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Transport and the Megacity: Improving Vitality with Connectivity

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Abstract

There is no easy answer to ensuring the world's rapid urban population growth is managed sustainably and in a manner that promotes economic growth, social cohesion, and health and wellbeing. However, densification of existing urban areas is increasingly recognised as an effective and socially responsible way for cities to accommodate growing populations and still operate as vital, vibrant spaces. The Future Spaces Foundation's Vital Cities: Transport Systems Scorecard explores how well-networked, safe and sustainable transport networks equip densifying cities to meet the needs of their rising and fast-changing populations. This paper uses data from the scorecard to examine the transport infrastructure and associated data networks of three large, rapidly densifying cities – Beijing, Mumbai and São Paulo – and highlight the successful measures and policies implemented between them. It includes an in-depth explanation of the scorecard's methodology, and concludes with an appeal for people-focused transport design that values safety, urban vibrancy and individual wellbeing over corporate efficiency.

Keywords: Transport, Densification, Infrastructure, Megacities, Cities

1. Introduction

1.1. Densification and the Need for Well-Managed Transport

The idea of urban living often conjures images of bustling city-center neighborhoods with a rich mix of residences and lively clusters of shops and cafes on their doorstep. But the reality for most urban residents is immensely different. Vast, fragmented swathes of urban sprawl afflict cities across North America (see Fig. 1) and Europe, where quality of life and social capital are steadily eroded through job sprawl, poor connectivity and the widespread implementation of single-use developments. Meanwhile, overcrowding is a major problem in cities in developing countries like India and Brazil, resulting in heaving favelas and slums plagued by substandard living conditions. In both cases, residents are isolated from critical amenities, their city's core and, in many ways, each other.

The world's urban population already accounts for more than half of the total population (*Demographia World Urban Areas*, 2016) and is predicted to rise to 66% by 2050 (Cox, 2012), at which point there will be more than 7 billion urban residents alone (Habitat III, 2016). A radical rethink is in order to ensure this growth is managed sustainably and in a manner that promotes equality, economic growth, social cohesion, and individuals' health and wellbeing. Of course there is no one-size-fits-all answer to this, but densification of existing urban areas is increasingly perceived as a realistic way to help cities accommodate growing populations and still operate as vibrant spaces where people want to live and work.

The Future Spaces Foundation – a think-tank established to advance research and debate about the demographic, technological and socioeconomic factors that affect the spaces people live in – produced a report in 2015 that names density as one of the cornerstones needed to improve cities' social and commercial vitality (Future Spaces Foundation, 2015). As the 'Vital Cities Not Garden Cities' report outlines, density has the potential to increase choice and opportunity on a personal level, and economic growth, diversity and social cohesion among the broader population. Importantly, it reduces the risk of producing monocultural communities, which arise when there are few public amenities and employment and entertainment options on offer (and therefore reduced opportunities for human contact outside the family unit).

Of course, density must be managed efficiently and intelligently, as the context in which a city grows unquestionably impacts its urban trajectory. And density alone is not sufficient to engender the vitality cities need to be successful, especially fast-growing cities in emerging markets. A complex mix of social, economic, political, environmental and infrastructural conditions need to align to facilitate the kind of development that benefits these cities, not least a considered, well-managed plan for transport infrastructure.

The Future Spaces Foundation's 2016 Vital Cities: Transport Systems Scorecard explores in detail how well-networked, efficient, safe and sustainable transport networks

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Figure 1. Urban sprawl in Los Angeles - © Skyhobo.

equip densifying cities to meet the needs of their rising and fast-changing populations, limit their environmental impact, and enhance their residents' abilities to interact, exchange and innovate (Future Spaces Foundation, 2016). The report's central argument is that a city's chances of economic and social success are vastly improved when its connections – pedestrian, bike, vehicle and public transport networks – are simple, comfortable, safe and affordable.

This paper uses data from the Vital Cities: Transport Systems Scorecard report to examine the transport infrastructure and associated data exchange networks of three large, rapidly densifying cities – Beijing, Mumbai and São Paulo – and highlight the successful measures and policies implemented between them. Given that the majority of the world's urban population still currently resides in cities with populations of fewer than 1 million people (*Demographia*, 2016), now is an opportune time to consider the ways small and mid-size cities can plan for the future, particularly with respect to transport infrastructure, considering its potential to facilitate vitality as a city grows and densifies.

