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QUALITY AND QUALITY MANAGEMENT IN ECOLOGICAL AUTOMOTIVE TRANSPORT – OPPORTUNITIES AND PERSPECTIVES

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Abstract: *The electric motor vehicle becomes indispensable in meeting the mobility needs of mankind, representing the foundation of the sustainable and long-lasting future of automotive transport. However, although it is the most viable and efficient transport solution at this time in the extra-urban environment, it is inefficient over long distances, creates uncertainty and distrust among users, being unattractive. Below we show a technical and managerial study with engineering nuances, through which readers can look at and understand the concept of sustainable development in a global context, presenting the place, role, efficiency, effectiveness and current stage of development of the electric motor vehicle in the road transport system, but also the characteristics that increase or decrease the quality of ecological road transport services.*

Key words: *quality, electromobility, electric motor vehicle, transport service, ecological automotive transport.*

1. INTRODUCTION

The sustainable development of automotive transport has always been and continues to be a particular concern of scientists.

The new human civilization is rapidly developing in all fields, through a solid exchange of material and intellectual capital and requires the continuous transportation of goods or people from one place to another. Road transport does not produce material goods. They create motor vehicle transport services. Thanks to this, the achievements in this sector are measured in abstract units. In fact, road transport continues productive processes in the field of the movement of goods or people. Transports are determined by the mobility of human being in space.

The evolution of the means of travel and those of transport went simultaneously, the technological development thus depending on each other. Over time, communication routes and transport systems have become so important that they are an integral part of everyday life. Through the evolution of the production forces, the social division of labor has increased, and the movement of people and goods have determined a rapid development of transports so that at the moment, they represent an independent branch.

Mobility and transport are important to all of us. From daily commuting to work, visiting family and friends, tourism, to the smooth running of the world's supply chains of goods to our shops and industrial production, mobility is a contributing factor in our economic and social life. The free movement of people and goods across internal borders is one of the fundamental freedoms of the European Union (EU) and its single market. Travelling in the EU has led to increased cohesion and the strengthening of European identity. As the second largest spending area for European households, the transport sector contributes 5 % to European GDP and directly employs around 10 million workers [14].

Worldwide, environmentally friendly motor vehicles, electric motor vehicles, are growing more and more. Electric motor vehicles appear in land transport systems as an alternative to the conventional vehicle that has become increasingly polluting for the environment.

As the renewable energy over the last decade, the automotive industry is currently investing heavily in the emergence of low- and zero-

emission vehicle technologies such as electric vehicles [13].

So, humanity is forced to find alternatives for mobility. Technological evolution has allowed it to do so. It seems that electric vehicles really represent a sustainable and hundredth-proof solution to the problem of human mobility. The quality of services in road transport is quite different from that of products.

In road transport, quality is determined by two main aspects. The first aspect concerns the degree of development of the road transport organization and the performance of its management, and the second aspect refers to the customer, to the degree of satisfaction achieved by him/her following the use of an electric vehicle or a transport service with it, from which he/she benefited.

2. CHALLENGES AND TRENDS REGARDING THE FUTURE EVOLUTION OF THE ELECTRIC MOTOR VEHICLE

In the field of electromobility, the period to come is a sign of continuous readjustment, which requires efficiency, effectiveness and constant reaction speed. Although this is not new for road transport, an overlap of complex challenges, predictable or not, must be brought about for the future. With regard to the current context, given the EU's policies on the decarbonization of transport systems, we believe that this is a time of opportunities that may arise for the relevant organizations, natural or legal persons, who will know how to prepare in advance for the current major geo-political changes. They will develop robust

Starting from these data, we can say that the future of electromobility is "green" and will not be able to be stopped. Otto's engine loses its importance as time goes on, with electromobility gaining ground. Major motor vehicle manufacturers continue their efforts to reach the Corporate Average Fuel Economy (CAFE) standard 2025. These standards can be achieved by strengthening strategies in the field of electromobility, with the expansion of mild-hybrid offer programmes, but also with new offers of plug-in hybrid and full electric vehicles. A range of completely new electric mustermechanisms to all problems and events taking place worldwide. It turns out that the transition from the classic engine to the electric, non-polluting one is encouraging. An alarming factor appears however: although sales of classic motor vehicles will enter a downward trend, it is expected that by the middle of the next decade they will exceed the threshold of 2 billion worldwide. To justify what has been said, in figure 1 we show the evolution of classic motor vehicles versus electromobility worldwide during the period 2017-2030. According to the graph, the end of this decade (2030) represents the decline of the motor vehicle with an internal combustion engine. It is noted that the number of electric vehicles is set to skyrocket from the middle of the next decade.

