

## DEVELOPMENT AND FINANCING OF INFRASTRUCTURE INVESTMENTS TO SHAPE SUSTAINABLE AND RESILIENT MOBILITY

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**Purpose:** The aim of the study is to identify the essential attributes that determine the development of a sustainable, innovative and resistant to disruption transport infrastructure and to answer two research questions: How to shape models for the development of sustainable and innovative transport infrastructure, while maintaining the logistic continuity of mobility and transport systems? and What actions should organizations take in the conditions of permanent change in order to maintain operational efficiency and cost-effectiveness of implemented investments, not only thinking about the possible return of the pandemic, but also about increasingly difficult access to resources, climate change and social needs?

**Design/methodology/approach:** The research methods and techniques used included, among others: content analysis, cause and effect analysis, selected methods of qualitative and quantitative analysis, which were used to present and discuss the results of the study.

**Findings:** Searching for methods of operationalization of the implementation of the assumptions of the new development paradigm, a conceptual framework for the model of sustainable development of transport infrastructure was developed. EU programs and instruments supporting the financing of activities in the field of development of sustainable, innovative and resilient transport infrastructure were reviewed. Attributes were indicated so that the development would strive for the simultaneous implementation of economic, social and environmental goals.

**Research limitations/implications:** The study did not measure the sustainability of infrastructure investments in transport. The precondition for successfully performing such a task is the availability of an accurate data set and the selection of appropriate measurement indicators. This has implications for future research.

**Practical implications:** One of the key challenges in cities is making decisions about investments in the development of economically effective, environmentally safe and socially important transport infrastructure. Hence, the development of algorithmic approaches that allow the use of the proposed qualitative model may contribute to improving the efficiency in making investment decisions.

**Originality/value:** The originality of the conducted research was achieved through its measurable character. The proposed model can contribute to the improvement of decision-making tools in the field of allocation of public and other funds for investments, so that they contribute to the sustainability of mobility systems.

**Keywords:** transport infrastructure, sustainable development, financial instruments.

**Category of the paper:** research paper.

## 1. Introduction

The initiatives adopted under the Sustainable and Smart Mobility Strategy (2020) and the "Fit for 55" package set out a number of actions for the development of sustainable, innovative and resilient mobility. Their implementation requires significant financial outlays in the short term and a comprehensive change in the approach to the functioning of the investment financing system in the entire value chain. In the face of weakening local budgets and rising national debt, the role of European Union (EU) funds and funding is undeniable. The current long-term EU support, in the 2021-2027 programming period, remains crucial to meeting the challenges of mobility in terms of sustainability and digitalization, while increasing transport demand. Taking into account the likelihood that public funds will be limited due to the scale and complexity of the projects, it will be important to increase investment in the sustainable mobility system by the private sector, including, among others, through "green" financial instruments. Responsibility for the development, financing and construction of transport infrastructure lies mainly with the EU Member States. EU funds, which must provide added value in the European dimension, should be subsidiary to private, i.e. market-based, sources of financing. Meanwhile, since 2008, expenditures, both from public and private funds, on transport investments have been gradually decreasing (European Commission, 2019). At the same time, the mobility system has changed radically in recent years and continues to transform rapidly. Driven by new technologies and changes in consumer behaviour, the mobility of the future will be more flexible, environmentally focused and based on 'use' rather than 'ownership' models. In the short and medium term, there are several main directions of activities related to the financing of solutions in the field of environmentally friendly and climate-neutral mobility.

Despite the adoption of new Sustainable Development Goals in 2015 and confirmed benefits related to social, economic and environmental aspects, the process of implementing sustainable mobility faces a number of challenges. Achieving zero net Greenhouse Gas (GHG) emissions by 2050, in line with the European Green Deal, requires the widespread availability of sustainable alternatives integrated into a fully integrated, efficient and resilient multimodal network EU transport infrastructure. Meanwhile, most countries are unable to provide the required quantity and quality of infrastructure investment. This reflects two fundamental and persistent barriers to investment. Firstly, countries are often unable to convert huge needs and

opportunities into a concrete set of projects, and much of the new investment is not as sustainable as it should be. This is due to the inherent complexity of transport development investments and political and institutional obstacles. Second, mobilizing long-term funding, taking into account the risk of the infrastructure project cycle and ensuring that funding is sustainable, remains a common challenge.

According to the adopted thesis, the development of a zero-emission, innovative and resilient economy requires the redirection of public and private capital to "sustainable" investments. Mobility plays an important role in this development. The main objective of the study, the results of which are presented in this article, is to identify the essential attributes determining the development of a sustainable, innovative and resistant to disruption transport infrastructure. For such a specific purpose, research questions were formulated:

- How to shape models for the development of sustainable and innovative transport infrastructure, while maintaining the logistic continuity of mobility and transport systems?
- What actions should organizations take in the conditions of permanent change in order to maintain operational efficiency and cost-effectiveness of implemented investments, not only thinking about the possible return of the pandemic, but also about increasingly difficult access to resources, climate change and social needs?

Investing in innovative and resilient transport infrastructure, taking into account environmental and social aspects, is a challenge, but also creates new business opportunities. Stakeholders are already recognizing the economic potential of the value chain of sustainable investments in transport and mobility infrastructure. The qualitative model of transport infrastructure development proposed in the article can contribute to the improvement of decision-making tools for the allocation of public funds and other sources for investments, so that they contribute to the sustainability of mobility systems.

