INRIX

Global Traffic Scorecard

INRIX Research • Trevor Reed • Joshua Kidd • February 2019

ABOUT INRIX RESEARCH

Launched in 2016, INRIX Research uses INRIX proprietary big data and expertise to make the movement of people and goods more efficient, safer and convenient.

We achieve this by leveraging 500 terabytes of INRIX data from 300 million different sources covering more than 5 million miles of road, combined with our other data sources including global parking, fuel, points of interest, public transport and road weather information. Together, our data provides a rich and fertile picture of urban mobility that enables INRIX Research to produce valuable and actionable insights for policy makers, transport professionals, automakers and drivers.

The INRIX Research team has researchers in Europe and North America, and is comprised of economists, transportation policy specialists and data scientists with backgrounds from academia, think tanks and commercial research and development groups. We have decades of experience in applying rigorous, cutting-edge methodologies to answer salient, real-world problems.

INRIX Research will continue to develop the INRIX Traffic Scorecard as a global, annual benchmark as well as develop new industry-leading metrics and original research reports. In addition to our research outputs, INRIX Research is a free and valuable resource for journalists, researchers and policymakers. We are able to assist with data, analysis and expert commentary on all aspects of urban mobility and smart cities. Spokespeople are available globally for interviews.

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1 INTRODUCTION

Congestion is an indiscriminate global phenomenon that is dramatically impacted by population, the economy, infrastructure, and the proliferation of rideshare and delivery services. It also imposes massive costs both economically and socially. Solving traffic – better stated, improving mobility – requires a tailored approach to each city's needs.

The INRIX 2018 Global Traffic Scorecard is an analysis of congestion and mobility trends in more than 200 cities, across 38 countries. A new methodology for the 2018 Global Traffic Scorecard allows for cross-national rankings and analysis, delivering in-depth insights for drivers and policy-makers to make better decisions informed by big data.

INRIX collects billions of anonymous data points every day from a diverse set of sources, including connected vehicles, cities, DOTs, road weather conditions, journalistic incidents, social media, parking, mobile and other IoT devices. With information on almost 90 percent of the world's roads across over 80 countries, INRIX is the preferred provider of driving and mobility intelligence for leading automakers.

2 CONGESTION

Congestion at the most basic level can be described as the demand for road space exceeding supply. However, the critical phenomena known as 'facility breakdown' is frequently underappreciated. It occurs when a road cannot effectively accommodate more vehicles, which causes a decrease in the roadway's overall capacity as more vehicles try to force their way onto the roads.[1]

Highways designed to operate safely at speeds of 60 MPH, can move nearly 2300 cars per lane per hour at 45 MPH. The same roadway may carry fewer than 700 cars per lane during facility breakdown.[2] Facility breakdown is why expansion and congestion relief measures frequently fail as the supply of road-space cannot increase enough to escape this trap. While this example pertains to highways, every road and/or road network is subject to facility breakdown. For instance, urban streets are subject to greater mobility demands than car-exclusive roadways.

INRIX Research recognizes that commute duration remains mostly constant across cities worldwide, irrespective of congestion levels. On average, commuters are unwilling to spend more than one hour per day commuting according to Marchetti's constant.[3] Trip times are kept in check by increased housing density, household relocation and greater mobility via infrastructure improvements.[4] According to INRIX data, travel speeds, congestion rates and time loss positively correlate with population and city density. However, motorists in high congestion cities do not typically travel as far since they are geographically closer to more destinations.[5] It is the driving experience that differs most across cities, not the duration of trips. Typically, dense cities experience low speeds and shorter commute distances in contrast to low-density cities which exhibit higher speeds, but longer distances traveled. In both contexts, commuters spend approximately a half-hour on average going to or from work.

One notable exception to this trend is Singapore. With aggressive anti-congestion policies, including high vehicle ownership fees and congestion tolls, the city's road network continues to facilitate high-speeds despite high urban density.[6] Charging for road space curtails the incidence and impact of facility breakdown. In Paris, Zurich, Barcelona and Madrid, authorities actively pursue policies that reduce roadway performance and capacity in favor of public transport, cycling and walking.[7] Prioritizing safety, often under the title of 'Vision Zero', has justifiably taken on much greater emphasis in recent years, and with significant success. New York City, for example, achieved the lowest number of roadway fatalities on record in 2018. Sustainable measures are sought for many reasons, including mobility, environmental, safety, health and economic considerations. When interpreting the 2018 Global Traffic Scorecard's results, understanding the context of road performance within a city's broader mobility framework is critical.

1 United States of America. Federal Highway Administration. U.S. Department of Transportation. Definition, Interpretation, and Calculation of Traffic Analysis Tools Measures of Effectiveness. By Richard Dowling. Vol. VI. Traffic Analysis Tool Box. Washington, DC: U.S. Federal Highway Administration, Office of Operations, 2007.

2 Ibid.

3 Marchetti, C. "Anthropological Invariants in Travel Behavior." Technological Forecasting and Social Change47, no. 1 (1994): 75-88. doi:10.1016/0040-1625(94)90041-8.

