GENERAL AND SPECIFIC ASPECTS OF SUSTAINABLE DEVELOPMENT IN URBAN TRANSPORT

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Rezumat. *Deplasarea excesivă pe trama stradală a orașelor cu autoturismul personal a produs asupra acestora fenomenul de congestie a traficului.Lucrarea științifică prezintă termenii de congestia traficului și dezvoltarea durabilă. În lucrare sunt prezentate soluții pentru diminuarea efectelor externe negative datorate utilizării excesive a autoturismelor personale pe trama stradală din marile orașe. In ziua de azi, mijloacele de transport devin tot mai rapide si tot mai inteligente. Într-o lume a vitezei şi pe o infrastructură are nu s-a dezvoltat în acelaşi ritm,având pe fond şi eroarea umană, iminent apar accidentele şi ambuteaje în trafic.*

Abstract. *Excessive travel on the street plot of cities by personal car has produced on them the phenomenon of traffic congestion. The scientific paper presents the terms of traffic congestion and sustainable development. The paper presents solutions to reduce negative externalities due to excessive use of personal cars on the street network in major cities. The paper presents solutions to reduce the negative externalities due to excessive use of personal cars on the street network in big cities. Nowadays, means of transport are becoming faster and smarter. In a world of speed and infrastructure, it has not developed at the same pace, with human error in the background, accidents and traffic jams are imminent.*

Keywords: Transport, sustenable development, public transport, traffic jam.

1. Introduction

Economic growth but also changes in travel behavior have led to an increase in traffic volume, with direct implications on the negative external effects of transport in social life (congestion, space occupancy, chemical and noise pollution, accidents, social inequity, etc.) [1], [3], [5].

Inside congested cities, road congestion is common due to the large number of cars. The level of congestion has become almost unbearable due to excessive use of the individual car on city streets.

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The use of road vehicles is increasing, the benefits they offer have been gradually diminished by external costs. As traffic increases as we approach the center, the open space of the road decreases. Increasing the size of the city increases the amount of traffic and can eventually lead to congestion.

The reduction of congestion was achieved until recently, by developing the capacity of road infrastructure, not taking into account that it is a limited resource and no matter how much it grows, it will always be reached.

Sustainable urban mobility is the unbridled satisfaction of the travel needs of current generations, without compromising the ability of future generations to meet the same needs [4].

Sustainable urban mobility preserves the environmental conditions and the transport is carried out with the fulfillment of certain quality parameters imposed by the administrations involved and accepted by those who are beneficiaries of the services offered, without affecting the persons not involved in the transport process.

Among the best known techniques for achieving sustainable urban mobility are: promoting walking and cycling (when distances are suitable for these modes of travel), the use of high-capacity means of transport (tram or subway) and the use of transport public, in general, to the detriment of the individual car [4].

2. Barriers to sustainable development in transport

The most irritating phenomenon of the life of the inhabitants of the big urban agglomerations is the traffic congestion. The increase in the number of cars and the insufficient development of the road infrastructure, as well as the lack of an urban development plan lead to the frequent formation of congestions. If the number of people who travel daily between cities is relatively small, things are different inside cities. Whether we go to work, college or the supermarket, we need a means of transportation that inevitably contributes to the congestion of the streets. In large cities, due to population density, roadblocks often occur, endless queues form at traffic lights, and the average speed decreases drastically. Most of the time the streets are crowded during rush hours, but there are other causes such as public works, unfavorable weather conditions (fog, frost), unforeseen collisions, etc. All of these things have a major impact on the economy (the Texas Transportation Institute, for example, has calculated a $ 67.5 billion loss in productivity due to traffic to the top 75 cities), the environment (due to pollution and greenhouse gases that contribute to global warming) and on drivers (stress, decreased traffic comfort and additional costs estimated at $ 1,000 per year for large cities).

Fig. 1. Congestion in New-York City

In addition to the negative impact they have on the economy, traffic congestion results in increased travel times and inability to estimate travel time; increasing fuel consumption; decrease in the reliability of cars due to frequent accelerations and braking; the impossibility of emergency vehicles (ambulance, fire, police) to move urgently where needed.

Congestion of the main arteries leads to congestion of the surrounding secondary streets and has a negative effect on residential areas due to noise pollution. The most irritating phenomenon of the life of the inhabitants of the big urban agglomerations is the traffic congestion.