## **2. Literature review**

The issue of sustainable development is now an integral element not only of environmental policy, but also of economic and social policy. Along with the strengthening of the concept of sustainable development in economic activity, transport infrastructure is of particular importance, which is reflected both in the literature on the subject (Ahern, 2011; Bhattacharya, 2016; Cho, Choi, 2021), as well as in strategic documents (UN, 2015) and sectors of individual economies (White Pape, 2011). Infrastructure determines the proper functioning of the economy and society, and at the same time it can be a source of unintended negative effects of a long-term nature, in the closer and further environment. From the perspective of sustainable development, it is both a manifestation and a determinant of this development. It is therefore

crucial that the processes of designing, developing and operating transport infrastructure are both conditions and factors that strengthen the implementation of the concept of sustainable development (Yannis, Chaziris, 2022). At the same time, it should be noted that despite widespread acceptance, the concept is sometimes criticized, mainly in the context of problems in implementing the principles of sustainable development and the lack of measurable effects in practice. Czyżewski and Staniszewski (2018) argue that critical voices most often result from a rather general definition of the term "sustainable development", which often makes it abstract and ambiguous.

When analyzing the role of transport infrastructure as one of the key factors determining sustainable development, it should be emphasized that there are no completely unambiguous relationships between infrastructure investments and development. Particularly problematic are cases where, as a result of differences in the interpretation of sustainability, the actions taken to achieve it are contradictory. Transport infrastructure is an important factor in the competitiveness of regions and countries, but after reaching a certain level of saturation with infrastructure in geographical areas and supply networks, a further increase in expenditure on infrastructure investments may be economically unjustified, and even become a barrier to development. As Zaremba (2014) points out, indiscriminate investment of capital, unsupported by plans to use infrastructure, sometimes leads to a slowdown in economic growth, which is accompanied by a lower level of social development and an increase in environmental costs. In turn, Chen (2013) and Zhou et al. (2021), analyzing investment models, prove that the impact of infrastructure investments on development varies significantly in individual regions. They also indicate the need to take into account externalities for neighboring regions. It is therefore important to avoid, in the development of infrastructure, e.g. investment projects that primarily increase the transit importance of a given area (Polyzos, Tsiotas, 2020). This effect causes certain benefits in the economic dimension, while quite often being a source of local external costs, e.g. an increase in CO<sub>2</sub> emissions or migration of the labor force to a more attractive region.

The unanimity of views on the important role of infrastructure in the processes of economic growth and development is accompanied by an increasing awareness of the change in the perception of transport infrastructure as a result of the impact of the main trends in socio-economic development. The essential assessment criteria are not only the quantity, but above all the quality of the infrastructure, capacity for resilience, accessibility and impact on the environment. These criteria make it possible to assess both direct and indirect effects of infrastructure development, including social and environmental ones. Hence, shaping transport infrastructure in accordance with the new paradigm requires specifying the essence of sustainable infrastructure development and systematic research into the possibility of its effective implementation.

The concept of sustainable development of transport infrastructure is related to the conditions of stable socio-economic development, in which the activity of enterprises in the transport-forwarding-logistics (TFL) sector significantly contributes to the improvement of prosperity, while maintaining the need to respect the principles of rational resource management. The common ground of the new paradigm of the development of logistics infrastructure are activities at the intersection of the following dimensions: economic, social, environmental, spatial and legal and institutional. At the basis of the analyzed concepts is a systemic approach to the study of individual dimensions and the relationships between them. At the same time, Rogall (2010) emphasizes that each of the systems develops at a different pace, hence maintaining appropriate relations between economic, social, environmental, as well as spatial and legal-institutional development is a major challenge in shaping a coherent transport infrastructure. The complexity of this problem is exacerbated by the multidimensional understanding of infrastructure (Andreas et al., 2019).

Nowadays, the domain of almost all areas of economic and social life is striving to ensure sustainable socio-economic development, which undoubtedly depends on a coherent, complete and mature transport infrastructure, closely related to the use of individual capitals, i.e.: natural, tangible, human, social and political. Thanks to it, it is possible to effectively meet the needs of individual groups of stakeholders and to achieve short- and long-term goals, i.e. to achieve a state of sustainability. In the context of the role of transport infrastructure in the process of sustainable development, however, the natural environment cannot be overlooked as a "stakeholder" of infrastructure (Champagne, Dubé, 2023). In this aspect, the development of infrastructure should enable the reconciliation of economic, social and environmental interests.

It seems reasonable that the role of transport infrastructure in shaping the modern concept of sustainable logistics and sustainable supply chains can be presented in a similar context. Undoubtedly, elements of transport infrastructure are exogenous factors for the development of sustainable logistics and sustainable supply chains, which in a certain way can affect the formation of these processes, i.e. stimulate or limit their development. The essence of these relationships is reflected, for example, in overloaded urban transport systems. They are the effects of new infrastructural investments, which, in accordance with the strategy implemented until the end of the 1990s, were to mitigate the negative effects of the increase in demand for road transport. This approach did not bring the expected results, on the contrary, the systematic increase in the demand for passenger car travel resulted in the increasing phenomenon of transport congestion and the need to build further connections (Przybyłowski, Podbielska, 2017). Therefore, it remains a constant challenge to seek such paths of sustainable development of transport infrastructure that, within a given generation and on an intergenerational scale, will ultimately ensure an improvement in the quality of services provided and durability of infrastructure, without compromising the speed of investment implementation, taking into account the needs of all stakeholders, including the environment.