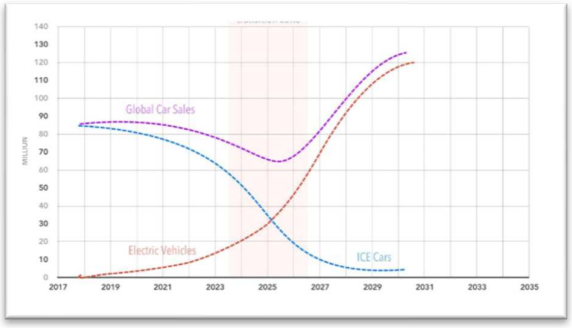

Fig. 1 The evolution of electromobility worldwide during the period 2017-2030 [11].

As for battery-powered electric vehicles, studies show an increase in the market share of new motor vehicle sales from 1%-2% in 2020 to 11%-30% in 2030. For plug-in hybrid vehicles, a share of 2% in 2020 and 5% to 20% by 2030 is expected [12].

vehicles have appeared on the market as from 2020 such as: The Tesla Y model, a small crossover built on the Model 3 platform; The Mini Electric, which shares much of the technology with the BMW i3 and a full range of electric vehicles from Volkswagen. Worldwide, several motor vehicle companies have followed the example of the Americans at Tesla, who have been pushing for electromobility in the automotive industry. At this time, every motor vehicle manufacturer in the world manufactures at least one electric model and one hybrid model.

Many of them focus on fully electric motor vehicles. Rivian, one such manufacturer in Irvine, California, received $ 700 million funding from Amazon in the beginning of 2020 and hopes to defeat Tesla by launching the first all-electric truck called R1T. In order to reduce the mass of electric motor vehicles that is defined by electric accumulators, implicitly the consumption of energy and the preservation of their autonomy, companies will have to focus on light materials, materials that reduce the own mass of the means of transport. Their tendency to use materials as light as possible, frequently changes from aluminum to carbon fiber not only for body elements, but also for the structure of interior components in the passenger compartment. For example, the upcoming Volo plug-in hybrid Polestar 1 EV and Polestar 2 EV motor vehicles are based on a carbon fiber interior structure. Analysts argue that the annual carbon fiber market rate will rise from 7.9% to 10.6% over the next five years. At the moment, however, the only impediments to the development of the electric vehicle, worldwide, are: the low autonomy of the electric batteries (they make them unattractive in terms of long-distance travel); the charging speed (the slow and frequent charges of the batteries of electric motor vehicles are inconvenient, it creates discomfort and delays); the charging network of electric batteries (poorly developed and insufficient in most European countries, especially in Eastern European ones); the high cost price of electric motor vehicles in relation to the standard of living of many countries in Europe (especially eastern European countries, the price being 10,000 to 15,000 euros higher than a similar motor vehicle with a classic engine); the low level of popularity that these vehicles have among the population. In fact, all the aspects that characterize an electric motor vehicle, which we have presented before, determine their low popularity among users.

As for the electric batteries it seems that the problem will be solved as soon as possible. At the end of 2020, there were electric vehicles whose minimum battery life was 450 km (Volvo Polestar) and the maximum was 595 km (Tesla S model). Samsung company has studied and developed a new type of liquid-free electrolyte battery, more stable and compact than conventional Li-ion solutions. Solid-state batteries promise to be more stable and durable over time, possibly exceeding the service life of the vehicle they power, ensuring a range of over 800 km. The reduction of charging time is also under study. Researchers estimate that in the year 2022 the batteries of electric motor vehicles could be charged in 5-10 minutes.

To do this, the team of researchers created an electric battery for motor vehicles that used a thin nickel foil to create an internal self-warming structure. Heating the battery to the said temperature and then cooling it to ambient temperature, they were able to charge it to 80% capacity in 10 minutes.

Autonomy is inextricably linked to charging systems. If charging takes a few hours in a garage or a street charging point, consumers will probably want the motor vehicle to offer considerable autonomy after each recharge. Even if the majority of the population travels short distances during a normal working day, it is likely that they will want to be able to travel longer distances when important trips are needed, not having to waste hours on recharging during such trips. Batteries will sometimes discharge in situations where the motor vehicle is not at a recharging point. Mechanisms must be designed for recharging on the side of the road in the event of an emergency or replacement of batteries [9].

