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Unlocking Cities

The impact of ridesharing across India

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The impact of ridesharing across India

Commissioned by

UBER

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April 2018

ABOUT THIS REPORT

Over the last eight years, there has been a rise in the number of ridesharing firms providing services in India. These include Uber and Ola. Ridesharing has introduced a new mode of transport to commuters. Despite being in a nascent stage, ridesharing has begun to influence the transport landscape. It is evident that ridesharing has the potential to be a vital part of the solution to the region's transportation needs.

Uber has commissioned the Boston Consulting Group to assess the potential benefits that greater adoption of ridesharing may bring to Asian cities. The findings in this report were reached through research utilising publicly available transport data, interviews with transport experts, and primary research involving commuters in each city. The cities covered in this report are Delhi, Mumbai, Bangalore and Kolkata. For comparison purposes, we have illustrated key indicators for Singapore, Kuala Lumpur, Jakarta, Surabaya, Bangkok, Hong Kong, Taipei, Ho Chi Minh City, Hanoi and Manila.

In Brief

- Growth in population and wealth have led to an explosion in transport demand in India—an increase of 8x since 1980.

- This explosive growth has put significant strain on Indian transport infrastructure. Major Indian cities are constantly ranked among the world's most congested.

- Going forward, solutions should create a balance between capital investments required to expand capacity with new infrastructure and improving the efficiency of existing assets.

- Ridesharing can play a key role in ensuring higher efficiency in the use of existing assets such as private vehicles. Ridesharing is a new point-to-point transport model characterised by seven features: (1) Flexible supply base, (2) Smart dispatching, (3) Dynamic pricing, (4) Customer network effect, (5) Dynamic routing, (6) Demand pooling and (7) Feedback collection and management system.

- With a combination of these features, ridesharing can deliver four major benefits which can ultimately reduce congestion by **17%-31%** and optimise infrastructure investment:

  - Providing alternatives to car ownership

  - Accelerating public transport adoption

  - Optimising infrastructure timing and location

  - Supplementing incomes

- However, realising these benefits would depend on collaboration between the rideshare ecosystem and the public sector. The willingness of governments to review outdated regulations to support rideshare growth will be an important first step.

  - **Public sector:** Develop an appropriate regulatory framework to enable rideshare to achieve the necessary scale

  - **Rideshare ecosystem**: Enhance rideshare offerings, particularly pooling

  - **Collaboration between public sector & rideshare:** Co-develop programs and incentives to encourage adoption of rideshare and pooling, particularly in conjunction with public transport

Ridesharing can help to reduce congestion by 17%-31% and optimise infrastructure investment

Executive Summary

Driven by a rapid increase in wealth and population, travel demand in India has grown eight-fold since 1980. However, the country's public transport infrastructure has lagged behind, leading to high levels of congestion across major cities.

We studied the current transportation situation in four of India's largest cities, namely Delhi, Mumbai, Bangalore and Kolkata. Our aim was to assess how rideshare could help these cities to relieve congestion. In the course of our research, we also compared the status and development in these Indian cities with that of major metropolitan cities in South East and East Asia. These comparison cities were covered in a similar BCG study published in 2017.

The level of congestion is significantly higher in Indian cities than comparable cities around Asia, averaging 149%. This is partly attributable to India's large population and high population density, as well as an under-developed public transportation network (especially rail-based transport). Additionally, the use of private car is relatively high in Indian cities. It is the most common mode of private transportation across the four cities surveyed (modality share ranges from 22%-45%).

Rideshare vehicles were able to achieve a high level of efficiency in comparison to private cars

High levels of private car usage have led to significant inefficiency. Ridesharing offers one way to improve the utilisation of these vehicles. Our study found that rideshare vehicles average 1.95x higher utilisation per year (measured as people-kilometres per vehicle per year). Furthermore, on an average, 80% of the commuters we surveyed expressed some willingness to forgo purchasing a car if rideshare could meet their desired level of service. In this way, rideshare adoption can potentially help to reduce private car ownership across these cities.

Ideally, rideshare vehicles are able to achieve a high level of efficiency due to several advantages inherent in their technologies and operating models:

- **Flexible supply base** consisting of predominantly private vehicles

- **Smart dispatch system** through smartphone applications

- **Dynamic pricing** to incentivise drivers onto the road during peak demand

- **Customer network effect** connecting drivers to a large number of available passengers

- **Dynamic routing** to avoid traffic

- **Demand pooling** to match multiple passengers into the same vehicle

- **Feedback collection and management system** to improve quality and encourage adoption

To demonstrate the magnitude of this impact, we created a theoretical scenario in which ridesharing matches private car ownership in terms of affordability, timeliness and availability. Our estimates show that this scenario would reduce the num-

ber of vehicles required to meet travel demand and bring several benefits in the four cities covered.
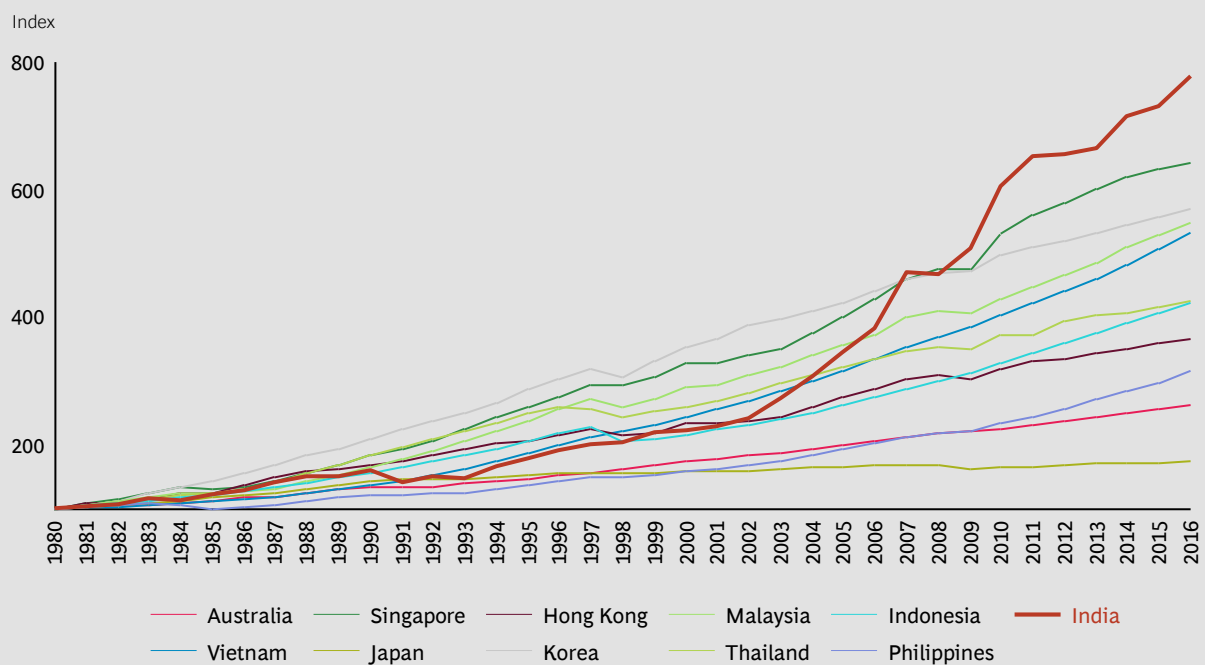
Specifically, in Delhi and Mumbai, the key benefits would include (1) Providing alternatives to car ownership, (2) Accelerating public transport adoption, and (3) Supplementing incomes. In Bangalore and Kolkata, the key benefits would include (1) Providing alternatives to car ownership, (2) Optimising the timing of infrastructure investment, and (3) Supplementing incomes.

In this optimal scenario, a reduction of 33%-68% in private cars and congestion reduction by 17%-31% can be achieved across these cities. Consequently, this could significantly help these cities improve their amenity by saving approximately 760 to 22,000 acres of unnecessary parking space in each city.

India's Transport Growth Journey

India's rapid growth in population and wealth over recent decades has led to a considerable strain on its transport infrastructure. Since 1980, the country's population has nearly doubled (~90% growth), replacing China as the world's most populous nation. In the same period, its Gross Domestic Product (GDP) per capital grew by more than 5 times, with most of the growth recorded in the period since 2000.[1] Based on research demonstrating the relationship between transport demand, population and wealth, we estimate that transport demand has increased by almost 8 times since 1980.[2]

EXHIBIT 1 | Indexed Estimated Growth in Travel Demand (1980 = 100)

Legend: Australia, Singapore, Hong Kong, Malaysia, Indonesia, India, Vietnam, Japan, Korea, Thailand, Philippines

Sources: World Bank; OECD; National Center for Sustainable Transportation; BCG analysis.

Major Indian cities are now consistently ranked among the world's most congested. In Delhi, congestion was estimated to cost the city USD 9.6 billion (~12% of its GDP) annually in fuel waste, reduced productivity, air pollution and accidents.[3] According to the latest World Bank Global Infrastructure Outlook, India would need approximately USD 4.5 trillion investment in infrastructure by 2040, of which USD 974 billion would be required for railway and road networks alone.[4]

In this report, we focus on the current state of transportation and congestion in four of the largest cities in India, namely Delhi, Mumbai, Bangalore, and Kolkata, where total congestion costs were estimated to be as much as USD 22 billion per year. We then estimate the potential positive impact of ridesharing in each city. Indian cities share similar challenges in terms of high congestion and under-developed public transport networks unable to meet demand. However, each city's transport network has unique characteristics. The cities covered in this study may be further divided into two categories:

- **Delhi and Mumbai:** These two cities are mega urban centres with relatively more developed modern public transport systems. According to our interviews, the Delhi metro is frequently considered to be the best quality transportation network in the country, while Mumbai's suburban rail, new metro line, and Bus Rapid Transit (BRT) are known to be the busiest nationwide. Nevertheless, congestion levels remain high due to a large number of private vehicles and the low quality of road infrastructure. With the burgeoning population and the growing prosperity of Delhi and Mumbai, the reliance on cars is expected to increase, adding more pressure to road networks.

- **Bangalore and Kolkata:** Relatively smaller than Delhi and Mumbai in terms of population, these two cities have less modern and more road-based public transport networks. While investments are being made to build more modern rail lines, the current lack of public transport capacity, coupled with huge private vehicle ownership numbers (both cars and motorbikes), has caused intense congestion.
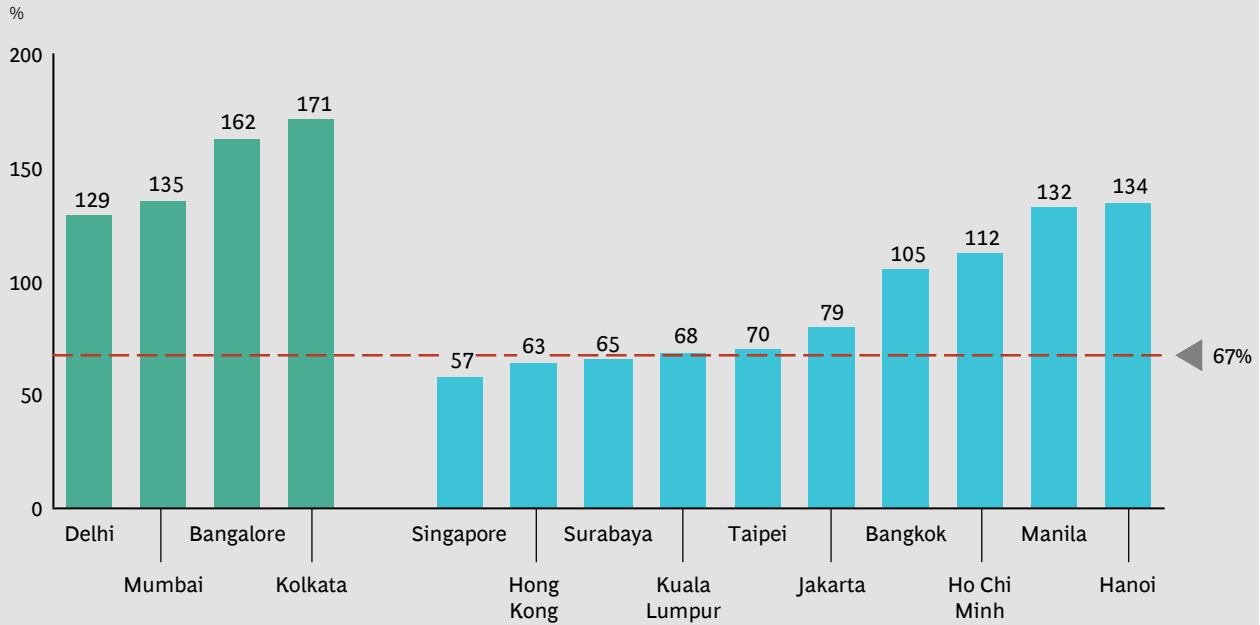
Going forward, each of these cities are expected to face diverse challenges that would require different approaches to achieve sustainable solutions. However, each city will need to reduce their reliance on private vehicles and find more efficient point-to-point transport alternatives.

- Overall, travel by public transport accounts for 19% and 54% of kilometres travelled in **Delhi and Mumbai**, respectively. The need to further improve overall quality, network reach and ease of access from feeder transport modes have been recognised as key challenge areas. Governments of both cities have indicated that maintaining control over vehicle growth and encouraging the use of public transport are their key objectives going forward.

- For **Kolkata and Bangalore**, congestion levels are relatively higher than in other cities, despite their smaller populations. This is driven by the limitation of their older public transport networks which are primarily road-based, along with a significant growth in private vehicles. Looking forward, a combination of infrastructure improvement, addition of more modern mass transit as well as efficient alternatives to vehicle ownership are likely to help curb congestion.
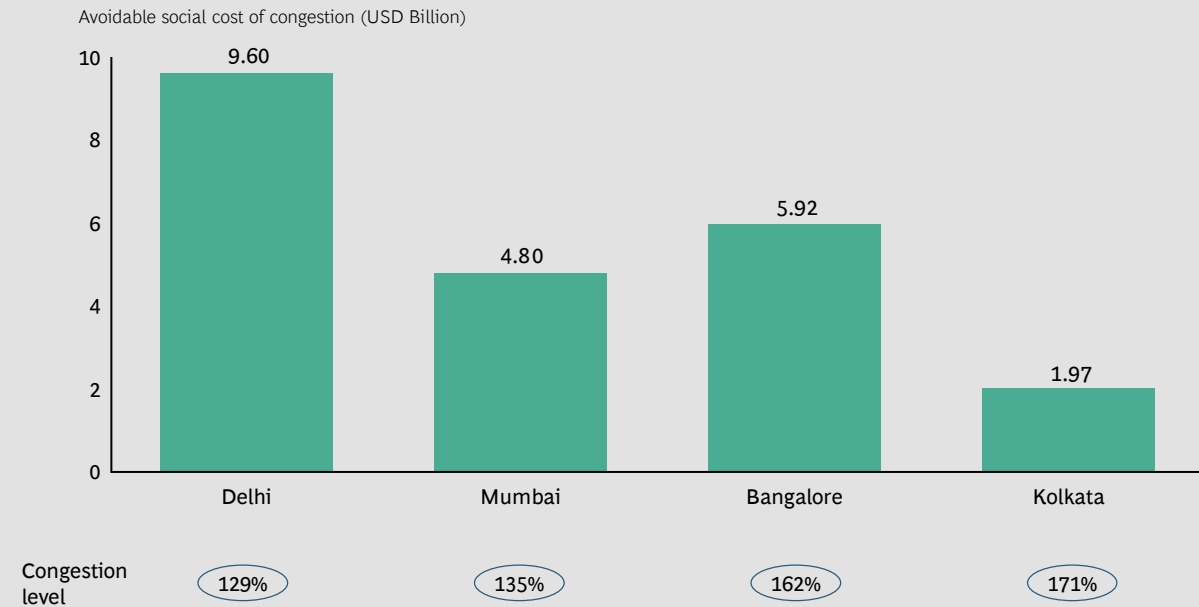
EXHIBIT 2 | Peak Hour Congestion (% Additional Time to Travel in Peak Hours)

%

Bar chart values:
- Delhi: 129
- Mumbai: 135
- Bangalore: 162
- Kolkata: 171
- Singapore: 57
- Hong Kong: 63
- Surabaya: 65
- Kuala Lumpur: 68
- Taipei: 70
- Jakarta: 79
- Bangkok: 105
- Ho Chi Minh: 112
- Manila: 132
- Hanoi: 134

Reference line: 67%

Sources: TomTom traffic index; Google API; Uber; Government statistics; BCG analysis.
Note: Asia average taken from average of East Asian cities based on TomTom traffic index.

