of innovative changes, an appropriate personnel policy should be implemented, which would include measures to teach the principles and methods of achieving collective and individual effectiveness, recruitment, systematic retraining and testing of management personnel, encouragement of individual motivations and promotion by service Transformation of innovation policy and development of a program of priority projects of innovative development of railway transport enterprises.

2. Formation of industry standards and requirements for projects of innovative development of railway transport enterprises.

3. Organization of control over the effectiveness of the program of priority projects of innovative development of railway transport enterprises by creating standard forms of reports and developing a system of indicators for assessing the degree of their implementation.

It is possible and necessary to ensure the innovative development of railway transport enterprises based on the implementation of progressive innovative projects through the formation of an integrated management system for the innovative development of the industry, which will ensure the full cycle of the implementation of innovative projects – from the definition of strategic directions and target parameters of development to obtaining new services and assessing their effectiveness.

In addition, it is also important to observe the following conditions in the process of managing innovative development projects of railway transport enterprises.

First, since innovative projects are a creative process that is characterized by a high level of uncertainty and risk, a revision of traditional project management principles is necessary, it is advisable to apply only the best practices in the field of project management and combine them with new approaches and tools to achieve an optimal result.

Secondly, depending on the type of innovative project, it is advisable to change the approach to its implementation. It is advisable to choose an approach to project management depending on the technological features of the project, the conditions of the external and internal environment. If the innovative project is technological in nature, it is rational to choose a systemic or structural approach. If the project has a research nature and is related to the search for new ways of developing high technologies, then a situational approach should be used in relation to them. In projects related to the introduction of new technology, it is rational to use a marketing or process approach.

Thirdly, the key factor in the success of the implementation of an innovative project is a correctly selected toolkit of strategic management. The management of the industry needs to find

a balance between strict adherence to the chosen strategy of innovative development of railway transport enterprises and flexible response to the changing conditions of the external and internal environment, which will lead to lower costs, increased economic efficiency and reduced risks.

Fourthly, in order to increase the effectiveness of the management of projects of innovative development of railway transport enterprises, it is necessary to ensure the introduction of progressive information, communication and digital technologies. When managing innovative projects, it is advisable to use the latest digital technologies (for example, big data analysis, Internet of Things technology). Big data science technologies will allow to increase the competitiveness of projects because they allow to perform big data analysis in the following areas: analysis of existing research and development (including patent search); analysis of technological Internet sites; simulation of launching complex algorithms of new ideas. An actual solution for increasing the effectiveness of innovative projects at railway transport enterprises is the use of technologies based on IoT (Internet of things). IoT technologies involve the use of a global network of devices interconnected with each other and are used for project communications, data collection, advanced data analytics, and dynamic planning, which leads to a significant reduction in project completion times.

The complexity of managing innovative projects has increased significantly over the last decade, which is caused by an increase in the level of uncertainty of project parameters, high dynamism of the internal and external environment of the project, a large amount of data for project management and management, the need to attract highly qualified specialists for the creation and application of intellectual property objects, using modern technologies and material resources.

Considering the fact that the management of innovative projects at railway transport enterprises involves, first of all, the adoption of such decisions that will ensure the technological renewal of the industry and the growth of its competitiveness in the transport market, it is advisable to use effective information technologies to support management decision-making in order to select effective projects of innovative development to innovate and to reduce the uncertainty and risks associated with them.

To date, the practice of management has developed a significant number of decision support systems that allow management to make progressive decisions using data, knowledge, objective and subjective models to analyze and solve poorly structured and unstructured problems.

In fact, a decision support system is a computer system that provides information support to a decision maker and provides it with easy access to models and information used for the development and implementation of innovative projects. The decision-making support system allows to track information on existing innovative projects, obtain comparative characteristics of similar innovative projects in terms of direction, forecast income from the implementation of a certain innovative project, consider all possible alternative options for projects, conduct training and personnel training; implement monitoring and control over the implementation of innovative projects; organize effective communications between project team members, customers and other stakeholders.

Based on the above, let's propose the creation of a decision-making support system for managing projects of innovative development of railway transport enterprises, which is a complex of

functional blocks-tasks and is based on the use of dynamic fuzzy cognitive maps as a tool for modeling, analysis, development and monitoring of the implementation of innovative projects of the development of enterprises in the industry (Fig. 8.3).

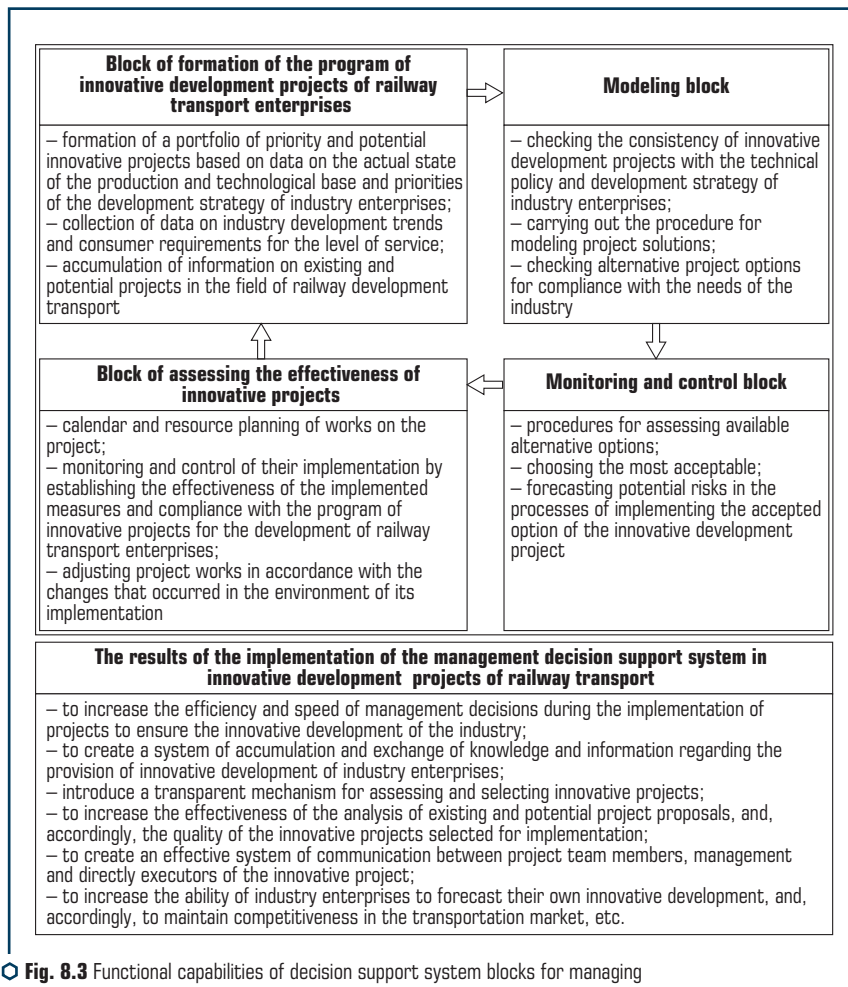


Fig. 8.3 Functional capabilities of decision support system blocks for managing projects of innovative development of railway transport enterprises

Source: author's development

Key blocks of this dynamic decision-making support system for the management of projects of innovative development of railway transport enterprises are defined as the block of forming

the program for the implementation of projects of innovative development of enterprises of the industry, the block of modeling, the block of assessing the effectiveness of innovative projects, the block of monitoring and control. Let's reveal in more detail the functionality of these task blocks.

The block for forming a program of innovative development projects of railway transport enterprises is intended for the formation of a portfolio of priority and potential innovative projects based on data on the actual state of the production and technological base and the priorities of the development strategy of the enterprises of the industry. Also, within this block, data collection will be carried out regarding trends in the development of the industry and consumer requirements for the level of service, as well as the accumulation of information on existing and potential projects in the field of railway transport development.

The modeling unit checks the consistency of innovative development projects with the technical policy and development strategy of industry enterprises, and also provides for the procedure of modeling project solutions, checking alternative versions of projects for compliance with the needs of the industry.

The unit for assessing the effectiveness of innovative projects includes procedures for assessing the available alternative options, choosing the most acceptable one, and forecasting potential risks in the processes of implementing the accepted option of the innovative development project.

The monitoring and control unit carries out calendar and resource planning of works on the project, as well as monitoring and control of their implementation by establishing the effectiveness of the implemented measures and compliance with the program of innovative projects for the development of railway transport enterprises. As a result of the assessment within this block, it is assumed that the project works will be adjusted in accordance with the changes that occurred in the environment of its implementation.

#### **8.4 DISCUSSION OF THE RESULTS OF THE FORMATION OF A DECISION-MAKING SUPPORT SYSTEM REGARDING THE INNOVATIVE DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES**

Taking into account the functional capabilities of the blocks of the decision-making support system for managing innovative development projects of railway transport enterprises, it is worth noting that its implementation will allow:

- increase the efficiency and speed of management decisions during the implementation of projects to ensure the innovative development of the industry;
- create a system of accumulation and exchange of knowledge and information regarding the provision of innovative development of industry enterprises;
- introduce a transparent mechanism for assessing and selecting innovative projects;
- increase the effectiveness of the analysis of existing and potential project proposals, and, accordingly, the quality of the innovative projects selected for implementation;

- create an effective system of communication between project team members, management and directly implementers of the innovation project;
- increase the ability of industry enterprises to forecast their own innovative development, and accordingly to maintain competitiveness in the transportation market, etc.

Since Chapters 7 and 8 lay the foundation for the development of railway transport enterprises, in Chapter 9 let's proceed to the development of conceptual provisions for their development in particular and the industry as a whole.

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# CONCEPTUAL PROVISIONS FOR ENSURING BALANCED DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES UNDER THE CONDITIONS OF IMPLEMENTATION OF DIGITAL CHANGES IN THE INDUSTRY

Volodymyr Dykan, Hanna Obruch, Illia Dmytriiev

## ABSTRACT

Today, the world is experiencing an era of radical changes caused by the rapid introduction of digital technologies into all types of economic and social activities. Digital technologies change not only individual sectors of the economy, but also transform the entire system of global economic relations, creating enormous opportunities for sustainable business development and increasing the competitiveness of countries. The technologies of big data, machine learning, virtual and augmented reality, and robotics shape the leadership potential of national economies in the global system of highly effective digital communications and determine their future place on the geo-economic map of the world. Aware of the importance of digital technologies for the development of new horizons of activity in sectors strategic for the economy and ensuring their inclusive development, already today the leading states are implementing a large-scale policy of digital transformation of the country, focused on restructuring business processes, competencies and models of operation of industry, transport, trade, system public administration and education.

As mentioned in the previous sections of this monograph, the key driver for the digital transformation of Ukraine's economy is the process of digitalization of infrastructure industries and, above all, domestic railway transport, the activity of which creates a multiplier effect, which is manifested in the ability not only to satisfy the needs of business entities in transportation, but also to stimulate the growth of economic activity in related industries by forming demand for products of metallurgy, instrument and wagon building, chemical and fuel and energy complexes.

## KEYWORDS

Digitalization, railway transport, modernization of services, business model, potential of railway transport enterprises.

### 9.1 THE NEED FOR DIGITIZATION AS A CHALLENGE TODAY

The urgency of the need for a digital restructuring of the business model of the functioning of Ukrainian railways is actualized in connection with the need to implement the Association Agreement between Ukraine and the EU, the provisions of which define the requirements for the transformation of the railway transport system in order to implement the European integration course of the country and include railway transport in the system of trans of European communications.

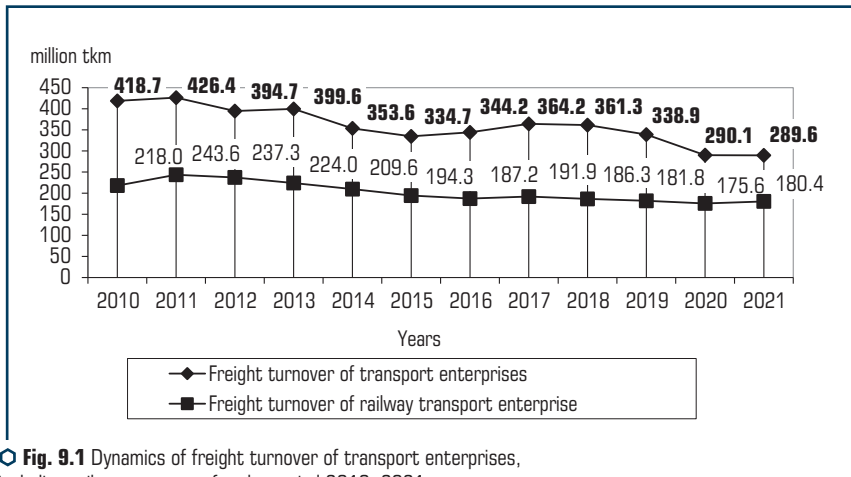
Along with this, the pressing problems of the functioning of domestic railway transport, the current system of management of the industry and the business model of the development of railway transport do not allow to take full advantage of the advantages of digitalization and ensure digital transformation and modernization of business processes of the enterprises of the industry. Currently, the enterprises of the industry face the need to solve a number of challenges associated with a high level of wear and tear of rolling stock and railway infrastructure and, as a result, a shortage of rolling stock and limited use of the infrastructure potential of the railway, a decrease in the turnover of the wagon fleet, customer dissatisfaction with the company's tariff policy and the quality of services railway transport, corruption violations in the company and strengthening of its financial obligations to international financial institutions. In the presence of a number of unresolved problems and imbalances, it is extremely difficult to ensure the implementation of innovative projects for the development of railway transport, in particular, aimed at the digital transformation of business processes and the business model of railway transport in general. In this regard, the formation of a conceptual basis for ensuring the balanced development of railway transport enterprises and the development of tools for its achievement, which will allow to level the imbalances of their activities and realize the potential of the enterprises of the industry in the direction of their digitalization, is of great importance.