### 3. Methods

Selected research methods and techniques were used in order to achieve the assumed research objective and to answer the formulated research questions. The descriptive analysis was used to define the subject of the study and to identify the basic relationships within it. To systematize the current scientific achievements and the state of knowledge about the essence and motives of sustainable development of transport infrastructure, the method of analysis and criticism of the literature turned out to be useful. The review of the literature on the subject was carried out in accordance with the classic approach, i.e.: selection of sources, search by keywords, review and selection of articles, in-depth analysis of selected publications in relation to the subject of the study, taking into account, among others, latest publications and number of citations. The analyzed scientific articles are indexed in the following databases: Scopus, Web of Science, Science Direct and Google Scholar. Compact scientific publications, reports, scientific expertise and statistical data used in the study were published by recognized publishing houses as well as foreign and domestic institutions. A review of the literature on the subject identified a general gap in knowledge about an integrated approach to support investment decisions in the development of sustainable transport infrastructure.

Using the cause-and-effect analysis, the implications of sustainable development for shaping the logistics infrastructure were defined, the attributes of sustainable development of transport infrastructure and the challenges related to the processes of their implementation from the perspective of the functioning of transport and logistics systems were identified.

Using the analysis and logical construction as well as qualitative analysis, a conceptual framework for the model of transport infrastructure development was developed in accordance with the idea of sustainable development. Its application requires taking into account many variables, due to the complexity of the development of the mobility system. It is expected that it may contribute to the improvement of tools supporting investment decisions in the field of sustainable transport infrastructure development. Using the general assumptions of the qualitative model, a review of EU programs and instruments supporting financing activities in the field of development of sustainable, innovative and resilient transport infrastructure was made.

## 4. Results

### 4.1. Conceptual framework for sustainable development of transport infrastructure

The idea of sustainable development of transport infrastructure is most often considered as a concept of socio-economic development, which must meet four common criteria of the new development paradigm, i.e. economic, social, environmental and institutional. Implications for a broader approach to the essence of sustainable development of transport infrastructure are the works of, among others: Bhattacharya et al. (2015) and Weber et al. (2016). The research work carried out for over two decades focused primarily on improving the concept of sustainable infrastructure development and the idea of sustainable transport infrastructure. Their context varies depending on the adopted criterion and categorization of its impact on the new development paradigm, while deepening the understanding of the essence of investments in the development of sustainable transport infrastructure.

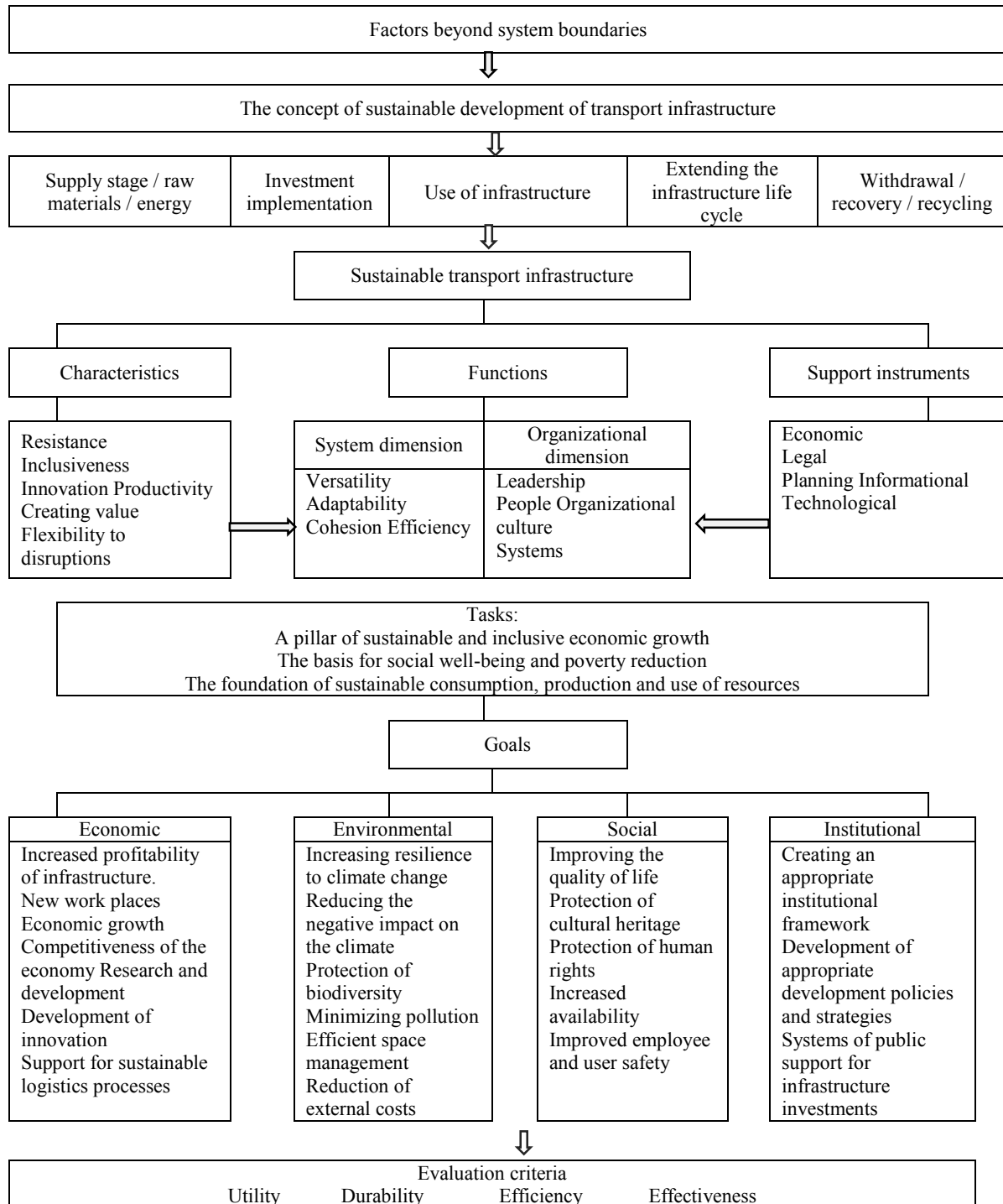
Along with the dissemination of the concept of sustainable development, the approach to planning and assessing infrastructure investments has changed. By adopting a hierarchy of functions and objectives, sustainable infrastructure development can be achieved by prioritizing specific strategic elements (Figure 1). In addition, to outperform what is currently common practice, logistics infrastructure operators should have clearly defined performance metrics and targets – not only in terms of economic performance but also environmental, social and institutional performance.

