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FORECASTING INVESTMENT ACTIVITIES OF RAIL TRANSPORT ENTERPRISES USING TREND MODELS

ABSTRACT

The object of the study is the investment activity of railway transport enterprises. The purpose of the work is to forecast the investment activity of railway transport enterprises by using economic-mathematical methods and models, namely trend models. The information base of the study is the data of the State Statistics Service and the Ministry of Finance. It has been proven that the transport industry is one of the important branches of the national economy, which provides a logistic connection from the transportation of passengers to the transportation of goods. On the basis of economic-mathematical models (one-dimensional trend forecasting methods), a conceptual scheme for building forecast values of investment activities of railway transport enterprises has been suggested, with the help of which it is possible not only to forecast capital investments but also to propose measures for their increase. The results of investment forecasting by funding sources are given (at the expense of state budget funds, local budget funds, own funds of enterprises and organizations, bank loans and other loans, funds of foreign investors, funds of domestic investment companies, funds, etc., public funds for housing construction, other funding sources). Investments are distinguished by types of economic activity: "Transport, warehousing, postal and courier activities". The received forecast values of investment activity have been interpreted. Measures to increase the investment activity of railway transport enterprises are proposed. The results of the study can form the basis of the formation of the state strategy for the regional development of the country and, separately, in the development of plans and recommendations for the development of railway transport enterprises at different levels of management.

Keywords: enterprises, railway transport, investments, management, forecasting

JEL Classification: P12, G31

INTRODUCTION

Transport has always been of great importance in the economic development of any country. Thus, a highly developed transport infrastructure is a catalyst for the development of all spheres of the state's life. It is with the help of the transport system that relationships are established from people (passengers) who take part in the transport process to goods transported by one or another mode of transport. Transport infrastructure provides solutions to various state-wide problems of an economic, social and political nature, including the economic security and integrity of the state, strengthening its defence capability. Thus, considering the military actions taking place on the territory of Ukraine as a result of the invasion of the Russian Federation transport companies take an active part. They are engaged in the evacuation of the population from the occupied and affected territories, provide the population with humanitarian aid and deliver military equipment for the armed forces of Ukraine to the territory where hostilities are directly taking place.

Scientific research on this topic is of crucial importance since it is railway transport that creates the prerequisites for the socio-economic development of the country, expands its external economic activity and international relations, ensures competitiveness and increases the volume of manufactured products. The results of such studies have practical application since the development of the transport industry prompts the need to

introduce reform measures, state support and search for new mechanisms to increase the investment activity of railway transport enterprises.

LITERATURE REVIEW

In general, a large number of scientists, both in Ukraine and abroad, have dealt with the issues related to the investment activities of enterprises. Thus, the work [5] presents the analysis of the results of material investments in enterprises of Malopolske Voivodship in Poland, in two groups of entities: those that implemented investments at the expense of European Union subsidies and those financed from other sources without using EU assistance. However, the author did not take into account support for business from the state and regional administration. The directions of investment activity of enterprises of Uzbekistan are suggested in work [6] and recommendations are given for its improvement, however, these recommendations cannot be adapted for the Ukrainian economy. The author [7] investigated the investment activity of enterprises as a basis for the development of strategic activity in Ukraine. As a result of his research, the author proposes to strengthen the financial system of the country, without justifying how this will be reflected in the regulatory and legislative framework. They substantiated the relevance of budgetary investment for enterprises as a whole [8], at the same time, the study did not take into account proposals for the development of a methodology for conducting an audit of the efficiency of budgetary investments. Investment projects as tools for decision-making based on commercial, technical, environmental, economic, financial and social analysis were given in the study [9]. It should be noted that, along with the undoubted advantages of the proposed organizational and economic mechanism for stimulating investment activity, questions regarding the effectiveness of the application of various modelling methods are not fully resolved. The investment opportunity for infrastructure enterprises was also investigated in [10]. The author analyzed the main approaches to determining the essence of investments and investment activities of the enterprise as a whole, however, she did not take into account separately the investment opportunity for transport enterprises, including railway ones. Investment activity at manufacturing enterprises was also studied in work [11], where the main external factors affecting it were identified, not taking into account internal factors that play an important role in the economy. In the study [12], attention was paid to the legislation that defines the general, legal, economic and social conditions of investment activity of business entities, but the authors did not substantiate what measures should be implemented in order to change the legislation. The investment activity of transport enterprises was also analyzed in works [13-14], however, the authors' research was conducted without considering the level of socioeconomic development of the state.