The scientific work of a wide range of scientists is dedicated to the study of the processes of ensuring the sustainable development of enterprises, in particular, railway transport, and to the determination of the features of the implementation of digital changes. However, today, taking into account the acceleration of the processes of development of the global digital transport and logistics space and the inability of railway transport enterprises in the conditions of the growing systemic crisis in the industry to ensure the implementation of qualitative digital changes, the formation of conceptual provisions for ensuring the balanced development of railway transport enterprises as a basis for the digital modernization of activities is of great importance enterprises of the railway industry.

The state and development trends of railway transport enterprises in recent years indicate a critical reduction of their economic potential and a gradual loss of technical ability to fully satisfy the demands of consumers for transport services. The implementation of radical organizational and structural changes in the railway transport management system and the gradual liberalization of the railway transport market took place in the conditions of deepening interstate conflicts, the complication of the political and economic situation, the introduction of epidemiological restrictions in connection with the spread of the pandemic and the reduction of the volume of work of enterprises, which led to the exacerbation competition in the market of transport services and the reduction of the share of JSC "Ukrzaliznytsia" in the transport market of Ukraine. Therefore, the share of the railway company in the freight transport market decreased from 57.3 % in 2010 to 50.7 % in 2021 (the highest value was recorded in 2014, when the share of railway transport reached 62.0 %). As evidenced by the data for 2021, despite the increase in the volume of freight transportation by railway transport by 2.9 % compared to the previous year, the increase in the volume of work of other types of transport took place at a faster pace. In particular, the rate of

increase in the volume of freight transportation by road transport amounted to 16.2 %, i.e. 13.3 % more than the rate of increase in the volume of freight work of railway transport.

Freight turnover of railway transport enterprises decreased by 17.2 % from 218.0 billion tkm in 2010 to 180.4 billion tkm in 2021 (**Fig. 9.1**). To a large extent, this situation is caused by the spread of the coronavirus pandemic in the world, social isolation and the narrowing of production and transport links between countries.



**Fig. 9.1** Dynamics of freight turnover of transport enterprises, including railway transport for the period 2010–2021  
Source: built on the basis of these works [1, 2]

Analyzing the volume performance indicators of the railway industry enterprises for previous years, it can be concluded that the volume of freight transportation for 2010-2021 decreased from 432.5 to 314.3 million tons, respectively, that is, by 27.3 %. In particular, in 2021, railway transport enterprises transported 149.8 million tons of cargo in domestic traffic, 112.4 million tons for export, 40.6 million tons for import, and 11.5 million tons for transit. The following types of cargo accounted for the largest share in the structure of railway transport cargo: iron and manganese ore – 24.7 %, construction materials – 20.9 %, hard coal – 16.0 %, and grain and their grinding products – 10.7 % (33.6 million tons) [3]. In turn, during January-August 2022, JSC "Ukrzaliznytsia" transported 106.1 million tons of cargo, which is 95.6 million tons less compared to the same period in 2021 [4]. In September 2022, 11.7 million tons of cargo were transported, which is 8.4 % more than the figure for August 2022 [5]. at the same time, about 30 % is the transportation of grain cargoes and products of their grinding, the volume of which was 3.4 million tons in September, and 1.916 million tons in 19 days of October [6].

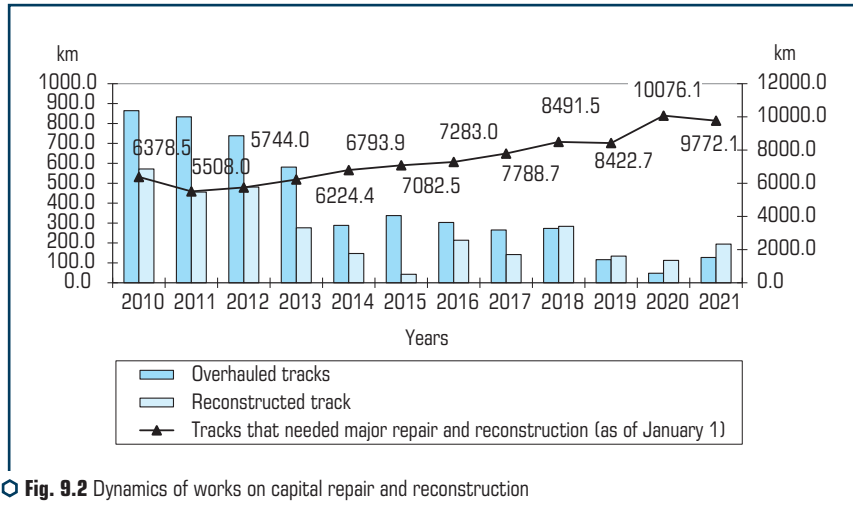
The presence of a number of system problems that have not been solved for many years complicates the work. Among them: high physical and moral wear and tear of rolling stock, railway

infrastructure objects, production and repair base, loss of transit potential, decrease in innovation and investment activity, imperfect personnel policy, decrease in customer loyalty and their reorientation to services of other types of transport. In particular, the wear and tear of locomotives today is estimated at 98.3 % (thermal locomotives) and 94.4 % (electric locomotives). Taking into account the technical unsuitability of most units of traction rolling stock for the full and timely performance of transportation volumes and the growing threat of stopping railway transport, the Government in August 2021 presented the Concept of working with the locomotive fleet of JSC "Ukrzaliznytsia" until 2033, which determined the need for 2,347 units of traction rolling stock (currently 2,088) by the specified period to fully ensure the growing volumes of transportation. In particular, we are talking about the need for 120 double-powered electric freight locomotives, 490 alternating current and 352 direct current. The number of shunting diesel locomotives in 2033 is predicted at the level of 850 units. As for the required amount of financial resources for the renewal and modernization of the fleet of traction rolling stock, in 2021 the need was estimated at 3.2 billion UAH, in 2022 – 4.7 billion UAH (taking into account the purchase of the first 5 new dual-powered electric locomotives), in 2023 – 6.7 billion UAH. In total, by 2033, 86.7 billion UAH will be needed for the maintenance and development of the locomotive fleet, of which more than 50 % is for the purchase of new machines [7]. However, given the events of recent months, the implementation of the planned plans is in jeopardy.

As of the end of 2021, 6,883.4 km of main tracks required major repairs, and 2,888.7 km required reconstruction of the railway track. For example, in 2021, only 78.5 km of main and 48.8 km of station and special tracks were rehabilitated, the level of track reconstruction was 194.3 km (**Fig. 9.2**) [8]. The trend of increasing the amount of overdue capital repair and reconstruction of the railway track has been maintained for many years, which is due to the reduction of the amount of modernization, capital repair and reconstruction of railway tracks.

The wagon park is no less worn out. So, if in 2010 the number of freight cars reached 120.6 thousand units, then as of June 2021 there was a significant decrease in them by 13.0 % to 104.9 thousand units, of which the working fleet is 46.3 % (48.5 thousand units), and non-working – 51.1 % (56.3 thousand units). Therefore, today the level of wear and tear of freight cars is a total of 92.72 %, in particular, the highest level of wear and tear is characteristic of such types of rolling stock as mineral carriers – 99.99 %, cement carriers – 97.28 %, grain carriers – 96.68 %, rolling stock carriers – 94.16 %, covered wagons – 93.05 %. The wear and tear of passenger cars is currently 92.8 %. In 1992–2021, about 700 units were purchased, and many times more were written off – more than 5 thousand units. At the same time as the reduction of the technical, innovative-technological and investment resources of railway transport enterprises, there is a loss of personnel potential in the railway industry, which is gradually losing highly qualified specialists who have significant practical experience and are capable of implementing quality reformation transformations in this area. In recent years, an alarming trend of a decrease in the number of employees has been recorded: in general, for the period 2010–2020, the average number of employees in the main activity has halved from 343.2 thousand people in 2010

to 174.2 thousand people in 2020. During 2021 the number of employees of the railway company decreased by 11 thousand people [11, 12].



**Fig. 9.2** Dynamics of works on capital repair and reconstruction of tracks for the period 2010–2021

Source: built on the basis of these works [9, 10]

So, summarizing the above, it is necessary to state the imbalance of the management system of the industry and the increased vulnerability of railway transport enterprises to the challenges of the environment of their operation. Therefore, the deepening of the internal problems of the development of railway transport enterprises not only limits their potential to implement digital changes in the industry, but also increases the inconsistency of the development trends of domestic railway transport enterprises with the world standards of the growth of the railway industry. The latter is reflected in the growth of imbalances in the functioning of railway transport enterprises of Ukraine in the areas of service development, innovation and investment activities, and the development of personnel competencies. The systematization of imbalances in the development of railway transport enterprises in the conditions of the transformation of world growth trends is presented in **Fig. 9.3**.

Taking into account the complexity of the problems of the development of railway transport enterprises and, in general, the imbalance and inconsistency of the current industry management system with the global growth trends of railway companies, it is expedient to use the potential of digital transformation and modernization of railway transport enterprises as a basis for ensuring their balanced growth requires an assessment of the current state of coherence between the goals of the development of enterprises in the industry and the tools for their practical implementation. In view of this, the development of a methodical basis for assessing the balanced development of railway transport enterprises is of great importance.

# INNOVATIVE DEVELOPMENT OF THE ROAD AND TRANSPORT COMPLEX: PROBLEMS AND PROSPECTS

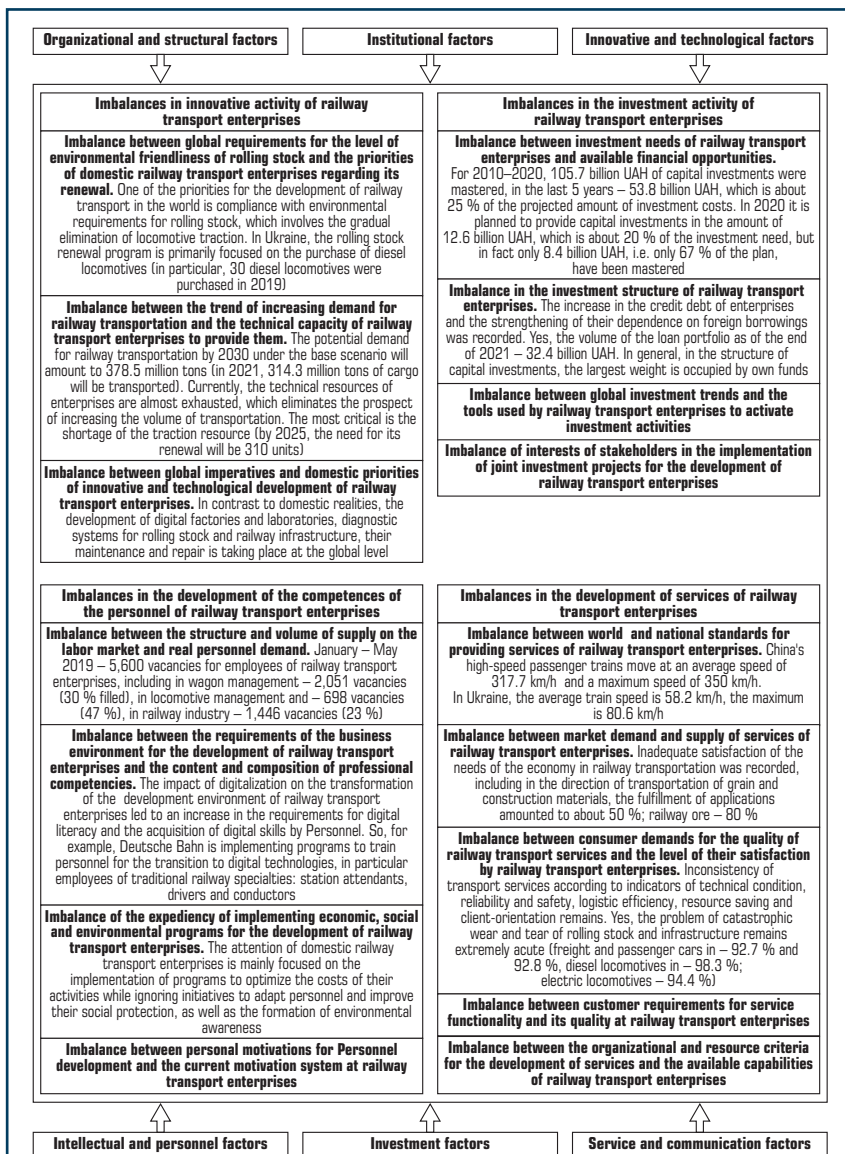
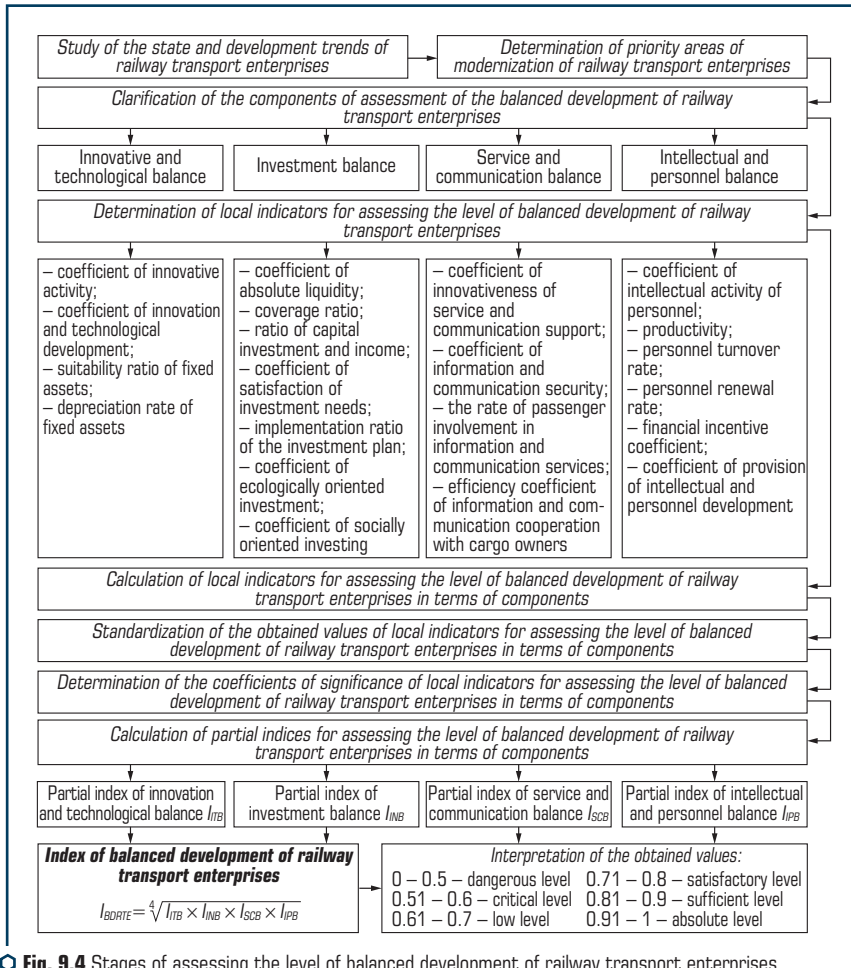


Fig. 9.3 Systematization of imbalances in the development of railway transport enterprises in the conditions of transformation of global trends in the growth of the railway industry  
Source: author's development

## 9.2 DIGITAL TRANSFORMATION AS A BASIS FOR ENSURING BALANCED GROWTH

Given the fact that the effectiveness of the implementation of digital changes in the industry primarily depends on the level of investment security and innovative and technological development of railway transport enterprises, their intellectual and personnel competence and service and communication maturity, it is advisable to conduct an assessment of the balanced development of the enterprises of the industry in terms of these components (**Fig. 9.4**).