4 Angel, Shlomo, and Alejandro M. Blei. "The Productivity of American Cities: How Densification, Relocation, and Greater Mobility Sustain the Productive Advantage of Larger U.S. Metropolitan Labor Markets." Cities51 (2016): 36-51. doi:10.1016/j.cities.2015.11.030.

5 Osman, Taner, Trevor Thomas, Andrew Monschein, and Brian Taylor. Not So Fast: A Study of Traffic Delays, Access, and Economic Activity in the San Francisco Bay Area. Report. Luskin School of Public Affairs, UCLA Institute of Transportation Studies. Los Angeles, CA: UCLA, 2016.

6 Goh, Mark. "Congestion Management and Electronic Road Pricing in Singapore." Journal of Transport Geography10, no. 1 (2002): 29-38. doi:10.1016/s0966-6923(01)00036-9.

7 Rosenthal, Elisabeth. "Across Europe: Irking Drivers Is Urban Policy." The New York Times (New York City), June 26, 2011.

3 DATA AND METHODOLOGY

4

The INRIX 2018 Global Traffic Scorecard is not directly comparable to the 2017 Global Traffic Scorecard due to different metrics and criteria of analysis. The 2017 Global Traffic Scorecard measured time spent in congestion for the median commuter whereas the 2018 Global Traffic Scorecard measures time lost due to congestion dependent upon the time of day. The 2018 Global Traffic Scorecard not only analyzes time lost, but also the severity of congestion.

The 2018 Global Traffic Scorecard addresses the above by employing peak, off-peak and free flow data for the busiest commuting corridors identified by data density. Peak corresponds to the absolute worst portion of the morning and afternoon commute. Off-peak is the low point between the peak periods. Free flow is the best performance experienced over 24 hours. Employing free-flow data enables a direct comparison between peak and off-peak periods and serves as the basis for calculating time loss. Total time lost is the difference in travel times experienced during the peak and off-peak periods compared to free flow conditions on a per capita basis.

Definitions:

Impact Rank: Impact rank is a calculated commute based upon a city's population and the delay attributable to congestion.

Urban Area: The geographic scope of a city as defined by its road network density.

Hours Lost in Congestion: The total number of hours lost in congestion during peak commute periods compared to free-flow conditions.

Year-Over-Year Change: The percentage difference in hours lost in congestion in 2018 compared to 2017.

Last Mile Travel Time: The time it takes to travel one mile into the central business district during peak hours.

Last Mile Speed: The speed at which a driver can expect to travel one mile into the central business district during peak hours.

For example, Los Angeles experiences high levels of congestion throughout the day, but its peak severity is less than Boston and Washington D.C. In other terms, Boston and Washington D.C. experience lower lows compared to Los Angeles' consistently congested roadways, although all three are heavily congested. Congestion severity correlates with city age and density because cities tend to develop around the popular transportation modes of the period.

The 2018 Global Traffic Scorecard uses two years of historical data to provide a complete year-over-year comparison of congestion and mobility. A multi-year approach enables the identification of trends in the world's largest cities and provides a basis for comparison.

4 ECONOMIC IMPACTS

The economic impacts associated with driving are pervasive, complex and dynamic. To understand the burden congestion places on each driver and the economy, INRIX Research estimates the costs of congestion in the United States, United Kingdom and Germany.

Time Loss to Passenger and Freight

Time loss is the excess amount of time taken on a trip caused by congestion. The cost of congestion depends upon the labor market, industrial sector, mode of transport, trip distance and travel conditions.[8] Two preferred methods for developing estimates for work and non-work passengers' travel time savings (non-freight movements) are revealed preference method and the cost-saving approach.[9] Given the limited availability of this data, creating a definitive answer for the costs of time loss for passengers is difficult. However, ranges are derived for cities in the U.S., U.K., and Germany based upon U.S Department of Transportation guidance.[10] Costs were then calculated in local currencies using 2018 values.

Congestion also increases the costs of freight movement via reduced driver productivity, higher operating costs and decreased reliability.[11] A high degree of variability exists between cities due to local economic conditions and the type of goods transported. For example, the impacts of delays on perishable goods are much higher than durable goods. Thus, the costs of congestion vary severely between cities. However, the American Transportation Research Institute estimates the total cost of congestion in the freight sector to be $74.5 billion annually, with $66.1 billion of it occurring in urban areas.[12]

Congestion as an Economic Indicator

While congestion incurs costs from time loss, increased pollution rates, and higher incidents of accidents, its presence is indicative of positive economic trends and a city's desirability. The occurrence of many of the world's most dynamic cities in this report should serve as no surprise. Higher density and population correlate directly with economic growth and innovation rates, while their co-occurrence has a multiplier effect.[13] The larger and denser the city is the more significant the benefits accrued to an individual city. Agglomeration economics is the phenomena of increasing productivity as a function of size and density.[14] For example, the Top 5 largest metros in the U.S. by GDP accounted for 26 percent of the nation's GDP, in 2017, but represented only 17 percent of the nation's population.[15,16] While congestion itself has little intrinsic worth, it's symptomatic of economic vitality. In the medium- and long-term, congestion can positively impact a city by catalyzing land use changes and driving investment in high-efficiency modes of transport (public transport, bicycling, walking). These investments reinforce agglomeration economics, amplifying their impact.

