# SMART CITIES – WHAT'S IN IT FOR CITIZENS?



JUNIPER RESEARCH

## Contents



# *What is a Smart City?*

*"A Smart City is an urban ecosystem that places emphasis on the use of digital technology, shared knowledge and cohesive processes to underpin citizen benefits in vectors such as mobility, public safety, health and productivity."*

## Study Background

Many smart city studies have been conducted with the aim of projecting technology spend, or service revenue for businesses. However, Juniper Research and Intel believe that these studies do not sufficiently account for the most important part of the city itself: its citizens.

As such, Juniper has conducted a study of smart cities across the globe with the aim of uncovering the measurable time rewards to citizens:

Time: **how can smart cities' technology and strategies be used to 'give back' time to citizens?** Free time is a scarce commodity in the modern world and has a powerful impact on an individual's ability to reduce stress, maintain happiness and health.

**Juniper examined cities in terms of their progress, and future potential, across 4 key indices, with the goal of evaluating how they might deliver positive citizen outcomes in terms of time and quality of life. These indices are:**

Mobility: urban transport systems, including public and private transport. Also includes non-motorised transport solutions.

Healthcare: healthcare service delivery for citizens, including access to services and performance.

Public safety: city safety as measured by crime levels, mortality and law enforcement services' efforts to combat these challenges.

Productivity: city policies and technologies in use aimed at promoting citizen productivity, democratisation of services and wealth distribution.

## *Smart Cities Will Deliver…*

*"If cities across the globe today were to universally adopt, and deploy, smart city technology and services, what would the benefits be for citizens?"*

15 DAYS

## Time Given Back

*Smart cities have the potential to 'give back' each city dweller 3 working weeks' worth of time every year.*

### How will This Time be Created?

#### Mobility Saves 60 Hours

Smart Traffic Systems including dynamic traffic light phasing and smart parking reduce time in traffic. Open Data Platforms enable citizens to choose the fastest metro/bus lines.

#### Public Safety Saves 35 Hours

Machine learning enabled software such as PredPol used to predict crime spots on a given day. ITS here is used to prioritise emergency service vehicles through traffic light phasing & driver re-routing.

#### Healthcare Saves 9 Hours

Healthcare preventative apps & telehealth aim to reduce average physician visits by promoting better overall wellbeing. While improved administration and preliminary diagnosis reduce wait times.

#### Productivity Saves 21 Hours

Apps or digital services will simplify administrative processes when citizens interact with city agencies.

### Benefits to Smart City Inhabitants

#### More Time for Family and Friends

Enough time to enjoy a meal with friends or family twice a week.

#### Get Active

Exercise for 45 minutes 3 times a week every week of the year.

#### Take a Long Vacation

An additional 50% to the average annual US vacation allowance.

#### Improved Recovery

Studies have indicated that wounds take up to 25% longer to heal when individuals are chronically stressed. 110 million people die every year as a direct result of stress.

#### Decreased Risk of Depression

Lost productivity and medical expenses from depression costs over $83 billion annually: $11.30 for every person on the planet, every year.

#### Improved Earning Potential

The cost of stress can be high: if left unaddressed, it could mean that individuals' potential earnings fall by $10,000

## Why do We Need Smart Cities?

### The Emergence of 'Megacities' & Overcrowding

The 20th and 21st century haven given birth to some 37 'megacities' (cities with populations greater than 10 million individuals), including Tokyo, Mexico City, New York City and Rio de Janeiro.

In each of these cities, the density of the population in relation to available resources, infrastructure and services has given rise to complaints about overcrowding, while demand for affordable housing, proper sanitation, food supply and healthcare services are all put under pressure as a result of mass migration to large cities.

*Cities are thus being forced to consider how to alleviate these pressures; technology, analytics and modern urban policies are emerging as 'smart solutions' to deliver sustainable, efficient environments for citizens.*

### Quality of Life

One of the main drivers for urban migration has been the promise of a higher quality of life, driven by increased personal wealth and a greater number of life-opportunities. As a result, cities are under pressure to present themselves as more favourable places to live and work, competing to attract the best talent and investment.

Meanwhile, many cities suffer from a large inequality gap; the *favelas* of Rio de Janeiro provide a notable example of vast differences in quality of life across cities.

*Smart cities are those that recognise these challenges and adopt their planning and strategy to address them. This requires smart policies to ensure wealth is not distributed unevenly, alongside technology as an enabler.*

### Congestion & Air Pollution

The motor vehicle, often presented as a symbol of personal freedom, is commonly anything but, inside city limits. High volumes of vehicle ownership, coupled with 20th century urban planning modelled around the automobile, have created massive pressure on the road infrastructure. Consequently, long traffic jams are a frequent bug-bear for citizens, elevating stress levels. Additionally, the slow movement of traffic increases the volume of microscopic particulate matter affecting the health of drivers, as well as those on the streets. Traffic, and air pollution, are serious issues facing cities today.

Addressing urban mobility is one of the key aims of smart cities, not least because of the substantial benefits realised in reducing congestion. Intelligent traffic systems are key here, alongside smart investment and a policy to reduce motor vehicle use.

