CITIES FOR PEOPLE

INSIGHTS FROM THE DATA

APRIL 2015

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Our approach is inspired by the work of Energy Foundation China, Calthorpe Associates, Gehl Architects, and the Institute for Transportation and Development Policy. We are indebted to these organizations for their pathbreaking work in China and are grateful for their support and partnership.

If you are interested in learning more about us or have specific feedback regarding this report, please reach out to us at urban@energyinnovation.org.

CITIES FOR PEOPLE: INSIGHTS INTO THE DATA
APRIL 2015

CONTENT*
Chris Busch (chris at energyinnovation.org)
CC Huang (cc at energyinnovation.org)

*Alphabetical order indicates co-equal authorship.

DESIGN
CC Huang

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INTRODUCTION

We set out to review the scientific literature on creating cities for people, especially in China. Our conclusion is that compact, walkable, and transit-oriented development is essential to sustainable, healthy, and economically vibrant cities that deliver a high quality of life.

Cities for People: Insights from the Data provides an overview and synthesis of quantitative research related to urban form and transportation with particular emphasis on evidence from China. Our report emphasizes studies that use real-world evidence. We hope that this report advances the science of understanding what makes cities better for people.

The shape of cities fundamentally influences the way people get around them, which in turn deeply affects quality of life and economic dynamism. Urban and transportation planners have been accumulating a better understanding of how to make cities work for people. This report shows that the fundamentals are common across countries and a global consensus is emerging. The 8 Principles, a set of guiding principles to ensure sustainable urban development (described in the next section), directly reflect this global consensus, which are distilled in the report *Planning Cities for People*.

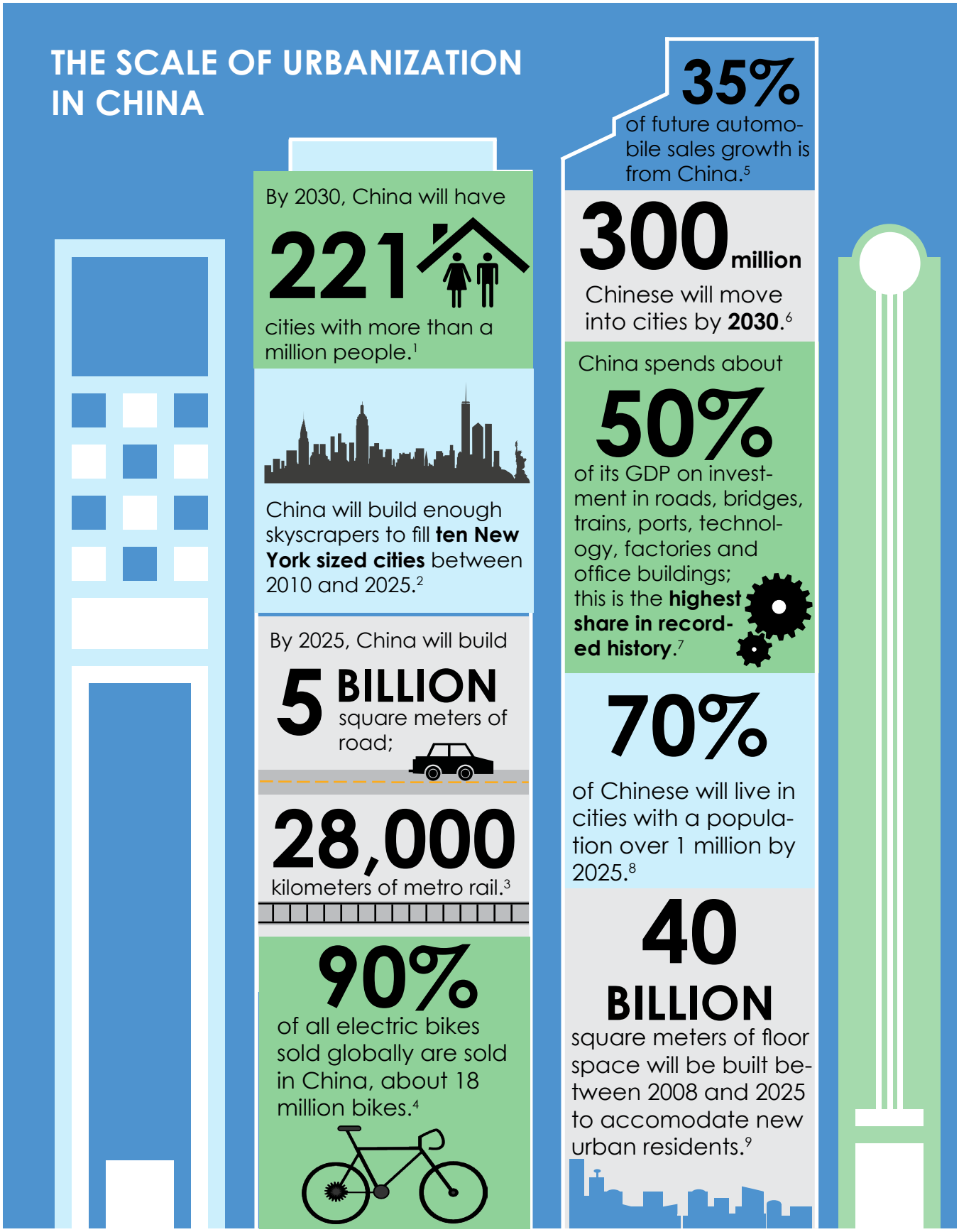
PURPOSE

We hope that this work serves as a resource to others advancing urban sustainability by aggregating the best studies of urban form and transportation solutions, especially pertaining to China. We are not aware of any similar existing survey of the literature as it relates to urbanization in China. The incredible pace of urbanization in China makes such studies of paramount importance. China's urban development trajectory will also produce key lessons for many other developing countries that are also rapidly urbanizing.

While we have captured a broad array of studies, we are sure that additional work still exists. In addition to surveying the research that has been done, this document also includes our assessment of gaps in the literature. We encourage readers to contact us with suggestions about other relevant research.

WHY CHINA?