EXHIBIT 3 | Cost of Congestion Across Cities

Avoidable social cost of congestion (USD Billion)

City	Cost	Congestion level
Delhi	9.60	129%
Mumbai	4.80	135%
Bangalore	5.92	162%
Kolkata	1.97	171%

Sources: Centre for Urban Economic Studies, Department of Economics, University of Calcutta, Kolkata, India.

Ridesharing and Its Implications for Indian Cities

Ridesharing players such as **Uber and Ola** have emerged in India over the last five years. While their entry has not been without controversy, commuters have benefited from a wider array of transport options. For the purposes of this report, we will focus on the benefits of ridesharing in meeting a city's transport needs, as well as the key challenges which have emerged with the introduction of this transport model.

WE DEFINE RIDESHARING AS A POINT-TO-POINT TRANSPORT MODEL CHARACTERISED BY SEVERAL ELEMENTS:

- **Flexible supply base:** Flexible driver supply base that utilises existing private vehicles and taxis, and can scale quickly to meet demand

- **Smart dispatching** (smart supply-demand matching): Efficiently maps supply against demand (one-to-one matching) and dispatches trip requests in the best way

- **Dynamic pricing:** demand-responsive prices, with higher price when demand surges to provide incentive for drivers to go where they are most needed

- **Customer network:** Rideshare technology allows drivers to connect with a large network of potential passengers

- **Dynamic routing:** Routes vehicles in a manner that avoids traffic and minimises travel time

- **Demand pooling:** Pools passengers based on live demand; increases vehicle occupancy and passenger-km delivered per vehicle

- **Quick feedback collection and management:** Real-time feedback and management system to ensure quality, safety, and satisfaction of customers

Flexible supply base. Rideshare opens up opportunities for qualified drivers to work part-time. Through the app, rideshare drivers can choose to drive only when it is most convenient, and makes the most economic sense depending on their personal schedule. Therefore, drivers can easily maintain other jobs while driving for rideshare to supplement their income. This flexible arrangement allows rideshare to attract large numbers of part-time drivers, to have an ample yet flexible supply base to meet demand.

Smart dispatching (smart supply-demand matching). Upon receiving booking requests, rideshare technology transmits them to the nearest vehicle. The system determines the most suitable driver for each request to maximize overall efficiency.

Dynamic pricing. Demand and pricing signals allow rideshare to efficiently mobilize drivers to where they are most needed. Areas where customer demand significantly exceeds driver supply will be shown to have higher pricing multiples (also known as dynamic price or price surge). The higher the demand for drivers, the

higher the price multiplier. Through the app, participating drivers can check real-time market conditions (demand in the areas, pricing multiples, etc.). While there have been debates on the use of dynamic pricing, this mechanism does provide drivers with both information and incentive to move to high-demand areas and provide customers greater accessibility and choice.

Customer network. Rideshare allows drivers to access a large and expanding network of passengers, thus decreasing the time drivers spend waiting for a booking. This also increases the efficiency of supply-demand matching and facilitates pooling services. As more customers join these platforms, the revenue pool for drivers also increases, attracting new drivers to join. The flow-on effect of a growing network is essential to realize the full potential of rideshare.

One factor appreciated by customers using rideshare, and which encourages loyalty, is the added convenience of electronic payment, stored profiles, and digital records. Frequent bonuses are given to customers who introduce new riders or drivers to these platforms. In addition, car-hire platforms worldwide have introduced incentives such as discounts and points redeemable for prizes to encourage repeat bookings (for example, the GrabRewards programs in Southeast Asia, Uber and SPG Preferred Guest Program, the Lyft and Delta Frequent Flyer partnership in the US, etc.). Together with a simplified registration process, these features have encouraged rideshare growth.

Dynamic routing. Once driver and rider are matched, drivers are provided with real-time updates on traffic conditions and the best route to the pickup location and destination. The dynamic routing feature keeps drivers informed of the best routes so they don't have to rely on their personal experience and knowledge of the roads. This feature not only maximizes driver benefits and helps to avoid congestion, but also ensures that customers are adequately informed about their trips. Knowing a driver's location, contact details, and estimated arrival time, as well as the approximate cost of their trip, provides customers with an added sense of security, especially if they are new to the area.

Demand pooling. With sufficient levels of adoption, rideshare can improve vehicle efficiency further through demand-pooling or trip-sharing. Drivers may have better income opportunities because they are able to pick up multiple passengers on a single trip. Pooling also lowers fares for customers, who share the cost of the trip. Rideshare quickly maps available routes for multiple bookings, compare existing bookings to identify potential synergy, and direct drivers to pick up multiple passengers on similar routes. Perhaps most importantly, demand- pooling also reduces the number of cars required to meet transportation demand. It can help to alleviate traffic congestion and reduce environmental impact.

Quick feedback collection and management. Rideshare prompts users, both drivers and riders, to give trip ratings immediately after their trips. If users fail to do so, they will often be prompted again before booking their next ride. This system encourages quick and efficient feedback collection, and averaged ratings are then used as signals for the quality of both drivers and riders. This two-way feedback system helps to improve accountability.

In **Delhi and Mumbai**, greater ridesharing adoption could benefit the cities by:

- **Providing alternatives to car ownership:** Among the commuters surveyed on average, 89% plan to buy a new car in the next 5 years. This underscores growing wealth in these cities and the general perception that owning a car is a symbol of success. However, over 79% of the respondents who plan to purchase a car also indicated that they would consider aborting their purchase plans, should the availability and timeliness of ridesharing equal or exceed private car ownership. Substituting ridesharing for private cars could eliminate between 46%-68% of the total cars on the road in these cities—going a long way towards eliminating congestion during peak hours.

  This means that the reduction in private car ownership would also support 'liveability' in these cities. With reduced car ownership, land previously used for parking spaces, could be re-allocated to enhance living conditions, such providing additional housing and social infrastructure. Fewer private cars usage would also help to significantly reduce CO2 emissions.
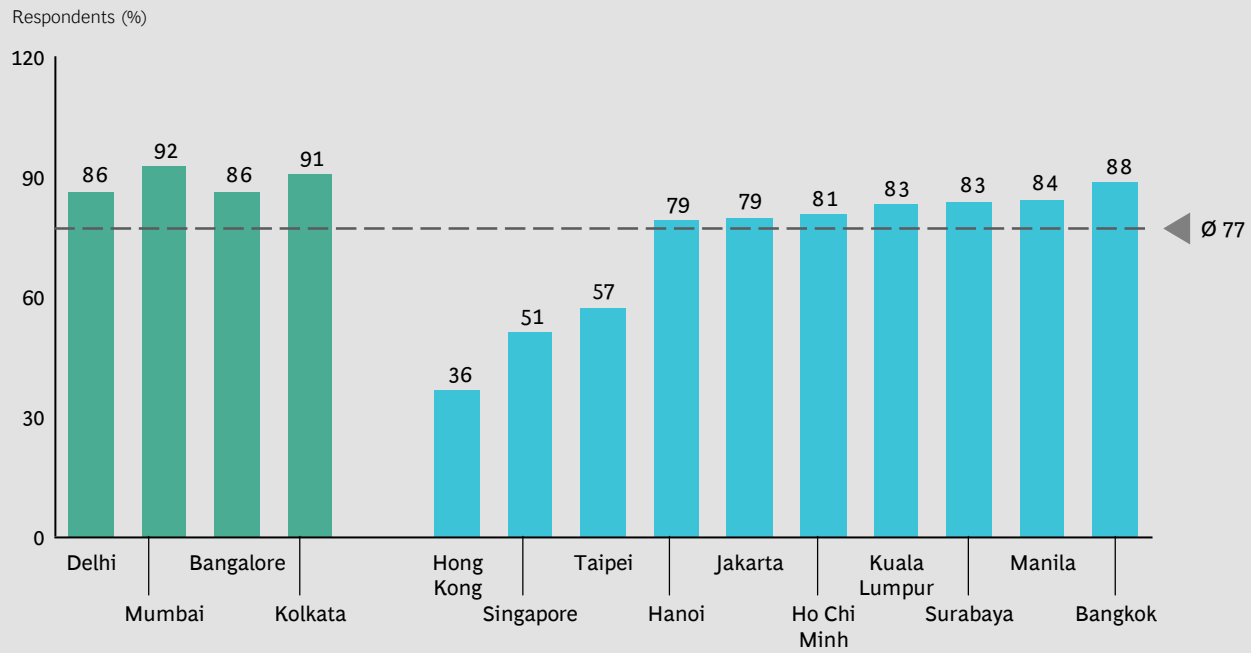
- **Accelerating public transport adoption:** Despite a significant investment in quality public transport infrastructure, the modal share of public transport remains dismally low. Ridesharing has the potential to act as a feeder to public transport, particularly if applications and incentives are developed to encourage intermodal transport usage. Outlying areas without easy access to public transport would particularly benefit, if there is a sufficient number of rideshare drivers to serve those areas.

- **Supplementing incomes:** On average 25% of the private car owners surveyed in Delhi and Mumbai expressed a keen interest in becoming rideshare drivers. An additional 43% were somewhat willing to consider the role in order to generate supplemental income.

In the case of **Kolkata and Bangalore**, the cities stand to benefit the most from ridesharing by:

- **Providing alternatives to car ownership:** Currently, Kolkata and Bangalore are ranked among the most congested cities in the country. In these cities, on average 89% of commuters surveyed indicated plans to purchase a car in the next five years. In Kolkata, where congestion was perceived to be the most severe among the cities studied, the same respondents showed the highest likelihood (~52% highly willing) to forgo purchasing a car if ridesharing could meet their transport requirements on price, timeliness and availability.

- **Optimising infrastructure timing & location:** Kolkata and Bangalore have ambitious plans to expand transport networks, especially by building modern metro lines. However, roll-out will require considerable time and funding. Ridesharing can assist governments to 'right-time' infrastructure investment, serving outlying areas where there may be insufficient demand to warrant fixed asset investments at the moment.
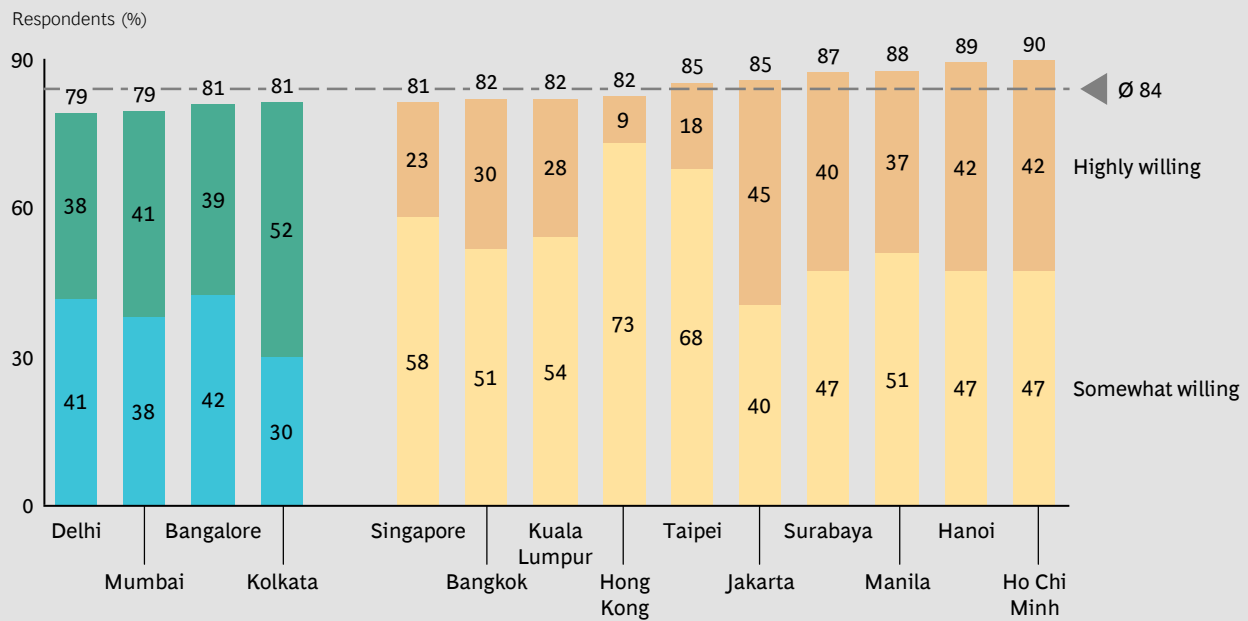
EXHIBIT 4 | Percentage of Respondents Who Plan to Buy a Car Within the Next Five Years

Respondents (%)

City	Value
Delhi	86
Mumbai	92
Bangalore	86
Kolkata	91
Hong Kong	36
Singapore	51
Taipei	57
Hanoi	79
Jakarta	79
Ho Chi Minh	81
Kuala Lumpur	83
Surabaya	83
Manila	84
Bangkok	88

Ø 77

Source: BCG survey.

EXHIBIT 5 | Willingness for a Planned Car Buyer to Forgo Purchase, Provided Rideshare Meets Desired Levels of Availability, Price, Timeliness

Respondents (%)

City	Somewhat willing	Highly willing	Total
Delhi	41	38	79
Mumbai	38	41	79
Bangalore	42	39	81
Kolkata	30	52	81
Singapore	58	23	81
Bangkok	51	30	82
Kuala Lumpur	54	28	82
Hong Kong	73	9	82
Taipei	68	18	85
Jakarta	40	45	85
Surabaya	47	40	87
Manila	51	37	88
Hanoi	47	42	89
Ho Chi Minh	47	42	90

Ø 84

Source: BCG survey.

- **Supplementing incomes:** Car owners in these two cities indicated higher willingness to drive for a ridesharing platform in order to increase their incomes. Between 27%-37% of car owners here indicated high willingness, while an additional 40% indicated moderate willingness to drive.