**Fig. 9.4** Stages of assessing the level of balanced development of railway transport enterprises  
Source: author's development



Standardization of the obtained values of local indicators for assessing the level of balanced development of railway transport enterprises should be carried out on the basis of assigning the indicators to stimulators or destimulators. Based on the standardization of the obtained values of local indicators and the determination of their significance coefficients, the calculation of partial indices for assessing the level of balance in the development of railway transport enterprises is carried out in terms of the components of innovation-technological (IITB), investment (IINB), intellectual-personnel (IIPB) and service-communication (ICSB) balance. On the basis of the obtained values, the balance index of the development of railway transport enterprises is calculated as the geometric mean partial indicators of the assessment of innovation-technological, investment, service-communication and intellectual-personnel balance. The results of the calculations are given in **Table 9.1**.

● **Table 9.1** Results of the calculation of partial indices for assessing the level of balanced development of railway transport enterprises for the period 2017–2021

Indicator	Value by years				
	2017	2018	2019	2020	2021
Partial index of innovation and technological balance	0.7296	0.6215	0.6165	0.5510	0.4610
Partial index of investment balance	0.6722	0.7245	0.9472	0.6723	0.4665
Partial index of service and communication balance	0.8830	0.8309	0.7461	0.8570	0.8244
Partial index of intellectual and personnel balance	0.8393	0.7469	0.8921	0.6991	0.6200
<i>Index of balanced development of railway transport enterprises</i>	<i>0.7765</i>	<i>0.7271</i>	<i>0.7896</i>	<i>0.6863</i>	<i>0.5758</i>

Thus, based on the assessment results, the following values of the comprehensive index of the balanced development of railway transport enterprises for the period 2017–2021 were obtained: in 2017, the balanced index of the development of the industry enterprises is 0.7765, in 2018 – 0.7271, in 2019 – 0.7896, in 2020 – 0.6863, in 2021 – 0.5758. Taking into account the fact that a characteristic feature of the modern stage is the provision of balanced growth of business entities due to the achievement of multifactorial consistency of economic, ecological and social goals within both the traditional and virtual environment, for the interpretation of the obtained values of the index of balanced development of railway transport enterprises, it is appropriate the following rating scale is used:

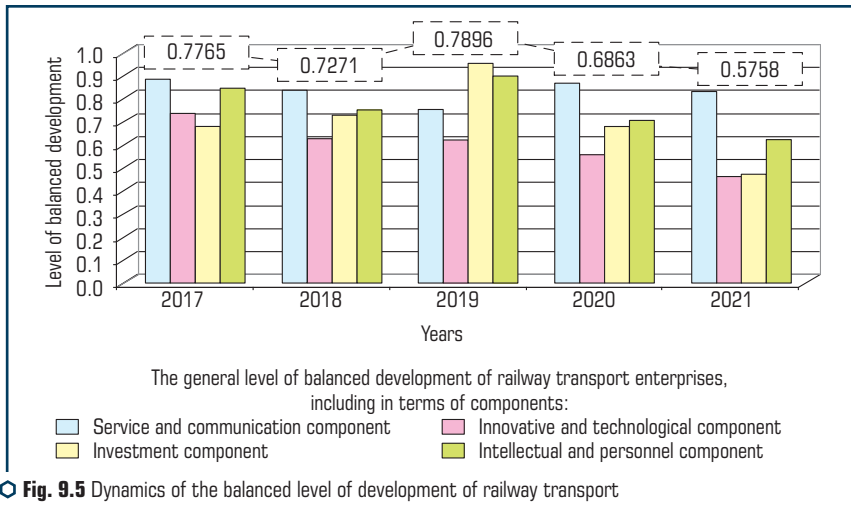
- from 0 to 0.5 – a dangerous level of balance in the development of railway transport enterprises, which reflects the complete imbalance of their management system and indicates the lack of own opportunities to implement qualitative transformations both within the limits of the real and virtual environment of the enterprises of the industry;
- from 0.51 to 0.6 – a critical level of balance in the development of railway transport enterprises, which indicates the disharmony of their growth goals and the insufficient level of resource provision of enterprises in the industry for the implementation of planned digital changes in their activities;
- from 0.61 to 0.7 – a low level of balanced development of railway transport enterprises, which indicates their focus on preserving existing positions and overcoming ripe problems due to the situational implementation of traditional digital solutions by enterprises of the industry;

– from 0.71 to 0.8 – a satisfactory level of balanced development of railway transport enterprises, which indicates a sufficient level of resource provision of the enterprises of the industry for the implementation of the priority goals of their growth and the implementation of local solutions in key areas of activity;

– from 0.81 to 0.9 – a sufficient level of balanced development of railway transport enterprises, which indicates the presence of sufficient potential for the gradual realization of the economic, social and environmental goals of their growth based on the fragmented implementation of both local and complex digital solutions at the enterprises of the industry;

– from 0.91 to 1 – an absolute level of balanced development of railway transport enterprises, which indicates full consistency of goals and high efficiency of the tools of digital transformation and modernization of enterprises of the industry, including in terms of innovation and technology, investment, service and communication and intellectual – personnel components, in accordance with global trends of technological modernization of railway transport.

Based on the results of the assessment of the level of balanced development of railway transport enterprises and the peculiarities of their interpretation, it should be pointed out the gradual loss of stabilization capabilities of the enterprises of the industry and the limitation of the available opportunities to ensure their digital transformation and modernization. According to **Fig. 9.5**, in 2017–2019, domestic railway transport enterprises have a satisfactory state of balance, and in 2020–2021 – a correspondingly low and critical level, which is caused by the deterioration of their service-communication, innovation-technological, investment, and intellectual-personnel capabilities to ensure sustainable development.



**Fig. 9.5** Dynamics of the balanced level of development of railway transport enterprises in the conditions of digital modernization of the railway industry  
Source: author's development

All this indicates the uncertainty of the goals and tools of digital modernization of services, investment and innovation processes and personnel competencies and indicates the expediency of the comprehensive application of the latest digital solutions in the field of railway transport as a basis for ensuring the balanced growth of enterprises in the industry.

Taking into account the established theoretical provisions for ensuring the balanced growth of railway transport enterprises and taking into account the obtained results of assessing the level of balance of their development, it should be noted the feasibility of developing an effective toolkit for ensuring the balanced growth of enterprises of the industry based on the formation of a corresponding concept and a system of scenarios for its practical implementation. The latter actualizes the need to research existing approaches to the formation of this kind of concept.

### 9.3 FORMATION OF THE CONCEPT AND SYSTEM OF SCENARIOS

As world experience shows, digital technologies are currently considered as an effective tool for achieving both economic, social and environmental goals of railway transport development. Today, the most large-scale infrastructure projects are the development of transport and logistics infrastructure equipped with digital technologies. Digitalized high-speed lines, transport corridors and transport and logistics hubs are being developed at an accelerated pace. Therefore, the world's first automated high-speed railway connecting Beijing and the city of Zhangjiakou has already been put into operation. Thanks to the use of rolling stock equipped with 5G mobile communication, wireless charging devices and "smart" lighting, which reaches a maximum speed of 350 km/h, it was possible to reduce the travel time from more than 3 hours to 47 minutes. In addition, work is underway in Beijing on the construction of underground transport and logistics hubs, which will create opportunities for passengers to transfer between subway trains and railways. Railway companies also implement a number of social projects aimed at improving the professional qualities of employees and activating their intellectual abilities, attracting and adapting new employees, ensuring social security of employees. So, for example, Deutsche Bahn (Germany) hired about 24,000 new employees, including drivers, conductors, electronics and information technology specialists. In particular, a new recruiting department was created in the concern, which is engaged in the search and hiring of specialists outside of Germany, in particular in Spain, Italy, Greece, North Macedonia, Serbia and Romania. For 2020, Deutsche Bahn plans to invest about 500 million euros in employee training. At the same time, great attention is paid to the creation of training programs for training personnel for the transition to digital technologies. Such programs were created for traditional railway specialties: station attendants, drivers and conductors.

Projects of modernization of railway transport, developed taking into account the ecological goals of its development, are of interest. So, in 2018, the Coradia train was launched in Germany iLint on hydrogen fuel cells, during the movement of which emissions into the environment are made only in the form of water and steam. The first two hydrogen-powered trains have been operating in Lower Saxony since September 2018. The local transport administration LNVG plans to organize the

movement of 14 such trains from 2021. Also in Germany, the Transport Association of the Rhine-Main Region RMV ordered 27 Coradia trains from Alstom iLint, which will allow to have the world's largest fleet of rolling stock on hydrogen fuel. Other countries are gradually joining the implementation of this initiative. In particular, tests of the Coradia train are planned in the Netherlands iLint in the first quarter of 2020 with the aim of further replacing diesel trains on non-electrified lines with rolling stock with hydrogen fuel cells. The San Bernardino County Transportation Authority of the State of California (USA) has signed a contract with the Stadler company for the supply of the first hydrogen-powered FLIRT train, followed by four more such trains. In particular, the first train on hydrogen fuel should start transporting passengers in Southern California from 2024 [13].

The Directorate of Railways of Norway (Jernbanedirektoratet), based on a study of the possibilities of abandoning the use of diesel traction on non-electrified lines with the aim of completely eliminating carbon dioxide emissions, indicated five alternative solutions: hydrogen fuel, biogas, biodiesel and traction batteries – with partial electrification of the line or its complete absence. Based on the results of the study, a conclusion was made about the most convenient use of rolling stock with traction batteries in combination with partial electrification. This technology is recognized as the most reliable, and it is also compatible with the existing infrastructure: trains with traction battery batteries can run throughout Norway's railway network. In general, it is planned to reduce emissions of carbon dioxide into the atmosphere by 45 % by 2030 [14]. The effectiveness of the use of such diesel trains has been recognized by Germany, which concluded a contract with the Alstom company for the manufacture and delivery of 11 Coradia electric trains Continental, designed for power from both the contact network and batteries.

Projects related to the transition of railway transport to alternative energy sources are being implemented at the global level. One of these projects is the construction of a solar power plant in Wasbeke as part of an agreement between the German Railways and the energy company Enerparc. The power plant with a capacity of 42 MW will be able to produce 38 GW/h of electricity annually. For the first time, the solar power plant will be connected to a converting substation that supplies power to the AC traction power supply system with a frequency of 16.7 Hz. In the future Deutsche Bahn AG intends to increase the number of solar power plants and bring the level of electricity consumption from renewable sources from 60 to 100 % by 2038.

Taking into account the two-component structure of the environment for the development of railway transport enterprises, which includes the real and virtual space of their operation, and the need to harmonize within them the multi-vector goals of the enterprises of the industry, it is expedient to develop conceptual provisions for ensuring the balanced growth of railway transport enterprises, which are based on the principle of multi- criteria coherence of the goals of their sustainable growth (**Fig. 9.6**).

The peculiarity of the developed concept is the reflection of goals, firstly, within the augmented real and virtual environment in accordance with the economic, ecological and social motives of the development of railway transport enterprises, and, secondly, in the directions of ensuring their balanced growth in the conditions of the implementation of digital changes. The strategic goal of the concept is to ensure the balanced development of railway transport enterprises based on digital transformation and modernization of the business environment of their operation.

