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CHAPTER 3

PROJECT MANAGEMENT OF UKRAINE'S INTEGRATION INTO THE TRANS-EUROPEAN TRANSPORT NETWORK

ABSTRACT

The chapter of the monograph "Project management of Ukraine's integration into the Trans-European transport network" is devoted to a comprehensive study of the management aspects of the integration of Ukrainian railways into the international transport infrastructure. It consists of three parts that analyze in detail the planning, implementation and specifics of management practices in the context of high-speed railways and integration projects.

The first part, "Planning of high-speed railway projects – global experience and Ukrainian perspectives", focuses on the global experience of planning and implementation of high-speed railway projects, in particular on examples from Europe, Asia and other regions. It analyzes various management models, technological innovations and economic aspects that contribute to the successful implementation of such projects. Special attention is paid to the adaptation of world practices to Ukrainian conditions, taking into account the specifics of the national infrastructure, economic and political factors.

The second part, "The project of the integration of Ukrainian railways into the Trans-European transport network (TEN-T) on the example of the development of the Lviv railway node", considers a specific case of the integration of Ukrainian railways into the Trans-European transport network. The stages of project implementation are described on the example of the Lviv railway node, including technical, organizational and financial aspects. An important role is played by the analysis of problems and achievements, as well as the impact of the project on the development of regional infrastructure and the economy.

The third part, "Peculiarities of the practical implementation of system-level project management in railway transport of Ukraine", focuses on the specifics of managing large projects in the railway transport system of Ukraine, using the example of the SAIRS-UZ project. It examines the practical aspects of management processes, including planning, implementation and monitoring of projects at the system level. Examples of successful and problematic projects illustrating the opportunities and challenges of the management process in the context of Ukrainian railway transport are considered separately.

The chapter of the monograph is addressed to teachers, researchers, graduate students, students, as well as practitioners in the field of project management, transport engineering and international integration. It offers in-depth analysis and practical recommendations to improve

management practices in the field of rail transport and the integration of national infrastructure into international transport networks.

KEYWORDS

Project management; railway transport; high-speed railways; integration; Trans-European transport network; Lviv railway node; infrastructure; rolling stock; vehicles; technical devices; international standards; planning; implementation of projects; transport integration; Ukrainian perspectives; economic aspects; technological innovations; system level; practical aspects; management processes; regular monitoring; problems and achievements; infrastructure development.

A project is defined as a temporary enterprise designed to create a unique product, service or result. A project has a defined beginning and end, as well as certain time, resource, and quality constraints. According to the PMBOK standard, a project is a unique activity that has a beginning and an end, and is also aimed at achieving specific goals [1].

Project management is the process of applying knowledge, skills, tools, and techniques to project activities to meet or exceed stakeholder expectations. This process includes the following phases: initiation, planning, implementation, monitoring and control, as well as project completion [1]. Project management is aimed at balancing the triangle of constraints: scope of work, time and cost. A fourth component is often added to this – quality.

The scope of work determines what exactly should be done in the project. This is a description of all the tasks and works necessary to achieve the goals of the project. Determining the scope of work is critically important to avoid changes in the project implementation process that may lead to an increase in cost or time delay [2].

Time in the context of project management includes planning, allocating, and controlling the completion of work on time. Effective time management allows to minimize the risks of delays and ensure timely implementation of the project [2]. For this, various methods and techniques are used, in particular, Gantt charts, critical path method (CPM) and program evaluation and analysis technique (PERT).

Project cost management includes the processes involved in planning, estimating, budgeting, financing, managing and controlling costs so that the project is completed within the approved budget. This includes estimating the cost of resources to be used in the project, as well as cost control during its implementation [3].

Quality in the project is defined as a measure of how well the final result meets the established requirements and expectations of the customer and interested parties. Quality management includes the processes of planning, assurance and quality control, which guarantees compliance of project results with standards and specifications [3].

Sectoral features of project management Each industry has its own project management features. For example, in construction, an important role is played by risk management and control over the performance of work at all stages of the project [4]. In the IT industry, special attention is paid to flexible project management methodologies, such as Agile and Scrum, which allow quick adaptation to changing requirements [5]. Resource management and logistics are important in the manufacturing industry [6].

Thus, project management is a complex and multifaceted process that includes planning, organization, execution and control of various aspects of activity. Understanding the basic concepts and their features in various fields is key to successful project implementation.

3.1 PLANNING OF HIGH-SPEED RAILWAY PROJECTS – WORLD EXPERIENCE AND UKRAINIAN PERSPECTIVES

3.1.1 EXPERIENCE OF A SUCCESSFUL PROJECT IN THE TRANSPORT INDUSTRY

Successful project in the field of high-speed railways (China) – "Construction of high-speed railway Beijing-Shanghai" project.

High-speed railways (HSRs) represent an advanced sector of transport infrastructure that provides fast, convenient and economical transportation of passengers over long distances. The high-speed railway project between Beijing and Shanghai is a vivid example of the successful implementation of a large-scale infrastructure project. The project not only demonstrated efficiency in the management of major infrastructure initiatives, but also served as an impetus for the further development of high-speed rail transport in China and beyond.

The project became one of the largest infrastructure projects of the 21st century. The 1,318 km long line connects the two largest economic centers of China – Beijing and Shanghai. Construction began in 2008, and the official launch of the line took place in June 2011. The project included not only the construction of new tracks, but also the modernization of existing facilities, which made it possible to increase the speed of trains to 300 km/h. This provided a significant reduction in travel time between cities from 10 hours to approximately 4 hours [7].

Designing and planning for the implementation of the Beijing-Shanghai high-speed railway required a comprehensive approach, therefore it included the following stages and areas of activity:

1. Assessment of needs and opportunities: at the initial stages of the project, a comprehensive analysis of traffic flows, demand for transportation and potential economic benefits was conducted. This made it possible to determine the optimal speed and frequency of train movement [8].

2. Geodetic and environmental studies: to ensure the stability and safety of the construction, detailed geodetic studies were carried out, including an assessment of possible environmental impacts. This made it possible to reduce risks and take into account all factors that could affect the implementation of the project [9].

3. Financing and budgeting: investments in the project amounted to more than 33 billion USD. Both public and private investments, as well as international creditors, were involved to provide financing [10].

4. Project management: project management was carried out through an integrated structure that included the national railway corporation (China Railway Corporation) and local authorities. Modern project monitoring and management systems were used to control quality and deadlines [7].

The implementation of the project involved several key stages:

1. Construction of infrastructure: construction of new tracks, bridges, tunnels and railway stations. This included the construction of more than 1,000 km of new tracks, 30 bridges, 200 tunnels and the modernization of existing facilities [8].

2. Implementation of technologies: the project used the latest technologies to ensure high speed and traffic safety. This included automated control systems, wireless communication technologies for monitoring the state of trains and infrastructure, as well as advanced signaling and control systems [9].

