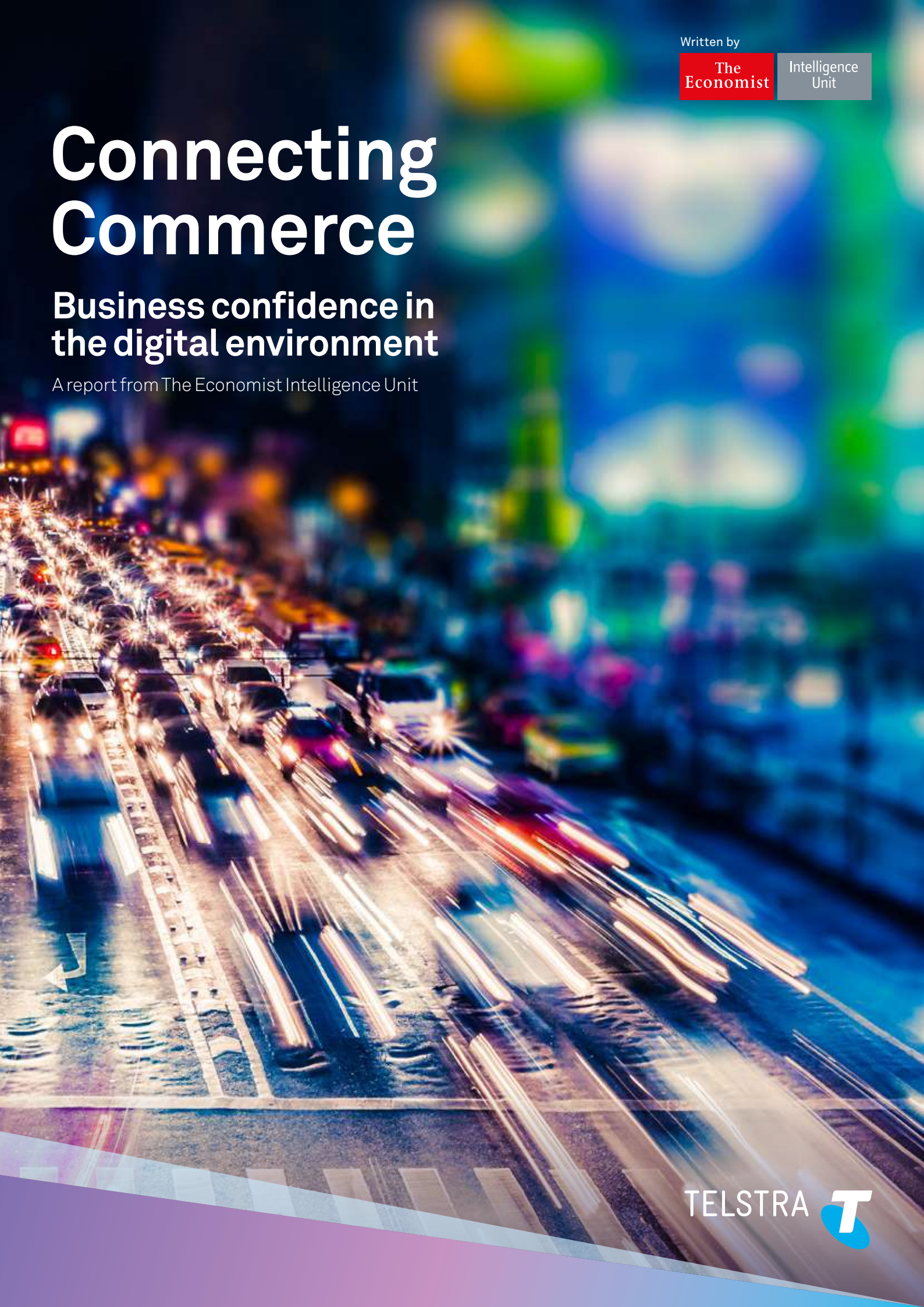
Written by

The Economist Intelligence Unit

Connecting Commerce

Business confidence in the digital environment

A report from The Economist Intelligence Unit



TELSTRA

Foreword

Connecting Commerce: Business confidence in the digital environment marks the fourth year that Telstra has partnered with the Economist Intelligence Unit to investigate organisational digital transformation on a global scale.

Over the time, what has become increasingly apparent is the critical importance of location on the success of digital transformation efforts. Whether looking to reach new markets, assessing access to digital talent, or creating digital partnerships among the local ecosystem, our reports have confirmed the link between thriving companies and where they reside.

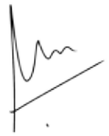
Until now most research into digital environments has focused its attention at a state-level. But, as any city-dweller will tell you, the differences between Sydney and Perth, Guangzhou and Shanghai, or New York and San Francisco couldn't be more stark.

Local authorities provide vital sources of skills, funding, and support. Yet what is clear is that organisations need to tap into different ecosystems - the skills market of India and China, the state support of Singapore and Seoul, the VC funding of Silicon Valley and London, the intellectual property reservoirs of established academic and tech hubs such as Tokyo or New York - to solve their specific needs.

To shed light on these issues and many more, we surveyed more than 2,600 business executives from 11 industries in 45 centres of commerce around the world. Their responses have been aggregated to create a barometer of city and industry performance.

Most importantly, what we've found provides a unique insight into the global digital transformation landscape, helping businesses around the world understand how your city can support your organisation's digital transformation efforts.

- Martijn Blanken,
Group Managing Director
and Chief Customer Officer at Telstra



About the report

Connecting commerce: Business confidence in the digital environment is a report from The Economist Intelligence Unit (EIU), commissioned by Telstra. Denis McCauley was the author and Charles Ross was the editor.

The analysis in the report is based on a survey of 2,620 executives in 45 cities conducted in June and July 2017. The list of cities includes 23 in Asia-Pacific, 19 in EMEA and three in North America. Eleven industries are represented, with the largest numbers of respondents coming from professional services, financial services, manufacturing, retail and education. (No respondents were included from the telecommunications or technology sectors.) C-level respondents account for 42% of the survey sample, with the balance being other senior executives.

Additional insights were obtained from in-depth interviews with senior executives, government officials and other experts based in several of the cities.

Our thanks are due to the following individuals (listed alphabetically by surname):

- Daria Batukhtina, co-founder, Startup4City Project
- Zac Bookman, chief executive officer, Opengov
- Federica Bordelot, policy advisor, Eurocities
- Viktor Bos, business connector, Job of the Future, Amsterdam Economic Board
- Andrew Graham, managing partner, Brisbane, RSM Australia
- Chan Meng Khoong, director and CEO, Institute of Systems Science, National University of Singapore
- Willem Koeman, business connector, Digital Connectivity, Amsterdam Economic Board
- Sean Lee, co-founder, Seoul Space
- Frauke Mispagel, managing director, Axel Springer Plug and Play Accelerator
- Rudy Pieck, partner, Business Services, BDO Australia
- Iain Reed, founder, EFA and chairman, TiE Hong Kong
- Alpesh Shah, senior partner and director, Boston Consulting Group India
- Adam Simon, global managing director, Retail Business Development, CONTEXT
- Greg Sutherland, chief innovation officer, Australia Post
- Nicholas Yang, Secretary for Innovation and Technology, Hong Kong Special Administrative Region Government
- Xania Wong, chief executive officer, Jobdoh.

Executive summary

Across geographies and industries, businesses are embarking on, or preparing for, a mission to put digital technology at the heart of everything they do, an exercise that has come to be known as digital transformation.

It can be an enormously difficult and complex undertaking, requiring not just the deployment of advanced technologies but also the overhauling of business processes and a large degree of cultural change. In most cases, firms' existing internal resources will not be enough to pull transformation off, and they need to look outside their own four walls for additional support.

Businesses will find most of that support in the city or cities where they operate. For start-ups and other small firms, the city environment often provides the only resources they tap into. Large businesses with national or global operations can look further afield for help, but their local offices– whether headquarters or branches– also rely heavily on the city environment for talent, ideas, financial resources or simply inspiration to help them achieve their digital initiatives.

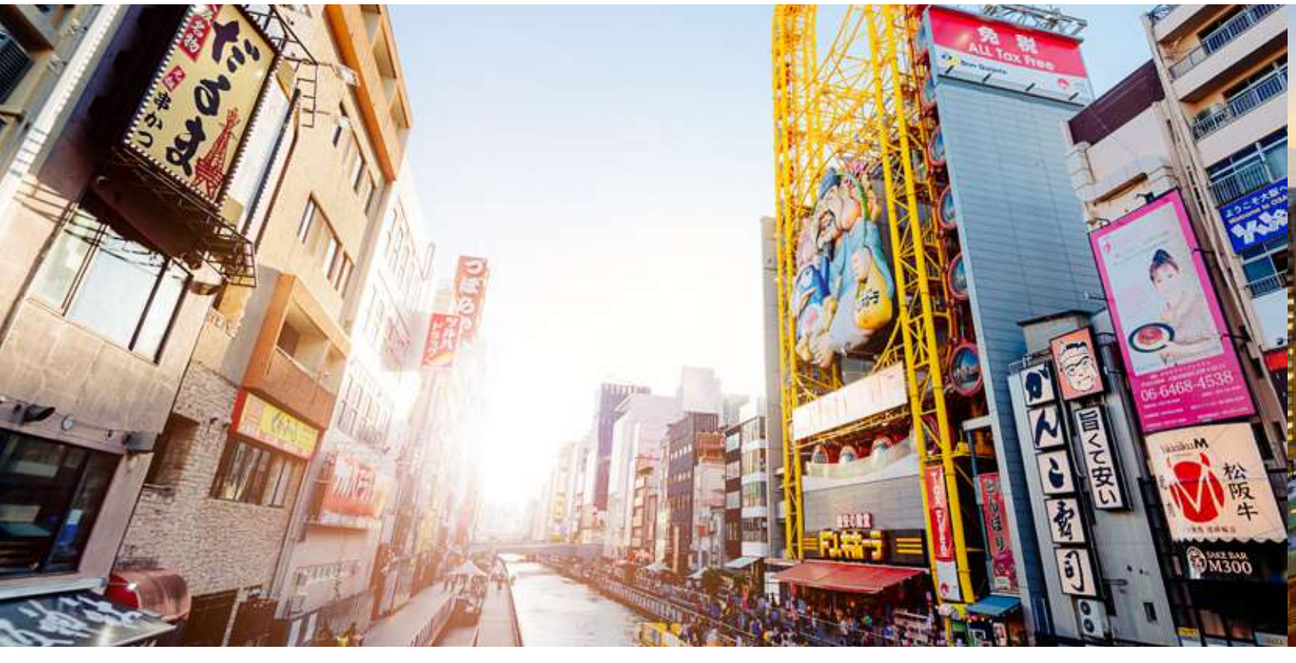
Even when it comes to government policies, those implemented by City Hall have more influence on businesses' digital success than national policies. The majority of business executives surveyed by The EIU believe this to be the case.