Regarding the logistics that ensure the charging of batteries for the propulsion of electric vehicles, a number of projects have been developed on the basis of which a lot of research has been made at European level.

According to AVERE (European Association for Electric Vehicles with Batteries, Hybrid and Fuel Cells) [7], a development plan has been established on initiatives to standardize the parameters of charging electricity for infrastructure, as follows [7]:

- ✓ End of 2011: ETSI & CEN-CENELEC provided their recommendations to the European Commission for a European standard;
- ✓ End of 2013: a DC standard is launched by the IEC;

- ✓ 2017: ACEA position on Module 3 (standard or accelerated charging with special socket for VE with multiple pins with control and protection functions on a specific circuit), Type 2 (single-phase and three-phase couplers for vehicles) & Type 2 accelerated charge 2/Combo 2 (Mennekes socket – Rated at 70A for single-phase voltage and 63A for three-phase voltage, with a max. voltage of 500V, with 7 pins).

As a result of the research carried out, the approximate charging time for a 24kW battery has been established, specified in Table 1, together with the required relevant energy.

Table 1

Approximate charging time for a 24kW battery and the required energy [7].

Charging time (hours)	Charged power (Kw)	Voltage (V)	Current (A)	Module*	Charging 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 charging modes for electric motor vehicles are approved [7]:

Module 1 – standard charging from a regular single-phase or three-phase electrical outlet (not recommended);

Module 2 – standard charging from a regular outlet, but equipped with specific protection devices for VE integrated into the cable;

Module 3 – standard or accelerated charging with special socket for VE with multiple pins with control and protection functions on a specific circuit;

Module 4 – accelerated charging with special charging technology, such as CHAdeMo (All necessary control and protection functions are included in the installed infrastructure).

The previous table shows that the technology on charging electric batteries has evolved a lot in recent times, and charging time has been substantially reduced from 10 hours to 15 minutes.

It seems that faster charging is starting to become technically possible. However, if the duration of the charge cannot be reduced approximately to the time required to fill a tank of gasoline, busy people will become impatient [9].

3. DEFINITION OF THE QUALITY AND CHARACTERISTICS OF TRANSPORT SERVICES THAT DETERMINE THE QUALITY WITH ELECTRIC VEHICLES

The term quality has its origin from Latin and it can be defined as "the way of being", but from the name of yesteryear until today, this term had to go a long way, it has acquired different definitions depending on the field of applicability, having to make a huge leap to be perceived by modern human being. The efforts of the Technical Committee of the International Organization for Standardization (ISO), made up of representatives of 20 member countries, materialized in 1986 by the publication of the ISO 8402 standard – The quality management and the quality assurance - terms, definitions and concepts applicable to this field [7].

According to the standard, quality is the set of characteristics of an establishment (independent content, existence determined in scope, value, content), material or non-material that gives it the ability to satisfy its needs (specifications and represent some requirements that are part of a contract), expressed and implicit [10].

Then, in the year 2000, the same organization develops the ISO 9000 standard, which defines quality as: the extent to which an assembly of default characteristics satisfies the requirements [10].

In this case, the requirement is represented by needs or expectations that are declared, implicit or binding. The characteristic is represented here by a temporal, sensory, behavioral, physical, functional trait.

Other more important definitions of quality were given by the great authors as follows:

suitable for use [5] or compliance with the requirements [1].

However, a proper description of the quality concept was made by Dr. Genichi Taguchi through quality by design [4], in the direction of quality achieved by design: quality must be built when designing the product, to ensure that the product will consistently achieve a predefined quality at the end of the manufacturing process [4].

Indeed, quality management systems have decision-making roles within road transport organizations, but each feature presented above has a decisive role in determining the quality. In the conception of other authors, improving and increasing the quality of material goods or services always leads to the achievement of excellence [7].

They appreciate that: Quality management systems are obviously the most powerful strategic means that managers of organizations have at their disposal to achieve quality, as it is understood today [8].

The origin of this standard derives from the British standards of defense, BS 5750. British standards were created solely to achieve and secure the quality of products. For this reason, its application and involvement in the field of services has been made quite difficult.