Special attention should be paid to works on the investment activities of railway transport enterprises. Thus, the importance of attracting investments in railway transport for the introduction of digital technologies into its operations is proposed in [15]. It is worth noting that the author of the work did not take into account the cost of implementing digitization based on the use of co-adaptive compatible digital solutions and the formation of a single information and digital space for their growth. The prerequisites for the implementation of public-private partnership projects at railway enterprises in order to increase their investment activity were formed in studies [16-17], however, proper attention was not paid to the improvement of the normative-legal and organizational-methodical base in the investment sphere. For example, the paper [18] suggested potential directions of investment policy in railway transport, while possible sources of investment support for implementation and their forecast values were not provided. Four models of innovative resource sharing for railway transport enterprises (equipment sharing, personnel sharing, engineering team sharing, ideas and development sharing) are highlighted in [19]. However, the proposed implementation mechanisms that have been formed do not take into account the influence of external factors.

Having analyzed the works [5–19], it can be stated that each of the scientists in their works investigated investment activity, forming certain mechanisms and directions for its improvement at enterprises. However, such mechanisms do not provide for the determination of the forecast values of the investment activities of enterprises, by using trend methods and models, especially this applies to railway transport enterprises, which currently play an important role in the transportation of passengers and cargo in cities, regions and the country in general. This indicates the need to determine forecast values, priority directions and ways to increase the investment activity of railway transport enterprises of Ukraine in order to ensure the recovery of the transport industry.

AIMS AND OBJECTIVES

The purpose. To forecast the investment activity of railway transport enterprises using modern economic and mathematical methods and models, namely trend models.

To achieve the set goal, the following tasks were formed in the work:

- to justify the importance of investment activities, including capital investments, for railway transport enterprises;
- to forecast capital investments by sources of financing in Ukraine in general, as well as distinguish them by types of economic activity;
- to form measures to increase the investment activity of railway transport enterprises.

METHODS

The object of the study is the investment activity of railway transport enterprises. In order to solve the problem of determining the number of investments and measures of their increase at railway transport enterprises, a conceptual scheme is proposed, which is formed on the basis of economic and mathematical methods and models. The data [2-3, 20] on the investment activities of enterprises have become the information base of this study. The main hypothesis of the study is that the work of the transport industry in the war and post-war periods has its own characteristics, which require detailed study. This is related to the improvement of the quality of transport services and international economic cooperation - the entry of Ukraine into the European transport system, as a country that has received the status of a candidate for EU membership. Such a problem has become relevant also in connection with the reform of the transport industry and the admission to the organization of the transportation process of state, private and international investments, where capital investments play an important role in the development of the transport industry potential.

It is worth noting that there are currently a large number of methods and models used by scientists to determine predictive values. These include adaptive forecasting models, ARIMA models, trend models, etc. Thus, trend models of one-dimensional time series forecasting, which are one of the most promising areas of research, have become widespread. To assess the quality of forecasts, such models allow for avoiding the levelling of aggregate positive and negative deviations of the actual values of indicators and those determined using quantitative forecasting methods. It is also worth considering that the advantages of using trend models are their simplicity and the speed of calculations. At the same time, the use of an additional package of application programs is not expected. On the basis of trend models, it is possible to make a forecast about the development of the investigated process for the future period. Forecasting on the basis of a time series of economic indicators refers to a one-dimensional forecasting method based on extrapolation, that is, it allows the continuation of the trend observed in the past into the future. With this approach, it is assumed that the predicted indicator is formed under the influence of a large number of factors, which are either impossible to single out, or about which there is no information [21].

The peculiarity of trend models is, first of all, that they reflect the initial characteristics of a number of indicators and are able to continuously take into account the evolution of the dynamic properties of the studied processes. The purpose of trend models is to build self-adjusting economic and mathematical models that are able to reflect changes over time, take into account the informational value of various members of the temporal sequence and give fairly accurate estimates of future members of this series. Thus, forecasting with multiplicative seasonality was proposed [22], as well as [23]. When processing time series, information from the latest period is usually important, as it indicates the further development of events.

Tabular and graphical methods have also been used in the study to summarize the data, which visually provides an opportunity to compare retrospective and prospective values of indicators of investment activity.

RESULTS

It is worth noting that all types of transport are developed in Ukraine [22]:

- railway;
- road;
- marine;
- river;
- aviation;
- pipeline;
- underground (metro).

Table 1 shows the quantitative indicators of transported passengers and cargo by various modes of transport in Ukraine from 2020 to 2022 according to the data [16-17].