This report finds that business leaders are relatively confident that their city environments can provide the support they need to meet their digital ambitions. There are clear indications, however, of areas where many cities are coming up short, including in the supply of digital talent and the sharing of government data. The study is based on a survey The EIU conducted of over 2,600 executives in 45 cities around the world, as well as one-on-one interviews with 15 business leaders, city officials and other experts. Following are its major findings:

Confidence in the digital environment is high in Asia's emerging market cities. Barometer readings of business confidence in the strength of the local environment for digital transformation vary widely across cities. Respondents in Bangalore, San Francisco and Mumbai are the most positive, and those in Berlin, Yokohama and Tokyo the least. Seven of the 10 highest readings are recorded in emerging Asian cities. Their confidence may be a reflection of growth market enthusiasm. Lower confidence in developed cities, meanwhile, may reflect a failure to meet high business expectations, for example in the areas of ICT (information and communications technology) infrastructure or education.

Firms will leave if the environment is not right. Almost half of surveyed executives (48%) say their firm has considered relocating operations to a city with a more favourable external environment. That number is highest in Asian cities (53%), while nearly half the survey respondents in US and Australian cities say the same. Digital entrepreneurs today have numerous options, domestically and internationally, for where to launch or relocate their ventures.

Local educational institutions must do better at supplying digital talent. Skills gaps are amongst the two toughest challenges companies face in pursuing their digital transformation, along with financial constraints. It may be encouraging, then, that most executives in the survey (57%) think their city's schools and universities do an effective job at turning out the talent firms need to drive digitisation. However, over 40% say otherwise, and more than one-fifth in cities with strong technology innovation reputations, such as Stockholm and Seoul, rate their local institutions as ineffective on this count. Digital security and advanced data analytics are identified as the two most critical skills needed for transformation, with softer skills such as networking also a top priority.



With open data, city governments are directly influencing firms' transformation. Firms leverage open data made available by local governments to provide new or improved services to their customers; some base their entire business models on it. A large majority of executives in the survey (69%) consider open data to be important to their business, and 30% deem it "very important". More than eight in 10 businesses make at least occasional use of it, including 35% that do so periodically and 20% frequently.

Cities in Asia-Pacific are behind the curve on open data. Executives believe that city agencies need to do better at sharing the troves of data they hold because of its importance to businesses. More than half of survey respondents (54%) think their cities make poor use of the data they collect. That figure is highest in Asian cities, and only slightly lower in Australia's. Interviews conducted for the study confirm that cities in the US and Europe are speeding ahead in this area.

Networks and communities are a growing source of local digital advice and support. Ecosystems are taking shape in most cities and consist of formal and informal networks, communities, forums and other support structures designed to help firms address their digital challenges. Companies in the survey are making active use of them. For example, 29% of firms in several Asian cities turn to innovation labs to obtain ideas and advice, and another 18% work with incubators and accelerators. (One quarter in Asia also tap government programmes for this purpose.) In European and US cities, innovation labs and centres are used by almost one quarter of firms, and university networks are an important source of digital ideas for 20% and 18% of firms, respectively.

City governments have a role to play in addressing firms' cyber-security concerns. In many countries, national governments take the lead in co-ordinating interaction with the private sector on cyber-security. City governments are also getting involved: 63% of respondents say local authorities have consulted them on cyber-security issues at least occasionally in the past two years. City Hall's role thus far is primarily as a facilitator of information sharing on good cyber-security practice. But its role is likely to grow as networked sensors proliferate (thanks to "smart city" programmes), creating new security vulnerabilities at local levels.

ICT infrastructure impedes firms' transformation in many cities. Fifteen percent of respondents cite shortcomings in their city's communication networks as a serious obstacle to achieving their digital ambitions. It is a concern, then, that almost half – 48% of the survey sample (and more than 60% in New York, San Francisco and Singapore) – believe their city is ineffective in providing ICT infrastructure that meets firms' digital transformation needs.

New roles are emerging to lead cities' digital transformation efforts. The role of chief technology officer (CTO) has been created in recent years in several cities, including Amsterdam, New York and London. This executive, who usually sits alongside the chief information officer (CIO), looks after the city government's own technology infrastructure and often leads its Internet of Things (IoT) initiatives. Chief digital officers (CDOs) are also beginning to emerge to spearhead cities' digital transformation efforts.

Companies, cities and nations

In October 2015, Australia Post was in the middle of a long-term effort to shift from a traditional mail business to an e-commerce business. Senior management at the company's Melbourne head office, where most of its digital teams are based, realised that it needed to be part of the start-up ecosystem and work with others to identify new opportunities for delivering products and services to customers. To that end, the government-owned corporation forged a partnership with the Melbourne Accelerator Program (MAP), run by the University of Melbourne, to fund and provide other types of support to local tech start-ups developing relevant ideas. It is an example of a business making use of resources available within the city environment to advance its digital transformation.

There are different definitions of digital transformation, but all involve placing digital technology at the heart of an organisation's operating model. For long-established businesses, particularly in traditional industries, this is a difficult and often painful process. Digital comes easier to younger companies that have been formed with online business models. But young or old, large or small, no organisation can thrive digitally without tapping resources in the external environment. These are most often found in the cities and surrounding regions where companies or their constituent parts operate.

A strong digital transformation environment is about more than good ICT infrastructure, important though that is. Businesses today compete for skilled employees to perform the digital roles needed to move transformation forward, and they rely on nearby universities and other educational institutions to train such staff. Large firms look to local accelerators and incubators for tech start-ups whose ideas and models it can help develop (or ultimately acquire). They and smaller businesses get involved in hackathons or similar events to obtain ideas for addressing specific technology challenges they are facing. Start-ups participate in meet-up groups and other forums to do the same, or to seek financing or referrals to talent. Many cities, of course, are home to sources of venture capital and corporate, or government programmes that fund start-ups' later stage growth. Through "smart city" or open-data projects, cities are catalysts themselves for developing, testing and deploying new digital services to the benefit of local businesses that take part in them.

"Cities have a critical role to play as launch pads for digital transformation"

- Daria Batukhtina, co-founder, Startup4City

The role of City Hall

A city government's policies and initiatives naturally have an important influence on the environment for transformation. Amsterdam Smart City (ASC), widely acknowledged as a model public-private partnership to advance municipal digitisation[1], was conceived by the Amsterdam Economic Board and is managed by the city's chief technology officer. Daria Batukhtina, founder of Startup4City, a small business advisory group, believes ASC's success underscores the value of City Hall acting as "chief facilitator, bringing together all the local stakeholders in digital transformation and getting them to work together".

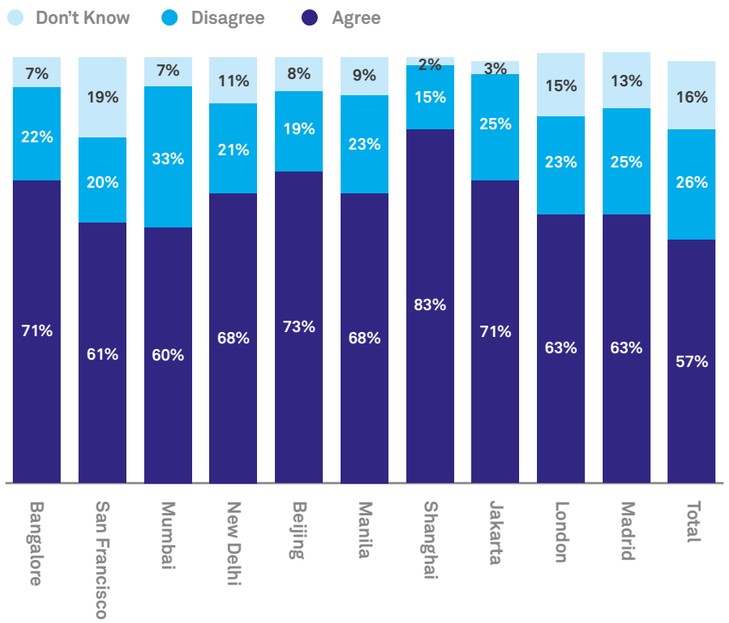
Indeed, many respondents believe policies pursued at a city level have a greater influence on businesses' digital success than those originating at the national level. This is the belief of a majority (57%) of business executives surveyed by The EIU across 45 cities. (Figure 1) This view is especially strong in Asian metropolises such as Shanghai, Beijing, Bangalore and Jakarta, but also in Barcelona and New York.

