CERTUS
Policy Think Tank

Ten approaches to tackling traffic congestion in Riga

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Sergejs Gubins

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EXECUTIVE SUMMARY

- A Riga commuter with a 30-minute long one-way drive will spend an additional 69 hours – or almost three days – sitting in traffic every year
- Congestion is likely to get worse in Riga for three main reasons:
  - Continuing internal migration from rural regions to the Riga agglomeration
  - Continued economic growth is associated with more frequent driving
  - People continue to choose to live in the suburbs circling Riga, but work and often also educate their children inside the city

There are 10 major anti-congestion policy options

POLICY	RATIONALE	IMPACT	EXAMPLES
 **1. Car-free and low-emission zone**	A radical but clear-cut solution that improves the environment, reduces congestion outside the zone and makes the city center more livable for residents and tourists.	Low-emission zones are limited in ambition and thus have a limited effect on air quality. There are no large car-free areas in major European cities.	There are more than 200 low-emission zones in Europe and many smaller city-centre car-free areas all across Europe.
 **2. Road construction**	Expansion of road capacity provides more space for cars to travel.	Road construction is very costly in the city center. Road expansion gives only short-term gains, as larger roads attract additional drivers.	All large European cities have plans for road construction. Tallinn plans to build a tunnel under the city center.
 **3. Smart IT solutions**	Use of IT solutions increase efficiency of the existing road infrastructure. More cars can travel on the same roads.	Increased road capacity gives only short-term gains, as more efficient roads attract additional drivers. Current drivers will not experience speedier travel in the long run.	Smart traffic-light management, advanced driver assistance systems, automatic emergency brakes. Driverless cars, car-sharing and Uber-like services.
 **4. Public transport**	Public transport provides an efficient alternative to car traffic.	High quality public transportation is expensive, and it is hard to attract a sufficient amount of car drivers to switch and thus ease congestion.	Introduction of free public transport in Tallinn did not reduce car traffic in the city. Large European cities continue to heavily invest in public transport.

POLICY	RATIONALE	IMPACT	EXAMPLES
 **5. Cycling**	An efficient, healthy and eco-friendly alternative to car traffic.	A high quality cycling infrastructure is expensive and largely attracts only short-distance commuters.	Many European cities invest in cycling infrastructure. Copenhagen and Amsterdam are global leaders in developing cycling as an alternative to cars in wealthy, developed states.
 **6. Parking**	Regulation of parking spaces and their prices might deter an excessive amount of cars entering the city center.	There are substantial effects on road congestion. Additional regulation of private parking spaces might reduce congestion.	Many European cities charge for parking. Nottingham introduced a fixed workplace parking levy that charges employers for providing workplace parking.
 **7. City zoning**	A long-term solution to the congestion problem. Land use restrictions might prevent excessively large commuting flows.	Land-use regulations are effective long-term solutions, but they are hard to introduce as it goes against the logic of the market economy.	Restrictions on urban sprawl have been adopted in some European cities.
 **8. Flexible working**	A differentiated start to working hours would spread commuter flow over time.	It requires cooperation with employers.	Usually a private initiative. No examples of a city level approach.
 **9. Car pooling**	Encourage more efficient use of personal vehicles.	Not a popular policy measure in Europe.	Adopted across the USA.
 **10. Congestion pricing**	Balance car traffic and road capacity.	The most effective tool to fight congestion. Does not require a lot of funding but lacks public support.	Stockholm and Gothenburg introduced time-varying congestion charges, while London and Milan have fixed charges.

INTRODUCTION

Does Riga have a road congestion problem?

Road congestion is a persistent, frustrating and costly urban problem. Heavy traffic causes drivers in large cities all over the world to spend dozens of unproductive additional hours in their cars every year.[1]

Riga is no exception. *TomTom* data shows that a typical Riga driver spends a quarter more time than necessary sitting in traffic due to congestion.[2] This can rise to almost 50% during morning and evening rush hours. Thus a Riga commuter with a 30-minute-long one-way drive will spend an additional 69 hours – or almost three days – sitting in traffic every year.[3] Figure 1 lists the negative impact this has on the economy, the environment and even mental health.

Figure 1

TIME LOSS
The quicker a driver arrives at a destination, the better. A commuter in Riga with a 30-minute-long one-way journey loses at least €290 per year due to time wasted sitting in traffic.[4]

TIME UNCERTAINTY
Road congestion brings journey time uncertainty, leading to faulty planning (too early or too late departures) and missed appointments.[5]

AIR POLLUTION
Riga's city center has high levels of air pollution caused in part by road traffic.[6] The concentration of fine dust occassionally exceeds the legal requirements.[7]

NEGATIVE WIDER ECONOMIC EFFECT
Road congestion reduces location accessibility.[8] This induces both customers and businesses to move away from the center, weakening agglomeration economic affects and reducing investment.

HIGHER TRAVEL COSTS
Drivers incur additional fuel as well as wear and tear costs due to longer travel.

STRESS AND ANGER
Sitting in congestion causes psychological stress and anxiety.