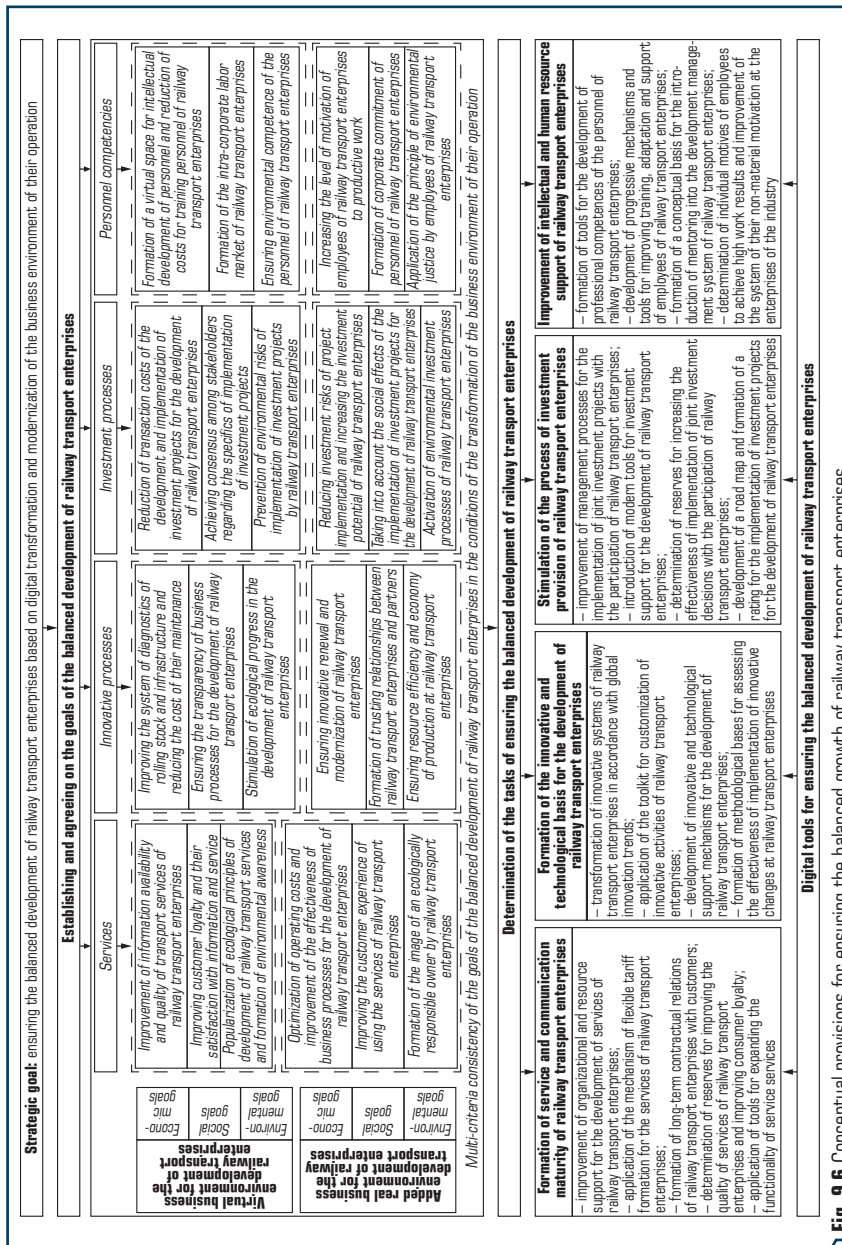


Fig. 9.6 Conceptual provisions for ensuring the balanced growth of railway transport enterprises

Source: author's development

At the stage of establishing and agreeing on the goals of the balanced development of railway transport enterprises, the key motives for the growth of the enterprises of the industry should be determined in the following areas:

a) firstly, within the virtual business environment for the development of railway transport enterprises:

– *according to the direction of service development*: improvement of information accessibility and quality of transport services; improvement of customer loyalty and their satisfaction with information and service; popularization of ecological principles of development of railway transport services and formation of environmental awareness;

– *according to the direction of development of innovative technological processes*: improvement of the system of diagnostics of rolling stock and infrastructure and reduction of the cost of their maintenance; ensuring the transparency of business processes for the development of railway transport enterprises; stimulation of ecological progress in the development of railway transport enterprises;

– *according to the direction of development of investment processes*: reduction of transaction costs of development and implementation of investment projects for the development of railway transport enterprises; achieving consensus among stakeholders regarding the specifics of implementation of investment projects; prevention of environmental risks of implementation of investment projects by enterprises of the industry;

– *according to the direction of the development of personnel competencies*: the formation of a virtual space for the intellectual development of personnel and the reduction of costs for training personnel of railway transport enterprises; formation of the intra-corporate labor market of industry enterprises; ensuring the environmental competence of the personnel of railway transport enterprises;

b) secondly, within the augmented real business environment for the development of railway transport enterprises:

– *according to the direction of service development*: optimization of operating costs and improvement of the effectiveness of business processes for the development of railway transport enterprises; improvement of the client's experience of using the services of industry enterprises; formation of the image of an ecologically responsible owner by railway transport enterprises;

– *according to the direction of development of innovative and technological processes*: ensuring innovative renewal and modernization of railway transport enterprises; formation of trusting relationships between railway transport enterprises and partners; ensuring resource efficiency and economy of production at railway transport enterprises;

– *according to the direction of development of investment processes*: reduction of investment risks of project implementation and increase of investment potential of railway transport enterprises; taking into account the social effects of the implementation of investment projects for the development of enterprises in the industry; activation of environmental investment processes of railway transport enterprises;

– *according to the direction of personnel competence development*: increasing the level of motivation of employees of railway transport enterprises for effective work; formation of corporate

commitment of personnel of railway transport enterprises; application of the principles of environmental justice by employees of railway transport enterprises, etc.

Ensuring the balanced growth of railway transport enterprises requires solving the following tasks:

1) formation of service and communication maturity of railway transport enterprises, which is based on the need: improvement of organizational and resource support for the development of services of railway transport enterprises; application of the mechanism of flexible tariff formation for the services of railway transport enterprises; formation of long-term contractual relations of railway transport enterprises with clients; determination of reserves for improving the quality of services of railway transport enterprises and improving consumer loyalty; application of tools for expanding the functionality of service services, etc.;

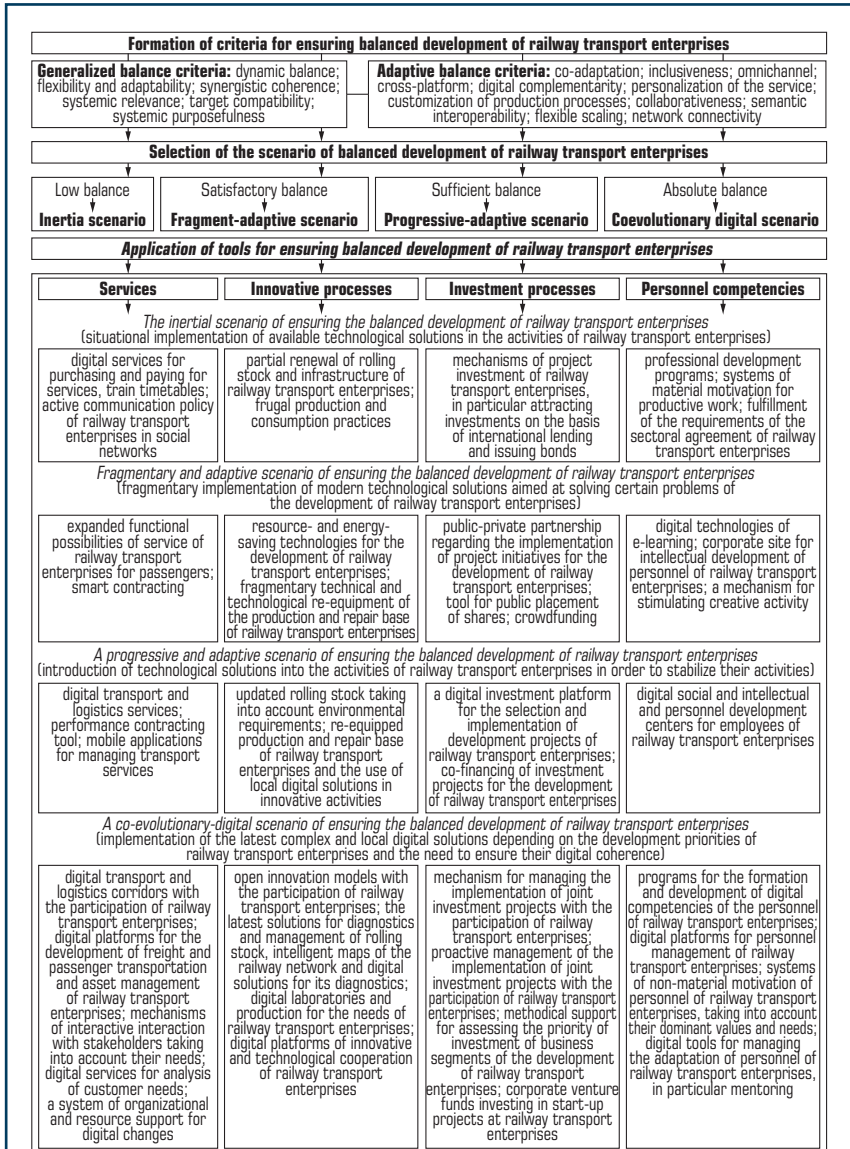
2) formation of the innovative and technological base for the development of railway transport enterprises due to: transformation of innovative systems of railway transport enterprises in accordance with global innovation trends; application of the toolkit for customization of innovative activities of railway transport enterprises; development of innovative and technological support mechanisms for the development of railway transport enterprises; formation of methodological bases for assessing the effectiveness of implementation of innovative changes at railway transport enterprises, etc.;

3) stimulation of investment support processes for railway transport enterprises, which requires: improvement of management processes for the implementation of joint investment projects with the participation of railway transport enterprises; introduction of modern tools for investment support for the development of railway transport enterprises; determination of reserves for increasing the effectiveness of implementation of joint investment decisions with the participation of railway transport enterprises; development of a road map and formation of a rating for the implementation of investment projects for the development of railway transport enterprises, etc.;

4) improvement of the intellectual and personnel support of railway transport enterprises, which is connected with: formation of tools for the development of professional competences of the personnel of railway transport enterprises; development of progressive mechanisms and tools for improving training, adaptation and support of employees of railway transport enterprises; formation of a conceptual basis for the introduction of mentoring into the system of managing the development of railway transport enterprises; determining the individual motives of employees to achieve high work results and improving the system of their intangible motivation at railway transport enterprises, etc.

The effectiveness of the implementation of the defined tasks of ensuring the balanced development of railway transport enterprises depends to a large extent on the effectiveness of the tools used and its compliance with global trends in the modernization of the railway industry. In order to ensure the desired state of balanced development of railway transport enterprises and the successful selection of digital tools for its achievement, it is proposed to use a system of scenarios for ensuring the balanced growth of enterprises in the industry, which, as a criterion for their selection, determines the degree of penetration of digital technologies into the activities of railway transport enterprises: inertial, fragmented-adaptive, progressive-adaptive, coevolutionary-digital (**Fig. 9.7**).

## 9 CONCEPTUAL PROVISIONS FOR ENSURING BALANCED DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES UNDER THE CONDITIONS OF IMPLEMENTATION OF DIGITAL CHANGES IN THE INDUSTRY



○ **Fig. 9.7** A system of scenarios for ensuring the balanced development of railway transport enterprises, taking into account the extent of their digital adaptation

Source: author's development



The choice of the scenario of ensuring the balanced development of railway transport enterprises depends on the current level and the desired state of balance of goals and the tools of sustainable growth of the enterprises of the industry. Accordingly, maintaining the achieved level of balanced development of railway transport enterprises requires the application of an inertial scenario, which is oriented on the situational implementation of available technological solutions in the activities of the enterprises of the industry. Achieving a satisfactory level of balance in the development of railway transport enterprises requires the application of a fragmented-adaptive scenario, which accordingly provides for the fragmented implementation of modern technological solutions aimed at solving specific problems of the development of enterprises in the industry. In turn, the progressive-adaptive scenario of ensuring the balanced development of railway transport enterprises, which involves the introduction of technological solutions into the activities of the enterprises of the industry in order to stabilize their activities, should be used in the case of achieving a sufficient level of balance. The coevolutionary-digital scenario of ensuring the balanced development of railway transport enterprises involves the implementation of the latest complex and local digital solutions depending on the development priorities of the enterprises of the industry and the need to ensure their digital coherence. Its practical implementation makes it possible to achieve absolute balance in the development of railway transport enterprises.

Taking into account the aspiration of railway transport enterprises to achieve absolute balance in their development and to form a basis for achieving stable competitive positions in the market of transport and logistics services, it should be pointed out the feasibility of using precisely the coevolutionary-digital scenario. Since the use of its tools will allow full-scale implementation of digital transformations in the direction of qualitative transformation of services, innovative and investment processes and formation of digital competencies of personnel of railway enterprises.

In particular, ensuring the balanced development of services of railway transport enterprises involves the use of such tools as digital transport and logistics corridors with the participation of railway transport enterprises, digital platforms for the development of freight and passenger transport and asset management of enterprises in the industry, mechanisms for interactive interaction with stakeholders taking into account their needs, digital analysis services customer needs, a system of organizational and resource support for digital changes, etc.

Activation of the processes of innovative and technological development of railway transport enterprises requires the introduction of such tools as open innovation models [15] with the participation of railway enterprises, the latest solutions for diagnostics and management of rolling stock, intelligent maps of the railway network and digital solutions for its diagnostics, digital laboratories and production for the needs railway transport enterprises, digital platforms of innovative and technological cooperation of industry enterprises, etc.

Stimulation of the processes of investment support for the balanced development of railway transport enterprises becomes possible thanks to the use of such tools as the mechanism for managing the implementation of joint investment projects with the participation of enterprises of the industry, proactive management of the implementation of joint investment projects with the participation of railway enterprises, methodical support for assessing the priority of investing busi-

ness segments of the development of enterprises of the industry and the formation of corporate venture funds for investment in startup projects, etc.

The development of personnel competencies as the basis of intellectual and personnel support for the balanced growth of railway transport enterprises involves the use of such tools as programs for the formation and development of digital competences of the personnel of the enterprises of the industry, digital platforms for the management of personnel of railway enterprises, systems of non-material motivation of the personnel of the enterprises of the industry, taking into account their dominant values and needs, digital tools for managing the adaptation of personnel of railway transport enterprises, in particular mentoring, etc.

#### **9.4 DISCUSSION OF THE RESULTS OF THE CONCEPTUAL PROVISIONS OF THE BALANCED DEVELOPMENT OF RAILWAY TRANSPORT ENTERPRISES**

Thus, in order to diagnose the potential of railway transport enterprises, an assessment of the level of balance in their development was carried out, the results of which allowed to come to the conclusion about the gradual loss of stabilization capabilities by the enterprises of the industry and the limitation of the available opportunities to ensure the latter's digital transformation and modernization of the business model, business processes, development of services and personnel competencies. On the basis of this, the uncertainty of the goals and tools of digital modernization of services, investment and innovation processes and personnel competencies were established and the feasibility of comprehensive application of the latest digital solutions in the field of railway transport as a basis for ensuring the balanced growth of industry enterprises was established.

