

## CONGESTION IN LARGE URBAN AGGLOMERATIONS AND SOLUTIONS TO REDUCE IT

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**Rezumat.** Creșterea traficului rutier și a cererii de transport din ultimii ani, în special de la începutul anilor 1990, a provocat congestia traficului, accidente, întârzieri și complicații de mediu, în special în orașele în curs de dezvoltare. Sunt afectate atât autovehiculele, cât și transportul public și are numeroase consecințe sociale negative pe lângă diminuarea eficienței economice. În zonele dens populate, urbanizarea, urmată de nevoia tot mai mare de mobilitate, a fost supusă constant la stres și în consecință la deteriorarea performanțelor de eficiență și siguranță. Situația este agravată și mai mult de numărul tot mai mare de autoturisme personale. Problemele de transport și trafic din fiecare oraș sunt doar o reflectare a unei planificări și organizări defectuoase a utilizării terenurilor. Îmbunătățirea infrastructurii existente presupune costuri prohibitive, de aceea este dorit folosirea acesteia la capacitate maximă. În zilele noastre, orașele se confruntă cu provocarea de a îmbunătăți calitatea vieții prin limitarea congestiei rutiere, reducerea emisiilor de poluare atmosferică și accidentelor rutiere.

**Abstract.** The increase in road traffic and transport demand in recent years, especially since the early 1990s, has caused traffic congestion, accidents, delays and environmental complications, especially in developing cities. Both cars and public transport are affected and it has numerous negative social consequences in addition to reducing economic efficiency. In densely populated areas, urbanization, followed by the increasing need for mobility, has been subjected to constant stress and consequently to the deterioration of efficiency and safety performance. The situation is further aggravated by the growing number of private cars. The transportation and traffic problems in every city are just a reflection of poor land use planning and organization. Improving the existing infrastructure involves prohibitive costs, therefore it is desirable to use it to its maximum capacity. Nowadays, cities face the challenge of improving the quality of life by limiting road congestion, reducing air pollution emissions and road accidents.

**Keywords:** Congestion, ITS, Public Transport

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### 1. Introduction

Since ancient times, "man" had to move to ensure his survival. Land mobility has been, is, and most certainly will remain an important aspect of human life. Following the invention of the wheel, land transport evolved as it is known today; the transition from animal-powered vehicles to modern magnetic levitation vehicles. Moving on his own feet, an individual can travel about 5

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In the 20th century, road transport increased the accessibility of goods and people through mobility, flexibility and convenience. The greater mobility provided by the automobile allowed workers to live some distance from their workplace.

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Transport in big cities is influenced by several factors:

- the number of vehicles
- existing infrastructure
- public transport

Road congestion represents the price paid for the multiple benefits obtained from the concentration of population and economic activities. The term "congestion", contrary to quasi-general expectations, entails ambiguities in interpretation:

- the person responsible for the infrastructure development strategy - is interested in the infrastructure elements taking over the normalized flows for which they were designed [1]
  - the infrastructure user (vehicle driver) is interested in not being embarrassed by other traffic participants on the same infrastructure; the decrease of the speed below that achieved on the free path is interpreted as the beginning of congestion[1]
  - the traffic engineer - this appears much later, namely only when the traffic intensity reaches a threshold located in the vicinity of the capacity (maximum flow) of a road[1]
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- the beneficiary of the transport (the traveler or the owner-recipient of the goods) highlights the congestion only to the extent that his expectations regarding the duration of the journey or the movement of the goods as assumed by the carrier (the user of the infrastructure, named above) were not respected. [1]

- the transport economist conceives congestion as an externality that forces those who are not the beneficiaries of a specific travel activity (river residents or even the entire population of an area or the planet, the other traffic participants) to pay the costs of the effects produced by the users the infrastructure. [1]

For each of the service levels of a road artery, the values of A (measurement of absolute delay) can be determined and a certain critical value can be defined (for example, 6 min/km, for A) above which the traffic is considered congested. [1]

## 2. Non-correlation between urban planning and transport

Recently, a large-scale development strategy has begun to flourish, which calls for the integration of land use and public transport by upgrading public transport, building new roads, providing freight services and sustainable passenger transport, where transport systems represent an essential role. [1,2]

Urban land redevelopment is a reconstruction on a previously developed area with existing transport facilities, this is an important component of the city's evolution. While it improves the efficiency of land use, it can have a negative impact on the transportation system, such as causing traffic congestion. [2]