Thus, the concern for the extension of this concept to the transport sector is also explained, where there is no universally accepted definition of quality and therefore no general valid model has been developed [2].

Road transport is part of a field of social and economic activities, through which the movement of people, goods or material goods in space with road vehicles, on certain traffic routes, is carried out in order to meet the material, cultural and spiritual needs of people in particular and of society in general. In our sense, the ecological road transport system comprises all the subsystems consisting of installations, constructions, environmentally friendly means of road transport, the infrastructure for charging the traction batteries of electric vehicles, which use certain techniques, rules or principles to move independently, controlled and coordinated, in order to transport goods, material goods or people. The optimal, efficient, effective, high-quality level functioning of an ecological road transport system, requires the accumulation of sufficient knowledge from the human resource, in order to set in motion the hybrid or electric means of transport, but also to know certain conditions of influence of this activity. The quality of services in road transport is quite different from that of products. In road transport, quality is determined by two main aspects. The first aspect is related 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 the degree of satisfaction achieved by him/her as a result of the transport services, from which he/she benefited. The differentiation of transport services from that of material goods is highlighted by certain characteristics that define quality. These characteristics are general and common to all transport fields, regardless of whether goods, material goods or people are transported.

The characteristics that define quality in road transport are as follows:

a) Lack of ownership of the transport vehicle or of the service provided

In the absence of ownership of the transport vehicle or the service provided, the customer benefits from the physical vehicle or the transport service with the vehicle in question, in the form of a transport of material goods, food (transport of goods), or he/she purchases a ticket or a subscription to travel by minibus, bus or coach, depending on his/her mobility needs (passenger transport).

If the journey is carried out by an environmentally friendly means of transport (hybrid or electric vehicle), its action is considered to be environmentally friendly, energy-efficient, without affecting the environment or the health of those around it.

b) Inseparability of the transport service

The inseparability of the transport service is defined by those actions by which it cannot be detached, isolated, separated from the elements that contribute to its proper development. In the case of the transport of goods, the transport service cannot be initiated and performed without a prior and categorical order of the customer. In this case, the electric motor vehicle

is dependent on the battery charging infrastructure, on specific maintenance works, its communication with the transport infrastructure, etc. The inseparability is evidenced by the multitude of customers benefiting at the same time by a certain road transport service. It is actually the aspect that determines the quality of the service provided. For example, the journey time with an electric motor vehicle increases exponentially when the battery capacity decreases, it discharges quickly and needs to be charged. If there is no charging station on the travel itinerary, things get even more complicated. Then if we further analyze this aspect, the charging times depend on the power of the station which, we do not find everywhere on the travel itinerary. These syncopes cause delays, and arriving at destination is not in line with the schedule that travelers or customers have set for themselves. That is why we consider that the qualitative nonconformities shown above constitute an aspect that somewhat overshadows the field of electromobility, making the electric motor vehicle unattractive from this point of view.

c) Intangibility of the transport service

If the transport service is performed with electric vehicles, the customer may be presented with certain aspects about how this type of vehicle can influence the quality of the respective transport, and in the end, he/she can be shown all the achievements obtained from the performance of the carrier (reaching the destination of goods or passengers, etc.). The road transport service cannot be seen, palpated or felt.

d) Variability of the transport service

The variability of the road transport service is determined by certain aspects pertaining to the suppliers, the date of dispatch of the goods or the start of the journey for persons, the place where these services are provided, but also the manner, procedures and methods of their provision.

If the road transport service provider uses electric means of transport for carriage, he/she must provide the customer with data related to the specifics of these means of transport (efficiency, effectiveness, the time of transport which is usually known, its observance is influenced by the technical characteristics, the state of the service infrastructure, the level of charging of the electric battery, the training stage and the knowledge held by the driver about the electric vehicle, about the infrastructure and use of the charging infrastructure, about the maintenance works that are carried out to maintain within the parameters the motor vehicle and the electrical system, etc.).

e) Perishability of the transport service

The perishability of the transport service is determined by the variability in time of the transport requests.