[1] The 2017 Inrix Global Traffic Scorecard, based on real-time traffic data, reports that in 2016 Moscow car drivers spent an average 91 hours in congestion, London - 74 hours, Paris – 69, Hamburg – 44, Warsaw – 35, Stockholm – 34, Amsterdam – 30, Gothenburg – 28, Gdansk – 26, Copenhagen – 24, Helsinki – 24. Information on Riga is not available. *http://inrix.com/scorecard/*

[2] TomTom traffic index. 2018. *https://www.tomtom.com/en_gb/trafficindex/city/riga*.

[3] A 30-minute-long commute in congestion turns into 21 minutes on congestion-free roads. This is a saving of 9 minutes each way, 18 minutes per day or 69 hours in a year (assuming 230 working days per year).

[4] Economists estimate the value of time – what a person is willing to pay to save one minute of travel. The standard assumption is that a traveler values one hour of short-term travel time saved as 50 percent of his hourly wage. Recent research shows that short-term travel time savings due to unexpected good traffic conditions are half as less valuable as long-term planned gains. For a person with the net hourly wage of €4.2 (app. €700 per month), the total gain due to saving 69 hours of travel amounts to €290 per year. Of course, this value is larger for people who earn more. Beck, M. J., Hess, S., Cabral M.O., Dubernet I., 2017. Valuing travel time savings: A case of short-term or long-term choices? Transportation Research Part E 100, 133-143.

[5] Fosgerau, M., 2016. Valuation of travel time variability. International Transport Forum, OECD, Paris.

[6] Online information on air quality in Riga is available on *http://www.rigaairtext.lv/*. Recent City Council report on air pollution in 2017 is *http://mvd.riga.lv/uploads/videgaiss/dok/Riga_gaisa_kvalitate_2017.pdf*

[7] Daily average concentration of fine dust PM10 above 50μg/m^3 is allowed for less than 35 days a year. This standard has been breached during several years. Slisane, D. and Blumberga, D., 2013. Assessment of Roadside Particulate Emission Mitigation Possibilities. *Scientific Journal of Riga Technical University. Environmental and Climate Technologies*, 12(1), pp.4-9.

[8] Moya-Gómez, B. and García-Palomares, J.C., 2017. The impacts of congestion on automobile accessibility. What happens in large European cities? Journal of Transport Geography, 62, pp.148-159.

The congestion situation in the center of Riga is likely to get worse in the near future for three main reasons:

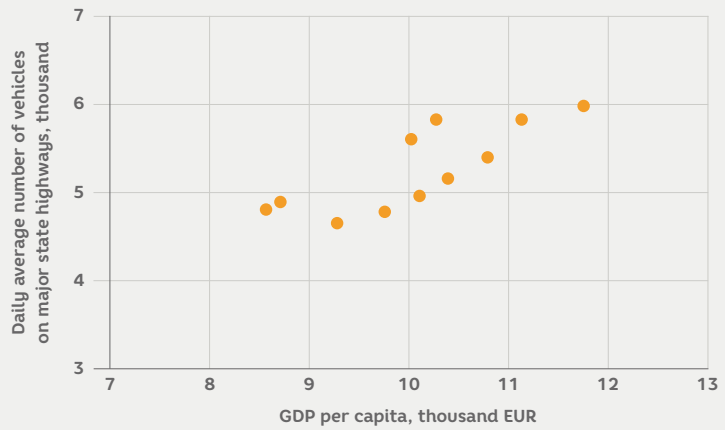
- First, continuing internal migration from rural regions to the Riga agglomeration (Riga and Pieriga) will keep the total population of the Riga area stable.[9]

- Second, Latvia is projected to see several years of economic growth which is usually associated with more frequent driving. Figure 2 shows that this was also the case with Latvia in the past. This is caused by both an increase in the number of cars, as Figure 3 shows, and a tendency to drive more often. Indeed, a recent survey shows that Riga inhabitants are increasingly using personal cars as their favored form of transport.[10]

- Third, Riga is undergoing a continuing and intensive suburbanization, as people choose to live in the suburbs circling Riga, but work and often also educate their children inside the city, creating more intensive car traffic at peak commuting times.[11]

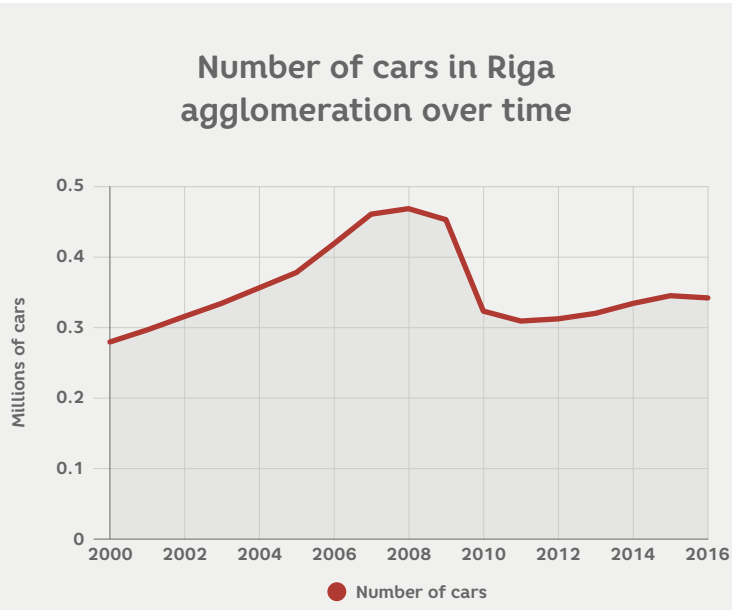
As a result, if nothing is done, the center of Riga will experience more intense congestion in the coming years, resulting in lost time for commuters, a lower quality of life and a negative impact on the attractiveness and general livability of Riga for locals and tourists alike. The following section compares the benefits and drawbacks of ten approaches that cities have taken in tackling the road congestion that clogs the center of Riga at particularly dense peak commuting hours in the morning and early evening.[12]