## How do These Factors Affect Me Today?

It is difficult to understand the need for smart cities when presented with abstracts that cannot easily be associated with the global population. As such, we have contextualised today's need for smart cities into a number of problem statements.

### "Heavy Congestion in Cities can Result In Drivers Spending More than 70 hours per Year in Gridlock"

- In many cities, the average peak-time vehicle speed is a crawling 4mph (6kmh);
- The stress of the morning commute has been shown to be hazardous to citizens' health; a study by the British Cardiac Patients Association in 2004 found that emergency call-outs for life-threatening heart attacks and strokes peak between 8am and 11am;
- WHO estimates that 3 million deaths every year are attributable to small particulate matter pollution, a large portion of which is generated by vehicle emissions. High levels of congestions result in higher levels of harmful pollutants in the air.

### "Cities Suffering from High Rates of Violent Crime are Statistically Likely to Impact the Majority of the Population"

- As a result of high levels of inequality, a large population mass and opportunity for organised crime operation, cities are often relatively dangerous places to live.
- Even an annual figure as 'low' as 2% means that most individuals are likely to suffer violent crime at some point during their lives.
- Violent crime resulting in personal injury can often mean time lost in hospital or rehabilitative care. Additionally, there are psychological consequences to consider; anxiety and stress can be damaging to an individual's well-being. Indeed, a 2015 study by the Office for National Statistics found that 20% more non-victims of violent crime reported feeling that their life was worthwhile in comparison to those that had been victims.

### "Hospital Overcrowding in Cities can Result in Patients Waiting Longer Than 4 Hours for a Bed"

- Many cities across the globe report very high hospital bed occupancy rates (over 85%). This can result in exorbitant wait times for in-patients, resulting in time wasted and additional stress for both patients and caregivers. In a healthcare scenario, this exacerbates the likelihood of mistakes being made.
- Furthermore, studies have indicated that overcrowding in hospitals can increase the risk of patients contracting an infection during their stay; in some cases this risk is increased by over 10%. This means that patients in hospital for non-life-threatening conditions may be exposed to environments that could prove fatal for them.

***Global smart cities: who are the leading performers today?***

***The study has ranked the top 20 global smart cities according to their performance and project deployments across the 4 indices studied, alongside their published strategies and key goals for future city development.***

**The Top 20 Global City Performance by Index, 2017**

| | Mobility | Health | Safety | Productivity |
|---|---|---|---|---|
| 1 | Singapore | Singapore | Singapore | Singapore |
| 2 | San Francisco | Seoul | New York | London |
| 3 | London | London | Chicago | Chicago |
| 4 | New York | Tokyo | Seoul | San Francisco |
| 5 | Barcelona | Berlin | Dubai | Berlin |
| 6 | Berlin | New York | Tokyo | New York |
| 7 | Chicago | San Francisco | London | Barcelona |
| 8 | Portland | Melbourne | San Francisco | Melbourne |
| 9 | Tokyo | Barcelona | Rio de Janeiro | Seoul |
| 10 | Melbourne | Chicago | Nice | Dubai |
| 11 | San Diego | Portland | San Diego | San Diego |
| 12 | Seoul | Dubai | Melbourne | Nice |
| 13 | Nice | Nice | Bhubaneswar | Portland |
| 14 | Dubai | San Diego | Barcelona | Tokyo |
| 15 | Mexico City | Wuxi | Berlin | Wuxi |
| 16 | Wuxi | Mexico City | Portland | Mexico City |
| 17 | Rio de Janeiro | Yinchuan | Mexico City | Rio de Janeiro |
| 18 | Yinchuan | Hangzhou | Wuxi | Yinchuan |
| 19 | Hangzhou | Rio de Janeiro | Yinchuan | Hangzhou |
| 20 | Bhubaneswar | Bhubaneswar | Hangzhou | Bhubaneswar |

*Source: Juniper Research*

Analysis of cities' performance in each index revealed some notable results.

Mobility winners:

Singapore, San Francisco and London were found to be world-leading cities in addressing urban transportation challenges. Singapore, for example, has applied smart, connected traffic solutions, in conjunction with very strong policy curtailing car ownership in an effort to reduce the number of vehicles on its roads. This level of policy enforcement is not possible in San Francisco or London; consequently, these cities have applied their own traffic calming technology solutions alongside long-term visions for transformative transportation paradigms in the form of MaaS (Mobility as a Service) and AVs (Autonomous Vehicles).

Mobility Trailers:

Trailing cities in this index include Yinchuan, Hangzhou and Bhubaneswar. The study found that, in spite of notable roll-outs such as Yinchuan's 'pay-by-face' public bus service, overall efforts to reduce congestion levels are at an early stage relative to the leading cities. For instance, public transport availability and uptake as a whole was found to be low, while key future urban transport innovations, such as shared transport solutions and AVs, were not found to form part of the cities' long term vision.

### Healthcare winners:

The leading cities in this index were found to be Singapore, Seoul and London. Both Singapore and Seoul were notable in terms of their focus on addressing healthcare service provision for elderly citizens through a range of technologies, including digital service platforms as well as remote monitoring devices. If one considers the fact that, on average, the number of annual visits to a physician increases substantially as one ages, it is clear that these strategies form a crucial part of ensuring that the overall healthcare system is not overburdened; in turn, improving overall healthcare outcomes. Meanwhile, London has applied a broad strategy that combines innovation (such as bicycle share schemes), telehealth and a strategy to reduce healthcare inequality in the city.