Sustainable development of logistics infrastructure is a very complex process. The current state of research in the field of shaping sustainable infrastructure confirms that in the pursuit of increasing sustainability, a properly selected set of features conducive to the development trajectory is decisive, i.e.: resilience, social inclusion, innovation as well as productivity and infrastructure flexibility to disruptions in a dynamically changing environment.

Infrastructure resilience can be treated as a derivative property of the system, which is the result of the investments made. Their implementation will help prepare the infrastructure for the increase in the frequency of extreme weather events caused by climate change. McKinsey Global Institute experts predict that over the next three decades the average global temperature is expected to increase between 1.5°C and 5°C, and the probability of an increase in extreme temperatures in the summer months is in the range of 15% to 30% (Climate risk, 2020). As a long-lived asset, transport infrastructure is particularly vulnerable to the effects of climate change.

Inclusivity and reliability in the social dimension is another target point of the process of changes constituting the essence of sustainable development of logistics infrastructure. It can be defined as "any infrastructure development that enhances positive social inclusion outcomes and ensures that no individual, community or social group is deprived of the benefits of improved infrastructure" (Stanley Jo., Stanley J., p. 2). Infrastructure facilities and services

must therefore be accessible, inclusive and beneficial to all. The features of increasing sustainability with regard to logistics infrastructure should also be associated with mutual benefit effects in terms of the implementation of new technologies, improved productivity and flexibility to disruptions in a turbulent environment.



**Figure 1.** Conceptual framework of the model of sustainable development of transport infrastructure.

Source: own study.



Technologies supporting the development of infrastructure have evolved at a rapid pace in recent years, from computer-aided design to digital solutions. At the current level of development, digital technologies are crucial in the sustainable transformation of logistics infrastructure in its myriad forms. Digital platforms can be used to improve transparency, streamline processes, and collaborate across phases of the infrastructure lifecycle to increase productivity and added value. In brownfields, they can also focus on creating value by reducing redundancy and leveraging the intelligent capabilities of infrastructure and data analytics and connectivity throughout the chain (Serrano, 2015). Digital solutions also determine the improvement of infrastructure flexibility, which should be able to cope with sudden and significant changes in demand, both predictable and unexpected.

The growing interest in sustainability and its implications for the development of logistics infrastructure confirms the perception of this process from an organizational and systemic perspective. Contemporary infrastructure development strategies and related economic models should take into account not only the expectations of individual stakeholders, but also of various participants providing this type of service. Taking into account the systemic approach to transport, sustainable development applies to linear, point and information infrastructure (Lipińska-Słota, Mutwil, 2019). On the other hand, in organizational terms, progress in development is determined by: leadership, organizational culture, human and social capital, and the organization of workstations. Enterprises are considered to be the main addressees of the principles of the new development paradigm, as they are the ones who benefit most from the following capitals: natural, economic, human, social and capital-integrating (institutional order) (Adamczyk, 2001). It can therefore be concluded that all forms of business activities related to the development and use of infrastructure, in accordance with the criteria of sustainable development, are conducive to the formation of a sustainable logistics infrastructure on a macroeconomic scale.