Table 1. Volumes of transported passengers and cargo. (Source: summarized by the authors based on [16,17])

Indicators	The volume of transported passengers by mode of transport, million pass	Volumes of transported goods by types of transport, million tons
2022 (as of 31.01.)		
railway	6.3	26.2
road	86.8	13.9
water	-	0.3
aviation	0.5	0.01
urban electric transport	115.8	-
pipeline	-	6.0
2021 (as of 31.12.)		
railway	81.3	314.3
road	1089.3	224.0
water	0.5	5.3
aviation	9.3	0.1
urban electric transport	1475.0	-
pipeline	-	77.6
2020 (as of 31.12.)		
railway	68.3	305.5
road	1083.9	191.4
water	0.3	5.6
aviation	4.8	0.1
urban electric transport	411.1	-
pipeline	-	97.5

The analysis of the data presented in Table 1 shows that the largest amount of cargo over the past 3 years has been transported by rail, and the smallest - by air. However, the shipping situation is only getting worse through the analyzed years. A similar situation has developed with the number of passengers carried by mode of transport, where the top three are occupied by urban electric transport, road and rail. Their numbers are also decreasing.

An example is the railway transport enterprises, which in 2018 made a passenger turnover of 28,685.2 million pass. km, and in 2021 only by 15,709.0 million pass. km. [16]. First of all, this is due to the outbreak of the COVID-19 pandemic and the period of complete lockdown, which led to crises in the transport industry both at the regional and state levels.

Thus, with the full-scale invasion of the Russian Federation on the territory of Ukraine in 2022 (Figure 1), the situation has significantly worsened in all modes of transport, including railways. It is also worth noting that official sources present information on the transportation of cargo and passengers, cargo and passenger traffic only for the third quarter of 2022, which has already shown a significant drop in transportation indicators.

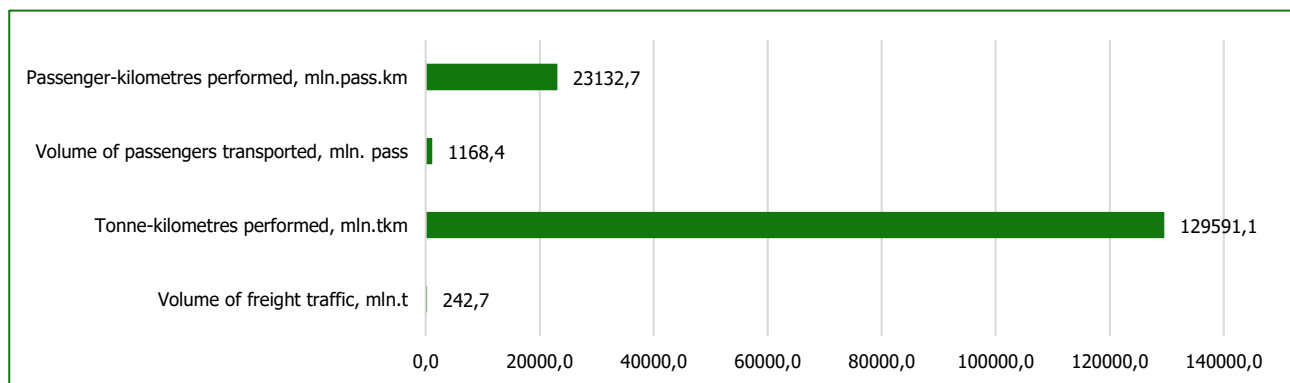


Figure 1. Transported cargo and passengers, cargo and passenger traffic as of September 1, 2022. (Source: developed by the authors based on [16])

Thus, the dynamics of changes in the indicators of the transportation of goods and passengers for the analyzed period show a significant drop, which indicates the need for immediate implementation of preventive measures. Of particular importance is railway transport, which occupies the largest share of cargo and passenger transportation in Ukraine. The advantage of railway transport is its reliability and relatively high speed of delivery of goods and passengers, independence from weather conditions, regularity, mass character, versatility, etc. Figure 2 shows the dynamics of the change in the transportation of goods by rail from 2014 to 2022. However, it should be borne in mind that in 2022 the data are given for only one month (as of January 01).