3. Testing and start-up: after the completion of the construction, a series of test runs were carried out to check all the systems under real operating conditions. The testing included checking the speed, safety and comfort of the trains [8].

4. Launch and operation: the official launch of the line took place on June 30, 2011. The first trains began to run between Beijing and Shanghai, providing a high level of comfort and schedule accuracy [7].

The Beijing-Shanghai high-speed railway project has achieved significant results:

1. Reduction of travel time: the travel time between Beijing and Shanghai was reduced to 4 hours, which significantly increased the convenience and efficiency of transportation [8].

2. Economic benefits: the project contributed to the significant growth of economic ties between northern and southern China, increasing the volume of passenger transportation and business activity in the regions [7].

3. Technological achievements: the introduction of the latest technologies in railway construction and management has become a model for further projects both in China and abroad [9].

4. Environmental benefits: high-speed trains have a lower environmental impact compared to road and air transport, which has contributed to the reduction of CO_2 emissions and reduced road traffic [10].

The Beijing-Shanghai high-speed railway project demonstrates the successful implementation of large-scale infrastructure projects through effective planning, management and implementation of innovative technologies. The success of this project is of great importance for understanding how complex projects can contribute to economic development and improve the quality of transport services. The experience of building the Beijing-Shanghai high-speed railway can serve as an important lesson for other countries seeking to modernize their transport infrastructure.

3.1.2 PLANNING OF A LARGE-SCALE PROJECT IN THE TRANSPORT INDUSTRY OF UKRAINE

Taking into account the goals of the National Transport Strategy of Ukraine for the period until 2030 (NTS-2030) regarding the formation of the transport market and increasing the share of non-state transport operators in railway transport to 25 % by 2025 and to 40 % by 2030 [11]

the need to implement large-scale transport projects to improve the convenience and mobility of passengers and the wider use of multimodal transport services, becomes even more urgent and requires the emergence of a separate operator of the infrastructure of the new high-speed railway (HSR) of Ukraine [12].

NTS-2030 provides for the gradual introduction of high-speed rail connections (up to 400 km/h) between the main centers of Ukraine on separate tracks with a width of 1435 mm and their use for mixed passenger and cargo transportation (for accelerated delivery). goods with high added value), as well as joining the national HSR network to the Trans-European TEN-T network [13].

As it is known, even in China with its powerful passenger flows and long distances, not all high-speed railway lines are profitable, so high-value goods that need urgent delivery are also forced to be transported there [14]. In Ukraine, moreover, the use of very expensive VSHZ lines only for passenger transportation will be clearly ineffective and unprofitable. Our preliminary estimates, made even before the full-scale Russian war against Ukraine, show that the payback period for the investment in the infrastructure and rolling stock of HSR, if it is used only for passenger transportation, will be hundreds of years, even with maximum passenger traffic. On the other hand, with a relatively small passenger flow in Ukraine, HSR will have enough free capacity for freight transportation [13].

Therefore, there is no alternative to the joint use of the future HSR of Ukraine for passenger and cargo transportation as part of international multimodal transport systems. The proposed **large-scale project** on the balance of freight and passenger transportation on the HSR according to the criteria of maximum profitability for the infrastructure operator, taking into account the interests of other market participants, is **important** for the development of high-speed multimodal transportation in Ukraine [15].

A future transportation system that includes high-speed rail will be an extremely expensive piece of infrastructure (compared to conventional rail). It will not be effective if it does not provide for the integrated use of infrastructure, firstly, for mass passenger transportation, as well as for cargo transportation (in certain market niches), and secondly, as a system-forming component in other types of economic activity (such as tourism, hotel business or residential construction in the area of HSR attraction). The implementation of such a project and the future functioning of such a transport system can be described only with the help of appropriate complex mathematical models [14].

Designing and planning for the **implementation** of the high-speed railway project of Ukraine requires a comprehensive approach, which includes a technical and economic justification for the business model of the future high-speed railway system in Ukraine. It is advisable to use the economic-mathematical model of the rational ratio of passenger and freight transportation on one line and the location of stations on it. The model proposed in the **large-scale project** [16] is based on taking into account the costs of construction and operation of the railway, the fee for using the railway infrastructure, the maximum and average operational speed of trains, other operational variables and taking into account the subsidization of unprofitable passenger transport.

In the object model, the balance of cargo and passenger transportation on the HSR includes taking into account two restrictions arising from the need to satisfy the demand for transportation [14]:

1. The need to transport all willing passengers.
2. The need to transport the maximum possible amount of cargo within the available capacity.

One of the problems of organizing the joint use of the VSHZ infrastructure for freight and passenger transportation is the different speed, as well as the different acceleration/deceleration dynamics of freight and passenger trains, which is reflected in the model with the proposed solution.

When trains with different speeds run on the line, the phenomenon of "removal" of trains of one speed category by trains of another speed category occurs, which leads to a loss of line capacity [14]. The proposed basic capacity model (3.1) reflects the influence on the capacity of the line on which trains of two speed categories run:

$$N_q = \frac{24 - t_{reg}}{j} - \left[1 + \frac{2}{j}\left(\frac{1}{v_q} - \frac{1}{v_a}\right)l\right]N_a, \tag{3.1}$$

where N_q – total number of freight trains per day, train; t_{reg} – regulated time of interruptions in movement during the day (for example, "windows" for carrying out scheduled works in track and energy management), hours; j – time interval between trains, h; l – length of the limiting run of the line (the distance between the stations at which the average time of the train is the longest), km; v_a – average speed of passenger trains, km/h; v_q – average speed of freight trains, km/h; N_a – total number of passenger trains per day, train.

The application of the model in the project is used for the maximum required number of passenger trains on the line, provided that the rest of its capacity is used for freight trains.

It is known from the world practice of managing railways, including Ukrainian ones, that passenger transportation is mostly unprofitable. In this case, subsidies are needed. In domestic practice, this is the so-called "cross-subsidization" of passenger transportation losses due to revenues from cargo transportation and other sources. In the future, this is unacceptable, both from the point of view of the railway transport legislation of the European Union, and from the point of view of the laws of the market economy [15].

Therefore, the project model offers an analytical tool for substantiating the rational ratio of passenger and cargo transportation on a single infrastructure, taking into account the balance of interests of infrastructure operators and transport enterprises, taking into account that the infrastructure operator cannot bear losses from the provision of infrastructure for the public needs of passenger and cargo transportation.

One of the criteria for the joint use of the HSR infrastructure for freight and passenger transportation in the model is proposed aggregate revenue from running along the line of freight and passenger trains, which have different sources and indicators of profitability (the cost of a ticket in a passenger train and the tariff for freight transportation of the corresponding category of cargo).

The mathematical model for calculating revenue at the maximum speed of passenger trains v_a^{max} has the following general form (3.2):

$$\left.\begin{cases} d_a N_a + d_q N_q \Rightarrow \max; \\ d_a \succ 0,\ N_a \succ N_{a\min},\ N_a \prec N_{a\max}; \\ d_q \succ 0 \end{cases}\right\}, \quad (3.2)$$

where d_a – train revenue rate for passenger transportation, (for example, euro/train-km); d_q – train revenue rate for container transportation, euro/train-km.