### Healthcare Trailers:

Hangzhou, Rio de Janeiro and Bhubaneswar were found to have continued challenges that could be addressed through technology and smarter policy. Rio and Bhubaneswar continue to have relatively low levels of hospital bed availability, which could be addressed through better preventative healthcare measures; first by improving citizens' level of access to digital services as well as wider roll-outs of telehealth and local connected clinics. Meanwhile, all 3 cities suffer from very poor air quality levels, with proven negative impacts on citizens' health.

### Safety Winners:

Singapore, New York and Chicago ranked highly in this index. In the case of New York, the city has worked hard over the last 25 years to address what was an epidemic of violent crime. This was kickstarted by a data-driven approach and has since developed into one where predictive modelling is a key asset both for law enforcement as well as the fire department; a strategy replicated by Chicago. Singapore meanwhile, has trialled smart video surveillance to detect criminal activity.

### Safety Trailers:

Wuxi, Yinchuan and Hangzhou were noted to have deployed smart initiatives (smart video surveillance forms part of Yinchuan and Hangzhou's public safety initiative for example), but have not yet reached a level of integration between emergency services to achieve the optimum response; an important factor in reducing response times and positive outcomes. Meanwhile, these cities have either not clearly outlined, or have a limited strategy to deal with major safety issues such as road traffic incidents and threats posed by cybercrime. This latter point is particularly pertinent to Chinese cities, owing to the country's high level of smart grid investment and consequent connection of critical infrastructure to the Internet.

### Productivity Winners:

The ability to not only encourage digital innovation to address city challenges, but also the ability for citizens to access digital services and city information was judged by Juniper to be critical in improving citizens' productivity. In that regard Singapore, London and Chicago were found to be leaders, each with large open data stores

alongside strategies to encourage private innovation either through funding, specialised test-bed environments (London and Singapore) or through city-wide initiatives to provide citizens with a variety of data (Chicago's Array of Things project).

Productivity Trailers:

Yinchuan, Hangzhou and Bhubaneswar remain as cities that have yet to address wider productivity challenges. None of these cities has, as yet, encouraged development of solutions from a bottom-up level, with most innovation driven from the top-down. As such, citizens have been, in part, excluded from the process. Meanwhile, the study found that these cities must yet address inequalities present in digital services access.

## *Smart City Index: Study Conclusions*

**The Top 20 Smart Cities Globally, Consolidated Performance 2017**

| | City | Region |
|---|---|---|
| 1 | Singapore | Asia Pacific |
| 2 | London | West Europe |
| 3 | New York | North America |
| 4 | San Francisco | North America |
| 5 | Chicago | North America |
| 6 | Seoul | Asia Pacific |
| 7 | Berlin | West Europe |
| 8 | Tokyo | Far East & China |
| 9 | Barcelona | West Europe |
| 10 | Melbourne | Asia Pacific |
| 11 | Dubai | Middle East & Africa |
| 12 | Portland | North America |
| 13 | Nice | West Europe |
| 14 | San Diego | North America |
| 15 | Rio de Janeiro | Latin America |
| 16 | Mexico City | Latin America |
| 17 | Wuxi | Far East & China |
| 18 | Yinchuan | Far East & China |
| 19 | Bhubaneswar | Indian Subcontinent |
| 20 | Hangzhou | Far East & China |

*Source: Juniper Research*

Juniper's study uncovered several highlights that it felt are worth noting. These include factors that allow a city to execute its vision, or simply key projects and strategies that Juniper felt were innovative and could serve as a blueprint for other cities to emulate.

Singapore's 'One Nation' Initiative and its position as a city-state makes it unique in its ability to execute its smart city vision. Its transformation, over the remarkably short time after its split from Malaysia, to the world's leading smart city, provides an example from which other cities can learn.

The positioning of the 5 US cities provides an interesting contrast. Overall, New York, San Francisco and Chicago were found to have a broader, more in-depth smart city vision and are further along in terms of execution. It is likely that pressures created by their standing as population-dense metro areas, alongside inherent talent in IT services, has spurred their smart city journey earlier. Meanwhile, cities such as San Diego and Portland can be considered as close to the 'tipping point' where smart city solutions are sought after. This means that the bulk of projects have initially been geared to solving key pressing issues, such as urban mobility. Focus on developing innovation, such as through the release of open data for example, has received less attention.

The study found that cities in Asia and the Indian Subcontinent are able to rapidly execute their vision, particularly smaller cities. This is due to strong national support for smart cities in the face of tremendous urban population growth. These regions are often able to find a more cohesive vision for the development of their smart cities on account of a more top-down approach to the market. Juniper anticipates that a similar ranking in future would skew more in favour of these regions.

