

The 2018 edition of Arcadis' Sustainable Cities Index (SCI) explores city sustainability from the perspective of the citizen. We seek to understand in more depth how different cities enable different citizen groups to meet their particular needs.



In many cities, citizens face huge challenges to meet their basic needs of survival, including shelter, access to food, water and warmth. Once these are met, the human need for community, managing society and moving from “A to B” take on far greater importance. Cities are powerful engines that bring people together and allow for resource sharing to meet collective needs. Our study highlights that emerging needs, such as digital connectivity, are being addressed in cities at all levels of sustainability.

A critical point is that human needs are fundamentally hierarchical in nature. And if certain needs are not met, for example if housing is too expensive, then dissatisfaction will follow. The SCI and other studies show that even highly developed cities can struggle to meet the basic needs of their citizens. As a result, the level of peoples' satisfaction associated with their purpose or well-being are undermined. Viewed from a citizen's perspective, a city that is highly ranked as sustainable but with elevated levels of congestion not meeting accessibility needs, is not truly sustainable.

This points to a series of core challenges for all cities that influence not only how they seek to improve their performance, but also how they prepare for a digitally-driven transformation. It is important to look at how cities maintain services at current levels of performance as they evolve, specifically if they use innovation to ensure that currently recognized needs and wants are met. Second, how they allocate new resources to meet changing citizen requirements – prioritizing initiatives to ensure that the greatest benefits are delivered. Finally, how do cities ensure that they are fit for the future – preserving resources so that the needs of tomorrow's citizens can be met as well as responding to changes in business models and economic circumstances.

In the 2018 edition of the SCI, we continue our exploration of the People, Profit and Planet dimensions of city sustainability, building a greater understanding of the underlying characteristics of cities that enable some to outperform their peers. Our intention is that by initiating further debate on the nature of long-term success, cities will continue to challenge themselves to meet the needs of their people for both today and tomorrow.

John Batten, Global Cities Director

The Sustainable Cities Index ranks 100 global cities on three pillars of sustainability: People (social), Planet (environmental) and Profit (economic).

The SCI overall findings highlight the following:

- The importance of the Profit pillar as a driver for long-term sustainability
- The need for mid-ranking cities to improve their performance across all pillars as a differentiator
- The growing potential for cities to use the digital evolution of their service provision to promote engagement with citizens and as a key means of improving the citizen experience of city life.

London is ranked the world's most sustainable city in 2018 with particularly high scores in the People and Profit pillars. The results highlight that strengths reflected in London's status can offset challenges associated with affordability and congestion. London's Planet ranking is lower, but still in the upper quartile, reflecting air quality and waste management issues seen in other large cities.

Stockholm, Edinburgh, Singapore and Vienna complete the top five in the Index. Whereas Stockholm and Vienna score highly against Planet criteria, Edinburgh is aligned more closely to the People agenda. Singapore is highest ranked in the Profit sub-index by a considerable margin.

The top 20 sustainable cities are mostly established European metropolises. Additionally, representing Asia are Singapore, Hong Kong and Seoul - both well-established trading cities. New

York, San Francisco and Seattle are the only U.S. cities in the top 20. Two additional cities, Tokyo and Sydney, are lower – ranking high for People, but need to improve in both Profit and Planet.

Major cities across Africa and Asia are represented in the bottom 10 of the rankings. Importantly, it is the Profit performance of these cities, particularly related to ease of doing business and output that contributes to their weak relative performance. Growing a robust local economy is a critical aspect of long-term sustainability, particularly given the close association of economic performance with improved quality of life.

Although coastal cities including New York and Seattle feature in the top 20, most U.S. cities fall in the bottom half of the ranking. U.S. cities tend to score evenly across the three pillars, highlighting that these cities face broad challenges across all pillars to improve their sustainability. In Latin America, Santiago, São Paulo, Mexico City and Buenos Aires are all tightly clustered at the top of the bottom quartile, typically scoring better in People and Planet than in the Profit pillar.

Kuala Lumpur benefits from consistent scores across all pillars and outranks all the cities in China except for Shenzhen as well as a number of U.S. and European cities.

Performance across the People pillar is relatively consistent across



the top 50 cities. Edinburgh tops the sub-index, and the other cities have scores within +/- 10%. Affordability of city life, access to public transport and income inequality are the big swing variables. A cluster of cities at the bottom of the rankings highlights the challenge of meeting citizen needs in many emerging economies. The affordability, health, education and digital infrastructure indicators all point to deep-seated challenges associated with improving life experiences in emerging cities.

A group of smaller European cities led by Stockholm, sit at the top of the Planet sub-index. Determinants of a high ranking include low carbon energy infrastructure and significant green spaces. The expanded 2018 Index also tracks investment in low carbon transport infrastructure, including bike sharing and electric vehicle incentives – highlighting the rapid adoption of these solutions in many cities.



The Profit sub-index highlights the extreme disparities in income. The top of the sub-index is dominated by global financial centers. Singapore, London and Hong Kong head up the list and hold a sizeable lead over New York in 4th place. Sixty cities, ranging from Oslo in 15th place to Lyon in 74th place, have scores within a range of +/-20% highlighting complementary strengths in employment, tourism or ease of doing business. Ten cities, all in developing countries have a lower ranking due to challenges in output, ease of doing business and innovation infrastructure.

The research features new work on city archetypes and clusters aimed at explaining the implications of a citizen experience showing a close correlation to the SCI rankings. The four city clusters used are based on an analysis of the citizen experiences of city living combined with the Index data.

The city clusters are:

- **Balanced Innovators:** Thirty-five cities in the SCI fall into this cluster and have an average ranking of 21st. Particularly strong in People and Profit sub-indices.
- **Post-industrial Opportunists:** Thirty-three cities in the SCI fall into this cluster and have an average ranking of 49th. Typical strengths are aligned to the People and Planet sub-indices. Cities in this cluster are mostly U.S. with some in Europe and Australia.
- **Evolutionary Cities:** Nineteen cities in the SCI fall into this cluster and have an average ranking of 84th. Cities are particularly weak in the Profit pillar. The cluster includes highly disrupted Western cities such as Athens as well as a number of large, emerging market cities.
- **Fast-growing Megacities:** Thirteen cities in the SCI fall into this cluster and have an average ranking of 85th. The Profit pillar is also weaker for this cluster. Cities in this cluster include very large cities from China and India.



Building a sustainable partnership

Our latest update of the SCI highlights the rapid impact that digital technologies are having on the citizens' experience of the city and on the relationship between city and its people. As the adoption of automated city services expands and as cities become more reliant on citizen-sourced data to support basic functions, this relationship will become even more complex.

The rapid development of urban mobility solutions, whether delivered by mass transit, ridesharing or ultimately by connected and autonomous vehicles (**CAV**) is perhaps the most extreme example of this rapidly evolving trend. Changes in mobility are already irreversibly shifting the way in which cities operate – only 15% of private-hire car journeys are now undertaken by licensed taxi cab in San Francisco – the harbinger of much greater change that could occur if Mobility as a Service (MaaS) develops at the pace predicted by forecasters.

The citizen centric analysis presented in the SCI highlights the dramatic impact of change affecting most city dwellers' experience of their city. There is little evidence of stability and balance in many citizens' lives, even in the highly sustainable cities at the top of the rankings.

The additional dynamism lent to cities through digital disruption is both a threat and an opportunity for city leaders. On the positive side, emerging opportunities for greater understanding of how cities operate through data as well as means to communicate to citizens through a range of digital platforms should enable cities to

be managed more effectively on behalf of all stakeholders. On the negative side, greater awareness of the pace and scale of change may detract from city living and some stakeholders - whether businesses, politicians or an elite may wield disproportionate influence over future investment and management priorities.

"The additional dynamism lent to cities through digital disruption is both a threat and an opportunity for city leaders."

However, the real negative is that new technologies are not, on current trajectories, going anywhere far enough or fast enough to mitigate many of the negative impacts of city living. The cities at the top of the Index have succeeded in achieving a degree of sustainable balance not only due to an historic economic legacy but also due to far-sighted decisions taken to manage the impacts of growth. London's sewers, New York's grid-based planning and Copenhagen's green infrastructure are all examples of far-sighted thinking that has helped to mitigate some of the problems of today and of the future.

Reflecting on the findings of the SCI and growing evidence of the importance of the citizen perspective, we highlight three aspects of citizen centric cities that will be critical in underpinning long-term city sustainability.

- **Short-term vs. long-term:** Compared to the long-term challenges of city sustainability, many aspects of digital disruption are inconsequential "noise". Cities must keep their focus on long-term resilience, even as they navigate their way through short-term change.
- **Firm foundations:** The SCI data consistently highlights that the foundations of city sustainability are an educated and healthy workforce, effective low-carbon infrastructure and ease of doing business. Irrespective of where a city is positioned in the SCI rankings, these attributes should never be put at risk by city planning.
- **Share the journey:** City sustainability is a long-term project and cities are increasingly connected. Maintaining a city's long-term competitiveness and resilience will need to be a shared mission. User perspectives, data and digital platforms enable unprecedented levels of collaboration and cities have a key role in leading the way.



What enables a city to meet present and future needs?

