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**IMPROVEMENT OF PUBLIC ROADS INFRASTRUCTURE  
MANAGEMENT IN THE REPUBLIC OF MOLDOVA**

**DOCTORAL PROGRAM**

**521.03 ECONOMY AND MANAGEMENT IN THE FIELD OF ACTIVITY**

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## CONCEPTUAL FOUNDATION OF THE RESEARCH

**Actuality and significance of the researched problem.** In the modern world, regional discrepancies in terms of economic development represent a challenge. Economic growth requires access to resources, services and education. Gavril Hoda, Mihai Iliescu, in their work, state that "an important and indispensable field in the economic-social activity of humanity is that of transports." Through them, the space movement of people and different categories of goods is carried out in order to satisfy the material and spiritual needs of human society. For the economy of a society, communication channels represent the main factor that favors the development of all sectors of activity, thus, mediating the mobility of goods and people throughout the territory" [30].

The existence of transport networks allows the country's riches to be highlighted, from the beauty of the landscapes to the route of goods and passengers. One of the most important means for the Republic of Moldova is the state ownership of public roads through which the development of the national economy can be influenced in accordance with the general interests of the country. However, for the Republic of Moldova, in addition to other major problems, the problem of roads remains a priority, the solution of which has a significant role in the economic development of the country. The problem of transport networks is of major interest and consists in building a network, which corresponds both to the interests of the national economy and to the interests of tourism and national defense.

Undeniably, roads and bridges are not easy to build and maintain. The requirements and demands, annually, are increasing, and their fulfillment involve a joint effort on the part of specialists and the community. In this sense, the financial means, reserved for roads, are extremely valuable, which must be used in an effective and transparent way, i.e., through effective management, appropriate for the rehabilitation of quality public roads.

The importance and actuality of the research theme can also be argued by the fact that roads constitute a component of the national transport system, which, representing land communication routes, must meet the following conditions:

- maximum safety, especially for passenger transport;
- speed, i.e., high traffic speed;
- mobility and access to all interesting places;
- regularity and punctuality, regardless of atmospheric conditions;
- high transport capacity along the entire route;
- cost-effectiveness, both in terms of initial investment and operating expenses, etc.

In this context, the efficient management of the public road administration process represents an important role in obtaining the result indicators aimed at the modernization of the quality transport networks in the Republic of Moldova with the assurance of road traffic safety.

**Degree of study.** In the domestic scientific and specialized literature, only certain aspects related to the subject of the research are developed more in depth, for example, the scientific determinants, such as: infrastructure, roads, the road infrastructure management system, being studied from a scientific point of view, but less economically or managerially. Thus, we can mention that there are sufficient sources covering the technical part of the road infrastructure. In this context, we quote the researchers: Ababii A., Bejan S., Munteanu M., Popescu D., Pogorlețchi Gh., Plămădeala V., Godonoga Iu., Ceban D., Vicoleanu Ș., Ciubuc I., Garștea N, Postolachi C, Plamadeala A. etc.

In the foreign literature, unlike the domestic one, researchers and experts have dedicated multiple works to road infrastructure in accordance with its management. The authors that have dealt with this aspect are: Tripp S., Paraphantakul Ch., Marshall S., Antameng M., Cozar A., Chiricuță I., Iliescu M., Matasaru T. Although in-depth theoretical studies on the main scientific determinants (roads, road infrastructure) are not enough, it is worth mentioning the well-known fundamental works of scholars as Tripp S. „Road traffic and its control” and Marshall S. „A first theoretical approach to classification of arterial streets”.

The science of management is known due to its general principles, which determine the level of its development, and these principles represent a system based on which any management of institutions, organizations, the sector or the country is conceived and modeled. Based on the given context, in this paper the emphasis was placed on the works that have as their subject the management system, written by scholars: Drucker P., Buuveibaatar, M., Kim, M.G., Shin, S.P., Brent, A., Labuschange, Surdu Al., Nicolescu Ov., Verboncu I., Dobre I., Păun M., Mustață-Horpos F., Negrău G., Puiu A., Istocescu A., Mironov S., Florea R., Bratianu C., Ulian G., Mironov S., Bugaian L., Cimpoies D., Prisăcaru V., Stratan A., Perciun R., Oleiniuc M., Mamaliga V., Călugăreanu I., Popa A., Căprărescu Gh. and others.

**The purpose of the research** consists in the analysis of the management system of the public roads infrastructure in the Republic of Moldova through the prism of the main elements in order to develop recommendations that will contribute to the improvement of the investigated management.

**Research objectives:**

1. Foundation of the road infrastructure management concept by defining the main scientific determinants, such as: roads, road infrastructure and management system.
2. Analysis of the international experience regarding the management of road infrastructure in order to adopt good practices.
3. Diagnosis of the road infrastructure management system in the Republic of Moldova through the prism of the main elements identified: subjects, object, current situation, variables, inputs, transformations and outputs.
4. Quantitative input-output analysis in road infrastructure management in order to determine their cause-effect correlation.
5. Identification of the main gaps in the management of road infrastructure in the Republic of Moldova.
6. Elaboration of recommendations regarding the improvement of road infrastructure management in the Republic of Moldova.
7. Identification of special performance indicators of road infrastructure management in the Republic of Moldova.

**Research hypothesis**

The research hypotheses, proposed for testing in this paper, derive from the researched literature and the analysis of international experience. Namely, the cost of transportation on communication routes derives an interdependence with the level of modernization of public roads in terms of quality and accessibility of use. For example, according to a study by the United Nations Road Safety Fund, it was revealed that bad roads cost California drivers 61 billion USD annually. The analysis was conducted for the average vehicle in the largest urban areas of the US, in the form of additional costs generated by driving on damaged roads. Another study, carried out by the World Bank, demonstrates that the losses of the owners of transport units depending on the condition of the roadway are from 9 to 32% [49]. Therefore, in this work, it is proposed to validate 2 research hypotheses:

*Hypothesis 1: One of the derived outputs of road infrastructure management represents the level of development of the national economy, i.e., a developed road infrastructure will lead to an increase in GDP.*

*Hypothesis 2. The outputs of road infrastructure management are largely dependent on the main input – the financial resources allocated for it.*

**The important scientific problem solved** consisted in the development of the logical-descriptive model of the road infrastructure management system in the Republic of Moldova, a fact that contributed to a more in-depth diagnosis of the current situation, to the identification of existing deficiencies and led to the development of recommendations for the improvement of the road infrastructure management.

**Synthesis of the research methodology and argumentation of the chosen research methods**

Applied research methods include qualitative and quantitative scientific methods, diagnostic

and computational techniques, such as: analysis and synthesis, induction and deduction, critical analysis of materials, monographic description and econometric models. Their choice was conditioned by the theme of the research, the object of study and the hypotheses proposed for validation. Thus, the analysis and synthesis allowed the author to systematize the studied information, their grouping according to elements and scientific determinants. Induction and deduction allowed the transfer of knowledge from the general to the particular and vice versa, the transposition of the analysis of the international experience on the reality of the Republic of Moldova, the formulation of certain recommendations for the improvement of the national road infrastructure management system. The dynamic analysis of the relevant indicators and their comparative analysis allowed the identification of the trend, problems, existing gaps in the Republic of Moldova. At the same time, methods were also used in the research process, such as: scientific observation, interviews and the graphic method. To test the research hypotheses, the methodology specific to econometric models was used, which are described in detail in Chapter 3.

**The scientific novelty and originality** emerge from the research carried out on the management of public road infrastructure in the Republic of Moldova and is substantiated by the research hypotheses proposed for testing. Thus, the scientific novelty consists in:

- elaboration of the logical-descriptive model of the road infrastructure management system in the Republic of Moldova;
- carrying out the diagnosis of road infrastructure management in the Republic of Moldova based on the model developed through the prism of the main identified elements, such as: subject, object, current situation, variables, inputs, transformations, outputs;
- carrying out the empirical study regarding the final consumer's perception of the road infrastructure management outputs in the Republic of Moldova;
- the application of the econometric model that determined the correlation between the main input (allocated financial resources) and the quality of the roads (the main researched output);
- the application of the econometric model that determined the correlation between the financial means allocated for roads and the GDP of the Republic of Moldova (the main output derived from the management of road infrastructure);
- adapting a set of road infrastructure management performance indicators and developing recommendations for its improvement.

**The theoretical significance** of the research consists in the modern approach to road infrastructure management through the elements of the management system. According to the analysis carried out, the theoretical-methodological basis for the Republic of Moldova regarding the management of the road infrastructure was developed, for the first time, by creating the logical-descriptive model of the road infrastructure management system; an extensive study was carried out on the economic mechanism and tools used in the management of the national road infrastructure, the performance indicators of the road infrastructure management were developed, the direct correlation between the road infrastructure and the economic development of the country was demonstrated, it was demonstrated that the quality of the roads in the Republic of Moldova depends on the financial resources used for their maintenance and rehabilitation. Also, the diachronic synthesis of road taxes accumulated in the Road Fund was carried out and recommendations were developed regarding the strategic directions for the development of the road infrastructure in the Republic of Moldova, especially through its cohesion in the European TEN-T network.

**The applied value of the research** is determined by the possibility of using the scientific results and recommendations, presented in the thesis, by the competent national authorities that ensure the management of road infrastructure.

**Implementation of scientific results.** The results of the study were applied by the SC State Administration of Roads.

**Approval of research results.** The scientific results of the research were reported at 6 international and national conferences, namely:

1. Management of public roads in the Republic of Moldova. International Symposium Experience. Knowledge. Contemporary Challenges 6th Edition „Humanity at a crossroad. Between

digital Economy and Need for a Paradigm of going back to Nature” May 14th-15th, 2020 Bucharest, Romania.

2. Development of public road networks in the Republic of Moldova. The international conference "Sustainable economic and social development of euroregions and cross-border areas, Iasi, October 29, 2021. Coordinators: Ciprian Ionel Alecu, Dumitru Tudor Jilie, Marilena Doncean.

3. Economic Importance of Road Networks in the Republic of Moldova. Proceedings of XVII. International Balkan and Near Eastern Social Sciences Congress Series on Economics, Business and Management-Plovdiv / Bulgaria, March 12-13, 2022 / Ed. Mariana IVANOVA, Dimitar NIKOLOSKI, Rasim YILMAZ.

4. Analysis of public road infrastructure in the Republic of Moldova. "Contemporary trends in the development of science: views of young researchers". Materials of the scientific conference of doctoral students, 8th edition, Chisinau, June 10, 2019: [in vol.] / comm. Aurelia Hanganu (president) [et. al] – Chisinau: "Dimitrie Cantemir" State University, 2019.

5. Improving the management of public roads in the Republic of Moldova. Contemporary research and evaluation methodologies: The national scientific conference of doctoral students dedicated to the 75th anniversary of SUM, April 22-23, 2021 / organizing committee: Aurelia Hanganu.

6. The perception of the final consumer regarding the management of the road infrastructure in the Republic of Moldova, the international scientific-practical conference "Economic development and research", June 21-23, 2023.

On the topic of research, 10 scientific papers were published, with a total volume of 4.3 a. sh.