Even under "ideal" conditions, when there is the necessary freight flow to use the full capacity of freight trains in the amount N_q after passing the required number of passenger trains N_a, the total revenue $\sum D$ from transportation decreases with the increase in the number of passenger trains. That is, the unprofitability and the need to subsidize passenger transportation has another confirmation here. Passenger transportation is a "social order" (state obligations), so in all countries it is subsidized in one way or another by the customers of these transportations, if they are unprofitable for the carrier [16].

An important factor in making a decision to implement a **large-scale project** for the HSR implementation in Ukraine is the amount of subsidizing the unearned income in the event of an increase in the number of passenger trains, which will be less profitable for the infrastructure operator than freight ones.

The size of the subsidy during the HSR operation S_{OP} can be determined taking into account such factors as: $D_{\max}$ – the maximum income on the HSR line under "ideal" conditions; D_{act} – the actual income on the HSR line, taking into account the "removal" of profitable freight trains by less profitable passenger trains, which occupy a larger capacity of the line [4].

The amount of subsidies is affected by the distance between stations l, both directly and in the form of more complex dependencies, for example, its effect on train speed. The average value of this distance, for a certain length of the line, affects the number of stations that need to be built on the line, and therefore, the size of capital investments, their payback period and the efficiency of using the HSR infrastructure [14].

The proposed economic-mathematical model of the project makes it possible to reflect the decrease in the need for subsidies S_{OP} when the number of stations K_{st} on the line increases, as its operation becomes more flexible when the size and structure of the train flow changes. Increasing train flow makes better use of capacity. On the other hand, the construction of a larger number of stations requires higher capital costs e_C, which is also evident from the results of the calculation based on the model. Instead, the objective function reflecting the total costs $S_{OP} + e_C$ has a clear minimum (in our case at $K_{st} = 6$), which corresponds to the optimal number of stations on the line under the given conditions of its construction and operation. Such a number of stations and the total length of the line make it possible to determine the average length of the run and reasonably place these stations on the line as close as possible to the points of formation and destination of passenger flows [14].

The HSR project of Ukraine provides for obtaining the following results:

1. **Highest profitability**: the profitability of a railway infrastructure operator depends on various factors, such as the average length of a run, the number and speed of freight and passenger trains. The highest profitability is observed with the minimum length of the run, the minimum number of passenger trains and the minimum difference in speed between passenger and freight trains [14].

1.1. An economic-mathematical model of the rational ratio of passenger and freight transportation on one line and the location of stations on it was used for the technological and economic substantiation of the business model.

1.2. The model takes into account the costs of construction and operation of the railway, fees for the use of railway infrastructure, the maximum and average operating speed of trains, other operational variables and taking into account the subsidization of unprofitable passenger transport [16].

2. **Rational ratio of passenger traffic and freight transportation**: rational ratio of passenger traffic and freight transportation on railways, taking into account the balance of interests of the infrastructure operator and transportation operators. The authors of [16] emphasize the need to change approaches to subsidizing passenger transportation, in particular, focusing on the lost revenue from freight transportation in the case of joint use of high-speed railways for passenger and freight transportation

3. **The price of transport services**: the parameters of the business model, including indicators of the technology and economy of passenger and cargo transportation, have been determined. These parameters are used to analyze the technological aspects of the business model, such as the optimal distance between stations, the required number of trains (wagons/containers in trains) for passenger and freight transportation. This allows to calculate transport costs and the price of transport services to achieve a balance of interests of infrastructure and transport operators [14].

3.2 THE PROJECT OF INTEGRATION OF UKRAINIAN RAILWAYS INTO THE TRANS-EUROPEAN TRANSPORT NETWORK (TEN-T) ON THE EXAMPLE OF THE LVIV RAILWAY NODE DEVELOPMENT

There is still a widespread opinion in Ukraine that integration into the EU is possible without changing the railway track width standard, because this process is complex and requires significant investments. However, the latest decisions of the European Union bodies in the field of railway transport indicate that the transition to the 1435 mm gauge is mandatory for all participating countries in the medium term (until 2050). Therefore, in order to join the EU, Ukraine must be ready for the global reconstruction of the railway network.

In 2022, the European Commission made changes to the plans for the development of Trans-European TEN-T networks and included Ukrainian railways in them.

The general strategy of the EU in the field of railway transport indicates that the European Union is unlikely to support the idea of building transshipment terminals on the border with Ukraine as the main strategy for the integration of Ukrainian railways into the EU transport network in the event of Ukraine's accession to the EU.

In this context, it is logical to consider the development of railway transport in Ukraine not in isolation, but in view of its integration into the European transport system. The most common gauge in the world is 1435 mm (4 English feet and 8.5 inches), which is why it is also called "normal gauge" [17, 18].

A 1520 mm wide track is laid to our western border, while in Europe a 1435 mm track is used. Ukraine is not the first country to face the problem of compatibility of two technical standards.

The experience of Spain, Portugal and the Baltic states proves that the operation of internal railway networks of excellent track width leads to the isolation of the railway and its reduced role. For Ukraine, this is unacceptable, as it will lead to an excessive load on highways that are not adapted to it, as well as to negative effects on the environment [19, 20].

Transportation of goods in a connection where different track widths are used is mainly carried out using transshipment technologies. This is the pumping of liquid cargoes (liquefied gas, oil products, chemicals); transshipment from car to car of bulk, bulk and container loads, etc. Overloading technologies require significant expenditure of time, labor and energy resources, and can have a negative impact on the environment. There are problems with the safety of cargo and rolling stock. In addition, in case of overloading of dangerous goods, there is a potential threat of man-made disasters.

The transportation of passengers is accompanied by the replacement of trolleys at the points of change of carriages when passing track nodes of different standards. This requires transfer points specially equipped with expensive equipment, causes significant technological delays for trains and inconvenience for passengers.

Transportation using traditional technologies, involving transshipment operations, causes damage to railway transport due to damage to cargo and rolling stock, and leads to significant time and labor costs.

Therefore, to transfer railways to a different track standard is not just to change wagons and "re-sewn" the tracks to a different standard width, but also to solve a complex technical, technological, and organizational problem.

Transferring the entire network of Ukrainian railways to the "European" track is a very difficult task. It is expensive, because it is necessary not only to "re-stitch" the tracks, but also to completely replace the rolling stock.

In addition, such a large-scale reconstruction can cause significant disruptions in rail traffic and affect the economy of the country as a whole. It is also important to take into account that a significant part of Ukraine's freight flows was directed to the east, where a track width of 1520 mm is used. Therefore, the transition to the European standard will require additional solutions to maintain the efficiency of transportation in the western direction.