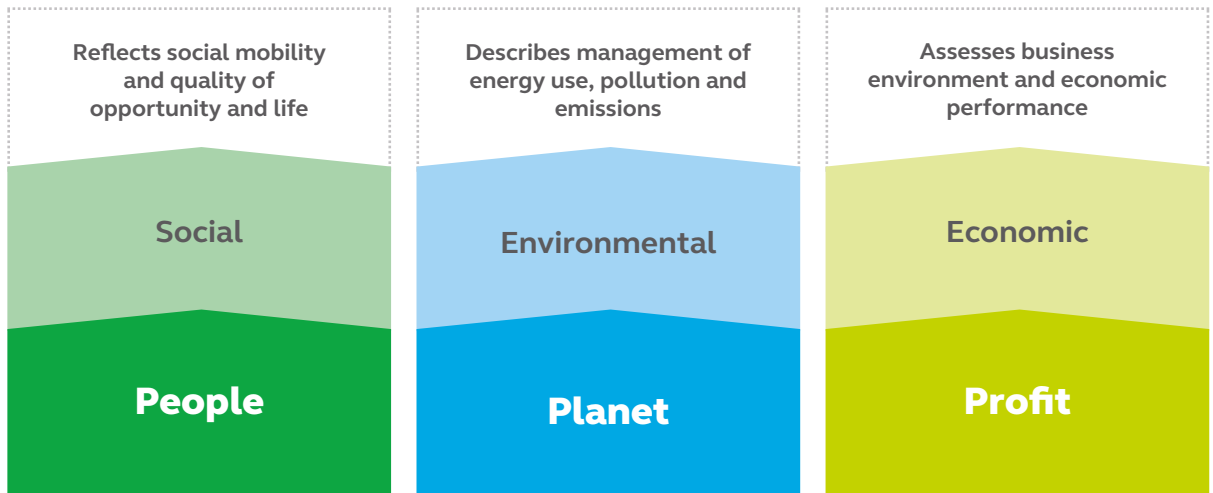
Sustainable cities can be thought of as places that are planned and managed with consideration for social, economic, environmental impact, providing a resilient habitat for existing populations, without compromising the ability of future generations to experience the same.

Accordingly, measures of sustainability need to be able to measure current city performance, ability to mitigate future impacts as well as investment in future capability – ideally measured from the perspective of the citizen.

The three pillars

The Sustainable Cities Index is a broad measure of sustainability, encompassing measures of the social, environmental and economic health of cities as shown in Figure 1.

Figure 1: The three pillars of sustainability



The Sustainable Cities Index ranks 100 global cities on three pillars of sustainability: **People**, **Planet** and **Profit**.

The three pillars are closely aligned to the UN Sustainable Development Goals (SDGs) and track progress against UN SDG commitments covering:

- Health and well-being
- Water and sanitation
- Industry, innovation and infrastructure
- Inclusive, safe, resilient and sustainable cities
- Climate change impacts
- Life on land
- Partnership.

The UN SDGs emphasize the cross-cutting nature of sustainability initiatives and the necessity for all cities to take a balanced approach in developing an agenda. In this release of the SCI, we bring an additional focus on how the characteristics of cities contribute to, or hold back, the development of sustainability initiatives. Understanding citizen needs and how cities function is key to identifying how initiatives to improve sustainability performance can be effectively implemented.

Metrics used to build the People sub-index indicators measure city performance in terms of:

- Personal well-being (health, education, crime),
- Working life (income inequality, working hours, the dependency ratio)
- Urban living (transport accessibility, digital services and other amenities).

Data included in the Planet sub-index ranks cities according to environmental impacts covering:

- Immediate needs of citizens (water supplies, sanitation and air pollution)
- Long-term impacts (energy consumption, recycling rates, greenhouse gas emissions)

- Investment in low carbon infrastructure (renewable energy, bicycle infrastructure and electric vehicle incentives)
- City resilience (natural catastrophe exposure and risk monitoring).

Metrics underpinning the Profit sub-index include:

- Effectiveness of transport infrastructure (rail, air and traffic congestion)
- Economic performance (GDP per capita, employment rates, ease of doing business, tourism, position in global economic networks)
- Business infrastructure (Mobile and broadband connectivity, employment rates and university technology research).

In 2018 we have revised the indicators of the indices to give greater emphasis to the digital capabilities of cities. We use the adoption of digital solutions as a proxy measure for the pace at which cities are equipping themselves to meet future needs. Connectivity, mobility, citizen engagement and disaster management are all areas where the adoption of new digital solutions will enable cities to accelerate their sustainable development.

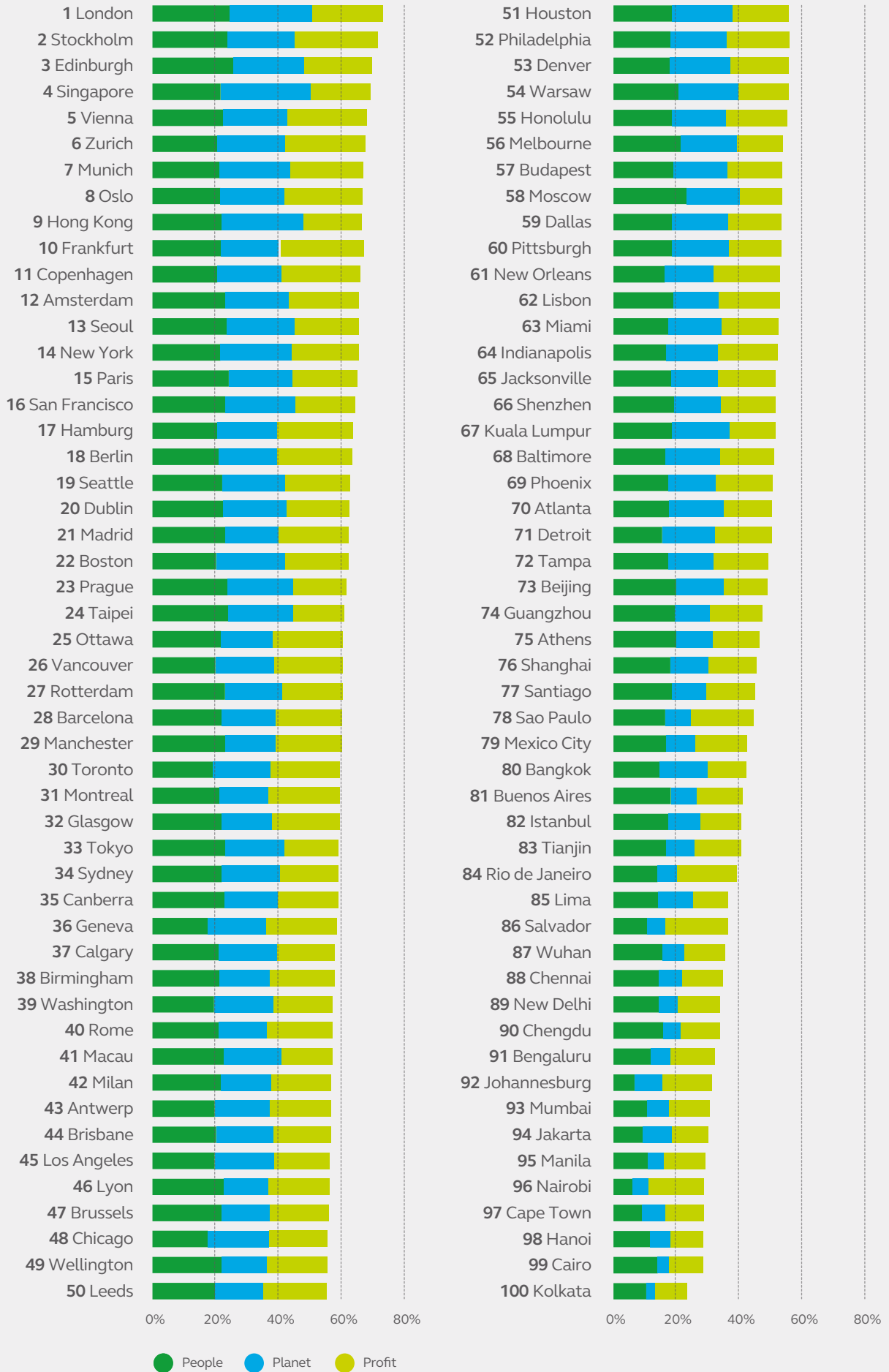
London tops the Index, ranking second in both People and Profit as well as ranking 11th against the Planet sub-index. London is one of few high performing balanced cities in the Index with similar scores across the three pillars.