On a macro level, the study found that North American and West European cities are typically more advanced in terms of transparency as well as their openness in adopting processes that rely on inter-city best practices and learnings. This means that information regarding smart city projects and cities' overall vision is far more readily available; meanwhile, these cities actively seek expertise from a wide range of actors, including third party entities and citizens themselves. Cities in Far East & China on the other hand, are more opaque in terms of their approach. Additionally, these cities have to contend with a lower proportion of citizens who are connected and able to benefit from smart city services. This means that the impact of roll-outs is not yet as significant as in other regions; indeed, for many cities in the Indian Subcontinent as well as the Far East & China, emphasis is placed first on connecting citizens with a view to rolling out wider smart city solutions at a later point.

## *A Smart City Future*

***"Imagine a world where all cities are smart and able to thrive as part of a cohesive effort between municipalities, businesses and citizens.***

***Many cities are now becoming smarter, adopting strategies to address a growing need to improve their 'liveability'. Here, we look at leading cities in this regard, exploring how efforts to improve mobility, public safety, public healthcare and productivity are being confronted as they transition to a smarter, more connected environment."***

***Mobility: Congestion, and delays moving from A to B, cost time, money and can make for a stressful experience.***

***Study Hypothesis: Smart cities will benefit citizens in terms of time, money and improve their quality of life.***

***Imagine a world where smart cities give back:***

## 59.5 hours per year per citizen

Juniper has found that smart mobility projects have the potential to 'give back' 59.5 hours per year per citizen; these are broken down as follows:

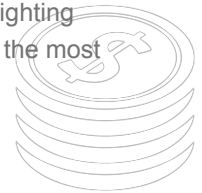
**Intelligent traffic systems: 19.4 hours**

ITS (Intelligent Traffic Systems) technology can be used to dynamically adjust traffic light phasing, with the aim of minimising red light delays and smoothing overall traffic flow. Meanwhile, parking space availability can be used to inform drivers where the nearest available space is, minimising the time spent 'cruising' for spaces.

Juniper has calculated the time benefit based on a long-term outlook of an average commute round-trip of 74 minutes. Meanwhile, ITS are expected to have a 10% positive benefit over the baseline. In both instances, the figures used are the result of anticipated population rises leading to greater pressure on infrastructure.

**Open Data: 31 hours**

City open data can be harnessed to enable both city agencies and third parties to develop innovation around that data. In the case of mobility, daily commute times can be reduced by up to 15% by highlighting optimum routes for any given time of day, while suggesting the most efficient transport mode.



**Cashless Payments: 1.2 hours**

Cashless payments are likely to impact some 360 billion journeys per year. On average, passengers will save 25 seconds every time they make a payment.

**Safer roads: 7.8 hours**

Initiatives such as AVs, MaaS and policies that succeed in moving modal share away from public transport, will create safer roads. The net result will be increased life expectancy, translating to nearly 8 hours per year for citizens.

Case Study: San Francisco

## Case Study – San Francisco

*MaaS, AVs are crucial to reducing vehicle ownership & congestion*

The USA's 'love affair' with the automobile has, in cities such as San Francisco, led to chronic congestion. According to TomTom's annual congestion index, San Francisco drivers waste 150 hours every year in congestion.

The city has recognised this as a key issue and developed a comprehensive strategy in an attempt to address the situation. Indeed, in 2016 it received some $11 million in funding, some of which has been earmarked to intelligently phase traffic lights to prioritise public transport. The following highlights 2 key elements of the city's future mobility strategy.

### Integrated & Shared Mobility

With 540 vehicles per 1,000 capita, the city notes that too many citizens are using their own vehicles to travel across the city. Meanwhile, on-demand rideshare companies have created much-needed competition for traditional taxi services, but the number of vehicles on the road, alongside uncertain regulation, have created a separate set of issues.

The city has thus set out a vision for a technology platform supporting an integrated service, allowing citizens to choose from a range of modal options. The primary elements of this vision are:

- Transportation as a Platform: establishment of a city framework for an integrated service across multiple providers;
- Transport as a Service: development of a consumer solution to handle pricing, routing, booking and payment through a single platform.

### Shared AVs (Autonomous Vehicles)

AVs deployed as shared, on-demand service vehicles will reduce the need for car ownership, where services are deployed as multi-occupancy rides, with vehicle passengers determined by similar origin, route or destination.

Meanwhile, the ability to drive safely in close proximity will maximise the road space and in turn reduce congestion.

Vehicles' communication with city infrastructure will ensure that software analytics running in the background can determine optimal traffic light phasing according to real-time conditions.

### Expected Outcomes

The city's vision is that every citizen will be able to select their journey across the city, on-demand, within 2 minutes. Journey time across the city should take no longer than 20 minutes. This would shave a third off of the current average San Francisco one-way commute time.

Other benefits as a result of lower congestion, lower transit overcrowding and deployment of shared AVs include improved air quality, lower travel costs and reduced traffic fatalities.

***Healthcare: inefficient healthcare systems mean services are complex to navigate and can sometimes result in poor outcomes for patients.***

***Study Hypothesis: Smart cities will improve patient access and result in better quality healthcare delivery.***

***Imagine a world where smart cities give back:***

## 9.7 hours per year per citizen

The study found that digital health services can play a big role in creating efficiencies, with benefits felt at both the citizen level as well as on the caregiving side; these are indicated below.

**Telemedicine impact on wait times: 0.9 hours**

The research found that in instances where telemedicine services had been deployed, overall patient hospital re-admission rates were reduced by between 20% and 40%. The net effect of a global roll-out would be to dramatically reduce the number of instances where wait times for hospital beds exceed 4 hours.