8 Sartori et.al. Guide to Cost-Benefit Analysis of Investment Projects: Economic Appraisal Tool for Cohesion Policy 2014-2020.
9 Ibid.
10 United States. Department of Transportation. Office of the Secretary of Transportation. Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis.
11 Ibid.
12 Hooper, Alan. Cost of Congestion to the Trucking Industry: 2018 Update. Report. American Transportation Research Institute. Atlanta, GA, 2018.
13 Glaeser, Edward, and Joshua Gottlieb. "The Economics of Place-Making Policies." 2008. doi:10.3386/w14373.
14 Ibid.
15 U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates
16 U.S. Department of Commerce. Bureau of Economic Analysis. "Gross Domestic Product by Metropolitan Area, 2017." News release. https://www.bea.gov/system/files/2018-09/gdp_metro0918_0.pdf.

5 RANKINGS

Global Ranking

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The INRIX 2018 Global Traffic Scorecard rankings deviate significantly from prior years. The variance is not a reflection of different data, but a transformation of the study. Prior Scorecards captured per capita time spent in congestion, while the INRIX 2018 Global Traffic Scorecard analyzes per capita time lost due traffic and its severity. Moscow, Istanbul, Bogota, Mexico City and Sao Paulo comprise the Top 5 in the Global Congestion Impact ranking. The dominance of Latin American cities should be of no surprise. Their breakneck rates of urbanization, high levels of informal settlements, unforgiving topographies and financial volatility make it difficult to improve mobility within these cities. However, in South America, volatility has driven innovation. Bus Rapid Transit (BRT) was developed first in Curitiba, Brazil, and has expanded throughout the region. Its popularity stems from its ability to move high volumes efficiently, with little capital expenditure and build times measured in months, not years. In addition to BRT, Medellin, Colombia, has successfully developed a cable car system that provides critical access to hillside communities. While South American cities face massive difficulties, their capacity for innovation and implementation is commendable.

When ranking by Hours Lost in Congestion, eight of the Top 10 cities globally are European. The age of these cities is a primary factor. In the cases of Rome (1), Paris (4), London (5) and Milan (6), their oldest roads can be traced back to the Roman period. Interestingly, each of these cities features a ring road, which forms a physical boundary between pre- and post-automotive construction. The outcome being car-centric infrastructure that quite literally runs into dense public transit or walking development patterns. In essence, cars enter neighborhoods designed for horses and walking.

In addition to their built form, European cities are the most progressive in reallocating road space to other transportation modes and for the public use. Congestion in cities like Barcelona, Copenhagen, London, Paris and Zurich is often accepted as a cost worth paying. Zurich famously made it a policy goal to slow traffic to promote other modes. Paris has embarked upon a remarkably aggressive policy of expanding public spaces, including the elimination of traffic from the lower quays on the Seine River, while Barcelona has received widespread international attention for its ‘superblock’ schemes. Similar to its European peers, London is undertaking major changes in road space allocation towards cycle, pedestrian and public transport, discussed further in the London case study (page 18). When London implemented congestion tolling in 2003, it was only the second city in the world behind Singapore to do so. The radical shift away from the personal automobile, predominately in European cities, constitutes a new frontier in mobility and an opportunity for data-driven solutions.

The lack of American and German cities in the Top 25, most noticeably Los Angeles, is not surprising due to the age of its road networks. The worst performing American cities – Boston and Washington D.C. – are also amongst the oldest. Their presence correlates with the prevalence of older European cities scoring highly. One city (country) which deserves further attention is Singapore. Its presence in the Top 25 is a function of its population. However, regarding yearly hours wasted it places 106th. Singapore manages car use more aggressively than any other city in the world, providing a positive example of effective pricing treatments.

INRIX Top 25 Most Congested Cities in the World

2018 IMPACT RANK (2017)	URBAN AREA	COUNTRY	REGION	HOURS LOST IN CONGESTION (RANK 2018)	YEAR OVER YEAR CHANGE	INNER CITY LAST MILE TRAVEL TIME (MINUTES)	INNER CITY LAST MILE SPEED (MPH)
1 (1)	Moscow	Russia	Europe	210 (10)	-12%	5	11
2 (3)	Istanbul	Turkey	Europe	157 (32)	6%	6	10
3 (2)	Bogota	Colombia	South America	272 (1)	-5%	8	7
4 (4)	Mexico City	Mexico	North America	218 (9)	3%	7	9
5 (5)	São Paulo	Brazil	South America	154 (39)	-1%	6	10
6 (6)	London	United Kingdom	Europe	227 (6)	1%	8	7
7 (8)	Rio de Janeiro	Brazil	South America	199 (13)	15%	5	13
8 (7)	Boston, MA	United States	North America	164 (25)	-10%	6	11
9 (9)	Saint Petersburg	Russia	Europe	200 (12)	-5%	6	11
10 (13)	Rome	Italy	Europe	254 (2)	16%	8	8
11 (10)	Ankara	Turkey	Europe	128 (75)	-5%	5	12
12 (11)	Izmir	Turkey	Europe	154 (38)	1%	6	10
13 (12)	Sydney	Australia	Oceania	138 (63)	-1%	6	10
14 (14)	Singapore	Singapore	Oceania	105 (106)	-2%	4	15
15 (16)	Berlin	Germany	Europe	154 (40)	-5%	5	11
16 (18)	Paris	France	Europe	237 (5)	7%	7	8
17 (15)	Melbourne	Australia	Oceania	118 (87)	-13%	6	11
18 (22)	Belo Horizonte	Brazil	South America	202 (11)	12%	8	8
19 (20)	Washington D.C.	United States	North America	155 (36)	-3%	5	11
20 (19)	Toronto, ON	Canada	North America	164 (26)	-4%	6	10
21 (23)	Guayaquil	Ecuador	South America	167 (24)	2%	5	12
22 (24)	Madrid	Spain	Europe	129 (74)	3%	7	8
23 (25)	Chicago, IL	United States	North America	138 (64)	4%	5	12
24 (26)	Brisbane	Australia	Oceania	157 (33)	3%	6	11
25 (26)	Medellin	Colombia	South America	138 (62)	12%	6	10