- Most highly ranked cities score well in one or two pillars. This is exemplified by Singapore and Hong Kong, both of which are in the top 10 driven by very high Profit rankings and middle of the road People and Planet rankings. Most of the top 10 cities do have very high Planet scores - these are Northern European cities, exemplified by Stockholm and Frankfurt which have been highly successful in combining economic prosperity and environmental stewardship.
- The U.S. has four cities in the upper quartile. The Profit pillar is typically strong for these cities, New York ranked 14th overall and 4th in Profit. Interestingly, Seattle, ranked 19th, is the epitome of a balanced city, ranking around the upper quartile in all three pillars. We include a large sample of U.S. cities in the Index and 15 of them rank between 50th and 75th, an exceptionally consistent pattern. These cities are mid to low ranking across all pillars, highlighting the complex challenge that post-industrial cities face. Most of the U.S. cities are in the process of a post-industrial transition, where cities are having to balance immediate investment in response to change with long-term sustainability. Sometimes this investment comes at the expense of legacy employment and with a greater sense of competition between city peers for available investment. We describe the citizen experience in these cities as *Post-industrial Opportunists*.
- Sixteen European cities are in the upper quartile. Many of these, Amsterdam and Vienna, for example, are balanced cities where our measures suggest that the needs of citizens, business and the environment are all served well. Cities in Southern Europe such as Spain, Italy, and Greece, score less well in the Profit Pillar, while cities more to the east such as Prague, Warsaw and Moscow face greater challenges associated with their sustainability agenda.
- Many of the European cities are increasingly reliant on automated systems and data to support their effective operation. They are also sensitive to corporate priorities for what makes a successful and sustainable city. We term the citizen experience in these cities *Balanced Innovators*.
- In Asia, we find a clear distinction between the well-established Seoul and Tokyo and a large group of cities in China and emerging markets. Of 23 cities in the sample, 14 are in the bottom quartile, facing significant challenges across all pillars. The performance gap affecting cities in the bottom quarter of the ranking is particularly daunting - figure 2 highlights that scores are disproportionately low. Delivering sustainable growth from such a baseline will require huge progress against the agenda set out by the UN SDGs. These cities are characterized by higher levels of informality. We have developed two models to describe these cities - *Evolutionary Cities* and *Fast-growing Megacities*, reflecting the scale of cities in these clusters and the balance between organized and informal activities in the cities.
- All cities in Latin America can be found in the lowest quartile. All seven cities in the sample are clustered within a range of 10 cities at the top end of quartile rankings. Latin American cities score relatively well in People and Planet but do less well in the Profit rankings. This is a common pattern for lower ranking cities. Citizen experience in Latin American cities most closely fits the *Evolutionary Cities* cluster.
- Overall, the results of the Index highlight that a cluster of relatively small European cities are particularly successful in balancing well-being and economic performance and are taking steps to mitigate some aspects of environmental impact. However, further down the scale, cities which represent the fastest growing economies, in Asia, South America and Africa all face huge challenges to deliver citizen-centric growth while mitigating wider environmental impacts. Analysis of the three pillars provides further insight into these challenges.

“Our neighborhood is very good. People are so caring, and we can spend a lot of time with our neighbors.”

Pooja, 44, New Delhi, India

Figure 2: Overall Index Rankings



The People sub-index

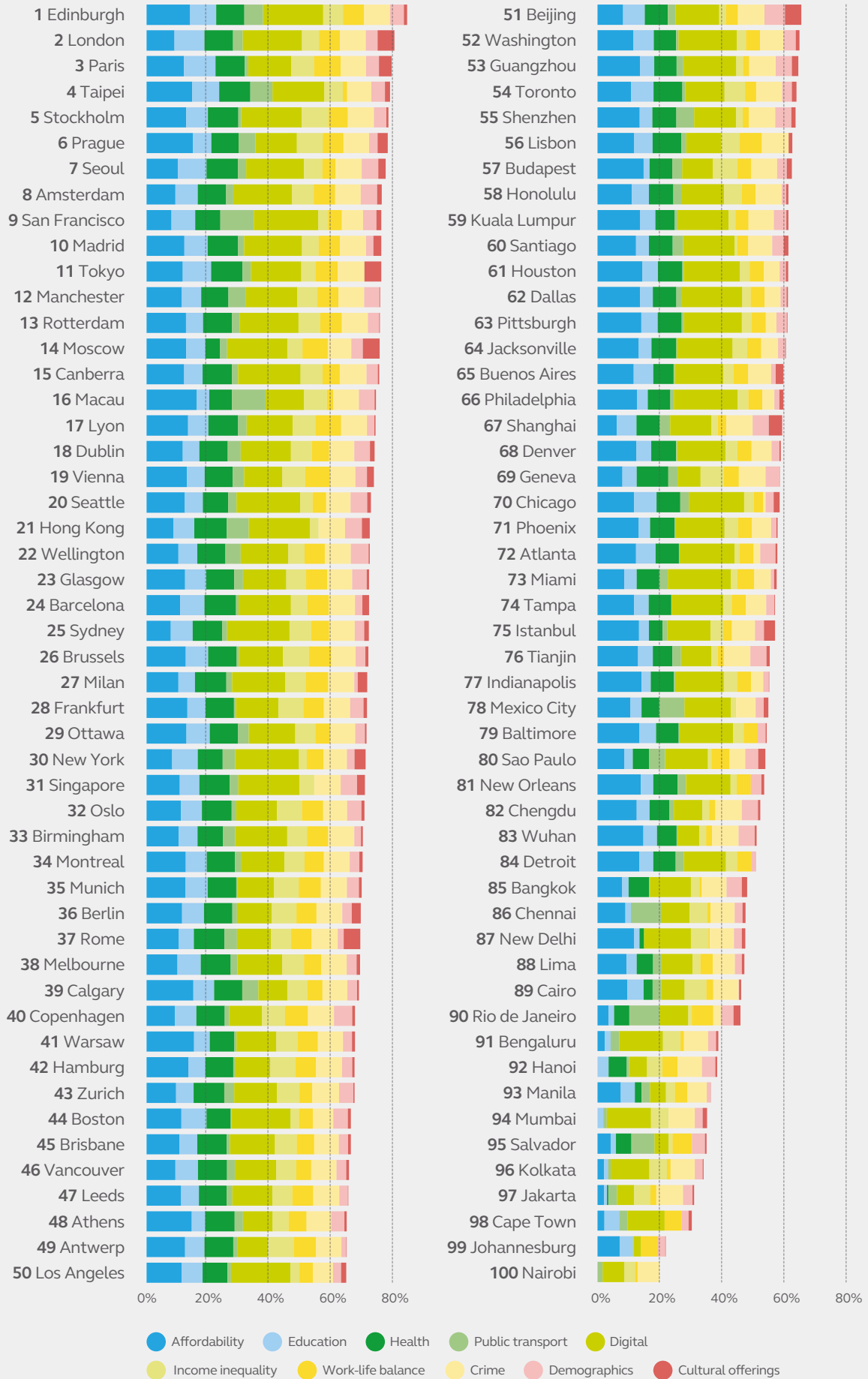
The People sub-index measures social sustainability - quality of life in the present and prospects for improvement for future generations. Our working hypothesis is that factors like good health and education hold the key to current social sustainability, and that a city's digital infrastructure will set the foundation for future quality of life. The People sub-index addresses UN SDGs dealing with poverty, health and well-being, education and reduced inequalities.

- Edinburgh ranks first here based on the combination of a highly educated and healthy workforce, a reasonably equal distribution of income and low crime rate.
- The rest of the top 10 includes smaller cities from Europe, developed cities in Asia and San Francisco representing the U.S. All these cities have strengths and weaknesses, but a recurring feature of these cities is their relatively high education scores, reflecting university rankings as well as participation rates. There are also some indications of a better digital experience. All cities in the top 10 form part of the *Balanced Innovator* cluster.
- Typically, cities in Europe, developed Asia and Oceania score well in the People sub-index. Cities in the U.S. are lacking, with only two in the upper quartile. The citizen experience of U.S. cities is affected by higher than average income inequality, crime and limited access to public transport. Many U.S. *Post-industrial Opportunist* cities are ranked below 50th in the sub-index.
- Santiago and Buenos Aires score relatively highly in the People sub-index based on reasonably strong scores in health and education, making them peers of many cities in the U.S. However, cities in Brazil, Mexico and Peru rank much lower as a result of poorer educational attainment and digital provision.
- The bottom three cities are all found in Africa but cities from all continents other than Europe and Oceania can be found in the lower quartile. Scores are particularly low for health and education outcomes, affordability and digital capability. Crime, income inequality and work-life balance are worse than for other cities but in reality, the performance of most cities in the lower half of the sub-index is significantly worse than the top half of the sub-index, highlighting common challenges for many cities in Africa, Asia, Southern Europe and the U.S. This finding highlights challenges for the citizen experience across most city types, particularly in *Evolutionary Cities* such as Jakarta or Cape Town.
- As part of our increased focus on the forward-looking capability of the city, we have also looked at how cities are using technology to improve quality of life for their citizens. Our ranking takes into account digital services associated with transport and property taxes as well as measures of connectivity including the affordability of broadband and the availability of Wi-Fi.
- The top 10 cities score well across these metrics, with cities such as San Francisco clearly having many digital advantages. However, aspects of digital services including Wi-Fi and digitally-accessed transport are widely available in a large share of the cities sampled, only in the bottom quartile does a real digital gap emerge. Digital is a strong point for U.S. cities, with only three cities having low levels of digital integration in the transport system.

“There's a real shortage of housing. That's why house prices and trending prices are sky high. You pay a lot of money for not a lot of space.”