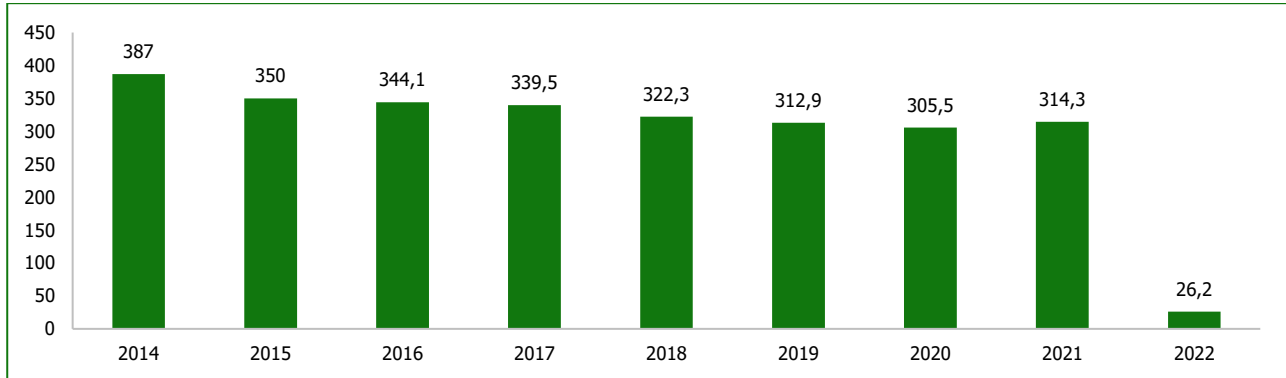


Figure 2. The dynamics of changes in the transportation of goods by railway transport from 2014 to 2022, million tons. (Source: developed by the authors based on [16])

Railway transport is one of the main branches of the national economy of Ukraine, which ensures its internal and external transport and economic connections and the transportation needs of the population [23].

Investments are all types of values that are invested in objects of business and other activities [24]. One of the types of investments is capital investment - financial resources directed to the reproduction of fixed assets, expansion, reconstruction and modernization of enterprises of various spheres of activity. Truly, outdated equipment, a large percentage of wear and tear of fixed assets, a drop in the quality of the services provided and, in general, the unprofitability of railway transport enterprises are, unfortunately, the realities of today. That is why capital investments play an important role in rebuilding the economy of Ukraine.

In order to develop ways to increase the investment activity of railway transport enterprises in the post-war period, the authors forecast capital investments by sources of financing. Funding sources include funds from the state budget, funds from local budgets, own funds of enterprises and organizations, bank loans and other loans, funds from foreign investors, funds from Ukrainian investment companies, etc., funds from the population for housing construction, and other sources of financing. Among capital investments in Ukraine as a whole, capital investments by types of economic activity, KVED - N (transport, warehousing, postal and courier activities) are singled out. The investment activity of Ukraine according to data [2, 20] is shown in Table 2.

Table 2. Dynamics of changes in investment activity in Ukraine. (Source: summarized by the authors based on [2, 20])

Years	Capital investments by sources of financing, million UAH	Capital investments by types of economic activity, million UAH
2010	157617.0	17331.2
2011	211549.4	22844.4
2012	244214.6	27832.3
2013	231322.6	16497.6
2014	204061.7	13956.0
2015	251154.3	16278.0
2016	326163.7	24737.7
2017	448461.5	35702.2
2018	578726.4	44920.5
2019	623978.9	41371.9
2020	419836.6	26488.2
2021	528802.0	37374.7

Table 2 shows the dynamics of changes in investment activity in Ukraine from 2010 to 2021. It is worth noting that in the indicator of capital investments by types of economic activity, only transport (railway, sea, river, etc.), warehousing, postal and courier activities have been analyzed.

For further forecasting of the investment activities of railway transport enterprises, a conceptual scheme has been formed, which includes 7 main stages (Figure 3).

