

BULLETIN

THE NATIONAL TRANSPORT UNIVERSITY

VOL. 29 | №2 | 2025

<https://ntu-bulletin.com/en>

ISSN 2308-6645, e-ISSN 2523-496X

Received: 28.05.2025. Revised: 19.10.2025. Accepted: 27.11.2025. Published: 04.01.2026.

UDC 330.341.1

DOI: 10.33744/2308-6645-2025-2-29-08-17

Ecological and economic assessment of enterprise sustainable development management

Olena Bakulich*

PhD in Technical Sciences, Professor
National Transport University
01010, 1 M. Omelyanovych-Pavlenko Str., Kyiv, Ukraine
<https://orcid.org/0000-0002-5700-0576>

Yevhen Samoylenko

PhD in Technical Sciences, Associate Professor
National Transport University
01010, 1 M. Omelyanovych-Pavlenko Str., Kyiv, Ukraine
<https://orcid.org/0000-0001-8352-2282>

Viktoriia Holodenko

PhD in Economic Sciences
National Transport University
01010, 1 M. Omelyanovych-Pavlenko Str., Kyiv, Ukraine
<https://orcid.org/0000-0002-8009-3539>

Mykola Hrebelnyk

Senior Lecturer
National Transport University
01010, 1 M. Omelyanovych-Pavlenko Str., Kyiv, Ukraine
<https://orcid.org/0000-0001-8385-8261>

Abstract. The article examined the ecological and economic management of the sustainable development of an enterprise. It considered the theoretical foundations of sustainable development as well as the practical aspects of its implementation at the enterprise level, with particular attention paid to achieving a balance between economic efficiency and environmental responsibility. The purpose of the study was to determine effective mechanisms for managing the sustainable development of enterprises through an assessment of the interrelated ecological and economic factors influencing their activities. The object of the study was the municipal transport enterprise Kyivpastrans, and the research was aimed at identifying effective mechanisms for managing its sustainable development. The relationships between the ecological and economic indicators of the enterprise's performance were analysed, key factors affecting its environmental and financial stability were identified, and the enterprise's resilience to external ecological and economic challenges was assessed. The research employed statistical and graphical methods, as well as mathematical modelling, which made it possible to quantitatively evaluate the relationships between ecological and economic characteristics and to develop proposals for their optimisation. Quantitative assessment methods were used to determine the dynamics of sustainable development indicators and to substantiate approaches to their further optimisation. The results obtained generalised the methodological foundations for improving sustainable development management in urban public transport enterprises. The interdependence between environmental and economic performance indicators was identified, enabling an assessment of enterprises' resistance to external environmental changes and their adaptability to contemporary

Suggested Citation: Bakulich, O., Samoylenko, Ye., Holodenko, V., & Hrebelnyk, M. (2025). Ecological and economic assessment of enterprise sustainable development management. *Bulletin of the National Transport University*, 29(2), 8-17. doi: 10.33744/2308-6645-2025-2-29-08-17.

*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

challenges. The practical significance of the study lay in the development of recommendations aimed at enhancing enterprise efficiency in accordance with the principles of sustainable development. The findings could be used as a decision-making tool in environmental and economic planning

 **Keywords:** sustainability indicators; ecological performance; economic efficiency; urban transport enterprise; Kyivpastrans; management tools; adaptive development

Introduction

Modern urban transport enterprises operate under conditions of increasing ecological pressures, economic instability, and growing demands for service quality, which necessitates the transition to sustainable development principles. Ensuring balanced ecological and economic performance is becoming a key prerequisite for strengthening the resilience and competitiveness of transport companies in the face of contemporary challenges. In this context, the development of effective management mechanisms requires a comprehensive assessment of environmental impacts, resource efficiency, and the economic outcomes of operational activities. The municipal transport company Kyivpastrans serves as a representative example of an enterprise functioning within a complex urban environment, where sustainable development indicators directly influence both operational stability and the quality of public transportation services. The need to integrate environmental considerations into economic decision-making highlights the importance of establishing reliable diagnostic tools that reflect the interconnection between ecological and economic factors. As noted by O.O. Bakulich & I.R. Kis (2021), modern transport enterprises face escalating ecological pressures, rising operational costs, and increasing expectations for safe and efficient mobility services. These challenges are particularly acute for urban public transport systems, which must simultaneously ensure environmental responsibility, economic stability, and high service quality. As a result, the need for effective sustainable development management has become especially relevant for transport companies, where the balance between ecological impact and economic performance directly influences the reliability and resilience of urban mobility. Sustainable development of enterprises in the long term is primarily conditioned by the introduction of the experience of innovative activities of highly developed countries, and the development of advanced achievements of domestic engineering, science and technology. V. Vlasova & O. Shynkaruk (2025) investigated the theoretical and methodological foundations and contemporary tools for assessing the sustainable development of transport enterprises, analysing the advantages and disadvantages of these tools for the formulation of effective innovative strategies, taking into account environmental, social, and economic aspects. A.S. Karapysh *et al.* (2025) found that the key element of the sustainable development concept is the principle of balance between economic, social, and environmental components; however, its excessive ideologisation and insufficient systematisation complicate the practical implementation of sustainable development goals, thereby necessitating the

introduction of specific applied instruments, primarily at the enterprise level. E. Širá *et al.* (2021) argued that an important condition for sustainable development is the flexibility of the management system – the ability to respond to changes by adjusting the set of managerial influences and directing the system to an equilibrium state. According to the authors, sustainable development had been implemented through the “20-20-20” approach, which included the reduction of greenhouse gas emissions, the improvement of energy efficiency, and an increase in the share of renewable energy sources in the overall energy balance. The study by F.V. Bekun *et al.* (2019) demonstrated that non-renewable energy consumption and economic growth had increased CO₂ emissions, whereas the development of renewable energy had contributed to their reduction, and an excessive reliance on natural resource rents without proper management had undermined environmental sustainability.