**The structure of the paper.** The content of the doctoral thesis includes: annotations in Romanian, English and Russian, introduction, three chapters, general conclusions and recommendations, 194 bibliographic sources 10 Annexes, 12 tables and 71 figures.

**Key words:** management, roads, road infrastructure, performance indicators, road fund, TEN-T network.

## THESIS CONTENT

The first objective of the research described in Chapter I "Conceptualization of public road infrastructure management" resides in the analysis of the concept of road infrastructure management by defining the main scientific determinants: infrastructure, roads, road infrastructure and road infrastructure management. Following the achievement of this objective, we made the following findings:

From the analysis of the international specialized literature (Chutipong Paraphantakul, Tripp S., Marshall S., Ighodaro, C.A.U., Horng C.C., Antameng M., Tung, T.T. and others) we identify that there are different classifications of the "roads" category. However, in most cases, the authors delimit roads into 3 broad categories: *arterial, sub-arterial and local roads*.

Each country can delimit and have its own road classification. But most often, the roads are classified: by the type of property and the subjects that ensure their management; depending on the traffic (volume, composition); by network role (location and connectivity); according to physical form – dimensions, alignment, etc.

China can serve as an example, where the classification of roads is carried out according to the administrative settlement: national, communal, municipal, district, special highways and local roads. In the EU, roads are classified according to three internationally comparable types: a) motorway; b) intra-village road; c) extra-urban road (express roads, 2+1 roads and others). There are also cycle lanes, bus lanes, cycle paths, which represent parts of roadways intended for use by cyclists and are distinguished from the rest of the roadway by longitudinal road markings. Cycle lanes can be mandatory or optional, regardless of whether or not other motor vehicles are allowed to enter the lane. Some bike lanes allow cyclists to ride against the flow. For certain moped types, the use of the bicycle lane may also be permitted. Some lanes may be available for both buses and cyclists.

However, the most common is the classification developed according to the following indicators: traffic speed, road length, destination, strategic role, circulation versus access, administration. These classifications are closely related to the following elements: traffic and related transport criteria, the strategic role of roads (ie the hierarchy related to their position) and the function related to traffic circulation and the degree of access to these roads.

From the research it was deduced that in order to provide a certain classification, the roads must be ranked. This hierarchy can be: *functional, administrative and structural*. Currently, a new dimension is emerging through which roads are analyzed, namely *robustness*, which determines the ability of the road to function at its normal capacity in the context of sustainable development.

Thus, in the context of globalization and the Sustainable Development Goals (SDGs), more literature treats the notion of roads through the prism of the term *robustness*. Establishing robustness is closely related to an accurate assessment of the current state of the road network, and an accurate determination of vulnerable elements is extremely important. "Vulnerability analysis is performed to determine weak points in the network and to assess the effects of network failure" [7]. In A. Cozar's view, robustness is the property that allows a road structure to bear the traffic surplus, occurring with the occurrence of unforeseen actions to keep the functionality and continuity of the road network intact, making that network robust in terms of regarding road structures". Within the same vision, robustness deals with the issue in terms of the ability of the network to operate at its normal capacity, while road reliability is the ability of roads to operate under the conditions for which the road was designed. Thus, road networks can face two categories of events, which can endanger the smooth flow of traffic, namely: (i) irregular and exceptional events: natural - disasters (earthquakes, hurricanes, floods, landslides, etc.); and artificial – serious road accidents, major road works, 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 works, maintenance.

At the same time, we attest that the criterion related to robustness or sustainability is present in few countries, including the Republic of Moldova. The investment study, carried out by Professor Bugaian L. [12], shows that the investment climate of the Republic of Moldova remains quite unattractive, which is evident by the position of the Republic of Moldova in international ratings, but also by the direct comparison of the performances regarding the attraction of foreign direct investments [12].

So, defining the main scientific determinant of the present research - the road - we return to the analysis of road infrastructure directly through the prism of the modern concept of this determinant, i.e. robust or sustainable roads.

Therefore, from the analysis of official documents, it is proven that the concept of sustainable road infrastructure development (Sustainable Road Infrastructure Development, SRID) covers a wider field, involving more and more companies in voluntary commitments for ecological transition in transport infrastructures [31]. This concept takes into account different dimensions and can be defined by: designing, building, operating, maintaining and deconstructing road infrastructure elements in a way that balances societal, economic and environmental concerns, necessary to support human justice, diversity and the functionality of the natural environment, representing a multidimensional structure (Table 1).

In this sense, in the French vision, we highlight the sustainability of road infrastructure as heritage, at the best economic and environmental cost, as well as its adaptation to climate change and applications which represent the basic managerial activity, which can be grouped according to the following axes: ( a) infrastructure asset management and (b) infrastructure techniques, methods and monitoring. Until now there has been varied knowledge about sustainability in terms of management, due to the involvement of multiple stakeholders with their own concerns, main priorities and interests, leading to different goals, as well as in terms of road infrastructure development, from the reason for the existence of multidimensional viewpoints of sustainability.



**Table 1. Characteristics of the conceptual framework of sustainable road infrastructure**

No.	Criteria
1.	Socio-cultural sustainability
2.	Economic sustainability
3.	Environmental sustainability
4.	Institutional sustainability
5.	Health and safety
6.	Project management
7.	Resource utilization and management
8.	Engineering performance
9.	Response to climate change
10.	Public participation
11.	Stakeholder management

*Source: elaborated by the author based on [31].*

Although there do exist sustainable road assessment tools, for example the one developed by VicRoads, GREENROADS, Envision, the adoption of these tools is quite limited and unclear, as they do not look at identifying and addressing issues that influence the gap between sustainability efforts and actual results (Table 2). At the same time, the specialized literature indicates the existence of some initiatives that try to develop indicators and tools to assess infrastructure sustainability, but they do not focus on a specific type of infrastructure, such as roads.

**Table 2. The framework for sustainable development of road infrastructure**

The system of road infrastructure management indicators proposed by:	Characteristics
<b>CEEQUAL</b>	Project management, land use, ecology and biodiversity; environment, energy, resource use, waste management, etc.
<b>FIDIC sustainable project management</b>	Equity, health, human rights, education, security, population, culture, integrity, atmosphere, oceans & seas, water, biodiversity, economic structure, consumption and product characteristics, etc.
<b>BE<sup>2</sup>-ST-In-Highways</b>	Hazardous waste, carbon savings, traffic noise, waste reduction, etc.
<b>Envision</b>	Climate, natural environment, resource allocation, energy and atmosphere, innovation and design
<b>Montgomery, Schirmer, Hirsch (2014)</b>	Quality of life, project leadership, natural environment, management of natural resources, use of resources, etc.
<b>Lim (2009)</b>	Environment, economy, social, engineering; resource use, management.

*Source: elaborated based on [48], [37], [24], [11], [5]*

Another empirical risk assessment study for public road infrastructure construction projects, conducted by P.Z. Razi, M.I. Ali, N.I. Ramli [45] indicated the existence of 13 subfactors and 4 delay factors, evaluated quantitatively. The authors, using the Analytical Hierarchy Process (abbreviated in English - AHP) technique, by prioritizing risk delay factors, identified the following ranked risks: project risk (0.348), land acquisition issues (0.555), followed by the environment (0.233), which in turn is caused by weather uncertainty (0.733), operational risk (0.309), caused by late submission of approved drawing for construction causing delay in project submission (0.396), and technical risk (0.110).

In conclusion, the vast majority of the researched literature has a common point of view related to the road infrastructure as a priority factor and it is related to the condition of the roads, such as the efforts to keep them maintained. According to the dictionary of road terms [21], road maintenance is defined as "all actions taken to maintain and restore the good functioning and level of use of roads" [21], with the following two sub-categories: (1) routine maintenance, which is defined as all operations that can be planned, on a regular basis, with a view to maintaining a satisfactory

level of use, as close as possible to the original condition and in accordance with the classification of the road, and (2) preventive maintenance and rehabilitation is defined as works undertaken for maintaining and restoring to good working order and extending the life of an existing road, where preventive maintenance is typically used for pavements in good condition with significant remaining life, without essential changes in structural capacity, rehabilitation being carried out when the structural performance of the existing road is compromised. According to Schraven, D., Hartmann, A., Dewulf, G. [46], "road reconstruction is defined as "work carried out to modernize the network or replace the entire road sector".

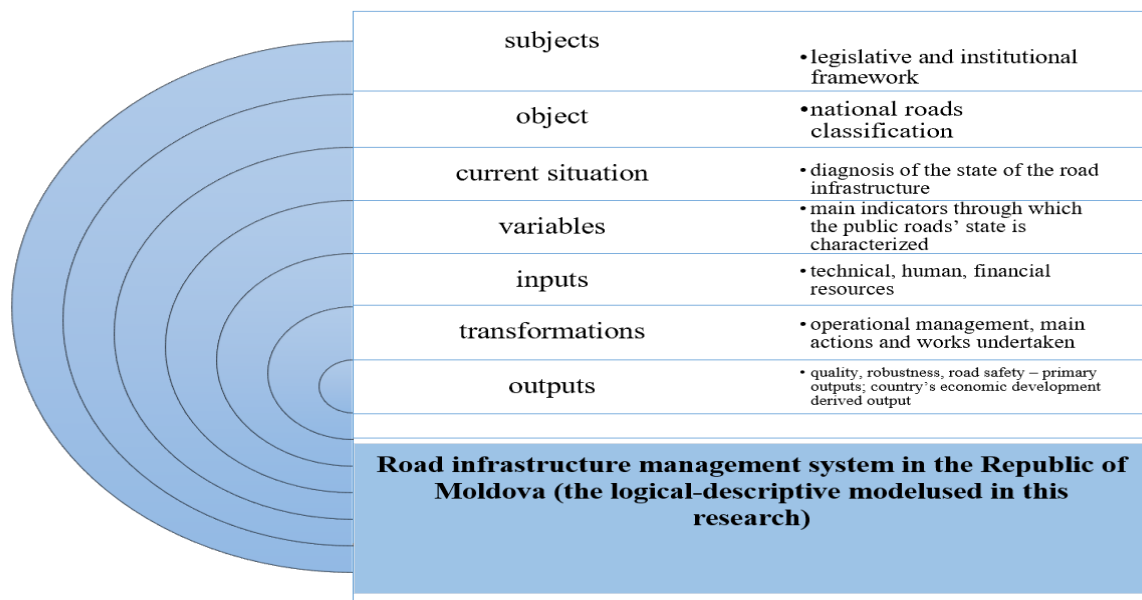
Following the achievement of the objective related to the analysis of the road infrastructure management concept, we found the following:

Road infrastructure management is based on the same principles, techniques, methods and procedures, characteristic of management as a science. Respectively, from the specialized literature, we deduced that any management of the road infrastructure can be divided into multiple subsystems, which are: the management itself, the road infrastructure and the means of transport.

A proper definition for the concept of "road infrastructure management" could be: a systematic process of maintenance, improvement and exploitation of heritage (roads, buildings, other heritage), combining engineering principles with sound business practices and economic thinking, to put tools available to facilitate a more organized and flexible approach to making the necessary decisions in order to meet the public's expectations.