The number of car owners registered on the Romanian territory amounts to a value of over 600 cars per thousand inhabitants. Bucharest has become a city with more cars than Amsterdam, Copenhagen, Prague or Rome (Engineering World no. 17 / 1-15 September 2015). The plan proposed by the Bucharest Metropolitan Transport Association (civil society structure established with the agreement of the General Council of Bucharest) involves solving the existing problems related to congestion by creating a complex network for public transport. The target for 2030 is to increase the number of public transport users from 20% at present to at least 80%.

This objective must be achieved in the area with the highest population density in the country - over 8000 inhabitants / km2. According to Sustainable Urban Mobility Plan 2016-2030 - Bucharest-Ilfov, Bucharest is the city with the highest congestion in Europe, and one of the the most affected in the world. This study determined the congestion index for several cities in the world and showed that Bucharest has a congestion index of 41%, reaching the 8th place (out of 146 countries analyzed) in the ranking of the worst in the world and the first place in Europe (fig. 4). However, in 2012 Warsaw was at the top of the ranking, with a congestion index of 42%, followed by Marseille (40%) and Palermo (39%), while

Bucharest was at the top. far behind them. While these cities have been able to reduce their congestion, the problem in Bucharest has worsened [7].

Fig. 2. Traffic jam in Bucharest.

Although the term congestion is used very frequently, it has different interpretations from partners who, with interests and points of view, often divergent, meet on the transport market (Raicu, 2007). We can name here: the person in charge of the transport infrastructure development strategy, the infrastructure user, the traffic engineer, the transport beneficiary and the transport economist. For each of them the notion of congestion has different meanings depending on the degree of involvement in the transport process. The person in charge of the transport infrastructure development strategy is interested in the elements of the infrastructure to take over the regulated flows for which they were designed. Otherwise, it means that the infrastructure has been oversized and that the financial resources consumed do not prove their efficiency. The user of the infrastructure (the driver of the vehicle) is interested in not being disturbed on the road by other traffic participants on the same infrastructure. From his point of view, the decrease in speed below that achieved on the freeway is interpreted as a beginning of congestion. For the traffic engineer, congestion occurs much later, ie only when the traffic intensity reaches a threshold in the vicinity of the capacity (maximum flow) of a road artery and when at relatively small increases in traffic intensity there are relatively significant decreases in traffic speed. flow displacement. The beneficiary of the transport (the passenger or the owner-consignee of the goods) is able to highlight the congestion only to the extent that his expectations regarding the duration of the journey or movement of the goods as assumed by the carrier have not been met as a result, of extending the duration of the itinerary on the given infrastructure.

The transport economist conceives congestion as an externality that forces those who are not beneficiaries of a particular travel activity (riparians or even the entire population of an area or planet, other road users) to pay the costs of the effects

produced by infrastructure users. From the brief enumeration of these subjective perceptions on the term congestion, it results that a first objective for the improvement of the knowledge in the field, is the elimination of the ambiguity of the discussed notion. In this sense, it would be possible to define an optimal demand of a road artery using as a criterion of optimization the total social costs, optimal demand in relation to which to define the congestion. The system for measuring traffic congestion must meet the following requirements: (Raicu, 2007) - the measurements (indicators) must have clear, easy to define meanings, - allow assessments at different levels of the road network (segment, link, route, area) and to offer the possibility to aggregate the evaluations, - to give the possibility to report to an ideal operation, to a reference standard, - the travel times (revealed or estimated) to be retained in the evaluations, - to be able to highlight the conditions of accentuated congestion.

From the examination of the listed requirements, the primary elements underlying a congestion quantification system can be deduced. These refer to: - the time required to cover a part of an itinerary, θ [min], - the time required to cover a unit of length in the part of an itinerary (slowness, slowness, ie the inverse of speed), I [min / km], - the absolute size of the average delay per unit length, A = Ir - If, where Ir and If represent the slowness of the length unit in the observed conditions, respectively in the free flow conditions, - the relative size of the average delay, a = A / If, - the length of the part of the route traveled in congested conditions, Lc, - the effects of congestion felt by users, calculated as a product between the number of users (passengers) or vehicles, Nc and the length of the part of the route, Lc affected by congestion, C = Lc × Nc, (1) - the actual flow provided by that part of the route, Dc = Nc * Vc, where Vc is the average speed of the means of transport flow on the studied part , - mobility index on a homogeneous portion of an itinerary, im = De / Dn, where Dn is the standard flow on that portion. [2].

