CONTRIBUTIONS REGARDING THE UPDATING OF THE TERRESTRIAL TRANSPORTATION SYSTEM DEVELOPMENT STRATEGY IN ROMANIA

Doctoral dissertation – Abstract

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The dissertation is structured in 7 chapters.

In the first chapter, the necessity to study the chosen research theme is presented and the scientific objectives proposed within the respective theme are stipulated.

Transportation systems represent a fundamental element for the economic growth of countries around the world. One of the main inconveniences faced by cities worldwide is the fact that there is an uncontrolled increase in traffic volume, which leads to serious problems in terms of delays, traffic jams, increased carbon dioxide emissions, accidents, as well as higher fuel prices.

The need for mobility in Europe continues to expand and creates serious problems in managing the current situation, as well as in managing potentially dangerous situations that arise on transport routes. In this context, transport safety issues require more attention and innovative solutions, while significantly increasing the efficiency of transport systems.

Urban transport measures can be implemented with funding from the European Union if a quantitative reduction in carbon emissions can be achieved through their adoption. These measures can be financed as part of a comprehensive sustainable urban development strategy that addresses the economic, climate, environmental, social and demographic aspects of urban areas. The European Commission recommends a set of practical measures at different levels to address various relevant aspects such as urban logistics, organizing access to urban areas, implementing technological and innovative solutions in the urban environment and road safety, and will closely monitor further actions.

There are some common trends in urban development worldwide. Technology and artificial intelligence are increasingly used to improve the quality of decision-making process, to connect different municipal services and to facilitate citizens' access to specific data and information about their cities. Citizens and societal actors such as businesses and NGOs, in addition to being consulted by local administrations on urban development projects, actively participate in the creation of information and new services. This is possible through a proactive effort on the part of local authorities. Therefore, urban innovation can be said to mean the active integration of experimental activity into urban public policy and close collaboration with experts and researchers when necessary.

CHAPTER 2: Transport represents a basic branch of the economy of any country and involves the allocation of a considerable part of the material and human resources of society, consisting of: labour, technical means, fuels, energy, materials etc., based on a fair policy and

of a legislation in accordance with the progress of society and with European policies and norms in the field.

In order to fulfil its role, regardless of whether it is carried out in a public or private setting, in the economic-social or personal field, transport must accumulate four essential conditions, fundamental characteristics: to be where, when and how it is needed and to achieve the optimal ratio quality/cost.

Ensuring these conditions requires special attention in each of the sectors involved in carrying out transport: the use of quality materials, the application of the latest manufacturing and exploitation technologies, the optimization of non-performing elements constructively and functionally, the practice of a modern, correct and efficient management.

Improving the quality of transport means more flexible and faster journeys. At the same time, greater flexibility is achieved for the economic environment in the sales-purchase process, respectively in the location of economic units and the selection of human resources.

Transport demand, an existential, economic and social necessity, has always been a priority for economic policies, without taking into account the negative effects on the environment and society.

Evaluating the factors that contribute to substantiating decisions to improve transport systems is essential for the development and efficient management of transport infrastructure. This evaluation involves a comprehensive analysis of several aspects that can influence the adoption of decisions in this field. Below we have summarized some key factors to consider:

- ✓ **Transportation Demand:** It is important to understand the current and future requirements of transportation users. This includes assessing traffic volume, demand growth trends and passenger or carrier preferences.
- ✓ **Efficiency and safety:** Assessing the current system for efficiency and safety is crucial. Studies can be carried out on road accidents, travel times, congestion and energy efficiency.
- ✓ **Environmental impact:** The environmental factor must be taken into account in decisions to improve transport. This includes reducing greenhouse gas emissions, air pollution and impact on local ecosystems.
- ✓ **Costs and financing:** Evaluating the costs of the project, as well as identifying sources of financing, such as European funds, loans or public-private partnerships, are essential to determine the viability of the project.
- ✓ **Technology assessment:** Analysing current and emerging technologies in transportation can influence decisions. The choice of electric vehicles, the development of autonomous vehicles or the introduction of intelligent systems can be important factors.
- ✓ **Social demand and politics:** Local community views and demands, as well as government policies and regulations can influence the direction of transport improvements. Public consultation and stakeholder involvement is crucial.
- ✓ **Urban planning:** Coordination between transport infrastructure development and urban planning is essential. This may include developing residential areas close to transport routes or creating public transport routes.
- ✓ **Innovation and Research:** Assessing research and innovation in transportation can help identify the latest trends and technologies that can be implemented in transportation systems.
- ✓ **Route design:** The selection of routes and types of transport (land, air, rail, sea, etc.) must be well-founded based on the specific requirements and needs of a region or community.
- ✓ **Cost-Benefit Analysis:** A rigorous analysis of project benefits and costs is essential to assess the effectiveness of transportation improvement investments.