Road infrastructure management, as a unitary process based on systems theory, road engineering and economic evaluation, appeared after 1960 [20], subsequently, the interest of scientists, but also of administrators, grew explosively, respectively, among heritage management systems road, a road infrastructure management system was set up.

Based on the topic of the research, we propose to analyze the management of the road infrastructure based on a logical-descriptive model of the management of the public road infrastructure, presented in Figure 1, and the main object of study in the case of the present study will be only the roads (as the main part of the infrastructure).



**Figure 1. The logical-descriptive model of road infrastructure management viewed as a system**

*Source: elaborated by author*

The next objective, achieved in this chapter, was the analysis of the European road infrastructure management system and the analysis of foreign experience in achieving an effective management of road infrastructure.

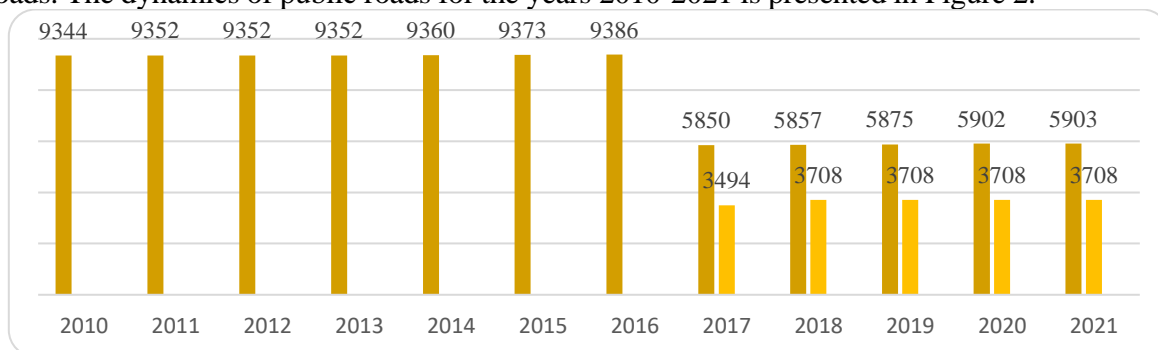
In order to take over good practices, the road infrastructure management system in Romania was analyzed. Thus, emerging from the value of financial support for the development of road networks, as a factor of interdependence of the elements of the management system, we can mention the emancipated role of the assistance offered by the development partners for the Republic of Moldova, or an elucidated example with reference to the Romanian state, with certainty, amplifies external funds/external sources as an important source of financing for the implementation of road infrastructure projects, as well as presents an opportunity for strengthening the institutional capacities of central and local public authorities.

Following the achievement of the objectives, we obtained the following scientific results: the development of the theoretical-methodological basis for the management of road infrastructure, which takes shape in a systematization of the literature on the notion of road (definition, classification, characteristic criteria), the notion of road infrastructure (definition, ranking, classification), the notion of road infrastructure management (definition, elements, subsystems, distinctive characteristics); and the analysis of the international experience regarding the management of road infrastructure both on a European level and in Romania.

Starting from the idea that the performance of a country's public road infrastructure is dependent on its management, in Chapter II "Road Infrastructure Management in the Republic of Moldova", the objective was achieved: Diagnosis of the road infrastructure management system in the Republic of Moldova through the prism of the main elements identified: subjects, object, current situation, variables, inputs, transformations, outputs. Thus, summarizing what was reported in this chapter, we note that the following were found:

The main subjects of the management, which contribute to the development of road infrastructure in the Republic of Moldova, are: The Government and the main relevant ministries, such as: the Ministry of Infrastructure, the Ministry of Finance, as well as donors. The responsibility for managing the construction and reconstruction, repair and maintenance of public roads and road management objects, as a distributor of all the means allocated for these purposes, is granted to the authority of the central public administration in the field of road management SC "ASD", and LPA manages the local roads of regional interest.

The object of road infrastructure management is stipulated and classified in the Road Law no. 509-XIII, where roads are classified according to destination into two categories, namely: public roads and private roads. In the present study, the object of research is public roads, which are qualified as follows: European roads, national roads and local roads. With regard to the current situation of public roads, we found that currently the Republic of Moldova has a public road infrastructure of about 10.6 thousand km, of which 5902 km of national roads are managed by SC "ASD", and 3708 km of local roads of district (municipal) interest are administered by LPA of level II. Thus, SC "ASD" manages 55.1% of all roads. The dynamics of public roads for the years 2010-2021 is presented in Figure 2.

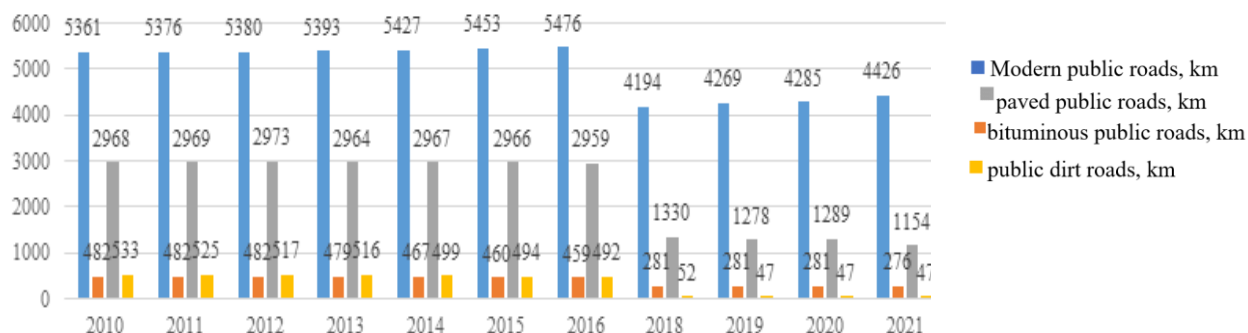


**Figure 2. The length of public roads administered by SC "ASD", from 2017 - by LPA, for the years 2010-2021, km**

*Source: Information synthesized by the author based on the reports on the execution of the activity programs of the SC "ASD" [43]*

The diagnostics carried out allowed us to conclude that the republican roads are modernized at the level of 98.2%, and in the case of the regional ones, access roads with cobbled coverings prevail -

39.5% and without covering (earth) - 1.6%. Out of the total network of national roads, those with modern clothing prevail, the share being 76.5%. However, there is a low degree of accessibility to certain regions of the Republic of Moldova, especially in the North, South-East and South regions. This, in turn, creates difficult development conditions for the respective regions' economies, reducing their competitiveness compared to other regions in the country and leading to social disparities.



**Figure 3. The evolution of public roads according to their road structure for the years 2010-2021**

*Source: Information synthesized by the author based on [43].*

The evaluation of the technical condition of the roads (Table 3) reveals that, if until 2014, the rise of public roads in good and mediocre condition persisted, then from 2015 they were traded in the direction of the decreasing trend, one of the influential derivatives was the decrease the level of financing of road networks. For the years 2019-2020, the "bad and very bad road condition" indicator was increased due to the reform of the public road network, which was mainly influenced by the condition of regional roads, which registered 63%, and for republican roads and express registered the index of 47%.

**Table 3. Dynamics of the international roughness index (IRI) in the Republic of Moldova**

Year		Good condition IRI (2 - 4), %	Mediocre condition IRI (4 - 6), %	Bad condition IRI (6 - 8), %	Very bad condition (IRI > 8), %
	<i>y</i>	<i>x<sub>1</sub></i>	<i>x<sub>2</sub></i>	<i>x<sub>3</sub></i>	<i>x<sub>4</sub></i>
<b>2009</b>	416.4	9.8	29.6	40.7	<b>19.9</b>
<b>2010</b>	421.8	19.7	36.7	27.1	<b>16.5</b>
<b>2012</b>	1137.5	31.8	41.1	19.3	<b>7.8</b>
<b>2013</b>	1162.7	41.26	37.99	14.93	<b>5.82</b>
<b>2014</b>	2044.4	35.87	77.51	17.05	<b>8.32</b>
<b>2015</b>	1153.1	25.19	37.81	16.89	<b>8.54</b>
<b>2016</b>	1120.3	15.8	31.67	24.93	<b>15.2</b>
<b>2017</b>	1104.5	17.65	30.43	23.21	<b>12.39</b>
<b>2018</b>	874.3	16.83	29.3	23.98	<b>14.63</b>
<b>2019</b>	1597.1	14.75	25.7	25.8	<b>21.23</b>
<b>2020</b>	2100.9	17.81	23.09	25.88	<b>20.92</b>
<b>2021</b>	<b>1977.8</b>	<b>42.72</b>	<b>24.59</b>	<b>18.8</b>	<b>13.86</b>

*Source: Information synthesized by the author based on [43].*

The analysis of the variables constituted another objective of chapter 2, respectively from its execution we conclude that the use of the norms of the years 1970-1980, for the public road infrastructure works carried out today, can no longer be effective. Thus, in the Republic of Moldova, the construction and modernization of public roads is carried out according to their categories. The technical condition of modern public roads is to be established using the performance criteria for the characterization of road structures from the point of view of: level of comfort, safety and structural condition.

**Technical resources.** The construction and maintenance of roads is not possible without special machines and equipment. The use of modern technologies for the repair and maintenance of the road infrastructure requires appropriate technical and organizational measures, which must lead to ensuring an irreproachable technical condition of the machines and equipment operated throughout the operative cycle of use, but also to the efficient performance of tasks under favorable conditions structural management in the field. Thus, the sufficient technical equipment of the 12 joint stock companies "Territorial Roads" plays an important role in increasing the degree of interventions for the execution of quality maintenance and current repair works of the road infrastructure in the Republic of Moldova. The possession of a sufficient number of technique, machines and equipment by state-owned companies ensures the execution of maintenance works in summer and winter, as well as repair works of major complexity. Earthworks, compaction, asphaltting, milling of bituminous layers or repair works (filling of cracks, repairs in successive layers) are carried out using trucks, motor graders, tractors with various equipment, excavators, loaders, asphalt cutters, compactors, sealing machines, snow blowers and other specialized machines in the field. [22] At the same time, the private sector companies also participate in the maintenance, rehabilitation and construction of roads, contracted according to the legislation in force, which expressly indicates the availability of economic operators with machinery and machines to ensure the quality performance of these nominated works.

The technical endowment inevitably leads to ensuring the quality of the road infrastructure and, last but not least, to *the quality control of the materials* used in the construction, rehabilitation, and repair of public roads, the samples of which are tested at the authorized and accredited construction testing and analysis laboratories. Among the 20 construction analysis and testing laboratories, authorized and accredited according to SM EN ISO/IEC 17025:2006/ SM EN ISO/IEC 17025:2018, the Testing Laboratory of SC "ASD".