Taking into account the need for timely adaptation of railway transport enterprises to the challenges of digitalization, conceptual provisions for ensuring the balanced growth of railway transport enterprises have been developed, which are based on multi-criteria consistency of the goals of their sustainable growth. The peculiarity of the concept is the display of goals, firstly, within the augmented real and virtual environment in accordance with the economic, ecological and social motives of the development of railway transport enterprises, and secondly, according to the directions of ensuring their balanced growth in the conditions of the implementation of digital transformations in the industry. It has been proven that its practical application will contribute to the creation of conditions for the digital modernization of railway transport enterprises.

In order to ensure the desired state of balanced development of railway transport enterprises and the successful selection of digital tools for its achievement, a system of scenarios for ensuring the balanced growth of enterprises of the industry has been developed, in which the degree of penetration of digital technologies into the activities of railway transport enterprises is used as a criterion for choosing alternatives: inertial, fragmented-adaptive, progressive-adaptive and coevolutionary-digital. Taking into account the desire of railway transport enterprises to achieve absolute balance in their development and to form a basis for achieving sustainable competitive

positions in the market of transport and logistics services, the expediency of using a coevolutionary-digital scenario has been proven, the use of which tools will allow full-scale implementation of digital transformations for the purpose of qualitative transformation of services, innovative and investment processes and the formation of digital competences of the personnel of enterprises of the industry.

However, it is impossible to talk about the balanced development of railway transport enterprises without the use of marketing management. The next Chapter 10 will be devoted to this issue.

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**ABSTRACT**

For railway transport enterprises, which have now experienced devastating crises, the issue of forming competitive advantages and ensuring their sustainable development is gaining relevance. One of these tools is marketing management, which is a modern concept of supporting customer-oriented business and the development of companies in a dynamic environment. Researchers associate its appearance with the development of markets, the expansion of the product range and the first awareness of the need to influence the consumer to maintain competitiveness. The application of marketing management in railway transport, which is based on the active implementation of digital solutions, will allow to achieve a number of economic and social effects, including saving operating costs, improving the quality of services based on the criteria of customer orientation, reliability and safety, and as a result, achieving the stabilization of the activities of enterprises railway industry and improving their competitive positions in the market of transport and logistics services.

**KEYWORDS**

Competitive advantages, marketing management, customer-oriented business, transport and logistics services, digital platforms.

**10.1 EVOLUTION OF THE DEVELOPMENT OF MARKETING MANAGEMENT**

Considering the evolution of the development of marketing management, it is worth pointing out that today, under the influence of the processes of digital development of the world economy, the concept of marketing management is also undergoing transformation. Implementation of the information (digital) economy objectively determines the need for radical digital changes in society aimed at the development of robotics, artificial intelligence, the Internet of Things, nanotechnology, synthetic biology, quantum computers, and "smart cities". After all, as it is commonly believed, artificial intelligence and digital technologies create an incredible impetus for the development of non-standard types of activities, transforming the entire system of social values and consumer preferences. These statements are the basis of the theory about the approaching era of the technological singularity, the content of which is revealed by Vernor Vinge, and his concepts were picked up by Ray Kurzweil and others [1]. Already today, digital technologies are being actively introduced into all spheres of social life. It is common to use fire fuel cell trains operating in France, which

has signed a contract to purchase 12 trains from the engineering company Alstom, which will be tested in 2023, and from 2025 the new express trains will start carrying passengers. In places where sections of the road are not electrified, the train will run on hydrogen fuel cells that convert hydrogen energy into electric current. Alstom notes that the hydrogen reserve, located in a special tank on the roof, is calculated on 600 km of the way.

In fact, cloud technologies and the so-called Internet of Things (IoT) have formed a very strong tandem, which is increasingly influencing and will influence all spheres of economic life in the future, significantly simplifying the processes of managing relationships between business entities. Cloud technologies create an opportunity for remote access to shared computer resources, because they allow storing and processing information, providing various digital services [2]. Technologies of the Internet of Things form the basis of the activities of economically developed companies, because they allow not only to organize the production process with lower costs, but also to develop effective management solutions to support favorable communications with customers.

The huge potential is for the modern economy of robotics, which is experiencing an era of prosperity, and thanks to the emergence of a large international market, the state and the corporate world began to actively invest in this industry, gradually receiving a radical return. Leading global companies not only buy robots, but also independently create new types of them, producing new areas of application for them, thus increasing competition and stimulating the development of innovations [3]. It is clear that the development of the field of robotics will depend on the international regulatory framework and on the extent to which engineers, designers and manufacturing firms will practice a socially responsible approach. The huge impact on the development of robotics will be exerted directly by consumers, increasingly increasing the requirements for quality and technical parameters of products.

A revolution in neurotechnology describes a wide set of approaches that gives a clear idea of the work of the human brain, allowing to obtain information about the outlook and preferences of consumers, expanding their feelings, changing behavior and principles of interaction in society. Neurobiology is gradually moving beyond the boundaries of medical and scientific laboratories, penetrating into everyday life, providing an opportunity to create new value systems, and at the same time generating serious risks and management tasks [4]. These technologies involve deciphering thoughts at fine levels of detail through new chemicals and interventions capable of influencing consumers' brains to correct errors and display functionality. Innovations in this field help to find new ways of communication and interaction with consumers, as well as to significantly expand the capabilities of the senses. First, the ability to correct shortcomings or multiply positive traits will be a huge advantage for those who can afford to buy or sell neurotechnologies and related services. At the same time, being able to access the innermost thoughts and influence thinking is a huge challenge in a world driven by algorithms and ubiquitous data collection. Secondly, neurotechnologies are the driving forces of this time, providing new forms of cognitive computing and improving the design of machine learning algorithms. The more neurotechnologies create opportunities for understanding consumer consciousness, the easier the process of managing consumer behavior will be [5]. Thirdly, neurotechnologies make it possible to directly influence the brain in more precise ways, thereby

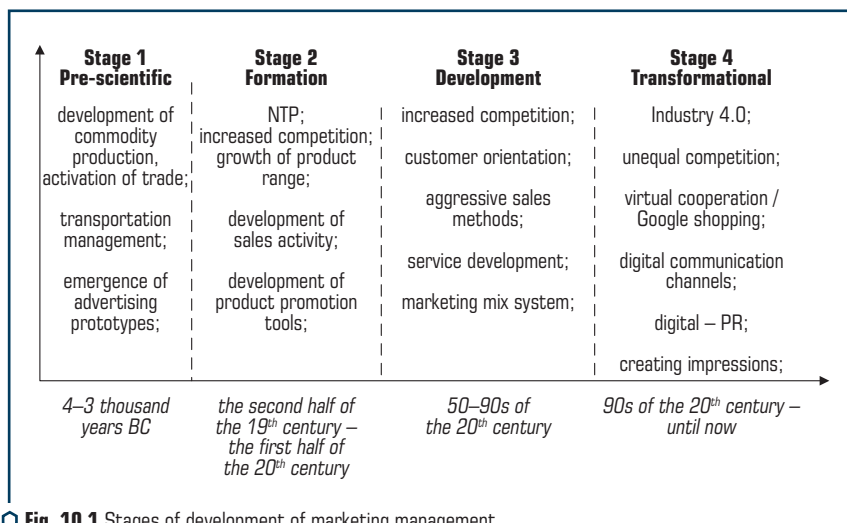
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creating an opportunity to change the sense of self, to find a new understanding of what experience is, and also to fundamentally rebuild the essence of reality. This will allow companies to control the subconscious of consumers, encourage them to make certain purchases [6].

Neurotechnologies will be able to have an even more powerful impact on the economy if they improve the capabilities of the human brain and improve labor productivity. Compared to other industries of the Fourth Industrial Revolution, such as space technologies, neurotechnologies enter the mass market quite slowly [7].

So, in fact, digital technologies are changing the toolkit of marketing management, giving rise to the emergence of new tools for managing consumer behavior. Therefore, considering the stages of development of marketing management, it is appropriate to single out the current period, which is characterized by the penetration of digital technologies into the field of marketing management.

Accordingly, the period from the 90s of the 20<sup>th</sup> century to the present is appropriate to call transformational and to associate it with the introduction of digital marketing tools into the management system. The stages of development of marketing management are presented in **Fig. 10.1**.



**Fig. 10.1** Stages of development of marketing management

Source: author's development

Today, the main characteristics of the market and the company's communication system with consumers are:

- firstly, the oversaturation of the market and the growth of the number of Internet users inclined to make emotional/spontaneous purchases (Google shopping), while most of them are picky about quality and price;
- secondly, unequal competition, in which small companies can easily become a competitor of a giant;

- thirdly, the formation of an online environment for interaction with both customers and business partners, the use of various digital channels to support communications, the development of digital marketing management platforms;

- fourth, the transformation of advertising tools: the emergence of native, viral and smart advertising, the use of digital – PR tools, etc. [8].

Thus, the modern transformation of information and communication technologies, including the Internet, has become in the last few years the driving force behind the formation of a new type of marketing management system, which is based on the achievements of the digital economy. Digitization has changed and continues to change the information environment of organizations, and information has become one of the strategic resources for the successful operation of companies, which creates conditions for reformatting the internal processes of their management activities.

### 10.2 PROBLEMS OF MARKETING MANAGEMENT AT RAILWAY TRANSPORT ENTERPRISES

Today, the problems of management at railway transport enterprises are covered in the publications of such scientists as Yuriy Barash, Volodymyr Dykan, Nataliia Kalycheva, Myroslava Korin, Larysa Marcenjuk, Viktoriia Ovchynnikova, Iryna Tokmakova, Tatyana Charkina, and others [9–16]. Paying tribute to the theoretical and practical value of scientists' research, it should be noted that a more thorough study of the potential opportunities of marketing management as an effective direction for ensuring efficient management of railway enterprises is currently needed.

The impetus for the emergence of marketing management in its modern form was the destruction of the original communal system, which led to the emergence of states, class structures and the development of commodity production, and against this background, the intensification of trade, including between individual states. After all, trade and material production were the basis of the prosperity of such ancient civilizations as Babylon, Ancient Greece, China, Egypt and India. The need to transport production products over long distances led to the emergence of prototypes of such modern tools of marketing management as packaging, advertising and sales promotion. By most scientists, it is the period of 4–3 thousand years BC, which is historically considered to be the stage of the birth of marketing management, which was called "pre-scientific" [7].

In the economic literature, scientists also express an opinion about the emergence of marketing management, which assumes that its origin dates back to the 1750s. The founder of marketing management at this time is Mitsui, who, having opened a prototype of a modern supermarket in Tokyo, introduced modern principles of marketing management into its activities. According to the concept of the development of his department store, firstly, the purchase of goods took place exclusively in accordance with the needs of consumers; secondly, the assortment of products was filled in the same way; thirdly, the practice of reimbursing funds to the consumer in case of returning the product was applied [10].



The industrial revolution that took place in the USA in the second half of the 19<sup>th</sup> century gave a huge impetus to the development of marketing and marketing management – the first half of the 20<sup>th</sup> century and the consequence of which was the appearance of mass standardized production, the rapid development of financial services. During this period, the development of professional sales and advertising took place, and the marketing concept officially took place by introducing the term marketing itself into professional circulation from the position of the key function of production management [18]. At the same time, companies began to create specialized marketing divisions, which at that time performed the functions of sales, market research and advertising development. Later, such departments were transformed into modern marketing centers, which deal with a wide range of issues: from analyzing competitors and consumers to developing strategies to support long-term competitiveness. Also, a prerequisite for the development of marketing management was the growth of the purchasing power of the population, which already at that time wanted to buy goods according to their own preferences.

The third stage of the development of marketing management in its modern manifestation falls on the 50s of the 20<sup>th</sup> century. It is based on the concept of holistic marketing, which involves the formation of an integrated marketing program and the organization of the activities of marketing divisions exclusively in accordance with marketing principles. In particular, in the work [10] it is noted that the basis of marketing management is the concept of integrated and internal marketing, which, on the one hand, determine the set of marketing measures necessary to win over the target audience, and on the other hand, establish the system of actions of the company's divisions for consumer research.

So, it is traditionally customary to distinguish 3 stages of the formation of the concept of marketing management, which most scientists divide into the following time periods:

Stage 1 – pre-scientific – 4–3 thousand years BC.

Stage 2 – the stage of formation – the second half of the 19<sup>th</sup> – the first half of the 20<sup>th</sup> century;

Stage 3 – development – 50s of the 20<sup>th</sup> century to the present time.

The approach to considering the evolution of marketing management from the point of view of implementing its tools in practical activity is quite common in the economic literature. In the framework of this approach, it is customary to distinguish such periods of the formation of marketing management as the life cycle, the era of growth, the era of costs, the era of differentiation and the era of personification, each of which takes into account the dominant marketing toolkit at that time. In particular, the first stage of development of marketing management, which was called the era of life and falls on the 50s of the 20<sup>th</sup> century, is characterized by the use of the concept of the product life cycle in order to position the company's position on the market and predict potential changes. During this period, companies focus a lot of attention on building their own market reputation, segmenting the market and, on this basis, developing personalized tools for managing consumer preferences. The second stage of the "growth era" (the 60s of the 20<sup>th</sup> century) is that during this period, for many companies, the marketing complex becomes a management style, but not as a whole company, but only on the scale of marketing departments. The third stage – the era of costs (70s of the 20<sup>th</sup> century) is closely related to the development of social and strategic

marketing concepts and involves a systematic study of consumer needs and requirements, segmentation and analysis of the product market portfolio in order to develop personalized products that are different from competitors' products, and formation of an effective strategy of competitive actions on this basis to gain better market positions. The next stage of development of marketing management, which falls on the 80s of the 20<sup>th</sup> century and is called the era of differentiation, is characterized by the use of "hard" and "soft" marketing tools in order to capture a larger share of the market. The basis of the companies' marketing strategy was measures aimed either at maintaining direct contact with consumers or at maintaining a client group within a certain region. The era of personification, which dates back to the early 90s of the 20<sup>th</sup> century and continues to the present, is characterized by the use of Internet services by companies to promote products on the market and support the client base. The key features of this period of development of marketing management are the spread of marketing networks and marketing to order, which allow to manage the preferences of a specific target audience, providing the latest necessary information about the product at the place and at the time when they need it [19].