This variation is specific to the transport of goods and can influence the quality of the service because in certain periods of time multiple requests may occur on certain routes for the movement of the means of transport by motor vehicle. In this case, the capacity of electric accumulators and charging times affects the quality of the freight service provided by electric means of transport. For passenger transport, the perishability of the transport service demonstrates non-quality when the means of public transport become overcrowded, too small and uncomfortable or show delays. If passenger transport is carried out by public transport, the excess weight when climbing ramps increases energy consumption and quickly discharges electric accumulators. Also, the speed of movement of electric buses is lower at overcrowding, due to the additional load, negatively influencing the comfort and safety of passengers. The continuous operation during the summer or winter of the air conditioning installations or those for the air conditioning of the public transport means, leads to the reduction of the capacity of electric batteries. A low autonomy of the batteries of accumulators, corroborated with a higher weight of electric vehicles, a long time allocated to its charging, a high price when purchasing them, but also the insufficiency, lack or low power of the charging stations creates and produces discomfort, delays, failure to fulfill the tasks, transport plans and programmes in due time, creates stress, insecurity and distrust among the population or customers, but also non-conformities in ensuring quality services with such vehicles.

Travelling with electric vehicles in Europe should be simple: this means that recharging with electricity must be as easy as powering the tank [5].

The dysfunctions and non-conformities created by them, decrease the quality of the environmentally friendly means of transport and of the services provided with them. They can be solved by researching and developing new technologies that reduce or fully compensate the qualitative non-conformities.

4. QUALITY OF SERVICES WHITH ELECTRIC VEHICLES

The quality of services with clean, environmentally friendly road vehicles must be understood as a complex notion, in a permanent dynamic, which meets the implicit and explicit requirements of passengers or customers, but also the requirements of noise or chemical pollution of the environment. Quality in this case must be applied in its complexity, being an emergency but also a necessity. We affirm all this because, acting with indifference, without logic, without discernment, the effects can have serious consequences, bringing technical, economic and financial prejudices to the organizations in the field. In the case of public transport, quality has specific features, characterized by the nature of what is transported, the human being, with his/her specific requirements, but in the case of transport of goods, quality has other characteristics. They derive from the nature of what is transported - material goods - with their specific requirements. The means of public transport (taxi, minibuses, buses, coaches) define the quality through a set of technical and organizational measures that lead to the optimal satisfaction of the requests in the public passenger transport, and in the case of the transport of goods (with trucks and special vehicles), it is defined by the same technical and organizational measures that, in the end, ensure the optimal satisfaction of the requests of all customers, be they natural persons, legal entities, organizations, etc. Ensuring the quality of transport services is the main basic objective of road transport organizations, especially if the transport is carried out by electric means of transport, on common communication routes on which people and conventional vehicles circulate. In the case of electric vehicles, quality becomes a problem defined by the shortcomings of the technology existing at this time. We say on this date, because at the moment they constitute technical nonconformities that directly influence the delay of goods or travelers to their destination, and if technology evolves, they will diminish or even disappear. The powers of the charging stations, the frequency of the charges which are determined by the capacities of the electric accumulators and which establish the autonomy of the environmentally friendly road transport vehicle, influence and directly modify the schedule of the means of transport and their transport plans. In the transport of goods or passengers, a number of types of quality defined by passengers or customers, by the conditions and technical potential of environmentally friendly means of transport are identified. Below we propose to describe them and explain how the factors or technical characteristics of the electric motor vehicle influence the quality in automotive transports.

4.1 Expected quality of transport services with electric motor vehicles

The expected quality of transport services with clean road vehicles, makes reference to the level of quality that customers who benefit from transport services (goods or passengers) want it explicitly or implicitly.

For example, in the field of public passenger transport, the quality of the service is reflected by the perception of the passengers about the performance of the transport service [3].

Quality requirements are part of the category of implicit and explicit requirements of the customers, which we show and define below.

Traffic safety on public roads is the basic condition of road transport. It shall be carried out in optimum conditions when all vehicles and transport installations are operated at designed parameters, uninterrupted, without errors.

The regularity of the movement of the means of road transport is achieved by strictly observing the schedule of the means of transport according to the traffic schedules (with the observance by the drivers of the departure and arrival times from the stations, from the suppliers to the customers or beneficiaries).

The rhythmicity of passenger transport vehicles on a given transport route is a qualitative objective on the basis of which the efficiency factors of any road transport organization are defined. In the case of provision of transport services by electric vehicles, the rhythmicity and punctuality may be conditioned by aspects such as: the charging times of the batteries and the power of the station, the autonomy of the electric accumulators, the malfunctions of the means of transport, the driver's behavior towards the means of transport and the way the vehicle is driven, traffic accidents, etc.