The basic field of the Laboratory is the testing of construction materials for roads at the objects managed by the SC "ASD", as well as the provision of services to certification centers for construction products and to requesting third parties. The laboratory is oriented towards determining the physico-mechanical and physico-chemical indices (organic binders) for the following materials: Organic binders (fluid, viscous bitumen, bituminous emulsion); Aggregates (sand, slag, crushed stone, gravel, filler); Mixture of aggregates, processed soils with organic/inorganic binders; Earth; Asphalt concrete from granular materials; Asphalt concrete (hot, warm, cold); Cement concrete; Anti-slip material (sand with salt, salt). [22]

The laboratory systematically cooperates with the Moldovan National Accreditation Center and provides services to the certification centers for construction products, having collaboration contracts with the CertMatCon certification body, the Technical Center for Industrial Security and Certification, the Applied Metrology and Certification Center and the National Metrology Institute. [22]

According to estimates, to ensure the transition to the EU road standards, about 100 million lei will be needed, which needs to be allocated by the contractors. This change would develop research methods in the field of using modern materials for road construction and maintenance, which would ensure the quality of the road infrastructure. During 2021, the opportunity of using the "Road Recorder" application was examined to digitize the way of checking the quality of construction, repair and periodic maintenance works, executed on the national roads of the Republic of Moldova. This action is to accumulate a wider perspective in helping the technical managers to ensure the quality elements of the verified works and exclude conflicts of interest.

In order to ensure the regularity of the commercialization of construction products, at minimum requirements, during the transition period to these related standards, the Testing Laboratory of the SC "ASD" was equipped with new equipment worth a total of 6.31 million lei. The equipment was purchased from the means of the Road Fund of 2017, in the amount of 2.01 million lei, for the year 2020 - in the amount of 2.6 million lei, and for the year 2021 - the amount of 1.7 million lei follows to allow the execution of tests provided for in the European standards adopted by the Republic of Moldova. [43]

From the analysis carried out, it is found that the Testing Laboratory of the SC "ASD" has possibilities to expertize the samples taken only from the concrete-asphalt surface layers, not having capabilities for the expertise of the foundation layers that are an integral part, directly of the constructed road.

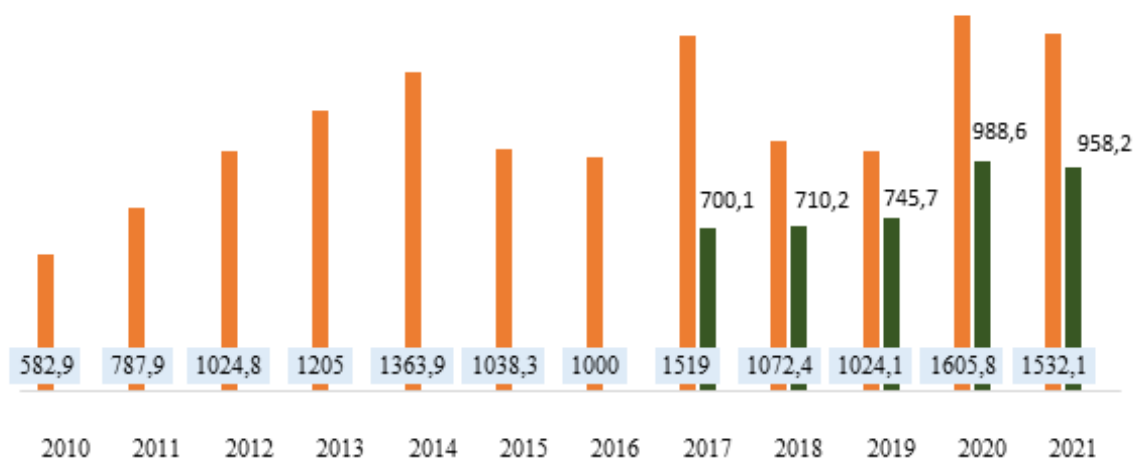
**The human resources** involved in the development of the road infrastructure carry within themselves the achievement of the most important objectives and general principles of development of this field, without which the current competitiveness is inconceivable. A highly skilled workforce with the ability to adapt to new technologies is essential to achieving progress in quality road infrastructure. In order to have human capital with the skills to maintain, repair and rehabilitate roads, an efficient institutional and administrative framework is needed to support development in the recruitment and professional training of human resources in the field.

If until 2016, according to the structure of the central apparatus of the Ministry of Transport and Road Infrastructure, for the development of policies in the field of road infrastructure development, an average of 15 employees were trained, who worked in 2 directions: the Road Development Department and the Maintenance Department roads, then, with the administrative reform in 2017, the merger of the Ministry of Economy and Infrastructure, the activities in this field were carried out by an average of 4 employees, the Road Infrastructure Section within the Transport Infrastructure Directorate. For the development of state policies in the field of road maintenance and development, a sufficient number of personnel with special knowledge is necessary, which would ensure the achievement of progress results aimed at the harmonization of legislation in the field, as well as the creation of favorable conditions for increasing the physical quality of roads and financial capacities in this regard. Thus, from 2021, the staff structure of the Ministry of Infrastructure and Regional Development was also formed by the Transport Infrastructure Directorate, with 6 employees responsible for developing policies in the field of roads, which would not fully amplify the large-scale need for resources human beings involved in the development of this sector, which represents a complex of training and expansion in proportions at an economic and social level.

For the implementation of the state policies of maintenance, repair and reconstruction of the road infrastructure, a potential of human resources is included which expresses one of the basic factors influencing the efficient development of the roads, which, in 2021, constituted a number of 183 employees or with 12 employees more than in 2019. At the same time, road maintenance and repair works are carried out by about 400 employees of the "Territorial Roads" joint-stock companies. Specialists, workers employed by private construction companies are also involved in the rehabilitation and reconstruction of roads, both from the state budget resources and from external resources.

Thus, due to the lack of well-defined policies, for example, strategies, feasibility studies in the field regarding the recruitment, professional training of specialists, as well as the training of workers with reference to the use of modern technologies, machines and equipment used in the maintenance procedure, modernization of quality road infrastructure, the quality and long-term operation of the roads cannot be ensured and achieved. A weak point identified in this chapter is the insufficiency of qualified staff, proven by the small number of employees trained both in the development of domain policies, and the staff trained in the implementation of these sectorial policies, endowed with high-performance development skills.

**Financial resources.** The dynamic analysis carried out allows to state that the inputs in the form of financial resources intended for the Road Fund have an oscillating and unstable trend. Thus, after a moderate rise in the years 2010-2014, they were reduced to 1 billion lei for 2016. Inputs have increased considerably, totaling the value of 2.6 billion lei in 2020, which represents a growth indicator about 3 times higher than in 2010, but in 2021 this indicator decreased again. (Figure 4)



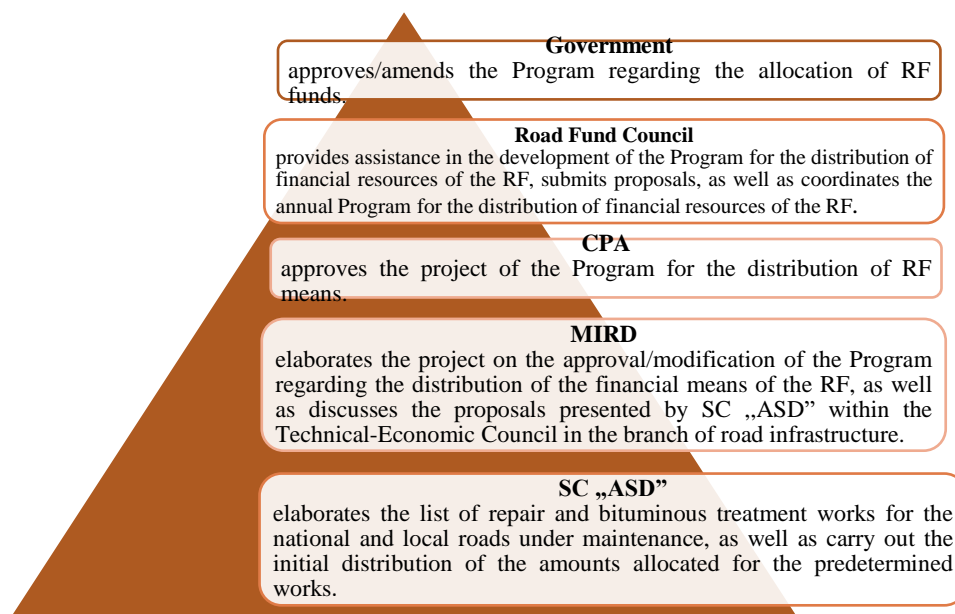
■ Sum of the financial means of the road fund for national public roads, million lei

■ Sum of the financial means of the road fund for local public roads, million lei

**Figure 4. The financial resources for establishing the Road Fund for the years 2010-2021, approved annually by the state budget law**

*Source: Information synthesized by the author based on the Annual Reports [43].*

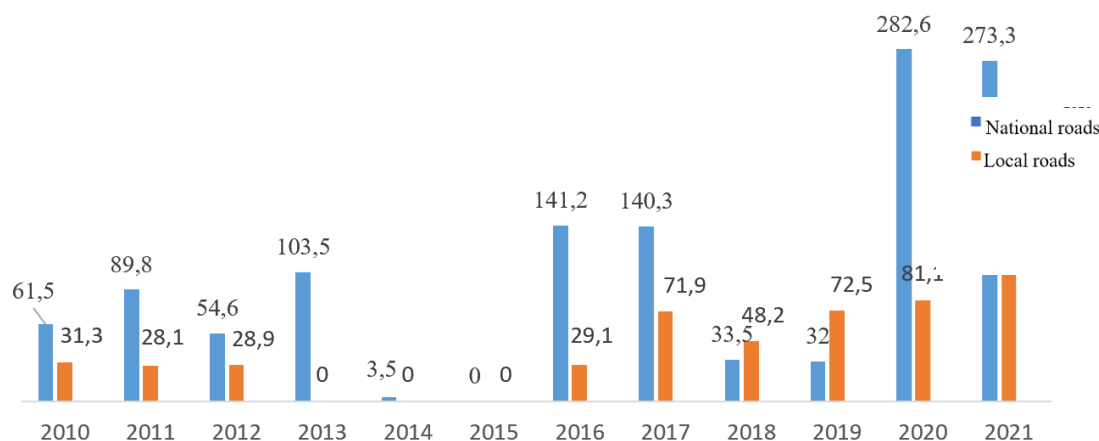
**The procedure for distributing the means of the Road Fund.** The SC "ASD" annually elaborates the "Program regarding the distribution of Road Fund funds" in coordination with the Ministry of Infrastructure and the RFC, later approved by the Government of the Republic of Moldova. The stages of development and approval of the Program regarding the distribution of Road Fund means are presented in Figure 5.



**Figure 5. Competent bodies in carrying out the procedure for developing and approving the program regarding the distribution of the Road Fund means**

*Source: Information presented by the author based on the regulatory framework.*

From the analysis carried out, we concluded that the financial means allocated annually only allow the execution of routine maintenance works (winter maintenance, pit filling, profiling, etc.). Due to the failure to carry out the necessary medium and capital repairs, more than 80% of the length of local roads have exceeded the established service term.