### **10.3 DIGITAL TRANSFORMATION IN THE DEVELOPMENT OF MARKETING MANAGEMENT AT RAILWAY TRANSPORT ENTERPRISES**

The digital transformation of enterprises entails the following revolutionary changes in the business models of company management:

1. Movement from a linear chain of value creation, characteristic of the pre-digital era, to a decentralized platform based on the network effect due to greater involvement of customers and suppliers, in which value is formed due to the creation of connections between consumers and producers.
2. Customer-centricity and customer orientation – a deeper understanding of customer needs, products (services) become more personalized, individualized thanks to the use of digital technologies.
3. Formation of a digital business ecosystem that ensures "seamless" interaction of all stakeholders based on digital services.

Currently, there is no unequivocal answer to the question of the nature of digital transformation from the point of view of temporal and managerial aspects in the scientific community. First of all, it concerns the temporal parameter of the effects of digital transformation and follows from the existence of different approaches to measuring the effectiveness of digital transformation. In most cases, the use of financial and operational indicators, which are inherently short-term, as criteria for assessing the effectiveness of digital transformation indicates that the latter is not considered as a process that is characterized by a long time and a lag in terms of achieving positive effects. From a practical point of view, such effects have not yet been assessed.

The development of artificial intelligence, big data analytics and machine learning opens up new opportunities for enterprises today. Among the new scientific and technological trends are

enterprise architectures (enterprises of a new type, based on the principles of modularity, efficiency, continuous improvement and adaptive innovation, with a modular business model that allows them to rebuild faster and more flexibly adapt to new requirements of the external environment), algorithmic models of trust (ensure data confidentiality), post-silicon computing (development of new advanced materials with enhanced capabilities for data storage and processing, calculations), formative artificial intelligence capable of transforming under the influence of external conditions and generating new algorithms and models for solving specific tasks.

Along with this, modern information and communication technologies make it possible to solve such tasks of marketing management as definition and analysis of factors affecting the socio-economic system, description, modeling and forecasting of the state of the enterprise as a socio-economic system, development of scenarios for its development, formation of a single base data, etc. To analyze factors affecting the enterprise, including risks, various methods and approaches are used today. Among the most new are model methods, which include methods of artificial intelligence, in particular multi-agent systems, collective behavior of automata, etc.

Thus, the narrow specialization and level of digital development of industry and production dictates strict rules and forces to modify classic tools of marketing management in order to maintain a balance between general digitalization and the capabilities of each specific enterprise.

Since the application of digital transformation is a response to the challenges of the external environment, it is impossible to do without the transformation of any one element of the business model: the formation of a radically new digital business model is required, which can be achieved only by changing all its elements. Such a radical change in the business model leads to the transformation of all other structural elements of the company (assets, capital, including the ownership structure, management system).

Features of marketing management of the enterprise in the conditions of digitalization are presented in **Table 10.1**.

The transition to the digital economy also places new demands on the head of the enterprise, on its professional competencies in the field of management, personnel management, and IT technologies. The issue of creating a corporate culture based on effective interaction at all levels of management and readiness for change is also important.

When digitizing railway transport enterprises, two levels of its implementation should be taken into account – organizational and technological. The basis of digitalization technological solutions is the development of an intelligent railway transport management system, which is focused on comprehensive automation of the main processes of planning and dispatch management of the transportation process, as well as on knowledge management, and uses an ontological model of infrastructure elements and technological processes. That is, from a technological point of view, the digital railway can be defined as a set of digital technologies and methods of describing the infrastructure, rolling stock, transportation process and traffic management technologies, ensuring the safety and maintenance of the infrastructure, which are aimed at achieving fundamentally new automated methods of planning, dispatching traffic management, resources and maintenance.

● **Table 10.1** Peculiarities of enterprise marketing management in modern conditions of digitalization

Feature	Impact on marketing management processes
Possibility of using automated management systems to collect, process and analyze large data in real time, as well as generate new models and algorithms of behavior with the help of artificial intelligence	Promptness of data provision, including already calculated financial and economic coefficients and other indicators necessary for making management decisions. Using the capabilities of artificial intelligence to generate new models and algorithms for the system's response to certain values, markers
Digital ecosystem: internal and external	Efficiency of interaction with state structures, customers, suppliers
Profitability paradox	Capitalization growth of digital companies against the background of their unprofitability
High speed of change	The need to accelerate management decision-making and forecasting the dynamics of the development of the macro- and micro-environment
Dynamics of the macroenvironment	The need for risk accounting
<i>The possibility of reducing costs due to the use of digital technologies</i>	
Remote work	The possibility of reducing office maintenance costs
Use of digital doubles	The possibility of reducing the costs of real tests with the help of the use of digital doubles (research of technical characteristics, such as strength, reliability, functionality, etc.) with the possibility of designing for a given cost
Digital sharing platforms	The possibility of reducing the costs of maintaining fixed assets

Source: author's development

From an organizational point of view, the digitalization of railway transport requires the implementation of a set of business models, transport services and means of their automation, united by the single principles of digitization of all physical assets and processes of railway transport enterprises and their integration into the global transport ecosystem.

Customization processes are of primary importance in the digitalization system of companies, including railway transport enterprises. Global brands increasingly create products and services based on the individual needs of their customers, and therefore customization comes to the fore.

Customization is the ability to independently choose/customize a product to your own needs or preferences. This kind of individualization of products according to the order of each client. For example, applying a specific print on a shirt in an online clothing store at the customer's request or ordering accessories with an individual inscription. The main goal of customization is to create conditions under which an individual authentic approach to the client's personal needs is best experienced.

At first, domestic marketers considered customization as the production of mass products to a specific customer order by adding additional elements or equipment. Along with this, it should be taken into account that individualization involves the release of a certain product that differs from competitors in specific properties and characteristics, including functional, external, etc., but this does not always mean that the individualized product meets the requirements of a specific client.

It is believed that mass customization allows the production of a sufficiently large volume of products for a relatively large market (or a number of niche markets) without compromising on cost, delivery and quality. Thus, mass customization means the use of flexible automated production systems, which allow to organize flexible production of products with individual characteristics, as well as to combine low costs and flexibility of individual customization. The economic features of customized production, advantages for the consumer and the producer became one of the key incentives that motivated companies to introduce customization tools into the marketing communications management policy.

The strategic nature of customization is also confirmed by foreign experts, who suggested that the tool of customization be considered a strategy that creates the value of one or another "company-consumer" interaction at the stages of manufacturing and/or assembly due to the creation of individual products at costs and prices comparable to the conditions of mass production. According to marketers, customization allows consumers to create a product for themselves, which allows to significantly improve the costs of researching consumer preferences. However, practice shows that companies do not always strive for customization, often preferring standard solutions. It can be argued that customization goes beyond manufacturing. Thus, the evolution of scientific ideas about the essence of customization led to its broader interpretation. If the beginning of the study of customization was connected with decisions in the field of technology and production, marketing tactics, cost management, then the modern stage of development of this concept is based on the understanding of customization as a strategy of the company's activity, which gives it a systemic character. It is interesting to note that previously only marketing was called a business philosophy, and now customization itself is recognized as such, although at first it was considered only one of the marketing tools and an alternative trend of doing business. Thus, customization from elements of marketing activities becomes an alternative and/or complements the marketing concept. At the same time, as experts rightly believe, customization can be different. In their opinion, according to the nature of product changes, customization can be:

- expert, when the product is created "for each client" – in this case, a more accurate definition would be individual customization;
- modular, that is, it provides the possibility for the client to choose the necessary equipment from the possibilities (elements or options) offered by the company;
- "at the level of appearance", which is based on the choice of external attributes – packaging design, product shape, etc.

The typological approach combines two criteria. First, the degree of customization of the product (from the maximum with expert customization to the minimum with customization at the level of appearance). Secondly, the flexibility of the production approach (from artificial production with expert customization to product customization at the final stages of production and sales).

An exclusively production approach is implemented in the typology of customization types, which implies the definition of its two types:

- horizontal customization (modification of products from identical, impersonal components);
- vertical customization (a unique product from unique "components", originally created for a specific client).

An active approach to castromization allows to distinguish four types of it based on the criterion of the behavior of the supplier (manufacturer or seller of the product) [20]. Collaborative (joint) customization means the development of a dialogue in which the supplier helps to formulate the needs of the consumer in order to clearly define product offerings that satisfy their needs. With adaptive customization, the consumer is offered a standard product, but in which some adjustment functions are "built-in" so that the user can change it itself. The release of a standard product, but with a customized image of it in the eyes of the consumer, is an example of cosmetic customization. Its opposite is transparent customization, which starts the independent change of the product.

However, in any case, customization can lead to the rejection of mass or serial production and the transition to production "to order" and/or to the need to produce the same product, but in different configurations, supplemented by a number of options (elements, modules and etc.), design solutions.

Obtaining new streams of income depends on the ability of the enterprise to quickly and flexibly implement its business ideas, therefore, in order to achieve its goals, enterprises need to cooperate with other enterprises by concluding cooperation agreements. This combination of forces guarantees that they will remain competitive in today's dynamic market. They just need to cooperate, join forces to compete. A group of self-contained independent enterprises, even geographically dispersed, begin to share core competencies, information, finances, and capabilities to create greater opportunities for profit. Examples of such cooperation are especially common in Europe, where different enterprises interact at the regional level. Many advanced industrial corporations, such as automobile companies, rely on "virtual" business relationships with corporate customers and suppliers. That is, information and communication technologies and electronic means of communication provide a higher level of integration in the European business landscape, although many actions can still be performed "manually". But using modern information and communication technologies, virtual partnerships limit their temporal and distance frameworks and accept various challenges of the market.

When partners combine their businesses within a single virtual system to meet consumer demands and opportunities presented by the market, and remain in business as long as these opportunities remain, a number of advantages arise, among which:

- 1) flexibility as the ability to recognize and then deal with any unexpected changes that may occur in the environment, so that one can respond more successfully to the opportunities presented by the market, as well as shorten the time to market together with higher quality at lower costs investments. Any virtual organization, using the resources of various partners, is able to form the most suitable set of skills to meet the needs of the consumer. It is also able, if necessary, to reorganize itself either by adding/removing some of its members, or by actively redistributing roles and tasks for some of its members. The purpose of such an organization is to create a synergistic effect in order to master new markets and further use creative business opportunities;

- 2) optimal size of competitive competencies. By engaging in virtual partnerships with other market stakeholders, businesses can achieve a "critical mass" (size) of competitive advantage to succeed;

3) competitiveness: the necessary level of profitability that ensures competitiveness in the market can be achieved if the sub-tasks are properly distributed among the partners working together. The competitiveness of the partners' joint business is also ensured by the flexibility of the structure;

4) optimization of resources. Smaller organizations can more successfully share their competitive advantages, infrastructure and knowledge, and minimize business risks;

5) innovations. There are increased opportunities for sharing and assessing ideas within the partnership, which increases the number of innovations.

It should be noted that railway companies of many countries are currently launching projects related to the development of digital platforms in various areas of their activity. Such solutions act as a technological environment for the formation and provision of services and act as a basis for cooperation between enterprises providing services and their consumers directly. They may include stages related to design, production and sale of products, as well as subsequent service. That is, digital platforms act as a mechanism and environment for the formation of product value, as well as a tool for accelerating the exchange of information and the value of products.

#### 10.4 DISCUSSION OF THE RESULTS OF THE DEVELOPMENT OF MARKETING MANAGEMENT AT RAILWAY TRANSPORT ENTERPRISES

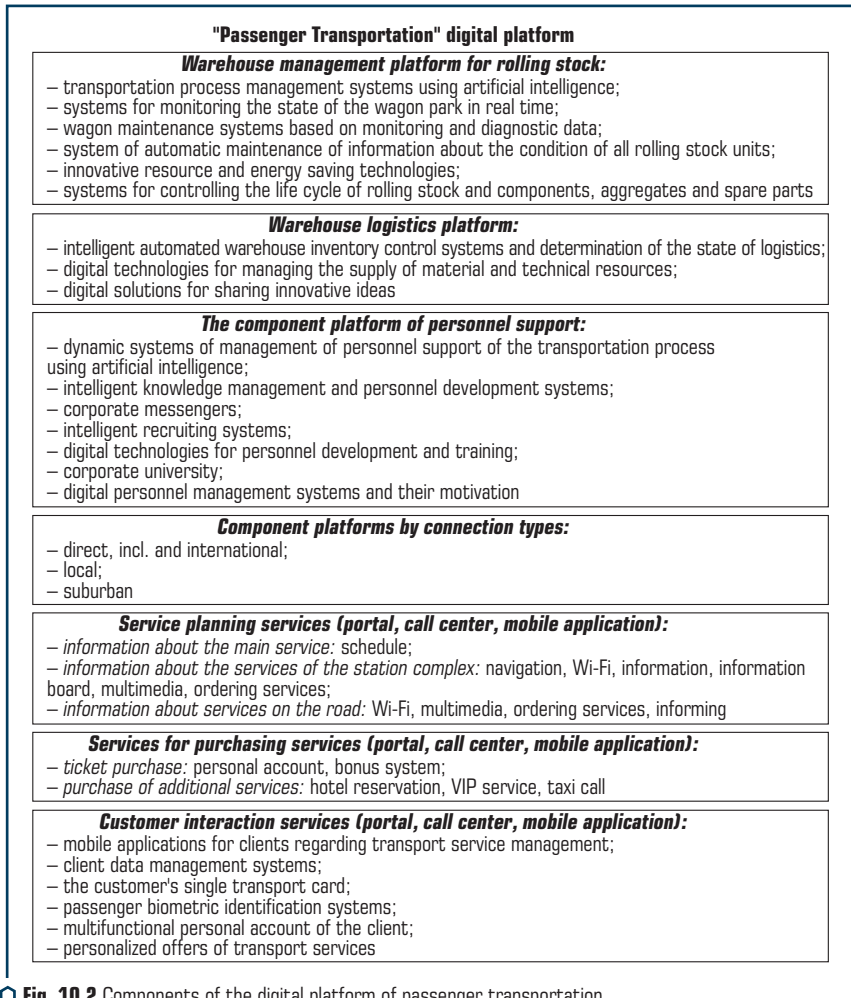
It is expedient to develop and implement a complex of digital platforms aimed at the development of freight and passenger transportation, related services, as well as direct management of other internal processes of enterprises of the industry at domestic railway transport enterprises. Taking into account the fact that the enterprises of the railway industry belong to the field of transportation organization, it is worth proposing to improve their work the formation of a suitable digital platform, which should include the components of the rolling stock management platform, logistics and personnel support, platforms by types of connections, planning services and purchasing services, as well as customer interaction services. The complex of platforms in the field of passenger transportation is presented in **Fig. 10.2**.

