MINISTRY OF EDUCATION

University POLITEHNICA of Bucharest

Doctoral School of Industrial Engineering and Robotics

Fundamental doctoral field Engineering Sciences

Doctoral Field Engineering and Management

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THESIS SUMMARY

Contributions on the integration of knowledge management in the sustainable development of road transport

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- 2023 –

Content of the doctoral thesis

The content of the summary of the doctoral thesis

Note:

Thesis summary includes chapters, subchapters, figures, tables, mathematical relations etc. taken from the doctoral thesis.

They are numbered identically as in the doctoral thesis.

The annexes of the doctoral thesis are not presented in the summary of the thesis.

This material is an integral part of the thesis.

Author

LIST OF ABBREVIATIONS

Nr. crt.	Abbreviation	Meaning
1	*°C*	degree Celsius
2	*A1*	highwayA1
3	*ACEA*	European Association of Motor Vehicle Manufacturers
4	*AFR*	Air Flow Ratio
5	*APIA*	Payments and Intervention Agency for Agriculture
6	*CE*	European Council
7	*CEE-ONU*	United Nations Economic Commission for Europe
8	*CH*	carbon-hydrogen group
9	*CNAIR*	National Highways and National Roads Company
10	*CNIR*	National Road Investment Company
11	*CO*	carbon monoxide
12	*Co*	Octane rating of gasoline
13	CO_2	carbon dioxide
14	*CP*	Horse-power
15	*dB*	decibels
16	*dBA*	Decibels (dB). The suffix „A" is defined by measurements where weighting filters are used for the human ear. The acoustic receptor in the human ear captures sound frequencies in the range of 20-20000 Hertz (Hz), at a distance of 50 cm from the signal source.
17	*dCI*	Diesel Commonrail Injection
18	*DN*	national road
19	*DRPCIV*	Driving License and Vehicle Registration Regime Directorate
20	*EGR*	Exhaust Gas Recirculation. Recirculation is done by means of valve
21	*EpoSS*	European Technology Platform on Smart Systems Integration
22	*ERTRAC*	European Road Transport Research Advisory Council
23	*EU ETS*	European Union Emissions Trading System
24	*EV*	Electric Vehicle
25	*GES*	Greenhouse gases
26	*GPL*	Liquefied petroleum gas
27	*GPS*	Global Positioning System (engl.)
28	H_2O	water
29	*HC*	hydrocarbons
30	*HnCn*	hidrocarbons (name from specialized literature)
31	*IGPR*	The General Inspectorate of Romanian Police
33	*INS*	National Institute of Statistics
45	*IOML*	International Organization of Legal Metrology
34	*ISO*	International Organization for Standardization
35	*ITP*	Periodic technical inspection
36	*Km/h*	kilometers/hour
37	*L*	liter
38	*MAC*	compression ignition engine
39	*MAS*	motor cu aprindere prin scânteie
40	*MPI*	Injection engine
41	*NEDC*	New European Driving Cycle
42	*NO*	Nitrogen monoxide
43	NO_x	Nitrogen oxide/oxides (nae from specialized literature)
44	O_2	oxygen
46	*OMS*	World Health Organization (W.H.O.)
47	*OUG*	Emergency ordinance of the Government
48	*PE-CONS*	European Parliament -Council
49	*PEMS*	Portable Emissions Measurement System
50	*PIB*	gross domestic product
51	*PMI*	bottom dead center
52	*PMS*	Top dead center
53	*PNRR*	The National Recovery and Resilience Plan
54	*PPM*	parts per million

Nr. crt.	Abbreviation	Meaning
56	*RAR*	Ramanian Car Registry
57	*RAV 4*	Recreational Active Vehicle with 4 Wheel Drive
58	*RDE*	Real Driving Emissions (engl.)
59	*REV*	Range Extender Vehicle. The term refers to a vehicle equipped with an internal combustion engine that drives a generator to charge the electric traction battery, withhout participating in the actual propulsion of the vehicle.
60	*RNTNR -1*	The regulation on the confirmation of the harmonization of road transport vehicles in the technical provisions of road traffic safety, environmental protection and in the category of use according to the destination of use, through technical inspection activities (Ordinul ministrului transporturilor 2.133, 2005).
61	*SARS-CoV-2*	Severe Acute Respiratory Syndrome Coronavirus 2
62	*SDV*	Tools, devices, testers
63	*SIT*	Intelligent Transport System (ITS)
64	*SUA*	United States of America
65	*SWOT*	Strengths, Weaknesses, Opportunities, Threats
66	*TDI*	Turbo Diesel Direct Injection
67	*TEN-T*	The Trans-European Transport Network
68	*TSI*	Turbo Stratified Injection
69	*TVA*	value added tax
70	*UE*	European Union (EU)
71	*UE ETS*	The European Union emission certificate trading system
72	*UNCE*	United Nations Economic Commission for Europe
73	*Vcc*	volts Direct Current
74	*WLTP*	Worldwide Harmonized Light-Duty Vehicles Test Procedure (Volkswagen.ro/WLTP, 2022).
75	*ZEV*	Zero Emmision Vehicle

FOREWORD

Noise pollution causes sleep disturbances, fatigue, stress and increased blood pressure. Chemical pollution has harmful effects on the human body, being the cause of a whole series of ailments. Particulate matter and high temperatures generated by global warming have been shown to irreparably damage the heart, respiratory function and central nervous system. All of these increase the risk of cardiovascular disease. Also, pollution can cause allergies and asthma. Frequent exposure to various pollutants generates in some people multiple chemical sensitivities, with manifestations similar to allergic reactions, and high-level noises and vibrations affect the central nervous system, disrupt sleep, producing discomfort and fatigue.

Doctoral thesis entitled "*Contributions regarding the integration of knowledge management in the sustainable development of road transport"* is the subject of research on chemical and noise pollution and the fuel consumption of road vehicles. The research was carried out in the context of the requirements of the World Health Organization to reduce the speed of road vehicles in the urban environment from 50 km/h to 30 km/h, with the aim of reducing the number of road accidents and the level of pollution from any way.

The intellectual property rights on this doctoral thesis belong equally to the author (Eng. Gheorghe Neamțu) as well as to the scientific supervisor, Prof. Univ. Dr. Eng., Dr. Ec. Aurel-Mihail Titu.

I send deep thanks to Prof. Univ. dr. eng., dr. ec. Aurel-Mihail Titu for the scientific management granted throughout the duration of my doctoral studies, for the trust, support and patience I enjoyed throughout this period from His Highness.

I express my sincere thanks to Prof. Univ. Dr. Eng. Nicolae Ionescu and Prof. Univ. Dr. Eng. Cristian-Vasile Doicin from the Polytechnic University of Bucharest, to Prof. Univ. Dr. Eng. Constantin Oprean from "Lucian Blaga" University in Sibiu and Mr. Prof. Univ. Dr. Eng. Mihai Dragomir from the Technical University of Cluj-Napoca for the appreciations, suggestions and guidance provided within the evaluation committees of scientific reports.

I express my sincere thanks to the university lecturer. Dr. Ioan Tincu and Professor Alexandru Boroiu for the guidance and support given to the creation of the mathematical model that validates the research on the main noxes emitted by motor vehicles.

I would like to thank the members of the doctoral committee for their constructive comments and recommendations, which will be the starting point for my future scientific projects.

I would like to thank all my relatives, acquaintances and friends who provided me with their personal cars for conducting experimental research.

I am grateful to my family for their understanding and moral support during the entire period of my doctoral studies.

author

INTRODUCTION

The transport process, determined by the need for mobility, takes several forms, depending on its object (people, goods), on the means or systems used for this purpose, but also on the vehicles through which the movement is made.

Compared to other sectors of the economy (energy, industry, construction, etc.), which have taken measures to mitigate pollution since 1990, the transport sector has developed rapidly and chaotically, which has caused polluting emissions from transport activities to grow and cause significant damage to nature and human health. For this reason, the transport sector has become a major obstacle to the implementation of European objectives in the field of environmental and health protection. Despite all the efforts made by authorities around the world (use of cleaner vehicle manufacturing technologies, ecological means of road transport – hybrid or electric), however, the amount of chemicals and waste of various natures that end up in nature is still high.

Based on the data presented in the analysis of the current state, motivation, hypotheses, research-development and innovation directions, the following general objective of the doctoral research activity is defined: Design and implementation of a generalized technical model, experimentally validated, of the functioning of organizations of road transport based on knowledge, respecting the principles of sustainable development.

In order to reduce the number of victims resulting from road accidents, as a result of the high speed of vehicles, but also to reduce pollution in the urban environment, the World Health Organization (W.H.O.) proposes reducing the traffic speed from 50 km/h to 30 km/h. According to the general objective, the theoretical-experimental research reaches the direction of research and development, to determine the extent to which the W.H.O. proposals are effective in terms of pollution with exhaust gases, vibrations or sounds, but also fuel consumption.

Applied to the requirements of the general objective, it is proposed to design and implement a generalized technical model, experimentally validated, of the operation of knowledge-based road transport organizations, respecting the principles of sustainable development, by creating the own conceptual model of sustainable development of ecological road transport, in correlation with the environment. In order to fulfill this requirement, the technical model is proposed for projection, the carrying out of experimental research on the level of chemical and noise pollution, as well as the fuel consumption of vehicles with Spark Ignition engine (MAS) and Compression Ignition Engine (MAC). Validation of the proposed model is achieved by creating and developing an appropriate mathematical model, which further confirms its applicability to the chemical noxes and noises measured in the vehicle cabin.

In the experimental research activity, cars are used from the composition of the national fleet of vehicles, taken as a measurable entity, which includes all the vehicles belonging to the owners (individuals) and legal entities (road transport organizations), at the national level. The knowledge needed to develop the proposed model belongs to the field of road transport, a vast field, strongly developed in our country. The knowledge necessary for the development of the technical model is frequently used by the employees of any specialized organization and belongs to the fields of: management; Sustainable Development; sustainability; transport system; road vehicles; road infrastructure; heat engines; electromobility; electric motors; hybrid engines; hydrogen engines - fuel cells; chemical and noise pollution; biofuels, fuel and fuel consumption; the quality of ecological road vehicles and the transport services provided with them; road safety and autonomous vehicles.

By creating the technical model, personal contributions are made, applying principles of sustainable development in road transport, contributing to: reducing resource consumption; reduction of chemical pollution and greenhouse gases; reducing noise and vibration pollution; increasing the share of energy efficiency; supporting and developing a viable road transport system for the entire life cycle (design, construction, operation, maintenance, decommissioning); ecological driving of vehicles; the expansion and development of the road transport infrastructure that will favor the increase of the average speeds of vehicle movement; streamlining of traffic; increasing the quality and diversification of transport offers with goods or passenger vehicles; optimization of routes and means of transport; increasing traffic safety; competitive development of specialized organizations; increasing the regeneration rate of the national vehicle fleet, with new, efficient, ecological, environmentally friendly vehicles; supporting, developing and implementing Intelligent Transport Systems, road safety and autonomous vehicles; supporting, developing and implementing electromobility; increasing efficiency in road transport by using multimodal transport systems; educating and reorienting the population to meet their own transport needs, through more frequent use of buses, trolleybuses, trams, bicycles, scooters, walking. All presented aspects were completed by drawing final conclusions and establishing further research directions. For a correct, complete and rigorous management of the doctoral research reports and the present thesis, mind maps were used. The doctoral thesis is structured in two parts. Part I, entitled "*The current state of knowledge in the field regarding the integration of knowledge management in the sustainable development of road transport"*, contains seven chapters. Part II, entitled *"Research on the degree of chemical and noise pollution from vehicles equipped with thermal engines, in the context of the proposals of the World Health Organization regarding the reduction of traffic speed in the urban environment"*, contains nine chapters.

The doctoral thesis is structured in two parts. Part I, entitled "*The current state of knowledge in the field regarding the integration of knowledge management in the sustainable development of road transport"*, contains seven chapters. Part II, entitled "*Research on the degree of chemical and noise pollution from vehicles equipped with thermal engines, in the context of the proposals of the World Health Organization regarding the reduction of traffic speed in the urban environment"*, contains nine chapters. The work is spread over 254 pages that include 156 figures, 70 tables and 160 bibliographic references. 44 annexes are added to them.

Part I

Chapter 1, entitled Basic Concepts of Organisation, Management and the Knowledge-Based Economy in Road Transport and structured into seven sub-chapters, dealt with issues relating to the organization as a system, the knowledge-based organisation, the learning organisation, management and the knowledge-based economy, the elements and features of the road transport organization. At the end of the chapter, conclusions specific to the concepts addressed were drawn.

In chapter 2, entitled Knowledge and knowledge management in the field of road transport, structured in seven sub-chapters, aspects related to knowledge and the typology of knowledge were dealt with. The concept of knowledge management was analyzed in the context of the addressed research, a parallel was made between knowledge management and knowledge-based management in road transport, the importance of the implementation of knowledge management in road transport organizations was shown, knowledge was defined in correlation with ecological/clean concepts and discussed aspects related to knowledge management in the field of ecological road transport.

In chapter 3, entitled Sustainable development and sustainability in the field of road transport, structured in six sub-chapters, aspects referring to sustainable development were dealt with. A parallel was made on the concept of sustainable development versus the concept of sustainability, management was analysed, the issue of sustainable development and sustainability in road transport, a deep analysis was carried out based on up-to-date figures of the road transport infrastructure and the national park of vehicles, then the level of sustainability that the Romanian authorities ensure for the domestic road transport system was presented.

In chapter 4, entitled the ecological vehicle - a step forward in order to ensure the sustainability of motor transport, structured in six sub-chapters, aspects were dealt with regarding four types of propulsion systems existing at this time on road vehicles. SWOT analysis were designed where strengths, weaknesses, opportunities and threats were established for thermal engine propulsion systems, hybrid electric engine propulsion systems, and hydrogen propulsion - fuel cells

In chapter 5, entitled The current state of knowledge in the field regarding ecological road transport, structured in eight subchapters, the main polluting factors in current road transport were presented, the way in which responsibility towards environmental protection is promoted in road transport was analyzed, carried out an analysis of the current state of environmental pollution worldwide, of the European policy in the field of ecological vehicles and of the current European standards regarding gas emissions from vehicles. An analysis of how European authorities have completed research in the field of electromobility has been carried out.

In chapter 6, entitled Quality and quality requirements in modern green road transport, structured in six sub-chapters, concepts related to quality and quality characteristics for green vehicle transport services were presented, factors influencing the quality of services were presented of ecological road transport, the indicators for assessing the quality of electric vehicles were established and defined.

In chapter 7, entitled Road safety and road safety management in the context of the sustainable development of the road transport system, structured in seven sub-chapters, the guidelines and policies of a technical-economic nature regarding road safety in the context addressed, road safety and safety management were presented European level, road safety and road safety management in Romania. An analysis of the current state of development of autonomous vehicles was carried out, based on which the level of automation of the driving assistance systems that contribute to the management of road safety, fuel consumption and noise, existing on Toyota hybrid cars, was evaluated. As a result of the evaluation process, more than 50 non-conformities of the analyzed systems were established, which lower the quality level of the car. The findings demonstrate that the autonomous vehicle is not yet ready for safe use on public roads.

Part II

In chapter 8, entitled Research methodology approached in the context of the doctoral research theme, structured in six subchapters, I presented the motivation, the main objective and the specific objectives of the scientific research, the research directions and the working hypotheses. At the end of the chapter I made a projection of the research methodology.

In chapter 9, entitled Contributions and research on the degree of pollution with chemical and sonic noxes from cars equipped with MAS and MAC, in the context of the proposals of the World Health Organization regarding the reduction of traffic speed in the urban environment, structured in seven sub-chapters, we presented the reference data on the chemical emissions emitted by vehicles with thermal engines, we presented the reference data on the acoustic emissions emitted by passenger cars, we calculated the Power to Mass Ratio (PMR), we presented the harmful thresholds of combustion gases from passenger cars, the specific conditions for conducting experimental research and we have centralized the results of chemical and phonic noises obtained through experimental research. At the end of the chapter, I presented the possible causes that generate the appearance of noxes in internal combustion engines.

In chapter 10, entitled Analysis and interpretation of the results of the research carried out to determine the degree of pollution with chemical noxes from cars equipped with MAS and MAC, in the context of the proposals of the World Health Organization regarding the reduction of the speed of traffic in the urban environment from 50 km/h, at 30 km/h, containing only one subchapter, we analyzed and interpreted the results of chemical noxes emitted by cars with MAS and MAC. The research was carried out on a hybrid car, six cars with petrol engines with European pollution standards between Euro 6 and Euro 3 and three diesel cars with European pollution standards between Euro 5 and Euro 3.

In chapter 11, entitled Analysis and interpretation of the results of the research carried out to determine the degree of noise pollution from vehicles equipped with MAS and MAC, in the context of the proposals of the World Health Organization regarding the reduction of the speed of traffic in the urban environment from 50 km/h, at 30 km/h, containing a single sub-chapter, we realized and interpreted the results of the noise emissions emitted and measured in the passenger compartment of vehicles with MAS and MAC. We carried out the research on a hybrid car with the European pollution standard Euro 6, six cars with petrol engines with the European pollution standard between Euro 6 and Euro 3 and three cars with Diesel engines with the European pollution standard between Euro 5 and Euro 3

In chapter 12, entitled Fuel consumption of vehicles equipped with thermal engines, containing only one sub-chapter, we carried out research on fuel consumption on passenger cars, following the following aspects: 1) fuel consumption of passenger cars in the context of the W.H.O. requirements for reducing the speed of traffic in the urban environment; 2) research on the fuel consumption obtained in the urban and extra-urban environment for passenger cars, compared to the fuel consumption approved by the manufacturer using the WLTP method.

In chapter 13, entitled Economic justification regarding the research addressed, structured in four sub-chapters, we made economic calculations on the quantities of fuel and CO_2 removed into the atmosphere by the thermal engines of the cars used in the experimental research process.

In chapter 14, entitled Mathematical model regarding the degree of pollution with chemical and noise pollution from vehicles equipped with MAS and MAC, structured in two subchapters, I presented and validated the mathematical model based on the results of the average values of chemical and noise pollution, emitted by the cars used in the experimental research process. At the end of the validation, we drew conclusions regarding the results obtained.

In chapter 15, entitled Final conclusions, original contributions and further research directions, structured in three sub-chapters, I drew the final conclusions, presented the original contributions and further research directions.

PART I.

THE CURRENT STATE OF KNOWLEDGE IN THE FIELD REGARDING THE INTEGRATION OF KNOWLEDGE MANAGEMENT IN THE SUSTAINABLE DEVELOPMENT OF ROAD TRANSPORT

Chapter 1. BASIC CONCEPTS OF THE ORGANIZATION, MANAGEMENT AND KNOWLEDGE-BASED ECONOMY IN ROAD TRANSPORT

1.1. The organization as a system

Within the society in which they operate, entities with an organizational structure create material goods or services necessary for people's daily living. The organization exists and functions by the association of a group of people who have common conceptions, concerns and ideals, united, in accordance with the provisions of a regulation or a statute, in order to carry out systematic activities.

1.2. The knowledge-based organization

The concept appeared between 1984-1988, then registering several phases of development.

Drucker defined the information society in which humanity irreversibly harmonizes as "a community of understanding and, at the same time, a collectivity of organizations" (Drucker P. , 1992, pg. 95-104).

There was then a variety of views on the term knowledge-based organization, leading to a significant number of interpretations, such as "mindfulness-focused organization" (Le Moigne, 1990, p. 94), or (Nurmi, 1998, pp. 26-32), which shows that "the organization is an intellectual-intensive firm", and (Hendriks, 1999, pp. 199-213) he calls it "an intelligent organization".

I am of the opinion that these organizations had the support of some resizing that completely improved the hierarchical forms, although they were an integral part of the era of industrial capitalism.

1.3. The learning organization

The concept of the learning organization was launched in 1990. Management experts at that time believed that learning within the organization was not functional and would lead to the disappearance of this type of organization from the market. Time, however, proved the opposite. This has proven to be the most effective and successful management method in the world.
The learning organization is made up of people, employees who learn, who transmit and produce new information every day.
Figure 1.4 shows the main activities of an organization that adopts the learning principle.

Fig. 1.4 The main activities of an organization that adopts the principle of learning (RoCoach Consult, 2022)

1.4. Knowledge -based management

Knowledge management or knowledge-based management is premised on capturing knowledge where it is created, then disseminating it to the organization's personnel, and finally implementing it in the production process. Since the 90s, the technological revolution has produced major changes in society, knowledge being forced even by economic globalization. In this context, under the pressure of information technology and communications, the concept of knowledge society was frequently used. For this reason, policies related to knowledge, knowledge, research, education, training and innovation have been of prime importance for the development of mankind in the midst of the rise of knowledge. The idea is supported that the transition to a knowledge society was achieved over time in stages, passing through periods of time related to their level of development.

In the personal conception, knowledge can also be obtained from the practice of other organizations.

1.5. The knowledge - based economy

The knowledge-based economy is defined as the concept that defines how knowledge is put to good use to benefit the organizations in which we work or the society in which we live. The basic principle is education and acquired knowledge, which are considered "the productive assets of a business, because they can be the first elements, of inestimable value in the realization of services or products" (Drucker P. , 1969). Some authors show that the four big changes that were of particular importance and that led to the conception of society based on knowledge are: the acceleration of knowledge productivity; increasing the microeconomic intangible capital load, as well as the macroeconomic one; innovation as a dominant diverse source; the revolution of tools and mechanisms by which knowledge is applied (David & Foray, 2003). In the personal view, the achievements of the presented sample of organizations are based on the knowledge baggage possessed by the employees, which are embedded in them.

1.6. Road transport organization

1.6.1. The elements that define the road transport organization

Considering the analysis carried out on the concepts of organization, management and knowledge-based economy, the main elements that define the road transport organization are: the organization has in its composition a group of people; the existence of one or more explicitly formulated goals; the existence of a form of rational, institutionalized structure; the group of individuals that make up the road transport organization interact.

1.6.2 Features of the road transport organization

Road transport organizations are complex structures, defined by the following features: a. The road transport organization is a technical-productive entity: b. The road transport organization is an administrative entity; c. The road transport organization is an economic entity; d. The road transport organization is a social entity; e. The road transport organization is defined as a decision-making center; f. The road transport organization functions as a system.

1.7. Conclusions

Changes in the structure of any organization take place within the system in which they find themselves and carry out their specific activities, being directly influenced by their relationships with the environment. The knowledge-based economy results in the knowledge revolution which is essentially the transition from an economy that was based on physical resources (land, machines, buildings, etc.) to a knowledge-based economy, which is the result of the development of the spectrum of knowledge in the mind people. Road transport organizations do not produce material goods. They produce transport services with vehicles or motor vehicles. The road transport organization differs from all others by the very specifics of the activities carried out.

Chapter 2. KNOWLEDGE AND KNOWLEDGE MANAGEMENT IN THE FIELD OF CAR TRANSPORT

2.1 Knowledge and typology of knowledge

Any organization can achieve outstanding results if it knows how to capitalize on its knowledge and if it relies more on the intellectual assets and knowledge held by employees than on material assets. In an organization, regardless of its profile, if existing staff do not leverage their knowledge to use the technology in the endowment, that organization does not function properly.