Figure 2



Source: Central Statistical Bureau of Latvia and Latvian State Roads.

Figure 3



Source: Central Statistical Bureau of Latvia.

[9] *Certus* demographic projections show that population of Riga agglomeration will stabilize at around 1 million inhabitants by 2022, mainly due to the internal immigration from the Latvia's regions and reduction of emigration abroad caused by growing wages. Auers, D. and S. Gubins. 2017. Latvijas demogrāfiskais portrets šodien... un rīt. *http://certusdomnica.lv/wp-content/uploads/2017/05/Certus_LatvijasDemografiskaisPortrets_2017_LV-1.pdf*

[10] 30 percent of city inhabitants used a car every day or almost every day in 2016, this is an increase from 20 percent in 2012. Riga Council, 2016. Riga city development department report on Riga sustainable development strategy till 2030. 65 percent of Riga commuters indicated in 2015 that driving is one of the main forms of commuter transport. This is the second largest share across all EU capital cities. Eurostat, 2015. Statistics on European cities. *http://ec.europa.eu/eurostat/documents/4031688/7672011/KS-04-16-588-EN-N.pdf*

[11] OECD, 2017. Economic survey of Latvia. *https://www.oecd.org/economy/surveys/Latvia-2017-OECD-economic-Survey-boosting-productivity-and-inclusiveness.pdf*

[12] Irregular traffic jams, caused by traffic accidents, construction work and extreme weather conditions that create road congestion in places where it usually does not occur, often require different solutions not covered in this Policy Brief.

What can be done?
Comparing approaches to easing road congestion

There are two interconnected ways of dealing with traffic congestion. The first is to manage road capacity through investments in construction, public transport or cycle paths while the second is to nudge and change individuals' travel behavior. In practice, city transport authorities use both approaches simultaneously.

At the same time, it should be stated that no major city in the world has succeeded in completely eradicating congestion. However, many cities have managed to cut travel times, improve air quality and make urban space more livable.

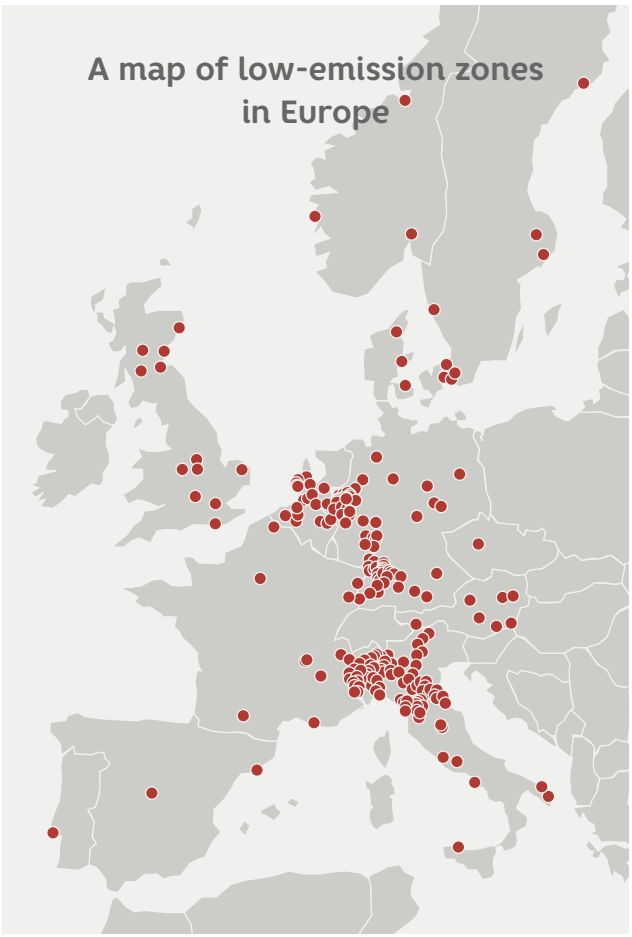
1. Car-free and low-emission zones

Creating low-emission zones in the city center, restricting access for polluting cars and forcing drivers to switch to public transport, biking, walking or, in the case of low-emission zones, less polluting cars is a radical measure increasingly taken by European cities (see Figure 4). This measure can potentially improve air quality and ease congestion outside the zone, as there will be fewer cars on the streets.