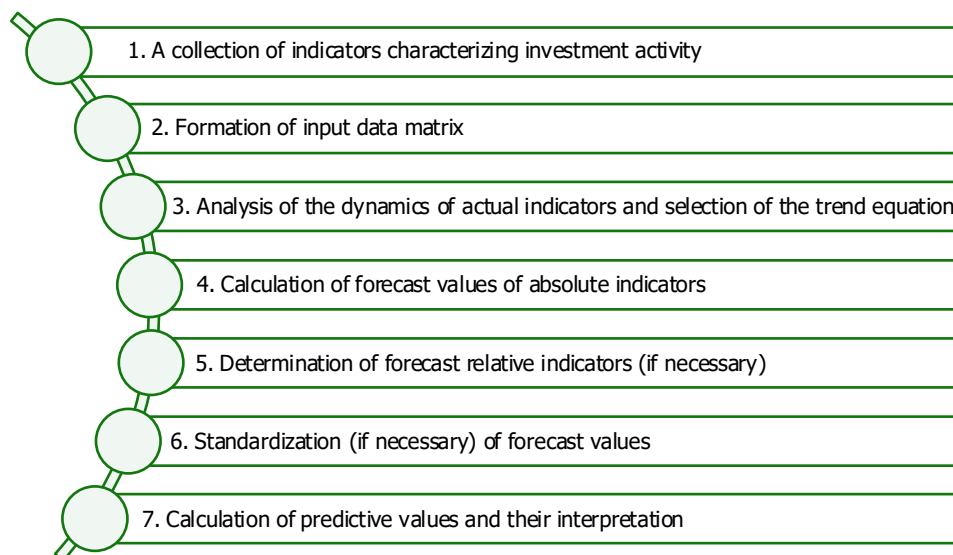


Figure 3. The conceptual scheme of construction of forecast values of investment activities of railway transport enterprises.

The complexity of modelling lies precisely at stages 1 and 2, which reflect the very indicators of investment activity on official sources. In the 3rd stage, trends are constructed with the determination of the R2 determination indicator. This indicator reflects the degree of approximation of the trend to the dynamics of the actual indicators (increasing the degree of trend equations ensures an increase in R2, however, it is worth considering that sometimes the results go against the economic interpretation of the analyzed indicators). In the 4th stage, the forecast values are calculated by substituting the ordinal numbers of the forecast periods into the trend equation as variables. The 5th and 6th stages are carried out if necessary, in case the indicators have different units of measurement, then their standardization is carried out, which will bring all the investigated indicators closer to a single type, for the sake of effective further interpretation of the data. In the 7th stage, the forecast values are calculated using retrospective information, namely, the results of previous calculations.

Forecast of investment activity by trend models is carried out using linear trend, exponential, polynomial, logarithmic and power.

At the same time, the linear trend is used when necessary, when it provides a significantly high value of the R2 approximation reliability criterion. The listed dependencies look like this (1–4).

$$y = k \times \ln x, \tag{1}$$

$$y = k \times x^b, \tag{2}$$

$$y = b \times e^{k \times x}, \tag{3}$$

$$y = k \times x + b, \tag{4}$$

where y – the predictive value of the indicator; x – the variable value of the trend equation, represented by the sequence number of the period; k – coefficient at x ; b – quantitative parameter of the trend equation.

The trend method involves the selection of a significant number of trends for each absolute (relative) indicator characterizing investment activity. Thus, in accordance with the given conceptual scheme of construction of forecast values, forecast

investments for railway transport enterprises have been determined, which will make it possible to form ways of development and improvement of the transport industry as a whole.

The forecast values have been calculated by substituting the ordinal numbers of the forecast periods into the trend equation as variables. The main criterion for the selection of trends was the determination indicator R², which reflects the degree of approximation of the trend to the dynamics of the actual indicators. Thus, an increase in the degree of the trend equations provides an increase in R², so the choice of equations (1–4) depended precisely on the reliability criterion of the R² approximation - when it showed the maximum value.

The trend for determining capital investments by funding sources is shown in Figure 4. The best results according to the R² approximation reliability criterion were demonstrated by the linear trend.

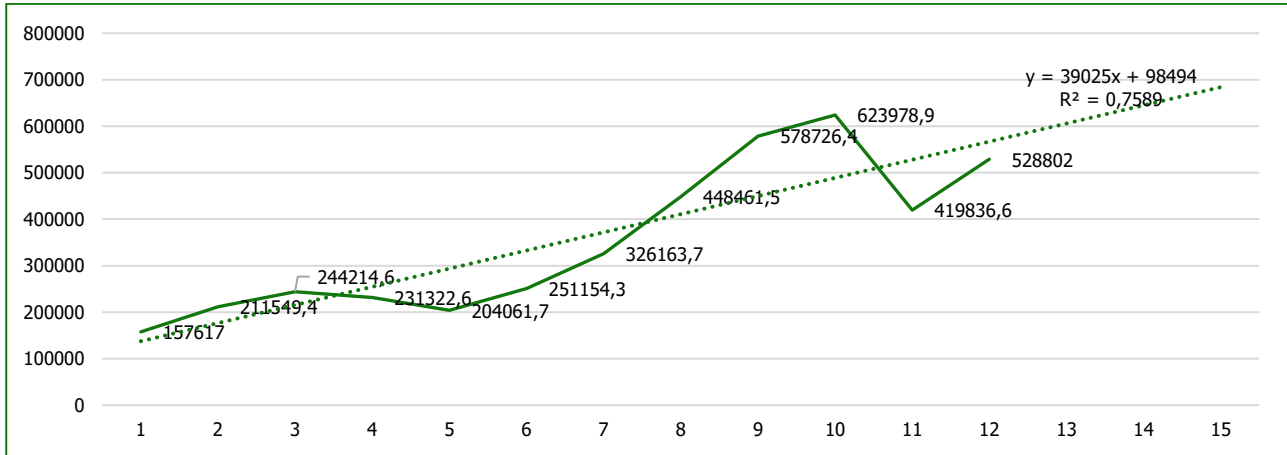


Figure 4. The trend for determining capital investments by funding sources.