2. Report and Methodology

2.1. Overview

For the Vital Cities: Transport Systems Scorecard, the Future Spaces Foundation investigated how 12 cities around the world fare in terms of transport infrastructure and associated data exchange networks. Using a unique scorecard that quantitatively and qualitatively measures the connectivity of each city's transport network, the report explores how each city has integrated transport and data into its unique manifestation, and provides a framework for determining how each can improve in terms of efficiency, sustainability and accessibility. The body of data collated for the research is presented graphically in an interactive data hub available online. For a snapshot of the results, see Fig. 2.

Of the dozen cities examined in the study, São Paulo, Beijing and Mumbai comprise the 'megacities' category, which refers to cities that have a population of more than 10 million and are located in rapidly urbanizing emerging markets. Incorporating effective infrastructure into such cities is, of course, a complex process that requires adequate political will, advanced engineering solutions and deep financial commitments. With the scorecard data, however, it becomes possible to begin a discussion on the

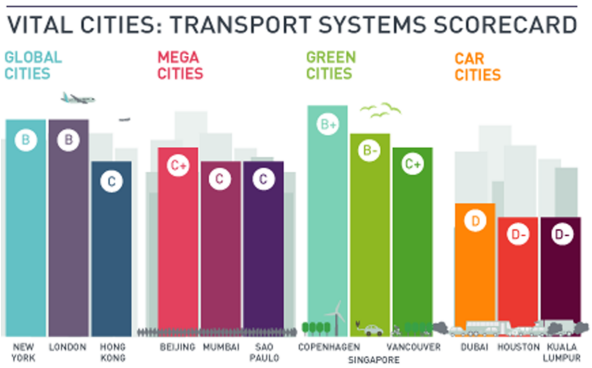


Figure 2. The Vital Cities: Transport Systems Scorecard.

connectivity challenges these cities face and how certain strategies are addressing these.

2.2. Categories

The 12 cities in the Future Spaces Foundation study are grouped into 4 categories: 'megacities' (Beijing, São Paulo and Mumbai), 'global cities' (London, New York and Hong Kong), 'green cities' (Copenhagen, Vancouver and Singapore), and 'car cities' (Houston, Dubai and Kuala Lumpur).

As mentioned, megacities in this context refer to cities located in rapidly urbanizing emerging markets, with populations of more 10 million people. Global cities, meanwhile, are well-established, densely packed metropolises with large daytime populations. Green cities are those that visibly strive for environmental sustainability by promoting cycling and public transport over cars; and car cities are historically automobile-heavy cities that are currently trying to shift to other transport modes.

2.3. City Groupings

Global cities	Megacities	Green cities	Car cities
Hong Kong	Beijing	Copenhagen	Dubai
London	Mumbai	Singapore	Houston
New York	São Paulo	Vancouver	Kuala Lumpur

Each city in the report has been appraised on 31 measures – a mix of quantitative data (for example, carbon emissions from transport per capita or the number of electric vehicle charging stations per square kilometer) and qualitative assessments (such as quality of cycle lanes or network reliability).

These 31 measures are spread across 10 categories: 4 'network inputs' (infrastructure and policies a city has in place to promote connectivity) and 6 'network impacts' (spheres a city's transport system can influence). See Fig. 3 for a full list of categories and measures. The scorecard awards each city an overall letter grade between A and F based on these measures, an exercise that offers a standalone assessment of how each one's overall approach to transport fares, and provides a basis for comparison between cities.

2.4. Scoring

To create the overall score for each city, each of the 31 individual measures is 'normalized' on a scale of 1 to 5. Quantitative measures are benchmarked against 'ideal' targets cities should strive to achieve – for example, a rapid transit network length of 1km per 1km^2 (considered ideal, since below this, few people can walk to such transit exchanges). Qualitative measures are scored using a tightly defined criteria based on policy information, local insights and expert judgements about city infrastructure and policies – the measure examining the quality of cycling infrastructure, for example, assesses network connectivity, the extent to which cycle lanes are separated from road and pedestrian traffic, and the availability of safety features like dedicated lighting and crossings.