Many developing countries are going through rapid urbanization, but China's pace and scale are unprecedented. The following infographic offers some perspective on the trajectory of urbanization in China.



Sources: 1-3) McKinsey and Company., "Preparing for China's Urban Billion," 2009; 3) Bloomberg Business, 2008; 4) McKinsey and Company, 2012; 5) United Nations, 2014; 6) New York Times, "Cultivating the Urge to Splurge," 2010; 7) Bloomberg Business, 2008; 8-9) Time Magazine, 2009.

THE 8 PRINCIPLES

The findings are organized around The 8 Principles from *Planning Cities for People*, a guide of urban form and transportation solutions to some of the most pressing challenges facing modern cities, including congestion, pollution, and urban sprawl. The 8 Principles are essential ingredients to sustainable, economically vibrant cities that deliver a high quality of life for people.

1. **Walk.** Develop neighborhoods that promote walking.
2. **Connect.** Create dense networks of streets and paths.
3. **Transit.** Build extensive, high-quality transit. Make connections between modes.
4. **Cycle.** Prioritize city bicycle networks that offer protected lanes.
5. **Mix.** Zone for mixed-use neighborhoods.
6. **Densify.** Actively encourage greater density around major transit hubs.
7. **Compact.** Set growth boundaries and plan for compact regions with short commutes.
8. **Shift.** Increase mobility by regulating parking and road use.

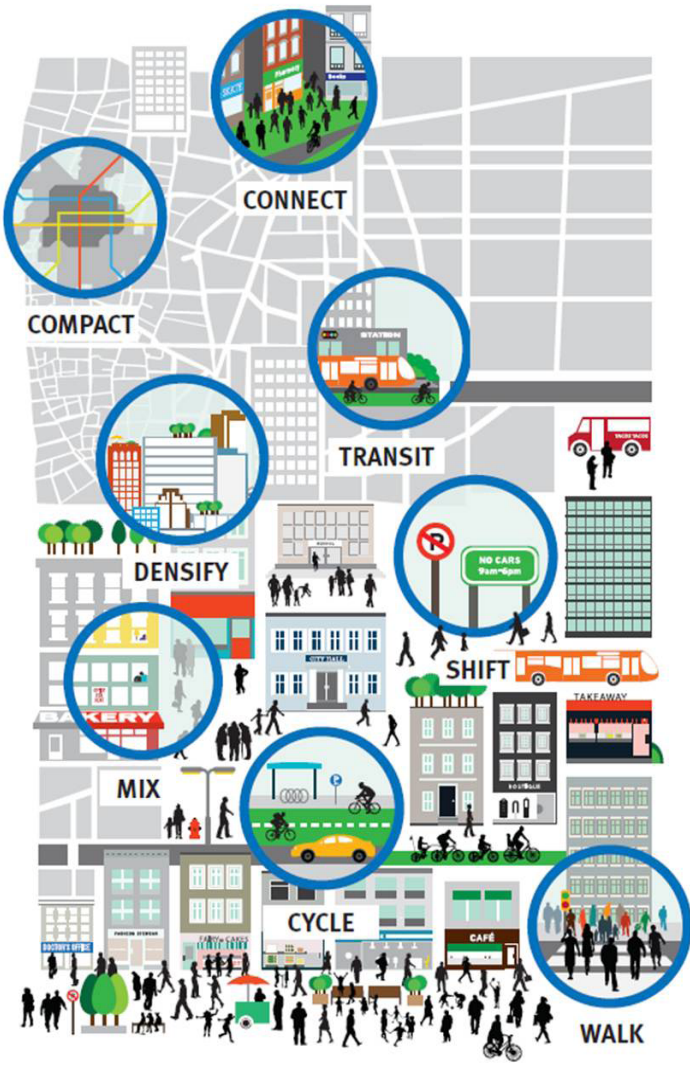


Photo by Gavin Anderson / CC BY 2.0; Graphic from ITDP.

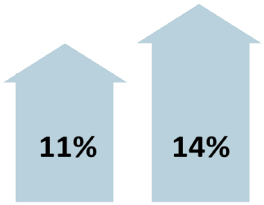
DATA HIGHLIGHTS

ORGANIZED BY THE 8 PRINCIPLES

WALK

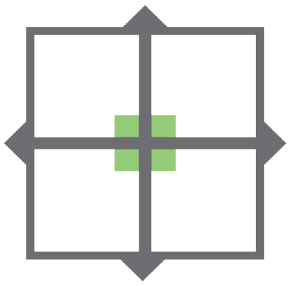
50% People have a 50% lower likelihood of developing **colon cancer** if there is physical activity from commuting found in Shanghai

Public transit boosts property values.



BOGOTA HONG KONG

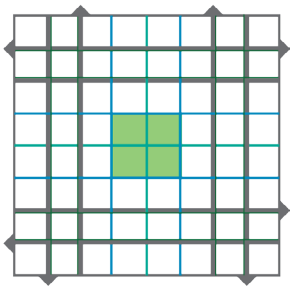
CONNECT



NEGATIVE IMPACTS OF **SUPERBLOCKS**:

- Produce more pollution and emissions
- Lowers quality of life
- Stunts commercial development
- Creates unfair access for elderly and children
- Worsens congestion

A BETTER ALTERNATIVE, THE **URBAN NETWORK**:



43% decrease in trip length

72% decrease in air pollution

59% decrease in carbon emissions

TRANSIT

In Copenhagen, $1 in health-care costs is saved for every additional kilometer that is completed on **bike.**

CYCLE

Investment in improving **bike** infrastructure yields benefits that are

10 - 25

times greater than the cost.

Density increases property values: In Shenzhen, profits and revenues increase along with the number of stories in a building.

DENSIFY

2%-6%

Productivity and **density** are highly correlated: productivity increases by 2% to 6% when density is doubled.

MIX

Mixed-use developments can save households money. In Fort St. John, Canada, savings amounted to:

$2,353

per year per household

In China, **mixed-use** neighborhoods lead to shorter commuting distances and lower emissions.

COMPACT

7%

Compact urban form reduces household costs by 7% in Portland.