**Figure 6. The financial resources utilized for the repair and rehabilitation of national roads in relation to local roads, million lei, for the years 2010-2021**

*Source: Synthesized analysis based on reports [45].*

Apart from the means obtained from the general revenue account of the state budget, annually, resources are also benefited from the account of projects financed from external sources. In this context, as a result of the negotiations, carried out between the years 2006-2007 between the Government of the Republic of Moldova and the World Bank, progress was achieved within the Project to support the Program of the Government of the Republic of Moldova in the road sector.

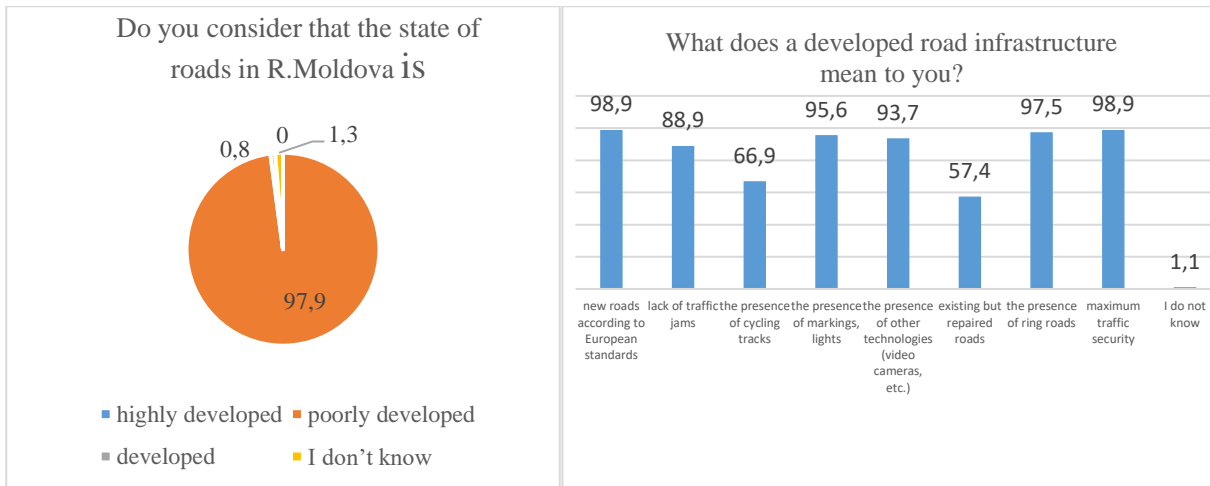
In order to ensure the full implementation of the "Rehabilitation of Roads in Moldova" Project, as well as to facilitate the availability of the necessary financial means to finance the rehabilitation works of the national road network and the construction of roads bypassing the localities, on May 18, 2021, it was signed the Amendment Agreement no. 2 to the Loan Agreement between the Republic of Moldova and the European Bank for Reconstruction and Development regarding the construction and rehabilitation of roads in the Republic of Moldova of June 28, 2013 [39], in the amount of 150 million Euro. At the same time, as a result of the negotiations, the financing contract was signed between the Republic of Moldova and the European Investment Bank for the implementation of the "Moldova roads IV" Project, in the amount of 150 million Euro, which represents a co-financing of the Project in the amount of 50%.

One objective advanced within this research was to conduct an empirical study, based on a questionnaire, which will ascertain the opinion of the final consumer (ie the population of the Republic of Moldova) regarding the perception of the outputs of the road infrastructure. This questionnaire was conducted in a mixed format, by questioning the participants in a direct and online format, based on the digital platform:

<https://docs.google.com/forms/d/e/1FAIpQLSeQ2LV1TgQqzHOcoRmqoPZbadwXL01GUVBiuQdUIhsQowTTMg/viewform?vc=0&c=0&w=1&flr=0>

According to the questionnaire, it was identified that 97.9% of the respondents mentioned that, in the Republic of Moldova, the road infrastructure is poorly developed and only 0.8% consider that the infrastructure is developed. Not a single respondent mentioned that there is a very developed road infrastructure in the Republic of Moldova. More than 94% of respondents believe that a developed road infrastructure must include the main outputs, such as: road quality, traffic safety, etc. (for example, new roads – 98.9%, maximum traffic safety – 98.9%, ring roads – 97.5%). (Figure 7)

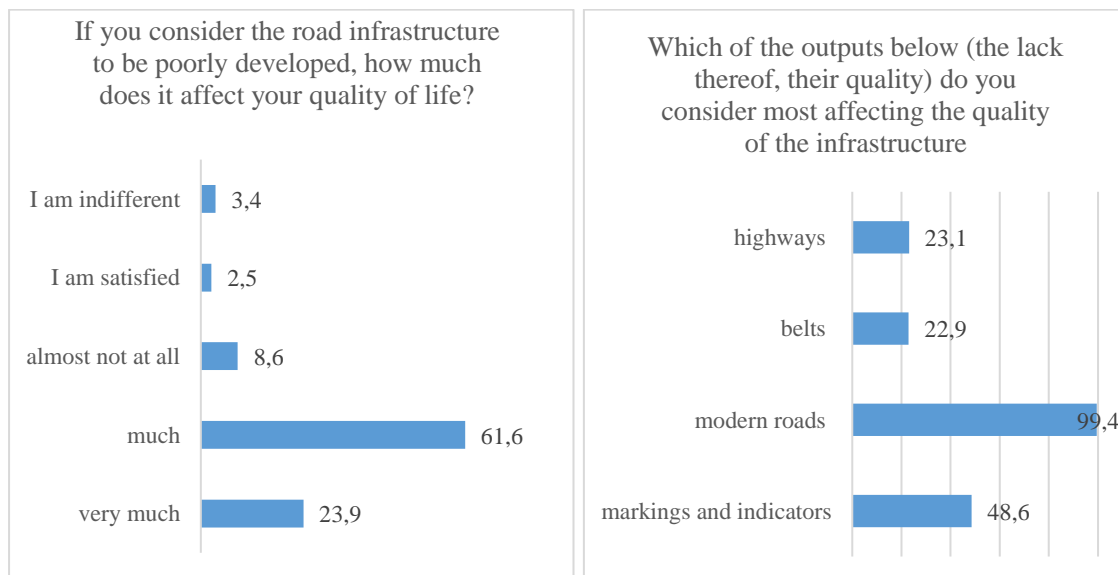




**Figure 7. Distribution of respondents regarding the perception of road infrastructure in the Republic of Moldova, %**

*Source: developed by the author based on the questionnaire*

A road infrastructure inevitably leads to the economic development of a country. However, in a country where a level of economic development is reached, the improvement in the quality of life of the population is also attested. Thus, **the impact of a poor road infrastructure on the quality of life** was determined based on the following question: If you consider that the road infrastructure is poorly developed, how much does it affect your quality of life? It was found that 62% of respondents are affected a lot, 24% - very much, and about 9% are not affected at all. At the same time, approximately 23% of the respondents considered that the lack of highways and belts affects the current infrastructure of roads, and the lack of modern roads was the majority answer - 99%. At the same time, approximately 23% of the respondents considered that the lack of highways and belts affects the current infrastructure of roads, and the lack of modern roads was the majority answer - 99%. (Figure 8)

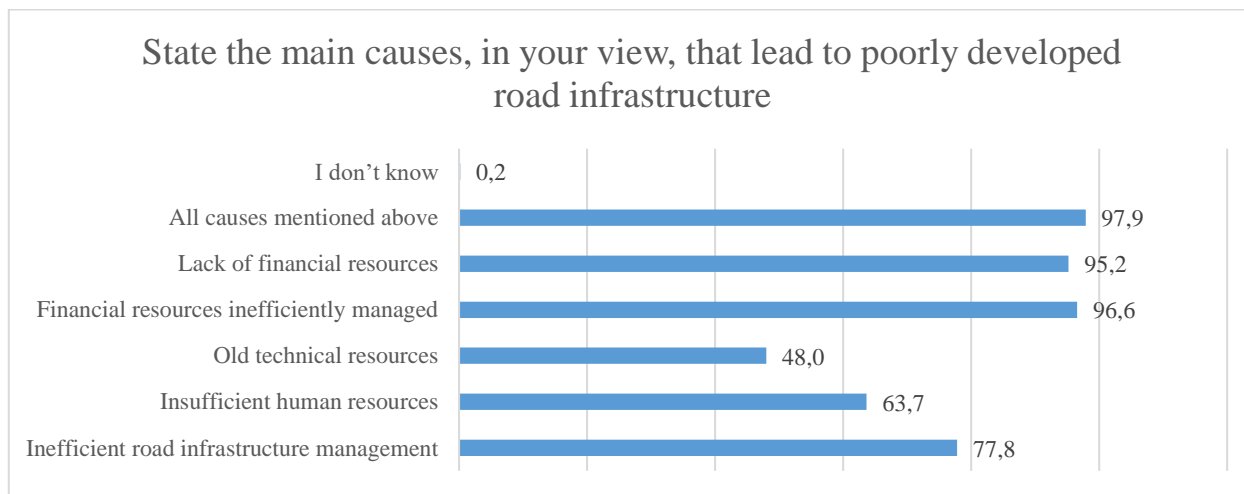


**Figure 8. Respondents' opinion on the impact of poor road infrastructure on the quality of life**

*Source: developed by the author based on the questionnaire*

Following the survey, we identified that: the majority of respondents believe that financial means are managed inefficiently (around 97%), 95% believe that there are not enough financial

sources, 78% point to inefficient infrastructure management, 48% pointed to the fact that there are no modern technical resources and 64% considered that the insufficiency of qualified human resources in the field is the main cause that leads to low-quality outputs, i.e. low-quality roads, the lack of new roads, the lack of belts, the lack of other infrastructure assets. However, about 98% mentioned that all these cumulative causes lead to a poorly developed road infrastructure in the Republic of Moldova. (Figure 9.)



**Figure 9. Respondents' opinion regarding the causes leading to poorly developed road infrastructure in the Republic of Moldova**

*Source: developed by the author based on the questionnaire*

According to specialized literature, the outputs of a developed infrastructure must possess certain characteristics, such as road quality, convenience, comfort, traffic safety, resilience, etc. So, in order to understand the population's perception of the importance of these criteria, I indicated in the created questionnaire a question, in which I asked the respondents to rank, by importance (preference), the main characteristics. Thus, in the first place, traffic safety was positioned, which represents an indicator that characterizes the degree of development of the road infrastructure. On the 2nd place, the final consumers selected the quality of the roads (here both the condition of the existing roads and the construction of new roads are considered), the convenience of the roads and their resilience are placed on the 3rd and 4th place, the comfort of the roads totaled 298 points, placing on the last place.

The set of questions, intended for the identification of **solutions to improve the outputs of road infrastructure management** in the view of the respondents, identified: about 92% of the respondents considered that the construction of new roads is the most effective way to improve the road infrastructure, 80% of the respondents think that the improvement of the existing infrastructure consists in carrying out the maintenance and repair works of the existing roads and 67% advocate for the modernization of the existing infrastructure through various facilities.