There is no universal model, however, for how proactive a city government should be in support of companies' transformation efforts. The authorities of Singapore (a national as well as a city government) are hands-on, consistent with their overall approach to fostering business growth. Chan Meng Khoong, director and CEO of the Institute of Systems Science at the National University of Singapore, believes the government's active role in sponsoring and financing digital innovation and entrepreneurship has engendered a high degree of trust between it and the private sector. His view is supported by a large share (43%) of Singapore-based executives, who state that government programmes are instrumental in helping their companies achieve their digital objectives, and by the majority (53%) pointing to government as their most important source of financing for transformation initiatives.

In Bangalore and Mumbai, far fewer state the same about their use of city government financial or other assistance. Yet executive confidence in the strength of the digital transformation environments in those cities is extremely high (see "The digital city barometer"). Alpesh Shah, a senior partner in the Boston Consulting Group (India), agrees that the digital environments in both cities are vibrant but attributes them to grassroots activism from the business and academic communities.

Figure 1: Local power

City governments are more influential than national governments (% of respondents)



[1] See, for example, "Six Lessons from Amsterdam's mart City Initiative", MIT Sloan Management Review, May 25, 2016, and "Six smart cities Sydney can learn from", The Sydney Morning Herald, November 19, 2015.

48% of respondents say their firm has considered moving operations to another city to take advantage of a more favourable external environment.

Voting with their feet

Would a company go as far as to trade cities in search of a more positive digital environment? The answer is yes, judging by the survey results: 48% of respondents say their firm has considered moving operations to another city to take advantage of a more favourable external environment. That number is highest in Asian cities (53%), although nearly half of respondents in US and Australian cities and 41% in Europe say the same. More mid-size firms – those with between 100 and 249 employees – have considered relocating for this reason than those of other sizes. (Figure 2)

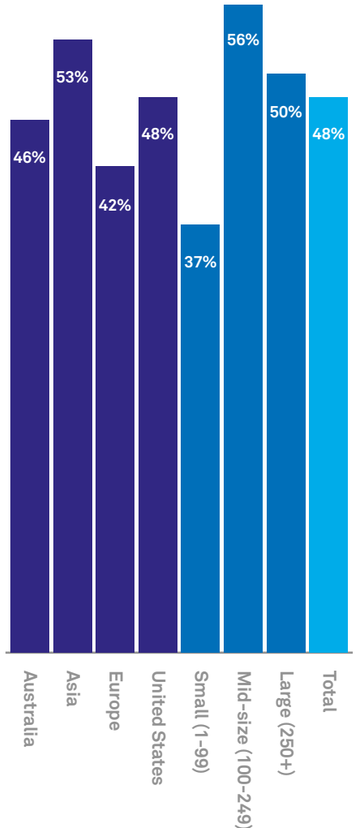
Multinationals are also not averse to relocating to take advantage of a more favourable digital environment. General Electric, a global industrial engineering giant, decided in early 2016 to shift its headquarters from Fairfield, Connecticut, its home for over 40 years, to Boston. Its express purpose: to take advantage of that city's well developed technology ecosystem[2].

In Europe, observes Ms Batukhtina, digital entrepreneurs have numerous options for where to launch or relocate their ventures, and European centres vie to attract such firms by touting their pools of technology talent, sources of funding, and plethora of research labs and other support structures. She also finds that the competition is no longer just within Europe. "There is now competition between Europe and Asia, because entrepreneurs understand that it's more convenient than ever for them to move on to Singapore, Beijing or elsewhere."

How do the world's major cities compare, on the support their environments provide to businesses as the latter strive to become fully digital? In the following pages we will provide some answers through the perspectives of 2,620 business executives who were surveyed in 45 of these cities, as well as the views of selected academic experts, consultants and municipal officials. Our analysis will focus on four areas–talent, open data, innovation ecosystems and ICT infrastructure–where businesses often rely on the city environment for key inputs. First, however, how confident are our surveyed executives in the overall strength of their cities' digital environments?

Figure 2: Greener pastures

Companies willing to relocate to take advantage of a more favourable environment (% of respondents)



[2] G.E. Is Moving Headquarters to Boston and Itself Into the Digital Era", The New York Times, January 13, 2016.

"There is now competition between Europe and Asia, because entrepreneurs understand that it's more convenient than ever for them to move on to Singapore, Beijing or elsewhere."

- Daria Batukhtina, co-founder, Startup4City

The digital cities barometer

India's cities may suffer more than most from infrastructure deficits, pollution, poverty and other ills, but when it comes to the environment for digital transformation, their executives are remarkably optimistic. This is particularly true of Bangalore, where business leaders express the highest levels of confidence in their digital environment than in any other city in the study. It is the case in all six of the barometer categories– overall, people and skills, financial environment, innovation and entrepreneurship, new technology development, and ICT infrastructure. For the full set of barometer readings, see appendix 1.

Seven of the 10 highest confidence levels in the survey are recorded in emerging Asian cities.

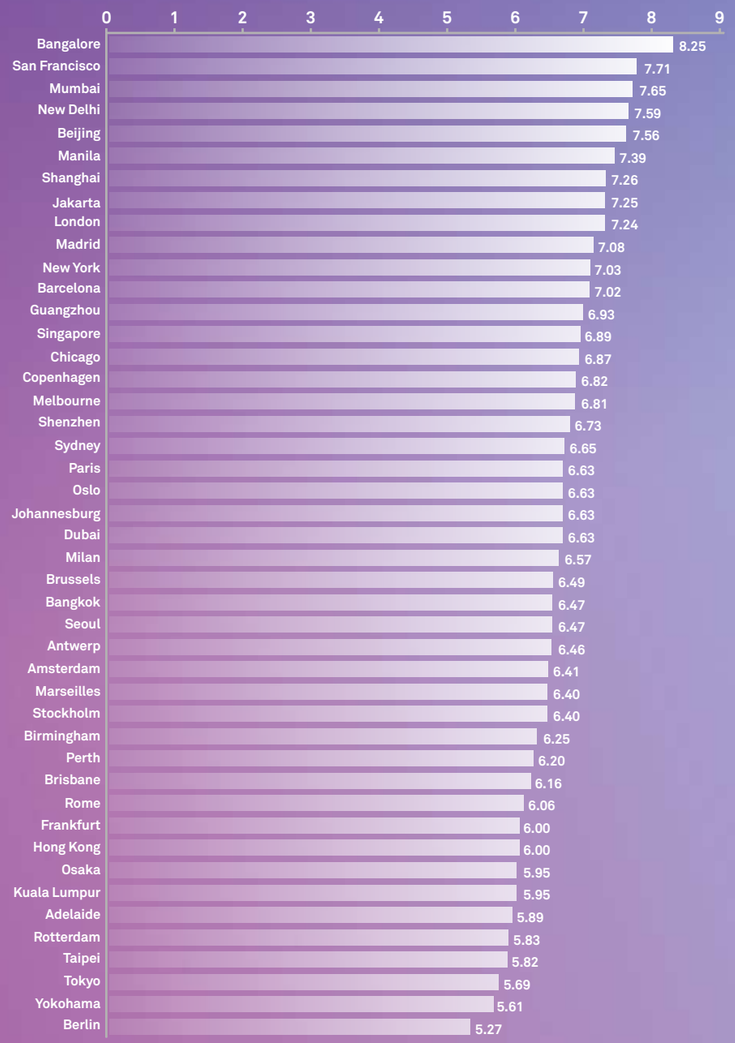
Their compatriots in Mumbai and New Delhi are only slightly less bullish, and they are not alone in the emerging world: seven of the 10 highest confidence levels in the survey are recorded in emerging Asian cities. Amongst rich-world cities, only San Francisco (2nd) registers in the top five and two others (London, 9th, and Madrid, 10th) make the top ten. By contrast, developed cities account for eight of the 10 lowest readings in the barometer, with executives in Berlin, Yokohama, Tokyo and Taipei the least confident of all. (Figure 3)

"You should pack your bags and move [to San Francisco] because it is where all the venture capitalists are, it is where the mentors are."

- Zac Bookman, founder, Opengov

Figure 3: Confidence in the environment

Overall digital transformation environment of 45 cities (Score out of 10)



Constructive critics?

Business confidence is a highly subjective measure based on attitudes, and is not necessarily an indication of a city's actual level of digital development. Confidence can be conditioned by cultural norms, for example, which perhaps helps to explain why Japan's famously conservative and hard-nosed managers appear downbeat about their cities' digital environments. Iain Reed, founder of EFA, a financial software start-up, and chairman of TiE Hong Kong, the local chapter of an entrepreneurs' association, ascribes the territory's relatively low confidence levels (37th overall) to the same cultural factor. Those low readings from local executives belie the digital buzz Mr Reed and others sense about Hong Kong. "The digital scene here has exploded in the past five years," he says. When it comes to communities and forums, for example, "we've gone from nothing in digital to several events happening every night".

The relatively low barometer readings in some developed cities may also reflect a degree of frustration if business leaders' high expectations are not being met in some areas. European cities such as Amsterdam, Stockholm and Berlin, for example, enjoy a reputation as technology innovation hubs with well-developed digital infrastructure, yet some entrepreneurs envy advantages that their counterparts in London enjoy, like access to venture capital and other types of financing. (London's is the 7th highest barometer reading when it comes to its financial environment for digital transformation; Amsterdam is 23rd, Stockholm 30th and Berlin 41st.)