The importance of transport in society is highlighted as being extremely vast, with a

significant impact on the economy, social development, the environment and the daily life of citizens.

The factors contributing to the decision to improve the transport systems listed above should be evaluated and weighted according to the specific context and objectives of the transport system in question. It is important to involve experts from various fields and to carry out feasibility studies and in-depth analyses in order to adopt the most informed and effective decisions regarding the improvement of transport systems.

CHAPTER 3: One of the many fields influenced by GIS technology is that of transportation. The transport sector is one of the basic elements of a country's economy. Goods and people carrying out their social and economic activities can move through transport systems. Automation of most tasks has been seen not only in industry but also in transport. Thus, GIS enables the analysis and visualization of spatial data, enabling the integration of geographic elements in transport planning and management. The benefits of using GIS in transportation are numerous, including improved efficiency, safety and sustainability.

GIS is used in a variety of transport applications, the most effective being the analysis and planning of transport data, constituting in an optimal management tool for this sector. It allows a better visualization and understanding of the physical characteristics and relationships that influence certain transport conditions, various factors can be modeled for impact analyses, etc. GIS can also be used for traffic analysis and management, such as analysing traffic patterns and identifying bottlenecks or congestion areas. Public transport planning and scheduling is another domain where GIS can be useful, as it can help optimize routes and timetables based on demand and other factors. Fleet management and logistics is another area where GIS can be applied, enabling the tracking and optimization of vehicle routes and resources.

The evaluation of GIS applications specific to the transportation field is necessary to be able to ensure that, once implemented, they meet the requirements and objectives specific to the transport sector. Below I have summarized some key factors that contribute to this assessment:

- **GIS Functionality:** Assessing the overall functionality of the GIS application is essential. This includes the ability to create, manage, analyse and visualize spatial data relevant to transport.
- **Data integration:** it must be checked if the GIS application can integrate different data sources, such as topographical data, traffic data, demographic data and meteorological data, depending on the specifics of the application to be implemented. The ability to combine and analyse data from multiple sources is crucial to understanding the transportation context.
- **Transport network analysis**: it must be verified that the application allows analysis and modeling of the transport network, including the calculation of travel times, congestion identification and resource allocation.
- **Route planning:** The GIS application should provide tools for planning and optimizing routes including for public transport vehicles and freight transport.
- **Simulation and prediction:** assessment of the application's ability to perform simulations and predictions related to traffic, infrastructure requirements and future trends.
- **The ability to handle spatial information:** it must be ensured that the application can handle complex spatial information, including thematic layers, 3D data and time-referenced data.
- **In-depth data analysis:** It should be checked whether the GIS application allows detailed analysis of the data to identify patterns, trends and anomalies related to transportation.
- **Decision support:** it must be ensured that the application can provide decision support tools, including reports, thematic maps and cost-benefit analyses.

- **Mobility:** it must be checked whether the GIS application supports mobile devices to allow the collection and updating of terrain data in real time.
- **User Interface**: An intuitive and easy-to-use user interface is important for users to work effectively with the GIS application.
- **Security and privacy:** assessment of security and privacy measures to protect sensitive transport-related data.
- **Scalability:** Users must ensure that the application is scalable and can handle an increased volume of data as the transport infrastructure develops.
- **Support and updates:** the availability of technical support service and software updates should be checked so that the GIS application remains relevant and functional over time.