* The Impact Ranking includes a weighting based on city population

The United States:

Boston and Washington D.C. are the top two cities in the U.S. both in terms of impact and time wasted. Drivers in each city lose up to 164 and 155 hours in traffic, respectively. Their geography, age and density create a road network that enters a severe state of breakdown once traffic strikes. In each, drivers experience congestion more than 15 hours per year greater than the next worst cities in terms of total hours: Chicago (138) and Seattle (138). Based upon Federal Department of Transportation time loss valuations, Boston drivers lose up to $2,291 per year, while Washington D.C. drivers lose up to $2,161. Nationwide, drivers lose 97 hours in congestion, which costs Americans $87 billion annually in time, an average of $1,348 per driver.

While this report provides a snapshot of the economic costs of congestion in cities, it does not reflect the impact of the time loss for individuals of different incomes. Boston may incur the most significant costs in dollar terms, but a robust public transit system means alternatives exist for lower-income households. In contrast, in a city like Houston (up to $1,365), many households depend on driving, which is more expensive on a per mile basis. Determining the true impacts of congestion is dependent upon a city's unique economic profile and commute trends.

The cities with the slowest downtown business districts in the U.S. are New York City, San Francisco and Philadelphia (9 MPH, 10 MPH and 10 MPH, respectfully). Again, their slow speeds make sense as they are amongst the country's oldest and densest – New York City and San Francisco being the two densest cities in the U.S. – meaning cycling is equal to or faster than driving. The driving characteristics in these cities' cores affirms their decisions to prioritize safety, public transport and non-motorized modes.

INRIX Top 25 Most Congested Cities in the U.S.

2018 IMPACT RANK (2017)	URBAN AREA	HOURS LOST IN CONGESTION (RANK 2018)	YEAR OVER YEAR CHANGE	INNER CITY LAST-MILE TRAVEL TIME (MINUTES)	INNER CITY LAST-MILE SPEED (MPH)	COST OF CONGESTION (PER DRIVER)	COST OF CONGESTION (PER CITY)
1 (1)	Boston, MA	164 (1)	-10%	6	11	$2,291	$ 4.1B
2 (2)	Washington, DC	155 (2)	-3%	5	11	$2,161	$ 4.6B
3 (5)	Chicago, IL	138 (4)	4%	5	12	$1,920	$ 6.2B
4 (3)	New York City, NY	133 (5)	-4%	7	9	$1,859	$ 9.5B
5 (4)	Los Angeles, CA	128 (6)	0%	4	14	$1,788	$ 9.3B
6 (6)	Seattle, WA	138 (3)	0%	6	10	$1,932	$ 2.9B
7 (11)	Pittsburgh, PA	127 (7)	5%	5	13	$1,776	$ 1.2B
8 (7)	San Francisco, CA	116 (9)	-5%	6	10	$1,624	$ 3.4B
9 (10)	Philadelphia, PA	112 (10)	0%	6	10	$1,568	$ 3.3B
10 (8)	Portland, OR	116 (8)	-9%	5	13	$1,625	$ 1.4B
11 (13)	Atlanta, GA	108 (11)	10%	4	14	$1,505	$ 3.5B
12 (9)	Miami, FL	105 (12)	-5%	5	12	$1,470	$ 4.0B
13 (14)	Houston, TX	98 (14)	6%	4	15	$1,365	$ 3.8B
14 (12)	Austin, TX	104 (13)	-2%	5	13	$1,452	$ 1.2B
15 (16)	Baltimore, MD	94 (16)	3%	6	10	$1,315	$ 1.3B
16 (15)	Charlotte, NC	95 (15)	0%	5	12	$1,332	$ 953.8M
17 (19)	Tampa, FL	87 (19)	11%	5	13	$1,216	$ 1.5B
18 (17)	Honolulu, HI	92 (17)	-4%	5	12	$1,282	$ 432.0M
19 (18)	Denver, CO	83 (20)	-3%	5	13	$1,152	$ 1.5B
20 (23)	Nashville, TN	87 (18)	20%	4	16	$1,221	$ 694.7M
21 (20)	Dallas, TX	76 (22)	6%	4	17	$1,065	$ 3.1B
22 (21)	Phoenix, AZ	73 (25)	3%	4	17	$1,013	$ 1.8B
23 (31)	Orlando, FL	74 (23)	16%	4	15	$1,037	$ 900.1
24 (24)	Minneapolis, MN	70 (28)	4%	4	14	$971	$ 1.3B
25 (26)	Columbus, OH	71 (27)	6%	4	14	$990	$ 734.9M