Considering all these factors, perhaps a more realistic approach will be the introduction of a phased transition and the use of combined solutions, such as a combined track or trolley change systems, which will allow gradual adaptation to the new standard without significant negative consequences for the transport system and the economy of Ukraine.

At the same time, it is quite realistic and expedient to reasonably define and develop cross-border corridors with the European track – as well as use the existing infrastructure of the 1435 mm track, which has not been operated for a long time, to build new sections of the European track to large cities in the regions bordering the EU. At the same time, it is necessary to revive the infrastructure of the European track, which already exists on the territory of Ukraine, but is hardly used, in the shortest possible time.

The introduction of intermodal transport between Ukraine and the EU will contribute to the reduction of logistics costs, the reduction of risks due to the use of safer transport, the reduction of cargo losses and damage, the acceleration of capital turnover, the improvement of the efficiency of the use of the wagon fleet and the creation of favorable conditions for users of railway transport.

Therefore, it is more expedient to stimulate the development of capacity for multimodal transportation throughout the territory of Ukraine and EU countries and at the nodes of tracks 1435/1520 and to encourage the introduction of new transportation and transshipment technologies [19].

Analysis of the methods of organizing cargo transportation in international connections with the European Union showed that the following options are possible:

– reloading of goods, in particular containers, from the rolling stock of the 1520 mm gauge to the rolling stock of the 1435 mm gauge;

– replacement of carts at points where wagons are changed during the transition between tracks of different standards;

– use of special rolling stock with sliding wheel pairs;

– extension of the 1520 mm track from the borders of Ukraine to the territory of Europe;

– extension of the 1435 mm track from the borders of Europe to the territory of Ukraine;

– use of a combined track of 1435/1520 mm.

So, it is possible to several possible alternative solutions to the problem of integrating Ukrainian railways into the Trans-European transport network (TEN-T), which requires the use of certain technologies, design and construction solutions. It is obvious that none of the alternatives is ideal, not every technology or solution can be economically expedient or implemented in specific conditions, but complex and phased application of various solutions is possible, which will give the best results on the path of European integration of Ukrainian railways [21].

3.2.1 THE PROJECT OF INTEGRATION OF UKRAINIAN RAILWAYS INTO THE TRANS-EUROPEAN TRANSPORT NETWORK (TEN-T) ON THE EXAMPLE OF THE LVIV RAILWAY NODE DEVELOPMENT

The Lviv railway node (**Fig. 3.1**) is unique: it was historically built at the intersection of the main railway lines. The largest sorting node at the node of track networks 1435 and 1520 [22].

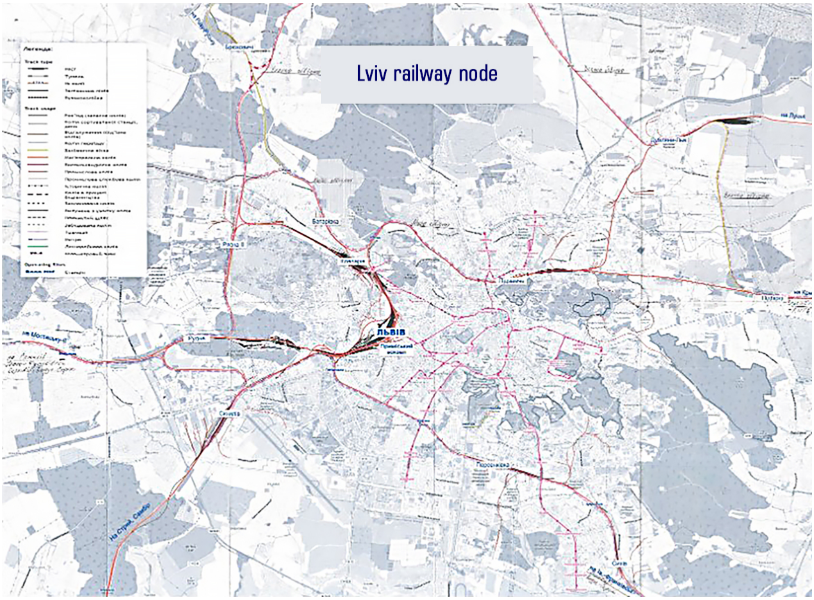


Fig. 3.1 Scheme of the Lviv node in the structure of the city of Lviv

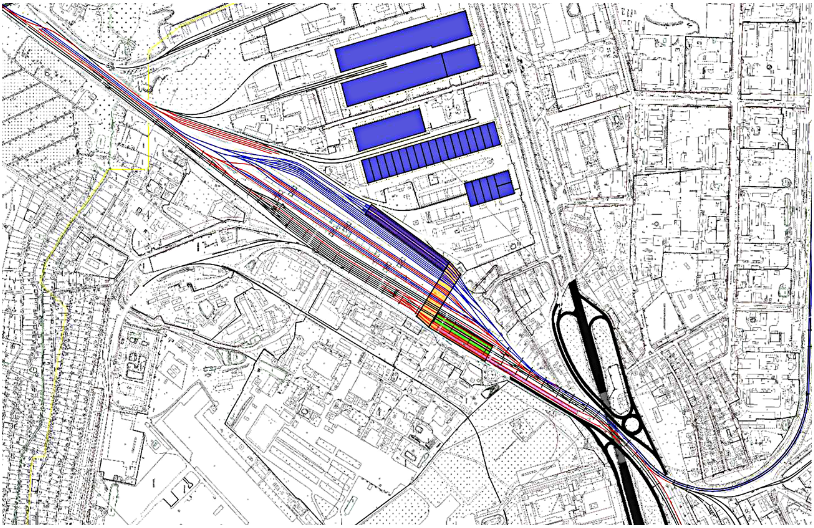
The Lviv railway node has 12 railway stations, 10 of which are located within the Lviv MTG. This includes 2 sorting stations, 3 cargo stations and 4 linear stations:

– Lviv Station (sorting station);
– Klepariv Station (sorting);
– Pidzamche (cargo);
– Sknyliv (cargo);
– Persenkivka (cargo);
– Sykhiv;
– Rudne;
– Riasna-2;
– Dubliany-Lviv;
– Briukhovychi.

As of today, the western cross-border railway crossings of Ukraine provide only 50 % of transport needs for export-import transportation.

The flow across the border of Poland is insignificant due to capacity limitations at the border [22].

It is proposed to consider as the first stage of the project the construction of a narrow track (1435 mm) in the direction of Mostyska II – Sknyliv (**Fig. 3.2**).



For reference:
The Mostyska II – Lviv section is part of the "Cretan" international transport corridor No. 3 (Berlin-Wroclaw-Lviv-Kyiv). Currently, track 1520 runs from Ukraine to Przemyśl station (Poland), Eurotrack runs from Przemyśl to Mostyska I station (Ukraine).
Sknyliv railway station is located in Lviv. It is located 5.5 km from Lviv railway station, 3 km from Lviv International Airport and 1 km from the bus station.