#### **4.2. Directions of investments in the development of sustainable transport infrastructure**

In the EU, in the context of recovering from the COVID-19 crisis and responding to a number of other threats, both environmental and geopolitical, it is necessary to implement decisive actions to increase the use of sustainable modes of transport and to develop alternative fuels. The modal shift has been recognized for years as the most effective means to decarbonize transport and achieve life-friendly "green" cities. Between 1990 and 2020, CO<sub>2</sub> emissions from transport increased by more than 33%, including international air transport, due to the increasing demand for passenger and freight transport. In 2020, transport accounted for 27% of total CO<sub>2</sub> emissions in the EU, of which 72% came from road transport (Greenhouse..., 9.09.2022). The decrease in emissions recorded in the first half of 2020 due to the COVID-19 pandemic was only temporary. Projections indicate that without the implementation of additional measures to decarbonize mobility, emissions from transport in 2030 could increase

by around 10% above 1990 levels. At the same time, according to data from the European Environment Agency (EEA), energy consumption in transport in 2020 was over 30% higher than in 1990. Oil-derived raw materials satisfied approx. 93% of transport energy needs. The greatest demand for oil derivatives was reported by road transport. In 2020, it was responsible for 71% of the total fuel needs of transport.

Sustainable logistics infrastructure, coordinating environmental, social and economic development, found support among participants of the World Economic Forum in 2021, in the context of a sustainable and resilient economic recovery after COVID-19 (OECD, 2020). Investing in innovative and resilient infrastructure, i.e. Infrastructure 4.0, and introducing improvements in the social and environmental dimensions was considered a priority. Estimates show that about 70% of the future increase in CO<sub>2</sub> emissions will come from infrastructure that has not yet been built (PwC, 2022). According to the concept and the formulated 13 recommendations, Infrastructure 4.0 is a future-proof infrastructure that uses technologies and information to ensure high-quality environmental, economic and social effects and functions as a technical system within wider human and natural systems (World Economic Forum, 2021). Future infrastructure investments should therefore focus on measures to reduce carbon consumption, shift from fossil fuels to renewable energy sources (RES), encourage cleaner and greener construction methods, and promote environmentally friendly means of transport. In other words, recovery efforts are designed to create the conditions to accelerate the transition to a climate-neutral, innovative and resilient economy. For the transport system this means:

- adaptation of infrastructure to new mobility patterns (i.e. modernization and construction of new elements),
- making new investments in infrastructure development for emission-free alternative fuels,
- adopting a new approach to network design and business model development.

The directions of development of sustainable and innovative transport are in line with the goals of the currently applicable strategic documents, which are the United Nations 2030 Agenda (UN, 2015) and the Paris Agreement on Climate Change (EU and the Paris Climate..., 2018). Intensifying climate and environmental changes have prompted the EU to take urgent and ambitious action under the European Green Deal. In the communication adopted in December 2019, a commitment was made to achieve climate neutrality by 2050, including the "green transition" in key cross-cutting programs and sectoral policies (European Green Deal, 2019). However, a net-zero society and economy will not be possible without a more sustainable, innovative and resilient transport system. It is estimated that achieving climate neutrality will require a 90% reduction in transport emissions by 2050. Sustainable transport investments have been identified as one of the strategic elements of the transition to a zero-emission, safe and smart mobility network. The importance of a holistic approach to investment planning was emphasized in the context of the development of a coherent multimodal system,

taking into account the local dimension and the need for the appropriate development of alternative fuels infrastructure.

The Strategy for Sustainable and Smart Mobility (EUSSSM) of 9 December 2020 contains specific milestones in the pursuit of a smart and sustainable future for the transport sector. They concern three main areas of activity, within which the development of a coherent multimodal system is treated as a priority. In order to achieve a systemic change in the scope of zero CO<sub>2</sub> emissions from transport, it is necessary to:

- make all modes of transport more sustainable,
- ensure the wide availability of sustainable alternatives in the multimodal transport system,
- implement the right incentives to support the transition.

In total, the strategy sets out 82 initiatives in 10 key areas and concrete actions to significantly reduce the current dependence on fossil fuels, increase the use of sustainable transport modes and internalize external costs, in particular for access to infrastructure and through CO<sub>2</sub> charging mechanisms. The overview of the initiatives and the specific tasks accompanying them show that all modes of transport need to become more sustainable, with green alternatives widely available and appropriate instruments to support the acceleration of the decarbonization of the mobility system. With regard to transport infrastructure, the development of affordable alternatives to increase the demand for zero-emission vehicles, the use of digital technologies to support the functioning of an integrated, multimodal transport network enabling the transport of people and cargo, and "green" financing to increase the resilience of transport infrastructure have been identified as priorities.

A greener, fairer, digital and resilient Europe is one of the EU's key priorities setting strategic directions for investment in the context of socio-economic development after the COVID-19 pandemic (Commission Work, 2021). In July 2021, the European Commission presented a package of proposals for the EU "Fit for 55", aimed at reducing GHG emissions by at least 55% by 2030 compared to 1990 levels and achieving climate neutrality by 2050. One of the important directions of action planned under the "Fit for 55" package are investments for the development of an innovative, sustainable and resilient multimodal mobility system in a way that saves resources and energy.

#### **4.3. Financing investments in the development of sustainable transport infrastructure in the European Union**

The EU mobility funding structure for 2021-2027 has two main pillars. The first is the 2021-2027 Multiannual Financial Framework with a budget of EUR 1.2 trillion, which is funded by the EU's own resources. The second pillar is Next Generation EU, a EUR 806.9 billion short-term recovery facility, funded by periodic capital markets borrowing. The greatest investment needs, apart from energy and buildings, are identified in the transport sector.