In the personal conception, knowledge represents the totality of information that the employees of an organization possess and which are acquired following a learning, educational process. As seen in figure 2.1, knowledge is placed higher than information. Knowledge is born from information when its user has the ability to understand the patterns based on it and can use it immediately or later.

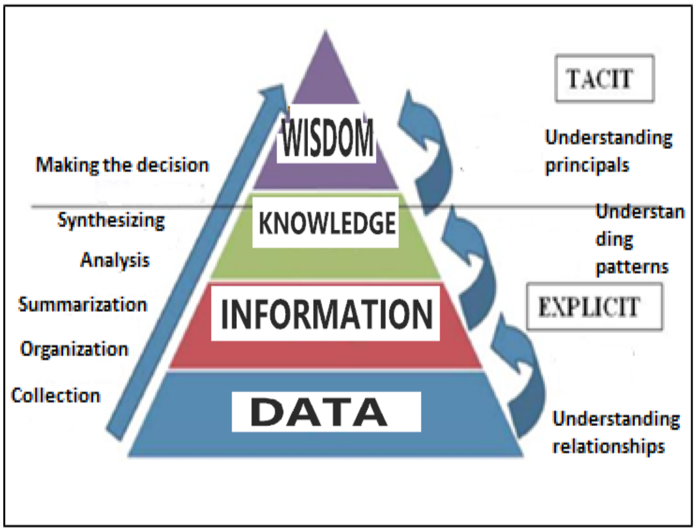

Fig. 2.1 Knowledge typology and theknowledge creation process (Iordache & Iordache, 2014, p. 172)

Some specialists claim that the top of the pyramid is occupied by the concept called wisdom, which represents the supreme stage in the evolution of the preceding concepts.

In my personal conception, it is not always enough for an organization to have the necessary knowledge to be successful. For the organization to be successful, the use of knowledge needs to be directed towards the customer and their needs.

2.2 The concept of knowlwdge management in the context of the research adressed

Knowledge management involves the dissemination of knowledge and the use of human capital with maximum efficiency, and this needs to be done when motivation, participation and knowledge sharing are almost instinctive and an integral part of the organization's daily activities. The concept of knowledge management in the field of road transport is premised on the capture of knowledge at the place where it is created, then it is necessary to disseminate it to the entire staff of the organization and finally, to implement it in the process of transporting goods or passengers (Țîțu, Neamțu, & Bulgariu, 2022).

Road transport services are perceived as high consumers of energy and financial resources, but their value is embedded in the final price of the transported goods or goods. In the end, the value of the transport is paid by the consumers, that is, by us, those who purchase the material good, the object transported by vehicles. For example, in the case of passenger transport, the value of the transport is given by the quality of transport services, passenger comfort or individual satisfaction. Travelers on public transport pay the price of a travel ticket. Most of the ticket price paid by the traveler goes to the account of the transport organization. The transport organization, in turn, pays a salary to the driver, who in fact, by exercising the function of driver, puts into value the knowledge acquired in the driving school, as well as those accumulated as a result of his specific training, that of driver of a means of public transport.

In the personal conception, the knowledge held by the members of an organization enables them to improve their performance in terms of creating, storing, sharing and exploiting knowledge. Knowledge management in the field of road transport improves the performance and experience of groups within the projects that the organization runs and minimizes the failure rate.

2.3 Knowledge management versus knowledge-based management in road transport

Regarding this aspect, it is also shown that knowledge-based management, approached as a science, consists in the study of knowledge-based managerial processes and relationships, in the discovery of the laws that govern them and in the design of new systems, methods or techniques, in order to increase functionality and the performance of organizations, capitalizing on the great values of knowledge. In formulating this definition, we started from the presumption that the foregrounding of knowledge within companies (as a resource, product, strategy, etc.) causes a fundamental change in managerial processes and relationships (Nicolescu O. , 2005) apud (Brătianu, 2015, p. 8).

My opinion is that the expression "knowledge" today has a different meaning, a broader meaning. At this time, knowledge represents science, learning, knowledge. Knowledge management in the field of road transport is an exclusive process of relevant organizations that is based only on the realization of the transport process, not being focused on identifying or validating the truth.

2.4 The importance of implementing knowledge management in road transport organizations

The implementation of knowledge management at the level of a road transport organization has a strong impact on it, with concrete manifestations on existing human capital and technology, on management and strategy. This impact is due primarily to the change, and secondly to the way the methods are organized. It is based on the technological factor and the way in which it is communicated at the level of the organization and it involves an accumulation of information of any nature.

In my personal conception, knowledge in the domain addressed is created by members of the organization at different positions in the hierarchy, and knowledge management has the role of making the connection between them. Managers and employees must create and disseminate in the organizational environment the knowledge they have accumulated through experience. They must understand that the tacit and explicit dimensions of knowledge are not disjoint, but they combine and complement each other. The development of knowledge is a uniquely human activity and will only progress through dialogue.

2.5 Knowledge management in the field of ecological road transport

Knowledge management in electromobility is the process of managing the knowledge, data and information held by an individual or organization about the electric car, its logistics and service infrastructure (Țîțu, Neamțu, & Bulgariu, 2022).

The lack of attractiveness and low popularity of electric vehicles is related to the low autonomy of electric batteries (defined by their capacity, charging time and the supply infrastructure, which is quite deficient in some European countries), but also to the high purchase price. To provide services in the field of road transport, there is a need for people trained in the field, who have the necessary knowledge to provide quality services to customers, in order to satisfy their needs and requirements.

Humanity depends on mobility at this time, and the electric car does not currently live up to our requirements as the classic car does, demonstrating efficiency exclusively in the urban environment. For now, due to the mentioned issues related to autonomy, power infrastructure and purchase price, it creates discomfort, delays and uncertainty about a smooth, fast and efficient transport. This is where innovation in the field of electric transportation technology must come in, which in the near future will solve and remove all the impediments that limit our access to electromobility.

2.6 Definition of knowledge in correlation with the ecological – clean concepts

The meaning of the term "ecological" in this context comes close to meanings such as "environmentally friendly", "harmless to nature", and has the connotation of correct behavior in relation to the ecosystems and habitats in which we live, the flora and fauna with which we coexist . If we think about the origin of the word, we will inevitably find the Greek words oikos - house and logos - science, that is, loosely translated, the science of the house. In this sense, the house represents the ecosystem or the habitat, in relation to the home, the village, the commune, the city in the country, the continent on the planet Earth, and science means knowledge. To know our house, to know everything about it.

To sustainably develop an ecosystem, an ecological habitat, everything must be done to preserve and keep it clean. An unpolluted environment is important for human health and the well-being of the habitats in which we live. Cleanliness within the ecosystem means its health and that of the inhabitants who live together. The noise and vibrations produced by road transport seriously affect the environment and human health. The climate changes that have occurred recently, the thinning of the ozone layer, the destruction of biodiversity and the soil produce serious effects on human health. Technology plays an important role in this case. The development, implementation and use of modern technologies in the field of electromobility will ensure an efficient, sustainable and energy-sustainable mode of transport. A special role in the sustainable development of ecological car transport is played by the sources from which the electric power comes from.

2.7 Conclusions

The knowledge acquired, accumulated and appropriated by the members of any organization enables them to improve their performance, facilitates their skills and potential towards their creativity, storage, sharing and exploitation throughout their life. In terms of performance, it was often the small organizations that possessed the necessary knowledge that achieved remarkable success, if they were able to rapidly capitalize on the potential of their domain knowledge. Of course, the basis of success was the transposition of the informational baggage into viable solutions, appropriate to each one's needs. Through the management of knowledge in road transport, the most important resources are developed that contribute to the smooth running of the processes necessary for the safe movement of goods or passengers. They increase the performance of the organization and eliminate what is old and obsolete. If an organization in the addressed field achieves that performance of identifying, applying and exploiting certain knowledge more quickly within it, success in the road transport market is guaranteed.

Chapter 3. SUSTAINABLE DEVELOPMENT AND SUSTAINABILITY IN THE FIELD OF CAR TRANSPORT

3.1 The concept of sustainable development versus the concept of sustainability

The concept of sustainable development was born during the world economic crisis of 1929–1933 and has since evolved to include all economic, social and human spheres. It is currently defining the new path of humanity.

At that time, the strong industrial exploitation of resources was harming the environment, and the concept was thought as a rescue from the ecological decline that would follow. Through the measures taken, an agreement was established between economic and social progress, without degrading the environment. The idea behind the concept is the superior quality of life of the current generations, but also of those who will follow. In the report Our Common Future, also known as the Brundtland Report and which became a reference document, being the first in which the term sustainable development was used, it was stipulated: sustainable development is the concept that seeks to meet current needs, without discredit the offspring's abilities to meet their own demands (Brundtland, 1986).

Sustainability derives from the term "to support", to provide support, support. It is defined by the quality of human actions to progress without fully consuming existing resources. Like sustainability, it ensures that balance between economic and social growth and environmental protection. With the emergence of the term sustainability, the concept that sustainable development is the foundation of human needs that improves the quality of life has been permanently developed in the minds of specialists.

I believe that, in its essence, the concept of sustainability refers to the responsible exploitation of resources and the environment from which they come, in order to increase economic efficiency in the medium and long term.

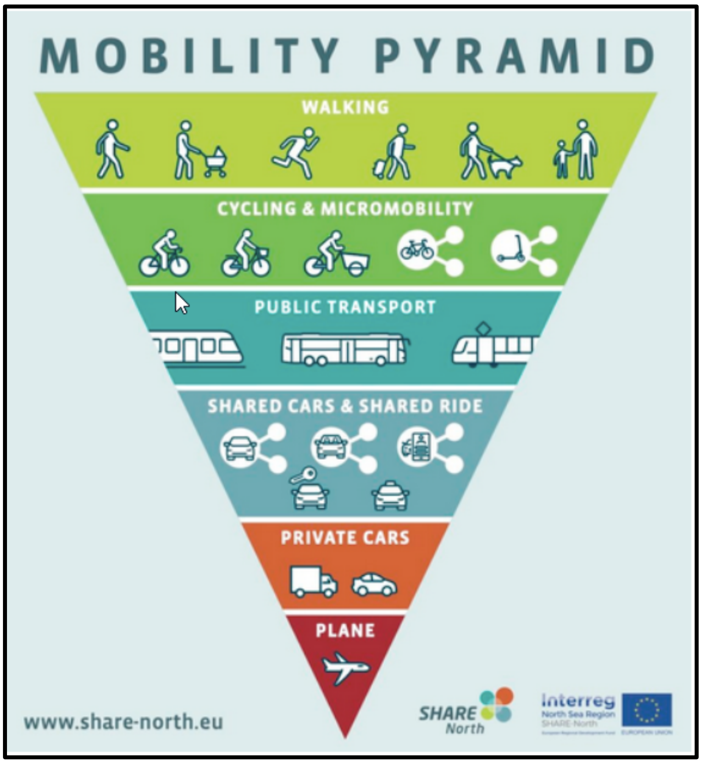

Fig. 3.1 The mobility pyramid for different modes of transport for a sustainable transport system (infoclimate, 2022)

3.2 The issue of sustainable development and sustainability in road transport

Figure 3.1 shows the mobility pyramid for different modes of transport, with a view to achieving a sustainable road transport system. The base of the pyramid, shown in light green, represents ecological, sustainable mobility. It is made up of ecological means of mobility (walking, cycling, public transport). These methods and means of transport should be used as often as possible to save resources. At the top of the pyramid are placed the least ecological means of transport (air transport and private cars, means of transport based on excessive consumption of energy resources). These means of transport should be avoided or limited as much as possible to save resources. It can be seen that the pyramid is arranged with the top down. This aspect suggests the claims of specialists (eg the top of the pyramid – dark red and orange – is represented by the means of transport that consume the most resources). The concept of sustainable transport is a fundamental element for ensuring human development and prosperity, and at this time, in order to ensure the mobility needs of mankind, it is considered to create a compromise between obtaining benefits and the constraints related to the cumulative effect that they have environmental costs and those associated with social needs.

3.3 Management of sustainable development in road transport

As a rule, the road transport organization is made up of a set of elements that make up a system characterized by work procedures, normative acts and operating rules that establish the concrete mode of action. The processes that take place in these types of organizations start from certain information that is processed by people with managerial functions, who, depending on them, make the decisions necessary to set in motion vehicles transporting goods or passengers. These aspects require structures of well-informed, multilateral and easily adaptable road transport organizations that have the ability to apply concepts and knowledge in the field so that they can easily adapt to the market through interchangeable skills (Doicin & Ulmeanu, 2015, p. 153). In making decisions, managers in the field of road transport use techniques and tools for coordination, management and control of specific activities. The techniques and tools by which the road transport activity is coordinated, managed and controlled must take into account certain factors, which are the basis of the sustainable development and sustainability of this sector.

3.4 Analysis of the road transport system in Romania

3.4.1 Road traansport infrastructure

If an analysis is made of the network of highways and roads existing at this date in Romania, it can be stated that before the Revolution of december 1989, only 113 km of highway were built. In the period after december 1989 and until 2007 when Romania entered the European Union (transition period), only 148 km were built and received, our country reaching a total of 261 km of highway. Between 2008 and 2017, our country accessed European funds for infrastructure development and managed to build another 487 km, reaching a total of 748 km of highway. At the end of 2018, the national highway network reached the figure of 823 kilometers built. Of these, only 101 km were completed in 2018, but only 60 km were put into use. After a long period of waiting, the 13 km of highway from lot no. 1, Sibiu – Boita, were put into use, so that, as of December 15. 2022, there is a total of 982 km of highway in Romania. At this time, Romania is in last place at the European level in terms of the number of kilometers of high-speed roads built per 100,000 inhabitants (Ministerul Afacerilor Interne - IGPR, 2022, p. 33).

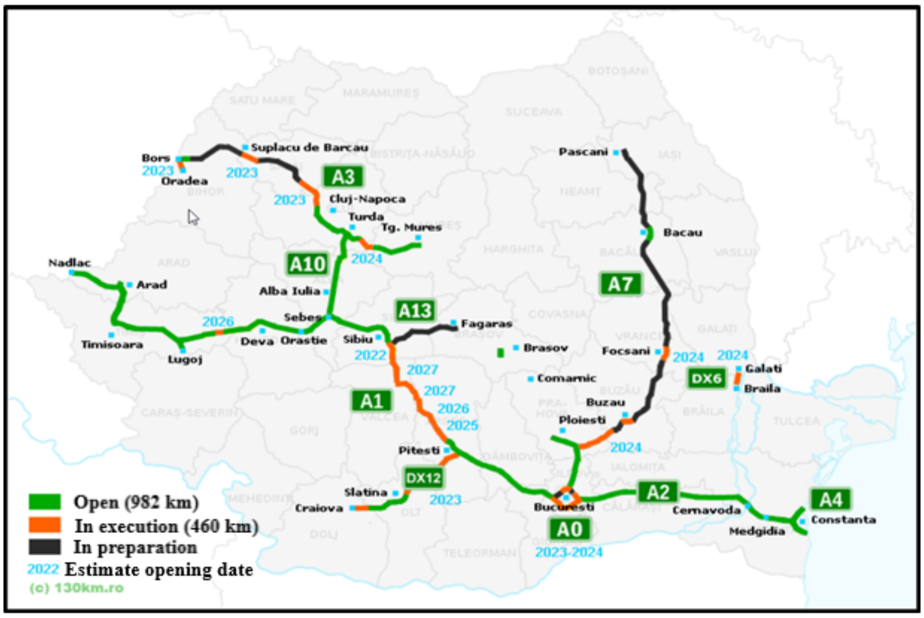

Fig. 3.2 The situation of existing highways in Romania on december 15 2022
(km.ro, 2022)

Figure 3.2 shows the situation of high-speed roads on December 15. 2022 in Romania, where the highways and open express roads are included, at this date in the execution stage. The routes of such roads that are in the proposal or feasibility study phase are also not included due to uncertainties regarding their execution (postponements, cancellations). The map is constantly updated and involves periodic (quarterly) changes, when routes of new roads or highways are opened.

The acute lack of high-speed infrastructure at the national level negatively influences the mobility index of goods and population (Neamțu & Țîțu, 2022). The mobility index, calculated as millions of vehicles x kilometers traveled, experienced continuous and sharp growth, so that in 2019 it had a value of 140%, much higher compared to 2010. The most spectacular increases from year to year were recorded in 2017 (21.5% increase) and 2018 (23.7% increase) (Ministerul Afacerilor Interne - IGPR, 2022, p. 33).

3.4.2 The national fleet of vehicles

According to the data provided by DRPCIV, cited by the Ministry of Internal Affairs in the Road Safety Bulletin for the year 2022, on December 31. 2021 Romania had an impressive fleet of road vehicles, reaching the figure of 9,661,483 units (fig 3.4) (Ministerul Afacerilor Interne - IGPR, 2022, p. 24).

Compared to 2020, the national fleet increased by a percentage of 4.7%, i.e. 336,312 vehicles (new and second-hand). Considering the rapid growth in recent years, it is estimated that at the end of 2023, Romania will pass the threshold of 10,000,000 units in road vehicle registrations.

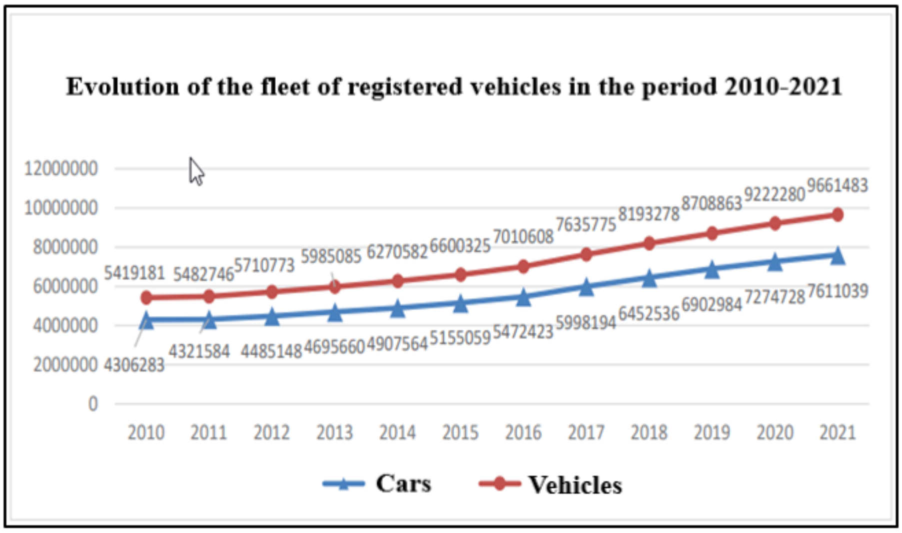

Fig. 3.4 Evolution of the fleet of registered vehicles in the period 2010 - 2021
(Ministerul Afacerilor Interne - IGPR, 2022, p. 25)

Analyzed through the prism of the distribution of motorized vehicles according to the fuel used at the end of 2021 (table 3.5), it is found that the number of diesel vehicles is higher than the number of gasoline vehicles. They have a share of 51.6% of all motorized vehicles.

Table 3.5 Distribution of mtorized vehicles according to the fuel used on December 31. 2021
Source: (Ministerul Afacerilor Interne - IGPR, 2022, p. 26)

Fuel type	Number of vehicles (units)	Percentage of total motorized vehicles
Benzine	3.964.225	41,3%
Diesel fuel	4.990.660	51,6%
Electric	13.310	0,1%
Hybrid	83.771	0,8%

If an analysis is made of the age of the passenger car fleet based on the data in table 3.6, it can be seen that at this date Romania has the oldest fleet of passenger cars in the European Union. At the end of 2021, the average age of the national fleet was 16.4 years, compared to the European average of 11.5 years. In this situation, we are at the bottom of the ranking in terms of this aspect, along with countries like Estonia and Lithuania. When it comes to new car registrations, our country ranks 16th out of 27 in the EU.

The aging of the national fleet of road vehicles has increased every year, and the number of cars older than 11 years has the highest share, 80.60% (table 3.6).

Tabel 3.6 Distribution of cars in the national park according to age on December 31. 2021 (years)
Source: (Ministerul Afacerilor Interne - IGPR, 2022, p. 26)

Seniority (years)	Number of car (units)	Percentage (%)
0 - 2	236.354	3,1
3 - 5	448.327	5,9
6 - 10	791.801	10,4
11 - 15	1.784.836	23,4
16 - 20	2.199032	28,9
> 20	2.150.689	28,2

3.5 Sustainability of road transport in Romania

In order for the proposed objective to produce its intended effect, for the development of road networks at the national level, certain reforms and investments will have to be made for implementation and development, in the component: sustainable transport, the pillar: the transition to a green community. Tables 3.7 and 3.8 present the main reforms and investments that Romania has proposed, as well as the financial funds necessary for the development of the road transport system, through the PNRR.

The content of the tables can be consulted in the doctoral thesis, which is submitted to the Polytehnic University of Bucharest library.

Fig. 3.9 presents the investments proposed by the Romanian authorities in the transport infrastructure, through the PNRR, submitted to the EC in 2021 by the Government of Romania. Both reforms and investments will be made on a reciprocal basis (Guvernul României; Ministerul Investițiilor și Proiectelor Europene, 2021):

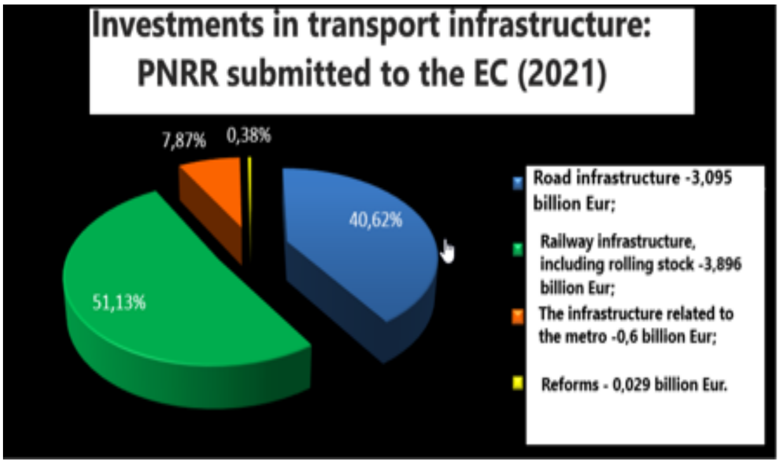

Fig. 3.9 Romanian Government investments in transport infrastrucure through PNRR 2021 (Bănescu, 2021)

- Climate policies at the European level (Comission, 2021);
- The European Green Pact (Comission, 2021);
- The EU plan regarding the climate objectives for the year 2030 (Commission, 2014);
- The European strategy on sustainable mobility (Commission, 2020, p. 8).

