CONCEPTUAL ASPECTS OF SUSTAINABLE ROAD INFRASTRUCTURE MANAGEMENT

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Abstract. The road infrastructure is closely correlated with the economic development of a country. Critical factors such as transportation facilitation, cost reduction, regional development stimulation, investment attraction, tourism promotion, increased economic productivity through reduced travel time, and improved logistics depend on the quality of road infrastructure management. In this study, the author theoretically grounded the concept of road infrastructure management from the perspective of sustainability and outlined a vision of road infrastructure management as an integrated system. The methods employed included monographic analysis, synthesis, deduction, comparative analysis, and other qualitative methods.
The relevance of this study lies in the synthesis of the theoretical conceptual model of sustainable road infrastructure management. The author reviewed the main characteristics of sustainable road infrastructure management, highlighted the key criteria evaluating the quality of sustainable infrastructure, and provided a comprehensive overview of the subject.
Keywords: management, infrastructure, sustainable roads, sustainability
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Introduction

The road infrastructure plays a crucial role in the development of a society and in facilitating various aspects of daily life. Firstly, road infrastructure is essential for the connectivity and accessibility of communities. A well-developed network of roads ensures the efficient mobility of people and goods, facilitating transportation from one place to another. This contributes to the economic development of countries and promotes increased trade between different areas, regions, and states. Additionally, developed infrastructure provides opportunities for the growth of tourism and other related economic sectors.
Secondly, road infrastructure has a significant impact on improving the quality of life. Well-maintained and safe roads reduce travel time, providing people with the opportunity to move quickly and efficiently. This contributes to the reduction of congestion, pollution, and traffic-related stress. Additionally, modern and safe roads are essential for preventing road accidents and ensuring the safety of traffic participants.
Currently, it is demonstrated that road infrastructure is an essential pillar of social and economic development, and the management of road infrastructure is a crucial component in ensuring the efficient and sustainable operation of the road network. Only through proper management, involving elements such as strategic planning, adequate maintenance, the adoption of modern technologies, and collaboration between entities, can an efficient, safe, and society-adapted road network be ensured.
In this study, we will focus on modern theoretical concepts and models applicable to sustainable road infrastructure management.

Research Methodology

The research was conducted considering the existing theoretical literature, exploring their context to meet the research objective. The study is primarily a literature review and aims to develop a conceptual framework for establishing a national model of sustainable road infrastructure management. This is elucidated through an in-depth discussion of the sustainable road infrastructure development concept.

The characteristics of the conceptual framework for sustainable road infrastructure

The characteristics of the conceptual framework for sustainable road infrastructure are crucial in the context of the Sustainable Development Goals (SDGs), and recent literature increasingly addresses the notion of roads through the lens of resilience and sustainability. Establishing resilience is closely tied to a precise assessment of the current state of the road network, and the accurate identification of vulnerable elements is highly important. Vulnerability analysis is conducted to pinpoint weaknesses in the network and assess the impact of its operational failures.

A conceptual framework for sustainable road infrastructure includes the following characteristics:

1. Robustness and Resilience: Road infrastructure must be robust and exhibit resilience to various shocks and disruptions, such as extreme weather events or natural disasters.
2. Energy Efficiency: Road transport systems should adopt technologies and practices that reduce energy consumption and minimize environmental impact during construction, maintenance, and usage.
3. Material Durability:The use of durable materials and innovative technologies in road construction and maintenance contributes to extending their lifespan and reducing the impact on natural resources.
4. Social Inclusion: The development of road infrastructure should consider the needs and accessibility for all social groups, ensuring connectivity and inclusive mobility for marginalized communities.
5. Smart Traffic Management: The use of modern technologies, such as traffic management systems and real-time information, contributes to optimizing traffic flows and reducing congestion.
6. Strategic Planning: An essential aspect of sustainable road infrastructure is strategic planning, involving anticipating future needs, identifying and correcting existing deficiencies, and ensuring the network's efficiency in response to socio-economic and environmental changes.

By integrating these characteristics into the conceptual framework of sustainable road infrastructure, the aim is to achieve sustainable development goals, contributing to economic prosperity, environmental protection, and the improvement of community life quality.