In the context of contemporary challenges, D. Gavrykov (2025) emphasised that digital transformation, including intelligent transport systems, big data, the Internet of Things and other advanced technologies, had constituted a critical pathway towards achieving sustainability in transport enterprises. The integration of digitalisation had expanded the scope of sustainability assessment beyond traditional economic and environmental indicators by recognising operational efficiency, resource optimisation and transparency as integral components of sustainable development. The review by D. Burchart & I. Przytuła (2024) of the transport sector's life-cycle sustainability assessment (LCSA) methods highlighted that comprehensive evaluation must integrate long-term environmental impacts, resource consumption, emissions, infrastructure lifecycle, and social outcomes – not only operational performance. This is significant because many conventional assessment methods, including enterprise-level indices, had tended to omit life-cycle impacts, thereby underestimating the actual ecological costs and the long-term risks to sustainability. A. Rossolov & S. Lyfenko (2021) assessed sustainability performance of the transport sector across European countries provides a broader context: it identifies structural challenges in reducing dependence on fossil fuels and meeting emissions targets, while recognising the need for harmonised sustainability indicators across nations for policy benchmarking. For a municipal operator like Kyivpastrans, such macro-level insights underline the importance of aligning enterprise-level sustainability efforts with wider sectoral and regulatory trends. A mixed-method investigation by M. Soufiemami (2022) examined social inclusivity and accessibility in public

transport systems, especially for disadvantaged groups (elderly, disabled, children). The research showed that sustainable transport must be socially equitable, safe, and accessible, adding an important dimension often underrepresented in enterprise-level indices. Integrating such social equity metrics may improve the social component of sustainability assessment for public transport enterprises. For municipal transport operators such as Kyivpastrans, sustainable development had constituted both a strategic objective and a practical necessity due to intensive energy use, emissions, infrastructure wear, and the obligation to provide socially essential services. Integrating ecological considerations into managerial decision-making had been essential for enhancing operational efficiency, mitigating environmental risks, and meeting contemporary standards of sustainable urban transport. Despite existing theoretical models, practical implementation at transport enterprises had often lacked systematic approaches capable of capturing the complex interactions between environmental and economic factors. The aim of the study was to investigate the processes of managing the sustainable development of an enterprise and the prospects for its activities on the basis of sustainable development, using the municipal transport company Kyivpas-trans as the case study.

Materials and Methods

The methodological framework of the study had been grounded in a combination of traditional general scientific and specialised methods. Statistical methods had been employed to analyse and identify patterns in the enterprise's performance indicators, while the index method had been used to determine aggregated indicators and assess the enterprise's sustainable development. A systems approach had facilitated a comprehensive examination of the management process of sustainable development

in a transport-sector enterprise as an integrated technical and socio-economic system, allowing for the identification of interrelationships among its elements. Inductive and deductive reasoning had been applied to form theoretical generalisations based on empirical data, and systematisation and classification had been used to structure the key factors and indicators of the enterprise's sustainable development. In addition, modern computer-based methods had been utilised for processing and visualising economic information. The information base of the study had comprised scientific publications by domestic and foreign scholars in the field of sustainable enterprise development management, legislative and regulatory documents governing enterprise activities, as well as statistical and financial reporting from the transport sector.

The assessment of an enterprise's sustainable development had been conducted using indicators – metrics derived from primary data – that enabled the evaluation of both the current state and the dynamics of sustainable development parameters. Two approaches had been applied in constructing the system of eco-economic indicators. The first involved the development of an integrated, aggregated indicator to assess the level of social and economic resilience, typically based on three groups of indicators: economic, environmental, and socio-economic. The second approach entailed the creation of a system of individual indicators, each reflecting specific aspects of sustainable development. These indicators had been designed to encompass economic, social, and environmental dimensions, recognising that sustainable development in an enterprise should promote economic growth while maintaining a balance with societal needs for improved quality of life and preventing environmental degradation. The use of such indicators had allowed for the quantitative measurement, monitoring, evaluation, and analysis of the pace and effectiveness of sustainable development (Table 1).

Table 1. Indicators for assessing the sustainable development of an enterprise

Indicator category	Indicators
Economic indicators	Industrial production volumes, capital investment volumes, profitability level, depreciation of fixed assets
Environmental indicators	Emissions of harmful substances into the air, discharges into water bodies, use of energy-saving technologies, expenditures on environmental protection measures
Social indicators	Number of jobs created, wage level, employee qualifications, level of workplace accidents
Risk indicators	Ability to withstand extreme external and internal pressures, quality and reliability of the enterprise's components

Source: developed by the authors based on L.M. Filipishyna (2017), O.V. Aref'yeva *et al.* (2023)

A quantitative assessment of enterprise sustainable development management was carried out based on an integrated sustainable development index, which included partial economic, environmental, and social indices and was expressed as:

$$I_{sd} = \frac{1}{m + n + k} \left(\sum_{j=1}^m I_j^{econ} + \sum_{j=1}^n I_j^{ecol} + \sum_{j=1}^k I_j^{soc} \right), \quad (1)$$

where I_j^{econ} , I_j^{ecol} , I_j^{soc} – indicators that respectively characterise the economic, environmental, and social components of an enterprise's sustainable development;

m , n , k – the number of indicators used to determine the partial indices.