Kirsten, 27, Amsterdam, Netherlands

Figure 3: People sub-index



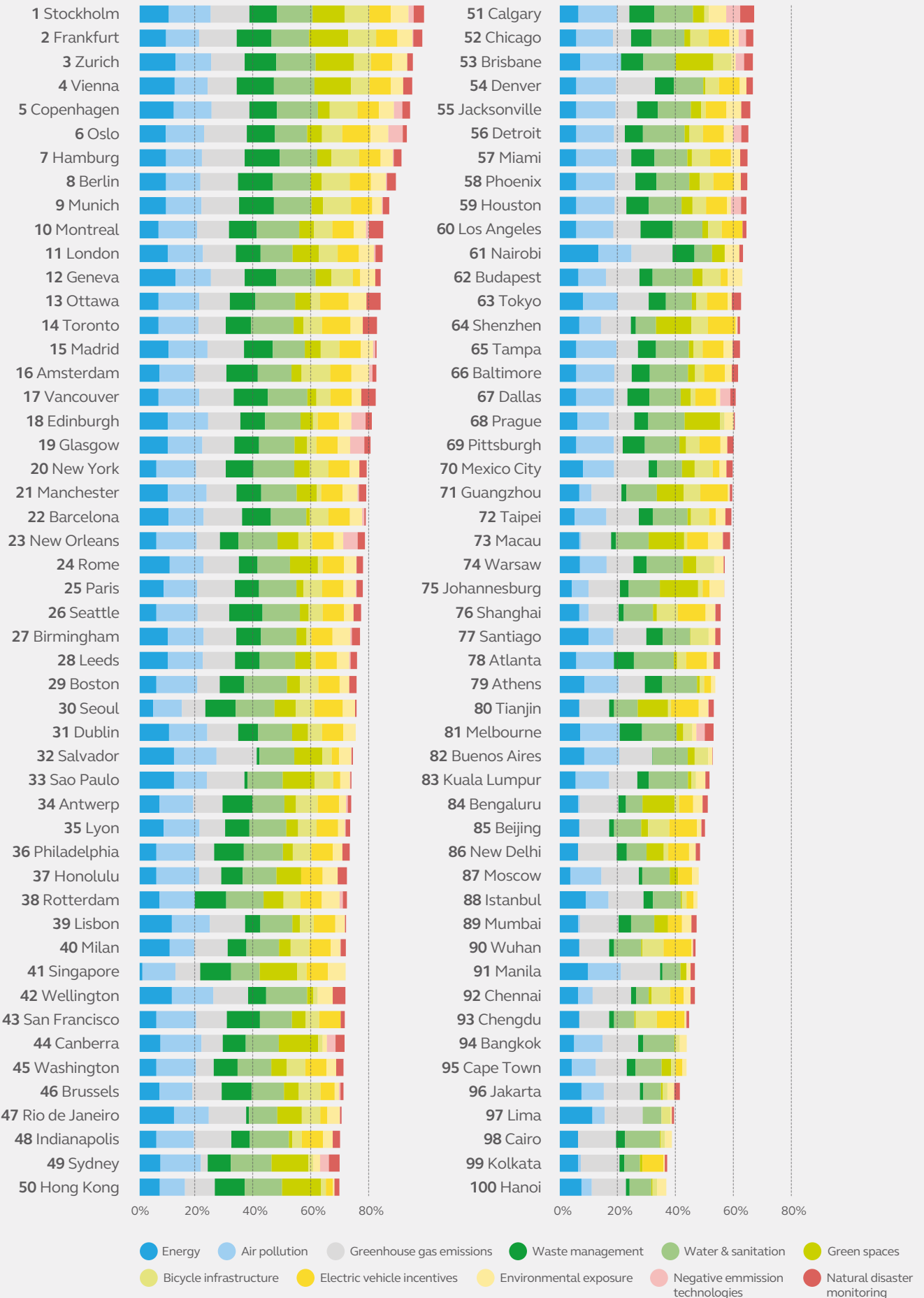
The Planet sub-index measures the sustainable attributes of a city such as green space and pollution in addition to leading indicators of environmental mitigation such as support for low carbon transport. The Planet sub-index addresses UN SDGs for clean water and sanitation, clean energy and climate action.

- Our data highlights that all cities in the upper quartile of the Planet sub-index are European or North American cities including four from Canada. Asian cities including Hong Kong and Singapore which score well overall do less well in the Planet sub-index – partly due to resilience risks associated with their exposure to natural catastrophe. This is a problem also faced by many cities in the U.S.
- Stockholm leads the Sustainable Cities Index on the Planet pillar, thanks to investment in sustainable infrastructure, low emissions and good air quality. For the top 10 cities, distinguishing features tend to be the legacy of lots of green space, below average air pollution and effective waste management. As a leading indicator of investment in low-carbon infrastructure, all of these cities have made significantly larger investments in bicycle infrastructure than many of their peers.
- The remainder of cities in the top half of the sub-index are located in Europe, Oceania, Brazil and (mostly) coastal cities in the U.S. These all fit the *Balanced Innovators*. Accordingly, this means that 14 cities in the U.S., including Chicago, Houston and Los Angeles are in the bottom half of the sub-index. All U.S. cities have a below-average energy use profile, and these three cities also have limited green space provision as well as sub-par waste management. In paradox, in car-loving U.S. cities, air quality is typically good, although greenhouse gas (GHG) emissions tend to be on the high side.
- The natural attributes of Latin American cities including São Paulo and Salvador mean that these cities score highly across most of the Planet sub-index rankings and appear in the top half of the rankings. Waste management tends to be challenging in these cities, leading to lower scores for some cities including Buenos Aires.
- Cities in the lowest quartile come mostly from Asia and Africa. Hanoi comes at the bottom of the rankings, facing legacy challenges associated limited green space, high levels of air pollution and poor waste management provision. Low levels of access to resources means that greenhouse gas emissions in the bottom 10 cities including Kolkata and Cairo are as low as those in the top 10. However, investment in low carbon technologies will inevitably be a lower priority when basic citizen needs like water and waste management still need to be fixed. There are an equal number of *Evolutionary Cities* and *Fast-growing Megacities* in the bottom quartile.
- The presence of developed world cities including Athens, Atlanta, Istanbul, Melbourne and Moscow in the bottom quartile highlights that there is no room for complacency. There are few common themes linking these cities other than isolated, very low scores in single indicators such as GHG emissions (Melbourne), waste management (Moscow) or green space (Atlanta and Athens). However, given low levels of investment in mitigation technologies such as Electric Vehicles and bicycle infrastructure, there is inconclusive evidence as to whether these cities are actively addressing their challenges.
- Across the Index, many cities are at risk to natural catastrophes. Even top 10 cities like Munich have a high exposure to flood risk. We have added a natural disaster monitoring indicator to assess how early warning technology is being used to mitigate these risks. The indicator highlights that the 10 cities with the greatest risk exposure have below par early warning systems. Interestingly, some cities with the lowest risk profile including Calgary and Ottawa, have highly developed warning systems, demonstrating the extent to which some cities are prepared to invest in their citizen's long-term quality of life.

“Since arriving six months ago, I have begun to feel healthier and more relaxed. While the city feels so equal and fair, I wish it was easier to really connect with people and make new friends.”

Erik, 26, Stockholm, Sweden

Figure 4: Planet sub-index



The Profit sub-index

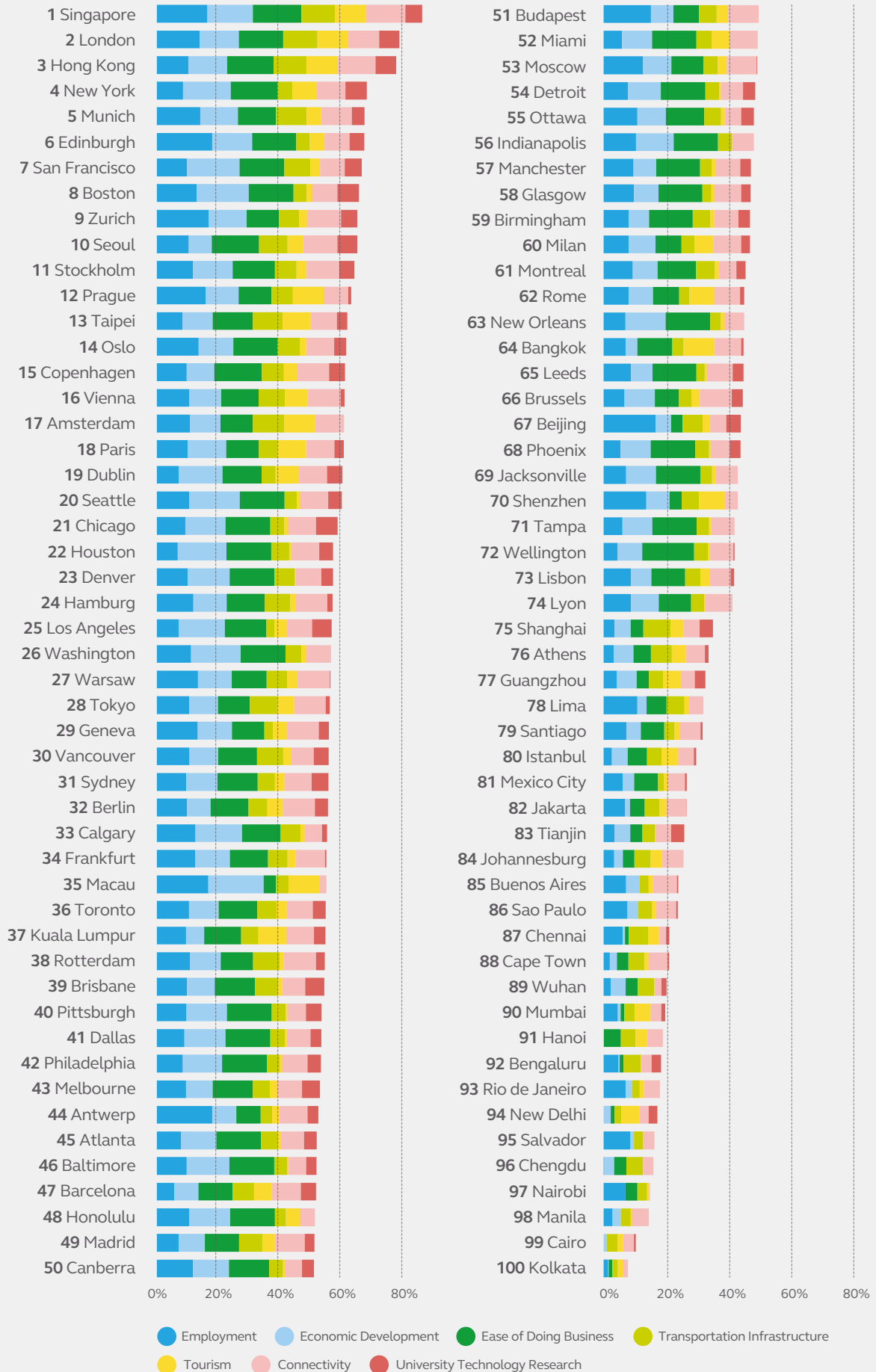
The Profit pillar measures the economic health of a city, incorporating indicators that reflect the productive capacity of cities today, as well as the presence of infrastructure and regulatory enablers that support growth and prosperity in the present and the future. UN SDGs addressed by the Profit pillar include economic growth, innovation and infrastructure.