Compact urban develpoment can save the U.S. **$250 billion** in 25 years.

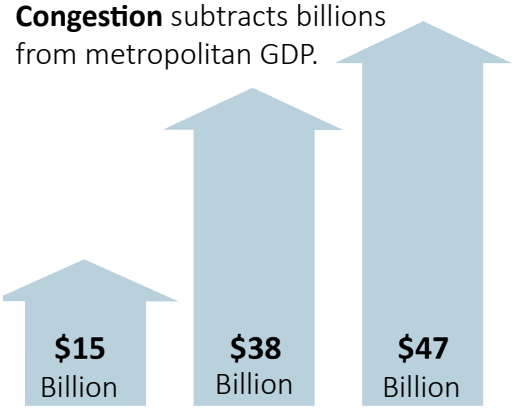
SHIFT

Emissions from automobiles account for

30%

of Beijing's air pollution.

Congestion subtracts billions from metropolitan GDP.



Rio de Janeiro São Paulo Beijing

FINDINGS

SUMMARY OF BENEFITS

Based on both empirical work in China and internationally, we find solid evidence to support practices recommended by The 8 Principles. Sustainable urban form and transportation approaches result in an array of environmental, economic, and social benefits. We use these benefits to categorize our data insights for both Chinese and international studies.

ENVIRONMENTAL

Decreased car dependence: Bike-share programs and protected bike lanes are effective in increasing biking as a transportation choice. The spontaneous bottom-up spread of bike-share systems across China, absent a significant national policy push, has been impressive. As of December 2014, Chinese cities have established 138 systems. The effectiveness of these systems can be magnified by upgraded bike path networks.

Improved air quality: The air quality problem in China led to 1.2 million premature deaths in 2010. Better urban design can reduce emissions from the transportation sector, which is responsible for over 30 percent of the PM 2.5 particulate pollution in Beijing, according to the Beijing Municipal Environmental Protection Bureau.

Decrease in GHG emissions: Worldwide, the transportation sector is responsible for 22 percent of energy-related greenhouse gas (GHG) emissions. China's infrastructure is beginning to rely heavily on vehicles, and much of the associated infrastructure is difficult to change. Better urban form and transportation planning can alleviate emissions by encouraging use of non-motorized transport.

ECONOMIC

Energy and other savings: Households can save money through more energy efficient travel due to mode shifting, access to more local goods from mixed-use development, and other savings such as parking costs.

Reduced congestion costs: Congestion has become very costly, with studies showing this costing about 8 percent of metropolitan GDP in Rio de Janeiro and São Paulo. Using The 8 Principles can deliver mobility with density.

Increased property values: Public transit accessibility and walkability increase property values. There is strong evidence for this across a range of cities.

Improved productivity: Density can contribute to economic productivity through network effects. Moreover, congestion and pollution can detract from productivity through loss of time and health. The link between productivity and urban design is established both in China and internationally.

Higher government revenues: The cost of capital, labor, public services and maintenance of urban infrastructure and are lower with optimized development strategies. By clustering, higher utilization rates can be achieved, necessitating a lower capital investment. Globally, $3 trillion in capital investment in urban infrastructure can be saved by pursuing more compact strategies in line with The 8 Principles, according to recent work by the New Climate Economy project.

SOCIAL

Improved health outcomes: Mixed-use, transit-oriented development increases physical activity and reduces time spent sitting and isolated in a motor vehicle. Failure to mix land-uses (e.g. creating purely residential or commercial areas) and higher car ownership have been found to increase the risk of obesity and colon cancer. Sustainably designed communities offer safer streets and reduce traffic-related injuries.

Better human mobility: By putting people first, cities can help people get where they need to go. Greater mobility saves time and expands choices for urban dwellers. Driving is one way to get around, but in congested cities, this can often mean extended time stuck in traffic rather than moving. Better urban design can increase flexibility. It can improve the experience of car travel while also freeing people from being dependent on their cars.

Increased equality of access: Currently, in a car-centric planning framework, low income individuals are often left out of the planning calculus. By building better public transit, sidewalks, and biking paths, those who cannot afford to drive are given equal access to the city. As Enrique Peñalosa, the former mayor of Bogotá, says of the bike paths added during his leadership: "They showed that a cyclist on a $30 bike was equally important as a citizen in a $30,000 car."

DATA INSIGHTS

Next we present an aggregated view of the best evidence on the net benefits of The 8 Principles. These studies are indicative of the most insightful, rigorous, or representative of a large set of similar work. We identify the range of impacts studied and quantified in that particular study, which largely reflect the categories of benefits outlined above. We hope that our China and International Data Insights tables can give researchers an idea of both the impacts already established and the impacts that might need more research.

We divide the studies into two categories - China and International. The studies specific to China are summarized first, followed by an annotated bibliography. Then, the international studies are summarized, also followed by an annotated bibliography. The annotated bibliography does not seek to summarize the entire study, but focuses on the insights and quantified impacts that are most relevant to The 8 Principles.

CHINA DATA INSIGHTS

The following figure summarizes all of the major studies we found pertinent to The 8 Principles done in China. The table shows which of The 8 Principles are highlighted in the study and which quantified benefits the authors focused on in their results. For more information on the key findings and the citation, please find the study with the same number in the relevant annotated bibliography.

CHINA DATA INSIGHTS

This table gives a high-level overview of studies done on China that look at The 8 Principles. Column 1 identifies the location of the study, column 2 references the number of the study later listed in the bibliography, column 3 isolates the key principles the study looks at, and the colored columns identify the benefits that are quantified in each study.