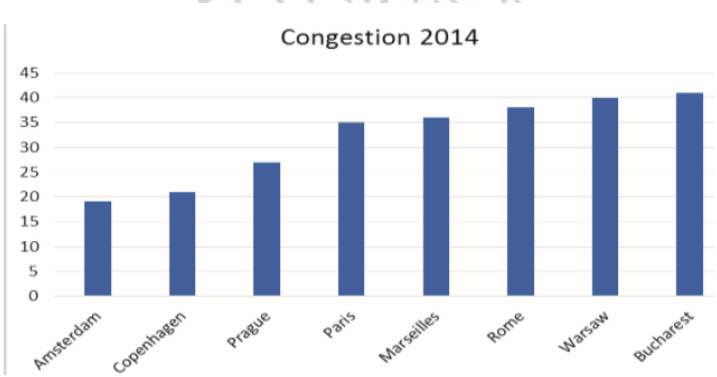

Fig. 3. Congestion index (source: Sustainable Urban Mobility Plan 2016-2030 - Bucharest-Ilfov [7]

3. Solutions for a sustainable development in transports

3.1. Alternative transport solutions

Riding a bicycle

At present, the bicycle plays an important role in urban road transport and not only, their number exceeding 500 million. In poorly developed countries the number of these vehicles is very high exceeding personal cars, while in developed countries they are used for sports and recreation.

It is a modern, future means of transport, increasingly used in developed countries in the EU and other parts of the world. It integrates easily and well with other forms of transport (road, air, rail, naval) and favors intermodal transport.

The reason for using the bicycle as a means of transport in underdeveloped countries is played by low costs, while in developed countries the bicycle is used to limit pollution, sports and recreation.

It is a healthy vehicle, maintaining physical condition, combating sedentary lifestyle and helping to maintain the health of users and public health in general, significantly reducing the risk of cardiovascular disease and obesity, but also indirectly cancer and other diseases, and also presenting no risks. for the health of users and for third parties if used correctly.

In order to use the bicycle in conditions of maximum safety, infrastructure, dedicated lanes for urban and suburban traffic must be built as soon as possible.

The use of bicycles for transport is very low in Bucharest. By comparison, Figure 4 shows the modal distribution in Copenhagen and Amsterdam, cities with a congestion index of 19% and 21% respectively.

These cities have managed to reduce both car travel and public transport by encouraging cycling, and an option that can be particularly attractive to Bucharest, as bike lanes are a cheap and easy to install infrastructure.

There is a small number of bicycle infrastructure in Bucharest. In the past, bicycle lanes have been marked on sidewalks, but this practice has ceased. By comparison, Copenhagen has 416 km of bike lanes and about 500,000 bicycles. Amsterdam has more than 500 km of bike paths.

A questionnaire was distributed among the inhabitants of Bucharest with the request to indicate their preferences for the extension of the network.

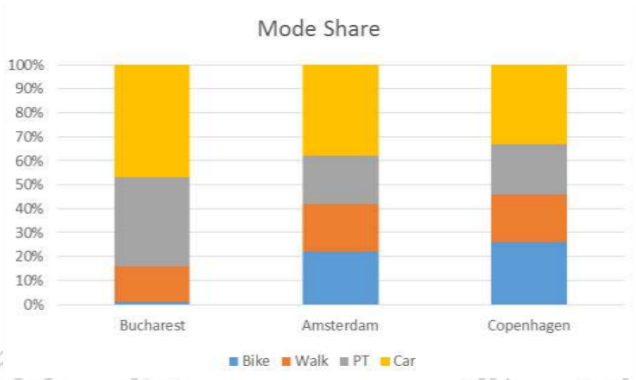

Fig. 4. Modal distribution for selected cities, Source: Eurostat.

According to the practice in various countries, local roads with a legal speed of 30 km / h or less, offer a possibility for local cyclists in mixed traffic without lanes dedicated to bicycles. Many of the local streets in Ilfov and Bucharest could accommodate a mixed use for cyclists. These areas with speeds of 30 km / h or less must focus on both the mobility of adults and children.

In April 2014, the Romanian Government allocated 44.63 million lei for a "Project for the implementation of bicycle infrastructure in the center of Bucharest". We believe that by building a massive bicycle network and sufficient parking spaces, 15% of car users can be transferred to bicycles, thus significantly reducing congestion and pollution.

Targets should include expanding the user base to a wider sector of the population by providing a safe and convenient network, developing sidewalks and bicycle facilities suitable for roads with nominal speeds of 50-70 km / h and marking possible areas on the map. with a speed of 30 km / h, with bicycle traffic integrated with vehicles.

In Ilfov, bicycles can be incorporated into the local transport network, functioning as access to public transport nodes that converge to Bucharest and to reduce congestion, as well as integrated into the local transport infrastructure for local travel.