These scores are then aggregated within their relevant category, which is awarded a score, converted on a scale of A to F (see Fig. 4). From here, an overall score is cal-

Network inputs:

1) Public transport network
- Length of the rapid transit network, km per km^2
- Network capacity
- Network connectivity
- Frequency and reliability
- Network maintenance and development

2) Bike and foot network
- Length of the cycle network, km per km^2
- Quality of the cycle network
- Bike-sharing scheme, locations per km^2
- Bike-sharing promotion
- Walkability score

3) Private vehicles
- Traffic reduction policy
- Car share clubs, locations per km^2
- Car-sharing promotion
- Electric vehicle charging infrastructure
- Electric vehicle promotion

4) Data & apps
- Open transit data policy
- Electronic payment facility
- Availability of wifi in the public transport system
- Quality of web- and mobile-based transport information
- Provision of real-time transport information

Network impacts:

5) Affordability
- Monthly ticket cost, share of average net monthly wage
- Cost-difference multiplier, outer vs inner zone

6) Accessibility
- Trips taken by public transport, share of motorised transport
- Accessibility of the public transport system

7) Sustainability
- Transport emissions, tonnes per capita

8) Breathability
- NO2, annual average
- SO2, annual average
- PM2.5, annual average

9) Mobility
- Trips taken by foot and bike, share of total

10) Safety
- Pedestrian fatalities, per 10,000 people walking to work and school
- Cyclist fatalities, per 10,000 people cycling to work and school

Figure 3. Individual measures and categories in the research.

culated, also converted on a scale of A to F (see Fig. 1). Each of the 10 categories has an equal weighting, and the maximum number of points in the overall scorecard is 50, converted as follows:

Score*	Points
A	47.5 and above
B	40 to 47.5
C	32.5 to 40
D	25 to 32.5
E	17.5 to 25
F	10 to 17.5

*'Plus' and 'minus' scores are derived at points equidistant from the main scores.

A city that achieves an A grade is considered to have excelled across the board, with reliable and well-connected public transport systems, safe and attractive environments for walking and cycling, smart road policies that promote green initiatives like car-sharing and low-carbon vehicles, and effective usage of open data and apps.

2.5. Data Sources

The above methodology was designed by Longitude Research in consultation with the Future Spaces Foundation, and is based on a wide programme of desk research and interviews.

Longitude Research spoke with several industry experts to gather feedback on the scorecard design, including Greg Lindsay, Urbanist and Senior Research Fellow at the New Cities Foundation; Carl Hughes, National Policy Director at the Institute for Transportation and Development Studies (ITDP); and Karl-Heinz Posch, Coordinator of the European Platform on Mobility Management.

Longitude also used local researchers in each city to collate primary information and source opinions and insights from stakeholders, all of which was used to inform the qualitative scores. Other data sources for the various scorecard measures include city administrations, policy documentation, transport companies, local and national statistical offices, traffic police reports, environmental agencies, local and international NGOs, and a variety of news sources.

Further information on the data and methodology used can be found on the Future Spaces Foundation's website:

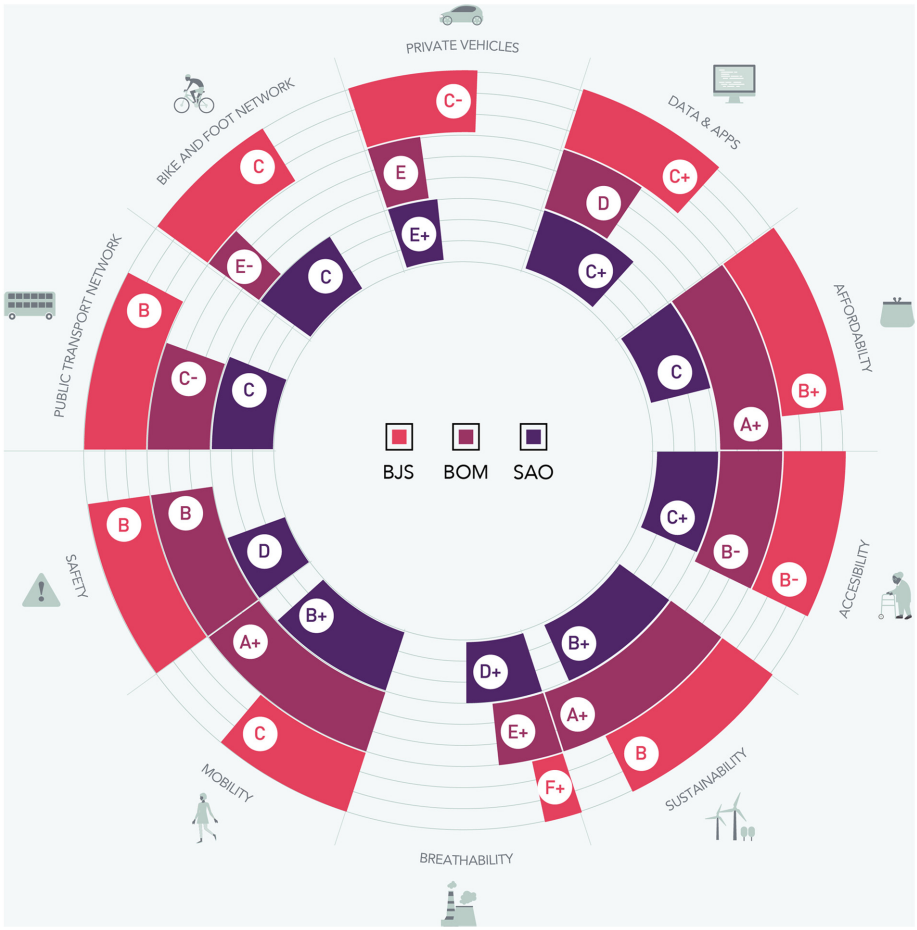


Figure 4. The scores for Beijing, Mumbai and São Paulo.

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3. Scorecard Results

3.1. How Megacities Fared

As Fig. 1 shows, the megacities came just behind the global cities and green cities in terms of overall scorecard results, and ahead of the car cities. Beijing scored a C+, while Mumbai and São Paulo each received a C. No city scored an A overall, though Copenhagen, showing an impressive record for sustainability, safety and mobility, topped the scorecard with a laudable B+.

Delving deeper (see Fig. 4, which shows the 10 category scores that together comprise each megacity's overall score), it is clear that, broadly speaking, Beijing, Mumbai and São Paulo have some way to go to achieve compete with global and green cities. At the same time, the research shows there is much these cities can be proud of, revealing many successfully implemented strategies and initiatives between them that other cities can learn from.

Below are a selection of highlights of their performance across the study.

4. Beijing Leads the Pack in Providing a Well-Networked Public Transport System

The public transport network category considers the extent to which a city has implemented a dense, reliable, well-networked mass transit system that acts as a green, space-saving alternative to private vehicle use.

Beijing is the clear forerunner of the three megacities in this category, outperforming São Paulo and Mumbai (as well as five other cities in the study). A primary reason for this is its substantive network connectivity and network capacity: Beijing comes first among the megacities (and joint second within the whole study) by both measures (See Fig. 5 for megacities' comparative score in this category.).

The following contributed to these high scores:

- The city has an extensive subway system – the second-largest in the world, after New York's – that serves both inner city areas as well as suburbs up to 30 km from central Beijing.
- Plans are in place that could add an additional 500 km of lines (including light rail and monorail) over the next 25 years.



Figure 6. Beijing bike-sharing scheme - © Tanuki Photography.

- Plans are in place to expand the suburban rail system into a 1,000 km network for commuters travelling up to 70 km from central Beijing.
- Bus networks are extensive, reaching far-flung suburbs
- Intercity and suburban railways connect into the subway.
- The airport express train connects to three subway lines in the city.
- The city operates a number of airport shuttle buses.
- The majority of railway stations are well served with nearby bus stops.
- Bike-sharing schemes that target commuters, some central and some suburban, are integrated into the rail network (see Fig. 6).
- A universal ticketing system is in place in which a single card can be used on all subway lines, city buses, expressway tollbooths and the airport express train, as well as some taxis and long-distance bus lines.
- Central government funding is used to support public transport development.

Along with reducing the number of cars on the road and cutting down associated levels of pollution, fuel consumption, congestion and traffic fatalities (all notably high in Beijing), this move towards a well-connected public transport network is integral to enabling people from all over the city to interact and exchange ideas – a crucial development, given Beijing's drastic suburbanisation in recent decades.

Addressing Beijing's horizontal expansion with a bigger and better-connected network will go a long way in

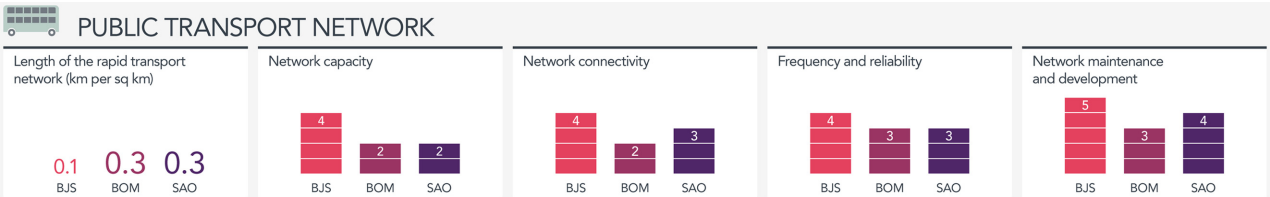


Figure 5. Public transport network findings.