Location	#	Principles	Environmental			Economic					Social		
			Decreased car travel	Improved air quality	Lower GHG emissions	Energy savings	Improved productivity	Reduced congestion	Higher property values	More government revenue	Improved health	Better human mobility	Increased equality of access
Beijing	1	Mix, Transit	■		■								
	2	Transit							■				
	3	Shift			■						■		
	4	Shift						■					
	5	Walk								■			
	6	Shift, Transit					■						
	7	Transit							■				
	8	Connect										■	
	9	Mix											■
	10	Mix	■										
Guangzhou	11	Bike						■					
	12	Mix							■				
	13	Walk							■				
Shanghai	14	Shift	■										
	15	Transit										■	
	16	Walk, Bike									■		
National/ Multiple Cities	17	All	■		■	■							
	18	Connect				■							
	19	Shift								■			
	20	Walk									■		
Chongqing	21	Walk, Connect						■					
Kunming	22	All	■	■	■								
Shenzhen	23	Densify							■				
Nanjing	24	Bike										■	
	25	Mix, Bike	■										
Jinan	26	Walk	■										
	27	Connect	■			■							
Hankou	28	Compact, Transit			■								
Xi'an	29	Transit	■										

ANNOTATED BIBLIOGRAPHY - CHINA DATA INSIGHTS

BEIJING

1. Mix, Transit • Decreased car travel, GHG reductions

Proximity to local employment centers plays an important role in emissions levels. Residing in a mixed-use neighborhood reduces emissions. The authors state that "High emissions neighborhoods have many car driving commuters."

Han, Sun Sheng, and Ray Greeb. Towards Low Carbon Cities in China: Urban Form and Greenhouse Gas Emissions. Routledge Studies in Low Carbon Development, 2014.

2. Transit • Higher property values

Residential properties near bus-rapid transit (BRT) increase at a statistically significant rate of 2.3 percent annually.

Deng, Taotao, and John D. Nelson. "The Impact of Bus Rapid Transit on Land Development: A Case Study of Beijing, China." World Academy of Science, Engineering, and Technology 4 (2010).

3. Shift • GHG reductions, Health

In Beijing, driving restrictions reduce passenger vehicle emissions by about 20 percent and provide health benefits (reduced morbidity) worth RMB 1.1 – 1.4 billion at a cost of about RMB 0.51 – 0.72 billion annually.

Brian Viard, V., and Shihe Fu. The Effect of Beijing's Driving Restrictions on Pollution and Economic Activity. Working Paper Series, n.d. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1917110.

4. Shift • Congestion

On average, 40 percent of taxis on the road in Beijing at any given time are empty, contributing to traffic congestion. Traffic congestion discourages people from taking taxis.

Fox, Martin, and Andrew Tallon. "Traffic Congestion in Beijing: Issues and Policies." Geography 98 (Spring 2013): 43–49.

5. Walk • Government revenue

Green space provided rainwater control benefits equal to RMB 1.34 billion in 2009 in Beijing.

Zhang, Biao, Gaodi Xie, Canqiang Zhang, and Jing Zhang. "The Economic Benefits of Rainwater Runoff Reduction by Urban Green Spaces in Beijing, China." Journal of Environmental Management 100 (June 2012).

6. Shift, Transit • Productivity

This study estimates that urban congestion and environmental damages reduce Beijing's economic output by 7.5 percent to 15 percent.

Creutzig, Felix, and He Dongquan. "Climate Change Mitigation and Co-Benefits of Feasible Transport Demand Policies in Beijing." Transportation Research Part D: Transport and Environment 14, no. 2 (2009): 120–31.

7. Transit • Property values

There was a price premium of about 5 percent for properties near rail stations, and this increases to up to 10 percent for stations in suburban and low-income areas. This means that the price premium of rail transit increases in neighborhoods where car ownership is less likely.

Ma, L., R. Ye, and H. Titheredge. Capitalization Effects of Rail Transit and BRT on Residential Property Values in a Booming Economy: Evidence from Beijing. Washington D.C.: Transportation Research Board 92nd Annual Meeting, 2013.

8. Connect • Human mobility

This study shows that urban form in Beijing has significant impacts on human mobility (travel length, distance, time, and frequency). By improving urban form, human mobility can also be improved.

Long, Y., Y. Shen, X. Yao, and S. Gao. Spatially Heterogenous Impact of Urban Form on Human Mobility: Evidence from Analysis of TAZ and Individual Scales in Beijing. Working Paper #52. Beijing City Lab, 2014.

9. Mix • Increased equality of access

Beijing's insufficient amount of mixed-use neighborhoods has prevented certain residents from having easy access to public services. There is an efficiency loss because residents from the more spatially mismatched neighborhoods (often lower-income) have to travel farther to gain access to schools, hospitals,

and parks.

Zheng, S., J. Wu, Y. Zhang, Y. Zhang, B. Zhang, and Y. Du. Constructing a Spatial Supply-Demand Matching Index for Local Public Services. Working Paper #23. Beijing City Lab, 2014.

10. Mix • Decreased car travel

One reason car use in Beijing is high is because there is a insufficient mixing of jobs and housing. On average, bus riders have shorter commutes due to better job-housing mixing. The results also show that car users commute longer distances and live farther away from Beijing's central district.

Zhou, J., E. Murphy, and Y. Long. Commuting Efficiency in the Beijing Metropolitan Area: An Exploration Combining Smartcard and Travel Survey Data. Working Paper #28. Beijing City Lab, 2014.

GUANGZHOU

11. Bike • Reduced congestion

Bike-share programs can alleviate congestion. In Guangzhou, the bike-share program leads to 20,000 bike trips per day, which directly means 14,000 avoided car trips daily. Moreover, 84 percent of bike-share users did not travel by bike previously.

The Bike-Share Planning Guide. Institute for Transportation and Development Policy, 2013. https://www.itdp.org/the-bike-share-planning-guide-2/.

12. Mix • Higher property values

Allowing mixed-use increases property values. Allowing the first floor of residential buildings to commercialize meant a 30 percent increase in Tianhe district property values.

Best Practices in Urban Development in the Pearl River Delta. Institute for Transportation and Development Policy, December 2012. http://s3.itdp-china.org/ud/Group+3+-+Midrise+Danwei+Housing.pdf.

13. Walk • Higher property values

View of green space and proximity to water bodies increases property values by 7 percent and 13 percent, respectively (controlling for other factors).

Jim, C. Y., and Wendy Y. Chen. "Impacts of Urban Environmental Elements on Residential Housing Prices in Guangzhou." Landscape and Urban Planning 78, no. 4 (2006).