Fig. 3.2 Proposal for the reconstruction of the Sknyliv station passenger and freight terminals of 1520 and 1435 mm tracks and the transshipment front

Designing and planning for the implementation of this project requires a comprehensive approach, which includes:

1. Topo-geodetic searches, pre-project proposals and environmental studies. To ensure the stability and safety of the construction, detailed geodetic studies were carried out, including an assessment of possible environmental impacts. This made it possible to reduce risks and take into account all factors that could affect the implementation of the project.

2. Technical and economic substantiation and design and estimate documentation.

At the initial stages of the project, a comprehensive analysis of traffic flows, demand for transportation and potential economic benefits was conducted.

3. Analysis of methods of organizing cargo transportation in international communication with the European Union.

4. Analysis of the approach scheme of the Lviv railway node (**Fig. 3.3**):

– Krasne – Lviv: main passage, two-track railway line, electrified on alternating current.

– Lviv – Stryi: main passage, two-track railway line, electrified on direct current.

– Lviv – Mostyska-II: two-track railway line, electrified on direct current.
– Lviv – Sambir: single-track railway line, electrified on direct current.
– Lviv – Khodoriv: single-track railway line, not electrified.
– Lviv – Sapizhanka: single-track railway line, not electrified.
– Lviv – Rava-Ruska: single-track railway line, not electrified.

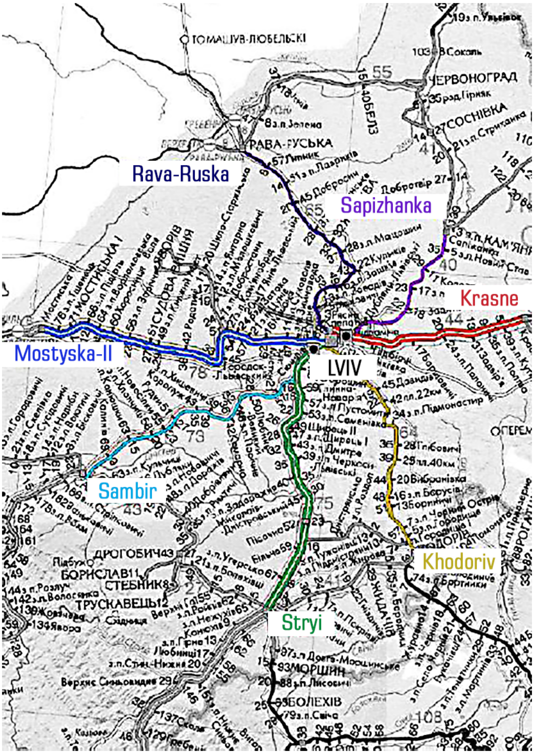


Fig. 3.3 Scheme of approaches to the Lviv railway node

5. Analysis of the structure of freight train flows after the beginning of the war (**Fig. 3.4**).

The flow across the border of Poland is not significant due to the limited capacity of the node at the border.

6. Financing and budgeting: the project had significant financial requirements.

Funding will be provided by the United States Agency for International Development (USAID).

Projected investments amount to more than 225 million USD [23].

7. Project management: project management will be carried out through an integrated structure that includes: The United States Agency for International Development (USAID), JSC Ukrzaliznytsia and local authorities. Modern monitoring and project management systems will be used to control quality and deadlines.

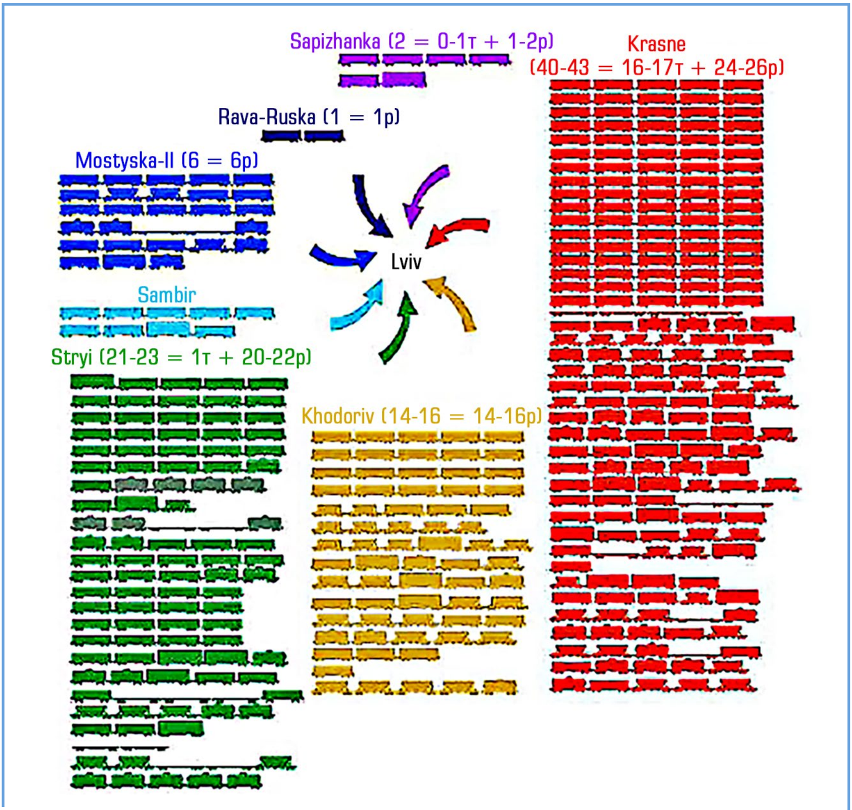


Fig. 3.4 The structure of freight train flows after the beginning of the war

The implementation of the project involves several key stages:

1. Construction of infrastructure: in the general complex of works, it is necessary to lay 69.8 km of combined track of 1435/1520 mm, build 3.1 km of track of 1435 mm, carry out 58.2 km of expansion of the earthworks site, carry out comprehensive rehabilitation of 9.5 km of the existing combined track and reconstruction of 8 stations, perform reconstruction and modernization of the electricity supply infrastructure, build the infrastructure of the station of the Sknyliv station, track 1435 mm.

2. Implementation of technologies: the project will use the latest technologies to ensure high speed and traffic safety. This includes automated control systems, wireless communication technologies for monitoring the condition of trains and infrastructure, as well as advanced signaling and control systems.

3. Testing and start-up: after the completion of the construction, a series of test runs will be carried out to check all the systems under real operating conditions. Testing includes checking the speed, safety and comfort of the trains.

Results:

– provision of a minimum speed limit of 160 km/h for passenger transport on the main and extended support networks, and 100 km/h for freight;

– first and last mile connections through multimodal passenger nodes in all EU cities that are connected to the network and have a population of over 100,000 inhabitants;

– strengthening air-rail connections for all EU airports in the network and those serving more than 4 million passengers; promotion of air-rail multimodal travel on such routes;

– the maximum waiting time at the border for freight trains is fifteen minutes;

– the possibility of transporting trucks by trains of the network;

– increased resistance to natural and anthropogenic disasters;

– implementation of European train control system (ETCS), including signaling and speed control (ERTMS), as well as a communication system (GSM-R).