"Can do"

Executives surveyed in US cities show few signs of low confidence or unmet digital expectations. San Francisco, recording the second highest barometer reading overall of the 45 cities, is a case in point. Zac Bookman, founder and chief executive of Opengov, Bay Area start-up providing software to government agencies, believes the city can improve on its existing infrastructure, but he maintains that "San Francisco's tech ecosystem is the best in the world. It has achieved a massive network effect where it is by far the best place to nurture innovation."

New Yorkers (11th in terms of the overall environment) are similarly positive about local support for digital innovation and entrepreneurship (where their reading is 6th highest) as well as about the financial environment for transformation (5th). Chicago (15th overall) is not as recognised as other US cities for its digital assets, but executives there display a good deal of confidence in the skills provided by its universities and other educational institutions (11th) and in the financial resources available for digital innovation. (The city made the top 10 of a global ranking of technology innovation hubs published recently by KPMG, an advisory firm[3].)

Australia's two largest cities, Melbourne and Sydney (17th and 19th overall, respectively), figure in the upper half of the barometer table, ahead of several European and Asian centres. Confidence in Melbourne and Sydney is relatively high in terms of the financial environment, new technology development, and talent and skills availability. (Executive confidence is lower in Australia's second-tier cities in every barometer category.)

The West's major cities are not, then, in imminent danger of losing their digital edge. Or at least the barometer readings do not suggest this is the case. Business executives' critical attitudes in some of them may indeed help to ensure that any weaknesses that are emerging are addressed in good time.

[3] KPMG, The changing landscape of disruptive technologies: Global technology innovation hubs, 2017.

Digital skills

Ask leaders of technology companies for a list of their toughest long-term challenges, and finding skilled employees is likely to be near the top. The same is true of respondents to our survey, all of whom work in sectors other than technology. As a global sample, they rank talent and skills shortages a close second behind financial constraints as the toughest challenges they face in pursuing digital transformation. The challenge appears acute in Asia-Pacific, and particularly so in Osaka, Bangkok and Bangalore, where it is cited by 40% or more of each city's executives. It is also a considerable worry for executives in New Delhi, Singapore and Adelaide, amongst other places. (Figure 4)

"Digital skills aren't taught as widely through our educational system as they should be. There are courses, and some schools are very focused on digital skills, but it's not enough to meet demand in the labour market."

- Viktor Bos, business connector, Job of the Future, Amsterdam Economic Board

Figure 4: Good people are hard to find

Cities with the greatest talent and skills shortages (% of respondents)

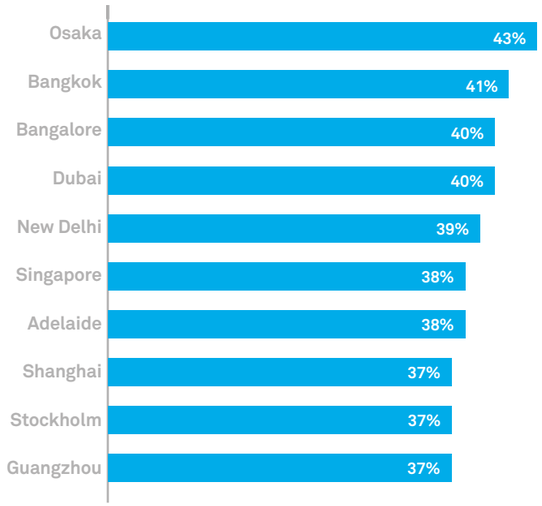
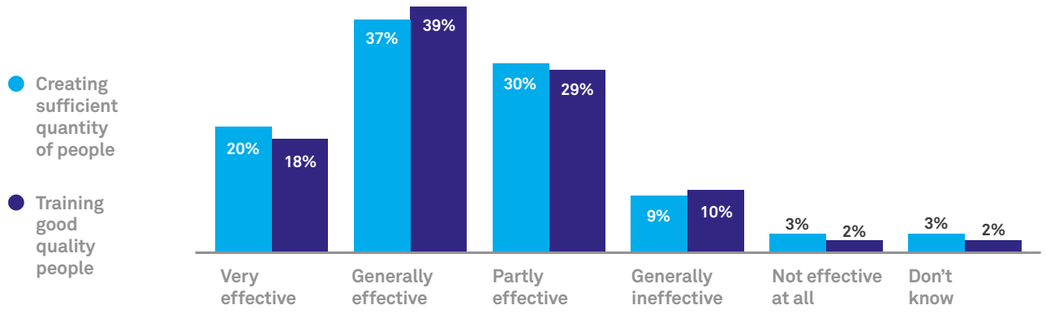


Figure 5: Building a talent pool

Effectiveness of educational institutions at equipping people with digital skills (% of respondents)



Brutal competition

Demand for talent with digital skills is strong everywhere. Most cities in our study have high-quality universities and other institutions that generate a growing volume of graduates with the technology skills local companies need. With few exceptions, however, it is not enough to keep up with demand. That is certainly the case in the San Francisco Bay area. "There is a fierce, brutal competition for talent here," says Zac Bookman. "It is very hard to recruit because there is a shortage on the order of tens of thousands of highly skilled engineers."

This is partly due to technology adoption patterns. Successful new technologies mature and are assimilated faster today than ever before, or so several experts believe[4]. Networked sensors, for example, part of the Internet of Things (IoT), are today embedded in over eight billion devices, machines and other physical objects, compared with less than one billion eight years ago. Their growth, and that of the reams of data they generate, has contributed to a surge in demand for employees with advanced data analysis skills.

Likewise, the application of artificial intelligence (AI) techniques in businesses has grown substantially in just the last three years. Demand for specialists with an understanding of AI is certain to rise in the coming years. Mr Khoong of the National University of Singapore agrees. "AI is a very important skillset that is just emerging in terms of employer investment in training. The need for AI education is growing exponentially."

It may be a cause for some concern, then, that over 40% of respondents believe their city's educational institutions are at best only partly effective at training people with the digital skills that firms need to implement their digital transformation initiatives. (Figure 5) Upwards of 20% of executives in cities with strong technology innovation reputations, such as Stockholm and Seoul, term local institutions as "ineffective" on this count. According to Sean Lee, co-founder of Seoul Space, an accelerator: "Seoul has some of the best technical universities in the world, but unfortunately not many graduates make their way into the start-up ecosystem. Most still join the chaebols [conglomerates]."

"There's a shortage of digital talent across all of Australia, and both corporates and start-ups feel it. We need to do more to grow our own talent as opposed to over-relying on overseas talent or outsourcing to IT hubs or centres."

- Andrew Graham, managing partner (Brisbane), RSM Australia

[4] See, for example, Rita Gunther McGrath, "The Pace of Technology Adoption is Speeding Up", Harvard Business Review, January 25, 2013; and Ron Adner and Rahul Kapoor, "Right Tech, Wrong Time", Harvard Business Review, November 2016.

"UX – user interface – is an increasingly important skills category. Think of how one-click ordering has driven the growth of Amazon and other online companies."

- Adam Simon, global managing director, Retail Business Development, CONTEXT

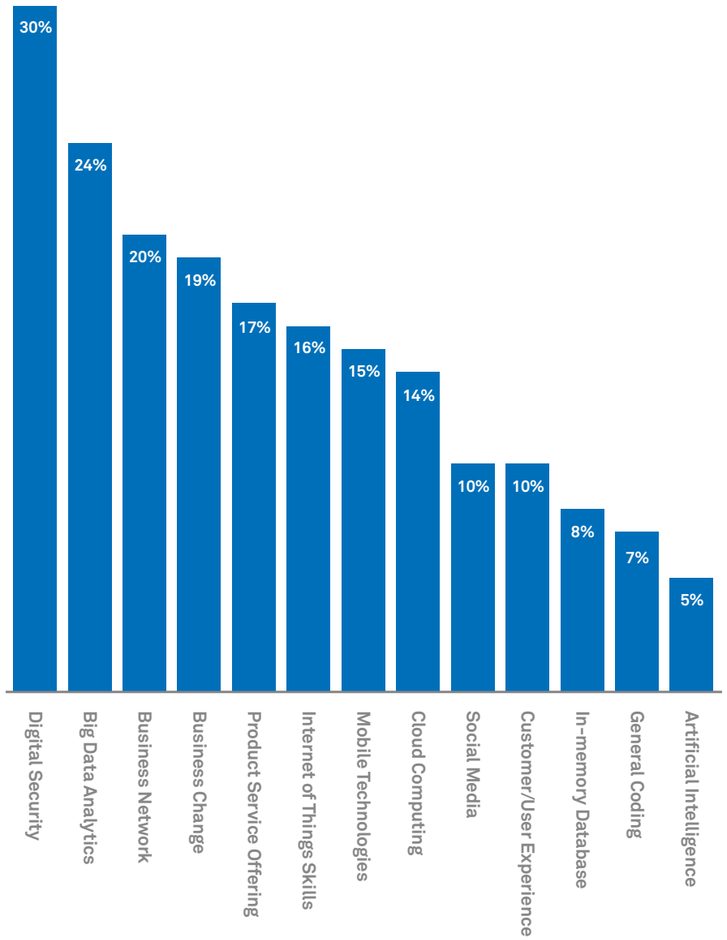
The gaps to be filled

The surveyed executives point to digital security and advanced data analytics as the two most critical skill needs as they pursue digital transformation. (Figure 6) As we will discuss later, cyber-security is a constant concern of business leaders just about everywhere, and few feel they are on top of it. This is no surprise given the headlines about major data breaches. It is fourth on respondents' list of the toughest challenges facing their digital transformation efforts. Rudy Pieck, an Adelaide-based partner of BDO Australia, a global professional services firm, believes that companies everywhere are "playing catch-up" on cyber-security. "We need people with the skills to plug some of the holes that exist. I think we've all been living on borrowed time in this area."