In the vision of Cozar A., robustness is the property that allows a road structure to withstand traffic surges resulting from unforeseen actions to maintain the functionalities and continuity of the road network, making it robust in terms of road structures. In the same vision, robustness addresses the issue from the perspective of the network's ability to function at its normal capacity, while road reliability represents the ability of roads to operate under the conditions for which a particular road was designed. Thus, road networks may face two categories of events that can jeopardize the smooth flow of traffic, namely: (i) irregular and exceptional events – natural disasters (earthquakes, hurricanes, floods, landslides, etc.); and artificial events – serious road accidents, major roadworks, social events (football matches, large fairs, etc.); (ii) regular and expected events – traffic fluctuations during a day, week, or season, as well as regular road maintenance works. (Andrei et, 2014)

The concept of Sustainable Road Infrastructure Development (SRID) covers a broader scope, increasingly involving more companies in voluntary commitments for ecological transition in transport infrastructures. This concept takes into account various dimensions and can be defined by the design, construction, operation, maintenance, and deconstruction of road infrastructure elements in a manner that balances societal, economic, and environmental concerns necessary to support human justice, diversity, and the functionality of the natural environment, representing a multidimensional framework.

Characteristics of the conceptual framework for sustainable road infrastructure include:

1. Environmental Considerations: Integration of eco-friendly practices in the planning, construction, and maintenance of road infrastructure to minimize environmental impact, promote biodiversity, and reduce carbon footprint.
2. Social Equity: Ensuring that road development projects consider the needs of all societal groups, provide inclusive accessibility, and minimize negative social impacts.
3. Economic Viability: Balancing economic feasibility with long-term sustainability, considering cost-effective construction methods, and assessing the economic benefits over the infrastructure's lifecycle.
4. Safety and Resilience: Prioritizing road safety measures and designing infrastructure to withstand and recover from various disruptions, including natural disasters and accidents.
5. Innovation and Technology: Utilizing modern technologies and innovative solutions for construction, traffic management, and maintenance to enhance efficiency and minimize resource use.
6. Multi-Modal Connectivity: Designing road networks that integrate seamlessly with other modes of transportation, promoting a well-connected and efficient overall transportation system.
7. Lifecycle Approach: Considering the entire lifecycle of road infrastructure, from planning and construction to maintenance and eventual deconstruction, to optimize resource use and minimize environmental impact.
8. Community Engagement: Involving local communities in the decision-making process, addressing their concerns, and ensuring that road projects contribute positively to the overall well-being of the community.
9. Climate Resilience: Designing road infrastructure to be resilient to the impacts of climate change, considering factors such as extreme weather events, rising sea levels, and changing precipitation patterns.
10. Adaptability: Creating flexible road designs that can adapt to evolving transportation needs, technological advancements, and changes in socio-economic and environmental conditions over time.

These characteristics collectively form a comprehensive framework for sustainable road infrastructure, addressing the complex interplay between environmental, social, and economic factors to ensure long-term viability and positive societal impact.

These criteria represent essential aspects in the evaluation and development of sustainable road infrastructure:

1. Socio-cultural Sustainability: Ensuring that road infrastructure respects and supports cultural diversity, the local community, and promotes social inclusion.
2. Economic Sustainability: Evaluating the long-term economic impact of road infrastructure, ensuring cost efficiency, and contributing to sustainable economic development.
3. Environmental Sustainability: Integrating ecological practices to minimize environmental impact, conserve natural resources, and reduce carbon emissions.
4. Institutional Sustainability: Ensuring the existence of adequate institutional structures and processes for the long-term planning, construction, and management of road infrastructure.
5. Health and Safety: Prioritizing road safety measures and ensuring a road environment that minimizes risks to public health.
6. Project Management: Implementing an efficient project management process, ensuring adherence to timelines, proper resource allocation, and achieving established objectives.
7. Resource Use and Management: Optimizing resource use, including materials, energy, and land, to minimize environmental impact and maximize efficiency.
8. Engineering Performance: Ensuring the quality and durability of construction, implementing high engineering standards for road infrastructure.
9. Climate Change Response: Adapting road infrastructure to climate change, including managing risks associated with extreme weather events.
10. Public Participation: Involving the community and citizens in the decision-making process regarding road infrastructure to ensure an inclusive and transparent approach.
11. Stakeholder Management: Efficiently managing relationships with all stakeholders involved in road infrastructure projects, ensuring open communication and effective collaboration.