The project of the integration of Ukrainian railways into the Trans-European transport network (TEN-T) on the example of the development of the Lviv railway node demonstrates the success of the implementation of large-scale infrastructure projects through effective planning, management and implementation of innovative technologies. The success of this project is of great importance for understanding how complex projects can contribute to economic development and improve the quality of transport services. The experience of implementing this project can serve as an important impetus for the further integration of Ukrainian railways into the Trans-European Transport Network (TEN-T).

The country will be able to switch to the 1435 mm gauge by 2040–2050 in various ways. It will be able to build an alternative railway network on the main transport routes – by completely decommissioning the 1520 mm wide tracks, or by replacing the infrastructure in stages. However, the long-term strategy must necessarily include the transition to a single European track gauge standard.

3.3 PECULIARITIES OF PRACTICAL IMPLEMENTATION OF SYSTEM-LEVEL PROJECT MANAGEMENT IN RAILWAY TRANSPORT OF UKRAINE

This chapter will provide examples of the implementation of projects in the railway transport of Ukraine during the first decade of the 21st century. The coordinator and main executor of these projects was the State Scientific and Research Center of Railway Transport of Ukraine (SSRCRTU), which was established in December 2001 as part of the State Administration of Railway Transport of Ukraine, the legal successor of which became JSC "Ukrainian Railway". In 2016–2020, the Scientific Research and Design and Technology Institute was established on the basis of SSRCRTU as a branch of JSC "Ukrainian Railway".

There were several projects: System of automatic identification of rolling stock and containers, Financial and economic information system, Psychological support of locomotive crews, etc. All of them were implemented according to the same principles. But this work presents the implementation of only one project.

3.3.1 DEVELOPMENT OF BASIC PRINCIPLES OF PROJECT MANAGEMENT

In the early years of the 21st century, the project approach was just beginning to be applied. It was then that the basic principles of project management for research, consulting, construction and some other organizations were developed. The project meant the creation of a new, as a rule, single non-repetitive product (product or technology). Although it should be noted that the project approach could be used for any company when implementing innovative programs and projects. These are the basic principles used in the SSRCRTU:

1) project management includes definition of its goals, formation of structure, planning and organization of works, coordination of actions of executors;

2) in terms of form, the structure of project management can correspond to a brigade (cross-functional) or divisional structure, in which a certain division (department) is created for a specific project and not always, but within the project's implementation period. Advantages of project management: high flexibility, reduction in the number of management personnel. The project cross-functional structure was typical for research enterprises of the military-industrial complex;

3) each project goes through four phases during its existence:

a) phase 1 – proving its **attractiveness**. Define the mission of the project, which should show all the participants of the project and its external environment that each of them will get from its successful implementation; having developed and presented first the concept, and then the business plan of the project;

b) phase 2 – **development**, when the project management team concentrates its efforts on creating the most effective project implementation plan. In the planning process:

– all the works of the project are presented in the form of a structural hierarchical decomposition of the works, which allows even the project to be broken down into components available for inspection;

– draw up a calendar plan for the project, which is optimized based on the availability of resources and the sequence of activities;

– develop schedules of the project's resource needs;

CHAPTER 3

– form the project budget;

– develop the organizational structure and project team;

– develop communication mechanisms and procedures for making changes to plans;

– etc.

The result of the planning is the consolidated project plan approved by the customer, which is the guiding document of the project team;

c) phase 3 – **implementation** or carrying out of the main works. At this stage, monitor the progress of work, monitor changes occurring both within the project and in its environment, and make appropriate changes to the project plans;

d) phase 4 – **completion.** The main tasks of the completion phase: deal with all "tails" of the project; to employ personnel who were temporarily involved in working on the project; analyze the experience, identify positive and negative features of implementation.

3.3.2 SYSTEM OF AUTOMATIC IDENTIFICATION OF ROLLING STOCK AND LARGE-TONNAGE CONTAINERS ON THE RAILWAYS OF UKRAINE (SAIRS UZ)

This is an international project of the CIS and Baltic States (Commonwealth), which have a single standard of railway track width of 1520 mm, in the development of which Ukraine participated independently, including by using the national technical base.

The management structure of the SAIRS-UZ project was built according to the divisional principle: a special department of the Chief Designer of the SAIRS was created at the SSRCRTU with 9 specialists headed by the deputy director of the SSRCRTU.

An operational headquarters under the deputy general director of Ukrzaliznytsia (UZ) was created. The progress of the project was reported twice a year to the UZ Council.

Phase 1

The purpose of the project: SAIRS-UZ is intended for automatic identification of freight cars, locomotives and large-tonnage containers in real time for the formation of information in the hierarchy of the Automated Freight Transportation Control System (AFT CS UZ) to solve the following tasks:

– operational control of locomotive, wagon and container fleets;

– numbered accounting and monitoring of the location and condition of locomotives, wagons and containers in real time;

– operational search of wagons and containers by their numbers;

– operational control of compliance with routes, established deadlines for the use of rolling stock and cargo delivery;

– numbered accounting of delivery and reception of transport objects at border stations, sea and river ports in international traffic, inter-railway and inter-state nodes, approach tracks;

– formation of data for mutual settlements for the use of wagons;

– calculation of the actual mileage of wagons, etc.

Project mission:

– increasing the efficiency, reliability and reliability of information about transport objects in the AFT CS UZ;

– ensuring integration into the pan-European identification system of transport objects.

System *efficiency* is achieved due to:

1) reduction of labor costs by:

– reading identification information from the transport facility;

– manual entry of information into the ACS;

– organization of control of entered information;

– correction of manual input errors;

2) increasing the reliability and efficiency of information on cargo transportation, which will provide opportunities:

– improve the technology of processing trains, wagons, containers and cargo at stations;

– improve the organization (procedures) of delivery-reception of transport objects at border stations, sea and river ports in international traffic, inter-railway and inter-state nodes, approach tracks;

– speed up the circulation of wagons and reduce the empty mileage of wagons;

– reduce costs for the repair of freight wagons as a result of the implementation of the program of transition to a system of repairs and maintenance according to the standards of the mileage actually performed.

Phase 2

The list of documents on the basis of which the system was created:

– comprehensive program of SAIRS implementation on the railways of the Commonwealth;

– concept of the construction of the "System of automatic identification of rolling stock and large-tonnage containers" was approved on May 8, 2002;

– automated control system of cargo transportation on the railway transport of Ukraine, Terms of Reference, 16289267.184154.201.T3;

– DSTU 3918–99 (ISO/IEC 12207:1995) Software life cycle processes;

– DSTU 3396.0–96 Protection of information. Technical protection of information. Basic Provisions;

– ISO 10374:1991/AMD.1:1995 Freight containers – Automatic identification.