There are around 200 low-emission zones in European cities.[13] They are growing in popularity and several major European cities have announced plans to restrict diesel car access – German cities such as Hamburg, Leipzig and Stuttgart have discussed banning diesel cars within the next few years, as well as Rome (by 2024) and Madrid (2025). However, recent studies have revealed only a small positive impact of low-emission zones on air quality and the isolated effect of the zone is surprisingly hard to measure.[14] This might be due to a lack of ambition as zoning restrictions often apply to just a relatively small group of cars.[15]

A car ban is arguably the most dramatic and provocative transport policy measure. Car-free zones have spread all across Europe (in Brussels, Ljubljana and Vienna for example), but they typically cover areas smaller than Riga's Old Town. They are usually city center shopping streets or areas with a very large tourist flow. Despite the recent interest in car bans, this approach is controversial and meets heavy resistance from drivers' groups. For instance, Oslo announced a plan to set-up a medium-scale car-free zone in 2015 but has since revised the decision. Instead the city will eliminate most parking places by 2020. In effect, a car ban is a sign of a failure to improve the situation with other, less draconian measures. No major city has introduced a car ban on a significant scale.

Figure 4



[13] The list of the areas is available at *http://urbanaccessregulations.eu*. *http://certusdomnica.lv/wp-content/uploads/2017/05/Certus_LatvijasDemografiskaisPortrets_2017_LV-1.pdf*

[14] Holman, C., Harrison, R. and Querol, X., 2015. Review of the efficacy of low emission zones to improve urban air quality in European cities. *Atmospheric Environment*, 111, pp.161-169.

[15] Ferreira, F., Gomes, P., Tente, H., Carvalho, A.C., Pereira, P. and Monjardino, J., 2015. Air quality improvements following implementation of Lisbon's Low Emission Zone. *Atmospheric Environment*, 122, pp.373-381.

2. Road construction

Road construction has long been the most typical response to congestion. While investment in road infrastructure is very popular across the EU, most new road construction is dedicated to intercity highways and city bypasses.[16] The core centers of old European cities were formed many centuries ago and there is little space for new or extended roads, while bridges across urban areas are eyesores and tunnels are expensive. In 2006 Dublin built a tunnel beneath the city center connecting a major highway with the seaport. 6,000 trucks deliver containers to the port along this road every day.[17] The 8.3 km-long tunnel cost €750 million. The city of Maastricht built a 2.4km-long double-level tunnel at a cost of €850 million in 2016. Tallinn is also planning to build a tunnel through the city center.[18]

However, road, bridge and tunnel construction is expensive and does little to mitigate congestion. Economists have recently empirically verified a "fundamental law of road congestion" which states that an expansion of a major highway in a metropolitan area leads to the exact same increase of traffic over the next decade.[19] This means that in the medium and long run drivers will not experience any speed improvement due to new road construction.[20] Drivers who used to drive outside peak hours start driving during the peak period while others switch to cars from public transport or simply drive more often.[21] Road construction also stimulates increased suburbanization, leading to even more traffic. Expanding road capacity is merely a short-term solution to congestion.

3. Smart IT solutions

Modern transport technologies, such as driverless cars or smart traffic-light management, are often seen as being capable of resolving congestion. Unfortunately, this is unlikely. Driverless cars alone are not able to solve the fundamental cause of congestion which is a high number of people travelling to the same destination at the same time. Irrespective of whether a car is driven by a human or a robot, or whether a driver owns or shares a car, the very fact of a vehicle being on the road with many others at the same time creates the conditions for congestion. The same applies to car-sharing and Uber-like services – they might reduce the number of cars owned but are unlikely to reduce the total kilometers driven during peak hours.

This is not to say that driverless technologies will not benefit road transportation. There will be certain aspects of driving that will change for the better. The most noticeable will be the increased smoothness of driving and reduction of collisions and traffic deaths, thanks to advanced driver assistance systems and automatic emergency brakes.[22] This is an important contribution to well-being. Traffic lights responding to actual car flows and smart technologies that prioritize public transport increase road capacity. These IT solutions will help cities to use the already available transport infrastructure to the maximum of its potential. But, as in the case of road construction, this will stimulate more driving.

Driverless technology may even cause more congestion.[23] First, it allows commuters to spend time in the car more productively and people may tolerate an even longer waiting time. Second, it might bring those currently not using private transport (teenagers and elderly people) onto the roads. Third, autonomous cars without passengers will create additional traffic as owners will send them out to park or pick up passengers. Novel IT solutions will likely benefit city inhabitants but road congestion will remain an issue.