To give a sense of the magnitude of the potential impact, we assessed a hypothetical scenario where ridesharing, including pooling, fully substitutes private car usage in each city. For instance, in Delhi, this would mean that ridesharing becomes 50% of total kilometres travelled by motorized vehicles.
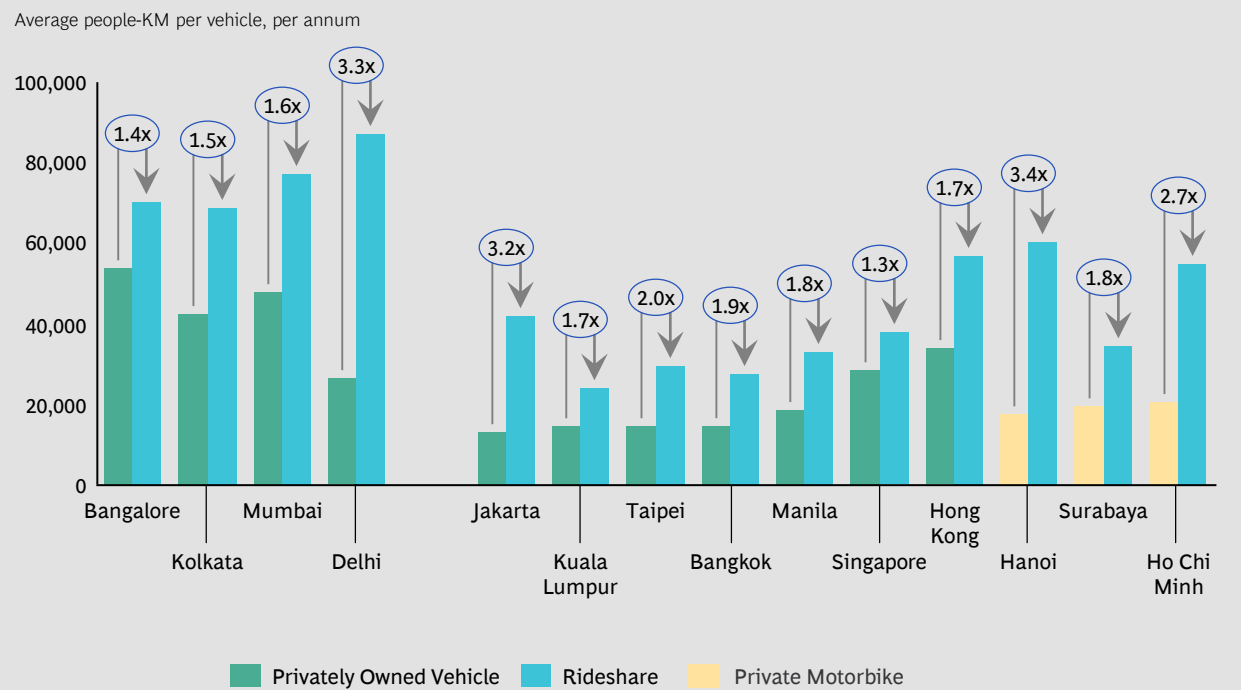
Under this scenario, ridesharing substantially reduces the number of vehicles required due to the higher people-kilometres ratio provided by each rideshare vehicle as compared to private cars. Congestion would also decline significantly as a result of the reduction in the number of cars trips. Furthermore, significant space, totalling as much as 33,000 acres, could be re-purposed from vehicle parking.

VEHICLES OTHER THAN PRIVATE CARS
While private cars have the highest modality share among private vehicles by passenger-KM a wide variety of vehicles are used across the cities surveyed.

Auto-rickshaws: Auto-rickshaws comprise an important part of the Indian transportation system. Their usage is common among commuters due to their conve-

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EXHIBIT 6 | Efficiency Gap Between Rideshare Vehicles vs. #1 Common Modes[5] of Private Vehicles (Car or Motorbike)
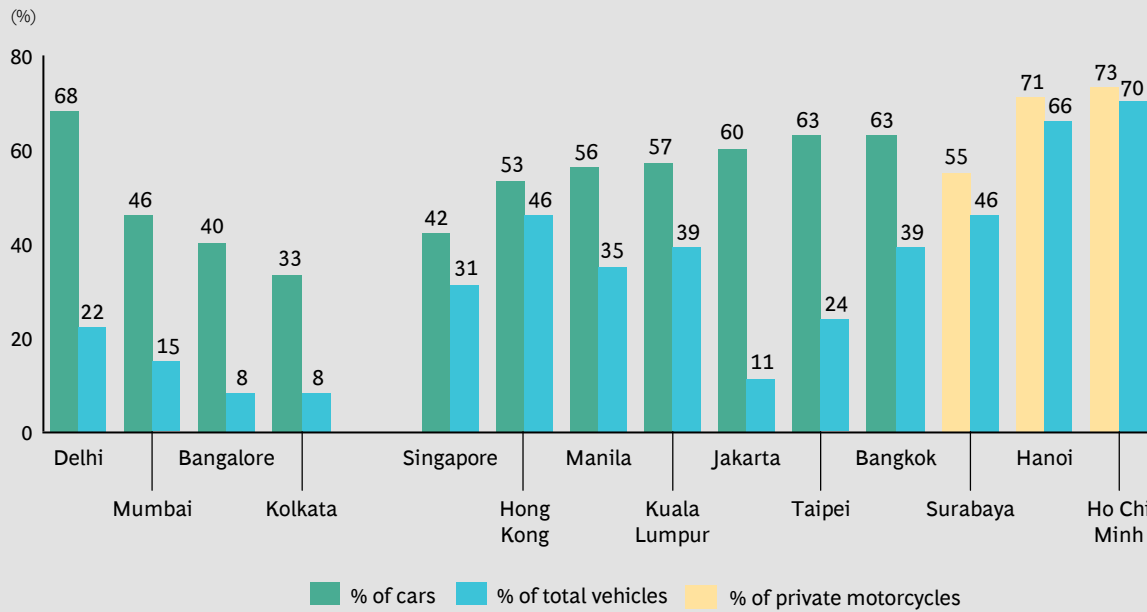

Average people-KM per vehicle, per annum

Legend: Privately Owned Vehicle · Rideshare · Private Motorbike

Efficiency multipliers by city: Bangalore 1.4x, Kolkata 1.5x, Mumbai 1.6x, Delhi 3.3x, Jakarta 3.2x, Kuala Lumpur 1.7x, Taipei 2.0x, Bangkok 1.9x, Manila 1.8x, Singapore 1.3x, Hong Kong 1.7x, Hanoi 3.4x, Surabaya 1.8x, Ho Chi Minh 2.7x

Source: BCG survey.

EXHIBIT 7 | Percentage of Private Vehicles and Total Vehicles Reduced with Rideshare

(%)

City	% of cars	% of total vehicles	% of private motorcycles
Delhi	68	22	
Mumbai	46	15	
Bangalore	40	8	
Kolkata	33	8	
Singapore	42	31	
Hong Kong	53	46	
Manila	56	35	
Kuala Lumpur	57	39	
Jakarta	60	11	
Taipei	63	24	
Bangkok	63	39	
Surabaya		46	55
Hanoi		66	71
Ho Chi Minh		70	73

■ % of cars ■ % of total vehicles ■ % of private motorcycles

Sources: Government statistics; BCG analysis.
1. With rideshare scenario under which ridesharing replaces private cars as the #2 or #3 mode of transport in respective cities and pool constitutes 50% of rides 2. Total number of vehicles includes private cars, motorcycles, buses, taxi and rideshare cars, 3. Total number of cars include private cars and ridesharing cars.

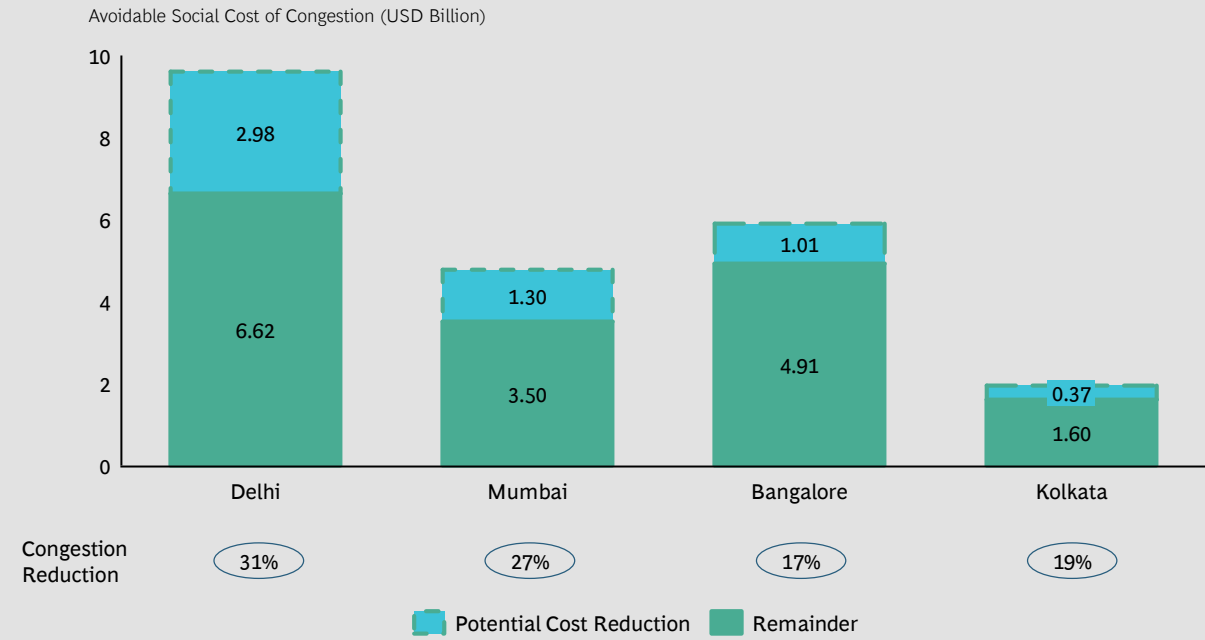**EXHIBIT 8 | Road Congestion During Peak Hours Before vs. After Rideshare (2017)**

(%)

City	Private Car	Rideshare	Reduction
Delhi	~130	~90	-31%
Mumbai	~137	~100	-27%
Bangalore	~162	~137	-17%
Kolkata	~172	~140	-19%

■ Private Car ■ Rideshare

Source: BCG analysis.
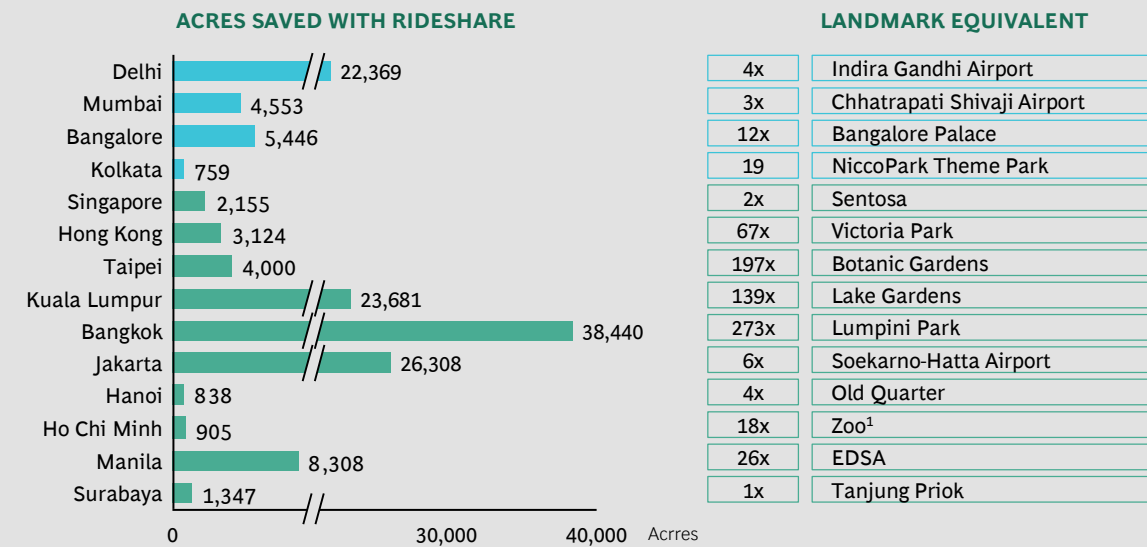**Note**: Reductions in congestion based on high-adoption, high-pooling scenario.

EXHIBIT 9 | Estimated Reduction in Avoidable Social Cost of Congestion as a Result of Rideshare Adoption

Avoidable Social Cost of Congestion (USD Billion)

City	Potential Cost Reduction	Remainder	Congestion Reduction
Delhi	2.98	6.62	31%
Mumbai	1.30	3.50	27%
Bangalore	1.01	4.91	17%
Kolkata	0.37	1.60	19%

Legend: ■ Potential Cost Reduction ■ Remainder

Source: Centre for Urban Economic Studies, Department of Economics, University of Calcutta, Kolkata, India; BCG analysis.

EXHIBIT 10 | Estimated Space That Can be Saved by Adopting Rideshare Assuming Rideshare Substitutes for Private Cars

ACRES SAVED WITH RIDESHARE

City	Acres
Delhi	22,369
Mumbai	4,553
Bangalore	5,446
Kolkata	759
Singapore	2,155
Hong Kong	3,124
Taipei	4,000
Kuala Lumpur	23,681
Bangkok	38,440
Jakarta	26,308
Hanoi	838
Ho Chi Minh	905
Manila	8,308
Surabaya	1,347

LANDMARK EQUIVALENT

Multiple	Landmark
4x	Indira Gandhi Airport
3x	Chhatrapati Shivaji Airport
12x	Bangalore Palace
19	NiccoPark Theme Park
2x	Sentosa
67x	Victoria Park
197x	Botanic Gardens
139x	Lake Gardens
273x	Lumpini Park
6x	Soekarno-Hatta Airport
4x	Old Quarter
18x	Zoo[1]
26x	EDSA
1x	Tanjung Priok

Sources: ASEAN Maritime Working Group, Data.Gov.Sg, FIFA, MapDevelopers/Google Maps, HDB, HK Census and Statistics Dept., LTA, Manila Times, Perdana Botanical Garden, URA, Thanhnien News, The Straits Times, Taipei Botanical Garden, expert interviews, BCG analysis.
Note: Size of local landmarks vary greatly between cities. Area represents estimated total flat area of all parking lots (existing and needed) to serve a city's car population. Area estimated by deriving ratio of cars (private + rideshare) to estimated parking lots in Singapore (~2.2) and then extrapolating this ratio to car populations in other markets. Assumes standard parking lot (19m2), Area saved under hypothetical scenario in which rideshare becomes displaces private vehicles in terms of modal split and 50% of rideshare is pooling.
1. HCMC Zoo and Garden complex.

nience and accessible pricing. Across the four cities, we estimate the share of auto-rickshaws to range between 8%-43% of the total passengers-KM travelled by public transport. This share has the potential to increase in the near future as government continues to issue more permits (e.g. Delhi's auto-rickshaws population more than doubled in 2016, reaching ~198,000).[6]

Like traditional taxis, auto-rickshaw drivers could stand to benefit from working with rideshare. This benefit is illustrated through the collaboration between Uber and Kaali-Peelis taxis (refer to section "Utilisation of taxi" below for more details). However, due to the price differences, consumers are unlikely to switch from rickshaws to rideshare. Thus, we have excluded auto-rickshaws from our quantitative analysis.

Motorbikes: In the cities studied, our model estimates that the share of motorbikes ranges from the lowest in Mumbai (12%) to the highest in Bangalore (32%), as measured by proportion of the total KM travelled. While these levels are lower compared to those of private cars, they still comprise a considerable proportion of each city's transportation demand. This makes motorbikes a significant contributor to congestion.

As an extension to the base scenario above, where rideshare is a substitute for private cars, we also examine the effects it may have on motorbike population. While replacing motorbike usage with rideshare adoption is less feasible given their cost differences, our calculation shows that even if only ~1/3 of the current motorbikes could be substituted with rideshare in addition to the base scenario above, it could reduce between 22% to 38% of the total vehicles in each of the cities studied.

ACHIEVING SUSTAINED BENEFITS

On a standalone basis, rideshare can act as a more efficient means of transport than private cars. However, its full benefits may be best realised with a higher adoption of rideshare and pooling in conjunction with public transport.

- **Delhi and Mumbai** have recently invested in public transport development and have ambitions to significantly increase their adoption. In Mumbai however, we estimate that even with the planned expansions and full capacity utilisation of current and future rail lines, the city may be unable to maintain the current levels of peak congestion by 2022. For Delhi, the main hurdle is improving public transport adoption. Given these constraints, according to our estimates, additional rail public transport adoption of close to 11% of total KM travelled would be needed by 2022, alongside utilisation of rail capacity, to maintain today's congestion levels.

- **Bangalore and Kolkata** intend to significantly increase rail- based public transport capacity. Despite these plans, we estimate that the added capacity of rail transport alone will not be sufficient to reduce their congestion levels. This is especially true for Bangalore, where we estimated that the added rail transport capacity still falls below the required level to maintain its congestion levels by 2022. According to our estimates, additional rail public transport adoption of close to 21% of total kilometres is essential, in conjunction with public transport, to maintain today's congestion levels.

By 2022, additional rail public transport adoption of close to 11% of total KM travelled would be needed to maintain today's congestion level in **Delhi**

The benefits of ridesharing discussed above are supported by recent studies conducted on ridesharing, shared mobility and car-pooling around the world. These include recent case studies from India.