10

Top 10 Worst US Corridors

For the fourth year in a row, the Cross Bronx Expressway (I-95) in New York City tops the INRIX list of worst corridors, with drivers wasting a total of 114 hours per year at peak hours in congestion. The list of corridors is dominated by the Top 5 most congested cities in the U.S., accounting for nine of the 10 worst. Surprisingly, Washington D.C., the second most congested city, does not have corridors that appear on the list. Despite extreme levels of congestion, traffic is diffusely across the region and concentrated to a high degree on major arterials.

INRIX Top 10 Worst Corridors in the U.S.

RANK	CITY	ROAD NAME	FROM	TO	DAILY DELAY (MINUTES)	YEARLY DELAY (HOURS)
1	New York City	Cross Bronx Expressway	Bruckner Expressway	Trans Manhattan Expressway	29	114
2	Chicago	I-94|I-90	Stevenson Expressway	I-294	26	102
3	Chicago	I-290 (Eisenhower Expressway)	I-94	I-294	23	93
4	Los Angeles	US-101	Hollywood	I-110	19	74
5	Pittsburgh	I-376	I-79	Pennsylvania Turnpike	18	72
6	Philadelphia	I-76	I-476	I-676	13	53
7	Boston	I-93	Massacheusetts Ave. Connector	Braintree	13	53
8	New York City	I-278 Brooklyn Queens Expressway	Long Island Expressway	Manhattan Bridge	13	51
9	Los Angeles	I-5	Hollywood	I-110	13	50
10	New York City	I-87 Major Deegan Expressway	Robert F. Kennedy Bridge	Cross Bronx Expressway	12	49


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Europe

European cities place amongst the slowest globally due to the vast majority of their growth occurring prior to widespread adoption of the automobile. Dense cores, narrow roads and complex road networks makes these cities ill-suited for car-based mobility. Moscow tops the 2018 Global Traffic Scorecard as the most congested city in Europe when weighting for population and commuting behavior. The cities with greatest time lost are Rome (254 hours), Dublin (246 hours), Paris (237 hours), Rostov-on-Don (237 hours) and London (227 hours). Dublin also has the distinction of having the slowest city center in all of Europe, where speeds dip as low as 6 MPH.

Luckily for the residents of most European cities, robust public transport networks exist while their density makes cycling and walking appealing alternatives. For example, central stations on the Paris Metro are only 548 meters apart on average. Furthermore, Western Europe is the most progressive region globally for the promotion of bicycling and walking. The shift to alternative modes of transport makes a particularly high degree of sense given their exceptionally slow city centers. While vehicle-based commuting has severely impaired in European cities, their overall mobility is much higher due to the diversity of mode options.

INRIX Top 25 Most Congested Cities in Europe

2018 IMPACT RANK (2017)	URBAN AREA	COUNTRY	HOURS LOST IN CONGESTION (RANK 2018)	YEAR OVER YEAR CHANGE	INNER CITY LAST-MILE TRAVEL TIME (MINUTES)	INNER CITY LAST-MILE SPEED (MPH)
1 (1)	Moscow	Russia	210 (8)	-12%	5	11
2 (2)	Istanbul	Turkey	157 (22)	6%	6	10
3 (3)	London	United Kingdom	227 (5)	1%	8	7
4 (4)	Saint Petersburg	Russia	200 (9)	-5%	6	11
5 (7)	Rome	Italy	254 (1)	16%	8	8
6 (5)	Ankara	Turkey	128 (52)	-5%	5	12
7 (6)	Izmir	Turkey	154 (26)	1%	6	10
8 (8)	Berlin	Germany	154 (27)	-5%	5	11
9 (9)	Paris	France	237 (4)	7%	7	8
10 (10)	Madrid	Spain	129 (51)	3%	7	8
11 (11)	Milan	Italy	226 (6)	6%	8	8
12 (12)	Warsaw	Poland	173 (15)	7%	5	13
13 (15)	Budapest	Hungary	162 (20)	11%	5	11
14 (13)	Rostov-on-Don	Russia	237 (3)	1%	7	8
15 (14)	Hamburg	Germany	139 (43)	-3%	5	12
16 (16)	Barcelona	Spain	147 (34)	5%	7	9
17 (18)	Nizhny Novgorod	Russia	180 (14)	2%	5	12
18 (19)	München	Germany	140 (42)	-3%	5	11
19 (17)	Vienna	Austria	109 (61)	-11%	5	11
20 (21)	Naples	Italy	186 (13)	-3%	9	7
21 (20)	Prague	Czech Republic	143 (35)	-4%	5	11
22 (22)	Turin	Italy	167 (16)	-2%	8	8
23 (23)	Birmingham	United Kingdom	134 (47)	-4%	5	12
24 (25)	Dublin	Ireland	246 (2)	-4%	10	6
25 (30)	Valencia	Spain	136 (45)	14%	6	10

The United Kingdom

Drivers in the U.K. face a much different congestion landscape than those found in the U.S. The age of cities in the U.K. has led to denser, less car friendly cores coupled with much earlier industrialization that resulted in rail-centric alternatives. The fact that London Underground operates lines older than 150 years speaks to a very different history of growth when compared to the U.S. While the U.K. did pursue major roadworks and expansion of motorways in the post-war period, hundreds of years of development is not easily undone.