SHANGHAI

14. Shift • Decreased car travel

On East Nanjing Road, pedestrians are 97 percent of the users of the surface space, though only 17 percent of this space is dedicated to pedestrians.

A Livability and Green Mobility Strategy: Huangpu Shanghai. Gehl Architects and Energy Foundation, 2014.

15. Transit • Human mobility

After the introduction of a metro stop in Huangpu Shanghai, the percentage of public transit trips taking longer than 30 minutes fell by 53 percent. Public transit also increased the number of times people went shopping downtown.

A Livability and Green Mobility Strategy: Huangpu Shanghai. Gehl Architects and Energy Foundation, 2014.

16. Walk, Bike • Improved health

People whose commute involves physical activity have a 50 percent reduced risk of developing colon cancer by 50 percent, as found in Shanghai.

Hou, Lifang, and Ji Bu-Tian. "Commuting Physical Activity and Risk of Colon Cancer in Shanghai." American Journal of Epidemiology 160, no. 9, 2004.

NATIONAL/MULTIPLE CITIES

17. All • Decreased car travel, GHG reductions, Energy and other savings

Improved urban form would reduce GHG emissions in China from the transportation sector by 29 percent over business-as-usual with similar reductions in vehicle-kilometers traveled and in fuel use.

Dongquan, He, and et al. "Energy Use Of, and CO2 Emissions from China's Urban Passenger Transportation Sector - Carbon Mitigation Scenarios upon the Transportation Mode Choices." Transportation Research Part A: Policy and Practice 53, no. 53–67, July 2013.

18. Connect • Energy and other savings

Cost savings of 31 percent can be achieved by building according to an urban network versus superblock model. This is from the urban network needing less pavement, curbs, drainage, street lights, and trees.

Institute for Transportation and Development Policy, unpublished, 2014.

19. Shift • Increased government revenue

The lottery system in Beijing for license plates is inefficient compared to Shanghai's auction system. An auction in Beijing would lead to a welfare gain of RMB 36 billion (USD 6 billion) and raise RMB 21 billion in government revenue, enough revenue to offset public transport subsidies.

Shanjun, Li. Better Lucky than Rich? Welfare Analysis of Automobile License Allocations in Beijing and Shanghai. Cornell University School of Applied Economics and Management Working Paper Series, 2014.

20. Walk • Health

This study found a correlation between urban design and the amount of walking in six neighborhoods in Shanghai and Hangzhou. There are associations between built environment features and the amount of walking in neighborhoods in China, as has been found in other countries.

Alfonzo, Mariela, Zhan Guo, Lin Lin, and Kristen Day. "Walking, Obesity, and Urban Design in Chinese Neighborhoods." Preventative Medicine 69 (2014).

CHONGQING

21. Walk, Connect • Reduced congestion

Pedestrian path and public space improvements in Chongqing encourage more people to walk. This and better street design will improve traffic speeds by 63 percent, as found in a simulation study. Moreover, public space upgrades already completed have increased in the number of people doing physical activities in these areas by 6.42 times.

Chenggong: Low Carbon City. Energy Foundation and Calthorpe Associates, May 2011.

KUNMING

22. All • Decreased car travel, Improved air quality, GHG reductions

Redesign of the new Chenggong district in Kunming according to The 8 Principles will produce a 72 percent reduction in air emissions, 59 percent reduction in greenhouse gas emissions, and 67 percent reduction in passenger vehicle-kilometers traveled.

Chenggong: Low Carbon City. Energy Foundation and Calthorpe Associates, May 2011.

SHENZHEN

23. Densify • Higher property values

Space in taller buildings commands higher prices, and this increases per floor up to a height of 35 stories.

Wang, Jingyuan, Xian Zheng, and Mo Yikui. "Establishment of Density Zoning and Determination of Floor Area Ratio Along Rail Transit Line Based on TOD: A Study on Rail Transit Line 3 in Shenzhen (in Chinese)." City Planning Review 35 (2011).

NANJING

24. Bike • Human mobility

Bike park-and-ride spaces at metro stations increases ridership originating from the station. Transit ridership increases by six people for each one additional park-and-ride space (controlling for other factors). More feeder bus lines, indicative of good intermodal connections, also increase metro use.

Zhao, Jinbao, Wei Deng, Yan Song, and Yueran Zun. "Analysis of Metro Ridership at Station Level and Station to Station Level in Nanjing: An Approach Based on Direct Demand Models." Transportation 31, no. 1 (2014): 133–55.

25. Mix, Bike • Human mobility

A better jobs-housing balance and mixed land-use strongly promotes greater bicycle use. A 1 percent improvement in the jobs-housing balance index increases the chance of a person choosing to bike by 0.5 percent and is found to be the most important causal factor. A 1 percent increase in a mixed-use index (diversity of land use) increases the probability of biking by 0.3 percent.

Zhao, Jinbao, Wei Deng, Yan Song, and Yueran Zun. "Analysis of Metro Ridership at Station Level and Station to Station Level in Nanjing: An Approach Based on Direct Demand Models." Transportation 31, no. 1 (2014): 133–55.

JINAN

26. Walk • Decreased car travel

People are more willing to walk to BRT stations when the walking environment has certain features (median transit-way station location, shaded corridors, busy and interesting sidewalks).

Jiang, Yang, Christopher P. Zegras, and Shomik Mehndiratta. "Walk the Line: Station Context, Corridor Type, and Bus Rapid Transit Walk Access in Jinan, China." Journal of Transport Geography 20 (2012).

27. Connect • Decreased car travel, Energy and other savings

Superblock residents tend to drive four times more than urban network residents. Thirty-three percent of superblock residents' trips are by car versus 8 percent for other urban form types. Superblock residents also use 2.75 times the amount of transportation energy. These patterns persist when controlling for income and location.

Design Manual for Low-Carbon Development. Energy Foundation, 2011. http://www.chinastc.org/sites/default/files/CSCP_LowCarbonDevelopmentDesignManual_EN.pdf.