Nor is it a surprise that data analytics figures prominently as a skill need for transformation. Specialised programmes in data engineering and analysis are increasingly common at universities and technical training schools. However, business demand seems to be far from sated for graduates and other recruits with a mastery of predictive analytics, for example. Judging by the survey results, the need for such specialists seems particularly acute in China's major cities, as well as in Mumbai, Rome and Amsterdam.

Figure 6: Digital skills in demand

Digital skills most needed by organisations (% of respondents)



"Parents in Hong Kong still want their children to study to become doctors or lawyers, rather than technology specialists. We need to change this mentality."

- Nicholas Yang, Secretary for Innovation and Technology, Hong Kong

Some of those interviewed for the study also highlight the need for coding skills to be taught more widely in local secondary and tertiary education. “Coding has never been on the educational agenda in Berlin or elsewhere in Germany,” notes Frauke Mispagel, who is the managing director of Axel Springer Plug and Play Accelerator.

But perhaps even more critical is the need for technologists who also possess analytical and communication skills. (Networking follows closely behind security and analytics in survey respondent’s list of their top skill needs.) These are people, says Mr Pieck, “who also understand what the customer is looking to do and what is driving their business, but they are rare in Adelaide – they don’t grow on trees.”

They are also rare in larger metropolises such as Hong Kong, says Xania Wong, founder and chief executive of JOBDOH, an online recruitment platform. “To be a good programmer is not just about knowing how to cope technically. You need to think about how to solve a problem, how to architect the whole programme, and on that front both there is still a lot of room for improvement in both quantity and quality in Hong Kong. Our education system has not historically trained students to think like that.”

A starting point for ensuring that an educational system can meet companies’ skill needs is a good understanding of what those needs are. Most of our interviewees believe a good degree of consultation takes place in their cities between businesses, local educational authorities and schools themselves. The survey respondents broadly agree: 53% confirm that such consultations take place between their firms and local educational institutions.

It is not the case everywhere, however. In Yokohama, for example, 60% of surveyed executives say such consultation does not take place with city authorities (only 20% say it does), and 58% say there is no such interaction between business and local educational institutions. Those numbers are almost as high in Osaka. Even in Seoul, Madrid, Birmingham and Brisbane, upwards of 40% of executives lament the absence of such discussions.

Most of our interviewees believe a good degree of consultation takes place in their cities between businesses, local educational authorities and schools themselves.

Skills development, Singapore-style

Singapore’s government has a reputation for leaving no stone unturned when it comes to technology development, as well as to education. Long-term strategic plans and roadmaps are favoured tools for achieving desired objectives in both areas, and digital skills are no exception. Chan Meng Khoong, director of the Institute of Systems Science at the National University of Singapore, dates the origins of the city-state’s thinking about digital skills back to the launch of its National Skills Framework in 2008. According to Mr Khoong, the latter, which covers more than 20 sectors, was conceived as part of a longer term effort to wean the economy off an earlier reliance on imported knowledge and talent in certain areas, including ICT.

The main vehicle for technology skills within this is the “National Infocomm Competency Framework (NICF)”, described as a roadmap to help employers and educators determine the specific technology skills required for over 300 individual job roles (across several different sectors) and develop suitable training programmes to teach them. The NICF is due to be updated in 2017, says Mr Khoong, and will place a particular emphasis on big data analytics, cyber-security and artificial intelligence.

The updated framework will also include a focus on “design thinking”, which Mr Khoong believes is particularly relevant to digital transformation. Loosely defined as a customer-centric approach to problem-solving, design thinking emphasises the use of imagination, intuition and reasoning in addressing challenges. Amongst other aims, it is meant to imbue employees in technology roles with the types of analytical, communication and customer relationship skills that several executives interviewed for this study find sorely lacking in their workforce.

The NICF is a prime example of the top-down approach to development Singapore is famous for. Mr Khoong stresses, however, that businesses and educational institutions like his have been consulted widely by the government on it and have been involved in drafting some of the job and skills specifications. The fruits of this effort for local businesses may take some years to emerge, but patience is a necessary ingredient in long-term planning.

Data dividends

Governments are sitting on a data goldmine. McKinsey, a consultancy, has estimated that open data made available by different levels of government has the ability to generate more than US$3 trillion in additional economic value per year in sectors such as education, transportation, consumer products, electricity, oil and gas, health care, and consumer finance[5]. In the US and elsewhere, says Zac Bookman, governments at all levels are "actively cataloguing their vast troves of internal operational data and publishing it for public consumption. A major reason they do this is to spur private sector innovation."

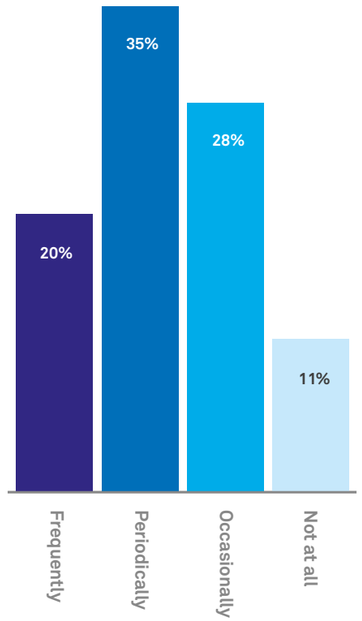
Such innovation often takes the form of apps that provide information or online services based on data made available by local governments. Start-ups in many of the cities covered in our study have based their entire business models on the use of such data. An example is San Francisco-based BuildZoom, an online platform that matches homeowners looking to re-model their homes with local contractors. The platform catalogues licensing and building permit data made available by city and local community governments across the US. Another is Purple Binder, a venture created by Chicago-based data scientists which began as an app listing all the social services available in the city; it now provides hospitals and health clinics with analytical services about the patients they refer to social services.

Large firms also use such data to provide new services to their existing customers. An example is Arup, a London-headquartered engineering and construction services provider, which created an online risk assessment service for clients utilising available public data on environmental hazards.

Over eight in 10 survey respondents (83%) say their firm makes at least occasional use of open government data provided by city agencies; 35% say they do so periodically and 20% say they make frequent use of it. (Figure 7) More than two-thirds (69%) say this type of data is important for their business, and 30% term it as "very important".

Figure 7: Open to using open government data

Usage of open government data by organisations (% of respondents)



[5] McKinsey Global Institute, Open data: Unlocking innovation and performance with liquid information, October 2013.

> **"Data is becoming currency. Who has it and how it is used can determine balances of power. Governments that understand the data they have and then organise it, clean it and put it into the hands of local businesses can create quite a lot of economic value."**
>
> **- Zac Bookman, Opengov**

54% of respondents say their cities make poor use of the data they collect.

Improving their game

The survey results suggest that companies' use of open data is widespread in Asian cities. This is not the case in Hong Kong, however, where only 10% of executives say their firms are frequent users of open data. (This compares with figures of 37% in New York and 25% in San Francisco.) Mr Reed, founder of EFA, believes the territory is behind the global curve in the case of open data. The government has made some information available online, he says, but in a rudimentary way, such as posting documents that can be searched. "There hasn't been much thinking on the next step, such as making data available through APIs [application programming interfaces]."

Executives certainly believe that their governments can do much more to share the large volumes of data they hold with local businesses. A majority in the survey (54%) assert that their cities make poor use of the data they collect. That figure is highest amongst executives in Asian cities and only slightly lower in Australia's. (Figure 8)

According to Nicholas Yang, Hong Kong's secretary for innovation and technology, the territory's government is in the process of releasing thousands of new data sets through APIs, and this process will gain pace over the next year. He acknowledges Hong Kong's slow start, however, advising other governments setting out on this path to first determine the economic value of their data. The investment required to convert it and create platforms for sharing it is considerable, he says. An understanding of its value is therefore needed to project the return-on-investment of an open data initiative.

Figure 8: Governments need to work better with data

City governments who make poor use of data (% of respondents)

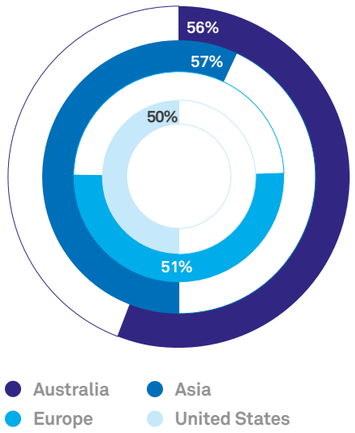
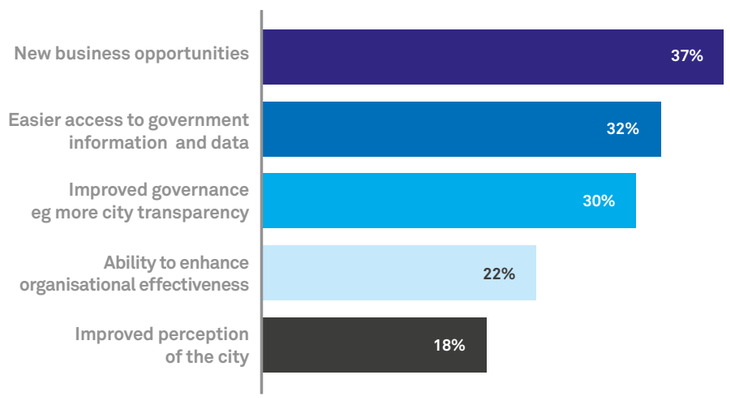


Figure 9: Open data, open business opportunities

Benefits of using open government data (% of respondents)



Judging by the views of several of the experts we interviewed, the world's major metropolises can learn directly from other cities about how to put open data to use. Federica Bordelot, a policy advisor with Eurocities, a network of major European cities, points to successful programmes in Bristol, Florence, Ghent and Eindhoven as models of far-sighted open data use in Europe. While Mr Bookman says the governments of the largest US cities make a substantial amount of public data available to citizens and businesses, they do not necessarily do it in a systematic and functional way. "If you want to see 'next gen' open data, go to Boston," he says.