In the early 20th century, planners began to pay attention to transportation and traffic issues and focus on city structure and land use. In 1910, the French designer, Eugène Hénard, sought to establish intersections at different levels and create traffic tunnels and multi-storey car parks to achieve safety and also provide spaces. Eugène Hénard also pointed out that the planning of the road network has an impact on the development of the city, because it constitutes the backbone and the main component of the formation of the city. The transportation and traffic problems in every city are just a reflection of poor land use planning and organization. To alleviate Egypt's severe traffic congestion, development initiatives have emerged recently, particularly in the areas of transportation and roads. The availability of land for urban sprawl is decreasing and there is a growing trend to build railway stations to connect different regions of the city. As a result, the government is trying to build underground structures to preserve space. [3]

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Analysis of stations, especially in the case of replacing the old transport with a modern one, this being one of the projects currently underway in the development process. This will have a significant impact on the surrounding urban environment, especially on the study area with the route of the Abu Qir line in Alexandria, which is being replaced by a metro line on the same route. The efficiency of roads and transport increases whenever there is economic development of the city. [3,4]

From a land management perspective, the US also faces traffic congestion in urban areas. Regarding the relationships between urban planning and traffic congestion, the results indicated that:

- polycentric urban morphologies were associated with higher levels of agglomeration
- abundance and polycentricity of high-intensity urban land use showed the strongest relationships with congestion measures
- the urban morphology influenced the general congestion to a greater extent than the rush hour congestion

The estimated annual total in the freight sector alone for the cost of congestion was \$74.5 billion in 2018 [6]. In terms of human health, congestion reduces air quality by increasing traffic-related air pollutants such as NO<sub>x</sub> and CO [7,8], and also endangers road safety by increasing the rate of fatal accidents and injured persons. [5]

In China (Shanghai), there are many examples of redevelopment projects causing traffic congestion. In order to better guide China's land redevelopment, it is necessary to find the reason for traffic congestion caused by urban land redevelopment and provide appropriate countermeasures. [9]

### **3. The inefficiency of public transport or its non-use**

The case of Afghanistan, especially in the capital Kabul, where rapid population growth makes it the fifth fastest growing city in the world. Traffic congestion affects not only the mobility of people and goods, but also the air quality, which leads to numerous deaths (3000 people) every year.

Insufficient and inefficient public transport together with the use of personal cars for commuting can be considered among the most important factors contributing to the congestion of the street. Study conducted on the Afghan capital to limit the traffic congestion tries to suggest that a possible solution is to improve the current public transport system in Kabul. The result suggests that improving the public transport system contributes to reducing traffic

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congestion and improving air quality, thereby reducing the number of air quality-related deaths. [10]

To limit the traffic congestion, he tries to suggest that a possible solution is to improve the current public transport system in Kabul.

In Iraq, the development of the number of roads and transport infrastructure is not enough to cope with the rapid increase in the number of vehicles. The absence of active public transport is also one of the causes of the congestion problem.

Cities in Saudi Arabia are facing critical traffic flow due to several factors, including the lack of use of public transport leading to a higher number of private cars, an insufficient road network to cope with the large number of vehicles. [11]

The city of Seville, as expected for an urban area with a high level of population working in the city center, the impact of congestion on accessibility is similar to that of the population distribution on the resulting transport demand. The Aljarafe area generates a high volume of transport demand during the morning peak traffic periods leading to road congestion. [12]

The low population density in suburban areas and the limitations resulting from public transport coverage lead to the use of personal cars. Even though the Aljarafe area is served by a three-lane highway, the concentration of demand during the morning peak causes high traffic flow. [12]

#### **4. The influence of parking spaces on road congestion**

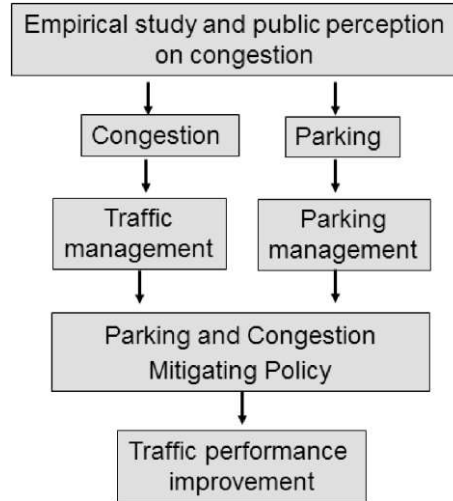
Road congestion is the result of various factors, including the increase in the number of vehicles parked on the road. A survey indicated that the main causes of congestion in Makassar were parking vehicles on the road, hence lane analysis and parking management are needed to solve this problem. [13]