**Chatbots & digital services access: 6.3 hours**

AI (artificial intelligence) will be used as a key element in future chatbots and services access, enabling them to be used as preliminary diagnosis tools for triage, or to generate appointments. Alone, chatbots can save an average of 15 minutes per contact over traditional mechanisms.

**Preventative healthcare apps & telehealth: 2.1 hours**

The average citizen visits the doctor 5 times a year; more when they are elderly or suffer from a chronic condition. Apps that analyse data received from 'quantified self' devices, as well as remote physician appointments by video link, can serve to reduce, or even eliminate, physical visits to the physician.

**Chronic condition management: 0.5 hours**

Individuals suffering from chronic conditions will often have to visit their physician multiple times per year; even now, over one-third of the world's population is in need of long-term healthcare management. In this case, remote monitoring devices can help reduce the need for physical diagnoses, while helping to better manage long-term conditions.

Case Study: London

## Case Study – Seoul

***Focus on elderly care, digital services delivery and leveraging emerging platforms key to Seoul's vision***

Seoul is, along with other major cities in developed regions, faced with the challenge of an ageing population, which in turn is beginning to put pressure on healthcare services. Meanwhile, citizen physical activity levels have been steadily decreasing since 2005, which in turn has led to increasing risk of health related issues as a result of obesity.

### U-Health

Seoul's plan for healthcare delivery is formulated under the 'U-Health' (Ubiquitous Health) strategy. Initially, this has involved transforming the manner by which citizens, in particular elderly citizens, are able to access healthcare. As part of this project, healthcare monitoring devices were initially sent out to a select number of citizens' homes, allowing caregivers to remotely monitor key indicators, such as blood pressure. More recently, this model has been expanded; local community centres now act as remote clinics where elderly patients are able to use these monitoring devices, thus saving time and unnecessary one-to-one physician visits.

Under the same strategy, future deployments will involve distribution of sensors to detect when elderly citizens are in distress, or have suffered a fall, whereby caregivers can be dispatched to their location quickly.

### Sharing Economy

As part of Seoul's 'sharing city' initiative which has promoted sharing economy technologies and services since 2013, the city has set out a program aimed at reducing elderly isolation from the community. The Ministry of Health and Welfare reported in 2015 that close to 1.4 million elderly citizens were living alone in the city; as such, Seoul has aimed to reduce this figure by encouraging home-sharing platforms to match elderly citizens with young room seekers.

### Strong Healthcare Delivery

Despite the current national legislative landscape meaning that emerging healthcare technologies, such as telehealth, are in their infancy, Seoul has positioned itself to ensure that healthcare delivery is as strong as it can be under current conditions. Hospital bed availability, for example, is very high, while urban planning since 2010 has been focused on increasing physical activity levels through the provision of urban green way routes as part of the Healthy Living Environments project.

Meanwhile, the city has ensured that technology will both directly and indirectly influence citizens' health in a positive manner. City-wide Wi-Fi is available free to citizens which, coupled with a strategy for digital delivery of public services, will ensure that healthcare services can be accessed anywhere. Meanwhile, the strong focus on electric vehicle charging infrastructure, including a sub-surface charging project for electric public transport vehicles in motion, will ensure that air pollutants are lowered as electric vehicle take-up increases.

***Public Safety: high levels of crime can negatively impact citizens' happiness, or worse, if those crimes are violent. Emergency services often struggle to reach victims in clogged city streets.***

***Study Hypothesis: Smart cities will reduce violent crime and reduce emergency service response delays.***

***Imagine a world where smart cities give back:***

## 34.7 hours per year per citizen

Juniper estimates that improvements in public safety; in particular emergency response, can have substantial time-benefits for citizens. In addition to this, the study found that the intangible benefits of smart cities would result in 4 million citizens leading happier lives every year. This would, for example, be achieved via an assumed 10% reduction in violent crime, as well as a 15% improvement in emergency response times; with both benefits serving to reduce the impact of stressful life events. A breakdown of the benefits are outlined below.

### Predictive crime & integration with traffic control: 30.6 hours

Machine learning can be leveraged to generate predictions around where crime is likely to occur on any given day. This allows law enforcement to target patrols in such areas, helping reduce crime more efficiently. The study estimated that such software could lead to the prevention of 3 million violent crimes. In addition to this, machine learning can be deployed as a tool for CCTV surveillance analysis; detection of unusual activity in real-time can serve to reduce response times to crime. Machine learning can also be used to predict where fires or flooding might happen.

Meanwhile, the study found that where cities integrated their emergency services with the municipal traffic control system, the prioritisation of emergency services vehicles and re-routing of civilian traffic could reduce arrival times by nearly 50%.

### Beating the 'golden hour': 4.1 hours

In medical terms, the 'golden hour' refers to the period of time after a life-threatening incident where treatment is most likely to save lives. Note that this 'hour' is not always an hour, depending on the severity of the circumstances; nonetheless, in all instances, the side-effect of faster emergency response times is an increase in average life expectancy. This effect has a global impact, in the context of violent crime, road traffic incidents and chronic conditions such as heart disease.