HANKOU

28. Compact, Transit • GHG reductions

Transportation-related emissions are 30 percent lower in the Hankou district (compact, good transit) than the Hanyang district (low road density, high proportion of car commuters).

Han, Sun Sheng, and Ray Greeb. Towards Low Carbon Cities in China: Urban Form and Greenhouse Gas Emissions. Routledge Studies in Low Carbon Development, 2014.

XI'AN

29. Transit • Decreased car travel

More extensive service on public transit leads to shorter commute times and greater use.

Han, Sun Sheng, and Ray Greeb. Towards Low Carbon Cities in China: Urban Form and Greenhouse Gas Emissions. Routledge Studies in Low Carbon Development, 2014.

INTERNATIONAL DATA INSIGHTS

The figure below summarizes the international studies on The 8 Principles. We were selective in which studies to include as there are many other studies that could be culled from. The Annotated Bibliography also provides more information on each of the studies.

INTERNATIONAL DATA INSIGHTS

This table gives a high-level overview of studies done internationally that look at The 8 Principles. Column 1 identifies the location of the study, column 2 references the number of the study later listed in the bibliography, column 3 isolates the key principles the study looks at, and the colored columns identify the benefits that are quantified in each study.

			Environmental			Economic					Social		
Location	#	Principles	Decreased car travel	Improved air quality	Lower GHG emissions	Energy and other savings	Improved productivity	Reduced congestion	Higher property values	More government revenue	Improved health	Better human mobility	Increased equality of access
International	1	Shift, Transit											
	2	All											
	3	Compact											
	4	All											
	5	All											
United States	6	All											
	7	Densify											
	8	Walk											
	9	Walk											
	10	Shift											
	11	Shift											
	12	Mix											
	13	Transit, Compact											
Japan	14	Densify											
Korea	15	Transit											
Brazil	16	Shift											
Norway	17	Bike											
Copenhagen	18	Shift, Bike											
Mexico	19	Transit											
New Zealand	20	Bike											
Canada	21	Densify, Mix											

ANNOTATED BIBLIOGRAPHY - INTERNATIONAL DATA INSIGHTS

INTERNATIONAL

1. Shift, Transit • GHG reductions, Energy and other savings

Cities can achieve carbon and energy savings of 10 to 15 percent by optimizing the flow of vehicles.

Zhou, Nan, Lynn Price, David Fridley, Stephanie Ohshita, and Nina Khanna. Strategies for Local Low-Carbon Development. Lawrence Berkeley National Laboratory, November 2012.

2. All • GHG reductions

This research indicates that, in aggregate, aggressive urban actions have the potential to reduce GHG emissions by about 3.7 $GtCO_2e$ in 2030, rising to approximately 8.0 $GtCO_2e$ in 2050, about two-thirds due to buildings and one-third in transportation energy due to improved urban form and other policies.

Creutzig, Felix, Giovanni Baiocchi, Robert Bierkandt, Peter-Paul Pichler, and Karen C. Seto. "Global Typology of Urban Energy Use and Potential for an Urban Mitigation Wedge." PNAS, 2014, doi:10.1073.

3. Compact • GHG reductions

Compact and accessible urban form and the elimination of energy subsidies have the potential to reduce energy-related GHG emissions by 26 percent over business-as-usual at negative cost (e.g., monetary savings) or at very low cost.

Creutzig, Felix, Giovanni Baiocchi, Robert Bierkandt, Peter-Paul Pichler, and Karen C. Seto. "Global Typology of Urban Energy Use and Potential for an Urban Mitigation Wedge." PNAS, n.d. doi:10.1073.

4. All • Productivity

According to work by The New Climate Economy, $3 trillion in capital investment from urban infrastructure improvements can be achieved over the next 15 years by pursuing better urban form and transportation strategies.

Better Growth, Better Climate: The New Climate Economy Report. The New Climate Economy, 2014. http://static.newclimateeconomy.report/wp-content/uploads/2014/08/NCE_Chapter2_Cities.pdf.

5. All • GHG reductions, Productivity

A case study of five large cities found GHG emissions can be reduced by 14-24 percent through cost-effective investments and 22-45 percent in reductions are available through cost netural measures. These numbers imply 10-18 percent to 15-34 percent lower global energy-related emissions in 2025.

Gouldson, Andy, Sarah Colenbrander, and Faye McAnnulla. The Economic Case for Low Carbon Cities. Stockholm Environmental Institute, November 2014. http://www.sei-international.org/mediamanager/documents/Publications/NCE-SEI-2014-Economic-Case-Low-Carbon-Cities.pdf.

UNITED STATES

6. All • GHG reductions, Productivity, Government revenue, Health

Smart growth in California would lead to the following benefits by 2050: 67 percent less land consumed, 19 percent lower capital infrastructure costs, 18 percent lower operations and maintenance costs, 16 percent increase in local government revenues, 38 percent less air pollution (GHGs and local pollutants) from transportation, and 27 percent savings in health costs.

Calthorpe, Peter. Vision California: Charting Our Future. Calthorpe Associates, May 2010. http://www.calthorpe.com/files/Vision%20California%20-%20Charting%20Our%20Future%20-%20Summmary.pdf.

7. Densify • GHG reductions

The study finds consistently lower household carbon footprints (HCF) in urban core cities where population densities are higher (~40 tCO_2e) and higher carbon footprints in outlying suburbs (~50 tCO_2e), with a range from ~25 to >80 tCO_2e in the 50 largest metropolitan areas. Population density contributes to relatively low HCF in the central cities of large metropolitan areas. The more extensive suburbanization

in these regions contributes to an overall net increase in HCF compared to smaller metropolitan areas.
Jones, Christopher, and Daniel Kammen. "Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density." Environmental Science Technology 48, no. 2 (2014): 895–902.

8. Walk • Property values

Walkable urban areas across the United States command higher rents, and this premium is about 74 percent higher for office space in walkable areas.
Leinberger, Christopher, and Patrick Lynch. Foot Traffic Ahead: Ranking Walkable Urbanism in America's Largest Metros. Center for Real Estate and Urban Analysis at George Washington University, 2004. http://www.smartgrowthamerica.org/documents/foot-traffic-ahead.pdf.