Regarding the avoidance of traffic jams, about 81% of the respondents pleaded for the construction of belts or other bypass options, 98% - for the construction of additional lanes, about 31% believe that the excellent condition of the roads will lead to the avoidance of traffic jams, and 23% of the respondents believe that the development of "green" transport routes will inevitably lead to the elimination of traffic jams. About 80% of the respondents consider the appearance of lanes for cyclists as very necessary, 57% – are not interested, and 29% think that lanes for cyclists are not necessary.

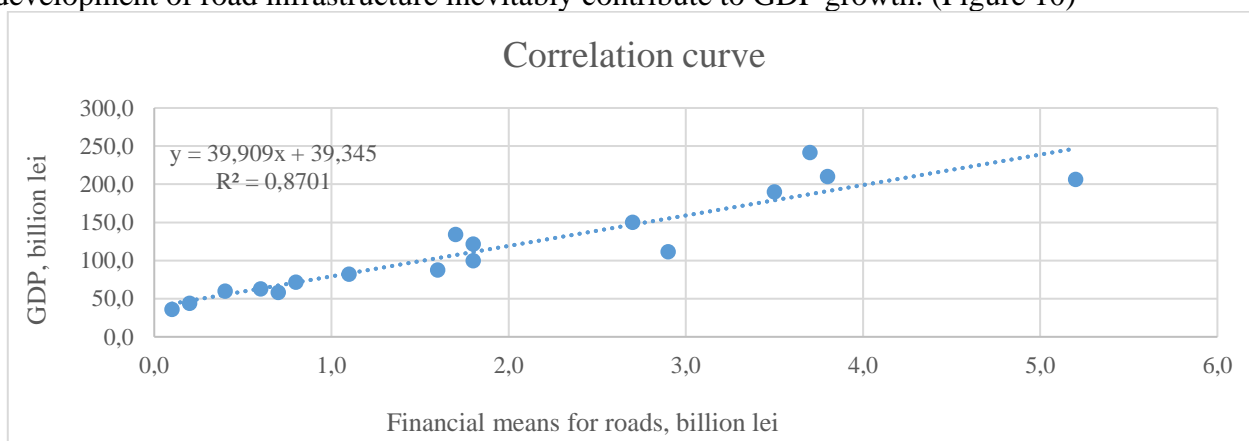
These views were included in the author's recommendations for improving the road infrastructure management.

From the analysis carried out, it was found that the increased number of high-tonnage freight transport units perpetuates the increase in pressure on the pavement beyond the norms for which it was designed. Increasing the level of demand on the car transport infrastructure is a factor in increasing the level of road degradation. As a result, we attest that users are affected by increased vehicle repair costs, reduced travel speed, reduced driving comfort and, last but not least, increased fuel consumption.

One of the research hypotheses proposed for justification is the hypothesis: there is an interdependence between road infrastructure and economic activity, which highlights even more *the role of high-quality, performing roads* in the national economy and international economic relations.

Empirically, these statements can be demonstrated by analyzing the freight transport – *a secondary indicator of outputs*. The transport of goods is, in general, dependent on the development of the economy as a whole, respectively, it is observed at the international level that the transport (measured in ton-kilometers) is directly proportional to the GDP growth.

In this context, in chapter 2 it was tested the research hypothesis no. 1, which assumed that a developed infrastructure of roads will lead to the economic development of the country. Thus, it can be stated that one of the derived outputs of road infrastructure management represents the state economy itself. To obtain this output it is necessary to have the respective inputs, in our study we identified the main input – *the invested financial resources*. Financial resources used for the development of road infrastructure inevitably contribute to GDP growth. (Figure 10)



**Figure 10. The correlation between GDP and financial resources allocated for roads**

*Source: developed by the author*

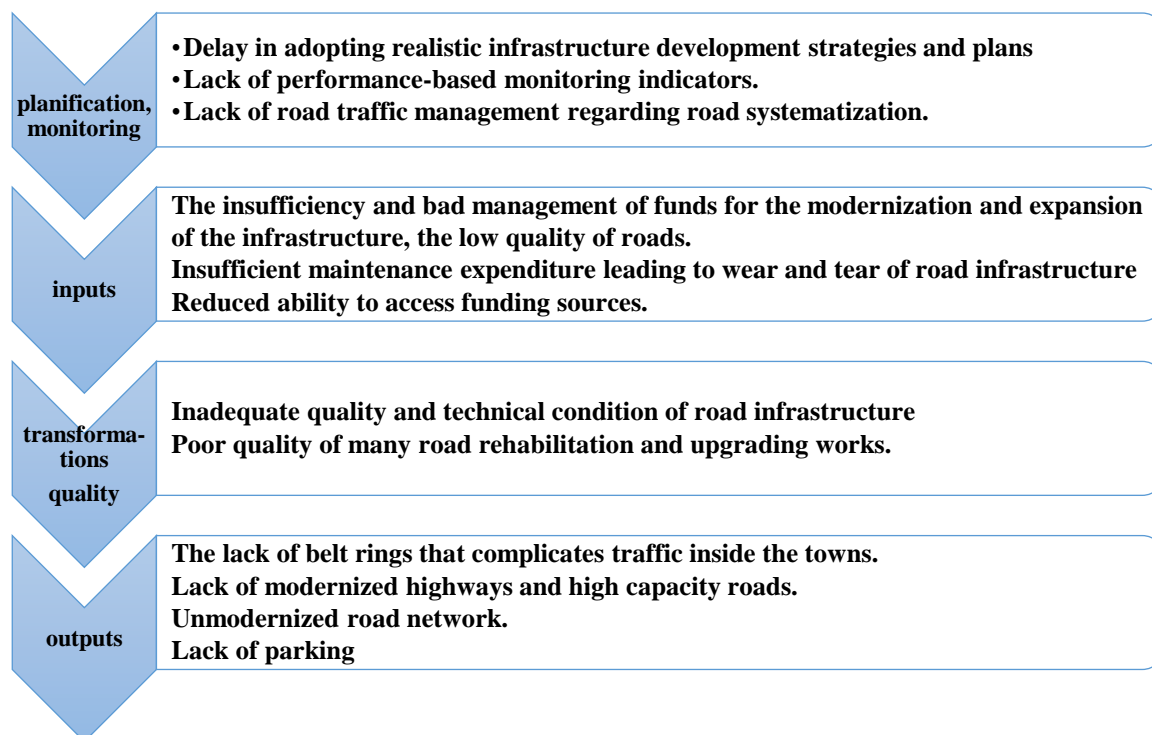
From testing the econometric model, we concluded that all the tests are true, and the correlation between the financial resources allocated for road infrastructure is directly proportional to the GDP, i.e. when the financial means allocated for roads increase by 1 (one) billion lei, the GDP will increase by 39.909 billion lei.

The diagnostics carried out in this chapter allowed us to identify the gaps and deficiencies of road infrastructure management (Figure 11).

Chapter III "Recommendations regarding the improvement of road infrastructure management in the Republic of Moldova" represents the innovative part of the work, where the author argues his own recommendations that are intended to improve the management of road infrastructure, as well as tests the second research hypothesis.

Based on the diagnostics carried out, we found that the major problem of road infrastructure management in the Republic of Moldova consists in outputs (that is, outputs in the form of results, products, etc.), which do not characterize an infrastructure developed according to European standards. From the analysis of the inputs, we identified that although there are weaknesses in technical (outdated technology, low-quality raw material, etc.) and human resources (lack of labor force, low wages, etc.), however, the biggest deficiencies are directly related to the financial resources

(administration method, their purpose, quantity, etc.). Accordingly, we concluded that the outputs of road infrastructure management are largely dependent on the main input – financial resources.



**Figure 11. The main deficiencies of road infrastructure management in the Republic of Moldova**

*Source: elaborated by author*

To test the research hypothesis, we built a multiple regression model, which determined the connection and dependence of the resources used for the maintenance and rehabilitation of roads in the Republic of Moldova on the four states of the roads: good, mediocre, bad and very bad. As a result, we obtained the following correlation:

- with the decrease in the good condition of the roads by 1% of their length, in the condition that other conditions are not taken into account, the resources used for their maintenance and rehabilitation would decrease by 23,908 million lei;

- with the decrease of the mediocre condition of the roads by 1% of their length, provided that other conditions are not taken into account, the resources used for their maintenance and rehabilitation would decrease by 13,873 million lei;

- with the increase in the bad condition of the roads by 1% of their length, provided that other conditions are not taken into account, the resources used for their maintenance and rehabilitation would decrease by 81,581 million lei;

- with the increase of the very bad condition of the roads by 1% of their length, in the condition that other conditions are not taken into account, the resources used for their maintenance and rehabilitation would increase by 135,948 million lei.

The author comes up with a series of recommendations, which would help to solve the applied scientific problem, in particular it is proposed: to increase investments in road infrastructure, inclusively through the creation of public-private partnerships and other alternative ways of innovative financing, as well as attracting accessible external funds; developing the appropriate road traffic management system through digitization and increasing the level of education of the population; creation and development of the effective monitoring and control framework of high-tonnage vehicles through automatic weight measurement facilities; ensuring road safety through the preparation and implementation of the strategic framework on traffic safety; providing continuous walking and cycling routes within road rehabilitation projects where feasible; reorganization of the road maintenance and modernization management system in the Republic of Moldova.

The author gives a particular importance to the recommendations aimed at the implementation of performance-based management. After studying international theory and practice, the author comes to the conclusion that only a management system based on results or performance indicators will be effective and productive.

Also, the author recommends moving from a system based on inputs (inputs) to a system centered on results (outputs), because from the analysis carried out from a diagnostic point of view, a rather small number of indicators was found, which partially correspond to a performance based management. Respectively, in order to remove this deficiency, the author proposes a set of performance indicators that complement the present ones, such as: The annual performance of the number of projects regarding the design of road rehabilitation/construction works, The degree of use of the works of design for road rehabilitation/construction, Road user satisfaction, etc. It should also be noted that reconstructed physical elements, bridges, floors, etc. are also measured. A performance element would be the period of realization of the reconstruction, the modernization of the roads with the evident performance of the final reception of the works performed with the measurement of the quality performance indicators.

Undoubtedly, the provision of good quality information on travel time and alternative routes can significantly help to make the best use of the available road network.

Another recommendation to which major attention has been drawn is the connection of the road infrastructure of the Republic of Moldova with the European TEN-T network. The trans-European road transport network (TEN-T network) is considered to be of common interest, respectively any infrastructure project related to these links has in mind:

A. Development of the network, in particular: *widening of highways or development of roads to high standards; building or setting up bypass roads of areas or urban agglomerations; strengthening the interoperability of national networks.*

B. Development of traffic management and user information systems, in particular: *creation of telematic infrastructures for collecting traffic data; development of traffic information centers and traffic control centers in different countries; the establishment of road information services, especially the technical interoperability of telematics infrastructures.*

In this context, based on the analysis of the situation, it was found that TEN-T projects present significant advantages in relation to typical infrastructure projects.

In this chapter we obtained the following elements of scientific novelty: the development of the econometric model that determined the correlation between the allocated financial means and the quality of the roads; development of the set of performance indicators of road infrastructure management and recommendations regarding its improvement.