The research found that in critical situations, every minute without CPR or defibrillation reduces survival chances by 10%; therefore, the study's modest 15% improvement in response times highlights that fact that every minute counts.

Case Study: Nice

## Case Study – New York City

***Data, predictive modelling and inter-agency co-ordination helps New York improve public safety standards***

Once known as the 'murder capital' of the USA, New York has made substantial inroads in addressing improved public safety standards over the past 20 years. In fact, the city now ranks as the safest of all of the major cities in the country.

### Data-driven Approaches

New York was the pioneer of statistical policing, beginning with the deployment of CompStat in 1994. This programme was relatively simple in nature (mapping and logging crimes according to time series and location data), but allowed the police force to identify key crime hot-spots and devise strategies aimed at increasing public safety in each area. CompStat's legacy has since formed the foundation for modern policing across the globe.

More recently, the city conducted a 2 year trial of *HunchLab*, a predictive crime software solution. Where previously the city's 'stop and frisk' programme served a statistically effective, albeit highly controversial, method of reducing crime rates in the city, the new software uses data and statistical modelling, including historical crime data, terrain modelling as well as time and weather information to correlate where crimes happen with specific types of locations.

These types of approaches do not stop at law enforcement. With capacity to inspect only one-third of the city's buildings annually, the NYC fire department required an innovative approach to reducing building fire damage. Here, it compiled a list of 60 factors influencing building fire risks. These factors, alongside historical data and predictive modelling, have allowed the department to target areas most likely to require building safety inspection.

### Cross-departmental Vision

New York's smart city strategy applies a multi-pronged approach for improving public safety. In this context, the city aims not only to reduce the number of road traffic incidents and violent crime, but also the manner in which these are treated. For instance, emergency response teams are well-integrated, allowing disparate agencies to function more efficiently, while a disaster response strategy has been established to better co-ordinate emergency response with the public in the event of a major incident. This latter development is key, considering that the city has been subject to the second highest number of terrorism-related events of the cities evaluated in the study.

***Productivity: high levels of inequality in cities often restrict opportunities to wealthier citizens. Additionally, the complex labyrinth of city regulations and red tape present laborious, costly challenges for entrepreneurs.***

***Study Hypothesis: Smart cities will democratise citizen opportunities and improve regulatory regulation.***

***Imagine a world where smart cities give back:***

## 21.2 hours per citizen per year

Juniper's study found that numerous services in the average city are ripe for disruption in terms of how they are organised and delivered. This is particularly the case where data is used to create more efficicent services; these range from complex issues surrounding the establishment of businesses in the city, to simple services, such as retail payments.

**Smart governance: 20.8 hours**

City departments have historically operated in silos from one another. The concept of ongoing shared information used as a means to create efficiency has been rarely implemented until recently. The result of this has been that, for example, the complex rules and permits required to start a business can use up a substantial amount of time. Citizens of Rio de Janeiro, for example, must wait on average for 45 days before their new business can begin operations. Meanwhile, cities still hold much of their data using paper copies, or still rely on antiquated mechanisms to share information. Some UK NHS Trusts, for example, must print and fax their patients' electronic health records owing to a failure to establish interoperable systems.

The study found that substantial time-savings could be achieved, if information was stored using interoperable software systems and aggregated using APIs or similar mechanisms. It found, for example, that Rio's 45 days could be reduced to a single day if this kind of approach were applied.

**Contactless & Cashless Payments: 0.8 hours**

The study has also focused on cashless payments on transport systems. Here, additional time-savings were considered in the retail environment across the city. Juniper found that, on average, citizens have the potential to save 15 seconds per transaction using cashless mechanisms, with the assumption that, under some circumstances, the transaction value of items purchased would not realise the full time saving benefits of a contactless payment.

Case Study: New York City

## Case Study – London

***Digital democratisation and open data foundation helps London increase citizens' productivity***

London has long been considered a capital for innovation, with several schemes in place aimed at improving citizens' productivity.

### Open Data Pioneer

London was one of the first cities in the world to recognise the potential of open data, launching the London Data Store in 2010. This data repository, which includes information from various public agencies, led to the creation of the Citymapper app, allowing citizens to plan their journey across the city according to real-time traffic and transport information. More recently, Citymapper has analysed available data to identify public transport routes that are either inefficient, or lacking in service availability. This resulted in the launch of the Citymapper smartbus service, a pilot route offering citizens a real-time view of the buses' position alongside software integration for advanced service scheduling according to real-time conditions.

### Encouraging Talent

Meanwhile, the city has positioned itself as a hub for fostering digital talent and innovative services. London is rated as one of the top cities in terms of 'ease of doing business'; ie, the red tape to overcome and timespan required to establish and operate a new business. Additionally, initiatives such as Tech City UK have provided funding for emerging digital companies; this, in combination with a high level of conferences and smart city hackathons has increased the overall level of engagement between citizens and business to address city-specific challenges.

### Connecting Business & Citizens

Recognising that access to digital services is key to driving productivity, the Super-connected Cities scheme was launched in 2012 in the UK. The scheme, of which London was a part, encouraged SMEs to apply for vouchers to help pay for installation of high-speed broadband access. This concept was later extended to citizens themselves, with London following on from New York's successful Link NYC programme in converting payphone boxes into city Wi-Fi hotspots. The LinkUK project aims to convert 1,000 payphone boxes, with the service funded by advertising displayed on kiosks' screens.