As a computerized tool for mapping and analysing events, GIS technology combines common database operations such as information integration and statistical analysis with the unique visualization and spatial analysis advantages of maps. These properties differentiate GIS from other information systems and make it increasingly widely used, both by individuals and implemented in private companies to explain phenomena, predict impacts and develop strategies.

Thus, it can be said that the evaluation of GIS applications specific to the field of transport must focus on functionality, the ability to analyse and manage spatial data, the user interface and the ability to support the specific objectives of the transport system. Choosing the right GIS application can bring significant benefits to streamlining transportation and making informed decisions.

CHAPTER 4: The use of GIS is relevant to transportation because of the essentially spatially distributed nature of transportation data and the need to perform various types of network-level analysis, statistical analysis, and spatial manipulation. Most transport modeling is spatial in nature. On the GIS platform, the transportation network database is generally extended by integrating multiple spatial datasets and its attributes through its linear reference system. In addition, GIS will facilitate the integration of all other socio-economic data with the transport network database for a wide variety of planning functions.

GIS applications can be successfully integrated for pavement management, traffic engineering, planning and research, bridge maintenance and field office support. Other planning applications include evacuation planning, hazardous material release incident planning, development of new census tract traffic analysis areas, and development of new urban highway networks.

Transportation is inherently geographic, and therefore GIS holds a technology with considerable potential for achieving dramatic gains in efficiency and productivity for a multitude of traditional transportation applications, as well as creating the opportunity to develop new applications. GIS applications in the field of transport can be considered as involving data retrieval, integration or analysis.

GIS technology provides the basic framework for an integrated road information system. The developed database can be further supplemented with new information as it becomes available. Thus, the database continues to evolve, which is otherwise not possible to compile at one time. The topological information available in the GIS database opens up new ways of analysing transportation-related data for various purposes. The various GIS functionalities, especially the spatial analysis functions and the query capability, are very useful tools for the day-to-day management of the road network by the organizations concerned.

As a personal proposal, I believe that, at the current moment, we must take advantage of the spectacular evolution of information technologies, a concrete possibility for the development of GIS in transport being represented by its transformation into WEB GIS.

The user, navigating the Web as an operator client, accesses the system through the web browser capable of handling HTML documents and some standard format images: Tag Image File Format (TIFF), Graphic Interchange Format (GIF), Joint Photographic Experts Group

(JPEG), Portable Network Graphics (PNG). In order to work even with other data formats, (eg vector data, audio or video files), browser functions must be extended according to one of different strategies, such as plug-ins, controls Active-X, Java Applets, CGI program (Common Gateway Interface), Web API server (Application Program Interface), Active Server Pages (ASP), Java Server Pages (JSP).

Regarding the proposal that the GIS in the transportation domain be transformed into a web-GIS system and make it available online, defining a structure is a difficult task because, in the web domain, the interaction between the different components is very high. For example, the connection speed affects the amount of data transferred, the types of data affect the volumes to be transferred, the number of users affects both the connection and the performance of the system, the control of access permissions affects the speed of data transfer.

Another proposal, based on the experience of working in local and central administrations, refers to the adequate professional training of the employed staff, the previously presented specialized GIS programs being subject to constant updates and improvements, thus requiring users who, once implemented, function to their true capacity and value to be able to amortize the high implementation costs.

CHAPTER 5: Trans-European transport networks (TEN-T) are a set of transport infrastructures that connect the various member states of the European Union (EU) and which aim to increase the efficiency, safety and competitiveness of transport in Europe. These consist of transport routes (road, rail, sea and air) as well as related infrastructure such as ports and airports.

The TEN-T networks are developed and managed by the European Commission, in collaboration with EU member states. They are divided into two categories: a main network and a complementary network. The core network consists of transport corridors passing through the main economic and population centres in Europe, while the complementary network connects these corridors with the less populated regions of the EU.