The generalized structural diagram of SAIRS-UZ is shown in **Fig. 3.5**. The system consists of the following functional components (subsystems):

1. Coded on-board sensors (COS).
2. COS programming tools (COSRT).
3. Stationary equipment for exposure and reading information from on-board sensors (ERE).
4. Software-hardware complex "ARM SAIRS-UZ".
5. Complex of telecommunication equipment SAIRS-UZ.

A technical task (TT) was developed for SAIRS-UZ, which also formulated requirements for: reliability, safety, ergonomics and technical aesthetics, operation and maintenance, information security, patent purity, standardization and unification, etc.

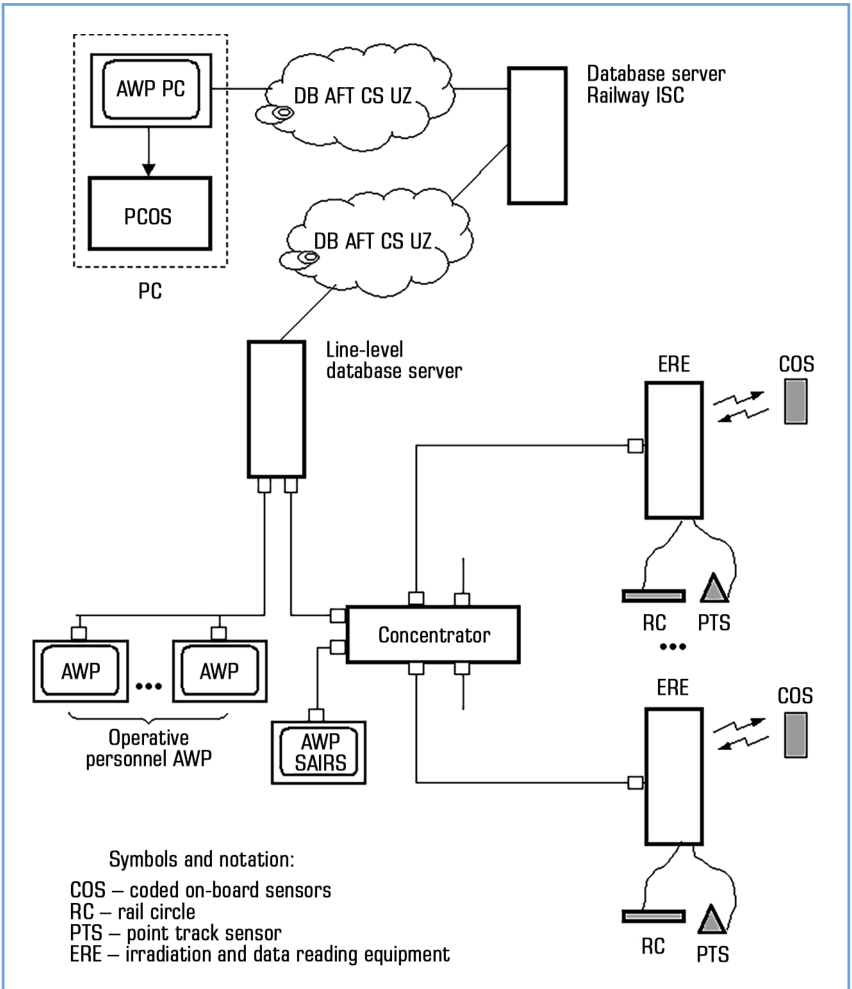


Fig. 3.5 SAIRS-UZ structure

TT has sections: mathematical support, information support, linguistic support, software, technical support. The system has an open architecture for the expansion of software and technical tools without changes to the software and information support, as well as additions and updates of functions. The basis for building a complex of technical means is a complex of mutually agreed and certified equipment in the UkrSEPRO state system, which provides the necessary technical characteristics of the system.

The functions of training and attestation of specialists should be performed by a specialized training center for AFT CS UZ users, created on the basis of the National Center of the Ukrainian Academy of Sciences. The qualification, number and mode of operation of SAIRS-UZ users are determined depending on real needs (specialization, features of the infrastructure and scope of work of the line enterprise).

The composition and content of the work on the creation of the system is given in **Table 3.1**.

Table 3.1 List of stages in the development and implementation of SAIRS-UZ

Stage No.	Name
1	Development of the technology of the sensor coding point in wagon repair and locomotive depots. Software implementation of the set of tasks "Programming code onboard sensors"
2	Development of technology for the point of reading information from sensors. Software implementation of the set of tasks "Reception and processing of identification information from coded on-board sensors"
3	Development of information interaction technology of SAIRS-UZ with the database of the railway ISC server. Software implementation of the set of tasks "Formation and transfer of information to the main models of the database of the railway level in the AFT CS UZ hierarchy
4	Development of technology for monitoring the technical condition of the SAIRS-UZ subsystems. Software implementation of the set of "System Testing" tasks
5	Development of technology for monitoring the functioning of SAIRS-UZ. Software implementation of sets of tasks: "Maintenance of an operational log of event registration in the system"; "Maintaining an archive log of event registration in the system"; "Audit of registered events in the system"
6	Development of technology and instructions for the operation of the complex of technical means SAIRS-UZ
7	Development of technology and instructions for forming and maintaining the SAIRS-UZ database
8	Development, coordination and approval of a set of operational documentation for SAIRS-UZ (ED, C1, B6, B7, I3, PD)
9	Equipment of the test site. Experimental operation of SAIRS-UZ at a designated training ground
10	Development and coordination of information exchange technology between neighboring states on the crossing of trains (locomotives, wagons, containers) at interstate node points within the CCRT
11	Development and implementation of the Partial technical task for the creation of AFT CS UZ unified secure workstation
12	PTT development for the creation of a COS and stationary equipment for exposure and reading information from on-board sensors (ERE). Organization of a tender for the PTT implementation
13	Program implementation of the set of tasks "Providing informative and reference information about numbered accounting, location and route of movement of locomotives"

Phase 3

The SAIRS-UZ implementation program on Ukrainian railways should go through two stages, as approved by the Decision of the thirtieth meeting of the Council on Railway Transport of the Commonwealth of Nations.

The 1st stage (2002-2003) provided for the creation of an internal experimental training ground and an international limited training ground for field tests of domestic and foreign components of SAIRS-UZ, as well as working out the tasks of transferring and using information received from the SAIRS-UZ system.

In 2002 the creation of an experimental training ground began (project work on the installation of stationary irradiation and reading equipment (ERE) at the Koziatyn locomotive depot and the Khutir-Mykhaylivsky station was completed). At this training ground, the components of the SAIRS were tested for efficiency and interoperability, as well as to work out the accounting of the control of the location and use of freight locomotives and locomotive crews. Separate car depots of the Prydniprovska and Donetsk railways have been equipped with sensor coding points, and freight cars have been equipped with sensors.