[16] Around 50% of EU structural funds were dedicated to road construction during 2007-2013. Total length of European highways increased by almost 50% to 68,000 km from 1990 till 2010. Garcia-López, M.À., 2018. All roads lead to Rome... and to sprawl? Evidence from European cities. IEB Working Paper 2018/02.
[17] To compare, approximately 1,200 trucks arrive at the seaport every day in Riga.
[18] Tallinn Development Plan 2014-2020. *https://www.tallinn.ee/eng/Tallinna_Arengukava_ENG_preview_veebi*
[19] Duranton, G. and Turner, M.A., 2011. The fundamental law of road congestion: Evidence from US cities. *American Economic Review* 101, 2616-2652.
[20] Of course, we talk here about already highly congested roads. One can always build an empty road to nowhere.
[21] Downs, A., 2004. Traffic: Why it's getting worse and what the government can do. The Brookings Institution, Policy Brief 128.
[22] Stern, R.E., Cui, S., Monache, M.L.D., Bhadani, R., Bunting, M., Churchill, M., Hamilton, N., Pohlmann, H., Wu, F., Piccoli, B. and Seibold, B., 2017. Dissipation of stop-and-go waves via control of autonomous vehicles: Field experiments. *arXiv preprint arXiv*:1705.01693.
[23] Fishman, E. and Davies, L., 2016, November. Road User Pricing: Driverless cars, congestion and policy responses. In Australasian Transport Research Forum (ATRF), 38th.

4. Public transport

Some of the most heated debates in transportation revolve around the role of public transport in reducing road congestion. Proponents of public transport argue that a comfortable, affordable and convenient urban public transport system will attract enough commuters to switch from cars to ease congestion. After all, the passenger capacity of a single bus or tram might substitute more than one hundred cars.

In 2013, Tallinn made its public transportation free for city residents.[24] However, data from 2015 shows that commuters did not change their travel habits and about 40% continued to be daily car users (compared to 36% in 2015).[25] At the same time, use of public transport did increase by 10-15%, but mostly due to a decline in walking and cycling.[26] Free public transport in Tallinn did little to change car traffic in the city.[27]

The Tallinn example reveals that other attributes of public transportation, such as speed, frequency, punctuality and comfort are just as important in attracting commuters as price. Many European cities, including Zurich, Vienna and Munich, have invested heavily in upgrading bus and tram networks with quick transfers, real-time information and state-of-the-art vehicles, and have seen the share of public transport trips increase.[28] However, these measures are often combined with those that make car trips less convenient (higher parking fees, lower speeds) thus the direct impact of upgraded public transport on road congestion is hard to measure. All in all, despite the important social role that public transport plays in providing mobility to people, upgraded public transport alone will not solve the congestion problem.

5. Cycling

Many cities have attempted to change the travel habits of commuters and make cycling more attractive. Cycling has several obvious advantages in that it is healthy, environmentally friendly, energy and space efficient and cheap. Like the globally-renowned cycling capitals of Copenhagen and Amsterdam, Riga is flat and relatively compact. While the temperature in Riga might drop to uncomfortable levels, the examples of cycling-friendly Helsinki and Stockholm show that colder climates do not need to discourage cyclists.[29] The basic prerequisites are in place to make cycling an important travel mode for Riga commuters.

Lessons learned from the most successful cycling cities show that the provision of separate cycling facilities along the most congested routes is necessary for a high adoption of cycling.[30] On the other hand, public campaigns that try to improve attitudes towards cycling have no long-term effect on travel behavior. Quite simply, the share of work-related bicycle trips will be very low without an infrastructure that improves travel time, cost, comfort and increases safety compared to other travel options.

Statistics show that people are willing to commute by bicycle for up to 20 minutes or 5 km (average cycling speed in Copenhagen is 15.5km/h).[31] After this threshold, commuters tend to consider other travel options. While Riga is a compact city, many commuters, especially from outside the city, cover longer distances. This means that biking will not be a good alternative for many commuters and will have a limited impact on road congestion.

[24] Registered city residents receive a 100% fare discount. City visitors must pay the regular fare of €1.1 for an hourly ticket.
[25] Poltimäe, H. and Jüssi, M., 2017. Factors Affecting Choice of Travel Mode in Tallinn. In Environmental Challenges in the Baltic Region (pp. 135-153). Palgrave Macmillan, Cham.
[26] Fare-free public transport in Tallinn. A report prepared for URMI. April 2017. *http://urmi.fi/wp-content/uploads/2017/05/URMI-2017-FARE-FREE-PUBLIC-TRANSPORT-IN-TALLINN.pdf*
[27] This might be in part due to the already high levels of use and low prices before free-fare introduction. Cats, O., Susilo, Y.O. and Reimal, T., 2017. The prospects of fare-free public transport: evidence from Tallinn. Transportation, 44(5), pp.1083-1104.
[28] Buehler, R., Pucher, J., Gerike, R. and Götschi, T., 2017. Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland. *Transport Reviews*, 37(1), pp.4-28.
[29] Helsinki aims to reach a modal share of 15% for bike trips by 2020. Source: *http://copenhagenizeindex.eu/18_helsinki.html*
[30] Pucher, J. and Buehler, R., 2008. Making cycling irresistible: lessons from the Netherlands, Denmark and Germany. *Transport reviews*, 28(4), pp.495-528.
[31] Larsen, J., El-Geneidy, A. and Yasmin, F., 2010. Beyond the quarter mile: examining travel distances by walking and cycling, Montréal, Canada. *Can J Urban Res*, 19, pp.70-88.