BENEFIT 1: PROVIDING ALTERNATIVE TO CAR OWNERSHIP

Ridesharing and car-sharing have been shown to act as a substitute for car ownership in some cities. For example, in London, researchers surveyed car-share users and found that **31% of users declined to purchase a car that they would have purchased otherwise, while 6% of car owners planned to or had recently disposed off a car due to ridesharing availability.**[7] By comparison, in Austin, Texas, researchers found that when Uber and Lyft were temporarily suspended in the city, **roughly 40% of those affected switched to a personal vehicle as their primary transport mode and approximately 9% purchased a vehicle, in response to the suspension.**[8, 9]

In a recent Shared Mobility Survey across six key cities in the US, **rideshare users reported the lowest car ownership levels**. On average, **30% of shared mobility users, including rideshare, reported shedding their vehicles.**[10]

BENEFIT 2: REDUCING CONGESTION THROUGH INCREASED EFFICIENCY

More passengers per vehicle

A recent study conducted across six US cities, namely Chicago, Los Angeles, Nashville, San Francisco, Seattle and Washington DC, showed **that only ~5% of ride-**

EXHIBIT 11 | Estimated Public Transport Demand in Relation to Public Transport Capacity in 2022

% KM travelled by public transport

— Estimated public transport capacity by 2022[1]

■ 2017 % KM travelled by public transport

■ 2022 % KM travelled by public transport to maintain current peak congestion

Sources: Government announcement on transport infrastructure master plan; BCG analysis.
1. Capacity is estimated based on current rail network and new rail lines/existing line extensions in operation before 2022 in each city: Thomson East Coast Line, Downtown line 3 extension for Singapore; total new railway projects equivalent to 25% of current capacity in Hong Kong; Circular Line stage 1, Anking Line, Danhai LRT, Wanda Line stage 1, Xinzhuang Line extension for Taipei; MRT Line 2 for Kuala Lumpur; 10 new rail lines and 3 existing line extensions for Bangkok; first Metro Line and 3 LRT lines for Jakarta; 6 Metro Rails (total 109 KM) for Ho Chi Minh; 6 new railway lines (total 246 KM) for Manila; one monorail for Surabaya.

share users drove solo, which is 5-6 times lower compared to non-rideshare users.[11] This higher vehicle occupancy is one of the key ways by which ridesharing could help reduce congestion.

This particular benefit was demonstrated in Jakarta where, in 1992, the government introduced a policy that required vehicles to carry at least three occupants when travelling on main routes during peak hours (3-in-1 policy). This policy, however, lifted in 2016 due, at least in part, to concerns regarding the informal passenger-for-hire (i.e. 'jockey') economy that had emerged as a consequence.[12]

A recent study by researchers at Harvard and MIT universities, found that following the repeal of this policy, morning and evening congestion on the newly-liberalised routes **leaped by a staggering 46% and 87% respectively.** Moreover, not only did congestion leap on those central Jakarta roads where car-pooling was previously mandated, **it also increased during non-peak hours on routes and in areas that were never subject to the pooling rule in the first place.** In the hour following the evening peak, for example 19:00-20:00, the repeal of this policy coincided with a roughly 50% increase in delays.[13]

The increase in vehicle occupancy through ridesharing could be further enhanced as there is evidence that pooled rides can become a substantial portion of ridesharing trips. For example, in Southeast Asia, Uber's pool option represented approximately 25% of total trips in August 2017.[14]

Greater vehicle utilisation per kilometre

A common challenge in cities is matching the transport supply with commuter demand to ensure sufficient supply during peak hours, and reducing supply during off-peak hours, to minimise kilometres travelled without passengers ('unproductive miles'). Research in San Francisco indicated that **rideshare vehicle 'unproductive miles' is approximately half of taxis (as a percentage of total miles).**[15] Responsiveness to flexible demand allows ridesharing vehicles to be potentially more efficient in meeting demand, without adding to congestion, at times of lower demand.

BENEFIT 3: ACCELERATING PUBLIC TRANSPORT ADOPTION

A study published by the National Academy of Sciences, which covered several major US cities, found that 43% of shared-mobility users reported an increase in their use of public transport, while only 28% of individuals reported reduced use of public transport.[16] Where public transport use has increased, the study suggests that ridesharing is used to complement public transport, and can support a "car light" lifestyle. This positive effect, however, may be limited due to economic conditions and timing of travels. For example, a recent shared-mobility study found no clear correlation between peak-hour use of rideshare and long-term increase in public transport usage.[17]

Nevertheless, transit authorities are recognising the potential for ridesharing to act as a feeder mechanism to public transport. In Portland, Oregon, for example, a local transit authority (TriMet) has integrated rideshare booking capabilities into its public transit app, as a means to enhance intermodal efficiency to public transport hubs.

> 43% of shared-mobility users reported an increase in their use of public transport in several major US cities

Benefit 4: Optimising infrastructure timing & location

Another benefit of existing rideshare models is improved transport coverage of areas beyond the core metropolitan space. Studies in Manhattan found that **outlying areas were generally better served by rideshare, compared with taxis.**[18] Ridesharing, therefore, supports transport needs where there is less access to public transport, and can serve as a bridging mechanism for infrastructure development in outlying areas. In 2016, a US suburb subsidised Uber rides to the local public transit hub, instead of using the funds to expand parking.

Benefit 5: Supplementing drivers' income

The introduction of rideshare models has provided a portion of the workforce with opportunities for additional income. A study in the United States has shown that close to 80% of Uber drivers are part-time drivers.[19] **Flexible working hours and the ability to smooth fluctuations from other income sources are the key reasons** for drivers to engage with rideshare companies.[20] In Singapore, rideshare companies such as Uber and Grab have also became the preferred choice for part-time jobs among students.[21]

Despite the obvious potential benefits of ridesharing, concerns have emerged about the interaction between ridesharing and other transport modes such as taxi operators and public transport players. BCG has therefore explored these concerns and suggested potential solutions. From our assessment, we found that a net positive outcome can be realised for all stakeholders—ridesharing is not and need not be a "zero sum" game. For Indian cities to achieve net positive benefits, several conditions must be achieved:

Ridesharing substituting against private vehicles

Ridesharing benefits are obtained by providing greater transport efficiency (people-kilometres) compared to private vehicles. However, to provide net positive benefits for congestion, cities must ensure that ridesharing does not cannibalise the share of public transport. While there is evidence that rideshare can supplement public transport and support car-light lifestyles (see above), there is mixed evidence suggesting that ridesharing may act as a substitute for public transport use, under certain conditions.[22] This concern, however, is less acute in India, where reliance on public transport remains relatively low.

This risk can be mitigated further by rideshare platforms and governments working together to establish programs that make ridesharing services an appealing complement to public transport. For example, governments can work with ridesharing platforms to provide commuters with live inter-modal travel data and to establish discounts or pooling schemes for feeder transport to arterial public transport infrastructure.

Utilisation of taxis

The rise of rideshare has been perceived to reduce taxi ridership in some cities. However, Ministers in both Singapore and Malaysia have suggested that rideshare has served as a positive complement to taxis, particularly in peak hours.[23, 24, 25]

"In the morning peak hours where we have an inadequate supply of full-time taxi drivers, many of the commuters' interests are served because there are supplementary drivers that

come in the form of Uber and Grab, and these are mostly part time drivers"

– Minister of Transport, Singapore

*"Instead of seeing the e-hailing companies as the new "taxi industry", I prefer to look at it in a way where **both services can co-exist.** Each has its own goals… 59% of e-hailing application users have never hailed a taxi before this"*

– Minister of Transport, Malaysia

Additionally, the emergence of rideshare technologies may have encouraged taxis to adopt more sophisticated technological advancements such as electronic applications, dynamic pricing and smart supply-demand matching tools—enhancing their competitive position and ultimately benefitting commuters. Furthermore, in Sydney, Australia, taxi ridership has grown since the entrance of rideshare, suggesting that the risk of disruption to taxis is uncertain and market specific.

Governments can also play a role in ensuring that taxi companies improve their competitive position, while offering commuters better outcomes. For example, taxis should be able to access the same technologies available to ridesharing vehicles. Both taxis and private vehicles can form part of the flexible supply base necessary to realise the congestion benefits outlined above. In particular, governments should ensure that taxis can use apps to connect with passengers, while ensuring that taxis can avail themselves of supply-demand matching mechanisms including dynamic pricing.

Partnerships between rideshare platforms and taxi companies can also benefit taxi drivers. Recent examples of partnerships between rideshare platforms and taxi companies include UberTAXI in Taiwan, UberFLASH in Malaysia and Grab's partnerships with multiple Singaporean and Vietnamese taxi companies. These partnerships promise to benefit taxi drivers by offering them access to technology which may allow more responsive matching of supply to demand, thereby increasing vehicle utilisation and ridership. They may also benefit drivers by offering them access to large networks of potential passengers.

In India, Uber collaborated with Kaali Peelis taxis in Mumbai to pilot usage of the rideshare app among Kaali Peelis drivers. The sandbox experiment yielded strongly positive results as drivers using the app were able to record 30% higher efficiency (in terms of total KMs travelled per hour) compared to the control group, resulting in 44% income uplift per hour.[24]

The demand for transport will continue to grow across Asian cities, leading to opportunities for incumbent transport models to evolve and for new transport models to enter—ultimately leading to better transport outcomes for commuters.

DYNAMIC PRICING TO EFFECTIVELY MATCH DEMAND AND SUPPLY

Dynamic pricing has long been used in the airline industry. However, technological advancement has allowed it to be widely adopted in other areas of transportation planning, such as highway toll roads and parking fees. Closer to home, the Indian Railways is also considering a flexi-fare system. Usage of dynamic pricing has been

Both taxis and private vehicles can form part of the flexible supply base necessary to realise the congestion reduction

shown to not only effectively regulate demand, but to also improve the utilisation of resources. For example, within the first 3 months of using dynamic pricing for its parking space, Los Angeles city recorded an overall decrease of ~11% in hourly rates, ~2% increase in revenues, ~10% less parking congestion and ~5% more occupancy of previously under-utilised space.[26]

Within the ridesharing industry, dynamic pricing has been the underlying mechanism through which driver supply can respond flexibly to variable passenger demand. It also promotes accessible pricing, since passengers do not need to cross-subsidise vehicles for their idle time. Nonetheless, as ridesharing continues to evolve globally, its use of dynamic pricing, specifically the level of surge imposed, has met with debates.

Published literature on this topic is understandably sparse (considering its emerging nature and there is not yet conclusive evidence on the exact ways that dynamic pricing affects behaviour of drivers and commuters). For example, Diakopoulos (2015) suggested that surge prices draw existing drivers to high demand areas, rather than increase the number of active drivers on the road as usually claimed. Nevertheless, most studies agree on the positive effect that dynamic pricing has in addressing peak demand while keeping acceptable service levels.[27]

Hall, Kendrik and Nosko (2015), showed that dynamic pricing helped rideshare, specifically Uber, in New York City, to effectively match demand-supply while maintaining required service levels. Comparing similar peak events, when surge prices worked as intended (e.g. after a sold-out concert in Madison Square Garden), there was a rapid increase in active drivers within the applicable areas, matching that of demand (~2x increase). This kept customers' waiting time at normal level, averaging 2.6 minutes, and 100% ride completion rate.

On the other hand, this efficiency was lacking when surge prices failed (e.g. New Year Eve 2014-2015 during 26-minute surge pricing outage). The completion rate of rides dropped drastically to ~10% at the lowest point (compared to 100% in earlier example). Waiting time also increased to 6 minutes at peak, more than 2 times the normal level.

Similar patterns were observed in Indian cities when state governments enforced ceilings for surge prices. For example, in Bangalore, as a result of regulatory reform, Uber imposed a ceiling on its surge prices starting from the night of May 30th, 2016. While average demand levels did not differ significantly before and after this surge ceiling introduction, the average estimated arrival time (i.e. customers' waiting time to be picked up) increased for both UberPool and UberGo services (two of its most popular services by volume of rides) in the subsequent 10 day period. The increase in waiting time was lower for UberGo, potentially due to its higher volume. However, waiting time during high-demand hours (i.e. top 3 hours each day with the most number of booking requests) increased significantly, by 12% and 15% for UberGo and UberPool, respectively.

The impact on the level of unmet demand (i.e. level of booking requests unfulfilled) was even more acute. Average level of unmet booking requests during high-demand hours increased by more than 3 times, in the 10 days after surge ceil-
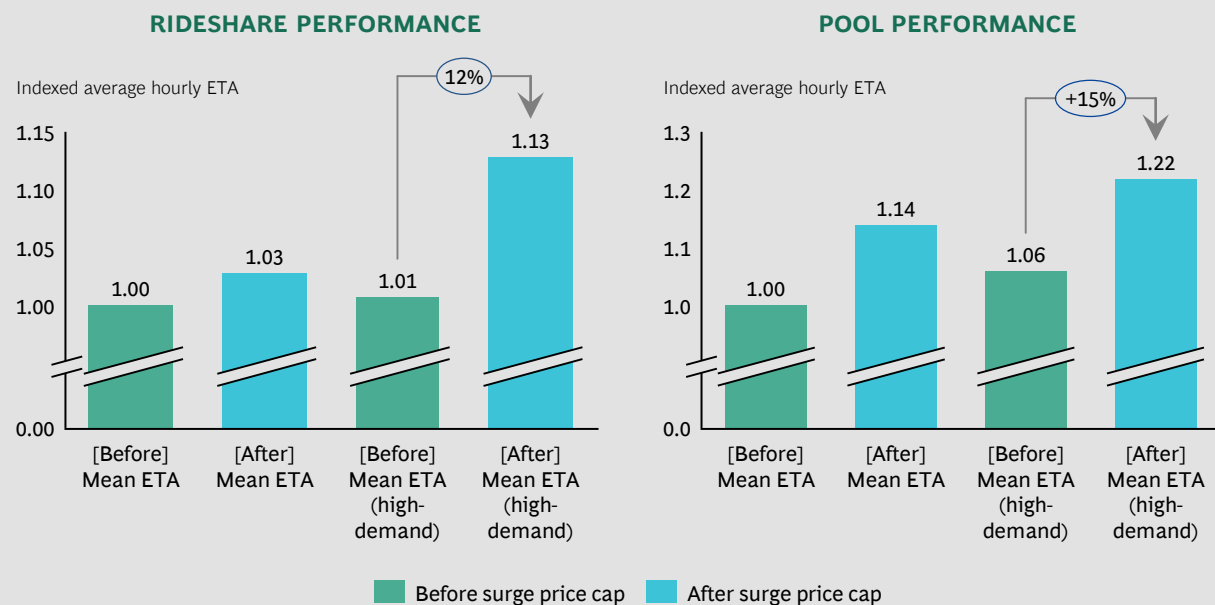
ing was introduced. This staggering increase occurred despite Uber's efforts to temporarily raise incentives for drivers during that period.

Castillo, Knoepfl and Wey (2017) referred to this situation (longer waiting time and high unfulfilled requests) as the "Wild-Goose-Chase" (WGC). Due to a lack of drivers willing to provide services, commuters were matched with those who were far away, resulting in long waiting times and high cancellation rates. This inefficiency is unfavourable for both drivers (waste of time and income) and commuters (long waiting time, high cancellation rate and lower chance of being able to book a ride). Using simulations based on Uber data in Manhattan in 2016-2017, their study showed that the usage of surge pricing is the best method to maximise total welfare.

The same researchers, explored alternatives for rationing demand and supply, all of which resulted in undesirable effects on the whole transportation system. For example, one way to reduce peak demand was randomly denying riders or denying those with long waiting time. This was inefficient compared to a pure price mechanism where drivers match with riders who have the highest willingness to pay. To increase supply, expanding the dispatch radius was considered, though it would lead to higher waiting time, and the possibility of riders being denied a trip during peak hours.