The economic components of an enterprise's sustainable development refer to the state of its economic system, determined by indicators such as industrial production volumes, capital investment volumes, profitability levels, and depreciation rates of fixed assets. The environmental component of sustainable development represents the enterprise's impact on the environment. Key indicators include emissions of harmful substances into the air, discharges into water bodies, the use of energy-saving technologies, and expenditures on

environmental protection measures. The social prerequisites for sustainable enterprise development encompass the state, indicators, and patterns of social sphere development. This group includes indicators such as the number of jobs created, wage levels, employee qualification levels, and workplace injury rates. Considering that all indicators and parameters forming the indices are part of the model, are measured using different physical units, have varying interpretations, fluctuate within different ranges, and exhibit different directional influences, it is necessary to standardise them using the following formulas. If indicator X_j has a direct correlation with the corresponding index (i.e., when the indicator increases, the corresponding index also increases), its standardised value is calculated as:

$$I_j = \frac{x_j - x_{\min}}{x_{\max} - x_{\min}}, \quad (2)$$

where $x_{\max}$ and $x_{\min}$ – the maximum and minimum values of the corresponding indicator.

If the indicator X_j has an inverse relationship with the corresponding index (i.e., when the indicator increases, the corresponding index decreases), its standardised value is determined as:

$$I_j = 1 - \frac{x_j - x_{\min}}{x_{\max} - x_{\min}}, \quad (3)$$

Such normalisation ensures the unidirectionality of the partial indices, with their values ranging from 0 to 1. The poorest indicator values in terms of sustainable development correspond to numerical values close to 0, whereas the best approach 1. The assessment of an enterprise's sustainable development involves calculating an integrated index based on the partial indicators of sustainable development. This process includes selecting and systematising the enterprise's statistical performance indicators, followed by the calculation and normalisation of the relative indicators (Širá et al., 2021). An index is a set of aggregated or weighted indicators or factors, while an indicator is a measurable or observable characteristic. Based on the normalised values of partial indicators grouped into categories – social development, economic, and environmental – partial indices are then calculated.

Results and Discussion

The process of managing the sustainable development of an enterprise is based on a management system that allows a comprehensive, holistic approach to the interaction of various subsystems involved in management processes. The enterprise management system is considered as a set of management areas (marketing, finance, human resources management, etc.) or management functions (planning, organisation, motivation and control) (Filipishyna, 2017; Bakulich et al., 2021). The enterprise sustainable development management mechanism involves the sequential execution of defined actions. When establishing the foundation for managing sustainable development, it is necessary to formulate the enterprise's goals, strategies, and management principles. The implementation of the enterprise strategy is a process of reproducing its strategic potential based on the study and consideration of internal and external factors, as well as dynamic cause-and-effect relationships between the enterprise and the external environment. The core idea of sustainable enterprise development is to find an optimal balance between socio-economic growth and resource utilisation that ensures environmental safety, does not threaten the resource availability of future generations, and guarantees the necessary quality of life and well-being of the population. Additionally, the sustainable development strategy aims to ensure the financial stability, operation, and growth of the enterprise, satisfy the interests of all stakeholders, meet employees' needs for decent working and living conditions, and establish the company's image as an environmentally and socially responsible economic entity whose activities contribute to societal development and minimise negative environmental impact. Sustainable enterprise development should be considered as its ability to conduct economic activities over a certain period under conditions of uncertainty caused by external environmental influences that disrupt normal functioning and growth. The achievement of sustainable development goals is facilitated by both external and internal environmental factors and their effective utilisation (Table 2).

Table 2. Key factors of sustainable enterprise development

External factors	Internal factors
Economic: population income growth, tax burden, labor potential, inflation reduction, unemployment reduction	Management: effective development strategy, resource management system, personnel management system, information systems and technologies
Market: market capacity and dynamics, demand level, competition level	Operational: cost structure, level of technical and technological development, asset utilisation, marketing activities
Other factors: accessibility to external markets, demographic indicators, political stability	Financial: effective investment management, liquid asset structure, reduction of financial risks

Source: developed by the authors based on L.M. Filipishyna (2017), S.M. Pylypenko (2020)

Table 2 presented the key external and internal factors that influence the sustainable development of an enterprise. External factors reflect the macro-environment in which the enterprise operates and can either enable or constrain sustainable development. For instance,

economic factors such as population income growth, tax burden, inflation, and unemployment levels directly affect consumer demand and purchasing power, which in turn impacts revenue generation and investment capacity. Market factors, including market capacity, dynamics,