The primary value of government data to businesses, as indicated above, lies in leveraging it to provide new or improved services to their customers. This is clearly reflected in the survey, where respondents point to new business opportunities as the main benefit they derive from using data provided by their city government. (Figure 9) Firms also tap into a wide variety of data categories. A study conducted in 2015 by the London-based Open Data Institute indicates that UK businesses make the greatest use of geospatial and mapping data, which typically underpins location-based apps and services. Public data on transport, environmental conditions and population demographics are also used widely by British firms[6].

[6] Open Data Institute, "Open data means business: UK innovation across sectors and regions", 2015.

GDPR in Europe: Burden or boon?

The European Union (EU) considers itself a world leader in the safeguarding of citizens' rights when it comes to data privacy. That reputation looks set to be reinforced when the General Data Protection Regulation (GDPR) comes into force in all 28 member states (including, for now, the UK) in May 2018. The GDPR is a major overhaul of the EU's original 1998 data protection law and has significant implications for how governments at all levels, as well as businesses, handle the data they obtain from citizens.

"It is a nightmare for municipalities that have been strenuously organising their data and trying to build a marketplace for it," says Daria Batukhtina of Startup4City. "GDPR means they now also have to think, for example, about how to sign service level agreements with users of real-time datasets. They have to think about how this data can be re-used, and who has rights to re-use it."

The new rules will also require government agencies to provide more detailed information to citizens on-demand than is currently the case. This includes the purpose of the data processing, the categories of data being processed, the recipients, the retention period and the original source of the data. Governments must also audit the citizen data they hold, develop a data protection strategy and conduct staff training on data use. Breaches could prove expensive: the European Commission can impose fines of up to €20 million on organisations that violate the regulation.

The burdens imposed on governments (as well as businesses) using open data are thus certain to grow. The GDPR could, however, prove a boon to the open data movement, forcing governments everywhere in Europe to think deeply about the value of the data they are sitting on.

> "GDPR is a nightmare for municipalities that have been strenuously organising their data and trying to build a marketplace for it."
>
> **- Daria Batukhtina, co-founder, Startup4City**

Innovation ecosystems

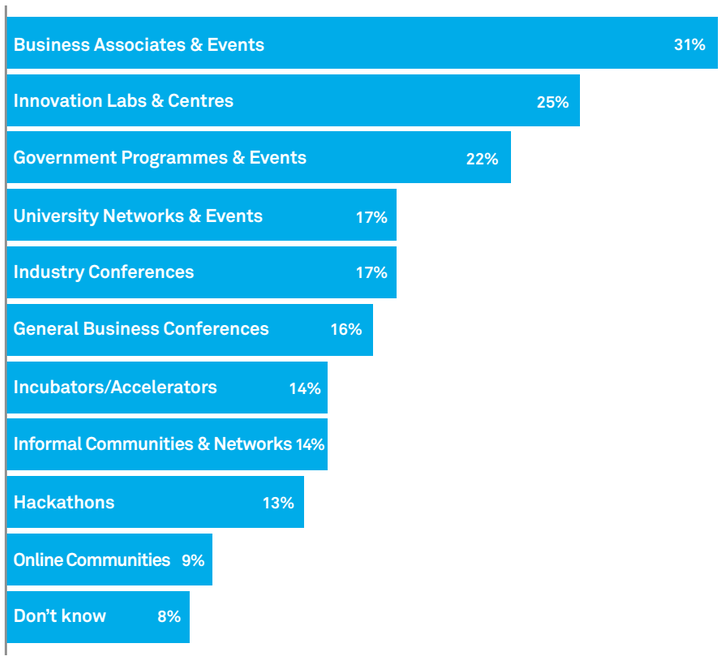
In research conducted by The EIU in 2015 on partnerships in the digital age, a strong view was voiced by business leaders that companies would have to be a part of a network in order to leverage technology trends[7]. In trying to pull off digital transformation, in other words, companies could not go it alone.

Firms turn, of course, to traditional, one-to-one partnerships and alliances to address digital opportunities and challenges. In the past decade, however, large ecosystems have formed in many cities consisting of formal and informal networks, communities, forums and other support structures, the missions of which are twofold: to help those participating to address their digital challenges, and to share ideas and advice that advance digital innovation.

Constituent parts of city ecosystems are typically technology accelerators and incubators, meet-up groups, business associations, university-based or company-sponsored innovation labs, online communities, and government bodies.(Figure 10) In most cases, the events and programmes they sponsor, and the assistance they offer, are readily accessible to companies and (with the exception of investment and financial assistance) normally entail few hard commitments.

Figure 10: Importance of face-to-face engagement

Groups and activities that help organisations with their digital transformation objectives (% of respondents)



[7] Connecting companies: Strategic partnerships for the digital age (A Telstra report written by The Economist Intelligence Unit), 2015.

"The number of accelerators [in Seoul] has grown from maybe one, seven years ago to 40 or 50 now."

- Sean Lee, Co-founder, Seoul Space

Hot spots

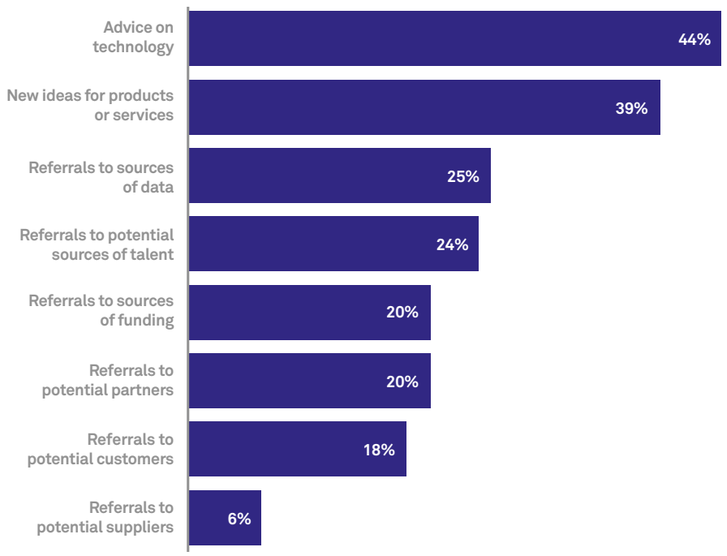
London, San Francisco and New York enjoy global renown for the breadth and vibrancy of their innovation ecosystems. This is due in part to the outsized presence in each of VC firms and other sources of funding. Core ingredients of London's role as a major fintech centre, for example, are its dynamic Shoreditch community of tech entrepreneurs, the accelerators and legions of informal networks that have grown up around it, and The City as a rich source of funding.

Few places boast all these advantages, but similar networks and support structures have been sprouting in most major cities in recent years. Xania Wong says she has witnessed this in Hong Kong, where structures have changed significantly since she launched her first tech start-up in 2008. "The support system was almost non-existent. But in the last three years we're seeing a lot more activity, including the emergence of accelerators and other support structures," she explains. Sean Lee says the same of Seoul. "The number of accelerators here has grown from maybe one seven years ago to 40 or 50 now." Greg Sutherland, chief innovation officer of Australia Post, notes that not long ago, digital innovation in Melbourne was concentrated among a few successful start-ups and the major corporates based there. Now, he says, much more of it originates in the city's accelerators.

Companies of all sizes in our survey make active use of such networks and structures to help address their digital challenges. In most cities, a large number turn to business associations and events for this purpose, but innovation labs and centres are also a favoured source of ideas or advice. (Figure 11) Over 40% of respondents in Guangzhou, Shanghai, Shenzhen and Singapore, for example, say such labs are helpful in this regard. More than four in 10 in Singapore and Taipei say the same of government programmes and events. University networks are an important source of help to executives in Berlin and San Francisco. Participation in hackathons is especially widespread in Oslo, Bangalore, New York, Seoul and Dubai.

Figure 11: Technology advice

Types of help from groups and activities (% of respondents)



Beyond technology advice, companies use these local networks to get new ideas for products and services, to obtain data and to get referrals to potential new recruits. Many start-up founders also take part to identify potential investors or other new sources of funding. (Figure 11)

Socialising around data in Amsterdam

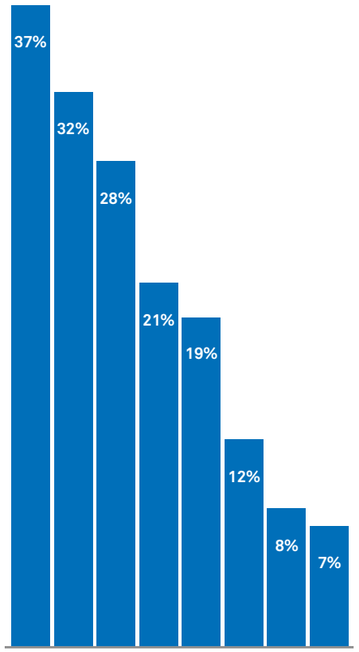
Amsterdam regularly figures in the top tier of global and European smart city rankings. One reason has been its use of open data initiatives to encourage the development of services that enhance mobility within the city (for example, apps with real-time information on bicycle routes and car parking), that help reduce energy consumption or that encourage recycling. The spearhead of these initiatives has been Amsterdam Smart City (ASC), a public-private partnership formed in 2009 between the municipal government, the Amsterdam Economic Board, a telecoms company (KPN) and a power grid operator (Alliander), amongst others. One of its initiatives is a portal (data.amsterdam.nl) where developers and companies can plug into real-time city data.