The TEN-T networks aim to improve accessibility and mobility in Europe, as well as to support economic and social development. They also help reduce carbon emissions by promoting sustainable and energy-efficient transport.

The financing of TEN-T projects is ensured through several financial instruments, such as the European Regional Development Fund (ERDF), the European Fund for Strategic Investments (EFSI) and the Instrument for Interregional Cooperation (ICI). EU Member States are also responsible for co-financing TEN-T projects.

TEN-T networks play an important role in facilitating trade and mobility in Europe, as well as promoting economic growth and well-being.

The transport infrastructure in Romania is composed of transport routes (road, rail, sea and air), as well as related infrastructures, such as ports and airports.

The road network in Romania consists of highways, national and county roads, with a total length of approximately 86,000 km. Currently, there are only a few highways in Romania, connecting the main cities of the country, such as Bucharest, Cluj-Napoca, Timișoara and Constanța. The highways in Romania are being developed, but they are still undersized compared to the needs of the country and the connection with those in Europe. National and county roads are mostly in good condition, but road traffic is heavy on some of them, leading to congestion and pollution problems. Despite this, the road network is constantly developing, with plans for the construction of new motorways and national roads, with the aim of improving accessibility and mobility throughout the country.

The railway network in Romania consists of approximately 22,000 km of railway lines, with a number of over 1,000 stations. Rail transport is used for both passenger and freight transport. Currently, there are plans for the modernization and development of the railway infrastructure, including the extension of the high-speed line that will connect the main cities

in Romania.

The maritime network in Romania consists of the seaports of Constanța, Midia and Mangalia, as well as the river ports of Galați and Brăila. Romania's ports play an important role in the country's international trade, with a total volume of over 100 million tons of goods transported annually. Currently, there are plans for the modernization and development of ports, including the construction of a new port in Dobrogea.

The air network in Romania consists of the international airports Henri Coandă in Bucharest, Aurel Vlaicu in Bucharest, Traian Vuia in Timișoara, George Enescu in Iași, as well as other regional and local airports. Air transport is used for both passenger and cargo transport. Currently, there are plans for the modernization and development of the air infrastructure, including the construction of new regional airports.

In general, the transport infrastructure in Romania is constantly developing, with plans to modernize and expand the existing transport networks, with the aim of improving accessibility, mobility and competitiveness throughout the country. The financing of transport infrastructure projects is provided through European funds.

Proper spatial planning implies the availability of powerful tools and services useful for preventing irrational exploitation and protecting existing resources in order to combat or at least mitigate the current problems facing society regarding air, water, soil and subsoil (parts of a single system in the case of where human actions can generate complex situations that require effective management).

According to the specifications of the National Strategy for Sustainable Development of Romania, the Geographical Information Systems (Geographic Information Systems) allow the continued delimitation and determination from coordinates, up to the level of parcels and owner, of all areas with economic destination, as well as their efficient administration through geospatial databases. I believe that development strategies, urban, regional or local planning can benefit from the contribution brought by spatial data management through Geographic Information Systems. Adopting strategies such as creating and ensuring good quality public spaces, modernizing infrastructure networks and increasing energy efficiency, pro-active innovation and educational policies, paying special attention to disadvantaged areas in the context of the city as a whole, strengthening the local economy and of the local policy related to the labour market, the promotion of pro-active education and training policies for children and young people and of an efficient and cheap urban transport is achieved through the spatial analyses carried out in the GIS.

Thus, in order to update the development strategy of the terrestrial transportation system in Romania, it is imperative to maintain or upload spatial information and update it continuously, which makes this system alive and necessary for a modern and efficient public administration. In addition, complex GISs are widely used worldwide to simulate highly complicated real-world situations and events. The thematic maps that can be created in the GIS environment need specialized institutional decision, which is often concentrated in a single person, which can lead to slippages.

Starting from the idea that all the technology in the world is not useful to us if it cannot be used to solve problems and syncope, through my doctoral thesis I proposed to bring my contribution to the establishment of action directions and the implementation of mobility development projects urban areas for the municipality of Reșita.