Therefore, it is observed that stemming from the necessity of infrastructure development, infrastructure management emerges, involving planning, designing, developing, producing, modifying, or maintaining the built infrastructure. It encompasses entities such as producers, contractors, and end-users of the final product. It is worth mentioning that sustainable development, as one of the Sustainable Development Goals (SDGs), applied to the concept of infrastructure, can be defined as a subsection of sustainable development that includes aspects related to procurement, planning, and organization of road infrastructure projects, material selection, waste reuse, and reduction.

In multiple sources, we identify a common description that defines sustainable infrastructure development as "the responsible construction and management of a built environment based on the judicious use of resources and environmental values" (Kibert, 1994). There are numerous additional descriptions, for example, from the American Society of Civil Engineers (ASCE) and the United States Environmental Protection Agency (USEPA), which focus on the ecological aspect of sustainability (Ametepey et, 2019).

Regarding the concept of sustainable road infrastructure development and its fundamental elements or variables, it is noteworthy that researchers hold diverse opinions, leading to a lack of consensus on the implementation process and an insufficient understanding of criteria and indicators (Lim, 2009, Oltean-Dumbrava, 2014, Ugwu et., 2007). While extensive research (CEEQUAL, 2007) on sustainability characteristics used to measure the implementation of sustainable road infrastructure, there is continued disagreement in the

scientific literature regarding different features and indicator systems of road infrastructure management, such as FIDIC's Project Sustainability Management (PSM) Guidelines (FIDIC, 2004), BE ST-In-Highways (Tinjum, 2013), CEEQUAL (2007), Envision, Green Guide for Roads, GreenLITES, GreenPave, Green Roads (Ametepey et, 2019).
After analyzing these frameworks, it is important to highlight that the CEEQUAL scheme (The Civil Engineering Environmental Quality Assessment and Awards Scheme), which translates to the Environmental Quality Assessment and Awards Scheme in Civil Engineering, is the most comprehensive framework. It considers the following 11 criteria: 1. Project Management, 2. Land Use, 3. Landscape, 4. Ecology & Biodiversity, 5. Historic Environment, 6. Energy & Carbon, 7. Material Use, 8. Waste Management, 9. Transport, 10. Effects on Neighbors, 11. Relations with the Local Community and Other Stakeholders.
Expert Lim S.K. (Lim, 2009) identified 23 critical sustainability factors specific to road infrastructure projects. These factors are grouped into 10 categories: environmental, economic, social, engineering, community involvement, relationship management, project management, institutional sustainability, health and safety, and resource use and management.
In this context, in the French perspective (CEREMA), sustainability of road infrastructure is highlighted as heritage, with the best economic and environmental cost, as well as adaptation to climate change and activities representing the core managerial function. This can be grouped according to the following axes: (a) infrastructure asset management and (b) techniques, methods, and infrastructure monitoring. To date, there have been varied insights into sustainability regarding management due to the involvement of multiple stakeholders with their own concerns, main priorities, and interests, leading to different objectives. The same diversity exists in the development of road infrastructure due to the multidimensional perspectives of sustainability.
Although there are tools for assessing sustainable roads, such as those developed by VicRoads, GREENROADS, and Envision, the adoption of these tools is quite limited and unclear. This is because they do not address the identification and resolution of issues that impact the gap between sustainability efforts and actual outcomes (Table 2). Additionally, the literature indicates the existence of initiatives attempting to develop indicators and assessment tools for infrastructure sustainability (Ugwu et., 2007), (Mârza, 2006), (FIDIC, 2004), (Brent et., 2004). However, these initiatives do not specifically focus on a certain type of infrastructure, such as roads.
The framework for sustainable road infrastructure development involves the integration of a set of principles and practices to ensure a balance between economic, social, and environmental aspects for long-term benefits. An effective framework for sustainable road infrastructure development may include the following elements (Table 1.).