### Digital Skills from the Ground Up

London has recognised that the economy is increasingly driven by digital technology. As such, the city's Smart London plan declared that extra funding would be channelled into the educational system to increase uptake of computer science courses. Additionally, the Greater London Authority conducted an assessment of the impact of digital exclusion (lack of access to digital services) in 2015, alongside a set of measures to reduce exclusion. In turn, this has resulted in schemes to increase digital literacy as well as reducing barriers for getting citizens online.

*Study Appendix*

*Methodology: How did we get the numbers?*

## Data Collection

The first stage of this study involved the assessment of cities across the globe, in terms of their vision, strategy and deployments. Given the wide range of cities analysed, this is used as a basis for further projections in terms of the potential of smart cities, in response to the question: ***"If cities across the globe today were to universally adopt, and deploy, smart city strategies, technology and services, what would they mean for citizens?"***

### Initial Indicators

Thus the initial phase of the study revolved around data collection, where critical 'top level' information was sought, for each respective city in the study. These 'initial indicator' datapoints serve as overarching datapoints used across the analysis of each respective index.

| Datapoint | Source | Purpose – What does this indicate? |
|---|---|---|
| Smart City Vision | Municipal authority publications | Depth & overall strategy, KPIs & success measures |
| Horizontal Platform Deployment | Municipal publications, press releases | Inter-agency integration potential |
| Open/Proprietary Technology | Vendor & city case studies | Future-proof/effectiveness |
| Open Data | Open data depositories | Open data breadth & potential |
| Communications Technology | City, regional or national data | City/citizen preparedness for smart city services |
| Life Expectancy | City, regional or national data | Life expectancy improvement potential |
| GVA (Gross Value Added) - $ | City/regional publications | Quality of life indicator, economic improvement potential |
| Population | City/census information | City size |

### Index-Specific Indicators

The next phase was to examine each index individually across each city. Readers will note that several indicators overlap across indices, as Juniper believes that these are important to more than one index.

## Mobility

| Datapoint | Source | Purpose – What does this indicate? |
|---|---|---|
| Average Vehicle Speed | City publications, press releases, third party sources | Peak time congestion & time-benefit potential indicator |
| Private Vehicles per Capita | City publications, press releases, third party sources | Congestion driver |
| Cycle Scheme Roll-Out | Vendor existence & city announcements | Congestion reduction & health improvement driver |
| Mobility-as-a-Service | Vendor existence & city strategic vision publications | Congestion reduction driver |
| Congestion Charge | City publications | Air quality improvement & congestion reduction driver |
| Road Accident Injuries per Capita | Transport statistics releases | Public health reduction driver |
| Air Quality | WHO | Public health reduction driver |
| Electric Vehicle Charging Stations | Cross-network charging station maps | Next-gen transport preparedness |
| Public Transport Journeys per Capita | Transport statistics releases | Network performance, availability & uptake |
| e/mPayment Infrastructure | Transport service provider websites | Transport payment convenience, time-benefit indicator |
| Autonomous Vehicle Testing | Press releases/city strategic vision | Next-gen transport preparedness |
| Smart Transport Initiatives, of which: | City strategic vision, vendor case studies, press | |
| - *Smart traffic light phasing* | | Congestion reduction driver & time-benefit indicator |
| - *Smart parking* | | Congestion reduction driver & time-benefit indicator |
| - *Open data for transport* | | Congestion reduction driver & time-benefit indicator |
| - *Strategy to reduce motor vehicle use* | | Congestion reduction driver & time-benefit indicator |
| - *Strategy to increase public transport use* | | Congestion reduction driver & time-benefit indicator |
| - *Citizen information dissemination solutions* | | Congestion reduction driver & time-benefit indicator |
| - *Interagency collaboration strategy* | | Congestion reduction driver & time-benefit indicator |
| - *Road safety strategy* | | Healthcare improvement indicator |

## Healthcare

| Datapoint | Source | Purpose – What does this indicate? |
|---|---|---|
| Hospital Beds per Capita | City, regional or national healthcare statistics | Bed availability & time-benefit indicator |
| Hospital Bed Occupancy Rate | City, regional or national healthcare statistics | Bed availability & time-benefit indicator |
| Congestion Charge | City publications | Air quality improvement & congestion reduction driver |
| Cycle Scheme Roll-Out | Vendor existence & city announcements | Congestion reduction & health improvement driver |
| Public Transport Journeys per Capita | Transport statistics releases | Network performance, availability & uptake |
| Road Accident Injuries per Capita | Transport statistics releases | Public health reduction driver |
| Violent Crime Rate | Law enforcement statistics | Public health & safety reduction driver |
| Police Force Size | Law enforcement statistics | Public health & safety improvement driver |
| Higher Education | Third party indices & statistical releases | Public health & safety improvement driver |
| City Terrorist Attacks since 2013, Domestic & Foreign Initiated | Global Terrorism Database | Public health & safety reduction driver |
| Public Safety Index | Numbeo | General safety & health indicator |
| Air Quality | WHO | Public health reduction driver |
| Electric Vehicle Charging Stations | Cross-network charging maps | Public health improvement driver |
| Autonomous Vehicle Testing | Press releases/city strategic vision | Public health improvement driver |
| Smart Healthcare Initiatives, of which: | City strategic vision, vendor case studies, press | |
| - *Telehealth/Remote healthcare services* | | Healthcare service improvement & time-benefit indicator |
| - *Digital health portals* | | Healthcare service improvement & time-benefit indicator |
| - *Chatbot services* | | Healthcare service improvement & time-benefit indicator |
| - *Digital healthcare for elderly strategy* | | Healthcare service improvement & time-benefit indicator |
| - *Transparent healthcare KPIs* | | Healthcare improvement indicator |
| - *Active lifestyle strategy* | | Healthcare improvement indicator |
| - *Road safety strategy* | | Healthcare improvement indicator |