All these ideas can be extrapolated on a national level for the development of the terrestrial transportation system, also aiming to facilitate, through the involvement of the authorities, the management and decision-making process at the local administrative level. Concretely, the implementation of a solution of the Geographic Information System type within the Reșita municipality, then within the framework of the Caraș-Severin County Council, I consider to be the optimal solution to ensure the management of spatial data characteristic of

the terrestrial transportation system.

A further development could be the development of a GIS, at the level of the entire country, which would include information specific to the terrestrial transportation system in Romania. Approaching the "Contributions regarding the update of the development strategy of the terrestrial transportation system in Romania" theme is of general and future importance, which can influence both from an economic and social point of view. The implementation of such an IT system is the basis of effective territorial development while ensuring sustainable development. The possibility of developing a database, querying, updating, creating dedicated databases will lead to an efficient management that will contribute to the optimization of activities related to this field.

GIS will no longer be a stand-alone product, but a fully integrated component in other information systems that will manage specific data for: smart traffic lights in the city with benefits in determining the shortest route to an incident (traffic accident, fire etc.), surveillance systems, decision-making regarding the development of the transport system in the context of the city's development.

CHAPTER 6: The research includes the realization of a research questionnaire developed on the basis of specialized literature and discussions with experts from the public administration in the Reșita municipality, which was applied, through Google forms platform, to the citizens of the Reșita municipality. The modeling of the market research represents the applicative part of the doctoral dissertation on the terrestrial transport strategy improvement and updating. As a deliverable, I proposed a conceptual model, customized for the Reșita municipality, which represents the basis for defining the solutions for improving and updating the terrestrial transport strategy in the mentioned municipality. Serving as a starting point, it can be extended to the national level, for updating the development strategy of the terrestrial transport system in Romania.

CHAPTER 7 entitled "General conclusions, personal contributions and future research directions" highlights the general conclusions drawn from the specialized literature and the research carried out in this dissertation regarding the improvement and updating of the terrestrial transportation strategy in Romania, specific conclusions regarding the case study - Reșita Municipality, the personal contributions of the author and the appreciation of the results obtained within the doctoral research program, expressed in scientific articles presented at various scientific events in the country and abroad and published in specialized journals with the aim of disseminating the results.

The social, economic and political framework determines the demand for transport but also vice versa, in the sense that this environment is influenced by the transport services offered. Therefore, this category of decisions must be meticulously analysed.

The first stage, of crucial importance, in updating the development strategy of the land transportation system in Romania, is represented by the recognition of existing management problems within the local and central administrations. Thus, one can move towards better organization using a Geographic Information System (GIS), being fully aware of how it has solved the problems identified in other administrations.

The impact of GIS technology in the development of transport information system and road infrastructure management is profound. If GIS technology is fully exploited, it will completely revolutionize the decision-making process in the field of transportation engineering. GIS is recognized worldwide as the most effective tool for integrating all types of data required for the transport sector. The vast amount of information related to the country's transport infrastructure could be brought together to be used most effectively in the planning, design, construction, maintenance and management of the transport system.

The GIS platform that is intended to be implemented within the local administration of the Reșita municipality and the developed application will allow, at the same time, correlation

with other components of the transport system in the city, including stationary transport (parking), so that it functions as an integrated operable system.

The applied research was carried out by applying a questionnaire to the citizens of the Reșita municipality in order to identify their preferences regarding urban mobility. The questionnaire was applied online, using the Google Form platform. The application period was July – August 2023. 390 valid responses were collected. This PhD dissertation highlights the results obtained for each investigated dimension. The data processing was carried out with the SPSS program and 4 hypotheses out of the 5 established were accepted: H1: Mobility management positively influences economic development, H2: Public transport, public lighting and public health positively influence economic development, H3: Safety and security influence positive economic development and H4: Economic development positively influences sustainable development. The rejected hypothesis was H5: Safety and security positively influence sustainable development.