3.2. Intelligent Transportation System

Intelligent Transportation System (ITS) adds information and technologies to cars and transport infrastructure to improve communication for traffic safety and reduce transport times, traffic congestion and fuel consumption. These systems use inductive loops, speed or infrared cameras, congestion detectors and other sensors embedded in traffic lights, intersection signs or asphalt.

ITS systems monitor traffic and can make decisions to streamline it; can automatically collect highway tolls, automatically recognize license plates, accident notification systems.

Communication technologies for STIs are varied:

• IEEE 802.11 protocol can be used over short distances (up to 500m) (WAVE standard and Dedicated Short Range Communications standard are promoted by the Intelligent Transportation Society of America and by the United States Department of Transportation);

• for long distances, infrastructures based on WiMax (IEEE 802.16), Global System for Mobile Communications (GSM) and 3G are proposed.

Communication protocols are useful, but the implementation of these infrastructures is very expensive. Remarkable progress has been made in car electronics, which has led to the use of high-performance processors and few in number. At the level of the 2000s, the car had 20 ÷ 100 microcontrollers interconnected.

Nowadays, we want to migrate to real-time operating systems and use microprocessors with memory management built into the hardware. Integrated platforms of this kind allow the implementation of artificial intelligence and the use of sophisticated software applications.

Inductive loops are detectors embedded in the pavement that generate an electromagnetic field, which is disturbed when vehicles pass through them. The principle of operation of the inductive loop is based on eddy currents (eddy currents). Simple detectors count vehicles that pass in a unit of time (60 seconds in the United States), and more sophisticated sensors estimate the speed, length, weight of cars, and the distance between them.

Inductive loops can be placed on one or more bands; they detect vehicles that are stopped, those that are moving at low speed, but also vehicles that are moving at high speed.

Camcorders, because they have the ability to transmit moving images in a closed circuit, have quickly found their application in the field of transport (in all modes of transport), for surveillance / detection of road traffic; technologies have developed and automated, and the analysis of captured images has begun to be automated, so that today's applications are based on electronic image processing. Traffic measurement and automatic accident detection are performed with their help. Camcorders are not placed inside streets, but on poles or similar suspended structures (the system is called non-intrusive), the images are sent to a processor that can simultaneously analyze data from one to eight cameras. This detection system monitors the speed of cars, their number and the occupancy of the lanes.

There are also systems that can detect stopped cars and measure the distance between vehicles.

3.3. Traffic congestion charging scheme

London shows how the traffic congestion tax works in a big city. On the occasion of the fourteenth anniversary of the application of this system in London, Director Michèle Dix explains how this successful project works. London implemented the first traffic congestion tax scheme after Singapore, which applied it in 1970. Then came Stockholm and Oslo. No developing country has yet resorted to such a toll, but more are exploring this possibility and certainly in the coming years more and more cities will embrace the toll system as a form of traffic management, as an alternative to simply building more roads. 100 years ago, during the horse-drawn carriage ride, the average traffic speed in London was 11 miles per hour. At the end of the twentieth century, the average speed was still 11 miles per hour. Most of the time, the streets were so crowded that the vehicles barely dragged or moved at all. A situation familiar to drivers of big cities around the world - frustration for the individual and loss of business. In February 2003, London took an important step towards resolving this situation. He introduced the traffic congestion tax in the busiest areas of the city center. The desire was to reduce congestion and raise funds for the London transport system, which had been neglected in recent years. Opponents predicted chaos and confusion. They said London would become a ghost town and the transport system would not cope. Now, after 3 years, it is clear that they were wrong. Drivers are charged £ 8 for entering the area or for driving inside it.

There are cameras that film the registration numbers of each car, so no one escapes without paying the tax. This scheme has managed to reduce congestion. The traffic in the area, in the tax collection interval (7 A.M - 6:30 P.M) decreased by 18% and the delays by 30%. The limitation of traffic in the area also had the effect of reducing the degree of pollution and the number of accidents, making central London a much more pleasant place for housing, work and tourism. Since the introduction of this system, the average speed has increased from 14 km / h to 17 km / h. Gas emissions in the area, nitrogen oxide and particulate matter (PM10) were reduced by 12% and CO2 emissions by 19%. Citizens have noticed an improvement in the environment. The scheme has helped reduce the number of accidents in London. Each year, there have been 70 fewer accidents. Tens of thousands of people now travel by bus. They have taken over the vast majority of passengers who now leave their cars at home. Of course, buses run more frequently and are safer. The number of cyclists has also increased by 20% in each of the last 3 years. It is a fast, cheap, healthy method of transport, does not harm the environment and seems much more attractive when traffic on the streets is lower. There have been rumors that this project will affect business in central

London. The most outraged were the retailers, who claimed that they would lose their customers, preferring to go elsewhere, or that if they continued to use their services, they would not spend as much.