A similar selection of trends has been carried out to determine capital investments by types of economic activity. The best results were demonstrated by the exponential trend. Thus, the trend for determining capital investments by types of economic activity "Transport, warehousing, postal and courier activities" is shown in Figure 5.

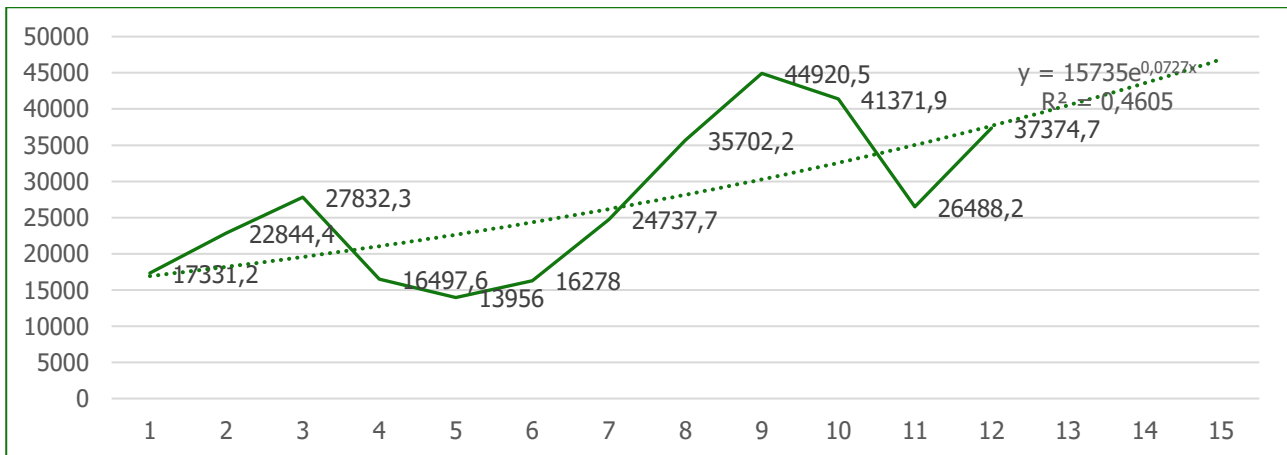


Figure 5. The trend for determining capital investments by types of economic activity "Transport, warehousing, postal and courier activities".

Table 3 shows the results of determining the forecast values of investment activity for the period from 2022 (there are no retrospective data) to 2024.

Indicator	Trend equation	R ²
Capital investments by sources of financing, million UAH	$y = 39025x + 98494$	0.7589
Capital investments by types of economic activity, million UAH	$y = 15735e^{0,0727x}$	0.4605

Thus, the formed actual and forecast values of the investment activity of Ukraine are shown in Figure 6 by types of economic activity in the forecast period.