Table 1. The framework for sustainable road infrastructure development

The indicator system of road infrastructure management proposed by:	Characteristics
CEEQUAL	Project management, land use, ecology and biodiversity; environment, energy, resource use, waste management, etc.

Sustainable project management" FIDIC	Equity, health, human rights, education, security, population, culture, integrity, atmosphere, oceans/seas, water, biodiversity, economic structure, consumption, and product characteristics, etc.
BE2-ST-In-Highways	Hazardous waste, carbon savings, traffic noise, waste reduction, etc.
Envision	Climate, natural environment, resource allocation, energy and atmosphere, innovation, and design.
Montgomery, Schirmer, Hirsch (2014)	Quality of life, project leadership, natural environment, natural resource management, resource use, etc.
Lim (2009)	Environment, economy, social, engineering; resource use, management.

Source: developed based on Ametepey et, 2019, Ugwu et., 2007, Mârza, 2006, FIDIC, 2004, Brent et., 2004

Another empirical study on risk assessment for public road infrastructure construction projects, conducted by P.Z. Razi, M.I. Ali, N.I. Ramli (Razi, 2020) indicated the existence of 13 sub-factors and 4 delay factors, evaluated quantitatively. Using the Analytic Hierarchy Process (AHP) technique to prioritize delay factors, the authors identified the following hierarchized risks: project risk (0.348), land acquisition issues (0.555), followed by environmental issues (0.233), which, in turn, is caused by weather uncertainty (0.733), operational risk (0.309) caused by delayed submission of the approved construction drawing, leading to project submission delays (0.396), and technical risk (0.110).

Road infrastructure management as a system

Road infrastructure management, analyzed as a system, aims primarily at the efficient utilization of roads by the community. The concept of management (Road Management Systems, 2022) involves handling in the most rational way to minimize any negative impact on the primary purpose. In this context, the objectives of road infrastructure management include:

1. Minimizing damage to roads and their infrastructure.
2. Ensuring the prompt completion of any necessary works for the provision of non-road infrastructure.
3. Minimizing disruptions for road users.
4. Minimizing risks to the safety and property of road users and the general public.
5. Facilitating the design and installation of infrastructure that minimizes risks to road user safety.
6. Restoring the road and any other infrastructure as close as possible to the existing state before the execution of works.
7. Protecting and conserving significant vegetation along the road and biological sites within the road reserve.

These objectives reflect an integrated and responsible approach to road infrastructure management to ensure sustainable benefits for the community and the surrounding environment.

According to the analysis of specialized literature, we identify that the concept of a system represents a scientific determinant used over time. The DEX (Dictionary of the Romanian Language) defines a system as "a set of elements (principles, rules, forces, etc.) dependent on each other and forming an organized whole, which brings order to a theoretical field of thinking, regulates the classification of material in a domain of natural sciences, or makes a practical activity function according to its intended purpose". The concept of a "system" has emerged and developed over the years as a result of highlighting common features and