Pricing policies are a key tool for sustainable mobility. Public acceptability of Euro parking charging policies and vehicle technology in favor of pollution limitation was found to be positive in the three main urban centers of Greece: Athens, Thessaloniki and Volos. Several statistical relationships were detected and quantified correlating the acceptability between the two examined policies with five variables: (i) demographic characteristics, (ii) trip characteristics, (iii) personal travel satisfaction, (iv) vehicle choice and (v) perspectives environmental. [14]

It should be noted that the travel profile showing a more intensive commute is positively correlated with higher levels of acceptability, probably because it is

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believed that the level of traffic congestion and parking management will be improved with the implementation of such policies by reducing time travel time, which includes the time of searching for a parking space. [14]



Source: [13] Lambang & Ilham, year 2021

**Fig. 1.** Conceptual framework for reducing congestion and solving parking problems in Makassar

## 5. The influence of the human factor and weather phenomena on congestion

Urban road transport and traffic engineering in general are long-discussed topics. Traffic problems are solved by looking at several aspects, such as transport infrastructure, transport organization, the high share of road traffic, the negative impact on air quality, emissions, etc. Along with economic growth, the development of individual states, the number of cars also increases - traffic volumes increase at the expense of road capacity. Congestion, especially on urban roads, is also influenced by the perception-reaction time of drivers. [15]

The phenomenon was studied at busy intersections in the city of České Budějovice (Czech Republic) during the morning and afternoon rush hours, the time with the highest level of daily congestion. [15]

One of the reasons for the formation of congestion in cities is the perception-delayed response time of drivers who, according to surveys, wait in line for other traffic participants in front of them to move and do not consistently follow the traffic by walking in line, or better called traffic lights at the intersection. The delayed reaction of drivers causes a so-called accordion

effect, which negatively and unnecessarily reduces the critical flow, and therefore contributes to the increase of congestion, or rather its expansion.

In general New York has a dense and mostly regular network, delays at intersections are almost inevitable. Meanwhile, recurring congestion also causes delays, along with slower traffic in adverse weather conditions such as rain. The effect of weather conditions on delays is also interesting, as bad weather can lead to a reduction in delay in some cases

## **6. Influences of intelligent transport systems on congestion**

Smart cities have been developed in the past decade, and reducing traffic congestion has been the most important concern in smart city development. Short communication delays between vehicles and roadside units, smooth traffic flow and road safety are the key challenges of Intelligent Transportation Systems (ITS). The rapid increase in the number of vehicles has led to an increase in traffic congestion and the number of road accidents. To remedy this problem, vehicular networks have developed many new ideas, including vehicle-to-vehicle communication, navigation, and traffic control. Machine Learning is an effective approach to find hidden insights in ITS without being explicitly programmed by learning from information. [16]

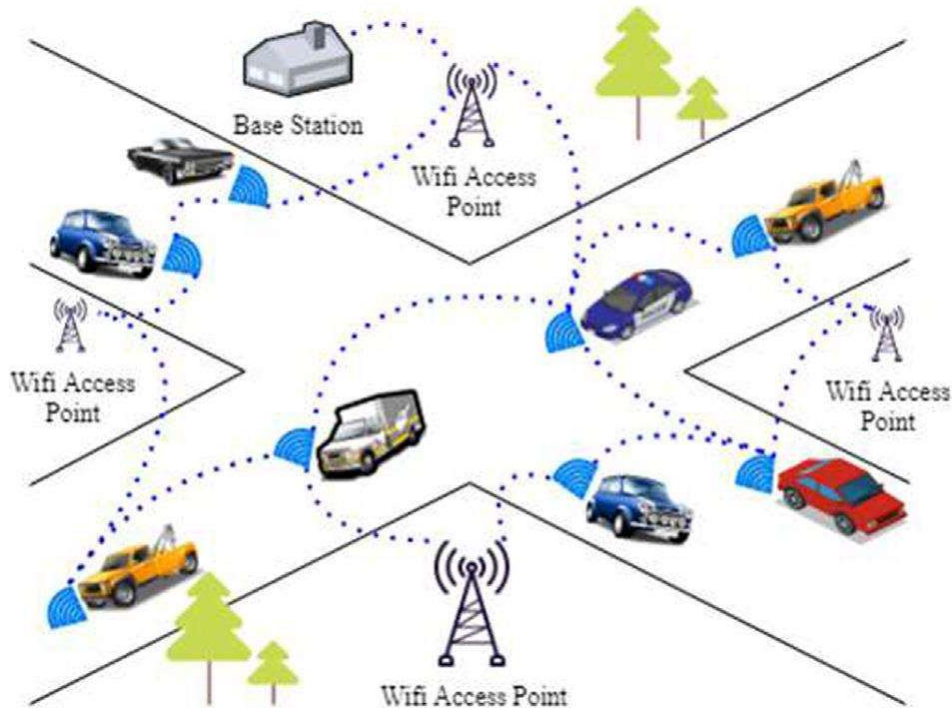
Proposing the use of an intelligent traffic congestion control system for the car network using Machine Learning techniques that collect traffic data and direct traffic to available routes to alleviate traffic congestion. [16]