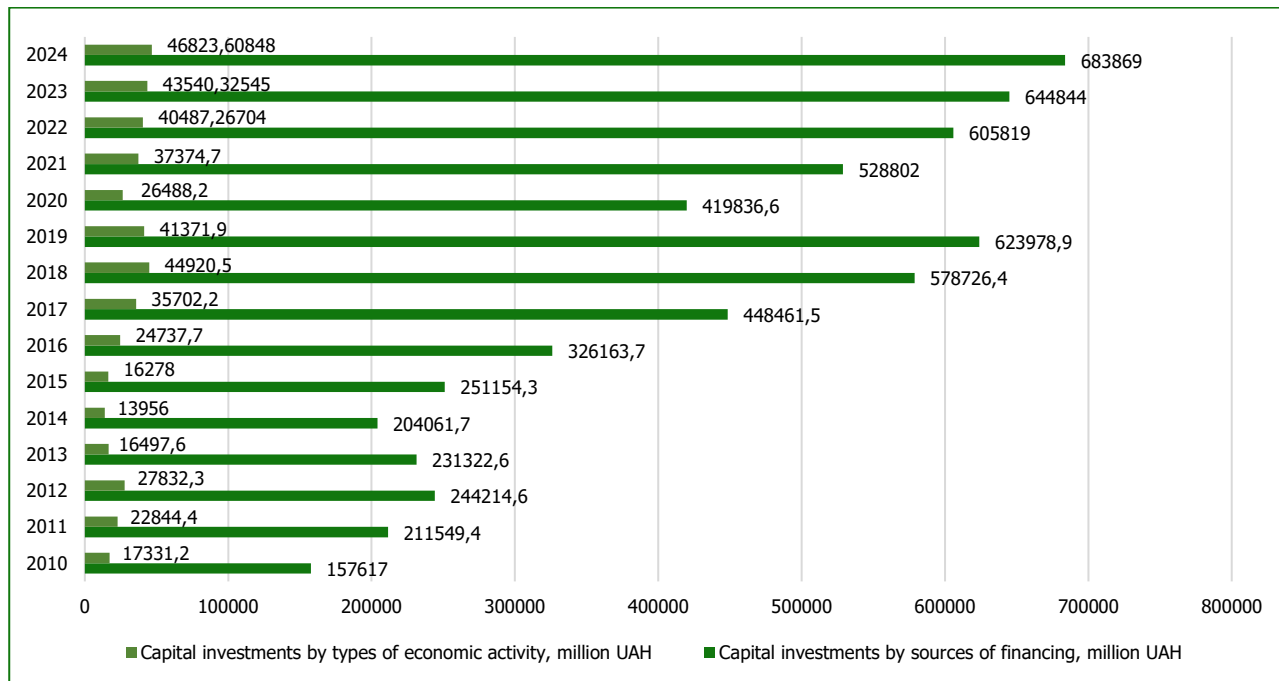


Figure 6. Forecast values of investment activity of Ukraine.

So, for example, the maximum values of capital investments by sources of financing in 2019 (investment volumes for the studied period were the largest) amounted to UAH 623,978.9 million, and by the end of 2024, their growth is forecasted by UAH 59,890.1 million. The situation is similar with investments by types of economic activity, the growth of which in 2024 compared to 2018 (investment volumes for the studied period were the largest) is forecasted to be UAH 1,903.108 million.

Considering the fact that the results of forecasting investment activity showed an increase in investment volumes in 2024, local, regional and state authorities need to implement further preventive measures to support this trend. Such measures, first of all, should be aimed at increasing the investment activity of railway transport enterprises, namely:

- improvement of the regulatory and legislative framework and ensuring its implementation;
- updating the production potential of railway transport enterprises;
- improving the quality of the services provided;
- search and attraction of state and international funds and grants;
- effective use and mobilization of own investment resources, etc.

DISCUSSION

Investments and investment activity are always at the centre of the attention of both scientists - theoreticians and managers - practitioners. The issues of investments are relevant in the modern economy, since every enterprise is formed and developed on the basis of financing and investments, and investment activities determine the conditions of their economic development. Investment activity can be considered a purposeful process of constant search for investment resources necessary for enterprises to ensure their efficient and uninterrupted work. Also, considering the military actions that are taking place at the moment, investment activity, in this case, plays an important role. At the same time, taking into account the future prospects - the accession of Ukraine to the European Union, the country's government must immediately resolve issues related to the integration of the railway industry of Ukraine into the EU transport system, considering the improvement of the quality of services provided by enterprises. However, the forecast values obtained in the study indicate an increase in the volume of capital investments both by sources of financing and by types of economic activity. Therefore,

it is important for the state government and the management of enterprises to continue to support and implement preventive measures in order to form a strategy for the development of the transport industry in the post-war period. It is also worth considering that in order to obtain a higher-quality forecast value, the largest possible number of time series (periods) is necessary. The study would only improve if other factors affecting the investment activity of enterprises were also taken into account. However, such problems arise with the limitation and timeliness of data presented on official sources.

The obtained research results are explained by the need to develop and find ways to increase the investment activity of railway transport enterprises. The transport sector is one of the important sectors of the national economy. It is the transport companies that provide the logistical connection from the transportation of passengers to the transportation of goods (humanitarian aid, food products, military equipment, etc.) from the zone where hostilities are conducted to safer ones and, in general, in the everyday life of everyone. Railway transport plays an important role in the total volume of the transport system of Ukraine. However, for the development of further uninterrupted and high-quality functioning of railway transport enterprises, it is necessary to implement investments.