behaviors for a series of processes and phenomena in different fields. This has allowed for their treatment from a structural-functional perspective in a unified, systemic manner.
The vision of the system appears in an incipient form in ancient Greek philosophy. Aristotle introduces the notion of a system, stating that the whole is more than the sum of its parts. The German biologist Ludwig von Bertalanffy, in the years 1928-1950, reformulated the classical concept of the system, determining it as "a category by which relationships between objects and phenomena are known" (Păun, 2014).
Currently, it is acknowledged that the management system represents a set, a totality of interconnected elements through which the actual management process is executed to achieve defined goals. Therefore, to define a system in any field, we must identify the elements that are a component of the type of activity, and at the same time, we need to determine the connections or, more precisely, the existing links between the elements of the process. Simultaneously, we should not forget to determine its objectives.
Surdu A (2011) in the work "General Systems Theory", provides a detailed analysis of the evolution of the notion of a system, stating that, "although it seems challenging to argue that there are historically significant elements in a general theory of systems, there are, nonetheless, interesting issues that have been debated since antiquity and are directly related to the topic at hand. Starting with this theory, the concept of a system began to be used in management. Thus, with the development of the management concept, the system is initially treated as a working method, a way of organizing a process, an operation."
In this context, Professor Păun M (2007)., in the work "Foundations of Systems Analysis," mentions: "In the general theory of systems, there is a law, formulated by Churchman, according to which any system can be considered under different conditions as a subsystem, highlighting the relative nature of these two basic concepts in systems analysis".
Furthermore, it should be noted that for a complete definition of the concept of a system, it is necessary to elucidate the fact that a system can be structured in various ways. Thus, Nicolescu O. and Verboncu I., as early as 1997, analyzed and defined management systems. In their view, a management system represents the totality of elements with organizational, informational, decisional, and methodological characteristics, interconnected and interdependent, ensuring the functionality of management processes and relationships to achieve objectives.
Also, in this work, the authors mention that the main subsystems in the management system are:
- Organizational subsystem;
- Decisional subsystem;
- Informational subsystem;
- Methodological subsystem (methods and techniques of management);
- Other elements of the management system.

Nicolescu Ov. and Verboncu I (Nicolescu et, 1997) consider that the organizational subsystem represents the most concrete component of the management system and, at the same time, it constitutes the backbone of the organization, influencing significantly the content and effectiveness of the activities carried out within it. The decisional subsystem represents the so-called command system, managing all the involved activities, through which all management functions are executed. The informational subsystem has the role of providing necessary information to all components of the organization. The methodological-managerial subsystem contributes to the exercise of each of the five management functions. It enhances the efficiency of each management process, as it represents a set of techniques, methods, and procedures, "just as knowledge substantially enhances human capacity to decide and act, the methodological-managerial subsystem significantly amplifies the functionality and performance of the organization.".

This description of the management system, developed by Nicolescu and Verboncu, is well-known and studied. Therefore, in our research, we conducted an investigation into a more modern approach to the concept of the management system. Taking into account the statement by Professors Cimpoieș D. and Simciuc E (Cimpoieș et, 2016): "There is no universally accepted theoretical model regarding the criteria/indicators for evaluating organizational performance," we intend to develop our own model that will characterize the management system of road infrastructure. We also considered the ISO Certification Dictionary: "A management system is a network of elements that are related to each other. These elements include responsibilities, authorities, relationships, functions, processes, practices, procedures, and resources. A management system uses these elements to develop policies and objectives and to develop ways to implement these policies and achieve these objectives".

The management of road infrastructure, as a unified process based on systems theory, road engineering, and economic evaluation, emerged after 1960 (Dicu, 2010). Subsequently, the interest of scientists and administrators has grown explosively. In this context, a road infrastructure management system has been integrated into road asset management systems. These are often described by the following elements: (Table 2).

Table 2. Road infrastructure management system elements

Road components	Operational functions	System objectives
1. Road pavement	1. Planning	1. Operation
2. Bridges	2. Design	2. Condition
3. Roadside area	3. Construction	3. Safety
4. Traffic control devices	4. Condition assessment	4. Cost
	5. Maintenance	5. Socio-economic factors
	6. Development	6. Energy
		7. Data management

Sourse: elaborated by author based on the References

The term "asset management system" includes: the procedures, tools, data, and policies necessary for achieving efficient asset management. Each management institution has its own vision of what constitutes assets in the road management field. Typical elements of assets may include: physical infrastructure such as pavements, bridges, etc.; human resources (personnel and knowledge); equipment and materials; other components such as road area, data, information system, methods, technologies, partners, etc. (Dicu, 2010).

Usually, road administrations engage in three generic activities: road asset management, traffic management, and road safety management.