9. Walk • Property values

Homes in walkable neighborhoods enjoy a price premium of about $4,000 to $34,000, based on a study of 15 metropolitan areas in the United States.
Cortright, Joe. Walking the Walk: How Walkability Raises Home Values in U.S. Cities. CEO's for Cities, 2009. http://blog.walkscore.com/wp-content/uploads/2009/08/WalkingTheWalk_CEOsforCities.pdf.

10. Shift • GHG reductions, Energy and other savings, Productivity, Congestion

The Texas Transportation Institute found that the total cost of congestion for the United States in 2011 is $121 billion, taking into account the costs of delay, wasted fuel, CO_2 emissions, and truck congestion.
Schrank, David, Bill Eisele, and Tim Lomax. Urban Mobility Report 2012, December 2012. http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/mobility-report-2012.pdf.

11. Shift • Productivity

In Utah, congestion pricing has been found to generate about $50 billion of social benefits and create 17,000 permanent jobs.
Brown, Michael. "Who Wants to Be a Billionaire? Embrace Congestion Pricing." Bacon's Rebellion, July 2014. http://www.baconsrebellion.com/2014/07/who-wants-to-be-a-billionaire-embrace-congestion-pricing.html.

12. Mix • Health

Each quartile increase in land-use mix is associated with a 12.2 percent reduction in the likelihood of obesity across gender and ethnicity.
Frank, LD, MA Andresen, and TL Schmidt. "Obesity Relationships with Community Design, Physical Activity, and Time Spent in Cars." American Journal of Preventative Medicine 27, no. 2 (August 2004): 87–96.

13. Transit, Compact • Energy and other savings

Portland saves $1.5 billion per year in transportation costs from having shorter commutes through good public transit and compact development. Portland has an average daily commute of 20.3 miles, versus 24.3 for populous areas in the United States. Residents avoid 2.9 billion miles of driving each year.
Cortright, Joe. Portland's Green Dividend. CEO's for Cities, July 2007. http://blog.oregonlive.com/commuting/2009/09/pdx-greendividend.pdf.

JAPAN

14. Densify • Human mobility

Higher density areas are correlated with better access to stores, medical facilities, and other public services.
Kaido, K., and J. Kwon. "Quality of Life and Spatial Urban Forms of Mega-City Regions in Japan." In World Cities and Urban Form: Fragmented, Polycentric, Sustainable?. New York: Routledge, 2008.

KOREA

15. Transit • Human mobility

BRT improved speeds on all roads where it was put into practice in Seoul. The speed improvement ranged from 32 percent to 85 percent.
Cervero, Robert. Bus Rapid Transit: An Efficient and Competitive Mode of Transportation. 20th ACEA Scientific Advisory Group Report, 2013.

BRAZIL

16. Shift • Productivity

In Rio and São Paulo, congestion costs the city about 7.8 percent of metropolitan GDP.

Rio de Janeiro and Sao Paulo Lost USD 43 Billion from Traffic Congestion in 2013. Industry Federation of the State of Rio de Janeiro, 2014.

NORWAY

17. Bike • Air quality, Energy and other savings

The benefits of bicycle networks are to be at least four to five times the cost of implementation as seen in evidence from three cities in Norway. The study finds that a change from motorized to non-motorized transportation reduces air pollution, noise, and parking costs. Moreover, "barrier costs" from motorized transport preventing non-motorized transportation from being used are just as high as the air pollution costs and double the noise pollution costs. These "barrier costs" are often not taken into account when doing cost-benefit analysis in favor of bike lanes.

Saelensminde, Kjartan. "Cost-Benefit Analyses of Walking and Cycling Track Networks Taking in Account Insecurity, Health Effects, and External Costs of Motorized Traffic." Transportation Research Part A: Policy and Practice 38, no. 8 (2004).

COPENHAGEN

18. Bike • GHG reductions, Energy and other savings, Congestion, Government revenue, Health

Copenhagen saved over $43 million in external costs due to shift from vehicles to bikes. For example, in terms of health, they estimate that Copenhagen residents saved $1 per 1 km cycled.

Copenhagen Cleantech Cluster. Copenhagen Solutions for Sustainable Cities. State of Green, 2014. http://subsite.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/Business/~/media/9E5C396089DA478D906A77C16C52F3AF.ashx.

MEXICO

19. Transit • Property values

The rent premium for developments located less than a mile from transport hubs is 26.8 percent.

Cushman & Wakefield. Urban Development: Faster Greener Commutes Key to Sustained City Growth. Cushman & Wakefield, 2014. http://www.cushmanwakefield.com/~/media/reports/corporate/Global%20Reports/CW_North%20American%20Transit%20Report%20Fall%202014.pdf.

NEW ZEALAND

20. Densify • Productivity

Investments in improving infrastructure for bikes yields benefits that are 10 to 25 times greater than the costs.

Macmillan, A. "The Societal Costs and Benefits of Commuter Bicycling: Simulating the Effects of Specific Policies Using System Dynamic Modeling." Environmental Health Perspectives 122, no. 4 (2012): 335–44.

CANADA

21. Densify, Mix • Energy and other savings

In Fort St. John, Canada, the Sheltair Group compared two urban patterns – low density and residential versus medium density and mixed-use. They found that each household will save $2,353 per year from lower capital and operating costs in the medium density and mixed-use case. Moreover, the government will save $294 per year for each household on infrastructure costs.

Sustainable Neighborhood Concept Plan, Fort. St. John: Draft for Community Review. The Sheltair Group, May 2009. http://www.fortstjohn.ca/sites/default/files/report/Sustainable%20Neighbourhood%20Concept%20Plan.pdf.

COST MANAGEMENT

For many developing countries, urbanization has become an inevitable trend and a primary development strategy to efficiently allocate resources by creating dense population pockets. While smart urban form and transportation planning are necessary, they are insufficient on their own. Well-enforced environmental standards, affordable housing policies, and management of the inconveniences of construction are also key components to induce smart growth.