Punctuality of the means of transport. Punctuality is defined by the optimal time, the established time, in which the means of transport reach the loading-unloading points to the customer or the beneficiary, and the buses arrive at the stations, according to the graphics or the transport schedule.

The comfort offered by the means of transport is a condition of quality specific to the means of public transport with the motor vehicle, minibus, bus or coach. Over time, science has shown that the ergonomics of the driving position and the inadequate comfort of the means of transport create fatigue and discomfort to users. Low engine noise is a high factor in the quality of electric transport vehicles.

4.2 The desired quality of the transport services with electric motor vehicles

It refers to the quality index set as an objective by the provider or the road transport organization and it is defined by quality factors related more to the compliance with transport schedules, programmes and plans, the way in which the transport organization responds to the requirements and needs of customers, the resolution of transport requests or their complaints. From this point of view, the desired quality takes the form of the expectations that customers have under the domination of internal and external pressures of the road transport system.

4.3 The achieved quality of the transport services with electric motor vehicles

The achieved quality of the service with electric road vehicles shows us what is the level of quality provided in a certain period of time (usually daily), seen through the perspective of passengers in the case of passenger transport by public transport, or of goods for the transport of goods or of material goods with freight vehicles.

If the transport is carried out by electric vehicles, then the quality of the service is considered to be efficient, being analyzed in this case in the light of environmental requirements.

4.4 The perceived quality of the transport services with electric motor vehicles

Due to the experiences acquired and accumulated over time, travelers or customers have the skills to appreciate the quality of a transport service offered by an organization specialized in this field.

The perceived quality may be assessed with the support of specially conducted surveys on the diversity of aspects of public passenger transport or freight transport, without taking into account a model or a benchmark.

Comfort, ease of driving, selfishness, efficiency, energy consumption and its low cost, low level of noise and zero level of chemical pollution, are some of the quality characteristics that define electric motor vehicles, increasing the perception of customers or users.

5. CONCLUSIONS

The electric motor vehicle has the opportunity to develop, but it still has many years to go. It's on the rise. This will only happen if the technology evolves rapidly and other sources or methods of mobility are discovered. People are still reluctant to acquire it. This reluctance is fueled by the low autonomy of the batteries of accumulators, the lack of charging points for accumulator batteries in some European states, the higher weight of these vehicles, due to additional electrical equipment and the high purchase price.

For a greater use of the concept of electromobility, we believe that research should be extended in the future regarding the autonomy of motor vehicle batteries, which needs to be increased. Battery charges should be made in a shorter time. Today, charging an accumulator for an electric vehicle, necessary to cover a route of about 450-600 km takes about

15 minutes at the fastest stations. Fast charging stations, we do not find everywhere, and for efficiency, the power supply must come from renewable sources (hydropower plants, wind plants, etc). Research should be extended to the development of lighter electric battery packs, with the purpose to reduce the weight of electric and hybrid cars.

The quality of services in road transport is quite different from that of products. In road transport, quality is determined by two main aspects. The first aspect concerns the degree of development of the road transport organization and the performance of its management, and the second aspect refers to the customer, to the degree of satisfaction achieved by him as a result of the transport services, from which he benefited.

Particular characteristics of a technical nature, specific to the ecological means of transport, which decrease the quality of road transport services, are the following: autonomy and the long waiting time for charging the electric accumulators; high price for the purchase of electric motor vehicles; small number and low power of charging stations; the higher weight of the vehicle as a result of additional electrical equipment (electric engines, electric accumulators and related equipment).

The quality of electric vehicle transport is a problem created by the shortcomings of the technology that exists at this time. We say at this time, because they constitute technical nonconformities that directly influence the delay of goods or passengers at their destination, influence and modify proportionally and directly the schedule of the means of transport and their transport plans. If the level of technology increases in terms of quality, they will diminish or even disappear.

The technical characteristics and performance of electric, non-polluting vehicles are defined by attributes that set out their quality indicators. Quality indicators are defined by the way in which an electric motor vehicle satisfies the degree of waiting of the driver (user or owner), the customer or the passenger (beneficiary of the transport service) over a certain period of time. In this case, the period of time can be interpreted as: the entire life cycle of the motor vehicle, the period of its possession by the owner, a trip on a certain route or travel itinerary, a transport of goods or passengers, etc. Quality indicators are the totality of a set of attributes that define the electric motor vehicle and that are based on and are actually defined by the systems and installations that contribute to their ergonomics, safety and comfort.