The above evidence, though limited, seems to suggest that dynamic pricing is necessary to enable the full benefits of ridesharing. Restrictions such as surge ceilings appear to immediately lower these benefits to below optimal for both commuters and drivers. Hence, while there have been various debates and regulation changes sur-

EXHIBIT 12 | Customers' Waiting Time Before and After Surge Ceiling Was Introduced

RIDESHARE PERFORMANCE

Indexed average hourly ETA

Category	Value
[Before] Mean ETA	1.00
[After] Mean ETA	1.03
[Before] Mean ETA (high-demand)	1.01
[After] Mean ETA (high-demand)	1.13

12% (from [Before] high-demand to [After] high-demand)

POOL PERFORMANCE

Indexed average hourly ETA

Category	Value
[Before] Mean ETA	1.00
[After] Mean ETA	1.14
[Before] Mean ETA (high-demand)	1.06
[After] Mean ETA (high-demand)	1.22

+15% (from [Before] high-demand to [After] high-demand)

■ Before surge price cap   ■ After surge price cap
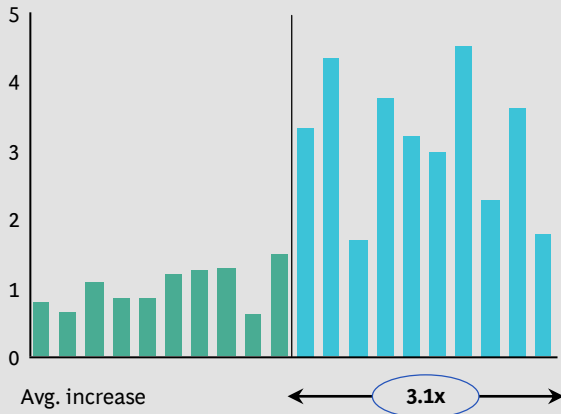
Source: Uber.
Note: Data captures service performance in the period of 10 days before and after May 30th, 2016 9PM, when surge ceiling was introduced in Bangalore; average level of performance was calculated for each period, and indexed with 1 = average level of performance in the 10 days before surge prices were capped. High demand hours are defined as the top 3 hours within each day based on total booking request.

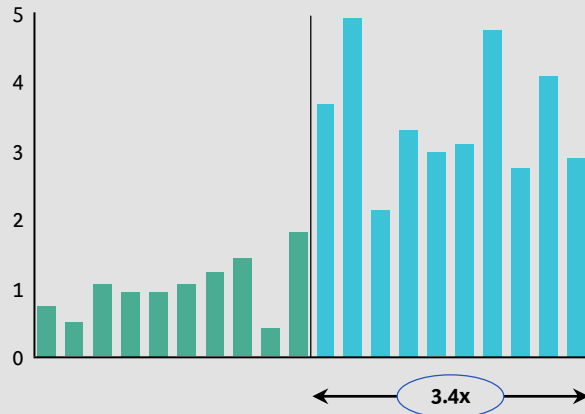**Exhibit 13 | Level of Unmet Booking Requests Before and After Surge Ceiling Was Introduced**

RIDESHARE PERFORMANCE

Indexed level of booking request un-fulfilled during high-demand hours

Avg. increase — 3.1x

POOL PERFORMANCE

Indexed Level of booking request un-fulfilled during high-demand hours

3.4x

Before surge price cap   After surge price cap

Source: Uber.
Note: Data captures service performance in the period of 10 days before and after May 30th, 2016 9PM, when surge ceiling was introduced in Bangalore; average level of performance was calculated for each period, and indexed with 1 = average level of performance in the 10 days before surge prices were capped. High demand hours are defined as the top 3 hours within each day based on total booking request.

rounding this topic in India, we believe that re-examination of current regulations to allow for more liberal pricing is required in order to maximise public benefits.

In the case of ridesharing, this review and revision process would be most effective if the government and the industry were to closely collaborate. While state government could be more open to reviewing and adjusting current rules, industry players could supply them with the necessary data enabling effective decision making.

The Path Forward: Realising the Benefits of Ridesharing

Ridesharing has the potential to support the growth in transport needs across Indian cities in a more sustainable and efficient manner than that of private car ownership. However, both the rideshare ecosystem and public sector must play a role to realise this outcome. Most importantly, more open discussions are needed between regulators and rideshare industry, to continuously refine current legal frameworks and fully realize rideshare benefits.

SUPPORT NEEDED FROM PUBLIC SECTOR

Regulatory restrictions for ridesharing vary across Indian states, with some cities adopting a more open market position, and others imposing explicit restrictions. While these regulations reflect differing circumstances across cities, a more open stance would be needed if ridesharing platforms are to achieve the improved levels of service that would encourage higher adoption:

- **Vehicle supply and driver qualification restrictions:** Placing limits on rideshare may inhibit adoption as ridesharing platforms may be unable to meet the levels of availability and timeliness that will encourage adoption and drive substitution of private vehicles. For example, driver licensing and permit regulations could be more consistent and streamlined among states. The July 2017 Supreme Court judgement has ruled that drivers with Light Motor Vehicle (LMV) license may drive commercial vehicles of 60 LMV class and below. However, many states still differentiate between private and commercial drivers, and hence, require a one-year mandatory period for conversion. This can significantly lower the ability of rideshare services to scale up its driver base and reach the optimal service level. Besides this long accreditation process, additional barriers exist in the form of drivers' geographical knowledge requirement, and restrictive vehicle requirement.

- **Price controls:** Price is an important characteristic of the ridesharing model. It encourages flexible driver supply to meet peaks in demand, which in turn impacts rideshare availability and travel time. Price also helps manage commuter demand—encouraging commuters to travel outside of peak demand periods, whenever possible. While price caps were historically instituted for commuter-protection in certain traditional transport models, they also inhibit a key ridesharing mechanism which helps to dynamically and responsively match supply with demand.

- **Barriers to application usage:** Mobile applications are essential to enable ridesharing platforms to dynamically match supply with demand and to ensure that commuters can connect with these services easily. Restrictions on the use of applications (e.g. pooling feature) can significantly limit the benefits of ridesharing.

Regulatory restrictions for ridesharing vary across Indian states, with some adopting a more open position, and others imposing explicit restrictions

ACTIONS NEEDED FROM RIDESHARING ECOSYSTEMS

Greater willingness for commuters to adopt ridesharing, specifically pooling, is essential to achieve the benefits of ridesharing. Enhanced prices, availability and more attractive travel times can help encourage adoption.

- **Price:** Across the cities surveyed, approximately 82% of non-rideshare users cite prices as a key deterrent. The majority of respondents indicate that prices must be at least 25% lower than their current preferred mode of transport to make them consider pooling.

- **Availability:** Rideshare availability is critical to higher adoption as lower availability can translate to longer wait times or difficulty in securing transport when it is needed. Lower than desired availability is cited by around 59% of respondents as a key barrier. Across cities, respondents note that pooling services must be at least as easily available as their current preferred mode of transport to encourage them to adopt the method.

- **Travel time:** Similarly, 69% of the respondents indicated longer commute times as being a deterrent.

Consequently, raising ridesharing service levels is essential to encourage greater adoption. While ridesharing platforms must enhance their pooling products, improved regulatory conditions can also aid rideshare platforms to achieve their desired outcomes.

COLLABORATION NEEDED BETWEEN GOVERNMENTS AND RIDESHARE ECOSYSTEM

Greater collaboration between government agencies and ridesharing platforms is needed to encourage modality shifts from less efficient modes of transport (e.g. private cars) to ridesharing. This substitution is essential to create net-positive benefits to congestion. Such collaborations are showing promise in a number of US cities. For example, Uber has partnered with the transit authorities in Atlanta, Los Angeles and Minneapolis, to provide a discount to commuters - using Uber to complement public transport. Programs such as Guaranteed Ride Home in Washington DC offer commuters who regularly use pooling (twice a week), reimbursement for emergency travel outside of peak hours. Collaborations like these can provide important incentives to commuters to adopt ridesharing in conjunction with public transport and to maximise the benefits of both transportation networks.

Ridesharing has the potential to positively impact the transport environment across India. Substantial growth in adoption is necessary in all cities, if benefits are to be realised on a sustained basis. A combination of improved service offerings from ridesharing platforms as well as support from state and regional regulators would be required.

NOTES
1. World Bank Database, retrieved January 15th, 2018
2. Based on indexed population and GDP per capita (constant) growth from 1980-2016 for Asian countries among top 100 GDPs in world
3. Delhi traffic chaos costs Rs 60,000 crore annually, Times of India, 2017
4. World Bank Global Infrastructure Outlook database, retrieved January 20th, 2018
5. Defined by modality share by passenger-km
6. Delhi government statistic, retrieved January 15th, 2018
7. Le Vine & Polak, 2017
8. Hampshire, Simek, Fabusuyi, Di, & Chen, 2017.
9. During this period, other rideshare platforms continued to operate within Austin. The portion of former Uber and Lyft customers who migrated to these alternative platforms is roughly the same as the portion that migrated to cars (roughly 40%).
10. Feigon and Murphy, 2018
11. Feigon and Murphy, 2018
12. Anggun Wijaya, 2016; Tempo.co, 2016
13. Hanna, Kreindler, & Olken, 2017
14. Lyft Blog,2015; Uber Data, 2017
15. San Francisco County Transportation Authority and Northeastern University, 2017
16. Shared mobility and the transformation of public transit, Feigon, Murphy, 2016. Shared mobility defined as public transit, bike sharing, car sharing, ridesharing, and similar modes
17. Feigon and Murphy, 2018
18. San Francisco County Transportaton Authority, 2017; Schaller, 2017
19. Hall and Krueger, 2016
20. Farrell and Greig, 2016a.

21. More tertiary students driving for Uber, Grab, The Straits Times Singapore, 2016

22. For example, in the US, according to the National Academy of Sciences study of shared mobility users referenced earlier, 43% of individuals reported an increase in their use of public transport, while only 28% of individuals reported using public transport less. However, a study from UC Davis Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States (October 2017) suggest that ridesharing may decrease use of bus and light-rail services by 6% and 3% respectively in several major metropolitan US cities.

23. The Straits Times Feb 2017, Abdullah; 967,000 taxi trips daily in 2013 to 954,000 trips daily last year (2016)

24. Don't stop taxi industry from adapting to competition: Ng Chee Meng; Channel News Asia, 2017

25. Both e-hailing and taxi services can coexist', Liow, The Star, 2017.

25. Kaali Peelis and the rideshare experience, Uber, 2017

26. Diakopoulos, 2015, Hall, Kendrik and Nosko, 2015 and Castillo, Knoepfl and Wey, 2017.

27. Xerox Smart Grid credential, retrieved January 15th, 2018

Appendix: Detailed Methodology

The focus of this report is to assess the potential benefits of ridesharing on key Indian cities. We have conducted both qualitative and quantitative analysis to reach our conclusions.

ANALYSIS CONDUCTED

1. Qualitative research:
   The qualitative research conducted as part of this report takes two primary forms:

   – **BCG survey of commuter sentiments in cities:** The objective of these surveys was to develop an understanding of commuter satisfaction with existing transportation options, their reasons for using or not using rideshare and pooling, their likelihood to adopt these methods, the impact of ridesharing on car ownership, and commuter desire to become rideshare drivers.

   – **Literature review of recent ridesharing studies:** We studied these to understand and compare the benefits and key conditions which must exist for cities to achieve net positive benefits of ridesharing and pooling

2. Quantitative research:
   The quantitative research conducted as part of this report was used to model the potential benefits provided by ridesharing and pooling under different adoption scenarios

1A. BCG SURVEY OF COMMUTER SENTIMENTS IN CITIES

SURVEY METHODOLOGY

In January 2018, we surveyed commuters across Delhi, Mumbai, Bangalore and Kolkata, covering approximately 300 commuters per city. The commuters surveyed used a wide range of transportation.

KEY SURVEY FINDINGS

Finding 1: Rideshare represents a relatively small proportion of modality
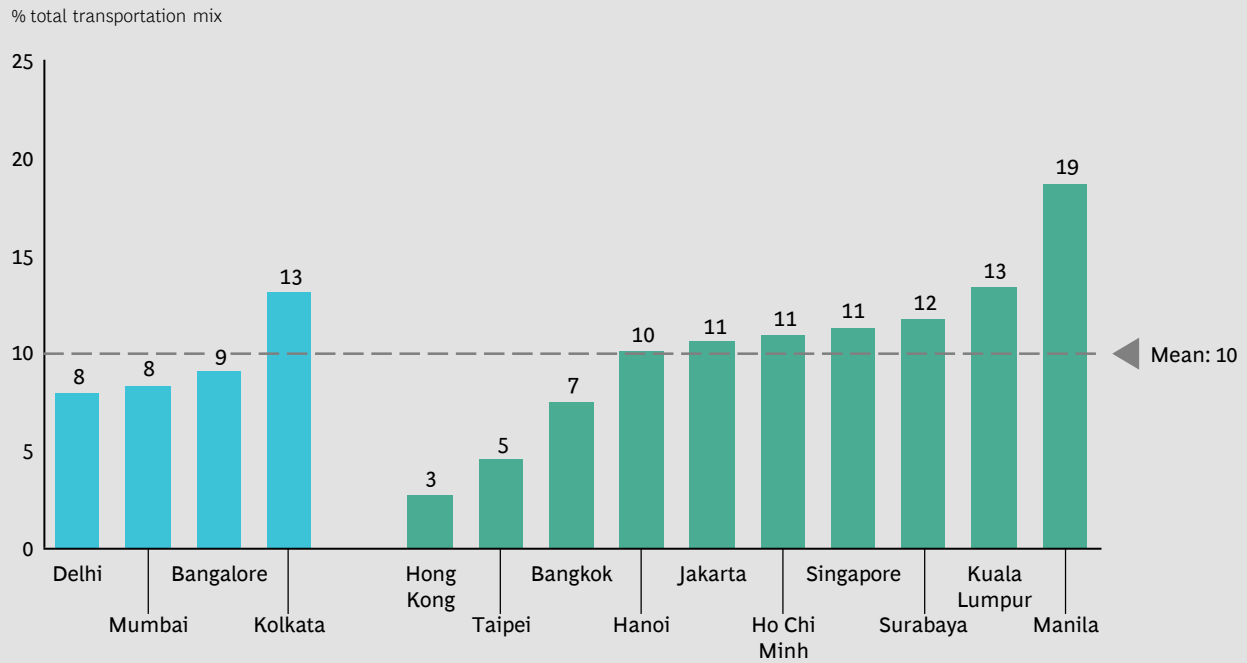
Our results suggest that, rideshare represents an average of 10% of transport used in the four Indian cities surveyed. These results support our quantitative assessment that rideshare adoption is in its nascent stages.