ensuring factions of people spread across the city do not become isolated from one another, from the rising number of young people choosing to live alone to the city's skyrocketing over-60 population (many of whom can no longer drive). With effective connections, Beijing's residents are better equipped to access education, medical care and employment, and establish and uphold social and professional ties – all of which, among many other benefits, preserves individuals' sense of agency and furthers the city's economic prospects.

5. São Paulo Demonstrates a Strong Effort on the Bike and Foot Network Front

This category considers the policies and infrastructure a city has implemented to encourage walking and cycling, from the length and quality of its cycle network to its efforts to promote bike-sharing.

São Paulo receives a C for its bike and foot network, far outstripping Mumbai's E- and coming joint third in this category (alongside Beijing) in the overall study. The city scores particularly highly for its bike-sharing cycling scheme (both in terms of promotion and locations per square kilometer) as well as the quality of its cycle network, outperformed only by Copenhagen in this latter measure. (See Fig. 7 for megacities' comparative score in this category.).

The following efforts contributed to this:

- A portion of the São Paulo 2014 Transport Masterplan is dedicated to developing a safe and attractive cycling network.
- The city is on track to provide 400km of dedicated – that is, physically separated from cars and pedestrians – cycle lanes by the end of 2016.
- More cycle lanes are currently being built outside the city center to improve connectivity.
- The city operates two bike hire schemes. These span 227 stations, are fairly cheap, and can be paid for by bank card, mobile phone app or a single ticket. The CicloSampa scheme is particularly popular with commuters, as it is well connected to transport hubs within central districts. The Bike Sampa system is also widespread.
- Officials are investing in cycling education and safety initiatives to encourage more and safer cycling.
- An SOS bike service is in place, which sees 40 bike mechanics regularly cycle around the city to help carry out bike repairs, with another 10 located in dedicated tents. While waiting for repairs, cyclists can use one of 120 free bikes for up to one hour.

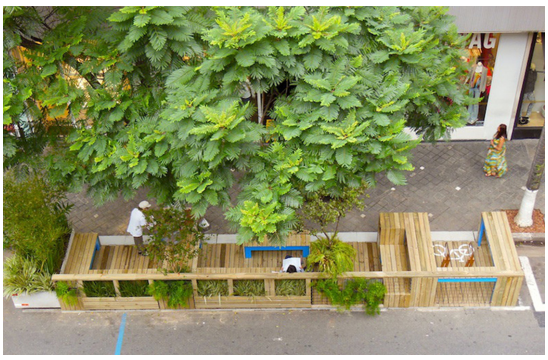


Figure 8. Parklets in São Paulo - © senaiaksoy.

Investing in a bigger, safer, more accessible bike and foot network is a significant bolster for health and safety in São Paulo. An incentive to walk or cycle where possible promotes exercise and an active lifestyle (vital in a country currently facing a growing obesity epidemic); has the capacity to significantly reduce the high carbon emissions of this heavily populated, car-focused city; brings life to the streets, not least via the introduction of 'parklets', mini recreational spaces in now-disused parking spaces (see Fig. 8); and promotes inclusivity, giving people of all economic means a safe, affordable option for transport.

While São Paulo's size, sprawl and patchy rail coverage are such that cars are simply unavoidable for certain journeys, the city's improving bike and foot network is nevertheless helping the city move away from its car-centric culture by making multi-modal commutes that include cycling an increasingly viable option, particularly for those commuting to and between the city's polycentric cores.

6. Mumbai Comes Out on Top in Terms of Affordability, Sustainability and Mobility

Mumbai leads the way in terms of affordability, sustainability and mobility, scoring an A+ in all three categories – the only city in the whole study to do so. (See Figs. 9,

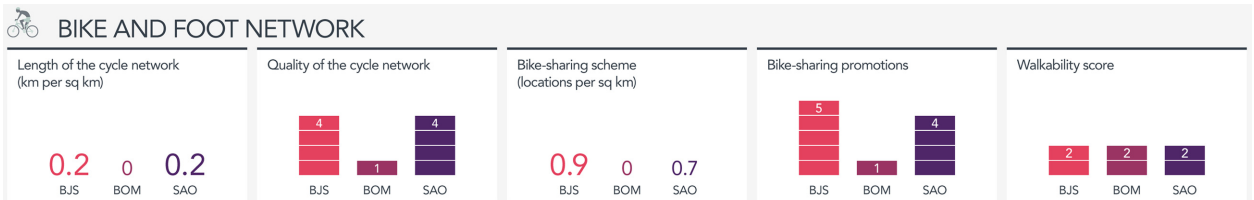


Figure 7. Bike and foot network findings.