The proposed system provides drivers with innovative services that allow a view of traffic flow and the volume of vehicles available on the road remotely, with the intention of avoiding traffic jams. The proposed model improves traffic flow and decreases congestion. The proposed system provides 95% accuracy and 5% miss rate, which is more efficient than previous approaches. [16]

However, processing and modeling traffic data is challenging due to the complexity of road networks, space-time dependencies, and heterogeneous traffic patterns.

Following congestion detection, traffic participants are informed by a message. Coast road users can then be redirected to alternative routes, avoiding the busy coast road. The proposed congestion detection algorithm provides encouraging results on the congested coastal road in downtown Patras, indicating its potential for real-time congestion detection and user information through a variable message indicator that can be installed upstream on the traffic segment. busy road.

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Source: [16] Saleem et al, year 2022

Fig. 2. Architecture of a network

## 7. Congestion charge and degree of acceptance

Problems caused by poor air quality and traffic congestion are particularly common in the urban centers of African cities. The region is characterized by cities with extensive road infrastructure, but of low quality, given the budgetary limitations for financing its maintenance. Although the majority of journeys are made by public transport, few roads are prioritized for this mode of transport, while private car travel has increased the use of road infrastructure and is responsible for most polluting emissions. [17] Road pricing, and more precisely, the implementation of so-called urban taxes, is an effective measure to reduce the use of private cars and traffic congestion and to increase the use of public transport in a more sustainable way. The sustainability and improvement of the environment in large cities and their surroundings, in addition, this measure allows obtaining an additional source of public revenue for the improvement of public and private transport, as revealed by the current experiences of Singapore since the mid-1970s or the European city taxes of London and Stockholm.



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The theory of traffic congestion charge was first proposed by Pigou 1920 and Knight 1924.

The practice of congestion charging in Singapore and London has achieved huge success but has not achieved widespread adoption. One of the reasons being public resistance.

According to the survey in London, if the congestion charge was considered only as a method of managing transport demand, the level of public support was 43%; if the congestion charge were reintroduced into the municipal transport system to improve road infrastructure or develop urban public transport, the level of support from the public increased to 63%. This indicates that the reasonable arrangement of the congestion charge fund is an important action that gains support from the citizens. The traffic congestion charge will drive citizens to use public transport

### **Conclusions**

Traffic congestion in major cities continues to worsen as a consequence of the growing economy, resulting in lost time in traffic, accidents, pollution and many other negative effects for the billions of urban dwellers. A great deal of research has been done on the causes and mitigation of traffic congestion worldwide in recent decades, but it has not always been heavily promoted on a large scale.

The clear existence of two parameters in the equation that causes road congestion are the balance between the demand and supply of road space.

In large urban agglomerations where population concentration is high and projected to continue to grow, the case for transit-oriented development is particularly strong. Despite many examples of successful frameworks internationally, development around transport networks has not yet been widely adopted, there are isolated cases but too few to make a significant difference in terms of productivity and sustainability.

To limit the effects of congestion, the measure of development and implicit use of urban public transport networks is proposed and analyzed, such as the implementation of a tax on traffic congestion, TOD development around the public transport network and the use of intelligent systems for transport.

### **Notations and/or Abbreviations**

TOD – Transit Oriented Development

ITS – Intelligent Transportation Systems

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