3.6 Conclusions

Through the sustainable development of urban transport, the efficiency of sales markets and the population's access to leisure activities can be increased, and through the development of the rural one, access to these markets is developed and ensured, production costs decrease and the rural economy unrelated to agriculture develops. Transport by motor vehicles outside cities, towns or villages, as well as external, develops internal and external trade through faster movement of goods and passengers. Accession to the Schengen area will further facilitate these aspects. By making transport services more efficient, a region develops faster in all aspects, facilitating the fruition of the skills and talent of the population, but also of natural resources. By protecting the environment and through a responsible use of resources, the sustainable and sustainable development of everything that will be left as wealth to our descendants can be ensured. The deficient infrastructure between regions, that between industrial or commercial centers, road traffic that transits villages, communes and cities, road traffic jams, the acute lack of high-speed infrastructure at the national level, negatively influence the mobility index of goods and the population. In 2020, Romania was not among the EU member states, whose intentions to recover must be approved by the European authorities through the PNRR. This aspect attracted criticism and created extremes of public opinion on the Romanian political scene.

Chapter 4. THE ECOLOGICAL VEHICLE - A STEP FORWARD FOR THE SUSTAINABLE DEVELOPMENT OF CAR TRANSPORT

4.1 The vehicle with thermal engine

4.1.1 Presentation of the vehicle with thermal engine

Automobiles are now the most precious means by which man satisfies his mobility needs. This aspect is due to the great benefits they offer to users. Sometimes cars turn out to be priceless collectibles owned by those who really know them (Boroiu & Țîțu, 2011).

In addition to technology, civilization, comfort and ergonomics, we add the dynamics and speed with which material goods, goods or people move in space. The classic automobile begins in 1769, when the steam engine was invented and used to transport goods or passengers (Eckermann, E, 2001).

4.1.2 SWOT analysis for thermal engine vehicles. Comments

The motor vehicle is the basic element of the road transport system. Due to its popularity and ease of operation, it is still preferred by users over the electric motor vehicle. Many drivers find it simpler and easier to fill the tank with petrol, LPG or diesel, get behind the wheel and drive 1,000-1,200 km without worry or stress, rather than looking for a car charging station electric. The charging time, which is defined by the power of the station, must also be taken into account. Currently, the electric car presents a series of disadvantages, which make humanity not ready for electromobility. We present below a SWOT analysis of the heat engine car, from which it derives its advantages and disadvantages.

The SWOT analysis for thermal engine vehicles can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

Due to environmental pollution, starting from the middle of the 20th century, the authorities of highly developed countries around the world consider environmental issues absolute priorities and develop laws, regulations, directives to support, reduce and remedy the destruction caused by polluting factors released uncontrolled in nature, to prevent future environmental contamination.

4.2 The vehicle with hybrid propulsion

4.2.1 Presentation of the vehicle with hybrid propulsion

Hybrid vehicles appear for the first time on the market with the manufacture of the Japanese Toyota Prius model in 1997, which became available on the world map in 2000. The Toyota Prius is one of the best-known and best-selling series hybrid cars worldwide, which -proven qualities regarding reliability over time. Since the debut of this model, it is said that the hybrid car market has developed and also become very interesting considering the demands of the customers in the recent period of time.

4.2.2 SWOT analysis for hibrid vehicles. Comments

This type of car has the advantage that, in addition to the thermal engine, it also has 1-2 electric motors, which contribute to propulsion or even provide it. If the battery can be charged to an electrical power network, has a high autonomy and can provide the energy needed to set the 1-2 electric motors in motion without starting the heat engine, then the hybrid car demonstrates maximum efficiency and effectiveness. In addition to all these aspects, the satisfaction of the user also increases, which saves financial resources and does not have to worry about filling up with gasoline too often. In the following, a SWOT analysis is presented, from which the advantages and disadvantages of the car with hybrid propulsion emerge.

The SWOT analysis for hybrid vehicles can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

Management systems integrated in hybrid vehicles ensure switching between electric, hybrid and internal combustion propulsion systems without affecting passenger comfort. In this sense, the electronic control system has permanent access to the data from the sensors of the internal combustion engine, the electric control unit, the state of charge of the accumulators, etc. The management system analyzes, adjusts and controls in real time the interaction between the two propulsion systems (Ehsani, Gao, & Gay, 2005). The advantage of combining the two types of engines consists in the fact that, when going down a slope or decelerating, the thermal engine stops or operates at idle, and the electric engines work in regenerative mode (electric generator mode), the kinetic energy thus obtained being sent and stored in electric accumulators. Propulsion systems that have in their composition, in addition to a conventional system with an internal combustion engine, at least one more system that provides traction torque to the wheels of the vehicle and that recovers part of the kinetic energy obtained during deceleration. These are called regenerative hybrid propulsion systems (Andreescu & Cruceru , 2006, pg. 10-12).

4.3 The vehicle with electric propulsion

4.3.1 Presentation of the vehicle with electric propusion

The first electric vehicle appeared in the world at the end of the 1800s. At the beginning of the 1900s it dominated every classic vehicle. In fact, there were over four thousand vehicles in the US at the time, according to research, and up to 30% of them were electric. The smell and vibrations produced by conventional automobiles using steam or gasoline had become unbearable at that time, and people were increasingly interested in the opportunities that arose in the alternative to polluting automobiles. Another reason why people were reoriented was the ease with which this type of automobile was driven. Conventional automobiles were started manually, and driving them required extra attention when changing gears. Steam-powered motor vehicles did not require manual gear shifting, but they had another drawback of taking a long time to start.

4.3.2 SWOT analysis for electric vehicles. Comments

Two of the basic advantages of electric motors are the following: they provide maximum torque at any rpm and are quiet in operation. However, in the world, the problem of the autonomy of these vehicles is far from being solved. Currently, the electric vehicle demonstrates its efficiency exclusively in the urban environment. To be effective in the extra-urban environment, the autonomy of electric traction batteries must be developed and extended. The reduced autonomy is one of its biggest disadvantages. In the following, a SWOT analysis is presented from which other advantages and disadvantages of the electric vehicle emerge.

The SWOT analysis for electric vehicles can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

The following comments constitute a personal point of view:

a) The electric car has a high purchase price. This price is imposed by the technology used. If the authorities of the European states will no longer grant the eco-bonuses for the purchase programs specific to each country (e.g. in Romania, 10,000 euros for the dedicated program), the price of the electric car will increase by 40-50%, and those who want such vehicles will not they will also allow to financially support the total purchase price, which has become unattractive (20,000-35,000 euros) compared to a vehicle with an internal combustion engine. b) If the price of electricity will increase, reaching the value of 1.95 lei/Kwh, this type of vehicle is no longer efficient and becomes unattractive. In this case, according to some calculations, traveling 100 km with an electric vehicle becomes equivalent to traveling the same distance with an internal combustion engine vehicle; c) A major problem for electric vehicle owners is the supply infrastructure for electric batteries, which in some states is deficient; d) Then there is the issue of maintenance. The skilled repair workforce is, like their market, in training and development; 5. It is assumed that local public authorities will no longer grant discounts on taxes and fees; e) Replacing the propulsion battery, if it fails or at the end of its life, is relatively expensive.

4.4 The vehicle powered by hydrogen – fuel cells

4.4.1 Presentation of the vehicle powered by hydrogen – fuel cells

It is the second use of hydrogen, in fuel cells, that can provide efficiency and effectiveness. In this case, through oxidation-reduction reactions at the level of the anode, respectively the cathode, the hydrogen is converted into electrical energy, which supplies the electric propulsion motors of the automobiles, and only water results in the exhaust pipe.

In this case, the efficiency decreases only after 250,000 km driven by the car, when it is necessary and appropriate to replace the battery. A fuel cell is more expensive than an electric battery. It follows from this that, where cutting-edge technology is involved, there will also be a commensurate price for the purchase of a new car, powered by hydrogen converted into electricity by means of fuel cells.

4.4.2 Swot analysis for the vehicle powered by hydrogen – fuel cells

In addition to the electric vehicle, the vehicle fueled by hydrogen in fuel cells is another source of efficient and non-polluting human movement. Using hydrogen as a power source in fuel cells, the oxidation-reduction process converts its energy into energy that powers the electric propulsion motors of this type of automobile. Hydrogen is a cheap, efficient, non-polluting, but dangerous fuel. Sophisticated and demanding and therefore expensive technologies are used for its storage. However, hydrogen is believed to be the energy source that will meet humanity's mobility needs in the future.

Hydrogen fuel cells only prove their efficiency if the hydrogen used for combustion is obtained from renewable sources (e.g. water electrolysis) (Carmo, Fritz, Mergel, & Stolten, 2013).

The SWOT analysis for electric vehicles can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

In my opinion, beyond these considerations, the big challenge this fuel variant presents to end-user acceptance is the instability of hydrogen itself. Liquid hydrogen is quite difficult to handle, requires special transport methods and must be stored at high pressures. Hydrogen car tanks require special construction and must be armored with explosion-proof materials (eg kevlar), because in the event of a car accident the hydrogen can explode. The pipes and connections of the hydrogen supply installations must be perfectly sealed and away from any heat source, because hydrogen ignites when it comes into contact with hot engine parts. These are some reasons why people do not want such automobiles.

4.5 An analysis of the propulsion types of motor vehicles

The classic engine car has reached its peak – meaning that it is now in decline – while the electric car is winning the competition. More and more states are banning the use of polluting cars. The imposition of ever-increasing taxes and fees for the use of such vehicles, the banning of access to vehicles with diesel engines with low pollution standards (Euro 1-3) in certain areas of large European cities is not a random phenomenon, but a reality since increasingly consistent. This aspect causes the citizens of those cities to turn to electromobility. It is considered that the authorities of the European states must legally compel public transport organizations on urban and interurban routes, as well as carriers of goods and people, to renew their vehicle fleets with new, modern, ecological, environmentally friendly vehicles, simultaneously with taking measures to decommission and scrap old, polluting, physically and morally worn automobiles. In this sense, it is necessary to strengthen the environmental legislation regarding the pollution with noxes from the thermal engines of motor vehicles.

4.6 Conclusions

The classic motor car is coming to an end, as more and more states ban the use of polluting cars. The imposition of ever-increasing taxes and fees for the use of such vehicles, the banning of access to vehicles with Diesel engines with a certain pollution class (euro 1-4) in certain areas of large European cities is not a random phenomenon, but a reality. The electric car has the opportunity to develop, being on the rise. This will only happen if technology evolves rapidly and other methods are discovered to ensure human mobility. It is considered that the hybrid, electric or hydrogen-fuel cell vehicle, taken in comparison with the thermal engine vehicle, represents at this time the most viable form of ecological transport. Both the electric car and the hydrogen fuel cell car are only effective as long as their direct energy source (electricity and hydrogen respectively) is obtained from ecological, green, renewable sources.

Chapter 5. THE CURRENT STATE OF MODERN ECOLOGICAL CAR TRANSPORT

5.1 The main polluting factors in current road transport

a) Chemical pollution (exhaust gas pollution) occurs as a result of the release into the atmosphere of toxic gases resulting from the processes of burning a fossil fuel (based on carbon) in the internal combustion engines of automobiles. Exhaust gas emissions have the following particularities: they are eliminated very close to the roadway (ground), an aspect that creates high concentrations at low altitudes. This effect is quite dangerous due to the fact that low-density gases have the ability to easily diffuse into the surrounding environment; it is carried out on large areas, especially in very crowded cities. Here, concentrations of harmful gases have their maximum effect when road traffic is high, and the possibilities of street ventilation are diminished by nearby construction elements.

The most important noxes eliminated by thermal engines in the atmosphere are: carbon dioxide (CO2), hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO2).
Carbon dioxide (CO2) results from the combustion of carbon-based fuels in the cylinders of heat engines.

• *Carbon monoxide (CO)* is formed due to the low combustion efficiency of thermal engines. It has the property of accumulating in large quantities in conditions of intense traffic and atmospheric calm, especially in winter and spring, due to its chemical stability at low temperatures

• *Hydrocarbons (HC)* are chemical compounds made up of carbon and hydrogen. As pollutants, they come from unburnt fuel released by heat engines into the atmosphere.

• *Nitrogen oxides (NOx),* combinations of nitrogen and oxygen in various proportions, result mainly from the combustion process of diesel fuel in internal combustion engines. In combination with water in the atmosphere, it generates acid rain that has destructive effects on buildings and vegetation.

• *Other harmful substances* resulting from the transport process by motor vehicles are: volatile organic compounds (VOC), soot, asbestos, dust particles, lead compounds, benz-α-pyrene, aldehydes and heavy metals.

b) Noise pollution it is represented by the noise produced by automobiles during operation and is created by the frictional forces between moving parts or organs relative to each other. Noise pollution is also produced by cars in motion when the tires come into contact with the road and when the air rubs against the exterior elements of the bodies. In terms of audibility, the perceived intensity of sounds varies between 0 and 120 dB(A). Normal conversational noise is in the range of 30-60 dB(A). The lower limit from which hearing is considered to suffer over time, in case of prolonged exposure, is 85 dB(A). Intensities of 140 dB(A) and above create a painful sensation and possible serious hearing damage.

c) Vibrations are transmitted to the ground (roadways) and the surrounding air by the suspensions and running systems of moving vehicles, respectively by the sound produced by their running engines.

5.2 Promoting responsability towards environmental protection in road transport

From the data researched so far and from those presented by the EEA, it can be seen that the average pollutant emissions for new motor vehicles registered in the EU member states (27 countries), to which Iceland, Great Britain and Norway are also added, were 122.4 grams of CO2/km in 2019, with an increase of 1.6 g compared to 2018. Although these emissions were below the target set by the EU for the year 2018, of 130 g/km, however pollutant emissions increased, instead of decreasing. Consequently, in 2020 the European Commission established even tougher measures regarding CO2 emissions from motor vehicles. They will not have to exceed the value of 95 grams of CO2/km, compared to the level of 2019. Therefore, European car manufacturers are obliged to refer exactly to this figure, if they do not want to incur penalties. In order to reduce harmful gas emissions, to decarbonise road transport and to reduce the growing greenhouse effect, the European Commission is further tightening environmental protection legislation and asking all Member States to propose and introduce new incentive schemes of the population to readjust their vision of purchasing new, non-polluting, environmentally friendly vehicles.

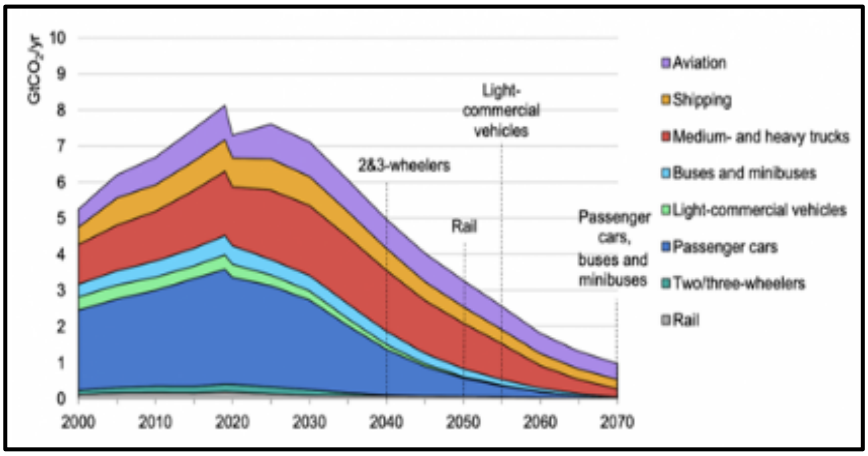

Fig. 5.5 The scenario regarding the sustainable and sustainable development of the transport sector worldwide, for the period 2000-2070 (IEA, 2021, p. 154)

5.3 The current situation in the problem of environmental pollution worldwide

In general, transport, as a branch of the industry of the countries of the world, emits enormous amounts of noxes into the atmosphere. For the coming decades, it is claimed that the demands on human mobility are expected to increase as the world's population continues to grow, incomes increase, living standards rise, people's appetite for travel increases and the automobile becomes the preferred mode of transportation.

The graph (fig. 5.5) represents a strong decrease in CO2 worldwide at the beginning of 2025, due to the introduction of new technologies, green, ecological means of transport. According to global pollution policies, certain transport sectors and sub-sectors will decarbonise over several decades. According to these policies, the IEA shows that polluting gas emissions will be gradually eliminated worldwide, as follows: from motorcycles, until 2040; in the railway sector, until 2050; for low tonnage vehicles, until 2060; and for passenger cars and buses, until 2070 and even beyond, with the total disappearance of carbon-based fuels.

5.4 European policy in the field of ecological vehicles

5.4.1 European policy on gas emissions from motor vehicles

The future strategies of the EU transport policy are focused on the decarbonisation of this sector. In this sense, in 2018 the European Commission developed some long-term strategies to reduce the impact on the climate, the main objective being to reduce to zero the emissions of gases that produce the greenhouse effect by 2050.

Speaking on the basis of the figures, with regard to the decarbonisation of road transport, EU policies on exhaust gas emissions in this area are set by legislation and have the following objectives in mind (Comisia Europeană, 2018) : reduction of CO2 emissions by 37.5% for new cars; reduction of CO2 emissions by 31% for new vans; reducing CO2 emissions by 30% for new trucks, with an intermediate reduction target of 15% by 2025; by 2025, car manufacturers are obliged to ensure at least 2% of the new vehicle sales market with low-emission and zero-emission vehicles.

All these percentages will be ensured until the year 2030, taken in comparison with the year 2019.

5.4.2 European policy in the field of ecological vehicles

In order to achieve the objective proposed by the European Commission of reducing greenhouse gas emissions to zero, an objective that must be achieved by 2050, EU policies in the field of electromobility are currently focused and act on the following main directions: financial incentives to reduce the cost gap between electric vehicles and those with an internal combustion engine; exemptions or reductions of local, national taxes and taxes for owners or transport organizations with their own fleets; free access to toll roads; free parking spaces on the territories of European states; cancellation of the first registration tax for hybrid and electric vehicles; facilitating access to areas or cities where access is restricted for vehicles with classic engines, for a certain pollution norm; programs for the implementation of the electricity charging infrastructure of the accumulator batteries of ecological vehicles; information campaigns in order to sensitize the population to orient themselves towards this type of vehicle, by presenting their benefits.

Regarding urban transport, according to the 2011 White Paper, the EU has also proposed an extensive development program through the introduction of alternative fuels and electric propulsion systems. In this direction, the following objectives are considered: halving the circulation of vehicles with internal combustion engines within cities, by 2030; their gradual elimination from the urban environment, until 2050; creating pragmatic logistics in congested cities without CO_2 emissions by 2030.

5.5 Current European standards regarding gas emissions from motor vehicles

Threshold values, in accordance with the European emission standard for internal combustion motor vehicles, apply for the following air pollutants: carbon monoxide (CO), nitrogen oxides (NOx), all hydrocarbons (HmCn) and particulate matter (P.M). Threshold values vary depending on the type of engine fitted to road transport vehicles and are constantly revised by the European Parliament. The limit values of the concentrations of pollutant emissions from the combustion gases of the internal combustion engines regulated by the EU, which are the subject of the pollution standards and the date of their entry into force, are presented in table 5.1.

Table 5.1 Limit values for European pollution standards and their entry into force date

Norm of pollution limit / Values (g/km)	Euro 1	Euro 2, ID	Euro 2, IID	Euro 3	Euro 4	Euro 5	Euro 6
CO	2,72	1,0 (63,24%)	1,0 (63,24%)	0,64 (36%)	0,50 (21,88)	0,50 (0%)	0,50 (0%)
NO_X	-	-	-	0,5	0,25 (50%)	0,18 (28%)	0,08 (55,56%)
$HC + NO_x$	0,97	0,70 (27,84%)	0,90 (7,22%)	0,56 (37,78%)	0,30 (46,43%)	0,23 (23,33%)	0,17 (26,09%)
PM	0,14	0,08 (42,86%)	0,10 (28,57%)	0,05 (50%)	0,025 (80%)	0,005 (80%)	0,005 (0%)
Date of entry into force of the norm (day/month/year)	01.07.1992	01.01.1996	01.01.1996	01.01.2000	01.01.2005	01.01.2009	01.09.2014

NOTE: The values in parentheses show the percentage reduction of the newly implemented pollutant emissions norm compared to the pollutant emissions from the previously presented pollution norm standard. Vehicles whose engine operates by indirect injection (IID-Euro 2) have been imposed minimum exhaust gas limits identical to those with direct injection engines (ID-Euro 2). The requirement was imposed on 30.09.1999. The Euro 5 pollution norm was applied to all types of vehicles, starting from January 1, 2011.

5.6 Research in the field of ecological vehicles

On this topic, the interest in the field of ecological, non-polluting vehicles at the EU level was triggered, which focused on five main areas of research, as follows: internal combustion engines; biofuels; hydrogen fuel cells; electric and hybrid vehicles; the infrastructure for powering electric cars.

As far as internal combustion engines are concerned, research has shown a reduction in the emissions of harmful gases resulting from the combustion of fossil fuels, gasoline and especially Diesel engines, some of the most polluting engines. The result is known: the appearance of internal combustion engines with the Euro 6 pollution standard. This initiative represents the technological leap towards more sustainable and greener mobility at the European level. Biofuels have been and are being researched for their wider use in internal combustion engines, either exclusively or mixed in various proportions with petrol or diesel. In this regard, of their exclusive or mixed combustion, the resulting percentage of noxes will be followed. The technological progress that has been achieved allows cars on European roads to use a mixture of conventional fuel and biofuel without problems. Blends containing 10% or more biofuel are already being used in some countries (Parlamentul European, 2003, p. 170). The issue of using hydrogen fuel cells to power green cars has been discussed since March 2007 by a group to implement a European technology platform entitled: "Hydrogen and fuel cells". In this area it is considered that little has been done, although substantial budgets have been allocated. Although the European authorities have established by legislation rules, methods and plans for the development and research of fuel cells, however, on European public roads, no vehicles using this type of clean energy are seen driving. In the field of electromobility, a field related to ecological vehicles, the research was carried out in a public-private partnership (cPPP) and was financed by the European Investment Bank (EIB), from research grants from the framework program number seven of the EU, but also from the private sector. This initiative cost the EU 5 billion euros in total and was launched in 2009 as a constituent element of the "Smart, Green and Integrated Transport" reference within the Horizon 2020 programme. The initiative was taken as a result of the global economic crisis in 2008 and was completed through 113 collaborative research projects.

5.6.7 A point of wiew on the implementation of project in the field of electromubility

Regarding the implementation of these projects at the European level, several aspects should be mentioned, as follows: 1. These projects remained at the local level and were not applied on a large scale. It would be necessary to apply them on a large scale at the European level in all countries, including the Eastern European countries; 2. It would be necessary to supply electric vehicle charging stations with energy from renewable sources; 3. It would be useful for the authorities of European countries to grant some facilities and subsidies, in order to purchase home charging devices for home users; 4. It would be useful to equip the community parking lots of housing blocks with charging stations for electric vehicles; 5. A measure of disincentive for the use of classic motor vehicles would be the gradual reduction of subsidies granted by the state authorities, until their total elimination, simultaneously with the development of the process of switching to electromobility; 6. It would be worth investing in the consolidation and development of the smart road project, where the electric car can be charged on the go (in Sweden there are already two kilometers of road built that can charge electric cars on the go with the help of induction loops); 7. It is necessary to implement and develop programs to popularize electric cars among the citizens of Eastern European countries.