## **GENERAL CONCLUSIONS AND RECOMMENDATIONS**

The analysis of the management of public road infrastructure allowed us to argue the importance and topicality of the research topic both on a national and international level, and to prove the fact that the efficient management of the public road administration process has an important role in obtaining the result indicators aimed at modernization it in the Republic of Moldova.

In this context, the doctoral research allowed the formulation of the following conclusions:

Following the achievement of objective 1 – Analysis of the road infrastructure management concept by defining the main scientific determinants: infrastructure, road infrastructure, roads, road infrastructure management, we reached the following results:

The study of international specialized literature allowed us to find that the theoretical bases of road infrastructure management are reflected in the works of Kindleberger C., Marshal A., Perrow F., Pozamantira E.I., Pottier P., Heita F.A. and others. In the Republic of Moldova, this subject was studied mainly by engineering specialists, technicians, economists in the field: Popescu D., Pogorlețchi Gh., Plămădeală V., Godonoga I., Ceban D., Vicolleanu Ș., Chiricuță A., Ciubuc I., Godonoga I., Plamadalea A., Cozar A., Ulian G, Bugaian L, Prisăcaru V., Cimpoiș D, Popa A, Perciun R, Călugăreanu I., and others (p.1.1 of the thesis).

The concept of road infrastructure management consists in the fact that this is a system with the main purpose to optimize the overall performance of transport systems through the continuous improvement of public road infrastructure in order to increase road traffic safety. In the author's view, any road infrastructure management system has three main elements in its composition, which are in a strong interdependent relationship: *heritage (asset) management, traffic management and the managerial tools used.*

*A proper definition* arising from the peculiarities of the Republic of Moldova, for the concept of "road infrastructure management" could be: a systematic process of maintenance, improvement and exploitation of heritage (roads, buildings, other heritage), combining engineering principles with solid commercial practices and economic thinking, in order to provide tools that facilitate a more organized and flexible approach to making the necessary decisions in order to meet the public's expectations (p.1.2 of the thesis).

*In order to achieve the research objectives, we identified a new approach to the analysis of road infrastructure management, an approach that allowed us to systematize the main components of management and create its logical-descriptive model.* The main elements of road infrastructure management are: *objectives, resources, variables, relationships, transformations, inputs, parameters and outputs.* These elements were stipulated, analyzed and described by the author in p. 1.2, and their substantiation resulted in an element of scientific novelty (p. 1.2 of the thesis).

Following the achievement of objective 2 – Analysis of the international experience regarding the management of road infrastructure in order to take over good practices, the author reached the main conclusion: each country can delimit and have its own classification of roads. However, there is a common classification, which is the most common: by type of property and subjects that ensure their management, by traffic (volume, composition), by role in the network (location and connectivity) and by physical form – dimensions, alignment etc. (p. 1.3 of the thesis).

Also, a case study was carried out based on Romania, which aimed to analyze the management of public road infrastructure and identify the main subjects, mechanisms, tools, indicators that are used in Romania. This case study served as an argument for the recommendations and solutions for improving the management of the domestic public road infrastructure (p. 1.3 of the thesis).

By achieving objective 3 – Diagnosing the road infrastructure management system in the Republic of Moldova through the prism of the main identified elements: subjects, object, current situation, variables, inputs, transformations, outputs, we drew the following conclusions:

The main subjects that ensure the management of road infrastructure in the Republic of Moldova are: SC "ASD" - representative of the central public administration and PLA - manages the local roads of regional interest (p. 2.1 of the thesis).

The object of road infrastructure management is stipulated and classified in the Road Law no. 509-XIII, where roads are classified into two categories, according to destination, namely: public roads and private roads. In this work, the object of research is public roads, which are classified into: European roads, national roads and local roads. The synthesis regarding the technical characteristics of public roads is carried out in p. 2.1.

The diagnostics carried out allowed us to conclude that the republican roads are modernized at the level of 98,2%, and in the case of the regional ones, access roads with cobbled coverings prevail – 39,5% and without covering (earth) – 1,6%. Out of the total network of national roads, those with modern covering prevail, the weight being 76,5% (p. 2.2 of the thesis).

The significant share of about 50-90% of the financial resources belongs to the expenses for road maintenance and about 10-20% represents the expenses for their reconstruction and rehabilitation (p. 2.3 of the thesis).

SC "ASD" allocates resources to achieve the following transformations and outputs: maintenance of existing road infrastructure; modernization of the networks in order to increase the level of applied standards and the efficiency of road operation; investments in the construction of new road networks.

In order to carry out a qualitative analysis regarding the perception of the quality of the outputs by the final consumer, an empirical study was developed based on a survey of 523 respondents.

The general conclusion drawn is: 97,9% of the respondents mentioned that in the Republic of Moldova the road infrastructure is poorly developed, More than 94% of the respondents believe that a developed road infrastructure must include the main outputs, such as: the quality of the roads (answer: new roads – 98,9%, maximum traffic safety – 98,9%, ring roads – 97,5%). About 62% of the respondents are affected a lot by the state of the infrastructure in the Republic of Moldova, 24% – very much. About 92% of the respondents considered that the construction of new roads is the most effective way to improve the road infrastructure, 80% of the respondents are of the opinion that the improvement of the existing infrastructure consists in carrying out the maintenance and repair works of the existing roads, and 67% advocate for the modernization the existing infrastructure through various endowments (p. 2.3 of the thesis).

To demonstrate, from a scientific point of view, how important the presence of development infrastructure is, the author validated the first research hypothesis: Hypothesis 1: A developed road infrastructure leads to the economic development of the country. That is, the more financial resources are invested in road infrastructure, the more GDP will increase (p. 2.3 of the thesis).

To test the first hypothesis, a unifactorial econometric model was built, which allowed demonstrating the direct dependence between GDP and the financial means allocated for roads. It was found: when the financial means allocated for roads increase by 1 billion lei, the GDP will increase by 39,909 billion lei (p. 2.3 of the thesis).

To validate the research hypothesis no. 2: The quality of roads in the Republic of Moldova depends on the financial resources used for their maintenance and rehabilitation, both unifactorial models and a multiple regression model were built, thus we managed to attest the connection and dependence of the financial resources used for road maintenance and rehabilitation from the Republic of Moldova by the four states of the roads identified from the diagnostic analysis: good, mediocre, bad and very bad. As a result of the testing, we certify the following: in the condition that other conditions are not taken into account: with the decrease in the good condition of the roads by 1% of their length, the resources used for their maintenance and rehabilitation would decrease by 23,908 million lei; with the decrease in the mediocre condition of the roads by 1% of their length, the resources used for their maintenance and rehabilitation would decrease by 13,873 million lei; with the increase in the bad condition of the roads by 1% of their length, the resources used for their maintenance and rehabilitation would decrease by 81,581 million lei; with the increase in the very bad condition of the roads by 1% of their length, the resources used for their maintenance and rehabilitation would increase by 135,948 million lei (p. 3.1 of the thesis).

Following this research, the author comes up with a series of recommendations, stipulated in paragraphs 3.2 and 3.3, which aim to improve the management of road infrastructure in the Republic of Moldova.

At the same time, the author recommends moving from a system based on inputs to a system centered on results (outputs) and the introduction of performance indicators that complement the existing ones (Table 3.7, p. 3.3 of the thesis).

*Regarding the constraints of the research:* considering that the research theme of the thesis is exhaustive and interdisciplinary, the author is aware of the fact that some topics have not been fully analyzed, because the content of the thesis is restricted in terms of volume and specialty. Thus, we mention that the analysis of other assets (property), which are part of the road infrastructure, such as: bridges, buildings, traffic lights, other installations, etc., were not included in this investigation. In this scientific study we analyzed only one object of the infrastructure – public roads. In the Transformations component, the author did not develop the technological processes, raw material quality, standards and other elements directly related to the process of transforming inputs into outputs, given the fact that they mainly relate to engineering and engineering technological processes.

We conclude that the objectives proposed in the thesis have been achieved, and the scientific results represent the elements of scientific novelty, stipulated in the Introduction, which led to the solution of the important scientific problem, which consisted in the development of the logical-descriptive model of road infrastructure management in the Republic of Moldova, which contributed to the identification of existing deficiencies in the management of road infrastructure in the Republic of Moldova, and led to the development of recommendations for its improvement.

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4. OBOROCEANU A. Managementul drumurilor publice în Republica Moldova. *International Symposium Experience. Knowledge. Contemporary Challenges 6th Edition*

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  9. OBOROCEANU A. Perfecționarea managementului drumurilor publice în Republica Moldova. Contemporary research and evaluation methodologies: The national scientific conference of doctoral students dedicated to the 75th anniversary of USM, April 22-23, 2021 / organising committee: Aurelia Hanganu [et al.]. – Chisinau : CEP USM, 2022 – ISBN 978-9975-159-16-6. Page 181-189

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10. OBOROCEANU A. Performans of national roads in the Republic of Moldova, International Scientific Conference ”Accounting and Finance – the global languages in business”, 7th Edition Pitesti, April 8, 2022.

## ADNOTARE

**OBOROCEANU Aliona: „Perfecționarea managementului infrastructurii drumurilor publice în Republica Moldova”,** teză de doctor în științe economice, program de doctorat: 521.03 – economie și management în domeniul de activitate, Chișinău, 2023

**Structura tezei:** introducere, 3 capitole, concluzii generale și recomandări, 194 de surse bibliografice, 10 anexe, 150 de pagini de text de bază, 71 figuri, 12 tabele. Rezultatele obținute sunt publicate în 9 lucrări științifice.

**Cuvinte-cheie:** management, drumuri, infrastructura drumurilor, indicatori de performanță, fond rutier, rețeaua TEN-T.

**Scopul** studiului constă în analiza sistemului de management al infrastructurii drumurilor publice în Republica Moldova prin prisma principalelor elemente în vederea elaborării recomandărilor care vor contribui la perfecționarea managementului investigat.

### **Obiectivele cercetării:**

1. Fundamentarea conceptului de management al infrastructurii drumurilor prin definirea principalelor determinante științifice: drumuri, infrastructura drumurilor și sistemul de management.

2. Analiza experienței internaționale cu privire la managementul infrastructurii drumurilor în scopul prelucrării bunelor practici.

3. Diagnosticarea sistemului de management al infrastructurii drumurilor în R. Moldova prin prisma principalelor elemente identificate: subiecți, obiect, situația actuală, variabile, inputuri, transformări, outputuri.

4. Analiza cantitativă input-output în managementul infrastructurii drumurilor în scopul determinării corelației dintre cauză-efect a acestora.