demand, and competition, determine the potential for enterprise growth and innovation, while other factors such as accessibility to external markets, demographic trends, and political stability shape the broader operational environment and affect strategic decision-making. A favourable external environment enhances the enterprise's opportunities to implement sustainability initiatives, whereas adverse conditions may require adaptive management strategies to maintain balanced development. Internal factors constitute the enterprise's inherent potential for sustainable development. Effective management, achieved through a coherent development strategy, resource allocation, personnel administration, and advanced information systems, allows the enterprise to coordinate economic, operational, and social activities efficiently. Operational factors, including cost structure, technological advancement, asset utilisation, and marketing activities, influence the efficiency with which inputs are converted into sustainable outputs. Financial factors, encompassing investment management, liquidity, and risk mitigation, provide the financial stability necessary to support long-term development projects and strategic initiatives. The interplay between external and internal factors is crucial: while external conditions set the boundaries and create opportunities or threats, internal capabilities define the enterprise's capacity to respond, adapt, and exploit these opportunities. For Kyivpastrans, external factors such as market demand for transport services, regulatory conditions, and population mobility trends directly affect the scope and efficiency of sustainability measures. Simultaneously,

internal factors, particularly the effectiveness of management systems, technological readiness, and financial stability, determine the enterprise's ability to implement environmentally friendly technologies, improve service quality, and ensure social equity in urban transport provision. Overall, the Table 2 highlighted that sustainable development results from the dynamic interaction between external influences and the enterprise's internal potential. Enterprises are required to monitor external changes continuously while simultaneously enhancing internal capabilities to achieve balanced and long-term sustainability outcomes.

The primary responsibility of Kyivpastrans is to provide public transportation services to the residents and visitors of Kyiv. Despite the current state of martial law and the challenging circumstances facing the country, the municipal enterprise continues to ensure the stable operation of the city's transport infrastructure. In 2023, compared to the previous year, transport work volumes (thousands of vehicle-kilometers) in regular service increased by 43.5%, including 31.1% for trams, 76.9% for trolleybuses, and 33.0% for buses (Fig. 1). This increase resulted from the opening of new routes and the expansion of rolling stock on existing routes. Throughout 2023, the total number of passengers transported by the company amounted to 224.5 million, which is 79.8 million more than in 2022. In regular service, 224.1 million passengers were transported, representing a 55.3% increase compared to 2022. The number of fare-paying passengers reached 101.1 million, an increase of 96.3% from 2022. The dynamics of passenger transportation indicators are presented in Figure 2.

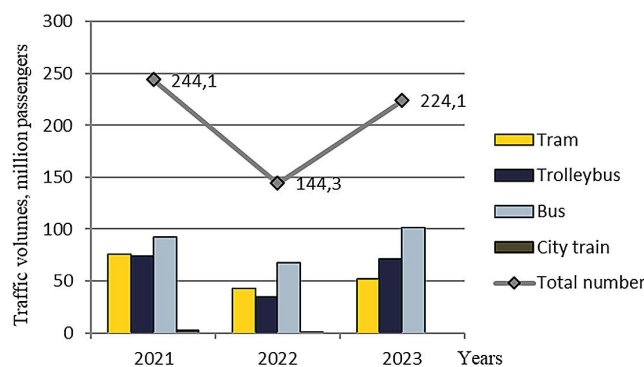


Figure 1. Dynamics of the enterprise's transport performance indicators during the period 2021-2023

Source: Kyivpastrans (2023; 2024)

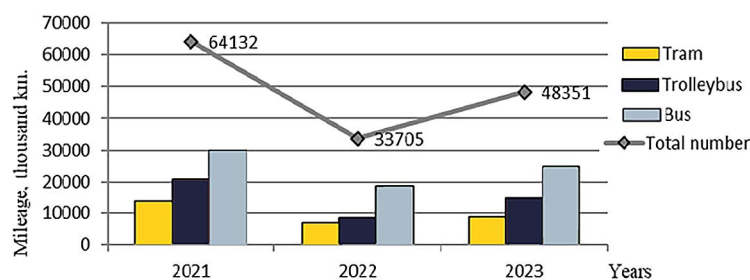


Figure 2. Dynamics of transportation volume indicators during the period 2021-2023

Source: Kyivpastrans (2023; 2024)

The analysis of passenger transportation volumes and structure at Kyivpastrans showed that buses account for the largest share – 45% of total passenger transport. When considering paid passenger transport, buses make up approximately 48%. In 2023, the company's own revenue amounted to 1,811.4 million UAH, representing an increase of 432.1 million UAH compared to the previous year. Local budget allocations in 2023 totalled 3,652.3 million UAH, an increase of 816.6 million UAH relative to 2022. Kyivpastrans's total expenditures in 2023 reached 4,686.2 million UAH, which is 900.5 million UAH higher than in 2022. The largest expenditure categories include material costs, depreciation charges, and payroll expenses.

The environmental policy of Kyivpastrans is based on the principle of sustainable development, which involves economic growth while ensuring the most efficient use of natural resources, maintaining ecological stability, and preserving the environment for future generations. To support this approach, the company has planned the renewal of its fleet by replacing older buses with newer models that comply with European environmental standards and increasing the number of trolleybuses and trams, which are considered environmentally friendly transport options. The actual expenditures for implementing key environmental protection measures at Kyivpastrans are presented in Table 3.

Table 3. Enterprise expenses for environmental protection measures

No.	Environmental protection service costs	2022 (thousand UAH)	2023 (thousand UAH)
1	Water resource protection	375.3	1,754.9
2	Waste management	1,207.6	4,911.2
3	Environmental taxes	17.0	26.6

Source: Kyivpastrans (2023; 2024)

In 2023, expenses for implementing annual measures related to water resource protection, waste management, and environmental taxes significantly increased compared to 2022. At Kyivpastrans, environmental management systems are continuously updated and improved. Planned activities include the repair of gas-cleaning units for stationary sources of air emissions,

efforts to reduce the generation of solid waste, and initiatives related to the disposal of hazardous waste. As of December 31, 2023, the total number of employees at Kyivpastrans is 4,448. Among them, 1,554 are women, with 141 holding managerial positions. The structural dynamics of the company's workforce in recent years are illustrated in Figure 3.