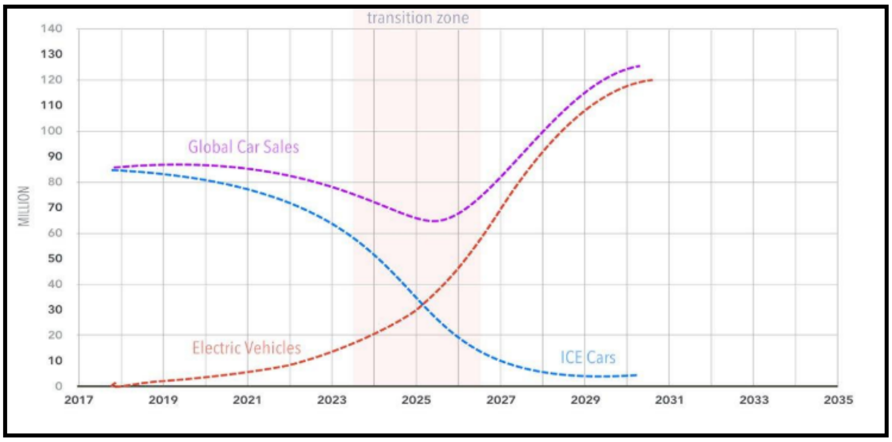

Fig. 5.10 The evolution of electromobility worldwide between 2017 and 2030
(Tessien, 2018)

5.7 Challenges and trends regarding the future evolution of green vehicles

Regarding the current context regarding EU policies regarding the decarbonization of transport systems, it is considered to be a period of opportunities that may arise for profile organizations, natural or legal persons, who will know how to prepare in time for geo-political changes current majors and will develop robust mechanisms to respond to all issues and events occurring worldwide.

Figure 5.10 shows the evolution of cars with a classic engine versus electromobility worldwide, in the period 2017-2030. According to the graph, at the end of this decade (the year 2030), the decline of the internal combustion engine car will begin. In this context, the number of electric vehicles is set to grow rapidly from the middle of the next decade.

Following the research carried out, the approximate charging time for a 24 kW electric battery, as well as the relevant energy requirement, is determined (table 5.2):

Table 5.2 Approximate charging time for a 24 kW electric battery and energy requirement
Source: (Noon, 2012, p. 46)

Loading time (hours)	Power supplied (kW)	Voltage (V)	Current (A)	Module*	Upload speed
10,4	2,3	230 AC	10	2-3	Slow
8,3	3	230 AC	13	2-3	Slow
6,5	3,7	230 AC	16	2-3	Slow
3,2	7,4	230 AC	32	3	Accelerated
1,6	14,5	230 AC	63	3	Accelerated
1,04	23	230 AC	100	3	Accelerated
0,29	50	400-500 DC	100-400	4	Fast
0,15	100	400-500 DC	100-400	4	Fast

According to the IEC 61851-1 standard, four modes of charging electric cars are approved (Noon, 2012, p. 47).

5.8 Conclusions

The chemical reactions that take place in a catalytic converter transform harmful chemicals into safer and more environmentally friendly substances, like this: hydrocarbons (HmCn) and oxygen (O_2) are transformed into carbon dioxide (CO_2) and water vapor (H_2O); carbon monoxide (CO) and oxygen (O_2) are converted into carbon dioxide (CO_2); nitrogen oxides (NO) and hydrogen (H_2) are converted to nitrogen (N_2) and water vapor (H_2O). Carbon monoxide is a dangerous gas that, when inhaled instead of oxygen, causes death by blocking hemoglobin (the compound that carries oxygen in the blood). Nitrogen oxides (NOx) have similar toxic effects. Photochemical smog is formed from hydrocarbons resulting from unburned fuels, in combination with nitrogen oxides from the exhaust gases of automobiles, following a complex mechanism that includes a whole series of chemical reactions, catalyzed by the sun's rays. Also, in the composition of smog there are fine water droplets formed by the oxidation of hydrocarbons, which affect visibility. Currently, electromobility is defined by certain disadvantageous technical conditions, especially in terms of autonomy, which makes the user prefer the classic car for the time being. Due to the fact that they are silent, electric vehicles are not audible to pedestrians, which can generate panic and road accidents. It is necessary to equip all electric vehicles with sound generators. In terms of maintenance, the electric car will completely change the service activity. Annual inspections of electric vehicles are much simpler and visits to repair shops are less frequent, as a result of high reliability. Maintenance being totally different, until the number of electric cars increases, specialists in this field will have to be trained and trained in vocational schools, high schools and specialized faculties. Service units will have to completely readjust their repair process and work procedures, stock up with workshop equipment, SDVs and control, verification and diagnostic equipment. The governments of the European states will propose to the relevant ministries to foresee these objectives in order to realize them as soon as possible, in order to fulfill the requirements of the electromobility policies. In Romania, the number of specialists trained in the troubleshooting, diagnosis and remediation of technical faults occurring in the various types and brands of electric cars is currently insufficient, so the owners of such vehicles are forced to carry out maintenance operations at service workshops outside the country.

Chapter 6. QUALITY AND QUALITY MANAGEMENT IN THE FIELD OF ECOLOGICAL CAR TRANSPORT

6.1 Definition of quality. Characteristics of transport services with environmenally friendly vehicles that determine quality

6.1.1 Definition of quality

The term quality has its origins in the Latin language and would translate to "the way of being". From this translation, however, and to the meaning of today, this term had to travel a long way, it acquired different definitions depending on the field of applicability, having to make a huge leap to be perceived by modern man (Agency International of Energy, 2020), (Țîțu & Oprean, 2006).

The most common definitions of quality are: *fit for use* (Juran, 1988); *according to the requirements* (Crosby, 1979).

International standards from the ISO 9000:2015 family are applied in transport (Asociația de Standardizare, 2022) , where terminologies for quality management systems are found. In the chapter of terms that refer to quality we find definitions and notions about quality, characteristics, requirements, processes, organization, products-services, supplier and customer. Of course, the transport activity also requires reporting to other families of standards, such as those related to the environment, through the ISO 14001:2015 standards (DNV, 2022) – the requirements of an environmental management system and ISO 14064-1:2018, ISO 14064-2:2019 (ASRO, 2022). The latter refer to organizations that remove GHG (greenhouse gases) into the atmosphere.

6.1.2 Characteristics of transport services that influence quality. Particularities in the case of electromobility

The technical parameters specific to means of transport with electric propulsion are the following: autonomy of the electric battery; charging time of the electric battery; the existence, number and capacity of charging stations at the end of the line or on the route; the weight of the electric vehicle (which is greater than the classic vehicle, due to the electric motor, batteries and related equipment). These parameters can lead to a decrease in the quality of electric vehicle transport services, in the context of the following general characteristics of road transport services.

1 The beneficiary does not own the means of transport or the service provided;
2. The inseparability of the transport service from the infrastructure elements;
3. Lack of tangibility of the transport service;
4. The variability (heterogeneity) of the transport service;
5. Perishability of the transport service.

6.2 The quality of services with clean ecological vehicles

6.2.1 Espected quality of transport services with ecological road vehicles

The expected quality of transport services with ecological road vehicles refers to what the beneficiaries of the transport services (goods or passengers) want, explicitly or implicitly.

6.2.2 The desired quality of transport services with ecological road vehicles

The desired quality of the ecological road transport service refers to the level of quality set as an objective by the road transport provider or organization.

6.2.3 The achieved quality of transport services with ecological road vehicles

The achieved quality of the service with clean road vehicles shows us the level of quality provided as a function of time (usually daily), seen from the perspective of passengers, in the case of the transport of passengers by means of public transport, or of goods, for the transport of goods or material goods with goods transport vehicles.

6.2.4 Perceived/ achieved quality of green road transport services

Thanks to the experiences acquired and accumulated over time, travelers or customers have the ability to appreciate the quality of a transport service offered by a certain profile organization.

6.3 Factors influencing the quality of ecological road transport services

In the case of road transport organizations that have different means of transport in their fleet, regardless of the specifics and type of services provided (goods or passengers), the quality of the activities carried out is influenced by internal or external factors.

6.3.1 External factors influencing the quality of ecological road transport services

The external factors that influence the quality of transport services with ecological vehicles are:
a) natural factors; b) technical and technological factors; c) social, political and cultural factors; d) economic factors; e) legal factors; f) factors related to the suppliers' environment; g) factors related to people's level of knowledge and education.

6.3.2 Internal factors influencing the quality of ecological road transport services

Internal factors that influence the quality of hybrid or electric vehicle transport services relate to the organization, climate and internal policies of road transport organisations. Such factors are: a) the structural set of the organization; b) specific processes and activities carried out in the organizational environment; c) the human resource with its values and knowledge. People's attitude towards the work done.

6.4 Indicators for assessing the quality of ecological road vehicles

Table 6.2 presents the main assessment indicators of the quality of ecological vehicles, the requirement to which the quality indicator relates, the way in which the expected quality is influenced and the corrective measures that must be applied for compliance.

The table with the main assessment indicators of the quality of ecological vehicles can be consulted in the doctoral thesis that can be found at the Polytehnic University of Bucharest library.

6.5 Conclusions

A low autonomy of accumulator batteries, combined with a higher weight of vehicles, a long time allocated to its charging, a high price for their purchase, but also the insufficiency, lack or low power of charging stations create and produce discomfort, delays, the non-fulfillment of tasks, transport plans and programs on time creates stress, insecurity and mistrust among customers, but also non-conformities in ensuring quality services with such vehicles. The quality indicators of ecological vehicles are defined by the way in which a hybrid or electric car satisfies the degree of expectation of the driver (user or owner), the customer or the passenger (beneficiary of the transport service), in a defined time interval . In this case, the period of time can be interpreted as: the entire life cycle of the car, the period of its ownership by the owner, a trip on a certain route or travel itinerary, a transport of goods or passengers, the loan period or renting a vehicle, etc. Quality indicators represent the totality of a set of attributes that define the green car, which are based on and are in fact defined by the systems and installations that make up and enhance ergonomics, safety and comfort.

Chapter 7. ROAD SAFETY AND ITS MANAGEMENT IN THE CONTEXT OF THE SUSTAINABLE DEVELOPMENT OF THE ROAD TRANSPORT SYSTEM

7.1 Guidelines and policies of a technical-economic nature regarding road safety

Road safety is an issue of major importance in the policies of the European Union. Through the policy of a technical and economic nature carried out by the European Parliament to improve the quality and safety of vehicle traffic on European roads, based on the Regulation of the European Parliament and of the Council (PE-CONS 82 of October 18. 2019) amending Regulation (EU) 858 of May 30. 2018, European parliamentarians come up with new proposals on equipping vehicles with safety systems to protect passengers, pedestrians and cyclists. They became mandatory from January 1. 2022 and consist of the following obligations to which all vehicle manufacturers on the European continent must refer: (Comisia, 2019)

a) **For cars and light vehicles:** systems that help the driver to maintain the lane; emergency braking systems and seat belts with improved crash tests; expanding the impact protection zones for the head of pedestrians, cyclists and motorcyclists in the event of a road accident;
b) **For trucks and buses:** systems to improve the direct visibility of bus and truck drivers; systems that eliminate blind spots; vehicle-mounted front and side systems that detect and warn of the presence of vulnerable road users such as pedestrians and cyclists. The latter are necessary and support drivers of heavy vehicles when turning.
c) **For cars, light vehicles, trucks and buses:** warning systems for situations when the driver falls asleep at the wheel or is not paying attention to the road (e.g. using mobile phones or other gadgets while driving); intelligent speed control assistance systems (ISA); warning systems and visibility when driving backwards; on-board recorders in the event of an accident ("black box"); immobilizer systems with breathalyzer (Neamțu G. , Țîțu, Pop, & Bogorin - Predescu, 2022); systems that ensure emergency braking of the vehicle; TPW tire pressure monitoring systems (some manufacturers have already adopted this system).

7.2 Road safety and road safety management at European level

In 2021, at the level of the European Union, the number of deaths caused by road traffic increased by 5% (1,000 deaths) compared to 2020, representing a number of 19,823 loss of human life. At the same time, there were 13% fewer deaths (3,000) reported in 2019, before the start of the pandemic period (Ministerul Afacerilor Interne - IGPR, 2022, p. 7).

At the level of the European Union, in recent decades road safety has improved appreciably, and if a parallel is made with what is happening worldwide in this regard (1.35 million deaths and 50 million bodily injuries), it can be stated that European countries currently have the safest road transport systems in the world, with almost 44 deaths per million inhabitants (the rate of deaths from road accidents fell from 68 in 2010 to 44 in 2021) (Ministerul Afacerilor Interne - IGPR, 2022, p. 7).

Cumulatively, at European level, cumulative road accidents produce approximately 500 victims per week. Deaths are no longer accepted in other transport systems, and neither are they accepted in the road system, and this premise will have to be introduced into the road safety decision-making process. It is very important, and at the same time necessary, to implement the "Safe System" at EU level as soon as possible. As part of the Europe on the Move package from May 2018, the European Commission presented a medium-term strategic action plan, but also a new approach to public road safety policy.

7.3 Road safety and road safety management in Romania

If an analysis is made of the main indicators that define road events recorded in 2021, an increase in the number of minor accidents is noted. In 2021, 5,356 more events with low impact occurred in Romania, representing a 32.4% increase compared to the previous year. In this case, there is a 3.7% (+80) increase in the victims of road accidents who were slightly injured. Regarding serious road accidents, in 2021 at national level there were 1,356 fewer compared to the previous year (-21.6%), while the number of bodily injuries (deaths or serious injuries) in such events was down 1,559, representing a 21.9% decrease (Ministerul Afacerilor Interne - IGPR, 2022, p. 8).

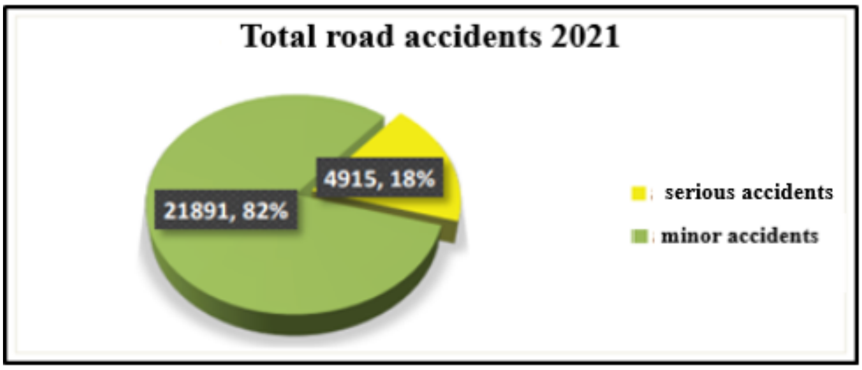

Fig. 7.2 The total numbers of road accidents at national level in 2021 (Ministerul Afacerilor Interne - IGPR, 2022, p. 34)

Figure 7.2 shows the total number of road accidents by category, produced at national level in 2021, and figure 7.3 shows the situation of road accidents produced at national level in 2020 and 2021, and in fig. 7.4 presents the mortality index for the same period.

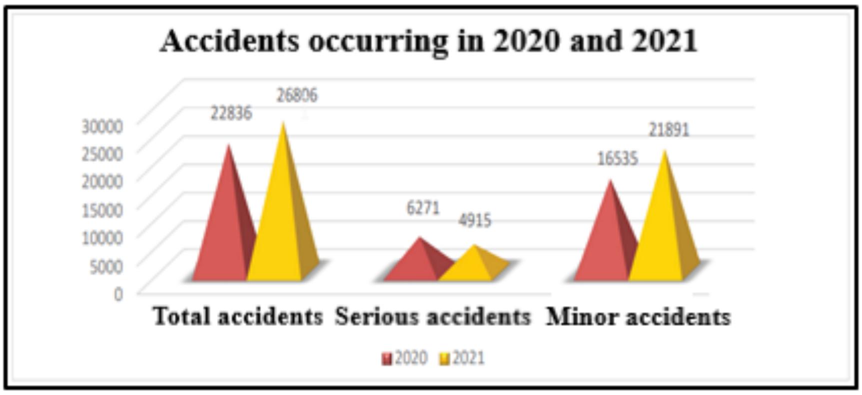

Fig. 7.3 The situation of road accidents occurring at national level in 2020 and 2021 (Ministerul Afacerilor Interne - IGPR, 2022, p. 36)

Based on these data, the statistics show that Romania's performance in the field of road safety has not improved in the last year. The fatality index increased from 26.2% in 2020 to 36.2% in 2021, determining the number of people who died in all serious road accidents (Ministerul Afacerilor Interne - IGPR, 2022, p. 10).

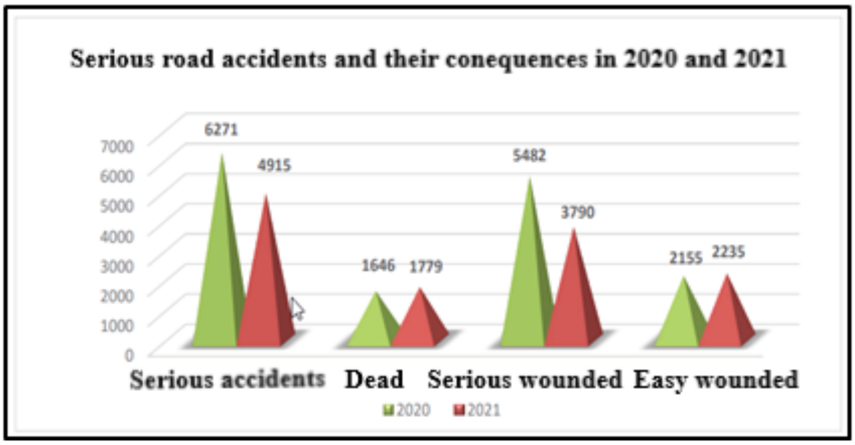

Fig. 7.4 Motality index recorded at national level in the years 2020 and 2021 (Ministerul Afacerilor Interne - IGPR, 2022, p. 36)

The most vulnerable categories of traffic participants were pedestrians, cyclists, motorcyclist and old people in rural areas, but, compared to pedestrians, cyclists are numerically less represented among the deceased. In the year 2021 in the rural environment the mortality index has a weight of 37.2% compared to the urban environment, where it has a weight of 22.3% (Neamțu G. , Țîțu, Pop, & Bogorin - Predescu, 2022).

The number of deaths resulting from road accidents is slightly increasing compared to the previous year due to the increase in the number of deaths following events produced in rural and extra-urban areas. In the urban environment there are decreases of 24.6% compared to 2021 in terms of the number of serious road events (with 581 fewer serious road events), but also in terms of the human consequences of serious road events (with 49 fewer deaths and 638 fewer serious injuries).

In rural areas, serious road accidents decreased by 22.05% (with 542 fewer serious road accidents), instead there were 35 more deaths and 678 fewer serious injuries. Also, in the extra-urban environment in 2021, 16.1% fewer serious road accidents were recorded compared to the previous year (-235 accidents), with 99 more deaths and 378 fewer seriously injured people (Ministerul Afacerilor Interne - IGPR, 2022, p. 11).

The main causes of road accidents are: non-adjustment of traffic speed to traffic conditions; indiscipline of pedestrians; not giving priority to pedestrian crossings; traffic violations by cyclists; failure to give priority at intersections.

Failure to adapt vehicle speed to road conditions is the main cause that generated in 2021, 25.7% of all road accidents caused by young people between the ages of 18 and 29. According to the data presented in figure 7.9, the main causes of serious road accidents caused by young drivers in 2021 are still (Ministerul Afacerilor Interne - IGPR, 2022, p. 71):

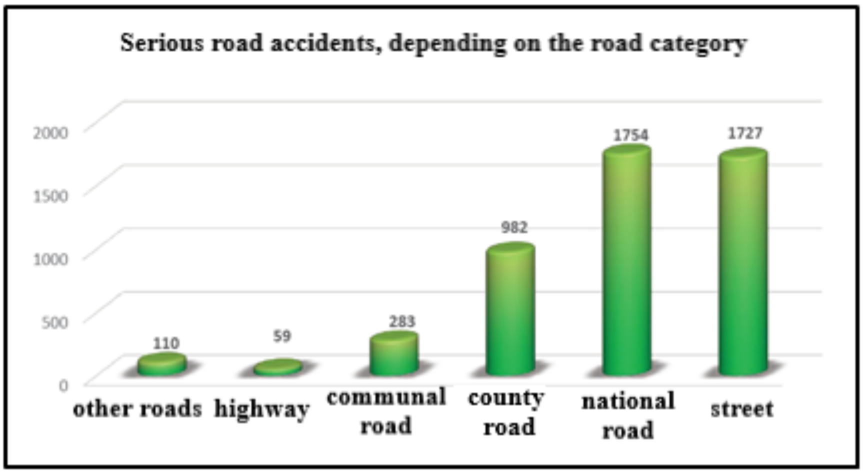

Fig. 7.9 The serious road accidents that occurred in 2021 in Romania, depending on the road category (Ministerul Afacerilor Interne - IGPR, 2022, p. 37)

From the analysis of the data in fig. 7.9 shows that the failure to adapt the speed of vehicles to road conditions is the main cause of serious road accidents caused by young people. It is also observed that young people are guilty of more than 1/3 of the serious road accidents that had as their main cause the speed not adapted to the road conditions.

Another source of serious road accidents within the road transport system is the road infrastructure, which in our country is deficient both in urban and non-urban areas. Depending on their category, roads continued to cause casualties among road users in 2021. That is why it is important to highlight how deficiencies and non-conformities in road infrastructure cause casualties among drivers, pedestrians or travelers, lead to significant destruction of material assets and goods or create significant damage to the road transport system. Figure 7.11 shows the serious road events that occurred in 2021 in Romania, depending on the road category.

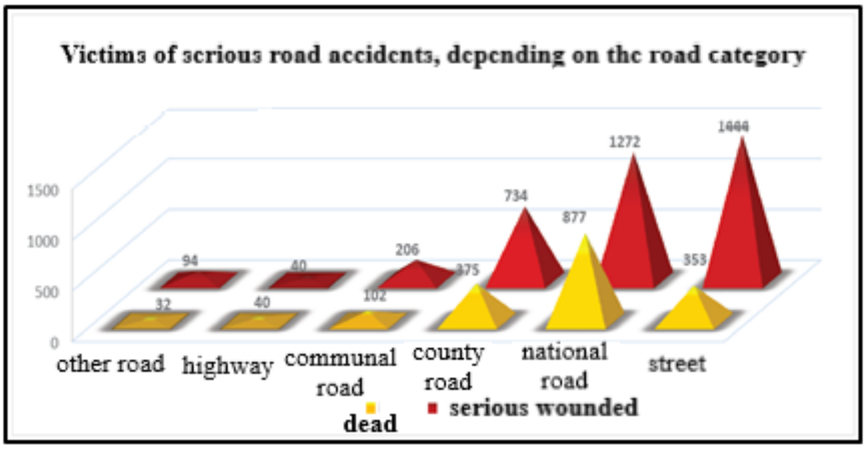

Fig. 7.11 The number of victims resulting from serious road accidents in 2021 in Romania, depending on the road category (Ministerul Afacerilor Interne - IGPR, 2022, p. 38)

In this sense, in the urban environment the street is the first category generating serious road events (35.1%), and in the extra-urban environment national roads are the second category of road communication routes that have generated a multitude of serious events, quantifying a percentage of 35.7% of their total.