In the current decade, private and public investment needs for sustainable mobility are estimated at almost EUR 230 billion per year. According to the estimates of the European Commission, the total value of investments necessary for the development of TEN-T infrastructure and urban infrastructure is around EUR 130 billion per year. The needs for funds for investments in the development of the core network are estimated at around EUR 500 billion in 2021-2030. Taking into account the financial needs of the comprehensive network and other investments in transport infrastructure in the calculations, this amount increases to approx. EUR 1.5 trillion (Delivering TEN-T..., 2017).

In the 2021-2027 programming period, support to entities involved in the development of sustainable, innovative and resilient transport infrastructure mainly under the Recovery and Resilience Facility (RRF), the Connecting Europe Facility (CEF), the InvestEU programme, the European Structural and Investment Funds (ESIF), including in particular the Cohesion Fund (CF) and the European Regional Development Fund (ERDF), as well as Horizon Europe and LIFE (Table 1).

The Investment Plan for a Sustainable and Climate-Neutral Europe aims to mobilize sustainable public and private investment over the coming decade. Mobilizing at least EUR 1 trillion requires a combination of funds made available under the EU budget, as well as further public and private investment mobilized by these funds. An important role in attracting private and public investments for the "green" transformation of mobility is planned for the InvestEU Fund, the Innovation Fund and the European Investment Bank (EIB).

Some of the investments needed to make the green transition involve greater risks that the private sector cannot bear alone. In such cases, public funding under the InvestEU Fund can be used to reduce project risks and create a leverage effect to attract private finance. By providing guarantees from the EU budget to partially cover the risks of financial and investment operations, InvestEU is expected to mobilize around EUR 279 billion in private and public climate and environmental investments between 2021 and 2030. The Fund can provide support through loans, guarantees, capital market instruments, credit enhancement instruments, direct and indirect equity and quasi-equity (EU funds and financing..., 2022). Investments in sustainable, safer and smart mobility projects are eligible under the Sustainable Infrastructure Policy Window. EUR 9.9 billion, i.e. 38% of the Fund's total guarantee, was allocated for their implementation. At least 30% of the InvestEU guarantee is dedicated to climate-related objectives, with a figure of 60% in the policy window on sustainable infrastructure. The InvestEU Fund includes the possibility to combine its support with EU grants and financial instruments from sectoral programs and is correlated with the RRF.

Highly technologically innovative infrastructure projects with European added value that can contribute to significant reductions in CO<sub>2</sub> emissions may apply for financial support from the Innovation Fund budget. Support is available for projects located in all EU Member States, Norway and Iceland. The Fund streamlines the sharing of project risks by granting more funding more flexibly through a simpler selection process. It's about sharing risks with project

promoters to help showcase highly innovative pioneering projects. This may concern innovative, high-risk projects in the development of zero-emission vehicles and transport networks, together with innovative infrastructure for alternative means of transport. The Innovation Fund will support up to 60% of the additional capital and operating costs of large-scale projects and up to 60% of the capital costs of small-scale projects. The fund, operating outside the long-term EU budget, co-finances projects through part of the proceeds from the auctioning of CO<sub>2</sub> emission allowances under the emissions trading system (Sustainable Europe Investment..., 2020).

**Table 1.**

*Programs for financing European Union investments in the development of sustainable transport infrastructure in 2021-2027*

<b>Programs/Instruments</b>	<b>Financial assistance</b>	<b>Scope of support</b>
Recovery and Resilience Facility (2021-2023)	EUR 723.8 billion - total EUR 72.2 billion – investments in sustainable and green mobility	Green and digital transformation of transport Territorial cohesion The use of low-emission and zero-emission technologies in transport Railway infrastructure and urban transport
"Connecting Europe"	EUR 42.30 billion - total EUR 25.81 billion CEF Transport including: EUR 242.2 million - research on sustainable transport infrastructure	European TEN-T transport network European alternative fuel charging infrastructure network Ecological means of transport, Transport infrastructure for civil and military needs
Cohesion Fund and the European Regional Development Fund	EUR 11.29 billion - total EUR 1.69 billion – civil and military infrastructural investments	Financing trans-European networks in the area of TEN-T transport infrastructure Support for cross-border, regional, local and urban mobility Ecologically "clean" vehicles Improving the safety of bridges and tunnels Vehicles, aircraft and vessels designed and built or adapted for use by civil protection and fire services
Horizon Europe	EUR 95.5 billion – total, including EUR 5.4 billion from the European Recovery Instrument EUR 15.3 billion - Cluster 5: Climate, Energy and Mobility	Clean Hydrogen Partnership Green Aviation Partnership Partnership for European Railway Connected and automated mobility Batteries Emission-free road transport Emission-free water transport Built4People partnership Transformation towards clean energy Partnership for the transformation of urban areas
LIFE Programme	EUR 5.5 billion - total	Projects targeting sustainable mobility, including measures for local public transport Sustainable mobility in road transport Actions supporting the transition to zero-emission mobility
Digital Europe Program	EUR 9.2 billion - total	Digitization of mobility and the use of artificial intelligence

Source: own study based on Regulation (EU) 2021/1058 of the European Parliament and of the Council of 24 June, 2021; Horizon Europe (2021).