Figure 9. Affordability findings.

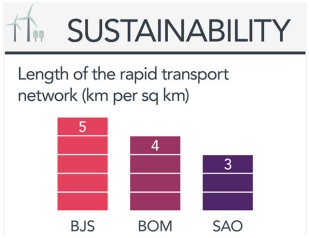


Figure 10. Sustainability findings.

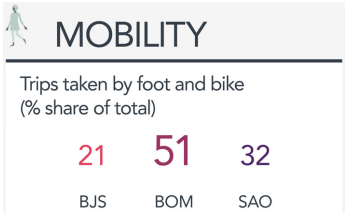


Figure 11. Mobility findings.

10 and 11 for megacities' comparative score in these categories.).

Between these categories are four individual measures: proportion of typical income spent on public transport, cost-difference multiplier, transport emissions per capita, and percentage of trips taken by foot or bike.

The following are among the factors that earned Mumbai its top marks:

- A second-class monthly rail ticket for the Greater Mumbai area costs just 1% of the average net wage (according to the latest state-level labor force survey) – the lowest relative price across all 12 cities studied.
- Mumbai's transport emissions amount to 0.3 tons per capita – the lowest across all cities studied.
- More than 50% of all trips in the city are taken by foot or bike (see Fig. 12) – again, the best score across all 12 cities.

Mumbai's high levels of affordability, sustainability and mobility make a strong case for the benefits of densification and the fight against urban sprawl. With some 67,000 people per square mile, the city is the fifth-densest in the world (*Demographia World Urban Areas*, 2016) and by far the densest in the FSF study, and still it manages to



Figure 12. Commuters in Mumbai - © anandoart.

produce excellent ratings on 3 important transport-related outputs – not in spite of its population density but because of it. Take Mumbai's high figures for bike and foot trips – these are possible because of the close proximity of amenities across the city, and in turn have the potential for important knock-on effects, like addressing obesity in a city where it is rising dramatically.

Suburban growth has been significant in recent years to be sure, with architecture schemes like Make Architects' high-profile residential development Aranya emblematic of the rising middle class in Mumbai's broader metropolitan region. There's much that can still be done to ensure this outward growth doesn't prevent either metropolitan or central residents from being able to move easily around the city, not least a focus on upgrading the city's rail network (the forthcoming Mumbai Metro offers some hope on this front). Still, Mumbai's low ticket prices and carbon emissions are evidence of a transport network coping well in the face of rapid and continuing population growth.

7. Conclusion

7.1. The Need for People-Focused Design

A great deal of the architecture and urban design that emerged after the Second World War addressed growing populations by embracing manufactured global urbanism over local personality and placemaking – a notion best illustrated by the monolithic high-rises of modernist architect Le Corbusier. However, since the 1961 publication of Jane Jacobs's widely influential *The Death and Life of Great American Cities,* which pieces together criticisms of and antidotes to this ideology and its associated policy, many architects and planners have shifted their attention to more people-focused design.

This kind of design – which values safety, urban vibrancy and individual wellbeing over corporate efficiency – is integral to achieving vitality in rapidly expanding cities like Beijing, Mumbai and São Paulo. Expansion that ignores people's quality of life inevitably produces segregated sections of society – at best, these take the form of bland, low-density suburbs with lifeless housing blocks

and a high dependency on cars; at worst, they are teeming slums that suffer from poverty, crime and a lack of basic services. Reliable, accessible, well-managed transport infrastructure is crucial to addressing and preventing the many forms of isolations that result from poorly managed urbanization. Achieving greater connectivity is a key component in producing more cohesive communities with better social ties and economic prospects – in short, more vital cities.

With population growth and urban density on the rise, megacities like Beijing, Mumbai and São Paulo are the cities of the future. While all three have significant room for improvement on the transport front, they also boast noteworthy successes between them. Growing cities would do well to consider these accomplishments, which are paving the way for bigger, better, more vibrant urban environments.

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