POLLUTION

Urbanization gone awry can worsen pollution. However, when done right, cities can be livable, sustainable, and productive. Smart urban form and transportation can alleviate congestion. But other steps are needed as well to ensure that the density of people does not create a pollution hotspot. These steps include: motor vehicle tailpipe and boiler air pollution controls, building and appliance energy standards, effective environmental monitoring and enforcement, and adequate green space and vegetation. A package of policies are needed that comprehensively address, and thus minimize, the potential downsides of urbanization. This allows the potential upsides to dominate the cost-benefit calculus.

HOUSING COSTS

Affordable housing is another important concern of residents in dense, urban areas. Constraints on land supply can substantially increase the cost of housing. In fact, while floor space is often more expensive in denser areas, it is also often true that transportation costs are much lower in compact cities with quality transportation. Compact growth contributes to the cost-effectiveness of transit infrastructure. In Portland, transportation costs are 7 percent less than comparable Western cities. The savings on transportation costs can be so large as that they outweigh the price increases in housing costs. Take the examples of New York City and San Francisco, which are known for their expensive housing prices. Compared to the 20 other largest cities in the United States, New York City and San Francisco have the second and third lowest percentage of income spent on housing and transportation. Still, local governments must be cognizant of how to make housing affordable for all income levels in the city.

NOISE AND AIR POLLUTION FROM CONSTRUCTION

Local political roadblocks in the form of height limits and other zoning rules can slow construction. People do not like construction going on nearby and they worry that higher density inevitably means worsened congestion. It is important for policymakers to help to overcome the natural resistance of existing local residents who frequently are disinclined to support nearby development for fear of the disruptions of construction. We hope that this report can help policymakers communicate the benefits of smart, transit-oriented growth that puts people first.

GAPS ASSESSMENT

While this survey has culled from a large literature base, there are still gaps in our knowledge, especially when it comes to China-specific research. We seek suggestions for other work that should be included. We see the following gaps in the literature as priorities for further research:

1. Development of an urban solutions marginal abatement cost curve for China with quantified air quality benefits and their costs.

While we have found studies of air quality benefits (GHG emissions and local air pollutants) in China's cities due to urban form and transportation improvements, we have found very few that estimate the costs of such measures. The only examples we are aware of are ITDP's assessments of GHG reductions due to the introduction of a BRT system, which includes a cost and municipal finance assessment. Some recent work from the New Climate Economy consortium has provided compelling new evidence at the global scale, but more granular national-level work remains to be done.

2. Quantifying consumer preferences and trends for walkable, transit-oriented neighborhoods in China.

How are consumer preferences for neighborhoods and city spaces changing as China urbanizes? Is there a preference for walkability over car-dependent neighborhoods? Do these preferences change based on location, age, gender, or income class?

3. Case studies that combine public and private (e.g., investor) perspectives to evaluate new developments or redevelopments in the Chinese context.

What are the impacts on urban infrastructure costs in China of smaller, more connected, blocks in contrast to the default pattern of superblocks and large arterial street grids? Also, on a more granular level, what are the cost impacts of one-way couplets, mixed-use land developments, walkability efforts, and bike lanes?

4. Understanding the bike-rail connection.

The studies we have collected suggest a somewhat nuanced interaction. In congested areas, bike-share and motorized public transit can act as substitutes. Introducing bike-share serves to siphon off some motorized transit riders. This was the case in Washington, D.C., where the bike-share programs allevi-

ated congestion on public transit in the city center. In another study from Nanjing, based on data from the entire transit system and not just in the suburbs or city center, researchers found that bike parking increased transit use. We would like to further understand the relationship between biking and taking public transit, and how these two transportation modes can best work together.

5. Clarifying the connection between commercial activity and more walkable and bike-friendly neighborhoods.

We are interested in more evidence of the commercial and economic effects of making neighborhoods more conducive to walking and biking. We have some anecdotal evidence that downgrading car privileges, such as transforming a small parking lot into a plaza, increases sales at nearby businesses despite their initial concerns. Also, a tantalizing line of thinking is that greater density is particularly beneficial for service industry development. The Chinese leadership's interest in service sector growth as an aspect of economic rebalancing means this is important to explore.

6. Better characterization of the public health benefits from decreased congestion.

There has been some good work on the time lost and money spent on infrastructure due to traffic congestion. We have yet to find much quantification of the public health benefits and other indirect quality of life benefits of transportation solutions that reduce congestion.

7. Understanding how price premiums for properties next to public transit stations change over time.

Evidence from Beijing shows that values of properties next to BRT stations grow at a faster rate, but we have only found a few other studies in China indicating this. We have found a range of stories about positive real estate value effects due to proximity to transit. It would also be productive to explore these economic dynamics over time, and to find out if locations next to transit locations also mean more home sales.

8. Understanding the impact of small blocks and increased intersection density on neighborhoods.

Block size is one of the largest flaws in current Chinese planning practice. Large, single-use blocks are often built due to the ease of zoning, speed of construction, and consumer preference for large courtyards. However, there are isolated examples of small block neighborhoods in China (e.g., Liuyun Xiaoqu in Guangzhou and Xintiandi in Shanghai), and there are probably many more that have not been studied. The literature has a gap in understanding the economic, environmental, and social impacts of smaller block sizes in China.

9. Understanding urbanization patterns and the impact of The 8 Principles on second- and third-tier cities in China.

In general, there has been an emphasis in the urbanization literature on studying the largest and most developed cities in China. However, it is the second- and third tier cities that will go through the most changes and need the most information on how to optimize their urbanization process.

CONCLUSION

In some ways, we are in the early days of urbanization science. It is challenging to do statistical work on neighborhood-scale interventions because it is nearly impossible to find ideal control groups of any sample size. Every city is different. This is true of many other large-scale questions regarding public policy.

Fortunately, researchers have shown creativity in exploring the quantitative dimensions of the type of solutions represented by The 8 Principles of *Planning Cities for People*. Despite the near impossibility of achieving the gold standard of laboratory style experimental design, a significant body of research has been amassed.

Our review of the best evidence indicates that there are strong indicators that The 8 Principles will return substantial net benefits in the environmental, economic, and social realms.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