The EIB is also playing a key role in financing the transition to sustainable, CO<sub>2</sub>-neutral mobility. This bank's role in financing the sustainable transition will increase as it becomes the EU's climate bank. Its aim is to accelerate the implementation of sustainable transport solutions by mobilizing private investment while ensuring sustainable regional development. As part of its lending policy in the field of transport, the EIB provides long-term financing, mainly in the form of loans and guarantees, as well as financial and technical advice. The transport sector accounts for more than 25% of the total EIB portfolio and more than EUR 10 billion of new investments annually. EIB loans can cover up to 50% (75% for TEN-T projects) of the total investment costs. In addition, intermediary loans, innovative financial instruments and private equity funds are used to stimulate and catalyze private capital by investing in equity funds dedicated to transport infrastructure. The EIB can also support priority projects (up to EUR 300 million) with a high risk profile under the structured finance facility.

The EIB supports transport projects through many instruments and initiatives. The Cleaner Transport Facility (CTF) is an initiative of the EIB and the European Commission, launched in December 2016, to support investment by both public and private entities in low- and zero-emission transport projects. The aim of the CTF is to use the EIB's technical and financial capabilities to support the accelerated deployment of alternative fuels and infrastructure needs. Eligible projects can receive credits covering up to 50% of project costs. For some innovative projects, loans amount to EUR 7.5 million, but direct loans are usually above EUR 25 million. The CTF funding instruments are (Kwasniok, 2022):

- loans, capitals and guarantees as well as new financial instruments directed to the InnovFIN programme,
- life cycle costing models including risk-sharing financial instruments that mobilize private sector funds.

An EIB loan of EUR 50 million has, for example, enabled the financing of a new bus rapid transit system (known locally as MetroGuagua) in Las Palmas de Gran Canaria, Spain. In addition to the construction of new bus lanes, the project includes the purchase of 17 new electric or hybrid buses and the construction of three new charging stations, 17 bus stops and a traffic control center. The project also includes the creation of a new bicycle lane and the improvement and widening of sidewalks next to the new bus lanes. Pursuant to the contract, works under the project were carried out in the period 2017-2021 (Las Palmas saves..., 2022).

Together with the European Commission, the EIB is also responsible for implementing the ELENA (European Local Energy Assistance) instrument. ELENA provides subsidies up to 90% of eligible costs and technical assistance for investments in energy efficiency and renewable energy, including innovative urban and regional transport. Typically, ELENA supports mobility investment programs above EUR 30 million. In addition, the EIB offers support opportunities under the thematic Future Mobility Facility, which provides investments in high-risk projects in the transport sector. To date, contracts have been signed to finance projects in the field of mobility of the "future" amounting to approximately EUR 141 million.

The Gap Fund, launched by the World Bank and the EIB in September 2020, is a new partnership supporting the development of innovative and sustainable cities in developing and emerging economies, including transport projects. The fund provides grants and free technical assistance to cities in the early stages of project planning and preparation to facilitate investment preparation and improve the quality of projects.

#### **4.4. Selected financial market instruments for projects supporting the sustainable development of mobility**

The new EU Sustainable Finance Strategy sets out several initiatives to address environmental challenges in the financial market (Strategy for Financing ..., 2021). The Fit for 55 package and the Smart and Sustainable Mobility Strategy have identified it as a key means of leveraging private investment for the EU's financial transformation towards a multimodal sustainable mobility model. In the Action Plan on Financing Sustainable Growth, the EU introduced three core elements of a Sustainable Finance Framework (Action Plan, 2018):

- a classification system or "taxonomy" of sustainable activities,
- a disclosure framework for non-financial and financial companies,
- investment tools, including benchmarks, standards and labels.

The new strategy aims to stimulate sustainable finance and green investments, including transport investments, by better aligning with the EU taxonomy regulation and implementing a common reporting standard (Regulation EU 2020/852..., 2020). In addition, the strategy proposes a European standard for green bonds.

The technical classification criteria in the Taxonomy Regulation define the conditions for transport under which an investment qualifies as making a significant contribution to climate change mitigation or adaptation, and whether this type of transport activity causes significant harm to any from other environmental objectives (Commission Delegated Regulation..., 2021). For example, for urban and suburban passenger transport, they state that an activity is compliant if direct CO<sub>2</sub> emissions from vehicles or infrastructure are zero. It could be argued that since public transport is essentially a low-carbon and sustainable mode of transport, all types of projects should be eligible for consideration. Encouraging private sector investment in urban and suburban passenger transport will ensure a faster modal shift in EU cities. It will also facilitate public-private investment in complex and innovative projects, which often have relatively higher economic risks.

On July 6, 2021, the European Commission presented a proposal for a Regulation on European Green Bonds, the so-called European standard for green bonds (Proposal for a Regulation ... 2021). It aims to set a "gold standard" on how companies and public authorities, including the public transport sector, can use green bonds to raise funds in capital markets to finance ambitious large-scale investments, while meeting sustainability requirements and investor protection. The standard will use the detailed criteria of "green" economic activity contained in the EU taxonomy to define green investment.