According to INRIX data, six major U.K. cities exhibit last-mile travel times less than 10 MPH, which is very slow even in a European context. Drivers in 7 U.K. cities experience delays greater than 140 hours per year, with London clocking a remarkable 227 hours. In contrast, Germany has two cities with delays greater than 140 hours: Berlin (154 hours) and Munich (140 hours). The massive delays cost London drivers £1,680 annually ($2,199). While U.K. drivers lose more time in congestion, the difference in wages when compared to the U.S. results in lower gross costs of congestion. On average, drivers in the U.K. lost 178 hours due to congestion, costing the country £7.9 billion or £1,317 per driver ($10.3 billion; $1,725 per driver). Due to London's much larger population compared to other cities in the U.K., it significantly impacts the national average for time loss and cost per driver. When removing the capital, the average time loss drops to 131 hours, costing £969 annually ($1268).

INRIX Top 10 Most Congested Cities in the U.K.

2018 IMPACT RANK (2017)	URBAN AREA	HOURS LOST IN CONGESTION (RANK 2018)	YEAR OVER YEAR CHANGE	INNER CITY LAST-MILE TRAVEL TIME (MINUTES)	INNER CITY LAST-MILE SPEED (MPH)	COST OF CONGESTION (PER DRIVER)*	COST OF CONGESTION (PER CITY)*
1 (1)	London	227 (1)	1%	8	7	£ 1,680	£ 4.9B
2 (2)	Birmingham	134 (12)	-4%	5	12	£ 994	£ 388.7M
3 (3)	Glasgow	99 (16)	4%	5	13	£ 736	£ 320.4M
4 (7)	Manchester	156 (4)	2%	6	10	£ 1,157	£ 212.7M
5 (5)	Bristol	149 (9)	0%	8	8	£ 1,099	£ 212.0M
6 (4)	Edinburgh	165 (3)	-10%	8	7	£ 1,219	£ 211.4M
7 (8)	Sheffield	149 (8)	1%	6	10	£ 1,101	£ 205.3M
8 (9)	Leicester	155 (5)	-4%	6	11	£ 1,145	£ 182.9M
9 (10)	Leeds	143 (10)	6%	5	12	£ 1,057	£ 180.6M
10 (6)	Liverpool	119 (13)	-16%	6	9	£ 878	£ 174.6M

*Average hourly wage per capita, not household, was used in calculating the cost of congestion

INRIX Top 10 Worst Corridors Outside of London

Outside of the capital, Birmingham holds the distinction of having the most congested corridors with four cities appearing on the list. Leeds and Birmingham tie for most congested corridors outside of London with drivers losing 44 hours on Leeds Road and the A34 respectively.

RANK	CITY	ROAD NAME	FROM	TO	DAILY DELAY (MINUTES)	YEARLY DELAY (HOURS)
1	Leeds	Leeds Road | Saltaire Road	Harrogate Road	Bradford Road	11	44
2	Birmingham	A34 | Stratford Road	Highfield Road	Highgate Middleway	11	44
3	Birmingham	A34 | Stratford Road	Highgate Middleway	Highfield Road	11	42
4	Leeds	Huddersfield Road | Leeds Road	Dewsbury	Huddersfield	10	40
5	Manchester	Bury New Road	Higher Broughton	M60	9	34
6	Manchester	Bramhall Lane South	Bridge Lane	Stockport	8	33
7	Birmingham	Dudley Port	Black Country New Road	Dudley	8	32
8	Manchester	Chapel | Crescent | Broad Street	Victoria Bridge	M60	8	32
9	Glasgow	Great Western Road	Kelvinside	Bearsden Road	8	31
10	Birmingham	Soho Hill | Birmingham Road	Icknield Street	M5	8	30

INRIX Top 5 Worst Corridors in London

The A406 North Circular Road appears twice in the Top 5 for London due to exceptionally heavy traffic throughout the motorways length. Drivers on the A406 from Chiswick Roundabout to Hangar Lane lose approximately 15 minutes per day or 61 hours per year in congestion.

RANK	ROAD NAME	FROM	TO	DAILY DELAY (MINUTES)	YEARLY DELAY (HOURS)
1	A406 | North Circular Road	Chiswick Roundabout	Hangar lane	15	61
2	A23	Kennington	Thornton Road	14	56
3	Kingsway | Strand | Fleet | Cannon Street	Russell Square	Monument	12	49
4	A406 | North Circular Road	A1	A10	11	43
5	A2103	Canary Warf	Tower of London	11	43

Germany

Berlin (154 hours), Munich (140 hours) and Hamburg (139 hours) top the list of German cities with the most time lost due to congestion, and eight of the Top 10 German cites lost more than 100 hours per year. Of the German cities studied, all exhibit last mile speeds characteristic of dense cities falling between 10 to 15 MPH. Congestion imposes the greatest costs on Berliners at up to €1340 per year. On a national level, Germans lost an average of 120 hours due to congestion in 2018, costing the country €5.1 billion or €1052 per driver ($5.8 billion; $1,203 per driver).