Finding 2: Commuters cite price as the strongest factor inhibiting rideshare adoption

We surveyed current non-users of rideshare, in a bid to understand their key reasons for avoiding this mode of transport. In all cities surveyed, respondents cited relatively higher price of rideshare when compared to their primary mode of transport, as the strongest reason. At the other end of the spectrum, awareness of rideshare offerings was seen as the least severe inhibitor to rideshare adoption.
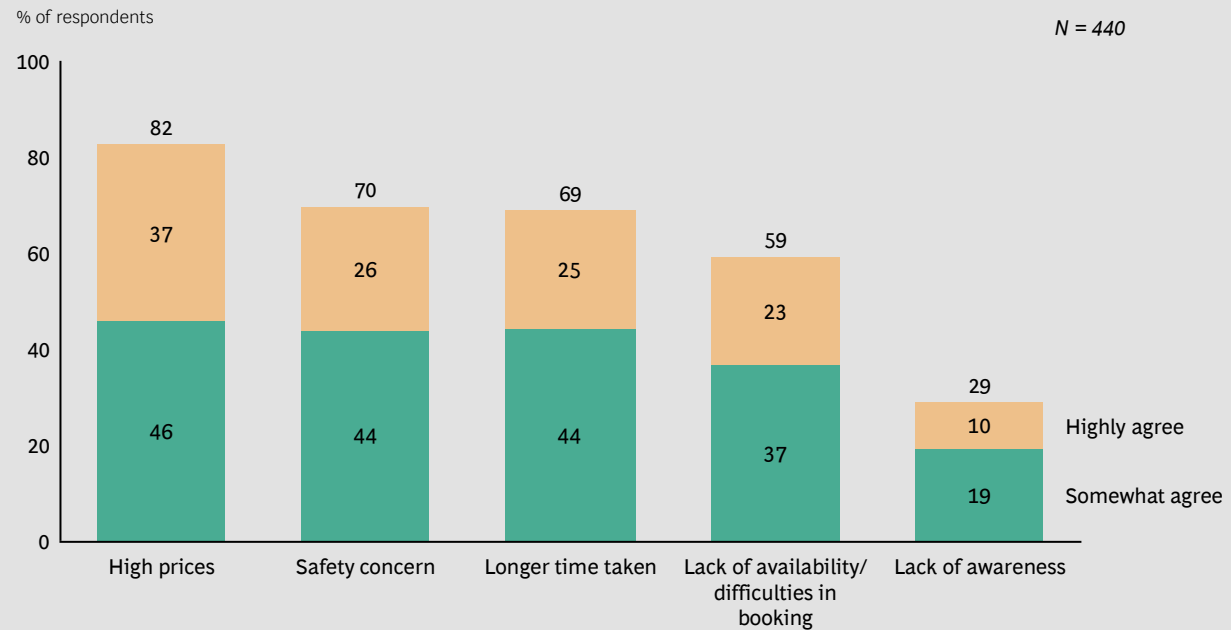
Appendix Exhibit 1 | Percentage of Respondents Who Use Rideshare

% total transportation mix

Bar chart values:
- Delhi: 8
- Mumbai: 8
- Bangalore: 9
- Kolkata: 13
- Hong Kong: 3
- Taipei: 5
- Bangkok: 7
- Hanoi: 10
- Jakarta: 11
- Ho Chi Minh: 11
- Singapore: 11
- Surabaya: 12
- Kuala Lumpur: 13
- Manila: 19

Mean: 10

Source: BCG survey.

Appendix Exhibit 2 | Reasons Cited for not Adopting Rideshare in Comparison to Respondent Preferred Mode of Transport

% of respondents

N = 440

Stacked bar chart values (Somewhat agree / Highly agree):
- High prices: 46 / 37 = 82
- Safety concern: 44 / 26 = 70
- Longer time taken: 44 / 25 = 69
- Lack of availability/ difficulties in booking: 37 / 23 = 59
- Lack of awareness: 19 / 10 = 29

Highly agree
Somewhat agree

Source: BCG survey.

Finding 3: Majority of respondents state that improvements in price, availability and travel time relative to their current primary mode of transport, are necessary for them to adopt pooling

In the majority of cities surveyed, two-thirds of current non-users state that they would be willing to adopt pooling if price, availability or speed worked out to be better than that of their most preferred mode of transportation.

Key Finding 4: Commuters show high willingness to decrease car ownership if desired rideshare service levels can be met

BCG surveyed the likelihood of commuters to purchase a car in the next 5 years. Overall, commuters in all four cities indicated high intentions to purchase, averaging at 87%. This relatively high probability can be attributed to the cities' increasing wealth and the fact that cars are considered to be a symbol for success.

We also observed the stated willingness of participants to forgo the purchase of a car in the event that ridesharing providers achieve their desired levels of service. The results indicate that, on average, 80% of respondents who previously indicated plans to purchase a car were either highly willing or somewhat willing to abort their purchase plans. This pattern is similar to the results that we had observed in other South East and East Asian cities where congestion is a major concern.

Key Finding 5: Majority of drivers are willing to consider driving for rideshare to supplement income

While the aforementioned topics primarily concern consumer behaviour as it relates to rideshare, of equal importance is the supply of individuals willing to work as rideshare drivers and the incentives that drive that behaviour.

Overall, across the cities studied, 69% of respondents either somewhat or highly agreed with the statement that they would be willing to use their own cars to work as rideshare drivers. Enthusiasm for driving was highest in Kolkata at 77%, whereas the level of willingness ranges from 65-69% in the other three cities.

1B. LITERATURE REVIEW
Due to the relatively nascent nature of ridesharing in Asia, BCG reviewed studies which assessed the impact of ridesharing in markets where ridesharing is more common. Our review of this literature surfaced both benefits and key conditions which must be met to achieve net positive benefits. These have been discussed in detail in the main section of our report under the title "Ridesharing and its key benefits".

2. QUANTITATIVE ANALYSIS
The focus of the quantitative analysis is to assess the impact of ridesharing on road congestion under different scenarios of rideshare adoption. We define congestion as the percentage of time difference in travelling during peak and non-peak hours compared to the time it would take to travel the same distance at posted speed limits. We have assessed peak hours at 7-9AM and 6-8pm.
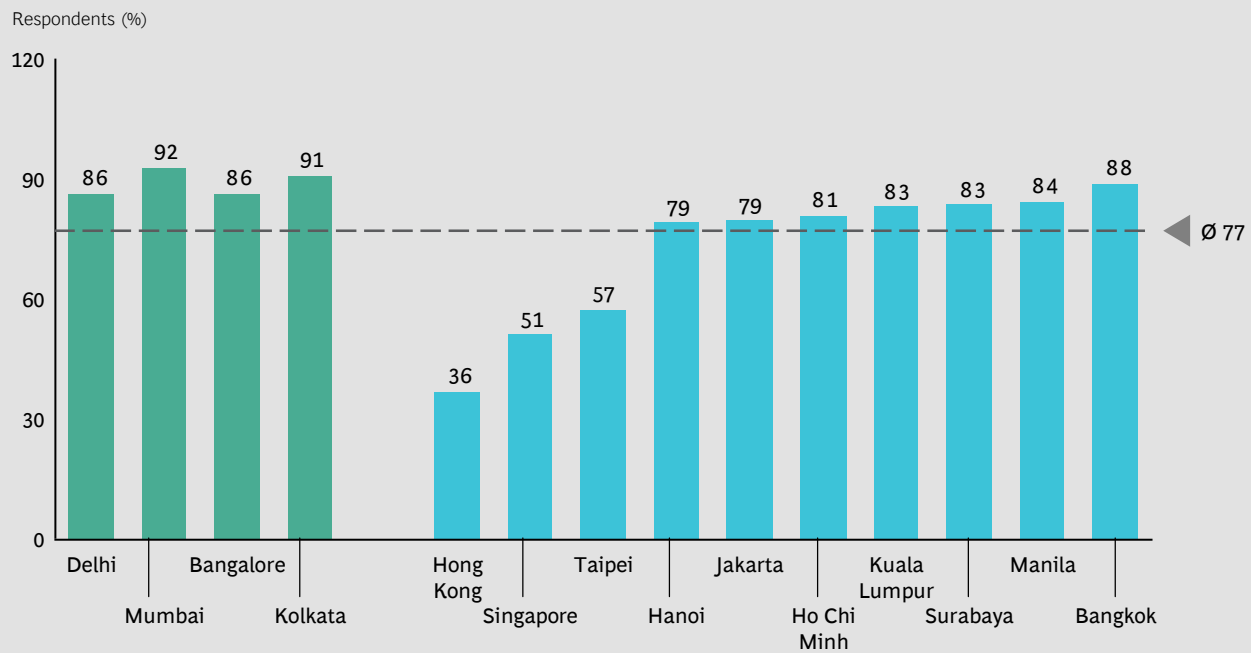
APPENDIX EXHIBIT 3 | Percentage of Respondents willing to try Pooled Private Hire Cars if Compared to Their Most Preferred Mode of Transportation...
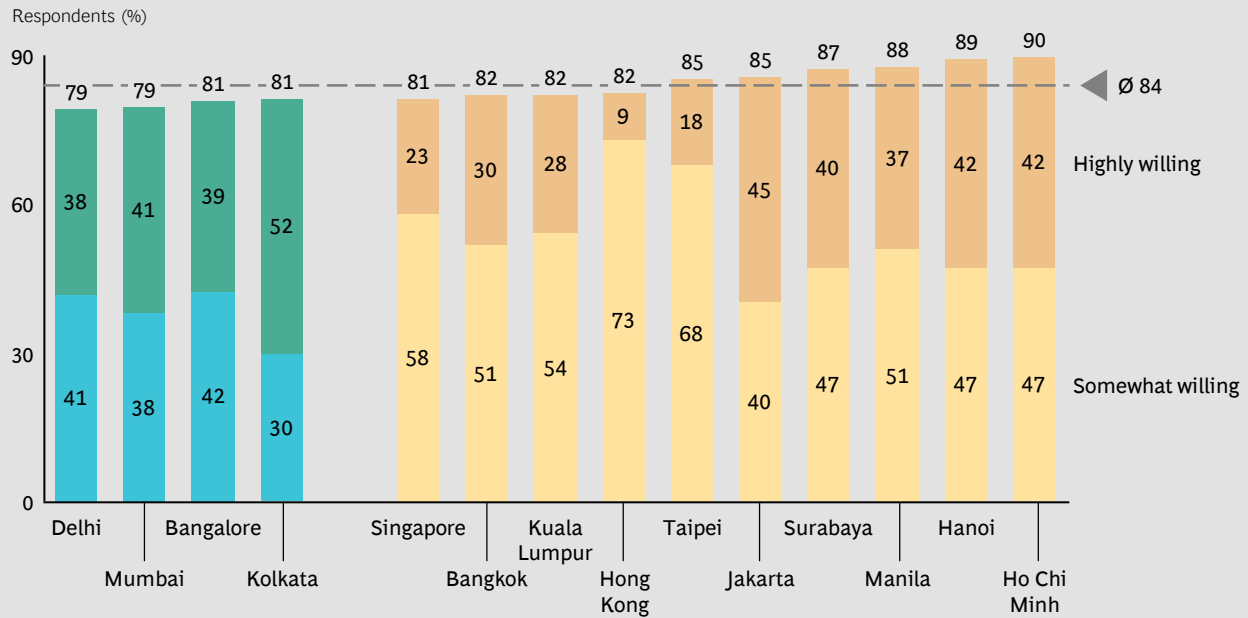
% of respondents

N = 440

Up to 25% cheaper	69
Slightly more easily available	70
Slightly faster	68
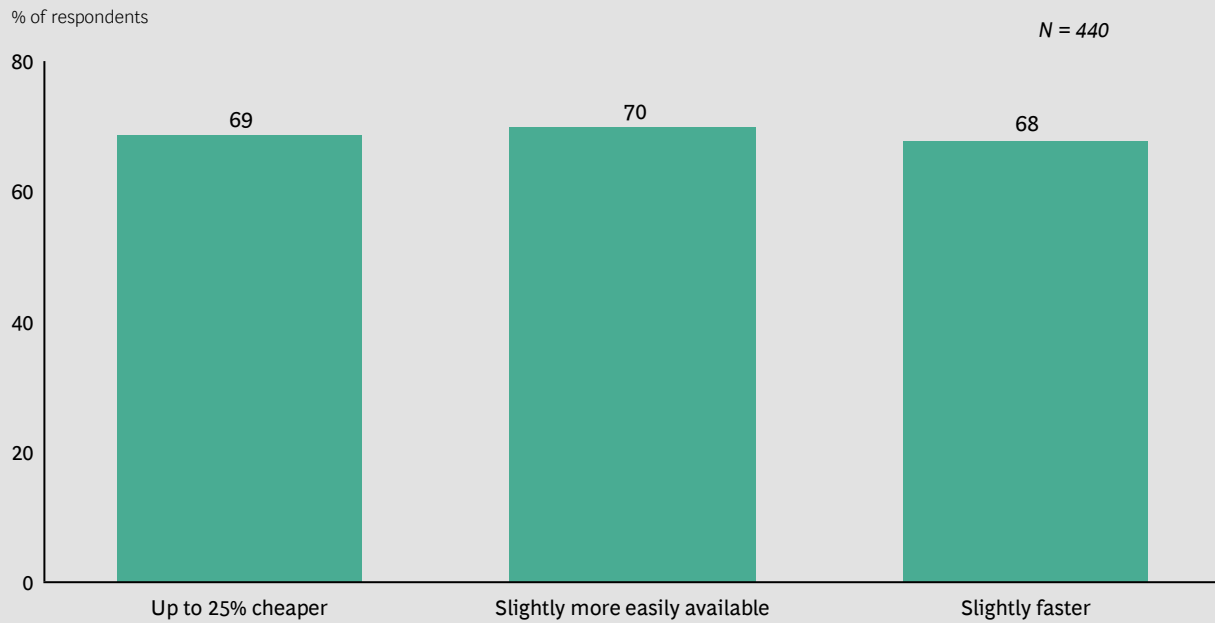
Source: BCG survey.

**APPENDIX EXHIBIT 4 | Percentage of Respondents Who Plan to Buy a Car Within the Next Five Years**

Respondents (%)

Ø 77

City	%
Delhi	86
Mumbai	92
Bangalore	86
Kolkata	91
Hong Kong	36
Singapore	51
Taipei	57
Hanoi	79
Jakarta	79
Ho Chi Minh	81
Kuala Lumpur	83
Surabaya	83
Manila	84
Bangkok	88

Source: BCG survey.

APPENDIX EXHIBIT 5 | Willingness for a Planned Car Buyer to Forego Purchase, Provided Rideshare Meets Desired Levels of Availability, Price, Timeliness

Respondents (%)

Source: BCG survey.

APPENDIX EXHIBIT 6 | Percentage of Respondents Willing to Drive for Rideshare

Respondents (%)

Source: BCG survey.
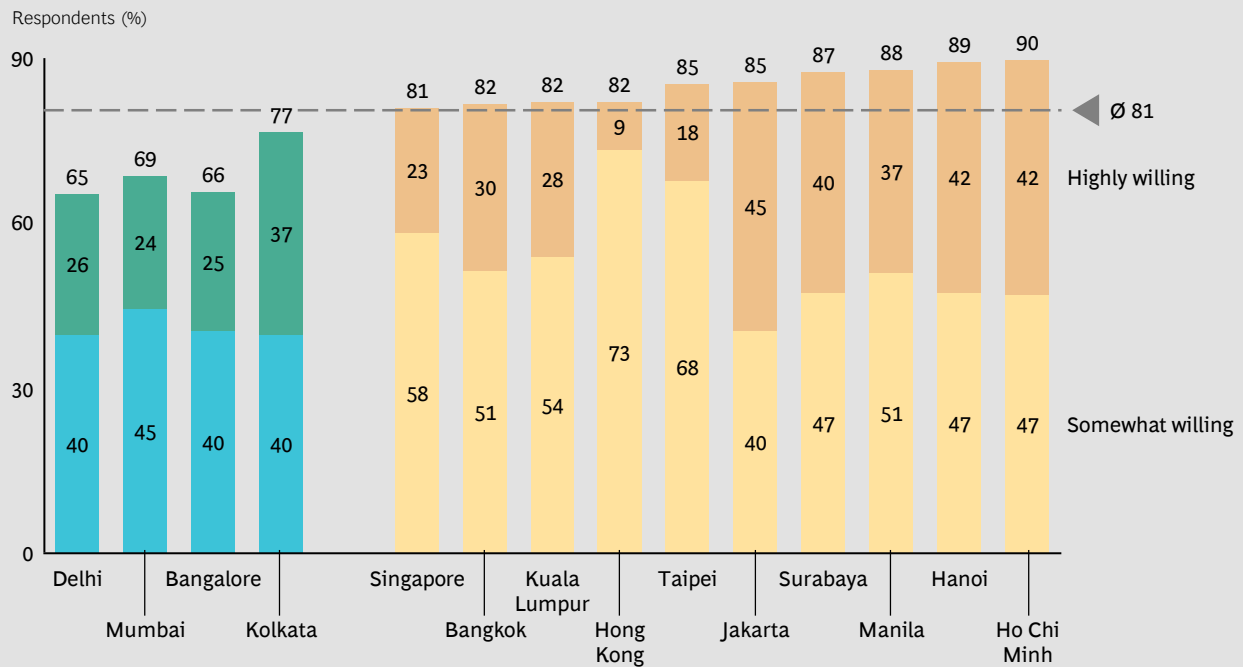
Road congestion is driven by a set of elements:

1. Travel speed (actual and speed limit)

2. Road capacity in terms of number of total vehicles on the road

3. Traffic volume on road during the defined periods (peak, non-peak hours)

Further details on each metric are below:

Key Findings for 2017 baseline

Road congestion in peak hours among the Indian cities studied averages at 149%, significantly higher than those of South East Asian and East Asian cities. This means that, on average, commuters take 1.5 times longer to travel a given distance in peak hours compared to travel time during non-peak hours.