The proposed strategic framework for improving and updating the terrestrial transportation strategy includes four action categories: development directions, strategic factors, resources and infrastructures. Each Category includes 5 subcategories that must be investigated at the municipal level in order to achieve the strategic objectives. This strategic framework can contribute to improving the efficiency of the organization and reducing the impact on the environment. It can be applied to entities of different sizes or with different characteristics.

Bibliografie:

Aldagheiri, M. (2009). The role of the transport road network in the economic development of Saudi Arabia. *WIT Transactions on the Built Environment*, *107*. https://doi.org/10.2495/UT090251

Alionescu, A., Herban, S., Muşat, C., Vîlceanu, B. (2015). Managing Urban Traffic and Road Network using GIS Facilities, *Scientific Bulletin of the Politehnica University of Timisoara, Transaction of Hydrotechnics*, Vol. 60(74), Issue 1, pp. 13-17.

Dungan, L.I., Vilceanu, C.-B. (2020). Infrastructura de transport, Editura Eurobit, Timișoara, ISBN 978-973-132-622-1

Irfan, M., Hassan, M., Hassan, N., Habib, M., Khan, S., & Nasruddin, A. M. (2020). Project Management Maturity and Organizational Reputation: A Case Study of Public Sector Organizations. *IEEE Access*, *8*. https://doi.org/10.1109/ACCESS.2020.2988511

Kadłubek, M., Thalassinos, E., Domagała, J., Grabowska, S., & Saniuk, S. (2022). Intelligent Transportation System Applications and Logistics Resources for Logistics Customer Service in Road Freight Transport Enterprises. *Energies*, *15*(13). https://doi.org/10.3390/en15134668

Kanwal, S., Rasheed, M. I., Pitafi, A. H., Pitafi, A., & Ren, M. (2020). Road and transport infrastructure development and community support for tourism: The role of perceived benefits, and community satisfaction. *Tourism Management*, *77*. https://doi.org/10.1016/j.tourman.2019.104014

Kisielińska, J., Roman, M., Pietrzak, P., Roman, M., Łukasiewicz, K., & Kacperska, E. (2021). Utilization of renewable energy sources in road transport in eu countries—topsis results. *Energies*, *14*(22). https://doi.org/10.3390/en14227457

Mesjasz-Lech, A., & Włodarczyk, A. (2022). The role of logistics infrastructure in development of sustainable road transport in Poland. *Research in Transportation Business and Management*, *44*. https://doi.org/10.1016/j.rtbm.2022.100841

Mo, F., & Wang, D. (2019). Environmental sustainability of road transport in OECD countries. *Energies*, *12*(18). https://doi.org/10.3390/en12183525

Mykytyuk, P., Semenets-Orlova, I., Blishchuk, K., Skoryk, H., Pidlisna, T., & Trebyk, L. (2021). Outsourcing as a Tool of Strategic Planning in Public Administration. *Estudios de Economia Aplicada*, *39*(3). https://doi.org/10.25115/eea.v39i3.4718

Siksnelyte-Butkiene, I., & Streimikiene, D. (2022). Sustainable Development of Road Transport in the EU: Multi-Criteria Analysis of Countries' Achievements. *Energies*, *15*(21). https://doi.org/10.3390/en15218291

Stazyk, E. C., & Davis, R. S. (2022). Introduction to the Research Handbook on Motivation in Public Administration. In *Research Handbook on Motivation in Public Administration*. https://doi.org/10.4337/9781789906806.00005

Vázquez-Noguerol, M. F., González-Boubeta, I., Dominguez-Caamaño, P., & Prado-Prado, J. C. (2018). Best practices in road transport: An exploratory study. *Journal of Industrial Engineering and Management*, *11*(2). https://doi.org/10.3926/jiem.2525

*** Pregătirea Planurilor de Mobilitate Urbană Durabilă. Ghid orientativ pentru autoritățile contractante din România. Disponibil online la https://adrvest.ro/wp-content/uploads/2016/07/Ghidul-PMUD-final-Jasper-RO.pdf

***, Reșița: Profilul strategic.

***, Strategia de dezvoltare locală a municipiului Reșița 2015-2025.

***, Strategia Reșița smart city orizont 2027.