5. Identificarea principalelor lacune în domeniul managementului infrastructurii drumurilor în R. Moldova.

6. Elaborarea recomandărilor privind perfecționarea managementului infrastructurii drumurilor în R. Moldova.

7. Identificarea indicatorilor speciali de performanță a managementului infrastructurii drumurilor în R. Moldova.

**Noutatea și originalitatea științifică** rezidă din cercetarea efectuată privind managementul infrastructurii drumurilor publice în R. Moldova și este fundamentată de ipotezele de cercetare propuse spre testare. Astfel, noutatea științifică constă în:

- elaborarea modelului logico-descriptiv al sistemului de management al infrastructurii drumurilor în R. Moldova;
- efectuarea diagnosticării managementului infrastructurii drumurilor în R. Moldova în baza modelului elaborat prin prisma principalelor elemente identificate: subiecți, obiect, situația actuală, variabile, inputuri, transformări, outputuri;
- elaborarea studiului empiric privind gradul de satisfacere a populației referitor la infrastructura drumurilor și outputurile existente în R. Moldova;
- elaborarea modelului econometric care a determinat corelația dintre inputul principal (resursele financiare) și outputurile managementului infrastructurii drumurilor;
- elaborarea modelului econometric care a determinat corelația dintre mijloacele financiare alocate pentru drumuri și PIB-ul R. Moldova;
- elaborarea setului de indicatori de performanță a managementului infrastructurii drumurilor și a recomandărilor privind perfecționarea acestuia.

**Problema științifică importantă soluționată** a constat în elaborarea modelului logico-descriptiv al sistemului de management al infrastructurii drumurilor în R. Moldova, fapt ce a contribuit la o diagnosticare mai aprofundată a situației actuale, la identificarea deficiențelor existente și a condus la elaborarea recomandărilor în vederea perfecționării managementului infrastructurii drumurilor.

**Semnificația teoretică** a cercetării constă în abordarea modernă a managementului infrastructurii drumurilor prin elementele sistemului de management. Potrivit analizei efectuate, a fost dezvoltată în premieră baza teoretico-metodologică pentru R. Moldova cu privire la managementul infrastructurii drumurilor prin crearea modelului logico-descriptiv al sistemului de management al infrastructurii drumurilor, a fost efectuat un studiu amplu privind mecanismul și instrumentarul economic utilizat în gestiunea infrastructurii drumurilor naționale, au fost elaborați indicatorii de performanță a managementului infrastructurii drumurilor, a fost demonstrată corelația directă dintre infrastructura drumurilor și dezvoltarea economică a țării, în special faptul că anume calitatea drumurilor în R. Moldova depinde de resursele bănești utilizate pentru întreținerea și reabilitarea acestora. De asemenea, a fost efectuată sinteza diacronică a taxelor rutiere acumulate în Fondul rutier și au fost elaborate recomandări privind direcțiile strategice de dezvoltare a infrastructurii drumurilor în R. Moldova, în deosebi prin coeziunea acesteia în rețeaua europeană – rețeaua TEN-T.

**Valoarea aplicativă a cercetării** este determinată de posibilitatea de utilizare a rezultatelor științifice și recomandărilor, prezentate în teză, de către factorii de decizie din R. Moldova pentru perfecționarea managementului infrastructurii drumurilor.

**Implementarea rezultatelor științifice.** Rezultatele studiului au fost aplicate de către Ministerul Infrastructurii și Dezvoltării Regionale al Republicii Moldova.

## ANNOTATION

**OBOROCEANU Aliona: "Improving the Management of Public Road Infrastructure in the Republic of Moldova",**  
doctoral thesis in economic sciences, doctoral program: 521.03 - economics and management in the field of activity,  
Chisinau, 2023.

**Thesis structure:** introduction, 3 chapters, general conclusions and recommendations, 194 bibliographic sources, 10 annexes, 150 pages of basic text, 71 figures, 12 tables. The obtained results are published in 9 scientific papers.

**Keywords:** management, roads, road infrastructure, performance indicators, road fund, TEN-T network.

**The aim of the study** is to analyze the management system of public road infrastructure in the Republic of Moldova in terms of its main elements, in order to develop recommendations that will contribute to the improvement of the investigated management.

**Research objectives:**

8. The justification of the concept of road infrastructure management by defining its main scientific determinants: roads, road infrastructure, and management system.

9. Analysis of international experience regarding the road infrastructure management for processing best practices.

10. Diagnosis of the road infrastructure management system in the Republic of Moldova through its main identified elements: subjects, objects, current situation, variables, inputs, transformations, outputs.

11. Quantitative input-output analysis in road infrastructure management in order to determine the cause-effect correlation between them.

12. Identification of the main gaps in the field of road infrastructure management in the Republic of Moldova.

13. Development of recommendations for the improvement of road infrastructure management in the Republic of Moldova.

14. Identification of special performance indicators for road infrastructure management in the Republic of Moldova.

**The scientific novelty and originality** of the research lies in the conducted study of public road infrastructure management in the Republic of Moldova and is based on the proposed research hypotheses for testing. Thus, the scientific novelty consists of:

- The development of a logical-descriptive model of the road infrastructure management system in the Republic of Moldova;
- The diagnosis of road infrastructure management in the Republic of Moldova based on the developed model through its main identified elements: subjects, objects, current situation, variables, inputs, transformations, outputs;
- The development of an empirical study on the degree of satisfaction of the population regarding road infrastructure and existing outputs in the Republic of Moldova;
- The development of an econometric model that determined the correlation between the main input (financial resources) and the outputs of road infrastructure management;
- The development of an econometric model that determined the correlation between the financial means allocated to roads and the GDP of the Republic of Moldova;
- The development of a set of performance indicators for road infrastructure management and recommendations for its improvement.

**The important scientific problem solved** consisted of the development of a logical-descriptive model of the road infrastructure management system in the Republic of Moldova, which contributed to a more in-depth diagnosis of the current situation, the identification of existing deficiencies, and led to the development of recommendations for improving road infrastructure management.

**The theoretical significance of the research** consists in the modern approach to road infrastructure management through the elements of the management system. According to the analysis carried out, the theoretical-methodological basis for the Republic of Moldova regarding road infrastructure management was developed for the first time by creating the logical-descriptive model of the road infrastructure management system, an extensive study was carried out regarding the economic mechanism and tools used in the management of the national road infrastructure, the performance indicators of the road infrastructure management were developed, the direct correlation between the road infrastructure and the economic development of the country was demonstrated, especially the fact that the quality of the roads in the Republic of Moldova depends on the financial resources used for maintenance and rehabilitation them. Also, the diachronic synthesis of road taxes accumulated in the Road Fund was carried out and recommendations were developed regarding the strategic directions for the development of the road infrastructure in the Republic of Moldova, especially through its cohesion in the European network - the TEN-T network.

**The applicative value** of the research is determined by the possibility of using the scientific results and recommendations, presented in the thesis, by the decision-makers in the Republic of Moldova for the improvement of road infrastructure management.

**Implementation of scientific results.** The results of the study were applied by Î.S. State Administration of Roads.

## АННОТАЦИЯ

к диссертации на соискание ученой степени доктора экономических наук «Улучшения управления дорожной инфраструктурой в Республике Молдова»

**ОБОРОЧАНУ Алена: докторская программа: 521.03 - экономика и управление в сфере деятельности, Кишинев, 2023 г.**

**Структура диссертации:** введение, 3 главы, общие выводы и рекомендации, 194 библиографических источника, 10 приложений, 150 страниц основного текста, 71 рисунок, 17 таблиц. Полученные результаты опубликованы в 9 научных работах.

**Ключевые слова:** управление, дороги, дорожная инфраструктура, показатели эффективности, дорожный фонд, сеть ТНТ-Т.

**Цель исследования** состоит в анализе системы управления дорожной инфраструктурой общего пользования в Республике Молдова через призму основных элементов с целью разработки рекомендаций, которые будут способствовать улучшению исследуемого управления.

**Задачи исследования:**

1. Обоснование концепции управления дорожной инфраструктурой путем определения основных научных детерминант: дороги, дорожной инфраструктуры и системы управления.
2. Анализ международного опыта управления дорожной инфраструктурой с целью разработки передовой практики.
3. Диагностика системы управления дорожной инфраструктурой в Республике Молдова через призму основных выявленных элементов: субъекты, объект, текущая ситуация, переменные, входы, преобразования, выходы.
4. Количественный анализ затрат и результатов в управлении дорожной инфраструктурой с целью определения их причинно-следственной связи.
5. Выявление основных пробелов в области управления дорожной инфраструктурой в Республике Молдова.
6. Разработка рекомендаций по улучшению управления дорожной инфраструктурой в Республике Молдова.
7. Определение специальных показателей эффективности управления дорожной инфраструктурой в Республике Молдова.

**Научная новизна и оригинальность** заключаются в проведенном исследовании по управлению дорожной инфраструктурой общего пользования в Республике Молдова и подтверждаются исследовательскими гипотезами, предложенными для проверки. Таким образом, научная новизна заключается в:

- разработка логико-описательной модели системы управления дорожной инфраструктурой Республики Молдова;
- проведение диагностики управления дорожной инфраструктурой в Республике Молдова на основе модели, разработанной через призму основных идентифицированных элементов: субъекты, объект, текущая ситуация, переменные, входы, преобразования, выходы;
- разработка эмпирического исследования относительно степени удовлетворенности населения дорожной инфраструктурой и существующими результатами в Республике Молдова;
- разработка эконометрической модели, определяющей соотношение между основными входами (финансовыми ресурсами) и выходами управления дорожной инфраструктурой;
- разработка эконометрической модели, определяющей соотношение между финансовыми средствами, выделяемыми на дороги, и ВВП Республики Молдова;
- разработка комплекса показателей эффективности управления дорожной инфраструктурой и рекомендаций по его совершенствованию

**Полученный результат, способствующий решению важной научной проблемы:** заключалась в разработке логико-описательной модели системы управления дорожной инфраструктурой Республики Молдова, что способствовало более глубокой диагностике текущей ситуации, выявлению существующих недостатков и привели к разработке рекомендаций по улучшению управления дорожной инфраструктурой.

**Теоретическая значимость исследования** заключается в современном подходе к управлению дорожной инфраструктурой через элементы системы управления. Согласно проведенному анализу, теоретико-методологическая основа для Республики Молдова в области управления дорожной инфраструктурой была впервые разработана путем создания логико-описательной модели системы управления дорожной инфраструктурой, было проведено обширное исследование в отношении экономического разработаны механизмы и инструменты управления дорожной инфраструктурой страны, разработаны показатели эффективности управления дорожной инфраструктурой, продемонстрирована прямая зависимость между дорожной инфраструктурой и экономическим развитием страны, особенно тот факт, что качество дорог в Республике Молдова зависит от финансовых ресурсов, используемых для их содержания и восстановления. Также был проведен диахронический синтез дорожных налогов, накопленных в Дорожном фонде, и выработаны рекомендации относительно стратегических направлений развития дорожной инфраструктуры в Республике Молдова, особенно за счет объединения в европейскую сеть - TEN-T сеть.

**Практическая значимость диссертации** заключается в том, что полученные результаты определяют возможность использования научных результатов и рекомендаций, представленных в диссертации, лицами, принимающими решения в Республике Молдова, для улучшения управления дорожной инфраструктурой.

**Внедрение научных результатов:** Результаты исследования были применены ГП Государственная Дорожная Администрация.

**OBOROCEANU ALIONA**

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MANAGEMENT IN THE REPUBLIC OF MOLDOVA**

**DOCTORAL PROGRAM**

**521.03 ECONOMY AND MANAGEMENT IN THE FIELD OF ACTIVITY**

**Summary of the doctoral thesis in economics**

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