This kind of system will make it possible to qualitatively improve the processes of organizing passenger transportation. Thus, within the framework of a single digital circuit, connect payment and accounting options for users of railway transport services, including due to contactless payment with bank cards, mobile devices with NFC function, to ensure registration and accounting of tickets by privileged categories of the population, to create opportunities for the introduction of a single digital ticket and the use of the so-called transfer tariff within the framework of the development of multimodal passenger transportation. In addition, there will be an opportunity to clearly control the quality of services provided to consumers and the level of their locality to railway transport enterprises, as well as to expand the information base about users and their preferences.

As effects of the introduction of a complex of digital platforms in the field of passenger transportation, it should be noted the improvement of the quality of transport and logistics services by enterprises of the industry; expanding the functionality of client services and reducing the cost of

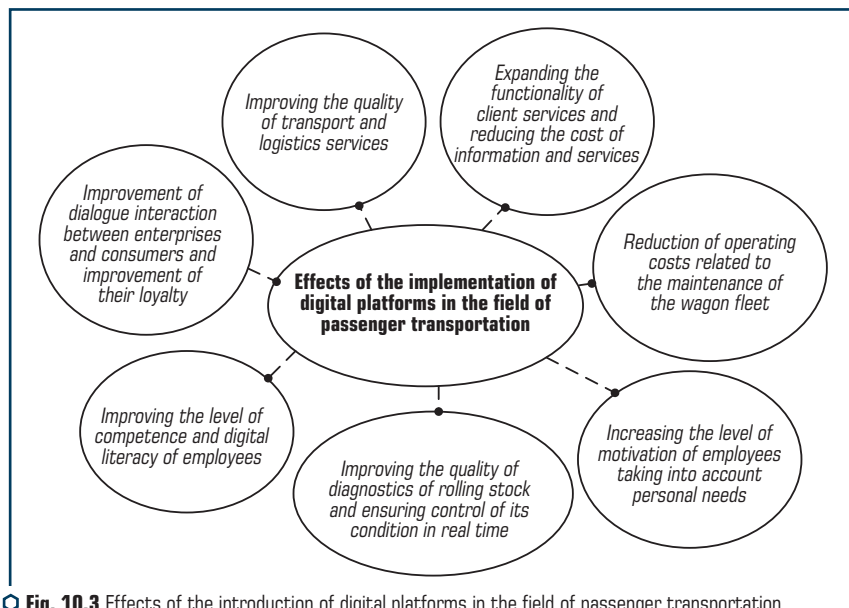
information and service services; improvement of dialogic interaction of railway transport enterprises with consumers and improvement of their loyalty.

Also, this will create opportunities to improve the quality of diagnostics of rolling stock and ensure control of its condition in real time, reduce operational costs related to the maintenance of the rolling stock, improve the level of competence and digital literacy of employees of railway transport enterprises, increase their level of motivation taking into account personal needs (Fig. 10.3).



**Fig. 10.2** Components of the digital platform of passenger transportation  
Source: author's development





**Fig. 10.3** Effects of the introduction of digital platforms in the field of passenger transportation  
Source: author's development

Thus, the application of marketing management in railway transport, which is based on the active implementation of digital solutions, will allow to achieve a number of economic and social effects, including saving operational costs, improving the quality of services according to the criteria of customer orientation, reliability and safety, and as a result achieve stabilizing the activities of railway enterprises and improving their competitive positions on the market of transport and logistics services.

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## 11

## HYBRID DRIVES AS A WAY TO EFFICIENT ROAD CONSTRUCTION

Anton Kholodov, Mykhailo Kholodov

## ABSTRACT

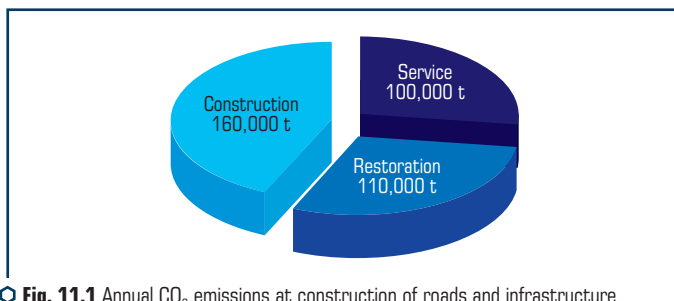
Effective use of means, including financial ones, in today's realities is the primary task of every region, every industry, every enterprise. Taking into account the scale of destruction of the road complex caused by military aggression, this task is particularly urgent. One of the methods of such savings in road construction is the use of hybrid drives. The impact of modern technologies in the field of creating hybrid drives on increasing the effective construction of the road construction complex as a whole is considered. The strategy for the development of hybrid drives of earthmoving machines (EMM) is considered on the example of the world's leading manufacturers of equipment. An analysis of the structural performance of the power drive as a whole and its individual elements, the interaction of power plant units in different operating modes is given.

## KEYWORDS

Hybrid drive, machine, cycle, efficient construction, energy, process.

## 11.1 ECOLOGICAL APPROACH IN ROAD CONSTRUCTION

For the last ones years question ecological security, in the perspectives of growing consumption hydrocarbons sources of energy, is particularly acute [1–3]. It is testified by the data of research by quantity of CO<sub>2</sub> emissions at construction of roads and infrastructure by different ministries of transport and infrastructure in the world (**Fig. 11.1**).



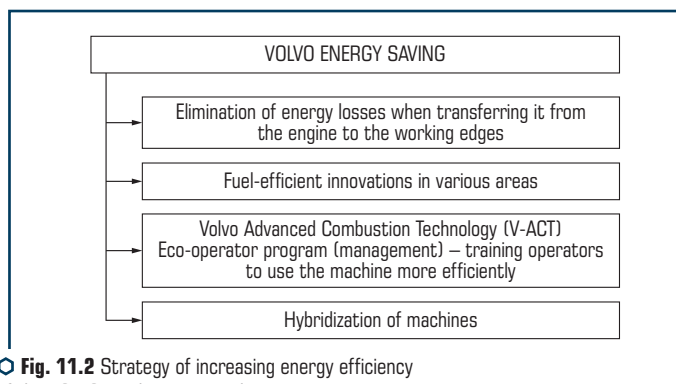
**Fig. 11.1** Annual CO<sub>2</sub> emissions at construction of roads and infrastructure  
Source: author's development

In this regard, the use of machines and equipment with high indicators of fuel economy and environmental safety, as well as the modernization of machines in operation, can be one of the most effective means of improving the fuel, energy and environmental situation [4].

Such machines are machines with hybrid power plants. Hybrids have been widely developed in the automotive industry, which cannot be said about earthmoving machines.

According to research, gasoline and diesel engines consume a large part of oil products. The average efficiency of engines is only 23 % (gasoline engines – up to 21 %, diesel engines – about 25 %) [3, 5]. Therefore, a large part of oil products is burned in vain and causes damage to the environment – it goes to heating and polluting the atmosphere. But this is far from a complete description of the efficiency of the machines. Its main indicator is not the efficiency of the engine, but the load factor. Unfortunately, earthmoving machines use powerful engines extremely inefficiently. Their engines are designed for heavy loads, but during the operation of the machine, they do not always reach the maximum. Car manufacturers in Germany, the USA, Japan, China, Sweden and other countries are trying to solve this problem in their own way by switching to gas fuel, switching to electric cars, installing a special absorber of harmful combustion products on each car and burning them in the muffler, optimizing the working process due to the improvement of the operator's qualifications, as well as redistribution of engine power, accumulation of underutilized power and its subsequent use in loaded operating modes.

For example, the VOLVO company [6] works in the field of improving energy efficiency in the following directions (**Fig. 11.2**).



**Fig. 11.2** Strategy of increasing energy efficiency of the VOLVO earthmoving machines

*Source: author's development*

As is known, electric hybrids have become widespread in the automotive industry. Thanks to the modern level of electrical engineering and electronics, it has become possible to create computerized energy converters of fairly small mass and cost, which is largely compensated by the advantages of an automated drive from the point of view of improving fuel economy and reducing the

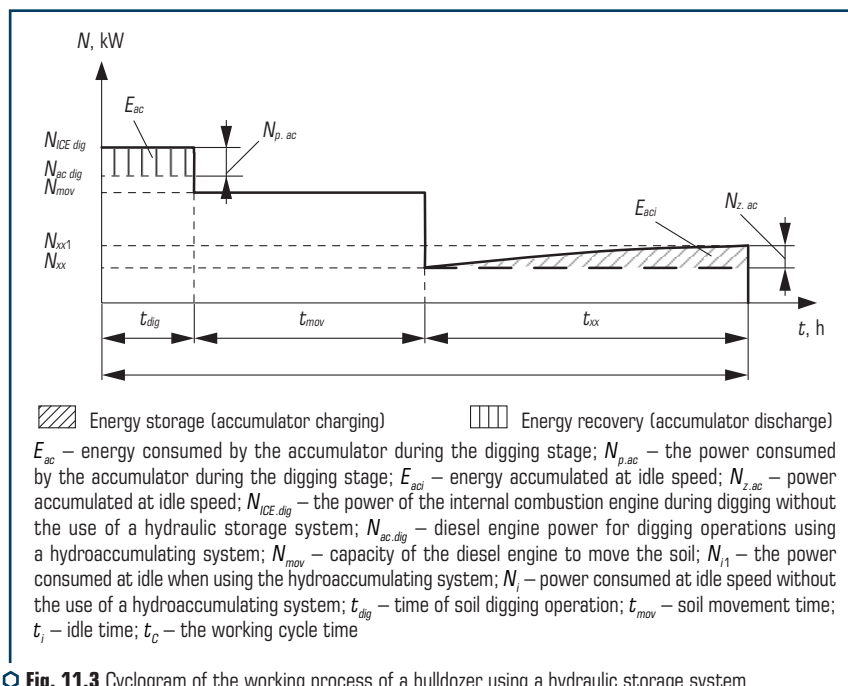
toxicity of exhaust gases of the internal combustion engine, which is part of the hybrid power plant. However, these system data assume the presence of energy sources for charging the batteries.

This condition is not always feasible for earthmoving machines, because most often they work in field conditions. Also, due to their large capacities, the volume of batteries and their charging time have increased significantly. Therefore, manufacturers are looking for other ways to increase the fuel efficiency of earthmoving machines.

With the help of hybrid systems based on fuel cells, as on Hino trucks. When the main unit of the hybrid installation is a 4-cylinder diesel engine (with turbocharging and a Common Rail fuel supply system) with a power of 110 kW and a torque of 420 Nm at a crankshaft rotation frequency of 2500 and 1400 min<sup>-1</sup>, respectively, combined with an electric motor – an alternating current generator with a power of 36 kW and a torque of 333 Nm [7].

Since these machines are most often hydrofied, it is rational to use hybrid units based on hydro-pneumatic accumulators, which allow to accumulate hydraulic energy when the machines are idling and return it during loaded operating modes [8, 9] (**Fig. 11.3**).

When using a hydro-accumulating system in the work cycle of the bulldozer, energy flows will be redistributed and the step-by-step consumption of engine power will change [10].



**Fig. 11.3** Cyclogram of the working process of a bulldozer using a hydraulic storage system  
Source: author's development

## 11.2 TECHNICAL COMPONENT IN THE CONTEXT OF EFFECTIVE ROAD CONSTRUCTION

By definition, a hybrid car is a car that uses more than one source of energy to drive mechanisms. Since the hydroaccumulating system (HAS) is the drive of the working equipment, the machines equipped with such systems can be called machines with hydrogenated hybrid power plants (MHPP).

Theoretically, the installed power of the engine of the hydraulic machine can be reduced by the amount of power accumulated by the hydroaccumulating system, which can be accumulated in the idle modes of the machine, during its braking, lowering of the working equipment, etc. [11], as well as due to the improvement of the hydraulic storage system itself:

$$N_{EICE} = N_{ICE} - N_{HS}, \quad (11.1)$$

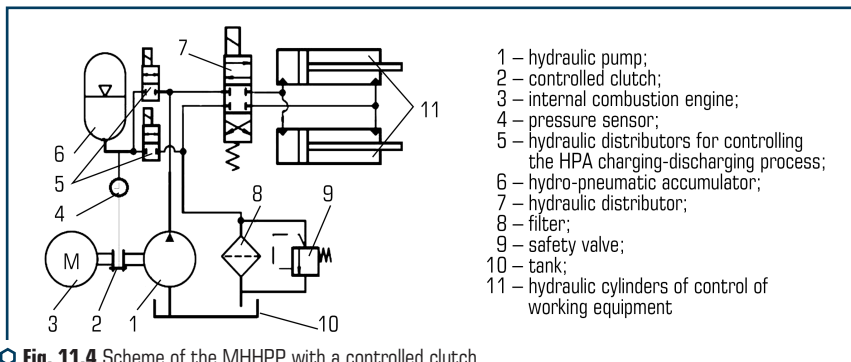
where  $N_{EICE}$  is the power of the MHPP engine;  $N_{ICE}$  is the power of the engine laid down during the design;  $N_{HS}$  is the capacity of the hydroaccumulating system.