Although serious road incidents decreased on all road categories, compared to the previous year, the most significant reductions in their number were achieved on national roads (-246 incidents, 12.3%) and on urban streets (more slightly with 611 road incidents, having a lower weight by 26.1%) (Ministerul Afacerilor Interne - IGPR, 2022, p. 37).

It is found that 49.3% of all road traffic participants died on national roads in 2021 as a result of road accidents. Serious road accidents on national roads are twice as many as those on urban streets. The situation is similar to that of 2020, where the national road was categorized as the road communication path that created the most victims among traffic participants. Although it ranks second in the ranking of serious road events, accidents generated on urban streets have the lowest mortality rate. The low frequency of road accidents is noticeable on the highway. The highway is, at this time, the safest artery for road traffic. At the same time, when road accidents do occur on the highway, they have devastating effects, due to the volume and intensity of traffic, as well as the high speed of travel, which is demonstrated by the highest death rate.

National roads, by their characteristics and specifics, invariably represent the scene of a high number of serious road accidents, with many victims and often with deaths. Constructive elements such as bridges, tunnels, intersections, railway level crossings, curves, with their special characteristics, do not seem to necessarily influence the occurrence of serious road accidents. Of the total number of serious road events produced during 2021, almost 2/3 of them happened on sections of the roads that did not have special characteristics. Intersections and curves presented the highest risk potential. Compared to the previous year, in 2021, serious road accidents occurring on curved roads were reduced by 293 events (28.3%), and those occurring at road intersections were reduced by 271 events (25.5%).

7.4 Analysis of the current state of development of autonomous vehicles

Autonomous vehicles are means of transport that, using artificial intelligence and electronic devices, can perceive, analyze and make decisions on their own to move on the roads, in the absence of human intervention in real time.

7.4.1 Devices and core elements specific to level 2 and 3 auonomous vehicle automation

For the perception of pedestrians, vehicles, objects or other traffic elements, autonomous vehicles **use video cameras, ultrasonic radar sensors and redundant power steering.**

A. Video cameras. The video cameras can be positioned anywhere on the vehicle body to transmit images in a full 360 degree angle, segmenting the perception area. They can be monocular (a single imaging sensor and a single lens) or binocular (stereo), with two sensors and two lenses.

Stereo video cameras segment the images and transmit them to a computer that analyzes them based on deep learning algorithms, transforming them into information such as the type of traffic sign found on the side of the road, the color of the electric traffic light positioned on the corner intersection, transverse and longitudinal markings on the road surface, etc. Based on this information, it acts on the control systems of the autonomous car.

B. Ultrasonic radar sensors support video cameras by providing additional information. If the video sensors see their functionality reduced in certain conditions (rain, snow, fog), this type of ultrasonic sensors transmit clear, prompt and accurate information to the computer regardless of the visibility regime. As a principle of operation, radar sensors emit electromagnetic waves around them, waves that reflect on the surrounding objects and return to the transmitter. The data thus obtained is then transmitted to the vehicle's computer, which combines it with that obtained from the video cameras. In this way, a precise mapping of the area in the vicinity is carried out.

C. Power steering with redundancy system. The steering system is the basic element of the movement of any vehicle in space. It is specific to each means of transport and is adapted to the environment on/in which the respective vehicle moves (land, air, water, underwater).

The maneuverability of the steering system of a land vehicle is directly influenced by the number and type of mechanical elements that make up the steering mechanism, but also by the frictional forces of the main elements that interact during operation.

7.4.2 Automation levels of autonomous vehicles

According to SAE (Society of Automotive Engineers), there are five levels of automation in the field of self-driving vehicles. Following the technological evolution of autonomous vehicles, the EC established a calendar regarding the implementation of automation levels until 2030, according to a calendar presented in figure 7.21.

Currently, the cutting edge of technology for autonomous vehicles is level 4 automation, and other functions related to autopilot are only at level 3 automation, and they are in full research and development on current production vehicles.

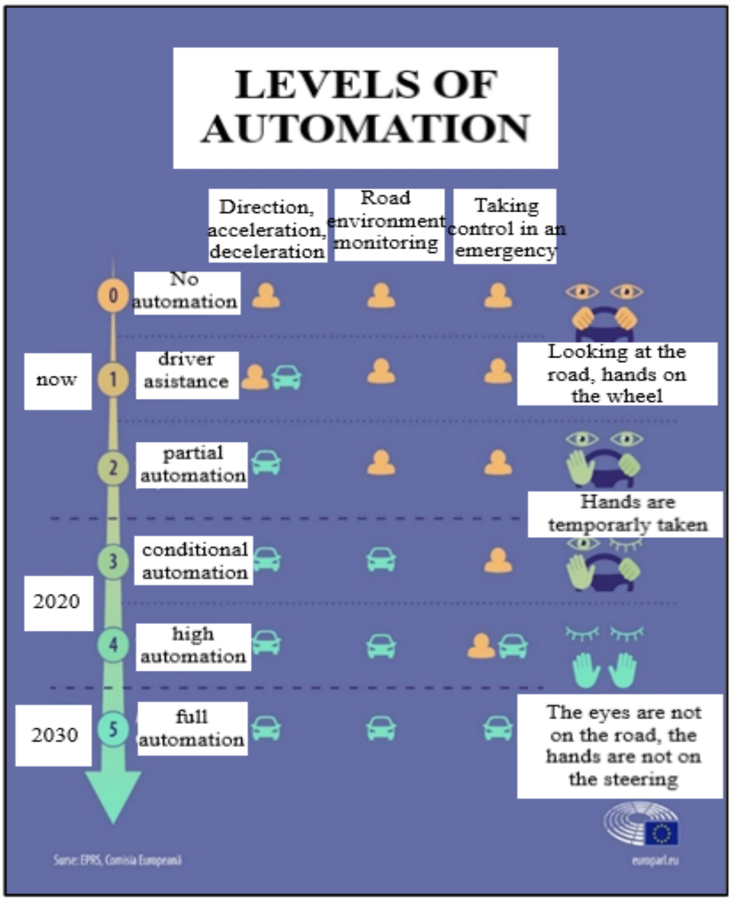

Fig. 7.21 Levels of automation of autonomous vehicles and the timing of their implementation (Parlamentul European, 2022)

7.4.3 Functions specific to automation levels

The specific functions of each level of automation for autonomous vehicles are as follows:

A. For the level of automation regarding assisted driving of the motor vehicle: the pilot function for automatic parking; remote parking assist function; evasive steering support function; function for automatic emergency braking;

B. For the partial automation level of the motor vehicle: roadside assistance function; integrated cruise assistance function (cruise speed control, lane departure warning); traffic jam assistance function;

C. For the level of complete and high automation of the motor vehicle: the pilot function in the urban environment; road/highway pilot function (lane keeping, traffic sign recognition, automatic high beam); autopilot function when stuck in traffic.

7.5 Evaluation of the level of automation of driving assistance systems for the Toyota hybrid car

In table 7.3 an evaluation of the driving assistance systems existing at this date on Toyota hybrid cars was made. This evaluation represents a personal point of view and is based on a car driving on public roads in Romania.

The evaluation was based on research on the personal car and is the author's own, original contribution. Here are presented all the shortcomings that were noticed by the user during operation, presenting the stage/level of development, the way in which the automations intervene on the behavior of the car in traffic.

The table with the evaluation of the existing driver assistance systems on Toyota hybrid cars can be consulted in the doctoral thesis found at the Polytehnic University of Bucharest library.

7.6 Conclusions

90% of road accidents on European roads are due to human error. For all series vehicles built in the European Union, starting from January 1, 2022, a series of safety and driver assistance systems will be introduced in the basic construction variants. They are in full research to develop and move them to the next level of automation. It is believed that in the near future they will lead to the achievement of the proposed target, namely the total automation of road vehicles, contributing to the reduction of the number of deaths and bodily injuries.

It is estimated that the safety systems that will be fitted to motor vehicles will save more than a quarter of a million human lives and prevent around 150000 serious injuries by the year 2038. They will contribute to the achievement of the objective proposed by the EU, under the long-term program long entitled "vision zero", that is zero deaths and serious injuries by the year 2050.

PART II

RESEARCH ON THE DEGREE OF CHEMICAL AND NOISE POLLUTION FROM CARS EQUIPPED WITH MAS AND MAC, IN THE CONTEXT OF THE W.H.O. PROPOSALS REGARDING THE REDUCTION OF TRAFFIC SPEED IN THE URBAN ENVIRONMENT

Chapter 8. RESEARCH METHODOLOGY APPROACHED IN THE CONTEXT OF THE DOCTORAL RESEARCH THEME

8.1 Research motivation

The motivation for scientific research started from the high level of greenhouse gas pollution and noise pollution caused by road vehicles, but also from the large number of victims of road accidents.

The aspects of the motivation of the research are justified in the following, as follows:

MOTIVATION I. The W.H.O. proposal on reducing the speed of vehicle traffic in the urban environment from 50 km/h to 30 km/h

In May 2021, with the occasion of Global Road Safety Week, W.H.O. director Dr. Tedros Adhanom Ghebreyesus proposed that the speed of road vehicles in cities around the world be legally limited to 30 km/h. For the USA, the limit would be 20 land miles, or 32.2 km/h (Biziday, 2021). The measure is proposed with the aim of protecting the lives of all road users, as well as reducing the level of chemicals and noise. In order to reduce the number of deaths and injuries caused by road accidents, but also the pollution with exhaust gases, noise and vibrations, many European countries, including our country, have already approved, to varying degrees, the measure of speed reduction of traffic at 30 km/h on city streets.

Considering these aspects, I set out to demonstrate practically, through experimental research, whether by reducing the speed of road vehicles in the urban environment from 50 km/h to 30 km/h, the level of chemical pollution is also reduced emitted by cars into the atmosphere.

MOTIVATION II. Noise pollution produced by motor vehicles in road traffic. The influence of vehicle noise on user comfort

The bibliographic research shows that currently, at European level, 20% of the population is affected by road traffic noise, which means that the objectives regarding noise pollution in Europe have not been reached. The high level of noise and vibrations produces various effects on human health, creates discomfort (22 million cases annually), sleep disorders (6.5 million cases annually), negatively affects the cardiovascular system (48,000 cases of ischemic heart disease annually) , the metabolic system (12,000 premature deaths per year), but also cognitive disorders in children (more than 12,000 children have difficulty reading).

Until now, the problem has not been raised to demonstrate whether these two components of a car's comfort (acoustic and vibrational) are reduced or not by reducing the speed of traffic. Considering the above, I set out to practically check whether by reducing the speed of road vehicles in the urban environment, the level of noise pollution in the cabin of some road vehicles with different comfort classes is also reduced.

MOTIVATION III. Choosing the most significant car brands for research

The choice was made on the basis of bibliographic research, by accessing several websites, especially websites of new or used car dealers, local or national magazines or newspapers and national TV stations. The first criterion was the frequency of appearance of the respective brand in the first 5-10 car brands preferred by Romanians. The second criterion was the age of the vehicles preferred by Romanians (new, respectively used, bought second-hand). From the research carried out, it is known that Romanians' appetite for second-hand, physically and morally worn, much more polluting, but cheaper vehicles is greater than for the purchase of a new, more non-polluting or even ecological vehicle (hybrid or electric). The third criterion for choosing the brands was defined by the top of the car brands purchased by the residents of Sibiu county.

Conclusion: Taking into account the above-mentioned car brand classifications and specified selection criteria, we decided that the research on chemical and noise pollution, as well as on fuel consumption, should be carried out on the following brands: 1. Dacia/Renault; 2. Volkswagen; 3. Ford; 4. Toyota. Selected car brands will have MAS and MAC. The European pollution standard of the selected vehicles is included in the Euro 3 - Euro 6 range.

8.2 Research directions

With reference to the W.H.O. proposal to reduce the traffic speed in the urban environment from 50 km/h to 30 km/h and starting from the data presented previously, the following research-development and innovation directions can be considered: the selection, in following an analysis of the most representative brands of vehicles equipped with MAS and MAC, at national level and in the city of Sibiu; research on the level of chemical (exhaust gases) and acoustic pollution in the passenger compartment of vehicles equipped with MAS and MAC, having Euro 2, 3, 4, 5 and 6 pollution standards, under the conditions of traffic in the urban environment at a speed of 30 km/h, 50 km/h and in highway mode (130 km/h); research on fuel consumption in vehicles with MAS and MAC; economic justification on fuel consumption and CO_2 emissions for vehicles with MAS and MAC; creating a mathematical model that validates the average values of chemical and phonic noises, obtained through experimental research.

8.3 The main objective of the research activity

The main objective of the doctoral research topic is the following***: Design and implementation of a generalized technical model, experimentally validated, of the operation of knowledge-based road transport organizations, respecting the principles of sustainable development.***

8.4 The specific objectives of the research activity

a) For part I of the doctoral thesis, entitled: "*The current state of knowledge in the field regarding the integration of knowledge management in the sustainable development of road transport",* we established the following specific objectives: ***Specific objective no. 1.*** Study of the road transport organization from the perspective of the knowledge-based organization; ***Specific objective no. 2.*** Study of knowledge typology and knowledge management in the field of road transport; ***Specific objective no. 3.*** Analysis of the current state of the management of the sustainable development of road transport at the national level; ***Specific objective no. 4.*** Analysis of the stage of development, the place and role of the ecological vehicle in the sustainable and sustainable development of road transport; ***Specific objective no. 5.*** Analysis of the current state of ecological car transport and pollution standards. Research in the field of ecological vehicles; ***Specific objective no. 6.*** Quality analysis and quality requirements in modern ecological road transport; ***Specific objective no. 7.*** Road safety analysis and road safety management in the context of sustainable development.

b) For the second part of the doctoral thesis, entitled: *"Research on the degree of chemical and noise pollution in vehicles with MAS and MAC, in the context of the W.H.O. proposals on reducing the speed of traffic in the urban environment from 50 km /h at 30 km/h",* we set the following specific objectives: ***Specific objective no. 1.*** Contributions and research regarding the degree of pollution with chemical and noise pollution from cars equipped with MAS and MAC, in the context of the W.H.O. proposals regarding the reduction of traffic speed in the urban environment; ***Specific objective no. 2.*** Contributions and research on the fuel consumption of cars equipped with MAS and MAC; ***Specific objective no. 3.***

Economic justification of fuel consumption and chemical pollution; ***Specific objective no. 4.*** Creation and validation of a mathematical model for chemical and acoustic noises emitted by cars with MAS and MAC.

8.5 Working hypotheses

The hypotheses on which the research was built are the following: ***I.1*** *Limiting the speed of traffic in the urban environment from 50 km/h to 30 km/h involves fuel consumption and pollution with toxic gases, lower vibrations and sounds;* ***I.2*** *Cars with hybrid propulsion, although they are part of the category of ecological road transport, are generators of polluting chemical emissions, due to the thermal engines mounted on them;* ***I.3*** *At low speeds (30 km/h), car engines operate at a higher rev level, and the level of noise pollution increases;* ***I.4*** *When moving vehicles on a highway route, the thermal engine operating at a higher speed regime, the tire-carriage contact and the friction of the vehicle with the air increase the level of chemical and acoustic noise.*

8.6 Research methodology

The research methodology, with specific approaches, decisions and tools, was intended to achieve the requirements of the main objective of the doctoral research activity and to create the premises for further research.

The stages of the research are: preliminary theoretical - experimental research; advanced theoretical - experimental research; data interpretation and processing; mathematical modeling; final conclusions, original contributions and further research directions.

Chapter 9. REGULATORY ACTS AND ORGANIZATIONAL MEASURES RELEVANT TO RESEARCH ON THE DETERMINATION OF THE DEGREE OF CHEMICAL AND NOISE POLLUTION FROM CARS EQUIPPED WITH MAS AND MAC, IN THE CONTEXT OF THE WHO PROPOSALS TO REDUCE TRAFFIC SPEED IN THE URBAN ENVIRONMENT FROM 50 KM/H TO 30 KM/H

9.1 Reference data on chemical emmissions from vehicles with MAS and MAC

In accordance with the provisions of Annex no. 13 to the regulations, in table 9.1 we presented the legal limit values for the main exhaust gases emitted by vehicles with MAS and MAC. Based on these limit values, in the ITP stations the traffic on public roads as "technical good" is approved or not for vehicles that perform the periodic technical inspection.

Table 9.1 Legal limit values for the main exhaust gases emitted by motor vehicles with MAS and MAC (Ordinul ministrului transporturilor 2.133, 2005).

Vehicle type	CO (%)		CO_2 (%)		HC (ppm)		NO (ppm)	
	Low engine speed (rot/min)	2.000-3.000 rot/min	Low engine speed (rot/min)	2.000-3.000 rot/min	Low engine speed (rot/min)	2.000-3.000 rot/min	Low engine speed (rot/min)	2.000-3.000 rot/min
Vehicle registred until 1986	4,5		Not specified		< 1.000		Not specified	
Vehicles registred since 1987	3,5		Not specified				Not specified	
Vehicles with pollution norm EURO 3-4*	0,5	0,3	Not specified		Not specified	< 100	Not specified	

Vehicle type	CO (%)		CO_2 (%)		HC (ppm)		NO (ppm)	
	Low engine speed (rot/min)	2.000-3.000 rot/min	Low engine speed (rot/min)	2.000-3.000 rot/min	Low engine speed (rot/min)	2.000-3.000 rot/min	Low engine speed (rot/min)	2.000-3.000 rot/min
Vehicles with pollution norm EURO 5-6**	0,3	0,2	Not specified		Not specified	< 100	Not specified	

Note: The yellow colored columns in table 9.1 are the subject of research. The cars used in the experimental research fall within the European pollution standards Euro 3, 4, 5, 6 and are subject to the legislation in force.

9.2 Reference data on noise emmisisons emitted by motor vehicles

In table 9.2 we presented the legal limit values of the sound level according to the specifications in Appendics III of the Regulation on the sound level of motor vehicles, issued by the European Commission on April 16. 2014.

Table 9.2 The legal limit values of the measured noise level, in accordance with the specifications of Appendix no. III of the Regulation on the sound level motor vehicles (Comisia, 2014).

Vehicle category	**Description of the vehicle category**	**Limit values expressed in dB(A) [decibels (A)]**		
		Stage 1 applicable to new vehicles from July 1, 2016	**Stage 2 applicable to new vehicles from July 1, 2020 and for the first registration from July 1, 2022**	**Stage 3 applicable to new vehicles from July 1, 2024 and for the first registration from July 1, 2026**
Vehicles for the transport of persons of category M				
M_1	Power – to -weight ≤ 120 kW/1.000 kg	72(*)	70(*)	68(*)

Note: The column colored yellow in table 9.2 is the subject of research. The noise produced by the cars used in the experimental research falls within the sound value of 72 dBA.

9.3 Power to mass ratio (PMR)

In order to fit each car on which I conducted experimental research into the legal norm regarding noise pollution according to Annex III of the Regulation on the sound level of motor vehicles, issued by the European Commission on April 16. 2014 (table 9.2), it was necessary to calculate the power mass ratio (PMR).

The power to mass ratio (PMR) is determined with the mathematical relationship (Comisia, 2014, p. 131):

$$PMR = (P_n/m_t) \times 1.000 \text{ [kW/kg]} \quad (9.1)$$

where,

P_n represents the nominal power and is measured in kilowatts (kW);

m_t - the total mass of the vehicle and is measured in kilograms (kg).

The table with the Power to Mass Ratio (PMR) calculated for the vehicles for which noise emissions were determined can be consulted in the doctoral thesis that can be found at the Polytehnic University of Bucharest library.

9.4 Harmful tresholds of combustion gases from motor vehicles

The harmful threshold of combustion gases is defined by the maximum value of the chemical substance that exceeds a so-called concentration in atmospheric air, measured in a certain time interval. The unit of measurement is the cubic centimeter (cm3). Volumetric units are used and interpreted as follows: the number of cubic centimeters (cm3) of gases, relative to 1 cubic meter (m3) of air. 1 cm3 represents the millionth part of a m3. In this context, the unit of measurement, which can be defined as one millionth of a cubic meter (m3), is hereafter referred to as parts per million (ppm).

To prove the demonstrate, those previosly mentioned, we used the relation:

$$10.000\ ppm = 10.000\ \frac{1\ cm^3}{1.000.000\ cm^3} = \frac{1}{100} = 1\% \qquad (9.3)$$

9.5 Specific conditions for conducting experimental research

To measure the chemical noxes emitted by MAS and MAC of the cars used in the research, we used the KANE AUTO 5-1 analyzer, a portable car emissions analyzer, OIML Class 1, for five gases (CO, HmCn, CO_2, NO_x, O_2); operation of the Lambda probe, or the air-fuel stoichiometric ratio - Air Flow Ratio (AFR). The obtained data were stored in the memory of the analyzer for the duration of the research.

Regarding the research with reference to the level of sound pollution measured inside the passenger compartment of the vehicles, they were carried out with the aim of defining the state of acoustic comfort provided to the driver and passengers during the movement of the vehicle. They were made by measuring and recording the sound waves and vibrations produced by vehicles, when moving in the urban environment at different speeds (30 km/h and 50 km/h), as well as on the highway, within the maximum legal speed limit (130 km/h), with the help of a professional sound level meter SL 400. All data was recorded in the internal memory of the sound level meter.

9.6 Possible causes that decrease or increase the emissions of chemical noxes of internal combustion engines

Reducing or increasing the level of chemical noxes that an internal combustion engine emits can be due to factors that directly influence the operation and combustion in the cylinders. These factors can be related either to the construction of the engine or to the operation of the vehicle and were identified by the author, based on the specialized literature and the experience accumulated in 40 years of professional activity in the field of automobiles and motor transport.

I presented in Appendix no. 17 (a17-1, a17-2, a17-3, a17-4, a17-5, a17-6, a17-7, a17-8) the most frequent causes that can change the emissions of chemical noxes in internal combustion engines.

Appendix no. 17 (a17-1, a17-2, a17-3, a17-4, a17-5, a17-6, a17-7, a17-8), in which are presented the most frequent causes that can change emissions chemical noxes in internal combustion engines can be consulted in the doctoral thesis located at the Polytehnic University of Bucharest library.

Chapter 10. DETERMINATION OF THE DEGREE OF CHEMICAL POLLUTION FROM CARS EQUIPPED WITH MAS AND MAC, IN THE CONTEXT OF THE WHO PROPOSALS REGARDING THE REDUCTION OF TRAFFIC SPEED IN THE URBAN ENVIRONMENT

10.1 Analysis and interpretation of the results of chemical noxes emitted by vehicles with MAS

10.1.1 Chemical emmissions emited by Toyota RAV 4hybrid, Euro 6

For the Toyota RAV 4 hybrid 2.5 l car, with the Euro 6 pollution standard, the emission situation regulated by the legislation in force (CO and HmCn) is as follows:

- when traveling the route at a speed of 30 km/h, they did not have a high level, a specific aspect of hybrid vehicles with the Euro 6 pollution norm. The level of pollution with the two gases increases in the urban environment with the increase of the traffic speed to 50 km/h h. The pollution with the two gases is not continuous, but sporadic, having short occurrences (10-30 seconds);
- when traveling the route on the highway, the CO exceedances reached even higher values, above the legal norm, which confirms hypothesis no. 4 when traveling the HmCn highway route had an increasing trend, an aspect that confirms hypothesis no. 4. Emissions were lower than in the urban environment when traveling the route at a speed of 50 km/h.