One other increasingly popular measure is the provision of bike-sharing services. In many European cities a growing numbers of bike-sharing enterprises offer travelers short-term bicycle rental.[32] However, bike-sharing has little impact on traffic congestion.[33] This is largely because many users switch from public transport rather than cars.[34]

6.  Parking

Management of city center parking is an important tool that affects travel demand. A commuter will be reluctant to use a car if an affordable parking space is hard to find. Cities can thus indirectly reduce the number of cars travelling to the city center by cutting the number of parking spaces or raising the price of parking. Riga already has an elaborate on-street parking scheme with varying tariffs across different city areas and across time (the first hour is cheaper than the subsequent ones).

Scholars argue that it is possible to set time-varying parking fees that significantly reduce congestion.[35] This would effectively mimic the congestion pricing discussed later. However, it is difficult to implement in practice, as many parking places are privately owned. Moreover, employers can provide their employees with free parking. Thus, no cities have yet implemented the complicated congestion-easing version of parking fees. In an attempt to reduce incoming traffic volume Nottingham in the UK introduced a fixed workplace parking levy that charges employer for providing workplace parking.[36] This has eased congestion.[37]

One other potential way to ease road congestion is to divert traffic to Park & Ride facilities outside city centers where drivers park and travel onward with public transport. There are more than 1,000 Park & Ride facilities across Europe, including Tallinn and Warsaw.[38] However, Park & Ride schemes lead to a net traffic increase as many users switched from public transport to the Park & Ride.[39]

7.  City zoning

Congestion arises from a great number of people heading to the same location at the same time. If it is possible to influence the end location, then this, in turn, will affect traffic flows. The mismatch between places where people live and the places where they work is relatively large in post-Soviet cities, in which “bedroom” neighborhoods were strictly separated from working areas.[40] As a result, the promotion of mixed land use might reduce commuting.

A harsher measure is to prevent firms from setting-up workplace areas and offices close to each other. However, this goes against the logic of businesses as co-location brings many benefits to the companies and employees. Nevertheless, this would eliminate crowds of workers trying to get to the same area at the same time. Suburbanization is another source of car traffic that city zoning might mitigate. Stricter city boundaries, for example, additional taxes and lower level of public service provision for those who live outside the city, create incentives for people to live inside the city and reduces car use.

[32] For example, there were 400 share bikes in Dublin in 2013, now there are around 1400. In London and Paris there are, respectively, 10,000 and 15,000. Data is available on *https://data.cdrc.ac.uk/product/bicycle-sharing-system-docking-stations?q=&sort=title_string+asc*.
[33] Ricci, M., 2015. Bike sharing: A review of evidence on impacts and processes of implementation and operation. *Research in Transportation Business & Management*, 15, pp.28-38.
[34] Fishman, E., Washington, S. and Haworth, N., 2013. Bike share: a synthesis of the literature. *Transport reviews*, 33(2), pp.148-165.
[35] Inci, E., 2015. A review of the economics of parking. *Economics of Transportation*, 4(1-2), pp.50-63.
[36] More information here: *http://www.nottinghamcity.gov.uk/transport-parking-and-streets/parking-and-permits/workplace-parking-levy/*.
[37] Dale, S., Frost, M., Ison, S., Quddus, M. and Warren, M.P., 2017. Evaluating the impact of a workplace parking levy on local traffic congestion: The case of Nottingham UK. *Transport Policy*, 59, pp.153-164.
[38] Warsaw Park & Ride is quite actively used – there were 740,000 cars in 2014. Source: *http://www.eltis.org/discover/case-studies/reducing-congestion-warsaws-park-and-ride-system-poland*.
[39] Parkhurst, G. and Meek, S., 2014. The effectiveness of park-and-ride as a policy measure for more sustainable mobility. In *Parking Issues and Policies* (pp. 185-211). Emerald Group Publishing Limited.
[40] Cirtautas, M., 2013. Urban Sprawl of Major Cities in the Baltic States. *Architecture and Urban Planning*, 7, pp.72-79.

8. Flexible working

One of the main causes of morning and evening traffic congestion is a synchronized start and end to the working day. There are numerous reasons why people prefer to work at the same time, both biological (daily rhythm) and conventional (things are done expediently). However, variation in the start of the working day might motivate people to commute at different times. For example, government institutions might start working time at 7:00, schools at 8.00, businesses at 9:00, spreading traffic flows over time. Another, more radical measure is the promotion of working from home. Both measures require cooperation between city authorities and both employers and employees.