- The Profit sub-index has the greatest dispersion across the three pillars. The top ten cities including New York, Hong Kong and Zurich score much higher than in the other sub-indices, while the lower quartile does much worse. These results highlight that inequality of economic performance is central to the challenge of city sustainability.
- Singapore, London and Hong Kong come out comfortably on top in this pillar breaking away from other top-performing cities on transportation, ease of doing business and connectivity. Singapore is the stand-out city with high levels of employment delivering correspondingly high levels of output. The remaining top 10, comprising U.S. coastal cities, as well as Seoul and three European cities including Zurich all score well on ease of doing business and output, but the performance of the transport system is much more mixed.
- Looking at regional groupings of cities across the sample, U.S. cities perform better against the Profit sub-index than other elements of the Index. Interestingly, highly ranked cities including Chicago, Houston and Denver do not perform anywhere near as well under either the People or Planet metrics. The long-term prioritization of economic performance over other aspects of sustainability has given many U.S. cities a legacy that is particularly challenging to overturn.
- By contrast in Europe, while the top 12 economic performers do well across all metrics, there is a further block of 15 cities including cities in the UK, France and Italy that do not score so highly. In the UK this may reflect the consequences of economic over-centralization, whereas elsewhere in Europe the data points to issues faced by many European cities in reinventing themselves for the new economy – particularly with respect to tourism, transport infrastructure and connectivity. This mixed pattern of performance means that the innovator/opportunist model is less effective in explaining city performance at the lower end of the spectrum.
- Latin American cities are all in the bottom quartile and score lowest across the Profit sub-index. This result reflects below-par scores across most metrics including output, tourism and connectivity.
- A key feature of the Profit sub-index are the particularly low scores for the lowest ranked cities in the Index—highlighting huge barriers to economic, social and environmental progress. Low scores for ease of doing business and relative output are the main drivers but scores are low across the board. These challenges are also evidenced across the bottom 25 cities. There is a close relationship between poor Profit rankings, low People rankings and a low overall Index ranking. Sixteen of the bottom cities are *Evolutionary Cities* where informal patterns of working are common in commerce and the service industry. The impact of these practices on ease of doing business may help to explain why the differential in performance on the Profit pillar is so marked.
- In the Profit pillar, we have included digital connectivity and university technology research and development as forward indicators for sustainable growth. Singapore, London and Hong Kong have outstanding scores in these areas, and the top 10. New York, San Francisco and Boston also do well. These results highlight that economically strong cities will often continue to have an advantage in reinventing themselves as well as sustaining current performance.

“The air pollution used to be really bad... you couldn’t even see the sky on some days. Things are getting better now as they start to clean things up, but it’s a bit incredible how bad things got.”

Zhang, 43, Shenzhen, China

Figure 5: Profit sub-index



City Clusters

Why is one city more sustainable than another? Is it because of physical attributes such as a safe, resilient location or as a result of far-sighted investment in green space? Is it the result of long periods of investment in health, education and transport infrastructure, or the impact of more recent actions taken to mitigate the impacts of unfettered growth? Most importantly, how do these drivers relate to citizen needs, both now and in the future? When comparing cities at opposite ends of the spectrum, these differences appear easy to spot, often in the levels of health and education infrastructure and the levels of meaningful employment, but as one compares peer cities, the differences are harder to discern.



To provide greater insight into the factors that influence city development and performance, we have developed a deeper understanding of how citizens and cities relate.

This insight is derived from city archetypes based on urban ethnographic research into how cities are evolving and the experience of the citizens living within them. The results of this research is a set of four city clusters.

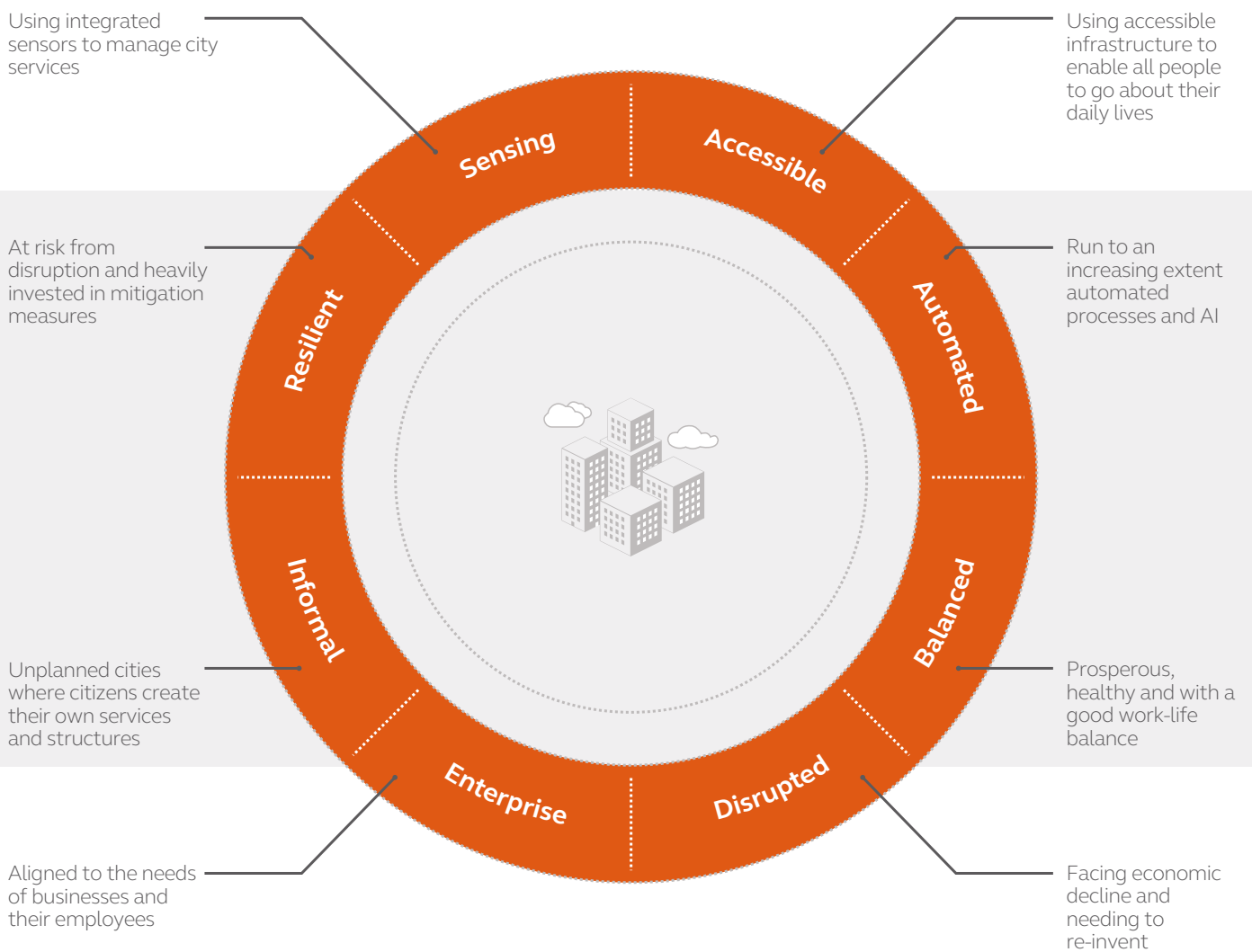
Our starting point for developing the clusters is that all cities are composites of different citizen experiences. Elements of a fast-growing city where citizen needs are met in part through an informal economy can be found alongside aspects of the most advanced, smart city technologies, where services and infrastructure are integrated using data and digital platforms. These experiences of a city, whether Informal or Sensing for example, help to connect the citizen to the city.

Our research has focused on eight archetypes that highlight how cities are experienced by citizens. A single archetype is not intended to describe a city. In each city, the archetypes combine to define the character of a city clusters. More detail about the archetypes can be found in the Appendix.