## Public Safety

| Datapoint | Source | Purpose – What does this indicate? |
|---|---|---|
| Smart Street Lighting | Utilities, municipal energy departments | Public safety improvement indicator |
| Intelligent Video Surveillance | Press releases, law enforcement case studies | Public safety improvement & time-benefit indicator |
| Congestion Charge | City publications | Public safety/road traffic safety improvement indicator |
| Cycle Scheme Roll-Out | Vendor existence & city announcements | Public safety reduction indicator |
| Emergency services response co-ordination | City publications | Public safety improvement & time-benefit indicator |
| Violent Crime Rate | Law enforcement statistics | Public health & safety reduction driver |
| Police Force Size | Law enforcement statistics | Public health & safety improvement driver |
| Predictive Crime Software | Press releases, law enforcement case studies | Public safety improvement & time-benefit indicator |
| Fire/Flood Prediction Software | Press releases, vendor case studies | Public safety improvement & time-benefit indicator |
| Higher Education | Third party indices & statistical releases | Public health & safety improvement driver |
| City Terrorist Attacks since 2013, Domestic & Foreign Initiated | Global Terrorism Database | Public health & safety reduction driver |
| Public Safety Index | Numbeo | General safety & health indicator |
| Smart Public Safety Initiatives, of which: | City strategic vision, vendor case studies, press | |
| - *Emergency services integration* | | Public safety improvement & time-benefit indicator |
| - *Road safety strategy* | | Public safety improvement & time-benefit indicator |
| - *Disaster plan* | | Public safety improvement & time-benefit indicator |
| - *Crime reduction strategy* | | Public safety improvement indicator |
| - *Cybersecurity strategy* | | Public safety improvement indicator |

## Productivity

| Datapoint | Source | Purpose – What does this indicate? |
|---|---|---|
| Project Funding Sources | City publications, press releases | Service expansion & productivity improvement indicator |
| Public-Private Partnership Incentives | City/national publications | Service expansion & productivity improvement indicator |
| Talent Acquisition Incentives | City/national publications | Service expansion & productivity improvement indicator |
| Ease of Doing Business | World Bank | Time-benefit potential |
| Digital Education Policies | City/national publications | Productivity improvement indicator |
| City Governance | Municipal websites | Regulatory complexity, time-benefit indicator |
| City Chief Technology Office/Equivalent | Municipal websites | Service expansion & productivity improvement indicator |
| Smart City Conference Hosting | Press/event releases | Engagement & productivity improvement indicator |
| Smart City Hackathons | Press/event releases | Engagement & productivity improvement indicator |
| Smart Productivity Initiatives, of which: | City strategic vision, vendor case studies, press | |
| - *Digital services access* | | Productivity improvement & time-benefit indicator |
| - *Smart education projects* | | Productivity improvement indicator |
| - *Cybersecurity & privacy strategy* | | Service uptake & productivity improvement indicator |
| - *Equality strategy* | | Productivity improvement indicator |
| - *Retail & city services cashless payments* | | Productivity improvement & time-benefit indicator |

## Scenario Modelling

Following data collection, scenarios were modelled across each index to examine potential citizen benefits. These benefits are examined in terms of:

- Historical roll-outs smart initiatives (as per those indicated as 'time-benefit' metrics) in the data;
- Projected impacts of smart initiatives.

The benefits, as measured in terms of their impact across the cities analysed for this study, are translated using weighted averages to a per capita metric. The global city population is then used to make a projection for the overall potential of smart cities.

### Assumptions in the Model

- The projections are based upon smart city service take-up being at, or close to, 100%. This take-up is reduced where, for example, a service might only impact the adult population.
- Barriers to roll-outs, in terms of scaling, financing and so on, are not accounted for in this study.
- Where city-specific data was not available, regional or national data was used, with assumptions related to the city in question used to calculate a city-specific datapoint.
- Assumptions were made with regard to data such as annual intra-city trips, shopping excursions and annual trips to the physician; these data were not adjusted according to regional or national differences for the purposes of making projections.

## Global Smart City Index

Following data collection:

- Raw scores were first ranked according top-performing (20) to lowest-performing city (1).
- Weights were assigned to each ranked variable under the index to arrive at a score.
- This methodology was also used to calculate a score in terms of the cities' overall smart city vision, using the 'initial indicators' data.
- The scores were added together to form the final score per index and overall.