Road asset management

Road asset management includes all activities related to the restoration or maintenance of road infrastructure in the desired condition, providing services to road users through the road infrastructure. The result of this activity is a road network with specific conditions or parameters that provide services to road users (TEM, 2021). At the same time, the concept of integrated road management is introduced in practical terms, often combined with the research cluster concept, for example, in the Korean perspective. This involves developing advanced technological solutions for roads and road infrastructure, aiming to ensure the safety and convenience of road infrastructure through systematic management and improved technology support. It also involves integrating activities in the areas of cooperation and support for road infrastructure at the local governance level. In the author's opinion, the concept of a system underlies the scientific nature of management, serving as a method that highlights the interaction of all factors, establishing a connection between effect and cause. For a system to operate efficiently, it is crucial that roles within it are well-placed and carried out at all levels: from strategic planning and investment coordination (what we do) to financing (with what resources), public procurement (with whom we collaborate), design and execution (how we do it), operation and maintenance (how we utilize and preserve what we have done), and evaluation (why we did it).

In specialized literature, it is mentioned that the road infrastructure management system, as well as transport networks, plays a significant role in the economic and social development of the community, specifically by bridging the gap between production and consumption. In the author's perspective, any road infrastructure management system comprises three main elements, strongly interdependent: asset management, traffic management, and the managerial toolkit used.

The elements of the asset management system should be treated as a set of tools, including policies, plans, processes, procedures, and IT systems (information management system). When an organization establishes its asset management system, it needs to consider both its internal and external contexts. The external context includes social, cultural, economic, and physical environments, as well as regulatory, financial, or other constraints. The internal context encompasses the organization's culture, mission, vision, and values. Inputs and expectations of stakeholders are also part of the organization's context.

Infrastructure operators can adopt 3 parallel implementation strategies:

1. Increasing Infrastructure Utility: This strategy aims to maximize asset utilization and improve the quality for road users.
2. Reducing Total Costs: By lowering operation and maintenance (O&M) costs and mitigating externalizations, the goal is to achieve a more economically efficient infrastructure.
3. Enhancing Long-Term Value: This strategy involves extending the lifespan of assets (roads) and reinvesting throughout the entire lifecycle, considering critical factors outlined in Table 3.

These strategies are designed to ensure sustainable and efficient management of road infrastructure, addressing aspects such as optimal resource utilization, cost reduction, and long-term quality maintenance.

Table 3. Critical success factors for the operation and maintenance of road infrastructure

Increasing utility	Maximizing asset utilization	Improving peak capacity and effective performance	Applying demand management	Optimizing availability/reducing downtime
	Improving quality for users	Adopting a customer-centric operating model	Improving end-to-end user experience	Utilizing smart technology to refine user performance
Reducing total cost	Cost reduction	Implementing simplified and automated processes	Optimizing procurement and outsourcing costs	Right-sizing management and support functions
	Mitigating externalities	Ensuring comprehensive sustainability: health, safety, environment	Integrating sustainability: health, safety, routine environment	Collaborating with relevant stakeholders
Increasing value over the lifespan	Extending asset lifespan	Investing in preventive maintenance	Controlling excessive asset consumption and stress	Strengthening resilience
	Reinvestment with a life cycle-based vision	Prioritizing project options through whole-life cost-benefit analysis	Selecting the contracting mode for the best value	Preparing for efficient project delivery
Enabling best practices in operation and maintenance	Securing funding	Allocating usage fees through maintenance funds	Implementing inclusive usage fees	Capturing ancillary business
	Developing capabilities	Introducing asset management planning	Applying benchmarks and data tools	Conducting training courses and talent development
	Governance reform	Corporatization and professionalization of public agencies	Promoting collaboration between agencies	Considering private sector involvement and competition

Sourse: elaborated by author based on the References

Traffic management

Traffic management is the second main activity of road agencies and encompasses all activities aimed at controlling traffic parameters by actively modifying the use of road infrastructure. Similar to road maintenance, traffic management contributes to creating value for road users by influencing the performance parameters of road infrastructure. However, while road maintenance indirectly provides services through road infrastructure meeting certain parameters, road agencies directly engage in traffic management measures. These measures include providing information about the current traffic situation, suggesting alternative routes in case of traffic jams, lane closures, or advising on appropriate driving behavior.

As road agencies adapt their traffic management measures to current traffic patterns, which are to some extent a response to previous road events, road agencies and road users interact, undertaking similar actions that mutually influence the management process. (Hartman et, 2016).