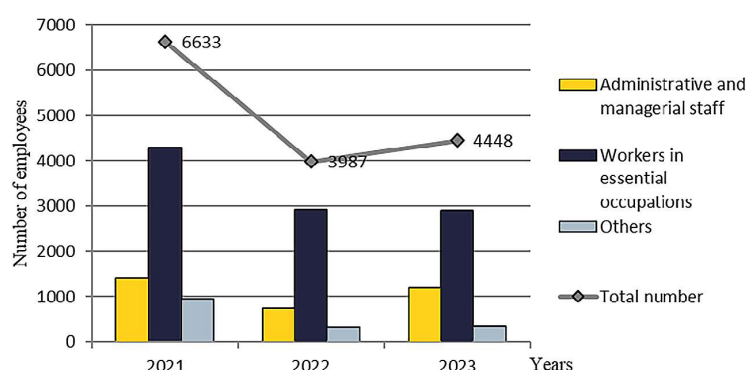


Figure 3. Structural dynamics of the enterprise's employees during the period 2021-2023

Source: Kyivpastrans (2023; 2024)

The assessment of the enterprise's sustainable development involves determining the integrated index based on the calculation of partial indices of sustainable development. This includes the selection and systematisation of the enterprise's statistical indicators, the calculation of their relative indicators, normalisation, and the determination of partial sustainable development indices for Kyivpastrans. The sustainable development assessment of the enterprise is carried out using an index formed based on the following components: economic activity development, environmental situation, and social sector development. Partial indices are calculated based on the normalised values of indicators for the identified groups.

The partial index of the enterprise's economic condition is proposed to be determined using four indicators: enterprise revenue, balance profit, passenger transportation volumes, and transport work. These indicators reflect the production, economic, operational activities, and the financial situation of the enterprise. The partial index of the enterprise's environmental situation is proposed to be determined using three indicators: expenses for water resource protection, waste management expenses, and environmental taxes. Together, these provide an overview of the ecological status and the scale of environmental protection efforts. The partial index of social sector development is proposed to be calculated based

on indicators such as the total number and structure of employees, and average salary. This set of measures captures the workforce structure, income distribution, and

general living conditions. Figure 4 presented the model of sustainable development management implemented at Kyivpastrans.

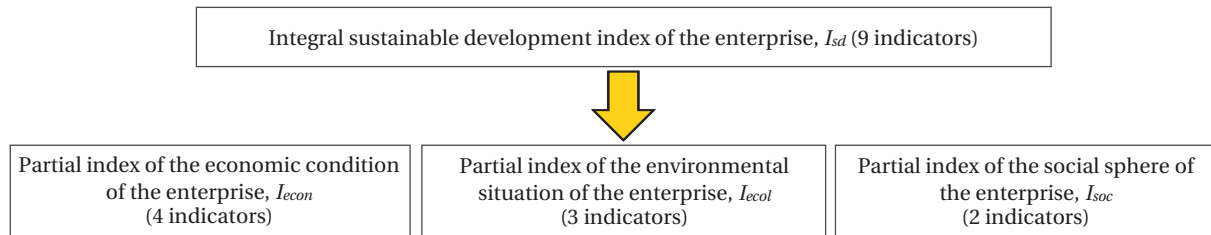


Figure 4. Sustainable development management model of the Kyivpastrans enterprise

Source: developed by the authors

Thus, the sustainable development index of the enterprise is determined as the weighted average of the three partial indices of sustainable development:

$$I_{sd} = \frac{1}{9} \left(\sum_{j=1}^4 I_j^{econ} + \sum_{j=1}^3 I_j^{ecol} + \sum_{j=1}^2 I_j^{soc} \right). \quad (4)$$

Normalisation of the studied indicators is carried out using formulas (2) and (3). The worst values of the normalised indicators, in terms of sustainable development for the enterprise, will correspond to numerical values close to 0, while the best values will approach 1. Thus, the integration of economic, social, and environmental indicators into a single sustainable development index allows for a comprehensive and balanced assessment of the enterprise's overall performance. By aggregating these three dimensions into one weighted metric, managers can identify

areas of strength and weakness, track progress over time, and prioritise interventions that will have the greatest impact on sustainable growth. In practice, this approach enables enterprise leadership to make informed decisions regarding resource allocation, investment planning, and strategic initiatives, ensuring that economic efficiency, social responsibility, and environmental stewardship are considered simultaneously. The normalisation of indicators, as carried out using formulas (4), ensures comparability across diverse metrics: values closer to 1 indicate favourable conditions, whereas values near 0 highlight critical areas requiring attention. Consequently, the sustainable development index serves as both a diagnostic and strategic tool, guiding management in achieving long-term resilience and balanced enterprise development. Figure 5 illustrated the structural dynamics of the integrated sustainable development index for Kyivpastrans.