Public transport adoption, particularly rail, is key to managing road congestion. However, the share of transportation kilometres conveyed by public transportation remains relatively small in Delhi and Bangalore. Mumbai and Kolkata have a higher modality share of public transportation. However, the crippling infrastructure in these cities coupled with limited capacity to scale, results in high levels of congestion.
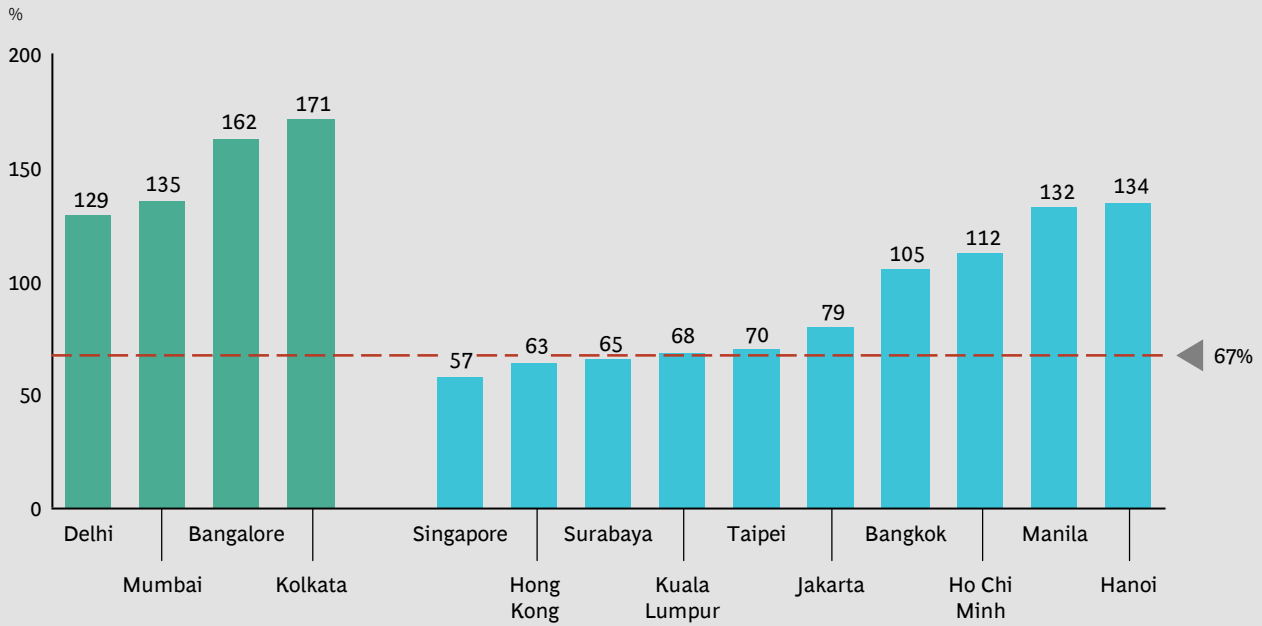
Appendix Exhibit 7 | Road Congestion Driver Tree
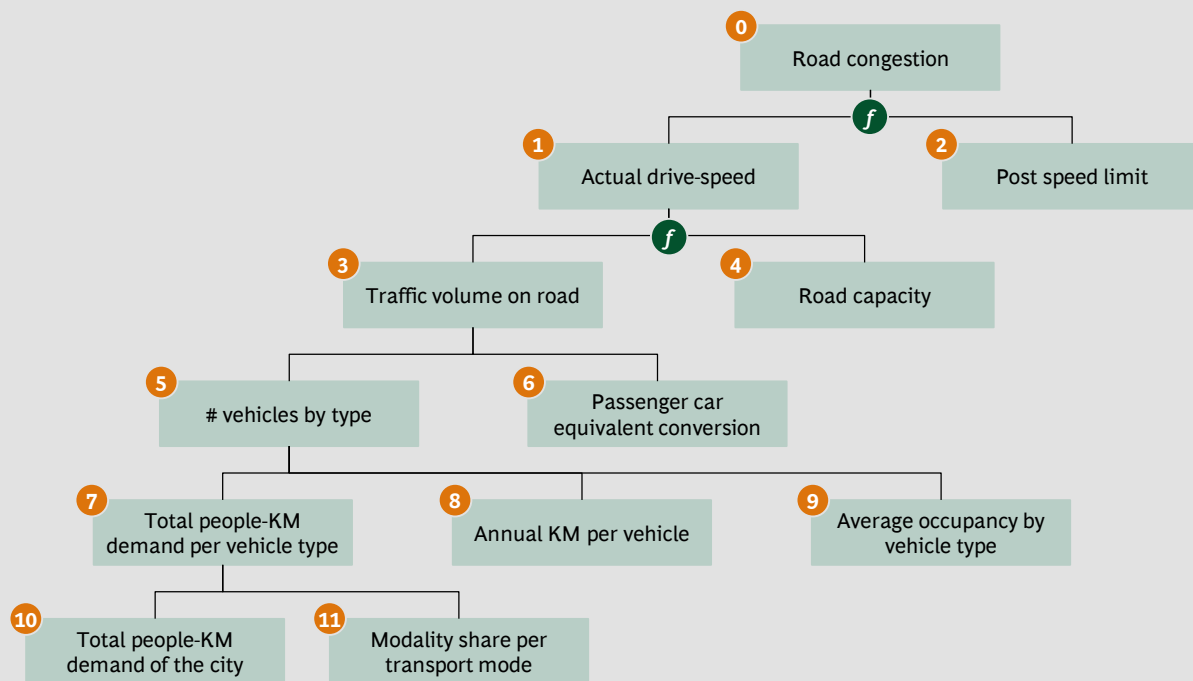
Source: BCG survey.

Appendix Exhibit 8 | Road Congestion Driver Tree Description

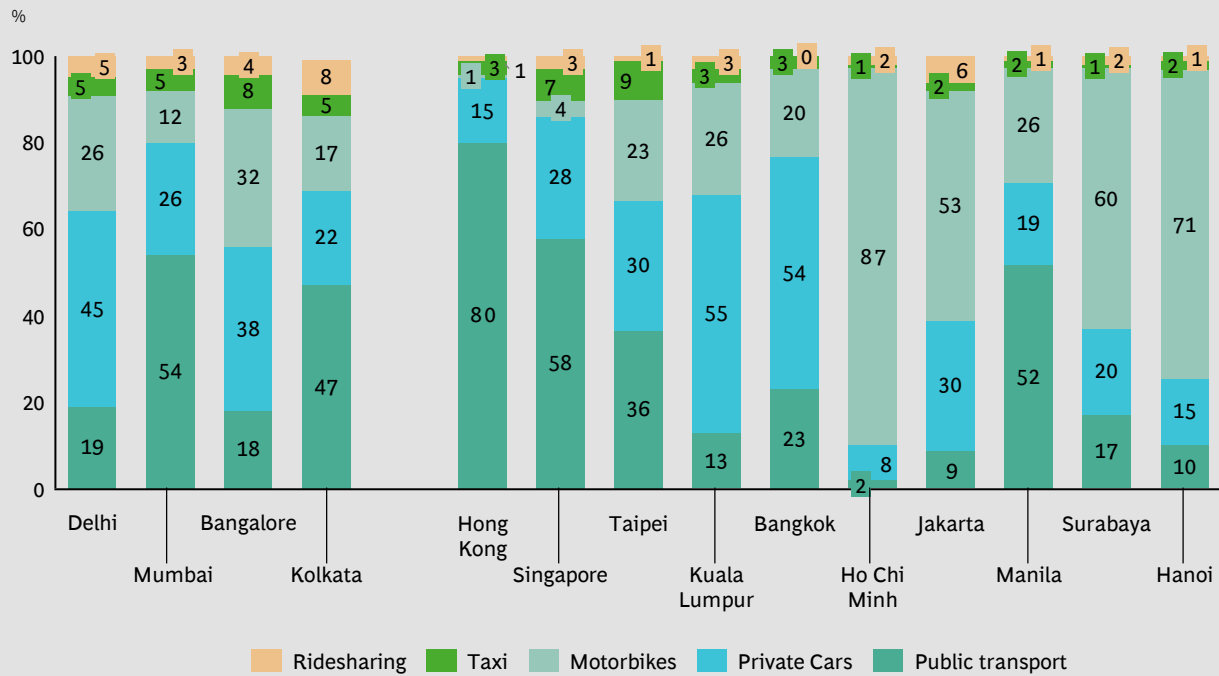| Metrics	Description	Data Source
0 **Road congestion**	• % of additional travel time on average in peak, non-peak hours, when compared to driving at post speed limit	• Tom Tom Traffic Index • Government statistics
1 **Actual drive speed**	• Actual drive speed of vehicles on the road in peak, non-peak hours	• Tom Tom traffic data • Google Map API • Government statistics • UBER travel data
2 **Post speed limit**	• Post speed limits on highways, urban roads per city	• Government data • Press search
3 **Traffic volume on road**	• Total traffic measured in passenger car equivalent units on the road in peak, non-peak hours	• Academic studies on Transportation Engineering • Government statistics • UBER data
4 **Road capacity**	• Estimated number of vehicles (in passenger car equivalent units) that a single lane can throughput by type of road • Highway: 2000 vehicles/link/lane • Urban road: 1200 vehicles/link/lane	• Expert interviews on typical design throughput per lane by type of road
5 **# vehicles by type**	• Number of vehicles by type: private cars, buses, taxi, motorcycles, ridesharing cars and etc.	• Government statistics • UBER data
6 **Passenger car equivalent**	• Vehicle units used to convert different types of vehicles to standard car unit based on the size/volume taken of a vehicle on the road	• Academic studies on Transportation Engineering • Expert interviews
7 **Total people-KM demand per vehicle type**	• Total distance travelled by the population using each of the modes of transport	• Government statistics • Survey
8 **Annual KM per vehicle**	• Average total kilometers travelled annually per type of vehicle (private car, taxi, motorcycles and ridesharing car)	• Government statistics • Survey
9 **Average occupancy by vehicle type**	• Average number of people in a vehicle per trip	• Government statistics • Survey • Expert interviews
10 **Total people-KM demand of the city**	• Total distance travelled by all modes of transport by total population of the city	• Government statistics
11 **Modality share per transport mode**	• % of KMs travelled by each mode of transport	• Government statistics

Source: BCG survey.

APPENDIX EXHIBIT 9 | Current Road Congestion during Peak Hours across Cities in 2017

%

Values by city:
- Delhi: 129
- Mumbai: 135
- Bangalore: 162
- Kolkata: 171
- Singapore: 57
- Hong Kong: 63
- Surabaya: 65
- Kuala Lumpur: 68
- Taipei: 70
- Jakarta: 79
- Bangkok: 105
- Ho Chi Minh: 112
- Manila: 132
- Hanoi: 134

Reference line: 67%

Sources: TomTom traffic index; Google API; Uber; Government statistics; BCG analysis.
Note: Asia average taken from average of East Asian cities based on TomTom traffic index.

APPENDIX EXHIBIT 10 | Current Mileage Modality Share by Vehicle Type in 2017

%

City	Ridesharing	Taxi	Motorbikes	Private Cars	Public transport
Delhi	5	5	26	45	19
Mumbai	3	5	12	26	54
Bangalore	4	8	32	38	18
Kolkata	8	5	17	22	47
Hong Kong	1	3	1	15	80
Singapore	3	7	4	28	58
Taipei	1	9	23	30	36
Kuala Lumpur	3	3	26	55	13
Bangkok	3	0	20	54	23
Ho Chi Minh	1	2	87	8	2
Jakarta	6	2	53	30	9
Manila	2	1	26	19	52
Surabaya	1	2	60	20	17
Hanoi	2	1	71	15	10

Legend: ▮ Ridesharing ▮ Taxi ▮ Motorbikes ▮ Private Cars ▮ Public transport

Source: Government statistics; press search; commuter surveys; BCG analysis.

While public transportation adoption is strongly linked to reduction of private cars usage, the efficiency of vehicles to provide transportation is also critical. We define efficiency based on the total people-kilometres each vehicle supplies per annum. This metric is driven by the total annual kilometres attributed to each transport mode, the number of vehicles supporting each transport mode in the city, and the average occupancy of each vehicle type, which corresponds to the ridership of that transport mode.

The ability for ridesharing vehicles to provide greater transportation benefits depends on the difference in people-kilometres each rideshare vehicle provides in comparison to other modes of transport. The figure below compares the estimated people-kilometres ratio provided by ridesharing vehicles against private cars in each city. Based on our estimate, ridesharing is between 1.4x-3.3x more efficient than using a privately owned car.

ASSESSMENT OF RIDESHARE BENEFITS IN 2017

In our study, we quantified the number of vehicles that could be taken off the road in a scenario where the most widely owned private vehicles were substituted for ridesharing. For example, in a market where private cars provide the second highest form of modality and ridesharing provides the fifth highest form of modality, we assessed how many vehicles could be saved if ridesharing became the second highest form of modality.

APPENDIX EXHIBIT 11 | Average Annual People-kilometers Travelled Per Vehicle Type With Pooling

RIDESHARE VEHICLES VS. # 1 PREFERRED MODE OF PRIVATELY OWNED VEHICLE (CAR OR MOTORBIKE)
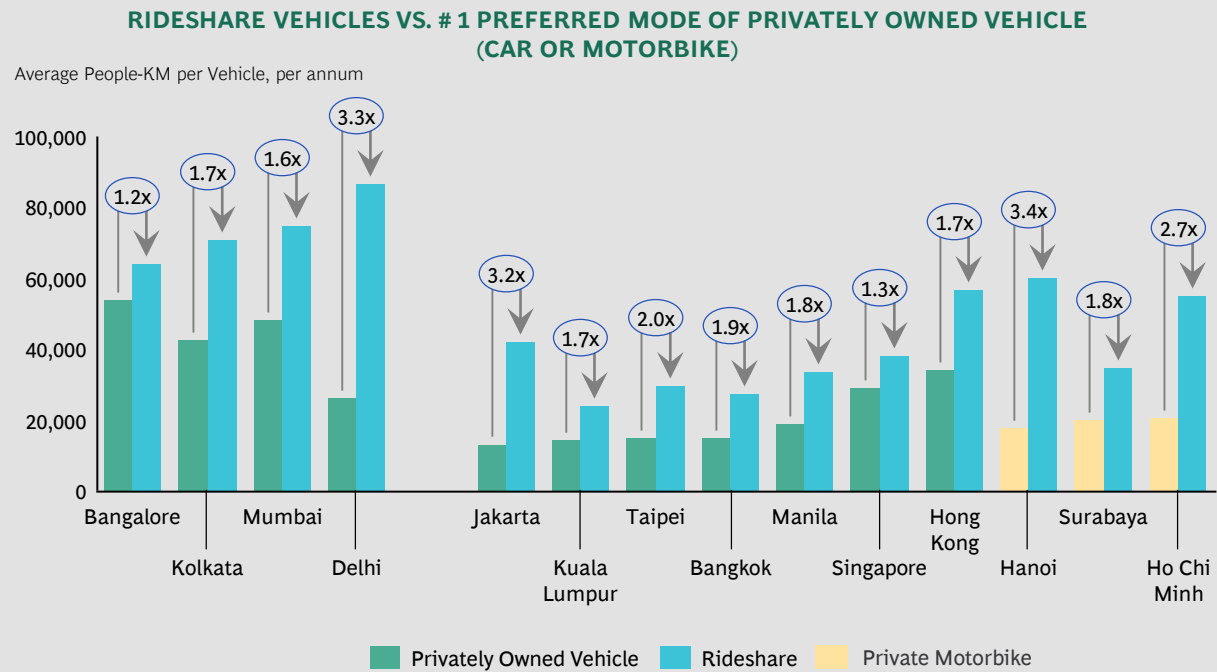
Source: BCG survey.