Given the above, we affirm with all our strength and conviction that the future of road transport is long-lasting and sustainable. It will be provided by ecological, environmentally friendly means of transport with increased energy efficiency.

7. REFERENCES

[1] **Crosby**, **Ph. B**., *Quality Is Free.* McGraw-Hill, New York, 1979

[2] **Dragu**, **V**., *Specific aspects of quality in transport,* AGIR Bulletin, Bucharest, pp. 104-107, ISSN 1224-7928, Issue 3, 2004

[3] **Dragu**, **V.**, **Roman**, **C. V.**, *Specific aspects of quality in urban public, Life and activities in large urban areas. Bucharest, present and future,* The works of the 7th edition of the Academic Days of the Romanian Academy of tehnical Sciences, pp 217-225, October 11-12, 2012, AGIR Bulletin, Bucharest

[4] **Ealey**, **L. A.**, Quality by design: Taguchi methods and U.S.Industry. Dearborn, Mich., ASI Press, 1988

[5] **Juncker**, **J. C.**, *Speech by the President of the European Commission*, Brussels, 2014

[6] Juran, J.M. Quality Control Handbook.McGraw-Hill, New York, 1988

[7] **Noon**, **M.**, *Electric vehicles in urban Europe, EVUE – approaches to e-mobility infrastructure. Urb Act -Connecting Cities – Building Success,* EU – Stakeholder Guide -Infrastructure, pp 1-88, Brussels, 2012

[8] **Oprean**, **C.**, **Kifor**, **C.**, *Quality managemnt,* Editura "Lucian Blaga" Publishing House from Sibiu, Sibiu, 2002

[9] **Sepi**, **M.**, *The road to wider use of electric vehicles,* Official Journal of the European Union, 11 february, 2011, Opinion of the European Economic and Social

Committee (exploratory opinion requestd by the Presidency (EESC), EUR-lex Publishing, pp 47-52, Issue 2011/C44/08, Brussels, 2011

[10] **Standardele ISO 8402-1986 (EN-28402-1991) – ISO 9000/2000**: https://www.iso.org/standard/29280.html

[11] **Tessien**, **R.**, *Global car sales electric, EVs, Oil, And ICE: Impact By 2023 And Beyond, 2018*: https://seekingalpha.com/article/4225153-evs-oil-and-ice-impact-2023-and-beyond

[12] **The European Commission**, *A European strategy on green and energy-efficient vehicles,* Communication from the Commision to the European Parliament, the Council, the European Economic and Social Council and the Committee of the Regions, p. 4, COM(2010)186 final/28.04.2010, Report, Brussels, 2010

[13] **The European Commission**, *A clean planet for everyone. A long-term strategic European vision for a prosperous, modern, competitive and climate-neutral economy,* Communication from the Commision to the European Parliament, the Council, the European Economic and Social Council and the Committee of the Regions, p. 12, COM 773 final, Report, Brussels, 2018

[14] **The European Commission**, *The strategy for sustainable and smart mobility-putting European transport on the parth to the future*, Communication from the Commision to the European Parliament, the Council, the European Economic and Social Council and the Committee of the Regions, COM(2020) 789 final-SWD(2020) 331 final/19.12.2020, Report, Brussels, 2020

CALITATEA ȘI MANAGEMENTUL CALITĂȚII ÎN TRANSPORTUL AUTO ECOLOGIC

Rezumat: Automobilul electric devine indispensabil în satisfacerea nevoilor de mobilitate a omenirii, reprezentând fundamentul viitorului durabil și sustenabil al transporturilor auto. Totuși, deși este cea mai viabilă și eficientă soluție de transport, la această dată în mediul extraurban, este ineficient pe distanțe lungi, creează incertitudine și neîncredere în rândul utilizatorilor, fiind neatractiv. În cele ce urmează, prezentăm un studiu tehnic și managerial cu nuanțe inginerești, prin intermediul căruia cititorii să privească și să înțeleagă conceptul de dezvoltare durabilă într-un context global, prezentând locul, rolul, eficiența, eficacitatea și stadiul actual de dezvoltare al autovehiculului electric în sistemul de transport rutier, dar și caracteristicile care cresc sau scad calitatea serviciilor de transport rutier ecologic.

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