Objective analysis and economic data show that the impact on business performance in the area was neutral. Some vendors experienced fluctuations in sales, but due to other factors such as the danger of terrorist acts and the closure of the subway line. At the same time, businesses that rely on product distribution have grown because they can move faster and take more orders a day. Now, more than 90% of those who arrive in the central area use public transport. Although the tax system has discouraged citizens from using their own cars in central London, they still come to the area by public transport, although more and more people prefer to walk or cycle. This project brings in an annual net income of over 100 million pounds, money then invested in the transport system. The improvements have taken the form of, for example, 450 new buses introduced on 12 routes. We have gradually introduced changes to make the toll easier to pay, to improve knowledge of how the scheme operates and to help drivers pay on time. , so as not to increase the rate of penalties for non-payment. It is now easier for payment to be made electronically, there are discounts for monthly and annual payments and a discount for companies that pay for their employees. 83% of payers say they are satisfied with the experiences they have had under this scheme. In addition, since 2007, it has been possible to pay the next day, which is required by many drivers. So, the scheme becomes easier to use and, after 3 years, the citizens understand it much better. This tax system worked well in central London and that is why the mayor decided to apply it to a larger area that became operational in February 2007.

Conclusions

Cycling - integrates easily and well with other forms of transport (road, air, rail, naval) and favors intermodal transport.It is a sufficiently fast means of transport for various uses, being for example in urban areas in many cases on average even significantly faster than cars.

It is a healthy vehicle, maintaining physical condition, combating sedentary lifestyle and helping to maintain the health of users and public health in general, significantly reducing the risk of cardiovascular disease and obesity, but also indirectly cancer and other diseases, and also presenting no risks. for the health of users and for third parties if used correctly.

It is an ecological means of transport, which does not emit noxious substances and does not produce noise, being also very energy efficient, having a potentially long

life cycle, not containing toxic or hard recyclable components and consuming relatively few resources for production, maintenance and decommissioning.

It is a modern, future means of transport, increasingly used in developed countries in the EU and other parts of the world.It is a relatively cheap means of transport, accessible to practically anyone and as a purchase and maintenance, especially compared to a car, and the costs for the construction and maintenance of specific infrastructures are much lower than for other forms of transport, thus making important savings on public budgets.

Intelligent Transportation System (ITS) adds information and technologies to cars and transport infrastructure to improve communication for traffic safety and reduce transport times, traffic congestion and fuel consumption. These systems use inductive loops, speed or infrared cameras, congestion detectors and other sensors embedded in traffic lights, intersection signs or asphalt [6, 8].

ITS systems monitor traffic and can make decisions to streamline it; can automatically collect highway tolls, automatically recognize license plates, accident notification systems.Traffic measurement and automatic accident detection are performed with their help. Camcorders are not placed inside streets, but on poles or similar suspended structures (the system is called non-intrusive), the images are sent to a processor that can simultaneously analyze data from one to eight cameras.

The traffic congestion charging scheme - an excellent solution, which at the beginning of the implementation seemed something exaggerated, something very drastic that will cause chaos and confusion, proved to be in fact something very useful.

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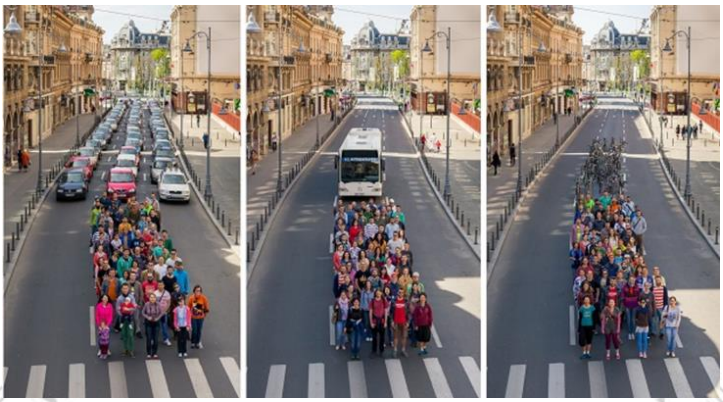

Fig. 5. Comparison between urban public transport and individual transport by car / bicycle

Notations and/or **Abbreviations**

ITS - Intelligent Transportation System

R E F E R E N C E S

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