Thus, a detailed study of energy flows in the working cycle of machines, research of ways to accumulate underutilized energy will allow to more evenly load the primary engine and reduce its installed power, which will lead to an increase in fuel economy and environmental safety [12].

The HAS improvement is possible due to the installation of controlled couplings between the primary engine and the hydraulic pump [12, 13], which allow it to be turned off in unmarried modes of operation (**Fig. 11.4, 11.5**).

The use of a controlled clutch in the hydraulic storage system will allow to reduce the energy consumption of the primary engine, and therefore the fuel consumption, in idle modes of operation and in loaded modes using the hydraulic storage system [14].

Experimental studies were conducted to increase the fuel efficiency of machines when the hydraulic pump is turned off, using the T-40 tractor as an example. The results of which are summarized in **Table 11.1** of technical and economic indicators.



**Fig. 11.4** Scheme of the MHPP with a controlled clutch  
 Source: author's development



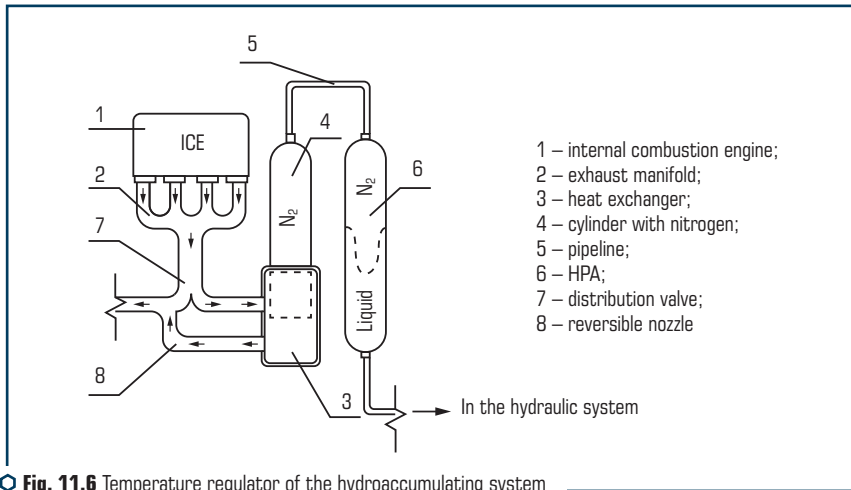
Fig. 11.5 3D model of the MHPP clutch

Source: author's development

Table 11.1 Technical and economic indicators of the studied bulldozers

Indexes	Marking	Indicator value				
		Bulldozer without HAS	Bulldozer with HAS	Increasing the efficiency of a bulldozer with HAS, %	Bulldozer with HAS and controlled clutch	Increasing the efficiency of a bulldozer with HAS and a controlled clutch, %
Engine power, kW	<i>N</i>	66	66	—	66	—
Productivity, m <sup>3</sup> /h	<i>P</i>	50.52	53.06	4.78	62.8	4.78
Bulldozer mass, t	<i>G</i>	7.185	7.220	—	7.23	—
Specific energy intensity of digging, kW/m <sup>3</sup> /h	<i>N/A</i>	1.3	1.2	7.69	1.05	7.69
Specific material capacity, t/m <sup>3</sup> /h	<i>G/P</i>	0.14	0.13	7.14	0.11	7.14
Total fuel consumption, l/shift	<i>Q</i>	47.3	45.6	3.59	42.8	9.59
Specific fuel consumption, l/m <sup>3</sup>	<i>q</i>	0.14	0.12	14.28	0.12	14.28
Generalized indicator, kW·t/(m <sup>3</sup> /h) <sup>2</sup>	$I_{NG} = \frac{NG}{I^2}$	0.185	0.169	8.64	0.12	8.64
Specific fuel consumption per unit of power, l/shift/kW	<i>Q/N</i>	0.71	0.69	2.81	0.64	9.85
Specific fuel consumption per unit of mass, l/shift/t	<i>Q/G</i>	6.5	6.3	3.07	5.9	9.23
Total fuel consumption per unit of performance, (l/shift)/(m <sup>3</sup> /h)	<i>Q/P</i>	0.93	0.86	7.52	0.68	13.97
Dump speed, m/s	<i>v</i>	0.32	0.41	21.95	0.41	21.95
Cycle duration, s	<i>t</i>	63	57	9.52	57	9.52
Cost of soil development, UAH/m <sup>3</sup>	<i>S<sub>un</sub></i>	17.86	17	4.81	16.74	6.22

A system is proposed that allows to adjust the temperature of the gas chamber, a hydro-pneumatic accumulator that allows to increase the pressure of the residual working fluid (**Fig. 11.6**).



**Fig. 11.6** Temperature regulator of the hydroaccumulating system

Source: author's development

The given scheme works as follows: at the moment when there is not enough pressure in the HPA to perform work operations, the distribution valve 7 blocks the flow of exhaust gases into the exhaust system and directs them to the heat exchanger 3, a cylinder with nitrogen gas ( $N_2$ ) 4 is built into the heat exchanger, when the temperature rises in the cylinder 4, the gas expands and is fed through the pipeline 5 into the gas cavity of the HPA 6, thus the pressure in the working cavity of the HPA increases, when the nominal pressure in the working cavity of the HPA is reached, the regulating valve closes the flow of exhaust gases going to the heat exchanger and directs them to the exhaust pipe.

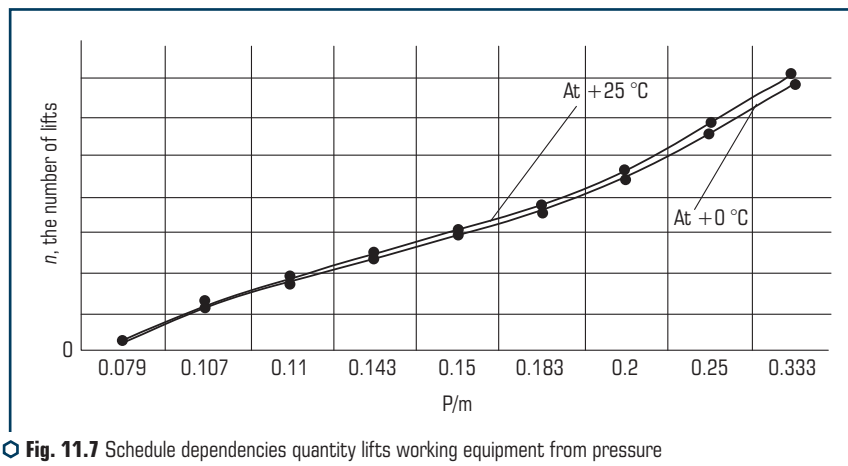
Experimental studies of this system showed an increase in the number of lifts of the working equipment on the accumulated energy (**Fig. 11.7**).

Thus, the prospects for the development of energy-efficient machines for earthworks can be presented as follows – **Fig. 11.8**.

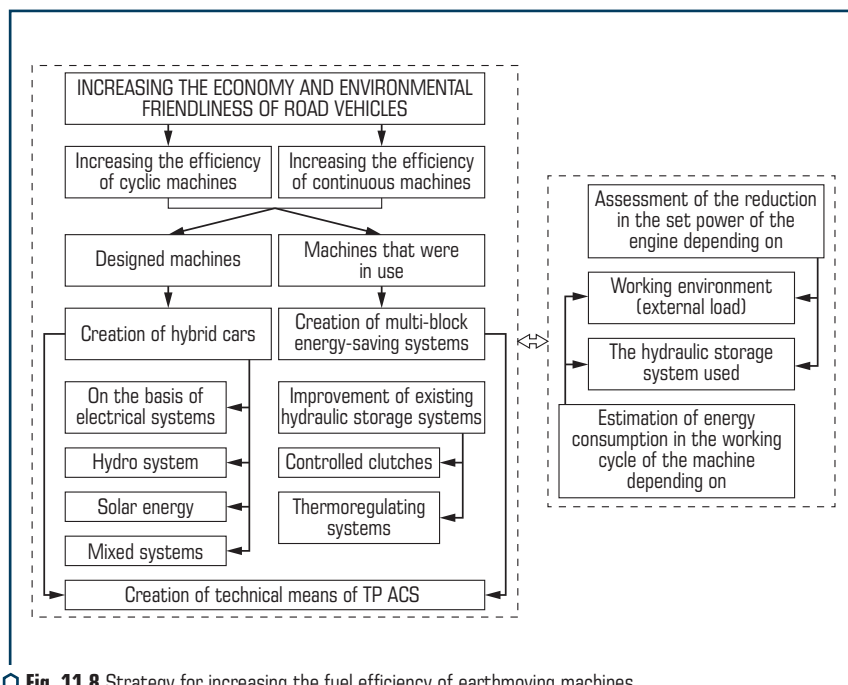
That is, it is necessary to study the energy saturation of the working processes of machines and the phased consumption of power, taking into account the conditions in which they will work, which will allow to reduce the installed power of engines, the use of alternative energy sources and the creation of hybrid power plants [15, 16].

The conducted analysis determines the strategy of improving the machines for earthworks in the field of fuel efficiency and environmental friendliness. Hybrid power plants for such machines will be able to increase fuel efficiency by up to 30 % for newly designed machines and up to 20 % for those already in operation.





**Fig. 11.7** Schedule dependencies quantity lifts working equipment from pressure charging and temperature surrounding environments of 0 °C and +25 °C  
Source: author's development



**Fig. 11.8** Strategy for increasing the fuel efficiency of earthmoving machines  
Source: author's development

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## CONCLUSIONS

According to the research results, it can be stated that the road transport complex is a powerful living organism, the functioning of which is ensured by a huge number of its components. Of course, the components considered in the framework of this work are not their complete interpretation, and are basic for ensuring the development of the road and transport complex as a whole.

Based on the conducted research, the following results can be distinguished:

1) the urgency and timeliness of the application of the functional-cost analysis is proven. Its practical use makes it possible to develop recommendations that enable the MTE management to identify objects of innovative activity, which include specific shippers, where a low level of both the efficiency of the transport process and the quality of the provision of transport services is observed, and to develop specific measures;

2) the factors influencing the transport infrastructure and the economic consequences of their implementation are systematized, a system of managing the motor transport infrastructure of the region is developed, the logical result of which is the formation of a program for increasing the efficiency of the development of the motor transport infrastructure in accordance with the needs of the region;

3) the definition of sustainable development is formulated, the levels are identified, the stages of formation and implementation of business strategies are developed, which determine the sustainable innovative development of motor vehicle enterprises;

4) the methodical approach to the development of the list of indicators of preventive anti-crisis management of the enterprise is improved thanks to the comprehensive consideration of the results of the study of the quantitative and qualitative composition of indicators of the CVP analysis; the specifics of the industry in which the motor transport enterprise operates and the distribution of responsibility for each selected controlled indicator with the calculation of the labor intensity of its implementation;

5) a personnel management system of the motor vehicle enterprise is formed based on a holistic approach as a set of three subsystems: management of incoming, internal and outgoing personnel flows. The main differences of this system are: personnel flows are considered from the enterprise as a supplier of work to the consumer (potential or existing personnel or personnel being fired); implementation of all main management functions (planning, organization, development, motivation and personnel control) is provided for; the "information, organizational and psychological support" element is included in the components of the system;

6) the proposed method of assessing the effectiveness of control of the personnel of the motor vehicle enterprise helps to identify the weakest points in the existing control system. This technique takes into account the peculiarities of control for different groups of employees and the importance of assessment criteria. The proposed method of estimating costs for the implementation of the personnel control function of the enterprise helps to identify the least significant works

in the existing control system and thereby contributes to the simplification of the system itself, reducing the costs of its support and increasing the efficiency of the motor vehicle enterprise;

7) to achieve digital security and management of transport and logistics services, it is proposed to implement electronic document flow, to ensure the creation of an "intelligent station", "smart stations", to implement intelligent traffic management systems, digital maps of the railway infrastructure, digital shunting control systems, interactive regulation systems train movement, technologies for automatic diagnosis of the state of infrastructure and rolling stock, energy and resource consumption monitoring systems, devices for digital identification of rolling stock, as well as automatic train control systems, etc.;

8) a decision-making support system for the innovative development of railway transport enterprises is proposed, which will increase the efficiency and speed of management decisions, create a system for the accumulation and exchange of knowledge and information, introduce a transparent mechanism for assessing and selecting innovative projects, and increase the effectiveness of the analysis of existing and potential project proposals, create an effective communication system between project team members, increase the ability of industry enterprises to forecast their own innovative development;

9) conceptual provisions for ensuring balanced growth of railway transport enterprises based on multi-criteria consistency of the goals of their sustainable growth are developed. A system of scenarios for ensuring balanced growth of industry enterprises are developed, in which the degree of penetration of digital technologies into the activities of railway transport enterprises is used as a criterion for choosing alternatives: inertial, fragmentary-adaptive, progressive-adaptive and co-evolutionary-digital;

10) in order to improve the work of railway transport enterprises, it is proposed to form an appropriate digital platform, which includes components of the rolling stock management platform, logistics and personnel support, platforms by types of connections, services for planning and purchasing services, as well as services for interacting with customers;

11) a strategy for improving earthmoving machines in the area of fuel efficiency and environmental friendliness is defined. Hybrid power plants for such machines will be able to increase fuel efficiency by up to 30 % for newly designed machines and up to 20 % for those already in operation.

Edited by  
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INNOVATIVE DEVELOPMENT OF THE ROAD AND TRANSPORT COMPLEX:  
PROBLEMS AND PROSPECTS

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