Figure 6: Creating city clusters



Figure 7: City archetypes detail



Fast-growing Megacities, Post-industrial Opportunists, Evolutionary Cities, Balanced Innovators

When looking at the clusters, our first hypothesis is that a highly developed, world city will be experienced in a radically different way to a rapidly developing, emerging economy city. Our second hypothesis is that the detailed difference between peer cities described by a cluster will explain in part their differing sustainability performance. All city clusters feature a different balance of archetypes that lead to different citizen experiences. Furthermore, not all people will be familiar with the experiences associated with each archetype.

As a result, differences in cities reflect how widely available an experience is as well as its character. For example, in a rapidly developing city, experiences associated with resilience, sensing and automation may only be available to an elite, whereas the experience of a large share of the population will be much more precarious and informal. By contrast, in highly developed city like Hong Kong, the experience of a highly Automated and Accessible city infrastructure is almost ubiquitous.

Figure 8: City clusters and archetype relationship

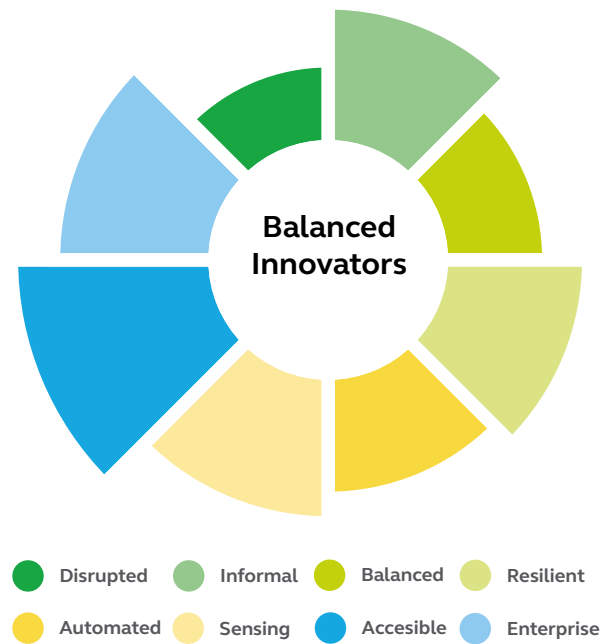


Cluster one. Balanced Innovators.

Thirty-five cities fit this profile, all of which are in the top half of the Index. All but one of the top 25 cities in the Index are classified as *Balanced Innovators*. This suggests a close association between the attributes of a sustainable city. The key citizen experiences associated with this profile are convenience and security associated with Automation and Sensing and high quality of life associated with an absence of Disruption as well as the infrastructure necessary for a Connected city. Cities that match the Balanced Innovator profile need to be prosperous and as a result, many of the service industry dominated cities of Northern Europe, Coastal U.S. and Asia fit within this profile. Looking forward, the role of technology in enabling seamless infrastructure and in supporting high expectations for service quality will grow exponentially.

The challenges that these cities face include addressing an aging population – which requires affordable housing and a diverse range of services. As they prosper, and their development accelerates, the ties that bind these cities socially and politically to their hinterlands may become strained, particularly given these cities continuing need for investment. This is reflected in the pace of change associated with the *Balanced Innovator* city, both in terms of citizen expectation and the need for investment and innovation.

Figure 9 Cluster 1: Balanced Innovators



Cities

Amsterdam / Antwerp / Barcelona / Berlin / Boston / Brisbane / Brussels / Canberra / Copenhagen / Dublin / Edinburgh / Frankfurt / Geneva / Hamburg / Hong Kong / London / Macau / Madrid / Milan / Munich / New York / Oslo / Paris / Prague / Rome / San Francisco / Seattle / Seoul / Singapore / Stockholm / Sydney / Taipei / Tokyo / Vienna / Zurich.

Defining city archetypes:

Enterprise - Aligned to the needs of businesses and their employees.

Automated - Run to an increasing extent automated processes and AI.

Sensing - Using integrated sensors to manage city services.

“People take a lot of pride in where they live here and care for each other.”

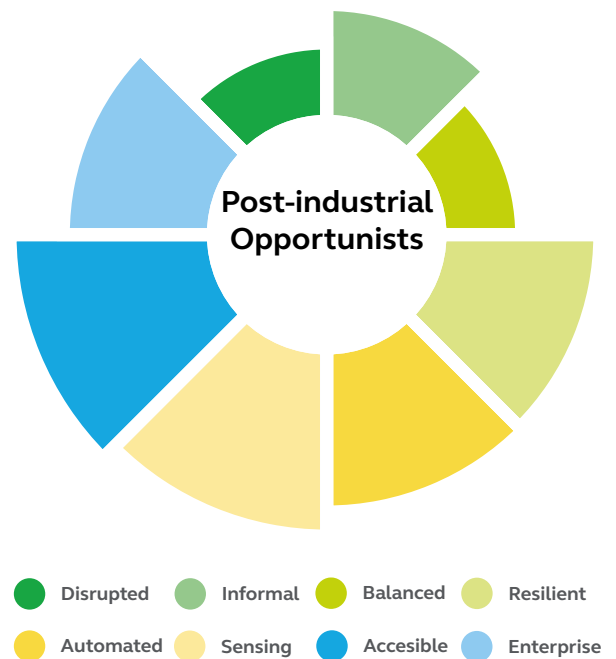
Jane, 30, Melbourne, Australia

Figure 10 Cluster 2: Post-industrial Opportunists

Cluster two. Post-industrial Opportunists.

Thirty-three cities fit this profile, all of which are placed in the middle two quartiles of the SCI. Accordingly, these are cities that in most cases deliver a good quality of life, but which have room to improve. The cluster consists mainly of American cities together with some European and Australian cities. Citizen experiences supported by a growing role of technology are mostly positive but might potentially be undermined by the impact of automation on legacy employment. Cities that match this profile have a more balanced economy so are less likely to be faced with the economic dislocation that has been seen in some recession-hit cities such as Detroit. However, even though these cities tend to be relatively well-managed, there may well be underlying tensions associated with the need to assure city resilience and to assure long-term sustainability of the city's economic model in response to change. Looking forward, these cities will likely be competing against one another to attract new investment and new city dwellers.

The challenges that these cities face are often associated with the need to compete by driving change. The adaptation of city infrastructure to accommodate digital innovation is a good example of these challenges, with citizens increasingly concerned about how data is used and how accountable organizations delivering city services will be in the future. Another challenge is associated with the increasing dynamism of these cities. As a result, the work-life balance and integrated communities associated with the Balanced archetype is less present. This can be seen in the war for talent between cities, manifested as a competition for employers and the people that they bring. The competition run by Amazon for their second U.S. HQ has vividly brought this reality to life over the past year. Given the potential pace of change and sense of dislocation in these cities, it is also essential that they retain a sense of coherent identity around which a diverse but increasingly connected group of citizens can rally around. Manchester's resilience following terrorist attack in 2017 was built on just such a strong shared sense of city identity.



Cities

Atlanta / Baltimore / Birmingham / Budapest / Calgary / Chicago / Dallas / Denver / Glasgow / Honolulu / Houston / Indianapolis / Jacksonville / Leeds / Lisbon / Los Angeles / Lyon / Manchester / Melbourne / Miami / Montreal / Moscow / New Orleans / Ottawa / Philadelphia / Phoenix / Pittsburgh / Rotterdam / Toronto / Vancouver / Warsaw / Washington / Wellington.

Defining city archetypes.

Accessible - Using accessible infrastructure to enable all people to go about their daily lives.

Automated - Run to an increasing extent automated processes and AI.

Resilient - At risk from disruption and heavily invested in mitigation measures.

Sensing - Using integrated sensors to manage city services.

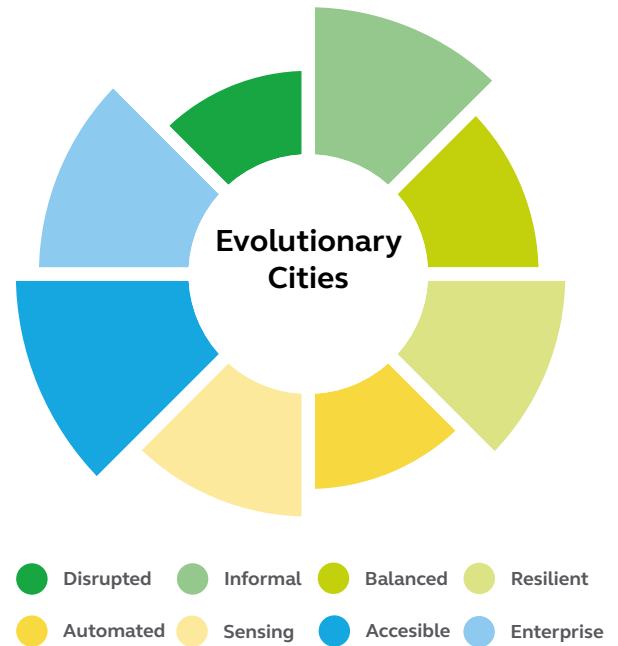
Cluster three. Evolutionary Cities.

Nineteen cities fit this profile. All of these cities in the bottom third of the SCI. This is a very diverse group that includes rapidly growing cities in emerging markets as well as cities in developed economies that are changing rapidly in response to new circumstances. Core citizen experiences in these cities are focused on aspects of informal entrepreneurialism - articulated possibly as micro-enterprise or alternatively as community self-help. One driver of the informal economy is the role of citizen enterprise in delivering services where city authorities are absent. Another driver is the core role of community – often at a really local level. On this basis, communities within the city are likely to be far more sustainable than the aggregate city itself. Enterprise also has a key role – shaping service delivery according to market logic than a public service agenda.