9. Car pooling

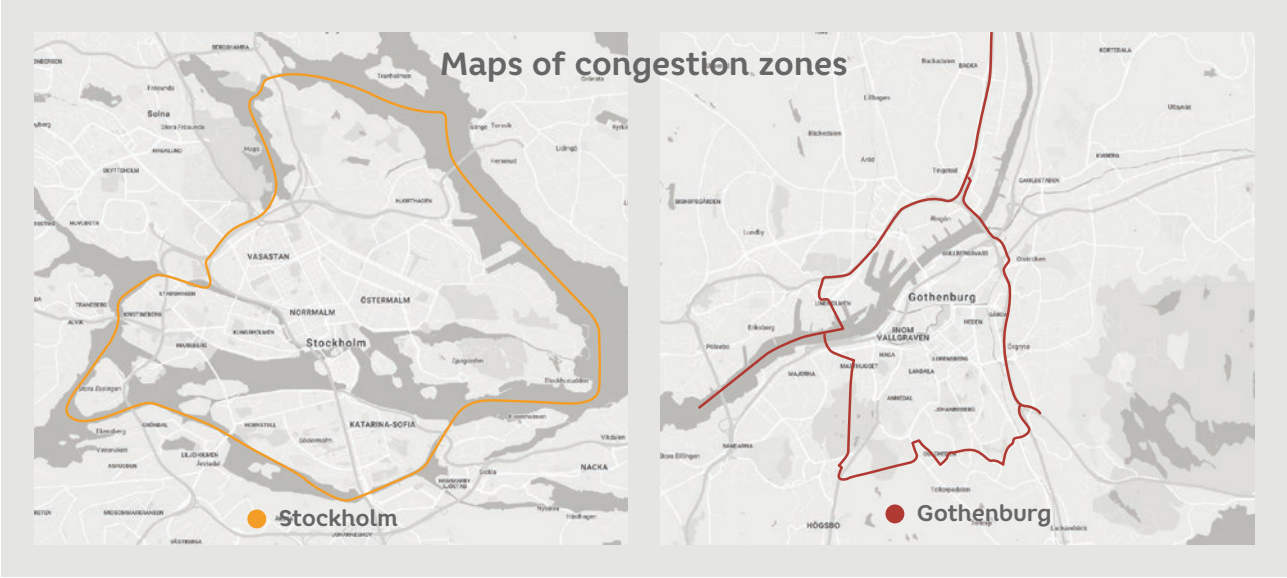
Car-pooling is the rather simple idea that instead of driving in two or three cars individually, people join-up for a single trip together in one car. This reduces fuel costs and creates more space on the road. The US, Spain and other states have specially designated and monitored high-occupancy vehicle lanes that drivers with multiple passengers can use. However, this measure is not widespread in Europe.

10. Congestion pricing

Economists typically advocate the introduction of a fixed or time-varying fee to balance the demand for city-center travel with the available road infrastructure.[41] Importantly, the congestion charge is not a tax that redistributes resources. Rather, it rations the arrival of cars to reduce congestion.

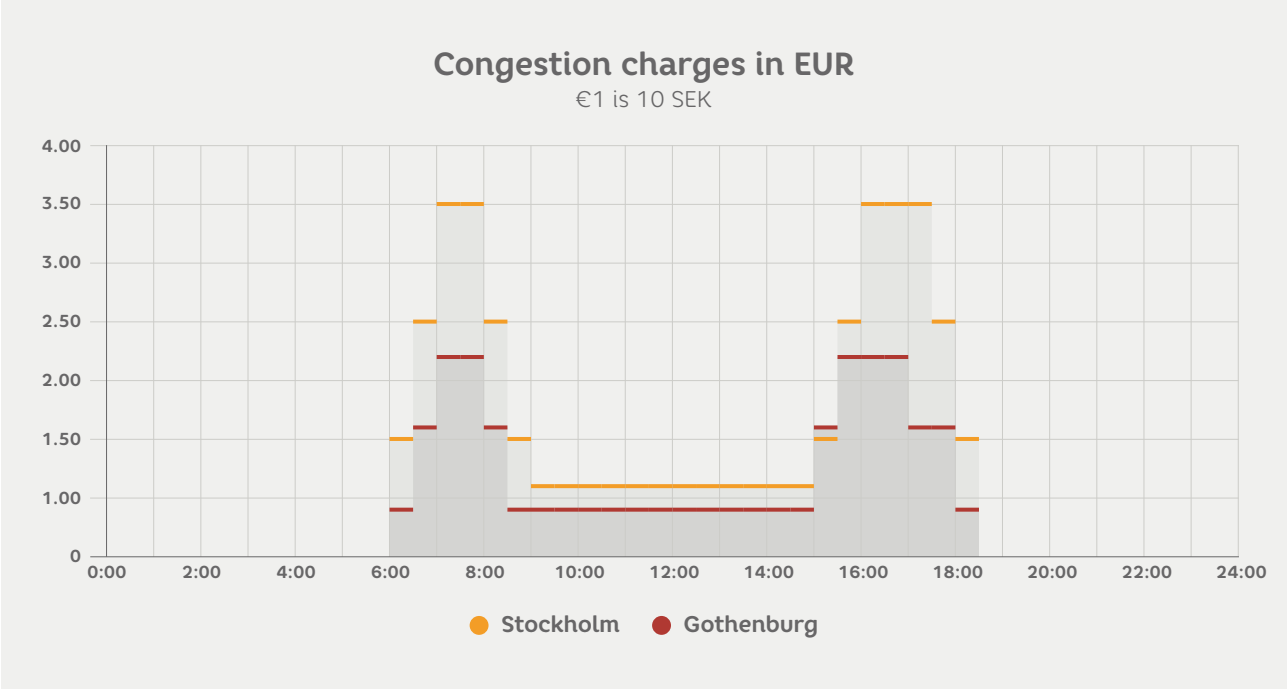
London, Milan, Stockholm and Gothenburg are among few European cities that have introduced congestion charging. The first two cities introduced a fixed cordon fee that every driver pays for crossing the border of a specially designated congestion zone. Swedish cities followed the lead of Singapore and introduced dynamic congestion fees, which vary over the time of day. Figure 5 shows maps of congestion zones and Figure 6 depicts congestion charge levels.[42] Figure 7 overviews congestion charges schemes across the four cities.