The results of the analysis of the researched works [5–19] have shown the ambiguity of the authors' opinions regarding the formation of a single mechanism or algorithm for ensuring the investment activity of railway transport enterprises in the future post-war period. Such mechanisms (algorithms) could be the basis of the strategy of innovation and investment development of railway transport enterprises, which is suggested in the paper [25]. In the author's opinion, such a strategy will stabilize the current situation within railway transport enterprises and ensure their ahead-of-the-line innovation and investment development in the strategic perspective. However, the author did not take into account the forecast values of indicators of investment activity for the future period. Railway transport as a priority direction of the country's strategic development goals is also considered in work [26], however, the impact of the investment component on transport has not been fully investigated. So, the peculiarity of this study is that the author's approach in the form of a conceptual scheme for determining the forecast values of investment activity, based on economic and mathematical modelling, has made it possible to forecast investments and develop measures to increase them. However, the main limitation of the study is the fact that the procedure has not been tested in other sectors of the country's economy, with the exception of transport.

The shortcoming of this study is the practical application of the conceptual scheme for constructing forecast values of the investment activity of railway transport enterprises since the specificity of the activity of transport enterprises depends on many factors that affect the range of input data. Therefore, to solve such shortcomings, it is necessary to pay attention to the 1st stage of the conceptual scheme (Figure 3), since the quality of management decisions depends on the indicators of investment activity chosen for the study.

The development of this study is in practical aspect for the state, as it makes it possible to consider forecast investment volumes when forming the state strategy for regional development of the country, developing plans and recommendations for the development of railway transport enterprises. However, when forecasting investment activity, one may face the problem of timely publication of indicators on official sources, taking into account the military actions that are currently taking place on the territory of Ukraine.

CONCLUSIONS

The dynamics of changes in indicators of transport in Ukraine, including railway, have been analyzed. The results have shown a significant drop in indicators for the transportation of goods and passengers, freight and passenger traffic during the studied period. Such negative changes require the immediate implementation of preventive anti-crisis measures.

It has been proven that investment activities, including capital investments, are an important basis for the reconstruction of railway transport enterprises in the war and post-war periods. Capital investments have been distinguished by economic activities, where "Transport, warehousing, postal and courier activities" are of particular interest.

A conceptual scheme for forecasting the investment activity of railway transport enterprises has been formed, which includes 7 main stages. The results of forecasting capital investments by sources of financing, as well as by types of their economic activity, have shown an increase in the amount of financing in the future, which is positive and indicates the further need to implement and develop measures to increase the investment activity.

The measures to improve the efficiency of investment activities of railway transport enterprises have been proposed. These include improvement of the regulatory and legislative framework; updating the production potential of enterprises; improving the quality of provided services; search and attraction of funds and grants; effective use and mobilization of own resources.

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ПРОГНОЗУВАННЯ ІНВЕСТИЦІЙНОЇ ДІЯЛЬНОСТІ ПІДПРИЄМСТВ ЗАЛІЗНИЧНОГО ТРАНСПОРТУ ШЛЯХОМ ВИКОРИСТАННЯ ТРЕНДОВИХ МОДЕЛЕЙ

Об'єктом дослідження виступає інвестиційна діяльність підприємств залізничного транспорту. Мета роботи: спрогнозувати інвестиційну діяльність підприємств залізничного транспорту шляхом використання економіко-математичних методів та моделей, а саме – трендових. Інформаційною базою дослідження стали дані Державної служби статистики та Міністерства фінансів. Доведено, що транспортна галузь є однією з важливих галузей національної економіки, яка забезпечує логістичний зв'язок від перевезення пасажирів до перевезення вантажів. На основі економіко-математичних моделей (одновимірних трендових методів прогнозування) запропоновано концептуальну схему побудови прогнозних значень інвестиційної діяльності підприємств залізничного транспорту, за допомогою якої вдалося не лише спрогнозувати капітальні інвестиції, а й запропонувати заходи щодо їх збільшення. Наведено результати прогнозування інвестицій за джерелами фінансування (за рахунок: коштів державного бюджету, коштів місцевих бюджетів, власних коштів підприємств і організацій, кредитів банків та інших позик, коштів іноземних інвесторів, коштів вітчизняних інвестиційних компаній, фондів тощо, коштів населення на будівництво житла, інших джерел фінансування). Виокремлено інвестиції за видами економічної діяльності: транспорт, складське господарство, поштова та кур'єрська діяльність. Інтерпретовано отримані прогнозні значення інвестиційної діяльності. Запропоновано заходи щодо підвищення інвестиційної діяльності підприємств залізничного транспорту. Результати дослідження можуть лягти в основу формування державної стратегії регіонального розвитку країни та окремо в розробку планів і рекомендацій щодо розвитку підприємств залізничного транспорту на різних рівнях управління.

Ключові слова: підприємства, залізничний транспорт, інвестиції, управління, прогнозування

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