Under this scenario, ridesharing significantly reduces the number of vehicles required. In cities where private cars comprise the majority of private transport, between ~33%-68% of cars can be removed.

Congestion is predicted to decline from the reduction of vehicles due to rideshare adoption.

ASSESSING THE BENEFITS OF RIDESHARE FOR 2022

To assess the impact of rideshare in 2022, we first estimated the increase in transportation demand between 2017 and 2022. Research by the National Center for Sustainable Transportation, United States (Circella, Tiedeman, Handy, & Mokhtarian, 2015) shows a strong correlation between transportation demand and wealth. It suggests that on a per capita basis, people tend to travel more as their wealth increases. These results are reinforced by BCG research on economic growth and its effect on passenger land transportation in Organisation for Economic Co-operation and Development (OECD) member nations, between 1970 and 2015. Our analysis suggests an approximate 1:0.75 relationship between annual GDP growth per capita and annual growth in land transport passenger kilometres.

The increase in travel demand in the city can potentially be met by a greater adoption of public transportation. Nevertheless, we estimate that the required increase in rail network infrastructure may be greater than the capacity which will be created by 2022 in Mumbai and Bangalore.

APPENDIX EXHIBIT 12 | Percentage of Private Vehicles (Car and Motorcycle) and Total Vehicles Reduced with Rideshare With Pooling
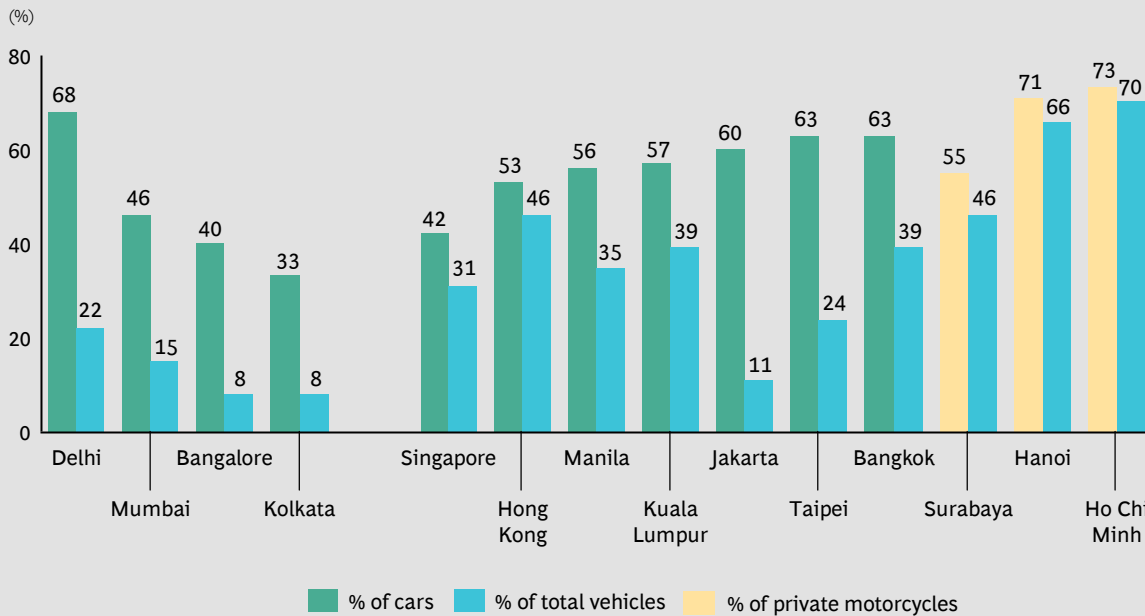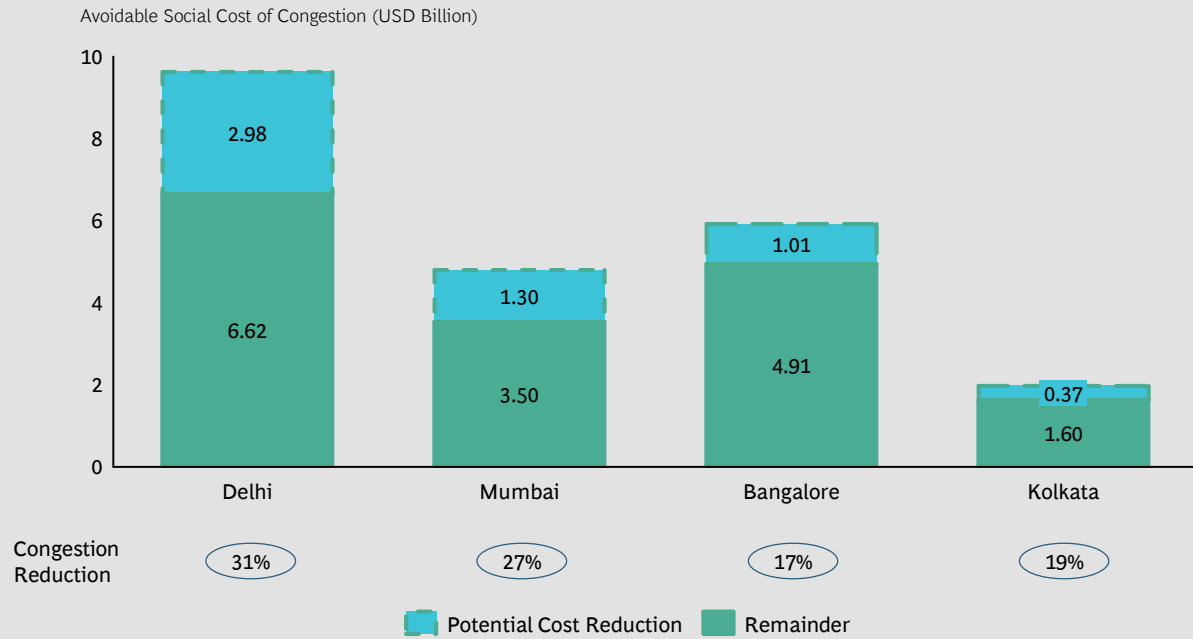
Source: Government statistics; BCG analysis.
1. With rideshare scenario under which ridesharing replaces private cars as the #2 or #3 mode of transport in respective cities and pool constitutes 50% of rides 2. Total number of vehicles includes private cars, motorcycles, buses, taxi and rideshare cars, 3. Total number of cars include private cars and ridesharing cars.

APPENDIX EXHIBIT 13 | Road Congestion During Peak Hours, Before and After Rideshare Impact Under Scenario Where Rideshare Substitutes for #1 Mode of Private Vehicle With Pooling
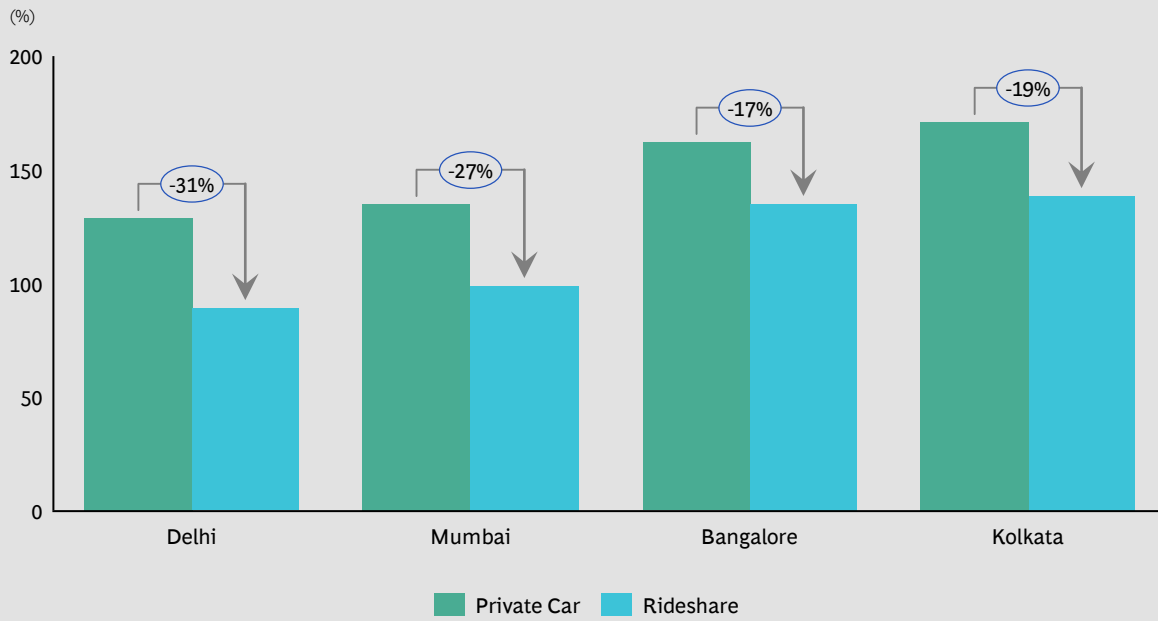
(%)

Legend: ■ Private Car   ■ Rideshare

Delhi: -31%
Mumbai: -27%
Bangalore: -17%
Kolkata: -19%

Source: BCG analysis.
Note: Reductions in congestion based on high-adoption, high-pooling scenario.

APPENDIX EXHIBIT 14 | Estimated reduction in congestion cost with pooling

Avoidable Social Cost of Congestion (USD Billion)

	Delhi	Mumbai	Bangalore	Kolkata
Potential Cost Reduction	2.98	1.30	1.01	0.37
Remainder	6.62	3.50	4.91	1.60
Congestion Reduction	31%	27%	17%	19%

Legend: ■ Potential Cost Reduction   ■ Remainder

Source: Centre for Urban Economic Studies, Department of Economics, University of Calcutta, Kolkata, India; BCG analysis.
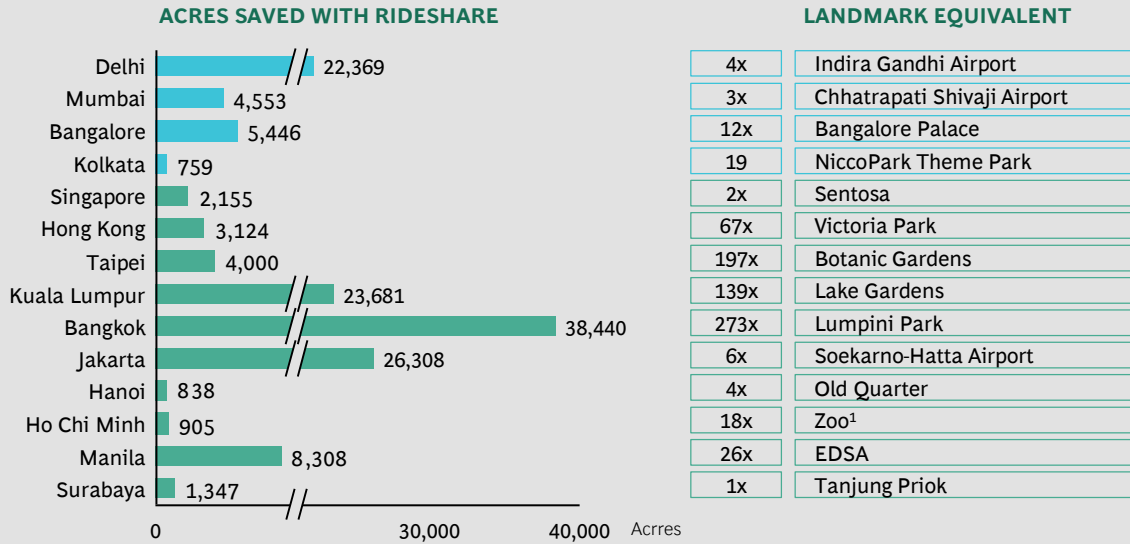
APPENDIX EXHIBIT 15 | Estimated % People-kilometres That Must Be Travelled By Public Transportation to Maintain Congestion Levels vs. Estimated Public Transportation Capacity

% KM travelled by public transport

Chart data (2017 % KM travelled by public transport / 2022 % KM travelled by public transport to maintain current peak congestion):
- Delhi: 19 / 30
- Mumbai: 52 / 65
- Bangalore: 18 / 39
- Kolkata: 46 / 61
- Singapore: 58 / 63
- Hong Kong: 81 / 83
- Taipei: 36 / 40
- Kuala Lumpur: 13 / 26
- Bangkok: 23 / 35
- Ho Chi Minh: 2 / 26
- Manila: 52 / 62
- Jakarta: 9 / 24
- Surabaya: 17 / 29

Legend:
- ▬ Estimated public transport capacity by 2022[1]
- ■ 2017 % KM travelled by public transport
- ■ 2022 % KM travelled by public transport to maintain current peak congestion

Sources: Government announcement on transport infrastructure master plan; BCG analysis.
1. Capacity is estimated based on current rail network and new rail lines/existing line extensions in operation before 2022 in each city: Thomson East Coast Line, Downtown line 3 extension for Singapore; total new railway projects equivalent to 25% of current capacity in Hong Kong; Circular Line stage 1, Anking Line, Danhai LRT, Wanda Line stage 1, Xinzhuang Line extension for Taipei; MRT Line 2 for Kuala Lumpur; 10 new rail lines and 3 existing line extensions for Bangkok; first Metro Line and 3 LRT lines for Jakarta; 6 Metro Rails (total 109 KM) for Ho Chi Minh; 6 new railway lines (total 246 KM) for Manila; one monorail for Surabaya.

APPENDIX EXHIBIT 16 | Estimated Space That Can be Saved by Adopting Rideshare Assuming Rideshare Substitutes for Private Cars

ACRES SAVED WITH RIDESHARE

- Delhi: 22,369
- Mumbai: 4,553
- Bangalore: 5,446
- Kolkata: 759
- Singapore: 2,155
- Hong Kong: 3,124
- Taipei: 4,000
- Kuala Lumpur: 23,681
- Bangkok: 38,440
- Jakarta: 26,308
- Hanoi: 838
- Ho Chi Minh: 905
- Manila: 8,308
- Surabaya: 1,347

(x-axis: 0, 30,000, 40,000 Acrres)

LANDMARK EQUIVALENT

4x	Indira Gandhi Airport
3x	Chhatrapati Shivaji Airport
12x	Bangalore Palace
19	NiccoPark Theme Park
2x	Sentosa
67x	Victoria Park
197x	Botanic Gardens
139x	Lake Gardens
273x	Lumpini Park
6x	Soekarno-Hatta Airport
4x	Old Quarter
18x	Zoo[1]
26x	EDSA
1x	Tanjung Priok

Sources: ASEAN Maritime Working Group, Data.Gov.Sg, FIFA, MapDevelopers/Google Maps, HDB, HK Census and Statistics Dept., LTA, Manila Times, Perdana Botanical Garden, URA, Thanhnien News, The Straits Times, Taipei Botanical Garden, expert interviews, BCG analysis.
Note: Size of local landmarks vary greatly between cities. Area represents estimated total flat area of all parking lots (existing and needed) to serve a city's car population. Area estimated by deriving ratio of cars (private + rideshare) to estimated parking lots in Singapore (~2.2) and then extrapolating this ratio to car populations in other markets. Assumes standard parking lot (19m2), Area saved under hypothetical scenario in which rideshare becomes displaces private vehicles in terms of modal split and 50% of rideshare is pooling.
1. HCMC Zoo and Garden complex.

We therefore suggest that rideshare could play a key role in complementing public transportation, both in accelerating adoption and in serving the residual demand that public transport infrastructure would not meet independently.

ASSESSING THE BROADER BENEFITS OF RIDESHARE

We estimate that the parking area that could be saved from a reduction in private vehicles as a result of rideshare (in each city studied), ranges from 759 to 22,369 acres.

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Acknowledgements

The authors would like to thank Panagiota Papakosta and the broader BCG GAMMA team for their traffic congestion analysis, Jamshed Daruwalla, Jasmin Pithawala, Kim Friedman and Pradeep Hire for design and production assistance and the BCG knowledge teams and Visual Services department.

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