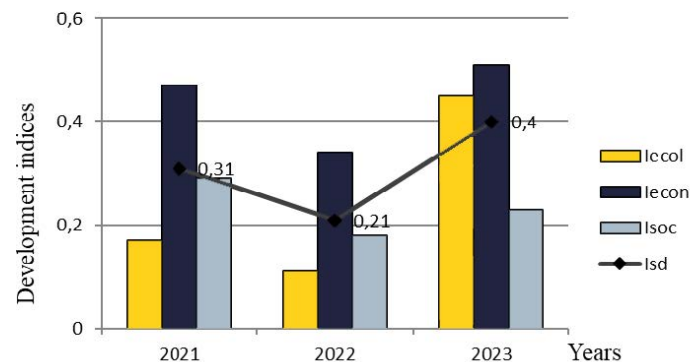


Figure 5. Dynamics of the integrated index of sustainable development of the enterprise during the period 2021-2023

Source: Kyivpastrans (2023; 2024)

It is worth noting that as of 2023, all partial indices increased compared to 2022. Notably, the environmental situation index saw a nearly fourfold increase, indicating positive dynamics in the enterprise's sustainable development. In 2022, the integrated sustainable development index of the enterprise decreased compared to 2021, but in 2023, it increased by almost twice. Thus, improving the effectiveness of activities and ensuring sustainable development at Kyivpastrans is a crucial task to provide convenient, fast, accessible, and safe public transportation.

The results of the study are consistent with the findings of other authors regarding sustainable development in transport enterprises and systems. V.M. Kudriavtsev & O.V. Kudriavtseva (2023) proposed a flexible, multi-stage method tailored to transport enterprises' starting conditions. Authors differentiate between qualitative and quantitative indicators and combine them into an overall integrated index, similar to our approach. However, this framework allows enterprises to adjust the indicator set and weights depending on strategic priorities, providing

flexibility that our fixed-set, expert-weighted index does not offer. For Kyivpastrans, adopting a configurable framework could enhance the adaptability of sustainability assessment, especially under changing operational conditions. A. Kwilinski *et al.* (2023) emphasised the role of digitalisation in improving environmental sustainability in the transport sector, including emissions monitoring, operational efficiency, and transparency. Compared to conducted study, which does not explicitly include digital or technological indicators, this research highlighted a future direction: integrating technological metrics into the ecological and economic assessment of Kyivpastrans could provide a more accurate picture of sustainability performance and identify digital transformation benefits. V.M. Kudriavtsev (2025) found that the sustainable development of a transport enterprise is determined by a system of interrelated economic, social, and environmental criteria, with effective income and cost management playing a key role in ensuring its stability, while the developed set of economic indicators enables a comprehensive assessment of the level of sustainable development and the identification of problematic aspects of enterprise activity.

V. Soti *et al.* (2023) developed a structural equation modelling (SEM) framework to analyse sustainability indicators for freight transportation in emerging economies. The authors grouped 16 indicators into economic, environmental, social, and risk categories, allowing the identification of latent factors and interactions. Compared to proposed in this study integral index method, SEM provided deeper insights into causal relationships between dimensions. Applying SEM to Kyivpastrans could help determine which sustainability components (economic, environmental, or social) most influence overall performance and guide targeted interventions. G.B. Suprayoga *et al.* (2020) analysed sustainability assessment indicators for road infrastructure projects, highlighting methodological challenges, such as indicator selection, weighting, and comparability. And the safest approach is to combine methods or adopt the integrated set developed to ensure exhaustive criteria inclusion. G. Boeing *et al.* (2022) developed a spatial indicator framework using open data to assess urban design and transport features for sustainable cities. Their approach situates enterprise-level operations within broader urban sustainability, considering factors such as network connectivity and accessibility. For Kyivpastrans, integrating such spatial indicators could enhance strategic planning by linking enterprise-level sustainability to city-level mobility goals. Proposed in this study integrated index aligns with the widely accepted three-dimensional framework of sustainability (economic, environmental, social), confirming its applicability for practical enterprise-level assessment. However, the aforementioned studies highlighted opportunities to refine and expand the methodology:

1) incorporating digitalisation and technological indicators;

2) applying advanced statistical models (e.g., SEM) to analyse interactions between sustainability components;

3) including life-cycle and long-term environmental impacts;

4) expanding social metrics to reflect accessibility, equity, and safety;

5) linking enterprise indicators to urban-scale spatial and transport features for strategic planning.

Thus, while proposed integral index provided a clear and practical tool for Kyivpastrans, adopting these enhancements would increase the depth, validity, and strategic value of sustainability assessments for urban transport enterprises. The development of an integrated index for Kyivpastrans was conducted in accordance with current best practices: it was context-specific rather than generic, balanced economic, environmental, and social dimensions, and remained open to future expansion (e.g., through the inclusion of digital-technological and spatial/urban indicators). At the same time, the literature indicated that no universal model existed, and that each assessment framework had to be adapted to the enterprise's operational context, data availability, strategic objectives, and external environment.