CO_2 in the urban environment, when traveling the route at a speed of 30 km/h, had a higher average value (9.33%). The average increased proportionally with the increase in traffic speed (11.6% in the urban environment at a speed of 50 km/h and 12.87% on the highway at a speed of 130 km/h). Analyzed after the evolution of the average values calculated for the three traffic speeds, the trend was an increasing one (it increased constantly in the city and on the highway).

NOx in the city, when traveling the route at a speed of 30 km/h, had a higher average value (6.34 ppm), demonstrating that the emissions of these gases are still high compared to the average value recorded at 50 km/h (2.19 ppm), respectively the average values recorded on the highway at 130 km/h (3.16 ppm).

Analyzed based on the graphic values, the reduction of traffic speed in the urban environment from 50 km/h to 30 km/h confirms hypothesis no. 1: pollution for this car is reduced, except for NOx, which reached higher values when driving the urban route at a speed of 30 km/h.

Analyzed on the basis of the average values of the four gases, reducing the traffic speed in the urban environment from 50 km/h to 30 km/h influences the level of chemical gas pollution as follows:

- CO decreased by 19.56%, the target being (-45%): confirms hypothesis no. 1, does not confirm hypothesis no. 2;
- HmCn increased by 84.04%, the target being (+45%): confirms hypotheses no. 1 and no. 2;
- CO_2 decreased by 19.56%, the target being (-15%): confirms hypothesis no. 1, does not confirm hypothesis no. 2;
- NOx increased by 65.45%, the target being (-40%): does not confirm hypothesis no. 1; confirms hypothesis no. 2.

10.1.2 Chemical emissions emited by Volkswagen Jetta, Euro 6

For the Volksvagen Jetta 1.4 TSI car, with the Euro 6 pollution standard, the emission situation regulated by the legislation in force (CO and HmCn) is as follows:

- the car was polluting in the urban environment while traveling the route at a speed of 30 km/h until the engine reached the optimal operating temperature. Pollution with the two gases at "cold" engine operation lasted for 1.45 minutes, after which it stabilized. The level of pollution with the two gases decreased in the urban environment with the increase in traffic speed to 50 km/h and remained below the legal pollution norm (an inverted atypical phenomenon, because low values were obtained at v=50 km/h and high values at v =30 km/h).

- when traveling the route on the highway, the normal excesses of CO reached high values (aspect that confirms hypothesis no. 4), having a downward trend (speed, load and high engine revs), after which it stabilized at lower values, below the norm legal.

- when traveling the route on the HmCn highway, they reached variable values below the legal norm, a specific aspect of the Euro 6 pollution norm, of the vehicle.

In the urban environment, when traveling the route at a speed of 30 km/h, CO_2 had a lower average value (12.48%). The average increased proportionally with the increase in traffic speed (12.75% in the urban environment at a speed of 50 km/h and respectively, 13.23% on the highway at a speed of 130 km/h). Analyzed after the evolution of the averages calculated for the three traffic speeds, the trend was a decreasing one (it decreased in the urban environment with the reduction of the traffic speed, from 50 km/h to 30 km/h).

NOx in the urban environment, when traveling the route at a speed of 30 km/h, had a higher average value (88.72 ppm), which demonstrates that the emissions of this gas are still high compared to the average value recorded at 50 km /h (41.99 ppm), respectively the average values recorded on the highway at 130 km/h (22.38 ppm).

Analyzed on the basis of graphic values, the reduction of traffic speed in the urban environment from 50 km/h to 30 km/h indicates the following:

- CO, HmCn and NOx reached higher values when traveling the urban route at a speed of 30 km/h and do not confirm hypothesis no. 1, the level of pollution with these gases increasing with decreasing traffic speed;

- CO_2 reached lower values when traveling the urban route at a speed of 30 km/h, an aspect that confirms hypothesis no. 1, the level of pollution for this gas decreasing with the decrease in traffic speed.

Analyzed on the basis of the average values of the four gases, the reduction of the traffic speed in the urban environment from 50 km/h to 30 km/h indicates the following:

- CO increased by 40%, the target being (-45%) - does not confirm hypothesis no. 1;
- HmCn increased by 37.5%, the target being (+45%) - confirms hypothesis no. 1;
- CO_2 decreased by 2.12%, the target being (-15%) ¬– confirms hypothesis no. 1;
- NOx increased by 53.46%, the target being (-40%) - does not confirm hypothesis no. 1.

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10.1.3 Chemicals noxes emitted by Volkswagen Jetta, Euro 5

The analysis of chemical emissions emitted by the Volkswagen Jetta car, Euro 5, is presented in the doctoral thesis that is deposited at the UPB library.

10.1.4 Chemicals noxes emitted by Dacia Logan, Euro 4

The analysis of the chemical emissions emitted by the Dacia Logan car, Euro 4, is presented in the doctoral thesis that is deposited at the UPB library.

10.1.5 Chemicals noxes emitted by Volkswagen Golf 1,6 L, Euro 4

The analysis of the chemical emissions emitted by the Volkswagen Golf 1.6 L, Euro 4 car in the doctoral thesis that is deposited at the UPB library.

10.1.6 Chemicals noxes emitted by Ford Focus ZX4 SUA 2,0 litri, Euro 3

The analysis of the chemical emissions emitted by the car Ford Focus ZX4 USA 2.0 liters, Euro 3, is presented in Appendix no. 3 (a3-1, a3-2, a3-3, a3-4, a3-5 a3-6);

10.1.7 Chemicals noxes emitted by Dacia Solenza 1.400 cm^3 MPI, Euro 3

The analysis of the chemical emissions emitted by the Dacia Solenza 1.4 MPI, Euro 3 car is presented in Appendix no. 4 (a4-1, a4-2, a4-3, a4-4, a4-5 a4-6).

The chemical noxes related to passenger cars from subchapters 10.1.6 and 10.1.7 can be consulted in the annexes stipulated under each one. The appendices are an integral part of the doctoral thesis, which can be found at the UPB library.

10.2 Analysis and interpretation of the results of chemical emissions, emitted by vehicles with MAC

10.2.1 Chemical emissions emitted by Renault Captur 1,5 dCI, Euro 5

For the Renault Captur 1,500 cm3 dCI, Euro 5 car, the emission situation regulated by the legislation in force (CO and HmCn) is as follows:

- in the urban environment at a speed of 30 km/h, the car engine did not pollute with CO and did not exceed the legal norm, which is a maximum of 0.2%. Both the maximum values reached and their averages were lower when traveling this route, compared to traveling the urban route at a speed of 50 km/h. And in this case the emissions remained below the legal pollution norm;
- when traveling the route on the highway at a speed of 130 km/h, the car's engine polluted with CO, exceeding the legal norm, an aspect that confirms hypothesis no. 4. The average of the values obtained when traveling the route on the highway at a speed of 130 km/h was lower compared to the average of the values obtained on the urban route at a speed of 30 km/h, respectively 50 km/h (atypical process).
- in the urban environment at a speed of 30 km/h, respectively at a speed of 50 km/h, the car engine did not pollute with HmCn and did not exceed the legal limit, which is 100 ppm.
- when traveling the route on the highway at a speed of 130 km/h, the car engine polluted with HC reaching two peaks (one of 187 ppm and one of 186 ppm) above the legal norm of 100 ppm, an aspect that confirms hypothesis no. 4.

For CO_2, the maximum values reached started from a higher level in the urban route at 30 km/h, decreased in the urban route at 50 km/h and further decreased in the highway route at speed of 130 km/h (atypical process, reversed). The average values of this gas started from a low level when traveling the urban route at a speed of 30 km/h, increased when traveling the urban route at a speed of 50 km/h and increased above the two values obtained in the urban environment, when traveling the highway route at a speed of 130 km/h (normal process).

For NOx, the maximum values reached started from a higher level when traveling the urban route at a speed of 30 km/h, decreased when traveling the urban route at a speed of 50 km/h (atypical process, reversed in the urban environment) and have increased above these values when traveling the route on the highway at a speed of 130 km/h. The mean values started from a high level when traveling the urban route at a speed of 30 km/h, decreased when traveling the urban route at a speed of 50 km/h (atypical process reversed in the urban environment) and increased above these values when traveling the highway route at a speed of 130 km/h.

Analyzed on the basis of graphic values, the reduction of traffic speed in the urban environment from 50 km/h to 30 km/h indicates the following:

- there was less CO pollution in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that confirms hypothesis no. 1.

- HmCn was more polluted in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that confirms hypothesis no. 1.

- CO_2 was more polluted in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that does not confirm hypothesis no. 1.

- NOx was more polluted in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that does not confirm hypothesis no. 1.

Analyzed on the basis of the average values of the four gases, the reduction of the traffic speed in the urban environment from 50 km/h to 30 km/h indicates the following:

- CO decreased by 66.6%, the target being (-45%) – confirms hypothesis no. 1;
- HmCn increased by 88.7%, the target being (+45%) – confirms hypothesis no. 1;
- CO_2 decreased by 22.9%, the target being (-15%) - confirms hypothesis no. 1;
- NOx increased by 58%, the target being (-40%) - does not confirm hypothesis no. 1.

10.2.2 Chemical noxes emitted by Volkswagen Jetta 2,0 TDI, Euro 4

For the Volksvagen Jetta TDI 2,000 cm3, Euro 4 car, the emission situation regulated by the legislation in force (CO and HmCn) is as follows:

- in the urban environment at a speed of 30 km/h, the car engine did not pollute with CO and did not exceed the legal norm, which is a maximum of 0.3%. Both the maximum values reached (0.07%) and the averages (0.03%) were lower when traveling this route, compared to traveling the urban route at a speed of 50 km/h (0.08%), respectively average (0.12%). And in this case, the emissions were below the legal pollution norm;

- when traveling the route on the highway at a speed of 130 km/h, the car engine did not pollute with CO and did not exceed the legal norm. Both the maximum value and the average of the values obtained when traveling the highway route at a speed of 130 km/h were identical to the values obtained when traveling the urban route at a speed of 50 km/h.

- in the urban environment at a speed of 30 km/h, respectively at a speed of 50 km/h, the car engine did not pollute with HmCn and did not exceed the legal norm, which is max. 100 ppm. The maximum level of HmCn was higher when driving the urban route at 30 km/h (4 ppm) compared to 50 km/h (2 ppm), but still did not exceed the legal pollution standard. When traveling the route on the highway at a speed of 130 km/h, the car engine did not pollute with this gas, the maximum value reaching 4 ppm.

In the case of CO_2, the maximum values reached were higher when traveling the urban route at a speed of 30 km/h (16.1%), decreased when traveling the urban route at a speed of 50 km/h (15.9%) and have increased again when traveling the route on the highway at a speed of 130 km/h (16.0%) (atypical process, reversed in the urban environment). The average values of this gas started from a low level when traveling the urban route at the speed of 30 km/h (12.83%), increased when traveling the urban route at the speed of 50 km/h (13.91%) and have increased above the two values obtained in the urban environment, when traveling the route on the highway at a speed of 130 km/h (13.93%) (normal process).

In the case of NOx, the maximum values reached were lower in the urban route at 30 km/h (206 ppm), increased in the urban route at 50 km/h (597 ppm) and continued to increase at traveling the route on the highway at a speed of 130 km/h (793 ppm). The average values of this gas started from a low level when traveling the urban route at the speed of 30 km/h (54.66 ppm), increased when traveling the urban route at the speed of 50 km/h (76.45 ppm) and have increased above these values when traveling the highway route at a speed of 130 km/h (126.47 ppm).

Analyzed on the basis of graphic values, the reduction of traffic speed in the urban environment from 50 km/h to 30 km/h indicates the following:

- there was less CO pollution in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that confirms hypothesis no. 1.

- with HmCn there was less pollution in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that does not confirm hypothesis no. 1.

- CO_2 was more polluted in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, an aspect that does not confirm hypothesis no. 1.

- NOx was less polluted in the urban environment at a speed of 30 km/h, compared to a speed of 50 km/h, which confirms hypothesis no. 1.

Analyzed on the basis of the average values of the four gases, the reduction of the traffic speed in the urban environment from 50 km/h to 30 km/h indicates the following:

- CO decreased by 62.5%, the target being (-45%) – confirms hypothesis no. 1;
- HmCn decreased by 99.49%, the target being (+45%) - does not confirm hypothesis no. 1;
- CO_2 decreased by 7.76%, the target being (-15%) - confirms hypothesis no. 1;
- NOx decreased by 28.5%, the target being (-40%) - confirms hypothesis no. 1.

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10.2.3 Chemical noxes emitted by Renault Symbol 1,5 dCI, Euro 3

The analysis of the chemical emissions emitted by the Renault Symbol 1.5 dCI, Euro 3 car is presented in Appendix no. 13 (a13-1, a13-2, a13-3, a13-4, a13-5, a13-6).

The chemical noxes related to the car from subchapter 10.2.3 can be consulted in the appendix stipulated in the car law. The appendix is an integral part of the doctoral thesis, which can be found at the Polytehnic University of Bucharest library.

Chapter 11. DETERMINATION OF THE DEGREE OF NOISE NOS FROM CARS EQUIPPED WITH MAS AND MAC, IN THE CONTEXT OF THE WHO PROPOSALS REGARDING THE REDUCTION OF TRAFFIC SPEED IN THE URBAN ENVIRONMENT

11.1 Analysis and interpretation of the results of noise emissions emitted by motor vehicles with MAS

11.1.1 The noise emitted in the passenger compartment of the car Toyota RAV 4 hibrid, Euro 6

The trend of noise evolution in the interior of the Toyota RAV 4 hybrid car, with the Euro 6 pollution standard, when driving the two urban routes and on the highway is an increasing one. The level of noise emitted in the passenger compartment of the car increases with the increase in speed. When traveling the urban route at a speed of 30 km/h, the emitted noise values do not exceed the legal norm (72 dBA), an aspect that does not confirm hypothesis no. 3. When traveling the urban route at a speed of 50 km/h, the minimum and average values of the emitted noise do not exceed the legal norm. The maximum values exceed the legal norm. When traveling the route on the A1 - Sibiu Highway, the minimum values of the emitted noise do not exceed the legal norm, but the average value and the maximum values exceed it, an aspect that confirms hypothesis no. 4. The noise emitted by the car decreases with the decrease of the traffic speed in the urban environment from 50 km/h to 30 km/h. The linear evolution of the noise emitted on the three routes registers a rapid increase in values.

11.1.2 The noise emitted in the passenger compartment of the car Volkswagen Jetta, 1,4 l, TSI, Euro 6

The trend of the evolution of the noise emitted in the passenger compartment of the Volkswagen Jetta 1,400 cm3 TSI, Euro 6 car, when driving the two urban routes and on the highway, is an increasing one. The level of noise emitted in the passenger compartment of the car increases with increasing speed. When traveling the urban route at a speed of 30 km/h, the minimum values and the average value of the emitted noise do not exceed the legal norm, which is 72 dBA. The maximum values exceed the legal norm, which confirms hypothesis no. 3; When traveling the urban route at a speed of 50 km/h, the minimum values and the average value of the emitted noise do not exceed the legal norm. The maximum values exceed the legal norm; When traveling the route on the A1 - Sibiu Highway, the minimum noise levels do not exceed the legal norm. The maximum values and the average value exceed the legal norm, which confirms hypothesis no. 4. The noise emitted by the car decreases with the decrease of the traffic speed in the urban environment from 50 km/h to 30 km/h. The linear evolution of the noise on the three routes registers a rapid increase in values.

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11.1.3 The noise emitted in the passenger compartment of the car Volkswagen Jetta 1,4 TSI, Euro 5

The analysis and interpretation of the noise emitted in the passenger compartment of the Volkswagen Jetta 1.4 TSI, Euro 5 car is presented in Appendix no. 19 (a19-1).

11.1.4 The noise emitted in the passenger compartment of the car Dacia Logan 1,4 MPI, Euro 4

The analysis and interpretation of the noises emitted in the passenger compartment of the Dacia Logan 1.4 MPI, Euro 4 car is presented in Appendix no. 20 (a20-1).

11.1.5 The noise emitted in the passenger compartment of the car Volkswagen Golf 1,6 L, Euro 4

The analysis and interpretation of the noise emitted in the passenger compartment of the Volkswagen Golf 1.6 L, Euro 4 car is presented in Annex no. 21 (a21-1).

11.1.6 The noise emitted in the passenger compartment of the car Ford Focus ZX4 SUA 2,0 L, Euro 3

The analysis and interpretation of the noises emitted in the passenger compartment of the Ford Focus ZX4 USA 2.0 L, Euro 3 car is presented in Appendix no. 22 (a22-1).

11.1.7 The noise emitted in the passenger compartment of the car Dacia Solenza 1,4 MPI, Euro 3

The analysis and interpretation of the noises emitted in the passenger compartment of the Dacia Solenza 1.4 MPI, Euro 3, is presented in Appendix no. 26 (a26-1).

The noise levels related to passenger cars from subchapters 11.1.3...11.1.7 can be consulted in the annexes stipulated in the right of each one. The appendices are an integral part of the doctoral thesis, which can be found at the Polytehnic University of Bucharest library.

11.2 Analysis and interpretation of the results of noise emissions emitted by motor vehicles with MAC

11.2.1 The noise emitted in the passenger compartment of the car Renault Captur 1,5 dCI, Euro 5

The trend of the evolution of the noise emitted in the passenger compartment of the Renault Captur 1.5 dCI, Euro 5 car, when driving the two urban routes and on the highway, is an increasing one. The level of noise emitted in the passenger compartment of the car increases with increasing speed. When traveling the urban route at a speed of 30 km/h, the emitted noise values do not exceed the legal norm of 72 dBA, an aspect that does not confirm hypothesis no. 3.

When traveling the urban route at a speed of 50 km/h, the minimum values and the average value of the emitted noise do not exceed the legal norm. The maximum values of the sound emitted in the passenger compartment exceed the legal norm.

When traveling the route on the A1 - Sibiu Highway, the minimum noise levels do not exceed the legal norm. The maximum values and the average value exceed the legal norm, which confirms hypothesis no. 4.

The noise emitted by the car in the passenger compartment decreases with the decrease of the traffic speed in the urban environment from 50 km/h to 30 km/h. The linear evolution of the noise on the three routes registers a rapid increase in values.

11.2.2 The noise emitted in the passenger compartment of the car Volkswagen Jetta 2,0 TDI, Euro 4

The trend of the evolution of the noise emitted in the passenger compartment of the Volkswagen Jetta 2,000 cm^3 TDI, Euro 4 car, when driving the two urban routes and on the highway, is an increase. The level of noise emitted in the passenger compartment of the car increases with increasing speed. When traveling the urban route at a speed of 30 km/h, the emitted noise values do not exceed the legal norm of 72 dBA, an aspect that does not confirm hypothesis no. 3;

When traveling the urban route at a speed of 50 km/h, the minimum and average noise values do not exceed the legal norm. The maximum values of the emitted noise exceed the legal norm;

When traveling the route on the A1 - Sibiu Highway, the minimum noise values do not exceed the legal norm. The maximum values and the average value exceed the legal norm, which confirms hypothesis no. 4.

The noise emitted by the car in the passenger compartment decreases with the decrease of the traffic speed in the urban environment from 50 km/h to 30 km/h. The linear evolution of the noise on the three routes shows a slow increase in values.

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★ ★

11.2.3 The noise emitted in the passenger compartment of the car Renault Symbol 1,5 dCI, Euro 3

The analysis and interpretation of the noise emitted in the passenger compartment of the Renault Symbol 1.5 dCI, Euro 3 car is presented in Appendix no. 32 (a32-1).

The noise pollution related to the car from subchapter 11.2.3 can be consulted in the annex stipulated in the car law. The appendix is an integral part of the doctoral thesis, which can be found at the Polytehnic University of Bucharest library.

Chapter 12. FUEL CONSUMPTION IN VEHICLES EQUIPPED WITH THERMAL ENGINES

12.1 Fuel consumption to motor vehicles

By definition, fuel consumption is the maximum allowed amount of gasoline, diesel, liquefied petroleum gas (LPG) or biofuel that can be consumed by a vehicle powered by a thermal engine over a well-established distance (usually 1,000 m), on a specific travel route, in which specific operating conditions, road category and environmental conditions are taken into account.

The aspects pursued in this chapter consist in the investigation of fuel consumption in passenger cars:

- in the context of W.H.O. proposals to reduce the speed of traffic in the urban environment from 50 km/h to 30 km/h;
- practically obtained in the urban and extra-urban environment, by comparison with the consumption approved by the manufacturer using the WLTP method.

12.2 Driving cycle Worldwide Harmonized Light-Duty Vehicles Test Procedure

Driving cycle *Worldwide Harmonized Light-Duty Vehicles Test Procedure* (WLTP) reprezin is a test method newly introduced by the EU to globally harmonize fuel consumption and CO_2 emissions for light vehicles (cars, minibuses, vans) with MAS and MAC. It replaced the previous determination method, the *New European Driving Cycle* (NEDC), as of September 1, 2017. The role of the newly implemented method is to provide real information on fuel consumption and pollutant emissions in automobiles, using much more dynamic parameters. The WLTP cycle generates and displays values of fuel consumption and pollutant emissions similar to those of daily vehicle use. The testing consists of longer test distances and durations, less stopping and stationary time, higher average travel speeds and the use of on-board facilities and equipment during trials. The changes made during the tests demonstrated a higher actual fuel consumption.

12.3 Research on fuel consumption in passenger cars with MAS

The use and implementation of the fuel consumption approval procedure for gasoline vehicles subject to experimental research requires separate management, defined by a specific procedure.