A key challenge that Evolutionary Cities face is the level of disruption affecting cities that are at a turning point in their trajectory. This disruption might affect jobs, crime levels and even mobility choices. As a result, the citizen experience can be focused much more on the downside associated with the change. This is why the drive obtained from Enterprise and Informal aspects of citizen experience is so important in building momentum around initiatives that will improve the quality of life.

From the perspective of citizen experience, where people have less overall control over city development and service delivery, there is a much greater likelihood of dissatisfaction – either due to the variable provision of services or due to the disruption of tight-knit networks and communities when development finally occurs. These factors are significant barriers to consistent sustainable development in cities.

Figure 11 Cluster 3: Evolutionary Cities



Cities

Athens / Bangkok / Buenos Aires / Cape Town / Detroit, Hanoi / Istanbul / Jakarta / Johannesburg / Kuala Lumpur / Lima / Manila / Mexico City / Nairobi / Rio de Janeiro / Salvador, Santiago / Sao Paulo / Tampa.

Defining city archetypes.

Enterprise - Aligned to the needs of businesses and their employees.

Informal - Unplanned cities where citizens create their own services and structures.

Disrupted - Facing economic decline and needing to re-invent.

“Don’t move here if you’re tired because you’ll need a lot of energy to do everything that the city has to offer.”

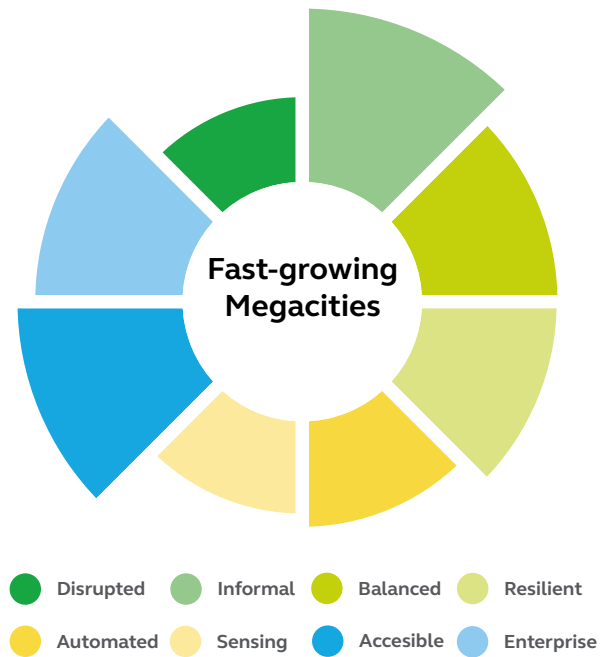
Jennifer, 48 São Paulo, Brazil

Cluster four. Fast-growing megacities.

Thirteen cities fit this profile. All but three of these cities are in the bottom quartile of the Index. All are located in rapidly growing economies including China and India, subject to high levels of inward-migration, investment in infrastructure and change. Cities like Mumbai, Shanghai and Shenzhen exhibit significant inequality in terms of income and access to resources and opportunity. Citizen experiences include high levels of informal economic activity as well as the powerful influence of enterprise – often directed by the state to deliver development and services. Citizens have little control over the way in which the city evolves but paradoxically the models suggest that many citizens retain a sense of stability through kinship and community links highlighted by the Balanced city archetype. Supporting these social networks through periods of rapid growth will demonstrate the extent to which these cities can thrive in line with the people agenda.

A key challenge for the city is engagement with the citizen. A good example of this is citizen experience of technology in comparison to other city clusters. This is not necessarily a reflection on the level of technological advancement as some of these cities, particularly in China, have a very sophisticated technology infrastructure. This is more a reflection on other citizen priorities. Another key problem is the accommodation of informal development – providing the basic infrastructure necessary to accommodate fast population growth. This challenge is reflected in the problems that many of these cities face with air quality as well as provision of food and clean water. Long-term resilience for these cities, some of which are exposed to a relatively high disaster risk, will be an important aspect of citizen’s experience as these cities continue to absorb growth.

Figure 12 Cluster 4: Fast-growing Megacities



Cities

Beijing / Bengaluru / Cairo / Chengdu / Chennai / Guangzhou / Kolkata / Mumbai / New Delhi / Shanghai / Shenzhen / Tianjin / Wuhan.

Defining city archetypes.

Enterprise - Aligned to the needs of businesses and their employees.

Informal - Unplanned cities where citizens create their own services and structures.

Resilient - At risk from disruption and heavily invested in mitigation measures.

“As a woman I don't feel secure especially at night. It is very unsafe for a woman to travel alone at night and even staying alone at home is also unsafe.”

Sangeeta, New Delhi, India

Disclaimer, authorship and acknowledgements

This report was commissioned by Arcadis and informed by research produced by the Centre for Economics and Business Research Ltd (Cebr), an independent economics and business research consultancy established in 1992. The expert commentary was compiled by a cross section of Arcadis' city and sustainability experts. The views expressed herein are those of the authors only and are based upon their independent research. While every effort has been made to ensure the accuracy of the material in this document, neither the Cebr nor Arcadis will be liable for any loss or damages incurred through the use of this report.

Data is constantly changing. Both Cebr and Arcadis have made every effort to ensure the quality and accuracy of the data. Cebr used its vast databases and connections to compile the data from globally

credible sources (e.g. the World Health Organization, CDP, Siemens etc.) Most sources are publicly available. With Arcadis wanting to include 100 cities in a global report, we had to use a data set that could be comparable. There are a lot of varied data sources around the world. Finding like-for-like data for all 100 selected cities limited our selection of sources. Some geographies or cities that did not have sufficient, comparable data were excluded. We focus on data and sources that are credible, comparable and valid. City-level data was used wherever possible, though in some cases only national-level data exists. Where there is no comparable city-level data across countries, the national value is taken, and a national database is used to scale the cities so that they were given a spread around the national average.

Methodology

The Sustainable Cities Index is constructed by a three-stage averaging process. Some of the indicators are composites, meaning these take an average of their component sub-indicators. In most cases this is the simple average, however given the importance of housing costs to household spending the affordability index was weighted 70:30 in favor of housing. The three sub-indices are calculated by taking weighted averages of their component indicators and the overall score is calculated by taking the simple average of the three sub-indices.

Even where there is no weighting system applied, since the number of indicators differs across sub-indices, the weights in the overall index do implicitly differ. The same applies for the sub-indicators: two components which go into one indicator will naturally have half the weight of another indicator within the same pillar which has only one component.

The averaging process demands that the scores be converted into common units, for which we use percentages. Each is scaled such that the worst-performing city receives 0% and the best performer receives 100%. Since the sub-indices and the overall index are simply averages of the indicators, they are also measured in percentage terms.

Several of the indicators have outlying values – these are defined as observations two standard deviations away from the mean. These are given the maximum or minimum score, as appropriate, and the next-highest/lowest value is defined as the boundary observation which is used to calculate the scores of the other (non-outlier) values.

City-level data are used wherever possible, though in some cases only national-level data exist. Where there is no comparable city-level data across countries, the national value is taken, and a national database is used to scale the cities so that they are given a spread around the national average.

In 2018 we have revised the calculation of the indices to give greater emphasis to the digital capabilities of cities. We use the adoption of digital solutions as a proxy measure for the pace at which cities are equipping themselves to meet future needs. Connectivity, mobility, citizen engagement and disaster management are all areas where the adoption of new digital solutions will enable cities to accelerate their sustainable development.

¹ The Weighting used for each indicator are shown in the table.

Indicator Details, Sources and Weightings

People pillar

Indicator name	Indicator description	Main Source(s)	Weighting	Rationale
Education	Primary school enrolment (% of relevant age group enrolled)	World Bank, US Census Bureau	10%	A good education system provides businesses with a skilled workforce and provides people with the opportunity to earn decent incomes.
	University rankings (sum of university overall scores by city)	QS World University Rankings		
	Share of population with tertiary education (%)	Eurostat, US Census Bureau, UNESCO		
Health	Life expectancy	World Bank	10%	A good healthcare system is crucial from both a productivity and quality of life standpoint.
	Infant mortality (deaths before age 1 per 1,000 live births)	Eurostat, Center for Disease Control		
Demographics	Age dependency ratio	National statistics, Eurostat, World Bank	6%	A large working age population is important in ensuring that various social systems can be well-funded. It also reduces the strain on educational / healthcare systems.
Income inequality	Gini coefficient	Various	8%	Ensuring that a city's wealth is distributed fairly among the population promotes a more cohesive society with fewer social issues.
Affordability	A basket of consumer goods (as a share of GDP per capita) (30%)	UBS Prices and Earnings, Numbeo	15%	The affordability of a city directly impacts the quality of life of its inhabitants on a daily basis.
	Residential rents (as a share of GDP per capita) (70%)	Numbeo		
Work-life balance	Average annual hours worked	Various	8%	As incomes rise, people will increasingly aspire for more time for leisure and family-related activities. Cities that foster a workplace culture in line with these needs are better placed to attract top talent and succeed in the long term.
Crime	Homicides per 100,000 population	Various	8%	Levels of serious crime have a major impact on a relatively small share of the population. However, high crime rates have spillover effects that extend beyond the immediate victims, for instance through less investment in an area or increased levels of stress.
Access to public transport Services	Bus and metro stops per km ²	Various	10%	With high levels of traffic congestion in most major cities, access to public transport is integral in allowing people to travel both for work and for leisure. This affects inhabitants' quality of life on a daily basis, but in a less fundamental way than the above indicators.
Transport applications and digital capabilities	Cebr score measuring digital capabilities for the public transport system (availability of city transport system on Google Maps, an app created by the transport authority, existence of digital ticketing)	Various	5%	Incorporation of digital capabilities into a transport system makes using public transport easier in cities.
Cultural offerings	Number of 'things to do' on TripAdvisor	Trip Advisor	5%	The range of attractions available in a city has an important effect on quality of life. However, this indicator is less integral to basic standards of living.
Cost of broadband	Cost of broadband as a share of GDP per capita	Numbeo	6%	A fast internet connection is increasingly important in accessing a variety of services. However, broadband accounts for a relatively small share of individuals expenditures so this indicator has been given a relatively low weighting.
Digital public services (property tax)	Cebr score based on ability to make online property tax payments	Various	4%	Since this is a binary indicator (either online property tax payments are available, or they are not), there is limited variation between the cities in the index.
Wi-Fi availability	Crowdsourced score availability of free Wi-Fi	Nomad List	5%	While accessing the internet in public areas is important, many people have access to the internet via their mobile phone or at home / in the office.