Green bonds are the most popular form of debt financing for sustainable development projects. A wide catalog of project categories that can be financed with funds from the issue includes, among others: emission-free transport. The country that leads European countries in terms of the volume of green bond issues in the EU is France. In 2021, an issue of green bonds was carried out by the city of Łódź, co-organized by Bank Pekao S.A. It was the first issue of green bonds by the local government in Poland. PLN 50 million obtained from the issue of green bonds was used to finance two investments, i.e. low-emission transport and water and sewage management. The reconstruction of one of the main streets in the south of Łódź - Przybyszewskiego Street, related to the implementation of the low-emission transport network project, estimated at PLN 34.5 million, is to be completed in 2023. The next issue of green bonds is planned for 2023. (*Zielone obligacje...*, 25.10.2022).

With access to sustainable finance, individuals, households and small and medium-sized enterprises can play an important role in the transformation of mobility towards a sustainable model. Opportunities for green retail loans and green mortgages offer an opportunity to accelerate green transport investments (e.g. purchase of zero-emission vehicles) among retail investors and small businesses.

## 5. Discussion

Taking into account the adopted main goal and research questions, the results of the analyzes carried out indicate several important findings that confirm the thesis contained in the article.

Sustainable development of transport infrastructure is an evolving concept that differs from the idea of a conventional approach to infrastructure development and management. The concepts of traditional infrastructure investment management focused on identifying and quantifying their value to the economy. The importance of infrastructure as a factor determining economic growth and development, or a factor increasing the efficiency of management, was confirmed, among others, by exogenous growth concepts, the most famous of which is the Solow and endogenous growth models by Barro, Shioji, as well as Ott and Turnovsky, or Duggal et al. (Zaremba, 2014).

The driving force behind the evolution of the essence of infrastructure in the economy was and still is the increasing range of issues related to the ongoing process of networking infrastructural investments. Since the concept of sustainable development was developed at the UN Forum in 1997 and given the official status of a global development strategy, infrastructure has ceased to be directly related to economic growth. In scientific research, there has been a systematic increase in interest in the issue of measuring the size of transport infrastructure in the context of its value for the economy, society and the environment. In the last 25 years,



researchers have increasingly agreed on the need to value the goods resulting from the use of this infrastructure (Eadie et al., 2013; Munyasya, Chileshe, 2018). The measurement of transport and telecommunications infrastructure should reflect such results as, for example, increased innovation, time savings or increased security (information, road traffic). At the same time, it was emphasized that the real reflection of the impact of infrastructure investments on development generates many problems. Hence, the analyzes carried out for the purposes of investments are a big challenge for investors in relation to the goals of the new development paradigm.

Currently, discussions of representatives of science and supranational organizations on the issue of sustainable infrastructure have highlighted the need to adopt an integrated approach to infrastructure investments and to take into account long-term aspects, including external effects in the project life cycle. A common feature of all dimensions of this approach is the consideration of the long-term benefits of infrastructure investments. Taking into account the growing spatial sensitivity and the already visible effects of climate change, as well as the need to preserve and restore natural capital, a number of innovative solutions have been proposed as part of the existing strategic documents, programs and sectoral policies.

Actions aimed at accelerating the development of sustainable and resilient transport infrastructure require regulatory, economic and institutional changes. The scale and complexity of challenges in terms of investment and advisory needs in relation to the development of sustainable transport infrastructure exceeds the financial and organizational capabilities of EU countries. It is necessary to raise private capital and appropriate changes in the financial sector that will support sustainable financing of transport investments. Although financial support for the development of sustainable infrastructure is increasing, current progress is unsatisfactory (Crossing the Bridge..., 2017). Among the key barriers that reduce the likelihood of private investment, they indicate, among others: lack of a coherent, universally applicable definition of sustainable logistics infrastructure. This state can be associated with multidimensionality in relation to the nature of infrastructure and connotations with sustainability. At the same time, it should be emphasized that the development of sustainable logistics infrastructure requires the conscious participation of all stakeholders, including social acceptance, in order to ensure their broad participation in socio-economic development. In this context, logistics infrastructure is of particular importance due to the contribution it can make to sustainable development. This is due to both the dynamics of its growth and the role it plays in the economies of individual countries.

## 6. Conclusion

A key challenge facing the transport sector is to significantly reduce CO<sub>2</sub> emissions and make the sector more sustainable. At the same time, these challenges represent an opportunity to improve the quality of life and modernize European industry in all value chains, to develop innovative products and services and to strengthen the resilience of the mobility system to disruptions. Due to the complexity of the concept of sustainable transport infrastructure development in the EU, it can be concluded that its implementation will be a gradual and long-term process, requiring an integrated approach. The measurable nature of the decisions made can be obtained by implementing the assumptions of the qualitative model presented in the article. At the same time, it should be taken into account that the effectiveness of the implemented activities and their significant effects may appear in the longer term. At the same time, obtaining them will require the implementation of specific actions under national and local policies, aimed not only at the development of sustainable transport infrastructure, but also at increasing social awareness for new solutions. The development and modernization of transport infrastructure is an important element in shaping a zero-emission, innovative and resilient EU economy.

The transformation towards a sustainable and climate-neutral mobility system, in line with the assumptions of the Paris Agreement, the UN 2030 Agenda and the European Green Deal strategy, will require the full commitment and support of all actors operating in the transport sector, as well as a significant increase in green investments from the public sector and private. The way to ensure sustainable infrastructure development remains a priority is a combination of grants, green bonds, financial guarantees, state aid, equity and private funds. Sustainable infrastructure investments therefore require a more substantial and stable funding framework as well as better targeting of funds to ensure their overall effectiveness.

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