Conclusions

The study examined the principal methodological approaches to managing the sustainable development of a transport enterprise, with particular emphasis on the integrated evaluation of ecological, economic, and social performance. Using a comprehensive analytical framework, it provided a detailed assessment of the enterprise's sustainability status and identified the key factors influencing its long-term development. An in-depth analysis of the financial and economic indicators of Kyivpastrans has revealed structural imbalances in revenue generation, cost allocation, and resource efficiency, which collectively constrain the enterprise's capacity for sustainable growth. At the environmental level, the evaluation has highlighted persistent issues associated with the aging vehicle fleet, high emissions, and insufficient implementation of modern ecological practices. The social dimension of the assessment underscored both the strengths of the enterprise – such as its critical role in ensuring mobility for the urban population – and the challenges related to service quality, workforce conditions, and passenger satisfaction. To consolidate these multidimensional findings, an integral sustainability index was constructed. This index integrates three core components: the development of economic activity, the environmental situation, and the social sphere. The results demonstrated that while Kyivpastrans exhibits moderate progress in certain sustainability components, its overall sustainable development level remains constrained by environmental and financial limitations. The assessment provided a clear foundation for identifying priority areas requiring strategic intervention, including fleet modernisation, energy-efficient technologies, optimisation of financial resources, and enhanced social responsibility initiatives. The findings of

this study underscored the necessity of adopting a holistic and system-based approach to sustainable development management within urban transport enterprises. Furthermore, the research highlights the importance of integrating sustainability considerations into operational decision-making to increase resilience, efficiency, and service quality. Future research should focus on developing predictive models for evaluating the long-term effects of sustainability-oriented measures at transport enterprises, expanding the methodological toolkit for assessing ecological and economic risks, and exploring digitalisation tools that support real-time monitoring of sustainability indicators. Additionally, comparative studies involving

multiple transport operators could further refine the understanding of best practices and enhance the generalisability of sustainability management approaches in the urban transport sector.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Aref'yeva, O.V., Safonik, N.P., & Dudik, A.O. (2023). Strategic analysis of the development of transport enterprises under innovative trends. *Problems of Contemporary Transformations. Series: Economics and Management*, 7. [doi: 10.54929/2786-5738-2023-7-04-16](https://doi.org/10.54929/2786-5738-2023-7-04-16).
- [2] Bakulich, O., Holodenko, V., & Zaiats, O. (2021). Environmental-oriented model of integrated management. *International Journal of Innovative Technologies in Economy*, 1(33). [doi: 10.31435/rsglobal_ijite/30032021/7471](https://doi.org/10.31435/rsglobal_ijite/30032021/7471).
- [3] Bakulich, O.O., & Kis, I.R. (2021). Situational method of environmental risk management of transport industry enterprises projects in a circular economy. *Management of Development of Complex Systems*, 46, 6-11. [doi: 10.32347/2412-9933.2021.46.6-11](https://doi.org/10.32347/2412-9933.2021.46.6-11).
- [4] Bekun, F.V., Alola, A.A., & Sarkodie, S.A. (2019). Toward a sustainable environment: Nexus between CO₂ emissions, resource rent, renewable and nonrenewable energy in 16-EU countries. *Science of The Total Environment*, 657, 1023-1029. [doi: 10.1016/j.scitotenv.2018.12.104](https://doi.org/10.1016/j.scitotenv.2018.12.104).
- [5] Boeing, G., et al. (2022). Using open data and open-source software to develop spatial indicators of urban design and transport features for achieving healthy and sustainable cities. *The Lancet Global Health*, 10(6), 907-918. [doi: 10.1016/S2214-109X\(22\)00072-9](https://doi.org/10.1016/S2214-109X(22)00072-9).
- [6] Burchart, D., & Przytuła, I. (2024). Sustainability assessment methods for the transport sector considering the life cycle concept – a review. *Sustainability*, 16(18), article number 8148. [doi: 10.3390/su16188148](https://doi.org/10.3390/su16188148).
- [7] Filipishyna, L.M. (2017). [Integrated assessment of industrial enterprises' development stability](#). *Economics and Enterprise Management*, 19, 280-285.
- [8] Gavrykov, D. (2025). Innovative and digital transformations as a path to sustainable development of transport complex enterprises. *International Science Journal of Management, Economics & Finance*, 4(4), 96-103. [doi: 10.46299/j.isjmef.20250404.10](https://doi.org/10.46299/j.isjmef.20250404.10).
- [9] Gruetzmacher, S.B., Vaz, C.B., & Ferreira, Â. (2022). Sustainability performance assessment of the transport sector in European countries. *Faculty of Engineering Journal*, 104, 42-52. [doi: 10.17533/udea.redin.20210742](https://doi.org/10.17533/udea.redin.20210742).
- [10] Karapysh, A.S., Kharchenko, O.I., & Barkalova, N.O. (2025). Analysis of socio-economic provisions of sustainable development of transport enterprises. *Transport Systems and Transportation Technologies*, 29, 95-102. [doi: 10.15802/tstt2025/325489](https://doi.org/10.15802/tstt2025/325489).
- [11] Kudriavtsev, V.M. (2025). Sustainable development of the transport enterprise: Integration of economic, social and environmental criteria. *Economics of the Transport Complex*, 45, 239-250. [doi: 10.30977/ETK.2225-2304.2025.45.239](https://doi.org/10.30977/ETK.2225-2304.2025.45.239).
- [12] Kudriavtsev, V.M., & Kudriavtseva, O.V. (2023). Methodology for assessing the level of sustainable development of a transport enterprise. *Economics of the Transport Complex*, 42, 168-181. [doi: 10.30977/ETK.2225-2304.2023.42.168](https://doi.org/10.30977/ETK.2225-2304.2023.42.168).
- [13] Kwilinski, A., Lyulyov, O., & Pimonenko, T. (2023). Environmental sustainability within attaining sustainable development goals: The role of digitalization and the transport sector. *Sustainability*, 15, article number 11282. [doi: 10.3390/su151911282](https://doi.org/10.3390/su151911282).
- [14] Kyivpastrans. (2023). *Cash flow statement (direct method) for 2022*. Retrieved from <https://surl.li/xsyoun>.
- [15] Kyivpastrans. (2024). *Cash flow statement (direct method) for 2023*. Retrieved from <https://surl.li/wligip>.
- [16] Pylypenko, S.M. (2020). Strategic enterprise management based on the concept of sustainable development. *Economics and Society*, 21, 79-85. [doi: 10.32782/2524-0072/2019-20-47](https://doi.org/10.32782/2524-0072/2019-20-47).
- [17] Rossolov, A., & Lyfenko, S. (2021). Assessment of sustainable development scenarios of city transport systems under car-oriented mobility. *Central Ukrainian Scientific Bulletin. Technical Sciences*, 4(35), 221-231. [doi: 10.32515/2664-262X.2021.4\(35\).221-231](https://doi.org/10.32515/2664-262X.2021.4(35).221-231).
- [18] Širá, E., Kotulič, R., Kravčáková Vozárová, I., & Daňová, M. (2021). Sustainable development in EU countries in the framework of the Europe 2020 strategy. *Processes*, 9(3), article number 443. [doi: 10.3390/pr9030443](https://doi.org/10.3390/pr9030443).