Planet pillar

Indicator name	Indicator description	Main Source(s)	Weighting	Rationale
Environmental Exposure	Natural catastrophe exposure, including drought, earthquake and extreme temperature	International Disasters Database	5%	This has been given a slightly lower weighting because many cities in the index are not affected significantly by natural hazards.
Green spaces	Green space as % of city area	Siemens Green City Index	11%	While this indicator is an important determinant of quality of life, it is less fundamental than the higher weighted indicators.
Energy	Energy use	Energy Information Administration	12%	These 5 indicators all measure central aspects of a city's environmental sustainability today, so have been allocated the highest weightings.
	Renewables share	Enerdata		
	Energy consumption per \$ GDP	Energy Information Administration, World Bank		
Air pollution	Mean level of pollutants (particulate matter)	World Health Organization	12%	
Greenhouse gas emissions	Emissions of CO2e metric tons (per capita)	CDP Cities	12%	
Waste management	Solid waste management (landfill vs recycling)	Siemens Green City Index, World Bank	12%	
	Share of wastewater treated	OECD, Food and Agricultural Organization (UN)		
Drinking water and sanitation	Access to drinking water (% of households)	UN, World Health Organization	12%	
	Access to improved sanitation (% of households with inside toilet)	UN, OECD, American Housing Survey		
	Risk to water supply	World Resources Institute, The Nature Conservancy		
Bicycle infrastructure	Bicycles per capita and bicycle sharing schemes (Cebr score)	MetroBike	8%	While promoting the use of bicycles is important for cleaning up the air in cities, its environmental significance is somewhat lower than other indicators.
Electric vehicle incentives	National and local government incentives for electric vehicles (Cebr score)	City government websites, International Council on Clean Transportation	8%	Promoting the switch towards electric vehicles will be crucial in improving air quality in the future. This indicator has been given a slightly lower weighting because electric vehicle take-up remains fairly low in a majority of cities.
Negative emissions technologies - carbon capture and storage	Carbon capture and storage facilities/projects	Global Carbon Capture and Storage Institute	4%	A majority of carbon capture and storage schemes are situated outside of city boundaries, so this is less of a direct measure of a city's environmental sustainability.
Natural disaster monitoring	Number of early warning systems, availability of digital alerts (Cebr score)	UN Office for Disaster Risk Reduction	4%	Since many cities in the index face a limited risk from natural disasters, this indicator only impacts a subset of the 100 cities.

Profit pillar

Indicator name	Indicator description	Main Source(s)	Weighting	Rationale
Transport infrastructure	Congestion	TomTom Traffic Index	15%	A good transport network facilitates economic interactions and promotes a more integrated city. However, it is less of a direct measure of a city's economic potential than the higher weighted indicators.
	Rail infrastructure	World Metro Database, Metrobits.org		
	Airport satisfaction	World Airport Awards 2018		
	Transport Economic Opportunity	Financial statements of transport providers		
	Transport Public Finance	Local government budgets		
Economic development	GDP per capita	Brookings Institute, Cebr analysis	18%	This is the most direct measure of a city's productivity, and is also a key determinant of how much cities can invest in the future.
Ease of doing business	Ease of Doing Business	World Bank	17%	A regulatory and financial environment that facilitates the smooth running of business is crucial in delivering sustainable growth.
Tourism	Number of tourists	Euromonitor, US Department of Commerce	10%	The number of international visitors reflects the attractiveness of a city's sights and how globally exposed the city is. However, it is also affected by the nature of nearby country borders.
	Tourists per capita	Euromonitor, US Department of Commerce		
Connectivity	Mobile connectivity (subscriptions per 100 inhabitants)	International Telecommunications Union	15%	With the rise of the digital economy, a city's digital infrastructure will become increasingly critical for generating economic growth.
	Broadband connectivity (% of residents using the internet)	International Telecommunications Union		
	Importance in global networks	Loughborough University		
	Internet speeds	Nomad List		
Employment	Number of people employed in city (% of city population)	Brookings Institute	18%	The share of people employed in a city not only reflects the productive capacity of the labor force but also the economic opportunities available to residents.
University Technology research	Ranking of city's top performing university in the field of technology & engineering	QS World University Rankings	7%	This indicator is a key measure of the level of technological development and innovation taking place in a city. However, the benefits of university research are often enjoyed beyond the city's boundaries.
		QS World University Rankings		

City Archetypes

Accessible

Cities that use a wide range of accessible social and economic infrastructure to enable all people to enjoy their daily lives. Cities that relate strongly to this archetype are relaxed places that are well provided with high quality public realm, transport and leisure. Work-life balance is generally good. Satisfied citizens benefit from high quality services and well-established local communities. Elderly citizens are a growing and important section of the population.

Automated

Cities increasingly reliant on industrial automation, robotics and artificial intelligence (AI). Industrial production is automated resulting in fewer blue-collar jobs, but strategic and creative jobs are available for highly skilled, technically-educated people. As a result, many citizens retrain for new jobs. High quality public and private transport is a given in this city and an increasing share of all modes of transport are electric. Falling activity levels increases the prevalence of lifestyle-related diseases.

Balanced

Cities focused on citizens' needs: exemplified by work-life balance, culture, sharing economy and unpolluted environments. In cities aligned to this archetype, the quality of life is high, and it is seen by other cities as inspiration. High levels of equality mean that fewer people are unhappy and crime rates are low. Work is highly productive; many citizens have flexible working hours and rarely work overtime. The sharing economy underpins transport around the city. Citizens quickly find the nearest bike or car and the whole public transport is intelligently designed and operated using citizen data.

Disrupted

Cities affected by rapid change, experiencing increasing unemployment, rising crime rates and depopulation. Many citizens are focused on the day-to-day challenges of getting on and do not notice the opportunities that are coming from rejuvenation. Work is very much the main-focus of citizens' lives. Citizens are tuned to corporate culture and strive to get ahead in any way possible. People who are unemployed do their best to develop new skills. Public transport is viewed as insufficient and unsafe, particularly at night and residents rely on their cars.

Enterprise

Cities focused on private interests and private companies - it is their needs and the needs of their employees that drive development and ambition. Many people work for dominant corporations in one way or another. They are offered superior work benefits and work in carefully crafted spaces. Social media keeps employers responsive to citizen needs but there is a growing feeling that dominant corporations are stifling innovation. Public transport and mobility networks are highly responsive, reliable and efficient, partly as a result of the city's large tax base.

Informal

Cities experiencing fast and unplanned growth. Communities and their interests create the structures and systems that shape city development at a local level. Plans to invest in city-wide infrastructure are met with concern about the effect this might have on existing communities. Many citizens work in the service and construction industries, starting early to commute into the urban core. They rely predominately on public transportation and walking. Public transport networks are struggling to cope with the increasing demand and congestion that is at an all-time high.

Resilient

Cities that need to prioritize investments in their sustainability because they are regularly exposed to severe disruption. Living here is not as comfortable as in some other cities. Due to their geographical location, there often are weather events, shortages of resources or issues with moving around the city. Citizens support and are proud of the investments that are being made to improve conditions. They are very industrious and work in many physical, labor-based industries as well as more technological ones. The city is investing heavily in progressive public transport systems focused on reducing traffic congestion and environmental impacts.


Sensing

Cities increasingly using sensors as part of delivering city services, collecting vast amounts of data. Life in sensing cities is managed. Some citizens appreciate the constant monitoring for the feeling of safety, security and personalization it provides, others feel that the city is verging on a police state and miss the spontaneity of the old city. Jobs are mostly focused in the service sector and are generally well-paying, based on a hard-working culture. Travel within the city is increasingly efficient, with big data being used to optimize the operation of roads and public transport.

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What do we mean by a citizen?

Citizen:

Noun. An inhabitant of a particular town or city

Derived from Anglo French *citesein*, *citezein* “city-dweller, town-dweller, citizen”; a citizen is an inhabitant of a particular town or city.

‘Citizens belong to a community because they live in it and because they have rights, duties and responsibilities in that community’

Arcadis. Improving quality of life