The calculation formula by means of which we determined the fuel consumption is as follows:

$$\mathrm{CC} = \frac{\mathrm{CCA}}{\mathrm{d}} \cdot 100 \qquad [\mathrm{l/100\ km}] \qquad (12.1)$$

where,

CC represents fuel consumption;

CCA - the amount of fuel supplied (in liters), completed after completing the route to fill the tank to full;

d - the distance in kilometers of the traveled route (read from the dashboard of the vehicle).

a) Toyota RAV 4 2.5 L, hybrid, Euro 6. The fuel consumption evolution trend of the TOYOTA RAV 4 2.5 L, hybrid, Euro 6 car, during the two urban routes and on the highway, was an increasing one. Fuel consumption increases with increasing speed. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 6.2 l/100 km to 4.2 l/100 km, the percentage of decrease being 32, 25% The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 4.4 l/100 km; extra-urban consumption – 4.7 l/100km. Experimentally, in the urban environment (50 km/h) and in the extra-urban environment, real fuel consumptions higher than those approved by the manufacturer were obtained. The increase compared to the consumption approved by the manufacturer is 24.19% in urban at a speed of 50 km/h and 45.78% in the extra-urban environment.

b) Volkswagen Jetta 1.4 TSI, Euro 6. The trend of fuel consumption evolution of the Volkswagen Jetta 1.4 TSI, Euro 6 car during the two urban routes was an increasing one. Fuel consumption increases with increasing speed. When driving the route on the highway, the fuel consumption decreased. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 7.9 l/100 km to 5.6 l/100 km, the percentage decrease being 29 ,11%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 6.9 l/100 km; extra-urban consumption – 4.5 l/100 km. Experimentally, in the urban environment at 50 km/h and in the extra-urban environment, real fuel consumptions higher than those approved by the manufacturer were obtained. The increase compared to the consumption approved by the manufacturer is 12.6% at a speed of 50 km/h and 6.25% in the extra-urban environment.

c) Volkswagen Jetta 1.4 TSI, Euro 5. The trend of fuel consumption evolution of the Volkswagen Jetta 1.4 TSI, Euro 5 car during the two urban experimental routes was an increasing one. Fuel consumption increases with increasing speed. On the highway route, fuel consumption dropped to 6.8 l/100 km. In the urban environment by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption decreased from 8.7 l/100 km to 7.1 l/100 km, the percentage of decrease under these conditions being of 11.49%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 9.7 l/100 km; extra-urban consumption – 6.0 l/100 km. Experimentally, in the urban environment at 50 km/h, real fuel consumption was obtained 10.3% lower than the one approved by the manufacturer, and in the extra-urban environment a consumption 11.76% higher than the approved one.

d) Dacia Logan 1.4 MPI, Euro 4. The trend of fuel consumption evolution of the Dacia Logan 1.4 MPI, Euro 4 car, when traveling the two urban routes and on the highway, was an increasing one. Fuel consumption increases with increasing speed. In the urban environment by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 7.5 l/100 km to 6.7 l/100 km, the percentage decrease under these conditions being of 10.66%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 6.9 l/100 km; extra-urban consumption – 9.6 l/100 km. Following the experimental research, in the urban environment at a speed of 50 km/h, a real fuel consumption was obtained 8% higher than the one approved by the manufacturer, and in extra-urban one equal to the approved one.

e) Volkswagen Golf 1.6 l, Euro 4. The trend of the evolution of the fuel consumption of the Volkswagen Golf 1.6 l, Euro 4 car, in the framework of the experimental research when traveling the two urban routes, is an increasing one. Fuel consumption increases with increasing speed. In the extra-urban environment, when traveling on the highway, fuel consumption dropped to 5.6 l/100 km. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, the fuel consumption drops from 9.9 l/100 km to 8.7 l/100 km, the percentage decrease under these conditions being 12.12%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 9.9 l/100 km; extra-urban consumption – 5.6 l/100 km. As a result of the experimental research, both in the urban and in the extra-urban environment, fuel consumptions identical to those approved by the manufacturer were obtained.

f) Ford Focus ZX4 SUA, Euro 3. The trend of the evolution of fuel consumption of the Ford Focus ZX4 USA, Euro 3 car during the two urban routes was an increasing one. Fuel consumption increased with increasing speed. When driving the route on the highway, fuel consumption decreased. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 9.4 l/100 km to 6.5 l/100 km, the percentage of decrease under these conditions being of 30.85%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 10.7 l/100 km; extra-urban consumption – 7.6 l/100 km. Following experimental research in the urban environment (50 km/h) and in the extra-urban environment (130 km/h), real fuel consumptions lower than those approved by the manufacturer were obtained. The decrease compared to the consumption approved by the manufacturer is 12.14% at a speed of 50 km/h and 17.1% at a speed of 130 km/h.

g) Dacia Solenza 1,4 MPI, Euro 3. The trend of the evolution of the fuel consumption of the Dacia Solenza 1.4 MPI, Euro 3 car during the two urban experimental routes was an increasing one. Fuel consumption increases with increasing speed. In the extra-urban environment, when traveling on the highway, fuel consumption dropped to 5.6 l/100 km. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 8.3 l/100 km to 7.2 l/100 km, the percentage of decrease under these conditions being of 13.25%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 8.3 l/100 km; extra-urban consumption – 5.6 l/100 km. As a result of the experimental research, both in the urban environment and in the extra-urban environment, fuel consumptions identical to those approved by the manufacturer were obtained.

12.4 Research on fuel consumption in passenger cars with MAC

a) Renault Captur 1,5 dCI, Euro 5. The trend of the evolution of the fuel consumption of the Renault Captur 1.5 dCI, Euro 5 car during the two urban routes was an increasing one. Fuel consumption increases with increasing speed. In the extra-urban environment, when driving on the highway, fuel consumption dropped to 4.9 l/100 km. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 13.6 l/100 km to 7.4 l/100 km, the percentage of decrease under these conditions being of 45.58%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 4.7 l/100 km; extra-urban consumption – 4.9 l/ 100 km. Following experimental research, in the urban environment (50 km/h) a higher actual fuel consumption was obtained than the one approved by the manufacturer. The increase in fuel consumption in the urban environment compared to that approved by the manufacturer is 24.19%. In the extra-urban environment, a fuel consumption identical to that approved by the manufacturer was obtained.

b) Volkswagen Jetta 2,0 TDI, Euro 4. The trend of the evolution of the fuel consumption of the Volkswagen Jetta 2.0 TDI, Euro 4 car during the two urban routes is an increasing one. Fuel consumption increases with increasing speed. In the extra-urban environment, when traveling on the highway, fuel consumption dropped to 4.7 l/100 km. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 15.8 l/100 km to 9.0 l/100 km, the percentage of decrease under these conditions being of 43.03%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 6.9 l/100 km; extra-urban consumption – 4.7 l/ 100 km. Following the experimental research, in the urban environment (50 km/h) a higher real fuel consumption was obtained than the one approved by the manufacturer. The increase in fuel consumption in the urban environment compared to the consumption approved by the manufacturer is 56.32%. In the extra-urban environment, a fuel consumption identical to the approved one was obtained.

c) Renault Symbol 1,5 dCI, Euro 3. The trend of the fuel consumption evolution of the Renault Symbol 1.5 dCI, Euro 3 car during the two urban routes is an increasing one. Fuel consumption increases with increasing speed. In the extra-urban environment, when traveling on the highway, fuel consumption dropped to 3.5 l/100 km. In the urban environment, by reducing the traffic speed from 50 km/h to 30 km/h, fuel consumption drops from 14.2 l/100 km to 8.1 l/100 km, the percentage of decrease under these conditions being of 42.95%. The car manufacturer approved the following fuel consumption using the WLTP method: urban consumption – 5.3 l/100 km; extra-urban consumption – 3.5 l/ 100 km. Following the experimental research, in the urban environment (50 km/h) a higher real fuel consumption was obtained than the one approved by the manufacturer. The increase in fuel consumption in the urban environment compared to the consumption approved by the manufacturer is 62.67%. In the extra-urban environment, a fuel consumption identical to the approved one was obtained.

Chapter 13. ECONOMIC JUSTIFICATIONS REGARDING THEBASPECTS UNDER RESEARCH

13.1 Economic justification regarding average fuel consumption

In order to drive economically - or for a car to fall within the fuel consumption norm approved by the manufacturer - a series of rules related to defensive driving must be applied. It cannot be equated with preventive driving, but they have common elements and meanings. Preventive driving is solely about road safety, while defensive driving is about how the car is driven and operated. If the rules and principles of each are respected, road safety increases, the number of road accidents decreases, fuel consumption and the level of noxious pollution are reduced, the level of traffic noise is reduced.

Defensive car driving can be analyzed from several perspectives, such as: fuel consumption, road safety, road events, traffic risk prevention, road infrastructure, climate factors, the state of the environment, etc.

Economic justification by evaluating costs related to fuel consumption is a decision based on managerial experience. This allows the estimation of the price, depending on the perspective of the resources involved in the transport process (Roșu, Doicin, Râpă, Ionescu, & Tabără, 2011).

In table 13.1 we presented the economic justification related to 1 km traveled and to the total resource (the total number of kilometers traveled), for cars with MAS.

The table can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

In table 13.2 we presented the economic justification related to 1 km traveled and to the total resource (the total number of kilometers traveled), for cars with MAC.

The table can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

13.2 Economic justification regarding chemical noxes

In order to practically demonstrate the amount of carbon dioxide (CO_2) and water (H_2O) emitted by the thermal engine of a car per 1 km traveled, I have presented in the following some notions of chemistry. Based on the combustion equations, we demonstrated by calculation the quantities of the two chemical elements in kg/liter, resulting from the combustions that take place in MAS and MAC for the main carbon-based fuels (gasoline, diesel and LPG).

13.2.1 The amount of CO_2 emitted by a car per 1 liter of gasoline

From a combustion point of view, gasoline can be approximated by octane, which is a normal constituent of this fuel. The molar mass of octane (C8H18) is the sum of the molar masses of the component atoms, so 12 x 8 + (2 x 8 + 2) = 114 g/mol. The amount of CO_2 per mole of octane burned is 44 x 8 = 352 g, and the amount of water per mole of octane burned is 18(8+1) = 162 g. Consequently, the ratio octane (gasoline) / CO_2 emissions is 352 / 114 = 3.09 g, and that of water is 352 / 114 = 1.42 g. The density of gasoline is 0.740 kg/liter. So, 1 g of gasoline burned emits 3.09 g of CO_2, respectively 1.42 g of H_2O. By doing a simple calculation, it turns out that a car that burns gasoline in the thermal engine emits 2.28 kg of CO_2/liter of gasoline into the atmosphere (0.74 x 3.09), respectively 1.491 kg of water/liter of gasoline (1.42 x 1, 05). Mass ratio CO2+H2O / mass of gasoline = 4.46 g (3.3/0.74).

13.2.2 The amount of CO_2 emitted by a car per 1 liter of diesel

Chemically, diesel can be approximated by hexadecane, n = 16. The molar mass of hexadecane is 12 x 6 + (2 x 16 + 2) = 226 g/mol. The amount of CO_2 per mole of hexadecane burned is 44 x 16 = 704 g, and the amount of water per mole of hexadecane burned is 18 (16 + 1) = 306 g. Consequently, the ratio hexadecane (diesel) / CO_2 emissions it is 704 / 226 = 3.11 g, and that of water is 306 g / 226 g = 1.35 g. The density of diesel is 0.850 kg/liter. So, 1 g of diesel fuel emits 3.11 g of carbon dioxide, respectively 1.35 g of H_2O. By doing a simple calculation, it turns out that a car that burns diesel in the thermal engine emits into the atmosphere 2.64 kg of CO_2/liter of diesel (0.85 x 3.11), respectively 1.55 kg of water/liter of diesel (1.35 x 1.15). Mass ratio CO_2+H_2O / diesel mass = 4.53 g (3.85/0.85).

13.2.3 The amount of CO_2 emitted by a car per 1 liter of GPL

For simplicity, a propane-butane ratio of 50/50 will be assumed. In this case, $n_{average}$ = 3.5. The amount of CO_2 emitted related to one mole of LPG burned is 44 x 3.5 = 154 g. The ratio LPG/CO_2 emitted is 154/51 = 3.02. At a ratio of 50/50 and at a temperature of 15˚C, the density of LPG is 0.55 kg/liter. 1 gram of LPG burned emits 3.02 g of CO_2 into the atmosphere. This results in 0.55 x 3.02 = 1.66 kg CO_2/l LPG. Mass ratio CO_2+H_2O / LPG mass = 3 g (1.66/0.55).

13.3 Economic calculation regarding the amount of CO2 emitted into the atmosphere by car engines

Because carbon dioxide is a harmful gas, which contributes fully to the greenhouse effect (global warming), I considered it necessary to demonstrate by calculation the amount of CO_2 removed into the atmosphere by the engines that equip the cars used in the experimental research, starting from previous calculations. The amount of CO_2 emitted is related to the number of actual kilometers traveled up to the date of the research and is calculated for a mixed fuel consumption (urban/extra-urban).

The calculation formula for CO_2 emissions in kg/km is as follows:

$$Q_{CO2} = \frac{CC \times CCO2}{100} \quad [kg/km] \quad (13.1)$$

where

Q_{CO2} represents the amount of CO_2 rmitted, expressed in kg/km;

CC - fuel consumption, xpressed in l/100 km;

C_{CO2} – the amount of CO_2 resulting from combustion expressed in kg/l.

In table 13.4 we presented the amount of CO_2 removed into the atmosphere, related to the total number of km traveled and to each year of age, for cars with MAS.

The table can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

In table 13.5 we presented the amount of CO_2 removed into the atmosphere, related to the total number of km traveled and to each year of age for cars with MAC.

The table can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

Table 13.6 presents the economic study on the cost of CO_2 related to the total number of km traveled and its value for each year of use, for cars with MAS.

The table can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

In table 13.7 I present the economic study on the cost of CO_2 related to the total number of km traveled and its value for each year of use, for cars with MAC.

The table can be consulted in the doctoral thesis that is deposited at the Polytehnic University of Bucharest library.

13.4 Conclusions

The energy obtained from burning LPG is much lower than that obtained from burning gasoline or diesel. A car whose thermal engine burns LPG will consume 25-30% more of this fuel per 100 km traveled compared to one running on petrol or diesel, this is because LPG has a much lower density than the two.

The more heavy alkanes the fuel contains (with higher n), the higher the amount of CO_2 per kilogram of fuel will be.

Although LPG is considered a greener fuel, it still generates a significant amount of CO_2. Thermal engines running on LPG emit 27.19% less CO_2 into the atmosphere than gasoline engines and 37.12% less than diesel engines.

Chapter 14. THE MATHEMATICAL MODEL OF CHEMICAL AND NOISE POLLUTION GENERATED BY CARS EQUIPPED WITH MAS AND MAC

14.1 Presentation of the mathematical model

The mathematical model consists of the application of the *Least Squares method* which is developed on the basis of a Cramer system, also called the "uniquely determined" system. Based on it, we obtained the values of the noxes necessary to validate the mathematical model.

The Cramer system is formed based on the following relationships:

$$a^* = \frac{\Delta 1}{\Delta S} = \frac{3e\gamma + f\theta\gamma + \beta g\theta - g\gamma^2 - e\theta^2 - 3\beta f}{3\alpha\gamma + 2\beta\gamma\theta - \gamma^3 - \alpha\theta^2 - 3\beta^2} \quad (14.29)$$

$$b^* = \frac{\Delta 2}{\Delta S} = \frac{3\alpha f + \beta g\gamma + \gamma e\theta - f\gamma^2 - \alpha g\theta - 3\beta e}{3\alpha\gamma + 2\beta\gamma\theta - \gamma^3 - \alpha\theta^2 - 3\beta^2} \quad (14.30)$$

$$c^* = \frac{\Delta 3}{\Delta S} = \frac{\alpha\gamma g + \beta\theta e + \beta\gamma f - e\gamma^2 - \alpha\theta f - \beta^2 g}{3\alpha\gamma + 2\beta\gamma\theta - \gamma^3 - \alpha\theta^2 - 3\beta^2} \quad (14.31)$$

We have a linear system of n equations with n unknowns, which is called a *Cramer system* if the matrix determinant of the coefficients of the obtained system is different from zero.

The *Cramer- tip system*, or the uniquely determined (compatible determined) system has a unique solution.

The mathematical calculation model for obtaining the values of θ, g, γ, β, α, e and f is defined and presented in table 14.3.

Tabel 14.3 Ther mathematical calculation model for obtaining the values of θ, g, γ, β, α, e și f

	v	y	v^2	v^3	v^4	v^2y	vy
	v_1	y_1	v_1^2	v_1^3	v_1^4	$v_1^2y_1$	v_1y_1
	v_2	y_2	v_2^2	v_2^3	v_2^4	$v_2^2y_2$	v_2y_2
	v_3	y_3	v_3^2	v_3^3	v_3^4	$v_3^2y_3$	v_3y_3
$\sum_{k=1}^{3}$	**$v_1+v_2+v_3$**	**$y_1+y_2+y_3$**	**$v_1^2+v_2^2+v_3^2$**	**$v_1^3+v_2^3+v_3^3$**	**$v_1^4+v_2^4+v_3^4$**	**$v_1^2y_1+v_2^2y_2+v_3^2y_3$**	**$v_1y_1+v_2y_2+v_3y_3$**
	θ	**g**	**γ**	**β**	**α**	**e**	**f**

where

v_1 = 30 km/h; v_2 = 50 km/h; v_3 = 130 km/h; y - noxes (CO_2, CO, HmCn, NOx). (14.32)

Thus,

$y \simeq h^* = h(v; a^*, b^*, c^*)$ (14.33)

Note: For $v = v_0$ (e.g. for speeds other than those used in the research, suchs as 10 km/h, 20 km/h, 40 km/h, 60 km/h, 70 km/h, 80 km/h and so on, can be obtained:

$y \simeq h^* = h(v_0; a^*, b^*, c^*) = a^* \cdot v_0^2 + b^* \cdot v_0 + c^*$ (14.34)

After obtaining the values of θ, g, γ, β, α, e și f, according to the mathematical model in table 14.3, we substituted in the relations (14.29), (14.30) and (14.31), where we arrive at the validation of the mathematical model for the noxes „y".

The validation of the mathematical model for all average values of chemical and acoustic noxes emitted by cars included in the experimental study is presented in subchapter 14.2.

14.2 Validation of the mathematical model

14.2.1 Validationof the mathematical model for chemical noxes

a) Validation of the mathematical model for the average values of CO_2 (%) emitted by the Toyota RAV 4 hibrid car, Euro 6.

In table 14.4 we presented the mathematical calculation model for obtaining the values of θ, g, γ, β, α, e and f of CO2 emissions (%), for the Toyota RAV 4 hybrid car, Euro 6.

Tabel 14.4 The mathematical calculation model for obtaining the values of *θ, g, γ, β, α, e* and *f* of CO_2 emissions (%) in the Toyota RAV 4 hybrid car, Euro 6

	v	y	v^2	v^3	v^4	v^2y	vy
	30	9,33	30^2	30^3	30^4	30^2 x 9,33	30 x 9,33
	50	11,6	50^2	50^3	50^4	50^2 x 11,6	50 x 11,6
	130	12,87	130^2	130^3	130^4	130^2 x 12,87	130 x 12,87
$\sum_{k=1}^{3}$	**210**	**33,8**	**20.300**	**2.349.000**	**292.670.000**	**254.900**	**2.533**
	θ	**g**	**γ**	**β**	**α**	**e**	**f**

The obtained mathematical model is:

$\%CO_2 = a^* \cdot v^2 + b^* \cdot v + c^*$; $\%CO_2 = 0{,}00097625 \cdot v^2 + 0{,}1916 \cdot v + 4{,}46062$ (14.44)

The mathematical model is represented graphically in figure 14.2.

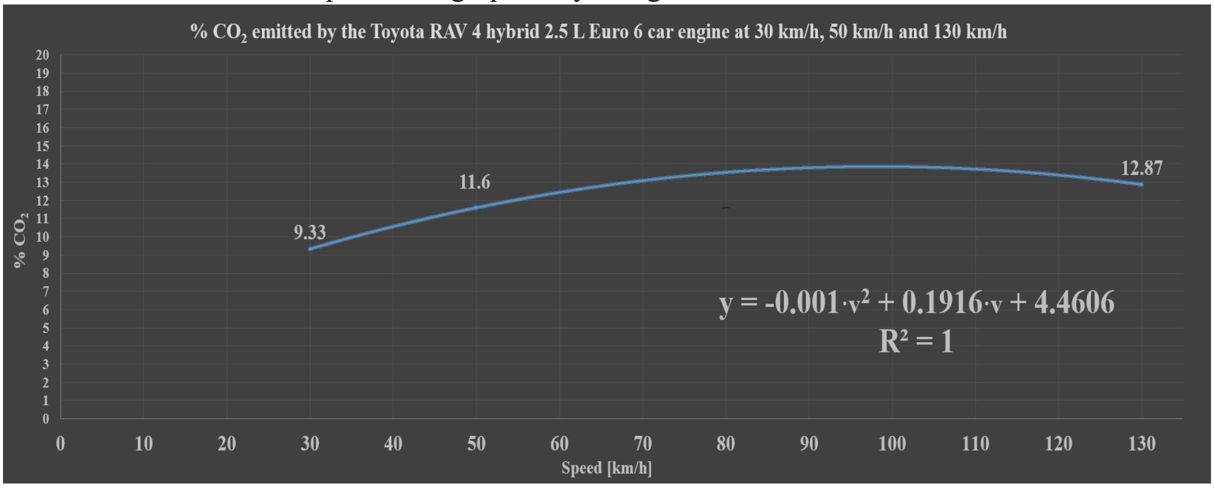

Fig. 14.2 % CO_2 emitted by Toyota RAV 4 hybrid 2.5 L Euro 6 car engine at speed of 30 km/h, 50 km/h and 130 km/h

We applied in relation (14.34) and obtained for speeds in the interval [0-130] km/h returned values of the CO_2 (%) corresponding to each speed in the interval **y = CO_2 $_{\text{Toyota RAV 4 hibrid}}$ = [0-12,87]%**, so:
a) v_0 = 10 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x10^2 + 0,1916x10 + 4,46062 = **6,28%**; b) v_0 = 20 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062 = -0,00097625x20^2 + 0,1916x20 + 4,46062 = **7,90%;** c) v_0 = 30 km/h:y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x30^2 + 0,1916x30 + 4,46062 = **9,33%;** d) v_0 = 40 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x40^2 + 0,1916x40 + 4,46062 = **10,56%;** e) v_0 = 50 km/h:y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x50^2 + 0,1916x50 + 4,46062 = **11,6%;** f) v_0 = 60 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x60^2 + 0,1916x60 + 4,46062 = **12,44%;** g) v_0 = 70 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x70^2 + 0,1916x70 + 4,46062 = **13,09%;** h) v_0 = 80 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x802 + 0,1916x80 + 4,46062 = **13,54%;** i) v_0 = 90 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x902 + 0,1916x90 + 4,46062 = **13,79%;** j) v_0 = 100 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x1002 + 0,1916x100 + 4,46062 = **13,85%;** k) v_0 = 110 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x1102 + 0,1916x110 + 4,46062 = **13,72%;** l) v_0 = 120 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x1202 + 0,1916x120 + 4,46062 = **13,39%;** m) v_0 = 130 km/h: y ≃ h* = h (-0,00097625; 0,1916; 4,46062) = -0,00097625x1302 + 0,1916x130 + 4,46062 = **12,87%;**

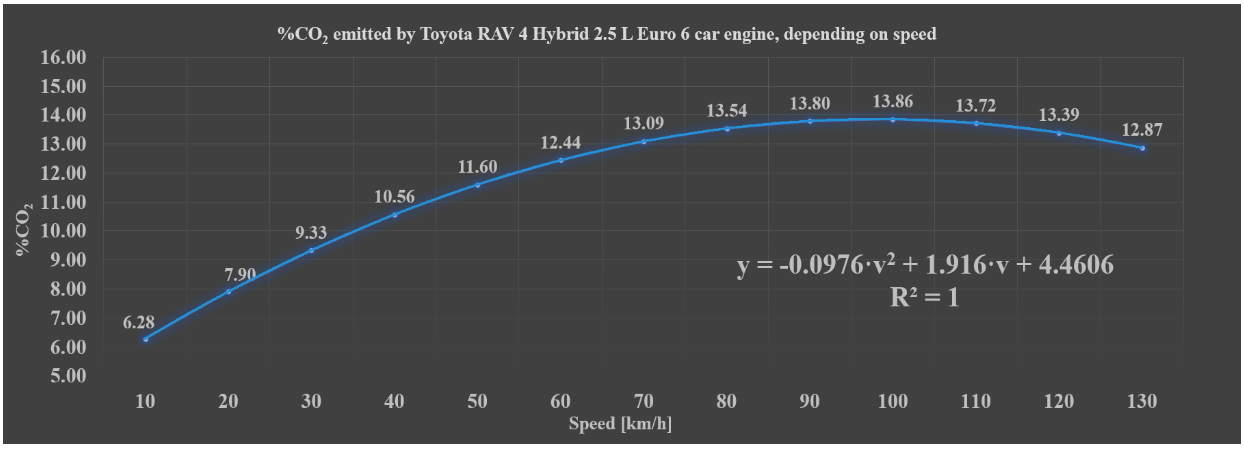

Fig. 14.3 %CO_2 emitted by Toyota RAV 4 hibrid 2.5 L Euro 6 car engine, depending on speed

For the speed range developed by the Toyota RAV 4 hybrid 2.5 L Euro 6 car, the %CO_2 values are shown in 10 km/h increments in figure 14.3.