Of late the city government has been trying to broaden its data-focussed interaction with the community beyond just APIs. In August 2016 it launched DataLab Amsterdam which, according to Willem Koeman, business connector for digital connectivity at the Amsterdam Economic Board, is an online and physical space "where data specialists working with the city, local companies, universities and research institutes can sit down and work with the data, but also to meet and discuss specific data topics. It's a kind of 21st century forum where people just talk about open data and what we can do with it."

DataLab organises meet-ups on a weekly or bi-weekly basis, including "Demo Thursdays" where ASC and other experts provide guidance on specific technical areas such as authentication or app deployment. Discussion panels are also organised on higher level topics; one held in June 2017 focused on data privacy, a matter of some urgency to citizens, governments and businesses in Europe as the date approaches when the EU's General Data Protection Regulation will enter into force (see "GDPR in Europe: Burden or boon?").

Figure 12: Traditional sources of finance

Types of financial assistance companies get for digital transformation
(% of respondents)



32% of surveyed businesses have tapped into government programmes in the past three years.

Financing digitisation

Not surprisingly, businesses turn most often to their banks to finance transformation initiatives, whether through loans or other instruments. But the other components of the local innovation ecosystem are also important sources of funding. Nearly one-third of surveyed businesses say they've tapped into government programmes for this purpose in the past three years. (Figure 12) In some cases the monies are earmarked in state or national budgets. This is the case in Brisbane, for example, where Andy Graham of RSM Australia notes that the Queensland government recently made several million dollars' worth of digital grants available to help small businesses boost their digital capabilities. Interestingly, the survey indicates that large and midsize firms make use of the different types of government financial assistance even more actively than small ones.

About three in 10 respondents have funded their digital programmes by selling equity in their ventures to VC funds or other classes of investors. Another one-fifth have received financial support from incubators or accelerators. Informal sources of investment (for example family, friends, communities or suppliers) are another favoured means of financing digital programmes, utilised by just over one-fifth of the surveyed companies. (Figure 12) Not surprisingly this channel is popular in Asian cities, particularly India and South-East Asia, but it also figures prominently in Western cities such as Chicago and New York.

Tech hub India

"Nothing is being done proactively by governments [in India] to help digital transformation. The best things governments do there is to stay out of the way."

- Alpesh Shah, Senior partner and director, Boston Consulting Group India

Alpesh Shah of BCG India is only slightly surprised at the bullishness that executives in Bangalore, Mumbai and New Delhi display toward their local digital environments (see "The Digital Cities Barometer"). Their educational institutions consistently churn out large numbers of quality technology graduates, he explains. The three cities also boast a multitude of formal and informal networks, forums and communities where digital entrepreneurs, technology managers and others come together almost daily. According to one recent study, incubators and accelerators number over 140 in India as a whole, the highest number in the world after China and the US; 40% of these are concentrated in Bangalore, Mumbai and New Delhi[8].

Mr Shah reserves particular enthusiasm for Bangalore's digital entrepreneurship environment. It is the "closest thing to Silicon Valley" in Asia, he says. Large corporates are active players in the local ecosystem: technology giants Amazon, Google, Microsoft, SAP, Qualcomm and Cisco, for example, all operate or sponsor accelerators in the city, as do Indian multinationals such as Tata Group and Mahindra & Mahindra. The growth of such structures and the involvement of multinationals in them, says Mr Shah, as well as the presence of VC firms and investment banks, are helping to make Bangalore a magnet for the country's technology talent.

Mr Shah attributes the vibrant digital environments in all three cities to the innate entrepreneurialism of its business people, but not to local government. "Nothing is being done proactively by governments to help digital transformation. The best things governments do there is to stay out of the way."

[8] "India now ranks third globally in number of incubators, accelerators: Report", VC Circle, May 6, 2017.

Speed and security

There is no component of a city's digital environment more fundamental than its ICT infrastructure. Start-ups and leviathans alike depend on fast, reliable and secure fixed and wireless networks to underpin their online presence and support almost all of their digital operations. In recent years, the definition of such infrastructure has broadened to include not just fibre, 4G mobile and WiFi, but also the IoT– which companies and governments alike are using to generate ever more data– and the cloud– which provides the storage and computing power to crunch the data.

In Western and developed Asia-Pacific cities, businesses have come to expect high-performing networks almost as a utility. They are not a given everywhere, however. That is a reason why Alpesh Shah believes that some local ICT initiatives in emerging world cities can help change companies' digital behaviours. He has observed as much in South Africa, for example, when major expansions of some cities' WiFi networks led companies to upgrade their online presence and to begin capturing and analysing data on their customers.

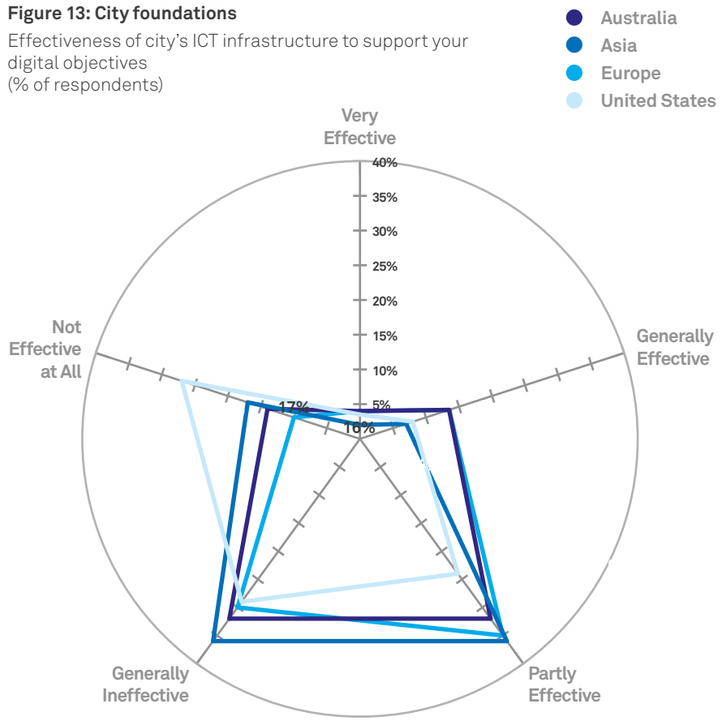
Notwithstanding high expectations, or perhaps because of them, executives in the survey are somewhat critical of their cities' efforts to provide ICT infrastructure that meets their companies' digital transformation needs. Only 15% of respondents overall believe their city is effective at this, while almost half (48%) say it is ineffective. (Figure 13) The latter figure is as high as 80% in Bangalore and 74% in Jakarta, but it also exceeds 60% of respondents in New York, San Francisco and Singapore.

Inadequate ICT infrastructure can be a significant impediment to companies' digital initiatives. Up to 15% of respondents in the overall sample list it amongst their toughest transformation challenges, but that number runs considerably higher in Asian cities such as Bangkok (27%), Kuala Lumpur (26%) and Beijing (25%), as well as European centres Barcelona (24%) and Amsterdam (22%). In the latter, executives generally regard the ICT infrastructure as being of high quality, according to Willem Koeman, but are concerned about a slowdown in the rollout of fibre networks.

Up to 15% of global respondents list inadequate ICT infrastructure amongst their toughest transformation challenges.

Figure 13: City foundations

Effectiveness of city's ICT infrastructure to support your digital objectives
(% of respondents)



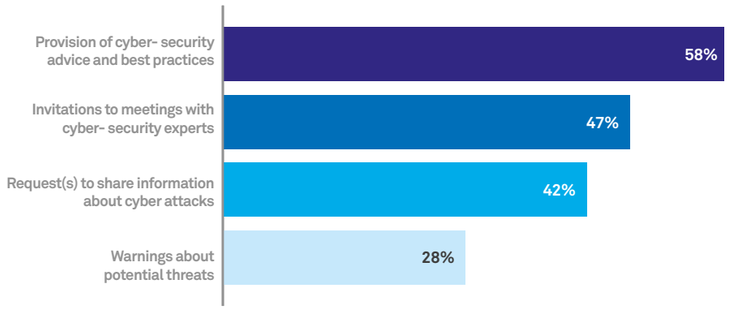
Cyber challenges

Cyber-security worries executives more than the state of local infrastructure. This is little surprise given the increasing frequency of reports in recent years of hackers' use of viruses, worms, malware and phishing to penetrate company firewalls and cause damage. Major "ransomware" attacks, in which malicious software installed on devices blocks victims' access to data, have further concentrated business minds on the perils of lax cyber-security. The rollout of smart city initiatives that involve deployment of networked IoT sensors poses additional concerns, as robust security standards for them have yet to be agreed upon by the technology industry.

Cyber-security is an area in which city governments have become more active as a facilitator of good practice. Most executives in the survey (63%) say city authorities have consulted them at least occasionally in the past two years in relation to cyber-security issues. Most often this has taken the form of providing advice and disseminating best practices of organisations. Local authorities also often organise meetings which bring company executives together with cyber-security experts. More active forms of intervention– such as city government warnings about imminent cyber-threats– occur less frequently. (Figure 14) This does not necessarily leave businesses in the dark, as in many countries, such as Australia, the UK and the US, national cyber-crime agencies or task forces take the lead on co-ordinating cyber-security initiatives with the private sector.