Road Safety Management

In recent years, road infrastructure design has been carried out in accordance with various concepts. For example, the "access management" concept focuses on ensuring traffic efficiency and safety by managing traffic access, utilizing data on maneuverability capacity and traffic volume. Another concept is the "forgiving road side design," which applies knowledge about human psychophysiological behavior limits to ensure road infrastructure safety. This concept has been complemented by the "positive guidance" approach, involving the systematization and processing of information intended for road users (Konovalova et., 2022).

The concept of "zero mortality" remains the most ethical design and management concept for road infrastructure, considering the overall road transport system with its components: roads, vehicles, and pedestrians, which, in cooperation, guarantee safety. One of the most progressive concepts that dictates the need for adjusting management tools is the concept of digital road infrastructure (Intelligent Traffic Infrastructure, ITI). The methodological assurance of adjusting management tools for the application of these concepts requires defining goals and objectives in the field of traffic safety, a road safety observer - a road safety audit system, a road safety inspection, a road safety assessment system based on the IRAP methodology (International Road Assessment Programme), with the determination of the costs of life and human trauma resulting from road accidents to assess the effectiveness of traffic organization measures and safety improvement. At the same time, the analysis of the most well-known urban management models, where urbanization, in the general scientific sense, means the process of connecting primary elements under the influence of external factors and interactions in a higher-order hierarchical structure, shows that there are still no comprehensive solutions in this field that would take into account both the network and the road infrastructure.

Conclusions

Therefore, a national transport system represents a fundamental component of society through at least two dimensions: economic and social. The development of a transport system that meets the needs of the economy is a strategic priority and must be correlated with the need for regional and national integration of communities. The components of the national transport system must be addressed with an integrated vision that supports the mobility of people and goods and is correlated with the country's development strategy, sectoral strategies, urban development strategies, European strategies, and international actions to mitigate environmental effects.

The road transport mode represents a fundamental component of the national transport system due to the significance of road transportation and the challenges it poses. The two constituent elements of this mode, infrastructure and vehicles, need to be addressed in an integrated manner, and the development of this mode should be achieved through a unified approach to the infrastructure-vehicle system. Road transport is primarily intended for the transportation of semi-finished and finished products, focusing on high-value goods. An advantage of road transport is its availability or accessibility; practically, any point of origin or destination is accessible due to the road network. Transit time is a notable advantage of road transport, as well as the safety of products. The transportation of goods depends on the size of shipments relative to the number of loading or unloading points and the nature of the transported goods. Travelers are transported locally, within urban regions, interurban areas, and suburbs, as well as across national borders, including transportation between neighboring countries or transit transportation. The means of transport used for goods transportation are divided into essential means, used on main routes, and terminal means, used at the initial and final stages, utilizing space and time as coordinates. The performance of road infrastructure is dependent on the institutional capacity to implement efficient actions through appropriate management.

By the nature of the tasks involved in carrying out infrastructure management and their mode of implementation, the functions are characterized by the following:

1. Forecasting: This function integrates three aspects – forecasting, programming, and planning, forming the basis for activities focused on the strengths and weaknesses of transportation network infrastructure. The aim is to understand which external conditions pose a threat or are favorable for the implementation of necessary works in the field.
2. Organization: This function enhances the organizational structure of the infrastructure domain, addressing all incompatibilities that may arise.
3. Coordination: Through this function, decisions and actions in the development of road infrastructure are harmonized. The existence of adequate communication at all levels of the transport network management system is essential for ensuring effective and efficient coordination.
4. Training/motivation: This function involves the gradual motivation for performing activities in the field, establishing a value system oriented towards the modernization of road infrastructure.
5. Evaluation and control: Through the managerial function of evaluation and control, the achievements in meeting the proposed objectives for the economic development of the infrastructure domain are measured.

The formation of the institutional framework regarding the planning, administration, and management of resources for the modernization and maintenance of transportation networks involves multiple actors. These actors represent central public authorities and specialized institutions. The accomplishment of the mentioned functions establishes the objectives and strategies of the transportation network system, integrating the development of all activity components.

From the analysis conducted, we conclude that the management of road infrastructure is constantly evolving. At the same time, there are various approaches and development models for it.

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