Conclusions: By applying the least squares method, we obtained values of the noxes "y", corresponding to the speed in the interval [0-130] km/h, respectively $y = CO_{2Toyota\ RAV\ 4\ hibrid\ [0\text{-}130]\ km/h} = [0 – 12,87]$ %. It is observed that the values of CO_2 emissions (%) obtained by mathematical calculation related to speeds of 30 km/h, 50 km/h and 130 km/h, respectively, are identical to the average values of CO_2 emissions (%) obtained experimentally at the same speeds (30 km/h = 9.33%; 50 km/h = 11.6%; 130 km/h = 12.87%). The mathematical model shows a high degree of correlation (the coefficient of correlation – determination is 1). Consequently, the mathematical model applied to the average values of CO2 (%), for the Toyota RAV 4 hybrid car is valid. Both the mathematical formulas and the calculations confirm the results returned by the measurement equipment for the CO_2 (%) emitted by the car engine.

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★ ★

The validation of the mathematical model for the average values of CO2 (%) emitted by the Volkswagen Jetta 1.4 TSI, Euro 5 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO (%) emitted by the Volkswagen Jetta 1.4 TSI, Euro 5 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of HmCn (ppm) emitted by the Volkswagen Jetta 1.4 TSI, Euro 5 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of NOx (ppm) emitted by the Volkswagen Jetta 1.4 TSI car, Euro 5, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO2 (%) emitted by the Dacia Logan 1.4 MPI, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO (%) emitted by the Dacia Logan 1.4 MPI, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of HmCn (ppm) emitted by the Dacia Logan 1.4 MPI, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of NOx (ppm) emitted by the Dacia Logan 1.4 MPI, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO2 (%) emitted by the Volkswagen Golf 1.6 l, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO (%) emitted by the Volkswagen Golf 1.6 l, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of HmCn (ppm) emitted by the Volkswagen Golf 1.6 l, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of NOx (ppm) emitted by the Volkswagen Golf 1.6 l, Euro 4 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO2 (%) emitted by the car Ford Focus ZX4 USA 2.0 l, Euro 3, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO (%) emitted by the car Ford Focus ZX4 USA 2.0 l, Euro 3, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of HmCn (ppm) emitted by the car Ford Focus ZX4 USA 2.0 l, Euro 3, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of NOx (ppm) emitted by the car Ford Focus ZX4 USA 2.0 l, Euro 3 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO2 (%) emitted by the Dacia Solenza 1.4 MPI, Euro 3 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of CO (%) emitted by the Dacia Solenza 1.4 MPI, Euro 3 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of HmCn (ppm) emitted by the Dacia Solenza 1.4 MPI, Euro 3 car is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of NOx (ppm) emitted by the Dacia Solenza 1.4 MPI, Euro 3 car is presented in the doctoral thesis that is deposited at the UPB library;

14.2.2 Validation of the mathematical model for phonic noxes

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Toyota RAV4, Euro 6 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Volkswagen Jetta 1.4 TSI, Euro 6 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Volkswagen Jetta 1.4 TSI, Euro 5 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Dacia Logan car, Euro 4 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Volkswagen Golf 1.6 Euro 4 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Ford Focus ZX4 USA 2.0 Euro 3 car, is presented in the doctoral thesis that is deposited at the UPB library;

The validation of the mathematical model for the average values of the sound received in the passenger compartment of the Dacia Solenza 1.4 MPI Euro 3 car, is presented in the doctoral thesis that is deposited at the UPB library;

All the previously mentioned appendices can be consulted in the doctoral thesis, which is located at the Polytehnic University of Bucharest library.

Chapter 15. FINAL CONCLUSIONS, ORIGINAL CONTRIBUTIONS AND FUTURE RESEARCH DIRECTIONS

15.1 Final conclusions

a) No transport organization is worthless without the knowledge of its employees.

b) The tacit know-how knowledge (know how) existing in a road transport organization represents the most difficult objective to achieve, this type of knowledge can be measured and at the same time capitalized when a decision can be made by an individual, then observing the consequences.

c) Knowledge management or knowledge-based management is premised on the capture of knowledge in the place where it is born, then its diffusion to the organization's personnel must take place, and finally its implementation in the production process.

d) Knowledge is an awareness, an understanding of facts, descriptions or information, the acquisition of skills through experience, education, learning or discovery.

e) Organizations must anticipate how customers will demand goods or services, and to be competitive in the market they must quickly adapt their production according to the requirements.

f) In the near future, innovation and technology will have their say in the problems that electromobility currently has – the autonomy of electric batteries, charging time, the presence and power of fuel stations on traffic arteries, and people will become more and more who are most interested in this mobility option.

g) The sustainable development of transport is the main pillar of economic development, the consequences of which are poverty reduction and access to the free market for goods and passengers, access to the labor market, to services, to education and to a decent life.

h) On December 15. 2022, 982 km of highway were built and put into use in Romania. At the European level, our country ranks last in terms of the number of kilometers of highway per 100,000 inhabitants.

i) On December 15. 2021, public roads in Romania had a total length of 86,199 km. Of these, 17,530 km are part of the national roads category, representing 20.3%. 35,096 km are part of the category of county roads, representing 40.7%, and 33,573 km are part of the category of communal roads, representing 39%.

k) The density of roads per 100 km2 of territory has increased permanently, but not enough. The increase of this indicator in 2020 was only 5.9% compared to 1990, and in 2021 it decreased by 0.54%, thus reaching the same value as in 2019. On December 31. 2021, the density of the public road network was of 36.2% reported per 100 km2 of Romania's territory.

l) The most recent report at the level of the European Union regarding the state of the road transport infrastructure (European Transport and Infrastructure Board from 2019) shows that our country is doing badly in this chapter, ranking last, with a score of 2.96 .

m) According to estimates made by specialists, our country currently needs a budget of 70 billion euros to bring the road infrastructure up to the standards required by the European Union.

n) On December 32. 2021, our country had a national fleet of 9,661,483 road vehicles, of which 7,611,039 (78.7%) are cars. Compared to 2020, the number of registered cars increased by 336,311 units (4.6%).

o) Diesel engine vehicles are more numerous than gasoline engine vehicles. They have a share of 51.6% of all motorized vehicles.

p) Gasoline vehicles have a share of 41.3%, and electric vehicles have a meager share of only 0.1%. They are less than hybrids, which have a share of 0.8% of the total national fleet of road vehicles.

q) The aging of the national vehicle fleet has increased in our country from year to year. At this time, Romania has the oldest fleet of vehicles in the European Union.

r) On December 31. 2021, the average age of cars in the national fleet is 16.4 years, compared to the average of the existing car fleet in the EU, which is 11.5 years.

s) In Romania, in 2021, 128,158 new road vehicles intended for public transport were registered.

In terms of ownership, 54% of new vehicle purchases were made by legal entities and 46% by individuals.

t) The average age of the vehicles that performed the periodic technical inspection in 2021 was around 14.8 years old.

u) The particular characteristics, of a technical nature, of the electric means of transport, such as the autonomy of the electric batteries, the long charging time, the high cost price, the numerical or power insufficiency of the charging stations at the end of the line or on the route or the weight of the vehicle as a result of additional electrical equipment, may lead to a decrease in the quality of road transport services.

v) Hydrogen in liquid state is difficult to store, requires special methods of transfer and transport, and the tanks of hydrogen vehicles require special protection.

w) Energy supply chain efficiency is likely to improve over time for hydrogen vehicles, and more renewable energy will contribute to hydrogen production.

x) The quality of services in road transport depends on factors other than that of the products. In road transport, quality is determined by two main aspects. The first relates to the degree of development of the road transport organization and the performance of its management, and the second aspect refers to the customer, to his degree of satisfaction following the transport services he has benefited from.

y) The quality of transport with hybrid vehicles does not impose special conditions regarding the autonomy or the charging of the accumulator batteries, however, in the case of vehicles with electric propulsion, the autonomy and charging capacity becomes a problem.

z) Active and passive safety systems and elements contribute substantially to reducing the number of road accidents.

aa) Nationally, in 2021, most accidents caused by young people (main culprit) were caused in rural areas. In this case, a number of 452 serious traffic accidents occurred on the territory of the country, but the largest number of serious road accidents, resulting in deaths among them, were registered outside the localities (mortality index 54, 8%).

bb) Failure to adapt vehicle speed to road conditions is the cause that generated the most serious road accidents in 2021 (25.7% of all road accidents), caused by young people aged between 18 and 29.

cc) The correct and regular attitude and action of autonomous vehicles in traffic is entirely based on artificial intelligence.

dd) According to European rules in the field, driver-driven vehicles, i.e. vehicles whose automation level is not higher than 2, are already sold on EU car markets. Vehicles with a maximum automation level of 4 are still in the research stage and are expected to be on European roads in the 2020-2030 range. Their full automation will be available after 2030.

ee). From the research done on the safety systems on the Toyota RAV 4 hybrid car, more than 50 non-conformities result. The non-conformities found prove that we are not yet ready for total autonomy.

ff) Chemical pollution in cars with MAS (Appendix no. 2). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, exhaust gas pollution (CO and HmCn), regulated by the Order of the Minister of Transport no. 2,133 (RTNR -1), **was reduced** to the following cars: a) average values for CO: Toyota RAV 4 hybrid 2.5 l, Euro 6 (from 0.08%, to 0.03%); Volkswagen Jetta 1.4 TSI, Euro 5 (from 4.48% to 2.67%); Dacia Logan 1.4 MPI, Euro 4 (from 1.44% to 0.56%); Ford Focus ZX 4 USA, Euro 3 (from 0.07%, to 0.01%) and Dacia Solenza 1.4 MPI, Euro 3 (from 9.52%, to 8.46%); b) average values for HmCn: Volkswagen Jetta 1.4 TSI, Euro 5 (from 43.51 ppm to 2.51 ppm); Dacia Logan 1.4 MPI, Euro 4 (from 19.14 ppm to 14.64 ppm); Ford Focus ZX 4 USA, Euro 3 (from 6.36 ppm, to 0.25 ppm) and Dacia Solenza 1.4 MPI, Euro 3 (from 130.93 ppm, to 129.71 ppm).

By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, exhaust gas pollution (CO and HmCn), regulated by the Order of the Minister of Transport no. 2,133 (RTNR -1), **increased** for the following cars: a) average values for CO: Volkswagen Jetta 1.4 TSI, Euro 6 (from 0.03% to 0.05%); Volkswagen Golf 1.6 l, Euro 4 (from 0.14% to 0.30%); b) average values for HmCn: Toyota RAV 4 hybrid 2.5 l, Euro 6 (from 8.11 ppm to 50.82 ppm); Volkswagen Jetta 1.4 TSI, Euro 6 (from 5.20 ppm, to 8.32 ppm) and Volkswagen Golf 1.6 l, Euro 4 (from 33.06 ppm, to 57.93 ppm). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, pollution with exhaust gases not regulated by legislation (CO2 and NOx), the values of which are indicative, **was reduced** for the following cars: a) average values for CO2: Toyota RAV 4 hybrid 2.5 l, Euro 6 (from 11.6%, to 9.33%); Volkswagen Jetta 1.4 TSI, Euro 6 (from 12.75% to 12.48%); Volkswagen Jetta 1.4 TSI, Euro 5 (from 14.22% to 13.28%); Volkswagen Golf 1.6 l, Euro 4 (from 13.93%, to 13.44%) and Ford Focus ZX 4 USA, Euro 3 (from 13.75%, to 13.55%); b) average values for NOx: Volkswagen Jetta 1.4 TSI, Euro 5 (from 28.29 ppm, to 9.13 ppm) and Dacia Logan 1.4 MPI, Euro 4 (from 31.38 ppm, to 4 .87 ppm). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, pollution with exhaust gases not regulated by legislation (CO2 and NOx), whose values are indicative, **increased** for the following cars: a) average values for CO2: Dacia Logan 1.4 MPI, Euro 4 (from 13.35%, to 14.13%) and Dacia Solenza 1.4 MPI, Euro 3 (from 10.89%, to 11.27 %); b) average values for NOx: Toyota RAV 2.5 l, Euro 6 (from 2.19 ppm to 6.34 ppm); Volkswagen Jetta 1.4 TSI, Euro 6 (from 41.29 ppm to 88.72 ppm); Volkswagen Golf 1.6 l, Euro 4 (from 48.37 ppm to 191.72 ppm); Ford Focus ZX 4 USA, Euro 3 (from 21.39 ppm, to 30.65 ppm) and Dacia Solenza 1.4 MPI, Euro 3 (from 21.51 ppm, to 58.99 ppm).

gg) Chemical pollution in cars with MAC (Appendix no. 15). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, exhaust gas pollution (CO and HmCn), regulated by the Order of the Minister of Transport no. 2,133 (RTNR -1) increased for the following cars: a) average values for CO: Renault Symbol 1.5 dCI, Euro 3 (from 0.03% to 0.08%); b) average values for HmCn: Renault Captur 1.5 dCI, Euro 5 (from 0.07 ppm to 0.62 ppm).

By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, pollution with exhaust gases not regulated by legislation (CO2 and NOx), the values of which are indicative, was reduced for the following cars: a) average values for CO2: Renault Captur 1.5 dCI, Euro 5 (from 12.8%, to 9.87%); Volkswagen Jet ta 1.4 TSI, Euro 4 (from 13.91%, to 12.83%) and Renault Symbol 1.5 dCI, Euro 3 (from 13.91%, to 12.83%); b) average values for NOx: Volkswagen Jetta 2.0 TDI, Euro 4 (from 76.45 ppm to 54.66 ppm) and Renault Symbol 1.5 dCI, Euro 3 (from 103.74 ppm, to 79, 28 ppm). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, the average CO2 pollution value did not increase for any vehicle with MAC. By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, the average value regarding NOx pollution increased for the Renault Captur 1.5 dCI, Euro 5 car from 19.77 ppm at 47.11 ppm.

hh) Noise emissions emitted in the passenger compartment of cars with MAS (Appendix no. 21). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, the average values of noise pollution received in the passenger compartment were **reduced** for the following cars: Toyota RAV 4 hybrid 2.5 l, Euro 6 (from 59.10 dBA to 57.2 dBA); Volkswagen Jetta 1.4 TSI, Euro 6 (from 63.00 dBA to 61.5 dBA); Dacia Logan 1.4 MPI, Euro 4 (from 58.10 dBA to 57.7 dBA); Volkswagen Golf 1.6 l, Euro 4 (from 69.20 dBA to 68.7 dBA); Ford Focus ZX4 USA, 2.0 L, Euro 3 (from 66.9 dBA to 64.9 dBA); Dacia Solenza 1.4 MPI, Euro 3 (from 70.60 dBA to 68.1 dBA). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, the average values of noise pollution received in the passenger compartment increased for the following cars: Volkswagen Jetta 1.4 TSI, Euro 5 (from 61 .9 dBA to 65.5 dBA).

ii) Noise emissions emitted in the passenger compartment of cars with MAC (Appendix no. 34). By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, there **were no increases in the average values of the noise received in the passenger compartment for any car**. In the case of cars with a diesel engine, from the analysis of the data presented previously, the level of sound pollution emitted in the passenger compartment is determined by: the level of engine speed, the type and profile of the tires, the state and degree of damage of the road surface, the state of maintenance, the level of noise produced of transmission elements and organs, age in years (moral wear and tear) and physical wear and tear.

jj) By reducing the speed of motor vehicles in the urban environment from 50 km/h to 30 km/h, fuel consumption actually decreased in the case of all analyzed cars (at MAS and MAC).

kk) Through experimental research on fuel consumption in passenger cars, we demonstrated differences between the consumption approved by the manufacturer and the actual consumption.

ll) For both MAS and MAC cars, fuel consumption is influenced by travel speed, driving style and engine sp

mm) From the analysis of the economic justifications on fuel consumption and CO_2 emissions, it follows that each car has consumed fuel and polluted with CO_2, in a direct proportion to the number of kilometers traveled since they were put into operation until now .

nn) The results obtained by validating the mathematical model for noise are identical to the results obtained with the specific equipment used in the experimental research process on cars.

oo) In table 15.1 I presented the conclusions on the operationalization of the objectives proposed in the research addressed. *The table can be consulted in the doctoral thesis that is deposited at the UPB library.*

pp) Starting from the general objective and going through the requirements of the specific objectives, the doctoral research project, the four research reports and the doctoral thesis were **schematically structured by means of mind maps**. *The mental maps can be consulted in the doctoral thesis (Appendices a1-1, a1-2, a1-3, a1-4, a1-5, a1-6, a1-7) which is deposited at the Polytehnic University of Bucharest library.*

15.2 Original contributions

a) At part I of the doctoral thesis:

In addition to bibliographic research on the current state of road transport, the following personal contributions have been made:

1. Carrying out SWOT analyzes of four types of propulsion systems of road vehicles (thermal engine propulsion, hybrid, electric and hydrogen propulsion - fuel cells), accompanied by conclusions, comments and personal point of view;
2. Presentation of an analysis regarding the types of motor vehicles;
3. Calculation of the percentage regarding the reductions of the newly implemented European norms regarding pollutant emissions, compared to the pollutant emissions from the standard of the European Pollution Norm presented previously;
4. Point of view, conclusions regarding the implementation method at the level of European countries, of the Electric Vehicle Network in Urban Europe project - URBACT II, (EVUE);
5. Designing and defining the indicators that establish and determine the quality of electric vehicles;
6. Definition and presentation of the evaluation indicators of electric vehicles. Appreciation of the way in which the quality of services provided with them decreases and corrective measures;
7. Evaluation of the level of automation of driving assistance systems that contribute to the management of road safety, fuel consumption and noise, existing on Toyota hybrid cars. Presentation of qualitative non-conformities in the analyzed systems;

8. Schematic realization in Visio software of the doctoral research project, a number of four doctoral research reports and the doctoral thesis.

b) In the second part of the doctoral thesis:

1. Definition of reference data regarding chemical and noise emissions emitted by cars with MAS and MAC;
2. Calculation of the power-to-mass ratio (PMR) for cars subject to experimental research;
3. Designing and defining specific conditions for experimental research;
4. Carrying out experimental research on cars with hybrid engines, MAS and MAC, to determine the level of chemical noxious pollution (CO2, CO, HmCn and NOx) in the urban environment, in the context of W.H.O. proposals to reduce the speed of road vehicles from 50 km/h to 30 km/h;
5. Carrying out experimental research on cars with hybrid engines, MAS and MAC, to determine the level of noise pollution emitted in the passenger compartment, in the context of W.H.O. proposals to reduce the speed of road vehicles from 50 km/h to 30 km/h ;
6. Carrying out experimental research on cars with hybrid engines, MAS and MAC, to determine the level of pollution with noxes (CO_2, CO, HmCn and NOx), in the extra-urban environment on the A1-Sibiu highway;
7. Carrying out experimental research on cars with hybrid engines, MAS and MAC, to determine the level of noise pollution emitted in the passenger compartment, in the extra-urban environment on the A1-Sibiu highway;
8. Identifying and defining the possible causes that generate the appearance of noxes in internal combustion engines;
9. Carrying out experimental research on cars with MAS and MAC to determine fuel consumption, as follows: 1) fuel consumption of cars, in the context of WHO proposals to reduce the speed of road vehicles in the urban environment from 50 km/h at 30 km/h; 2) the fuel consumption practically obtained in the urban and extra-urban environment for passenger cars, taken in comparison with the fuel consumption approved by the manufacturer using the WLTP method;
10. Making economic justifications regarding the fuel consumption of passenger cars and the amount of CO2 released into the atmosphere;
11. Creation of a mathematical model for the verification of chemical and acoustic noises emitted by cars with hybrid engines, MAS and MAC;
12. Validation of the mathematical model for the chemical noxes emitted into the atmosphere by cars with hybrid engines, MAS and MAC;
13. Validation of the mathematical model for noise emitted in the passenger compartment of cars with a hybrid engine, MAS and MAC.

15.3 Further research directions

Further research that can be developed on the subject of this doctoral thesis is the following:

a) Research on the determination of chemical, noise and fuel consumption for vehicles with hybrid engines, MAS and MAC, in winter and using higher quality fuels (eg petrol with an octane number of 99-100 or extra diesel) , biofuels (e.g. LPG, methanol, ethanol, biodiesel);

b) Research on the determination of chemical, acoustic and fuel consumption for high-tonnage MAC vehicles (trucks, trains, special vehicles whose engines drive machines or special installations mounted on them and whose speed exceeds more than 60% of the maximum speed of engine);

c) Research on the social impact and the adaptability of drivers and the population in the context of the W.H.O. proposals to reduce the speed of road vehicles in the urban environment from 50 km/h to 30 km/h;

d) Research on the determination of chemical, acoustic and fuel consumption for hybrid motor vehicles, MAS and MAC, using additional luggage devices and/or elements (e.g. roof rack, bicycle carrier, bulky luggage placed on the roof rack or the luggage rack attached to the rear of vehicles); in the same sense, the expansion of research for the same types of vehicles, when towing different types of trailers/semi-trailers (e.g. for the transport of goods, caravans, tankers, etc.);

e) Research on the development and implementation of sensors or video cameras on vehicles to extend the detection angle of small obstacles, wires, cables, cotton or lower obstacles at ground level. Research would contribute to the development of autonomous vehicles;

f) Research on ecological vehicles using the quality assessment indicators defined and explained in chapter no. 6;

g) Research on vehicles with MAS and MAC hybrid engines on how the cylinder capacity of the engines influences the emissions of noxes (chemical and phonic), at speeds of 30, 50, 130 km/h;

h) Manual gearbox versus automatic gearbox – research on noise (chemical and acoustic) emitted by vehicles with MAS and MAC at speeds of 30, 50, 130 km/h;

i) Research on the noxes (chemical and acoustic) emitted by vehicles with hybrid engines, MAS and MAC at speeds of 30, 50, 130 km/h – study for 2,000 km traveled in various operating modes, taking into account a longer time Operating;

j) The evolution over time of the noxes (chemical and acoustic) emitted by vehicles with hybrid engines, MAS and MAC at speeds of 30, 50, 130 km/h – study carried out according to wear and technical revisions;

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