Figure 5



[41] Small and Verhoef, 2007. The Economics of Urban Transportation. Routledge.
[42] Source: *https://transportstyrelsen.se/en/road/Congestion-taxes-in-Stockholm-and-Goteborg/#20029*.

Figure 6



Of course, there are no toll booths or physical barriers anywhere in the cities – toll collection is automated, with plate-recognition cameras installed at the entrances of the zone (see Figure 7). The toll might be settled by direct payment or sms message. There are usually some limits on how much one driver might pay during one day. For example, in Stockholm a single driver can be charged no more than €10.5 per day (105 SEK) in Stockholm. In Gothenburg, a driver pays only once if he passes several payment stations within one hour.

One of the main advantages of congestion pricing is that it does not require a big public investment to improve road traffic. Unlike other anti-congestion policies, congestion charges schemes recover their operating costs through the fees that are charged (see revenue and operating costs in Figure 8). At the same time the effect on easing congestion is substantial.[44] In Stockholm traffic was reduced by around 20% and in Gothenburg by 10%.[45]

The major drawback of congestion charge policy is its low public and political acceptability. Many city inhabitants usually perceive the charge as a tax which, coupled with uncertainty over personal gains and losses, raises public concerns.

[43] Information sources: Introduction to Congestion Pricing: A Guide for Practitioners in Developing Countries. 2015. Asian Development Bank and GIZ. Bonn and Manilla; Annual Report and Statement of Accounts 2016/2017, Transport for London. London; Charging scheme in city center (Area C) and other strategies in Milan. 2017. Agenzia mobilita ambiente e territorio. Milan; Andersson, D., Nässén J., 2016. The Gothenburg congestion charge scheme: A pre-post analysis of commuting behavior and travel satisfaction, Journal of Transport Geography, Vol. 52, p. 82-89; *https://www.trafikverket.se/*; West, J. and Börjesson, M., 2018. The Gothenburg congestion charges: cost–benefit analysis and distribution effects. *Transportation*, pp.1-30; *https://www.roadtraffic-technology.com/projects/congestion/*.

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Figure 7

Photo: *TransportStyrelsen.se*

Figure 8

Comparison of congestion pricing schemes[43]

	LONDON	MILAN	STOCKHOLM	GOTHENBURG
Charge type	Fixed	Fixed	Varying	Varying
Year of introduction	2003	2012	2006	2013
When is it applied?	Mon-Fri, from 7:00 till 18:00	Mon-Fri, from 7:30 till 19:30, Thu, till 18:00	Mon-Fri, from 6:30 till 18:30	Mon-Fri, from 6:00 till 18:30
Zone size, km^2	21	8	30	16
Number of entrance points	203	43	20	37
Charge, EUR	13.2	5	1.5-3.5	0.9-2.2
Charge for zone residents, EUR	1.32	2	same	same
Revenue, mln EUR (2016)	250	28	140	na
Operating cost, mln EUR (2016)	104	4	10	12
Traffic volume	-21%	-34%	-20%	-10%
Travel delays	-30%	-17%	-33%	-15%
Public transit use	+18%	na	+5%	+6%

CONCLUSION

The key problem with fighting road congestion is that any increase in road capacity attracts additional drivers (including those who have previously traveled off-peak hours or by public transport) to the point that the positive effect is neutralized. New road construction and innovative IT solutions that increase the efficiency of existing roads might help ease congestion in the short run, but in the long run the effect from these measures will likely to be small.

Public transport and cycling alone are also not able to relieve cities from congestion. A bus or a bike ride should be of higher quality than a car trip for both current car drivers and those potential drivers who would be ready to go onto the roads if traffic during the peak period would ease.

Congestion pricing is the most effective measure against traffic congestion. Unlike other measures, it can be implemented relatively quickly and does not require substantial public funds, as it is self-financed. The major drawback is low public and political acceptability which can only be dealt with by carefully planning extensive public discussion and debate about municipal transportation policies and short-term trial periods.

Author:

Dr Sergejs Gubins holds a PhD in Economics from the VU Amsterdam. Prior to joining the Certus team, he was a Postdoctoral Researcher at Bocconi University, Milan. He has had a number of research papers published in renowned transport economic journals in relation to road prices, use of city land, and information technologies in the transport sector. Dr Gubins has received a number of awards for outstanding research and scholarships including the Huygens scholarship from the Dutch Government.

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