Three major forces result in German cities performing better in terms of Hours Lost in Congestion compared to other cities around the world. First, Germany has consistently invested in rail and road networks, providing increased mobility and capacity. Second, it has also invested in pedestrian and cycle infrastructure to a higher degree and for longer than either the U.S. or U.K., decreasing the demand for car usage. Finally, Germany is a global leader in land use and transportation planning, as exemplified by car averse development in the medium-sized cities like Freiburg or Tubingen, and the adoption of highly innovative services like tram-trains. Holistic planning reduces road demand both through trip elimination and alternatives to driving. Germany's high last mile speeds (compared to other European cities) and system reliability reveal the power that long-range and all-round planning can have on mobility within a city.

INRIX Top 10 Most Congested Cities in Germany

2018 IMPACT RANK (2017)	URBAN AREA	HOURS LOST IN CONGESTION (RANK 2018)	YEAR OVER YEAR CHANGE	INNER CITY LAST-MILE TRAVEL TIME (MINUTES)	INNER CITY LAST-MILE SPEED (MPH)	COST OF CONGESTION (PER DRIVER)*	COST OF CONGESTION (PER CITY)*
1 (1)	Berlin	154 (1)	-5%	5	11	€ 1,340	€ 1.7B
2 (2)	Hamburg	139 (3)	-3%	5	12	€ 1,212	€ 758.2M
3 (3)	München	140 (2)	-3%	5	11	€ 1,218	€ 618.5M
4 (4)	Cologne	99 (10)	-7%	4	13	€ 867	€ 322.0M
5 (5)	Frankfurt	107 (7)	-8%	6	11	€ 935	€ 239.7M
6 (6)	Stuttgart	108 (5)	-11%	4	13	€ 938	€ 204.8M
7 (7)	Dusseldorf	100 (9)	-9%	4	14	€ 874	€ 187.3M
8 (8)	Leipzig	108 (4)	-4%	5	11	€ 941	€ 184.6M
9 (9)	Nuremberg	107 (6)	-11%	5	13	€ 937	€ 167.2M
10 (10)	Bremen	96 (11)	-2%	5	12	€ 839	€ 163.7M

*Average hourly wage per capita, not household, was used in calculating the cost of congestion

INRIX Top 10 Worst Corridors in Germany

Germany exhibits significantly lower time loss on its corridors than the United States or the United Kingdom. Berlin exhibits greater delays than other major cities in Germany with the B96 from Tempelhof to Hallesches topping the list at 28 hours lost per year. It is likely Berlin's more diffuse built environment and legacy of division, results in greater car dependency in comparison to its peers.

RANK	CITY	ROAD NAME	FROM	TO	DAILY DELAY (MINUTES)	YEARLY DELAY (HOURS)
1	Berlin	B96	Tempelhof	Hallesches	7	28
2	Hamburg	Elbchaussee | Vorsetzen	Hittfelder LandstraBe	Buy den Muren	6	23
3	Berlin	Budapester Str. | Tiergartenstraße	Leitzenburber Sraße	Eberstravße	6	22
4	Cologne	Hohenstaufenring	Roonstraße	Turiner Straße	4	17
5	Berlin	Skalitzer Str. | B96a	Kottbusser Tor	B1	4	16
6	Berlin	Greifswalder Straße	Potsdammer Platz	Danziger Straße	4	15
7	Hamburg	Mittelweg	Harvestuder weg	Gansmarkt	4	14
8	Hamburg	Spalding Straße	A1	Deichtorplatz	3	10
9	Frankfurt	Schwanheimer Hufer	Europabrucke	Kennedyallee	3	10
10	Frankfurt-Friedberger Landstraße	Freidberger Landstraße	Frankfurt-Freidberger Landstraße	Bleichstraße	3	10

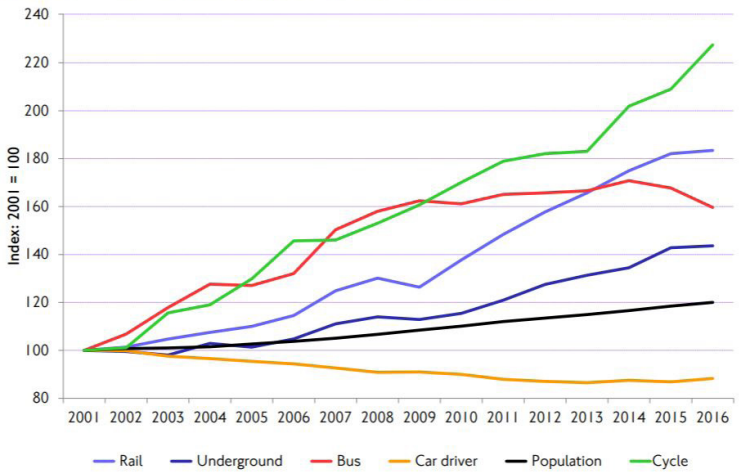
6 CASE STUDY

London

London is the sixth most congested metro area in the 2018 Global Traffic Scorecard. Mobility in London was one of major improvement focuses in the early 2000s, with the implementation of the congestion zone in central London in 2003. However, massive population and economic growth, coupled with the emergence of Transportation Network Companies (e.g. Uber and Lyft) and proliferation of delivery services, has placed extreme pressures on a fixed road network in recent years. While congestion has impacted the performance of London's bus network and has resulted in a drop in ridership in prior years, bus reliability in the capital over the last year has improved significantly.