- [19] Soti, V., Pratap, S., Dwivedi, A., & Lakshay. (2023). A structural equation modeling framework for studying sustainable freight transportation indicators in emerging economies. *Decision Analytics Journal*, 9, article number 100337. [doi: 10.1016/j.dajour.2023.100337](https://doi.org/10.1016/j.dajour.2023.100337).
- [20] Soufiemami, M. (2022). *Ameliorating transport system focusing on sustainability and inclusiveness through a mixed-method research (a case study in Tehran, Iran)*. Tehran: Shahid Beheshti University. [doi: 10.48550/arXiv.2301.07504](https://doi.org/10.48550/arXiv.2301.07504).
- [21] Suprayoga, G.B., Bakker, M., Witte, P., & Spit, T. (2020). A systematic review of indicators to assess the sustainability of road infrastructure projects. *European Transport Research Review*, 12, article number 19. [doi: 10.1186/s12544-020-0400-6](https://doi.org/10.1186/s12544-020-0400-6).
- [22] Vlasova, V., & Shynkaruk, O. (2025). Preconditions for the formation of an innovative strategy for sustainable development of transport enterprises. *Economics and Society*, 75. [doi: 10.32782/2524-0072/2025-75-47](https://doi.org/10.32782/2524-0072/2025-75-47).

Екологічно-економічна оцінка управління сталим розвитком підприємства

Олена Бакуліч

Кандидат технічних наук, професор
Національний транспортний університет
01010, вул. М. Омеляновича-Павленка, 1, м. Київ, Україна
<https://orcid.org/0000-0002-5700-0576>

Євген Самойленко

Кандидат технічних наук, доцент
Національний транспортний університет
01010, вул. М. Омеляновича-Павленка, 1, м. Київ, Україна
<https://orcid.org/0000-0001-8352-2282>

Вікторія Голоденко

Кандидат економічних наук
Національний транспортний університет
01010, вул. М. Омеляновича-Павленка, 1, м. Київ, Україна
<https://orcid.org/0000-0002-8009-3539>

Микола Гребельник

Старший викладач
Національний транспортний університет
01010, вул. М. Омеляновича-Павленка, 1, м. Київ, Україна
<https://orcid.org/0000-0001-8385-8261>

Анотація. У статті досліджено екологічне та економічне управління сталим розвитком підприємства. Розглянуто теоретичні засади сталого розвитку, а також практичні аспекти його впровадження на рівні підприємства, з особливою увагою до досягнення балансу між економічною ефективністю та екологічною відповідальністю. Метою дослідження було визначення ефективних механізмів управління сталим розвитком підприємств через оцінку взаємопов'язаних екологічних та економічних факторів, що впливають на їхню діяльність. Об'єктом дослідження було муніципальне транспортне підприємство «Київпастранс», а мета дослідження полягала у виявленні ефективних механізмів управління його сталим розвитком. Було проаналізовано взаємозв'язки між екологічними та економічними показниками діяльності підприємства, визначено ключові фактори, що впливають на його екологічну та фінансову стабільність, а також оцінено стійкість підприємства до зовнішніх екологічних та економічних викликів. У дослідженні застосовувалися статистичні та графічні методи, а також математичне моделювання, що дозволило кількісно оцінити взаємозв'язки між екологічними та економічними характеристиками та розробити пропозиції щодо їх оптимізації. Методи кількісної оцінки використовувалися для визначення динаміки показників сталого розвитку та обґрунтування підходів до їх подальшої оптимізації. Отримані результати узагальнили методологічні засади покращення управління сталим розвитком у міських підприємствах громадського транспорту. Виявлено взаємозалежність між показниками екологічної та економічної діяльності, що дозволяє оцінити стійкість підприємств до зовнішніх змін навколишнього середовища та їхню адаптивність до сучасних викликів. Практичне значення дослідження полягає у розробці рекомендацій, спрямованих на підвищення ефективності підприємства відповідно до принципів сталого розвитку. Результати можуть використовуватися як інструмент прийняття рішень у сфері екологічного та економічного планування.

Ключові слова: показники сталості; екологічна ефективність; економічна ефективність; міське транспортне підприємство; Київпастранс; інструменти управління; адаптивний розвиток