In 2003 it was supposed to complete the creation of an internal experimental training ground and create a limited training ground for international communication. Conduct research on the use of domestic components in the SAIRS-UZ system; experimental operation of the first phase of hardware and software complexes; development of software of the second phase, and also, at the experimental range based on the Koziatyn locomotive depot and the points of turnover of locomotives of the Koziatyn depot at the stations of the South-Western Railway, to work out the tasks related to the rational use of locomotive crews and the locomotive park, using the SAIRS-UZ information.

Start conducting scientific research on improving the organization of the transportation process and its information support, in connection with the SAIRS-UZ implementation.

Conduct a structural analysis and develop recommendations for the purchase of channel-forming equipment, concentrators, modems, which are additionally necessary for the transmission of information from SAIRS-UZ.

Equip the locomotives of the Koziatyn depot, an experimental training ground, and the locomotives of the Kupiansk-Sortuvalny depot, which serve the directions of the limited testing ground "SAIRS" of international traffic.

In order to equip freight cars with coded on-board sensors, it is planned to equip the car depot of the international training ground with a sensor coding point. Kupiansk-Sortuvalny station (Southern Railway) and to continue equipping freight cars with sensors on the Donetsk, Prydniprovska, and Southern Railways.

The 2nd stage (2004–2006) provided for the provision of automatic reading of information at interstate crossing points, inter-railway crossing points, main sorting stations, main freight and port stations, due to the equipment of their reading points, as well as rolling stock that participates in transportation, – information carriers (COS).

In 2004, it was foreseen:

– equip interstate node points and transmission stations with reading points;

– finish the work on the COS equipment of all railway locomotives;

– start work on the COS equipment of electric and diesel trains;

– continue work on the equipment of freight wagons with the COS means and wagon depots and railway stations with sensor coding points;

– oblige the enterprises adjacent to the stations (CMC, GOK, etc.) to equip approach tracks by ERE and to equip COS with its own rolling stock with numbering starting with the number "5".

In 2005:

– equip inter-railway node points and main sorting stations with reading points and to continue work on equipping freight cars with COS means.

In 2006:

– equip the main cargo and port stations with reading points;

– complete the equipment with COS devices of all rolling stock, including passenger cars;

– complete the modernization of all information systems taking into account the use of information from SAIRS-UZ;

– put SAIRS-UZ into industrial operation for the customer.

The implementation of the SAIRS-UZ project was carried out on the basis of annual planning and approval of plans at the level of the deputy general director of the UZ. **Table 3.2** presents a fragment of the plan for 2003 in an abbreviated version.

Table 3.2 Implementation plan of SAIRS-UZ in 2003

No.	Name of work, stages of work	Deadline	Volumes of financing for the current year, UAH	Expected result
1	Scientific and technical support		976 000	
2	Production tasks		12 482 625	
2.1	Creation of a limited training ground "SAIRS" of international traffic	01.07.2003	3 467 772	International restricted range
2.2	Creation of an internal experimental training ground	30.09.2003	4 966 159	Experimental training ground
2.3	In accordance with the planned types of repair work, equipment with coded on-board sensors of freight cars	31.12.2003	3 925 800	The main types of freight cars are equipped with SAIRS-UZ coded on-board sensors
2.4	Equipment for information integrators of ISC	3rd quarter 2003	22 894	Equipped with ISC information integrators of railways
2.5	Obtaining permission to use the radio frequency range for the operation of ERE equipment	2nd quarter 2003	100 000	Permission
3	Regulatory documentation		30 000	
Total for 2003:				13 488 625
Responsible for financing and sources of financing				Financing, UAH
CTech, CF, at the expense of centralized financing according to indicative R&D plans				976 000
Head of railway, CF, CID at the expense of the railways' own funds				12 482 625
CID, CF, at the expense of centralized financing according to indicative plans for the development of regulatory documentation				30 000

Phase 4

Unfortunately, the project was discontinued in 2006 for reasons beyond the control of its developers. The reasons are lack of funding. Although more than 40 % of all freight cars and more than 50 locomotives were equipped with COS at that time. 2 border training grounds were working, information was being sent to the CD UZ in an operational mode. SAIRS is still working.

Attempts to restore this project using GPS sensors instead of RFID technology ended in nothing.

Despite the fact that the SAIRS-UZ project did not end with complete success, the results achieved during its implementation are definitely positive. In the process of its development and implementation, a lot of experience in managing projects of this scale has been accumulated. As an example of the complex organization of work in different areas of the project, **Table 3.2** is given (the structure or fragment of the implementation plan of SAIRS-UZ for 2003).

CONCLUSIONS

Chapter 3 "Project management of Ukraine's integration into the Trans-European transport network" (TEN-T) focuses on the analysis and systematization of high-speed railway project management experience, both in Ukraine and abroad, on projects related to the phased transition of railways of Ukraine on the standards of TEN-T railway tracks, on the practical aspects of the large-scale project SAIRS-UZ (System of Automated Identification of Rolling Stock of Ukrzaliznytsia), as well as on the determination of prospects and challenges in the field of project management facing Ukraine in this context:

1. Successful experience of international projects: the Beijing-Shanghai high-speed railway project discussed in the section serves as an important example of effective management of large-scale infrastructure initiatives. It demonstrated the advantages of integrated management, innovative technologies, economic benefits and environmental benefits, which can be useful for the implementation of similar projects in Ukraine. The monitoring systems and modern technologies that were used became a model for further projects in the transport industry.

2. Planning and feasibility study: for the successful implementation of high-speed railway projects in Ukraine, a thorough feasibility study is required, which includes an assessment of the balancing of passenger and cargo transportation, the use of economic and mathematical models, and the introduction of the latest technologies. Since passenger transportation may not be economically viable due to high costs, it is important to ensure efficient use of freight infrastructure and find optimal financial solutions for subsidies.

3. Adaptation to European railway track standards: the transition to the European track width standard is critical for the integration of Ukraine into the Trans-European transport network. This will require significant investment in the reconstruction of infrastructure and rolling stock, as well as solving problems related to transshipment technologies. The Lviv Railway Node plays a key role in this process, providing connections between different track gauge standards.

4. Staged approach and international cooperation: the integration of Ukrainian railways into the Trans-European transport network should be carried out in stages, using combined solutions and technologies. Effective project management and international cooperation are essential to ensure financial and technical stability. International donors, such as USAID, can play an important role in project financing and coordination.

5. Lessons from project implementation: the experience of project implementation, such as SAIRS-UZ, shows the importance of stable financing, an integrated approach to resource management, the interest of management and the integration of projects with the overall development strategy. The accumulated experience emphasizes the need to adapt to changing conditions and improve technologies and management practices.

Thus, this chapter highlights key aspects of high-speed rail project management and integration into the Trans-European Transport Network, infrastructure and technology upgrades, showing that success in the implementation of such large-scale initiatives requires an integrated approach, effective management and close international cooperation.

The successful integration of Ukraine into the European transport system opens up new opportunities for the development of the economy and the improvement of transport infrastructure.

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