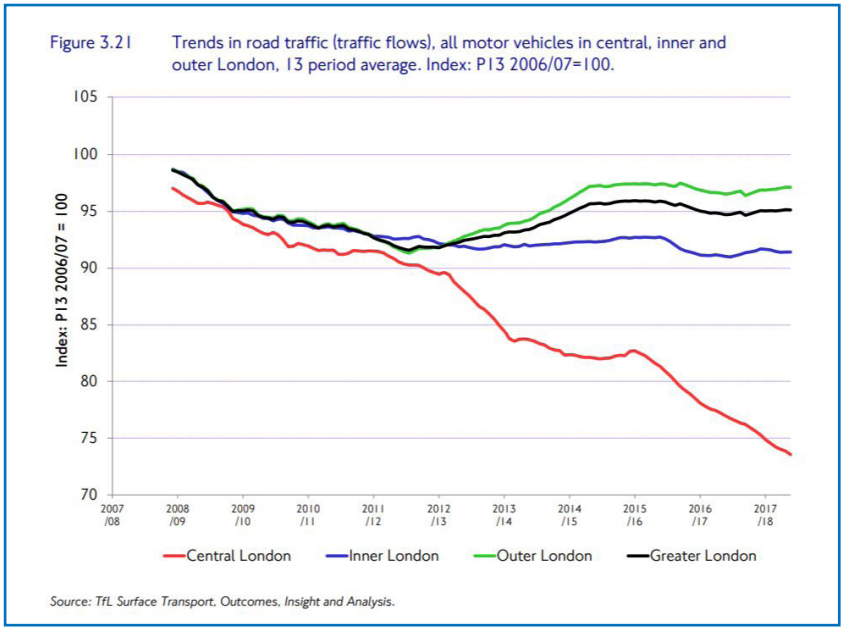
There has been an impressive growth in cycle rates. In 2016, 730,000 trips per day occurred, a 9 percent increase over 2015.[17] Where adopted, London's Cycle Highways move 46 percent of all road traffic in 30 percent of the road space.[18] The increase in cycle use and mode share will increase with the recently adopted £2.3 billion five-year plan for cycle infrastructure and will focus on creating higher quality cycle infrastructure. Continued investment in cycle infrastructure is supported by its massive growth since 2000.

Figure 2.5 Growth in journey stages on selected modes, 2001 to 2016.



Source: TfL City Planning, Strategic Analysis.

London has seen rapid and sustained population growth, but no increase in road capacity. High density land use places extreme demand on road space. In London's case, some roads predate the Romans. An irregular street network developed prior to the advent of the automobile increases the complexity of road network operations, placing further constraints on vehicular speeds. Despite massive demand increases for transport, vehicle kilometers traveled (VKT) have remained largely constant in the inner and outer boroughs, while decreasing in Central London. VKT trends coupled with modal shift data highlights how London has effectively expanded alternatives to motor vehicles.



Luckily, London has successfully undertaken major improvements and expansions of the underground, helping to address the increased demand for transport. In 1993, public transport accounted for less than half of trips taken by private vehicle, whereas now more trips are taken on public transport.[19] This trend captures the remarkable turnaround public transport experienced following the creation of the Greater London Authority and Transport for London (TfL) in 2000. From 2004/2005 to 2016/2017 gross public transit trips increased by 41 percent or, 402 million trips.[20]

The fact that the underground has increased market share while accommodating the increase in London's population highlights the success of the London Underground over the past two decades. However, TfL is facing future funding shortfalls, which are predominately driven by a decrease in trips per capita, declining national government funding and Crossrail delays and overruns.[21] While the Underground will have funding challenges, TfL's ability to increase service levels, expand and modernize the oldest system in the world speaks to effective management over its lifetime.

While Londoners have reason for optimism from improving alternatives to the automobile, the actual driving experience is unlikely to improve without major changes to the current congestion charging scheme. At present, average speeds are lower than they were prior to the scheme's adoption. Two near-term adjustments are being made to the congestion zone that should spell relief: the elimination of the Private Hire Vehicle (PHV) exemption will likely contribute to fewer vehicles driving in Central London during peak hours and adoption of the Ultra-Low Emission Zone (ULEZ) this coming April.[22] The impacts of ULEZ will likely decrease with time as consumers adopt lower emission drivetrains.

17 U.S. Census Bureau*
Persons per square mile: Los Angeles (8,484), Houston (3,842), Dallas (3,870) and Phoenix (3,126)
18 Hall, Peter. Cities of Tomorrow: An Intellectual History of Urban Planning.
19 Ibid.
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