Figure 14: Securing the digital environment

Government-business interactions involving cyber-security (% of respondents)



The rise of the city CTO

Strong leadership at the municipal level is the key to building a strong digital transformation environment, believes Daria Batukhtina. As evidence, she points to the digital progress made in recent years by Amsterdam, thanks partly to its well-regarded smart city programme (see "Socialising around data in Amsterdam") led by the city's chief technology officer (CTO), a position created in 2014. Amsterdam's success may be a reason why other cities are following suit. For example, New York, Seattle and Boston created a CTO role in the same year, as did London in 2016. In most cases this individual serves alongside the city's chief information officer (CIO).

Role descriptions differ from city to city, but while CIOs are generally tasked with managing the administration's internal information and other digital systems, the CTO looks after the technology infrastructure which supports the government's operations as well as having a role in monitoring and advising on the networks that businesses use.

In some cities, including Amsterdam, the CTO spearheads IoT initiatives involving transport, utilities and other public infrastructure.

These and other cities are spreading their digital responsibilities around. Chief digital officers (CDOs) can now be found in, for example, New York, San Francisco, Chicago, London, Brisbane and Canberra, for example. Their mandate: to oversee the digital transformation of the city itself.

Conclusion: Intangibles

There are other factors beyond those addressed in this study that influence the local environment in which companies pursue their digital transformation. They fit the category of intangible qualities, and are harder to pin down than talent pools, data or infrastructure. Their influence is less direct than the latter, but they are qualities that digital and other businesses consider when deciding in which cities to set down roots.

One is what Chan Meng Khoong calls "global connectivity". These are the ties that a city and its institutions have built over decades with other parts of the world that are considered business or technology hubs. Such connectivity confers advantages on historic trading hubs such as Singapore, Hong Kong, New York and London. Singapore's unique advantage derives partly from geography, says Mr Khoong, but more importantly "from the connections it has built over time through transport networks, through the Internet and through its long-standing trading relationships with the rest of the world. Some other innovation hubs, even Silicon Valley, struggle a bit with this notion of global connectivity". The latter, however, and the San Francisco Bay area generally, benefit from other types of global connectivity, such as those their universities enjoy with businesses and universities in other centres.

Another intangible quality is liveability – the factors which contribute to an individual's or a community's quality of life. The talent that companies operating in a city need to drive their digital transformation efforts will often be migratory– skilled workers searching not just for career enrichment but a pleasant and interesting place to live. The EIU considers factors such as climate, cultural offerings, sport, public health, education and civil infrastructure (amongst others) in its definition of city liveability. On those measures, it considers Melbourne the world's most liveable city[9]. The two other of our 45 cities making the Global Liveability Index top ten are Adelaide, ranked 5th and Perth, ranked 7th.

A final intangible that must be considered is a city's entrepreneurial ethos, or spirit. There is little doubt that the entrepreneurialism in the DNA of hubs such as San Francisco, New York and London is helping to fuel the growth of their digital ecosystems. Mr Shah believes a similar, grassroots ethos is at work in Bangalore. Both Nicholas Yang and Ian Reed, while acknowledging Hong Kong's weaknesses in comparison with the world's great technology hubs, believe its native entrepreneurial energy will help the city to make up digital ground relatively quickly.

Mention of these factors is a reminder that growth of a vibrant digital ecosystem that helps a city's businesses achieve their digital aspirations is a highly complex process that cannot easily be directed from above. Strong government leadership, as in the case of Amsterdam or Singapore, can achieve a lot, but a city's innate energies and skills are always instrumental in achieving digital leadership. In a city, as in a business, that is the magic of innovation.

[9] EIU, The Global Liveability Report, 2017.

Appendix 1

The digital cities barometer

Rank	Overall environment		Innovation and entrepreneurship		Financial environment	
1	Bangalore	8.25	Bangalore	8.2	Bangalore	7.9
2	San Francisco	7.71	Mumbai	7.85	New Delhi	7.55
3	Mumbai	7.65	Beijing	7.75	San Francisco	7.48
4	New Delhi	7.59	London	7.53	Beijing	7.47
5	Beijing	7.56	New Delhi	7.43	New York	7.41
6	Manila	7.39	New York	7.35	Mumbai	7.4
7	Shanghai	7.26	San Francisco	7.32	London	7.3
8	Jakarta	7.25	Jakarta	7.29	Manila	7.29
9	London	7.24	Shanghai	7.26	Jakarta	7.18
10	Madrid	7.08	Manila	7.14	Copenhagen	7.13
11	New York	7.03	Shenzhen	7.05	Guangzhou	7.09
12	Barcelona	7.02	Copenhagen	7.05	Chicago	7.01
13	Guangzhou	6.93	Dubai	7	Shenzhen	7
14	Singapore	6.89	Guangzhou	6.93	Shanghai	6.97
15	Chicago	6.87	Madrid	6.91	Madrid	6.96
16	Copenhagen	6.82	Bangkok	6.87	Singapore	6.85
17	Melbourne	6.81	Marseilles	6.85	Bangkok	6.74
18	Shenzhen	6.73	Milan	6.85	Melbourne	6.72
19	Sydney	6.65	Chicago	6.78	Barcelona	6.72
20	Paris	6.63	Melbourne	6.74	Milan	6.63
21	Oslo	6.63	Singapore	6.74	Sydney	6.6
22	Johannesburg	6.63	Barcelona	6.66	Frankfurt	6.58
23	Dubai	6.63	Johannesburg	6.63	Amsterdam	6.55
24	Milan	6.57	Sydney	6.54	Birmingham	6.48
25	Brussels	6.49	Amsterdam	6.41	Dubai	6.48
26	Bangkok	6.47	Brussels	6.4	Brussels	6.4
27	Seoul	6.47	Frankfurt	6.33	Johannesburg	6.4
28	Antwerp	6.46	Stockholm	6.25	Kuala Lumpur	6.36
29	Amsterdam	6.41	Brisbane	6.23	Rotterdam	6.33
30	Marseilles	6.4	Perth	6.22	Stockholm	6.33
31	Stockholm	6.4	Seoul	6.2	Hong Kong	6.3
32	Birmingham	6.25	Rotterdam	6.17	Paris	6.29
33	Perth	6.2	Birmingham	6.1	Brisbane	6.29
34	Brisbane	6.16	Oslo	6.1	Seoul	6.12
35	Rome	6.06	Taipei	6.01	Osaka	6.12
36	Frankfurt	6	Yokohama	6.01	Antwerp	6.06
37	Hong Kong	6	Paris	6.01	Perth	6.03
38	Osaka	5.95	Adelaide	5.98	Oslo	6.03
39	Kuala Lumpur	5.95	Osaka	5.89	Adelaide	6.02
40	Adelaide	5.89	Antwerp	5.82	Rome	5.94
41	Rotterdam	5.83	Kuala Lumpur	5.77	Berlin	5.9
42	Taipei	5.82	Rome	5.75	Marseilles	5.88
43	Tokyo	5.69	Hong Kong	5.65	Taipei	5.7
44	Yokohama	5.61	Tokyo	5.61	Tokyo	5.39
45	Berlin	5.27	Berlin	5.33	Yokohama	5.28

People and skills		Development of new technologies		ICT infrastructure		Rank
Bangalore	7.9	Bangalore	7.75	Bangalore	7.65	1
San Francisco	7.57	San Francisco	7.59	Shenzhen	7.59	2
New Delhi	7.55	Beijing	7.56	Beijing	7.47	3
London	7.53	Shenzhen	7.48	London	7.47	4
Copenhagen	7.52	Barcelona	7.45	Amsterdam	7.4	5
Beijing	7.52	New Delhi	7.43	Madrid	7.19	6
Manila	7.44	Jakarta	7.29	New Delhi	7.15	7
Stockholm	7.38	Manila	7.29	Manila	7.14	8
New York	7.37	Guangzhou	7.26	Jakarta	7.1	9
Shenzhen	7.21	Mumbai	7.25	Mumbai	7.1	10
Chicago	7.14	London	7.24	San Francisco	7.1	11
Jakarta	7.14	Stockholm	7.23	Shanghai	6.92	12
Mumbai	7.1	New York	7.08	Singapore	6.89	13
Barcelona	7.08	Singapore	7.04	New York	6.87	14
Antwerp	6.95	Melbourne	7.03	Guangzhou	6.87	15
Paris	6.85	Madrid	7.02	Barcelona	6.84	16
Guangzhou	6.82	Shanghai	7.02	Melbourne	6.74	17
Singapore	6.81	Dubai	6.78	Stockholm	6.7	18
Melbourne	6.81	Paris	6.74	Dubai	6.7	19
Shanghai	6.72	Antwerp	6.71	Brussels	6.67	20
Amsterdam	6.7	Sydney	6.7	Copenhagen	6.66	21
Madrid	6.68	Amsterdam	6.7	Marseilles	6.63	22
Brussels	6.67	Marseilles	6.63	Rotterdam	6.58	23
Sydney	6.67	Copenhagen	6.59	Sydney	6.57	24
Frankfurt	6.67	Bangkok	6.51	Rome	6.56	25
Perth	6.55	Perth	6.51	Paris	6.51	26
Bangkok	6.51	Frankfurt	6.5	Milan	6.51	27
Rotterdam	6.5	Chicago	6.49	Chicago	6.45	28
Dubai	6.48	Johannesburg	6.48	Bangkok	6.43	29
Milan	6.46	Oslo	6.4	Berlin	6.42	30
Rome	6.44	Milan	6.34	Frankfurt	6.42	31
Oslo	6.4	Rotterdam	6.33	Perth	6.41	32
Birmingham	6.4	Rome	6.31	Antwerp	6.38	33
Brisbane	6.39	Brussels	6.31	Taipei	6.25	34
Adelaide	6.27	Berlin	6.25	Oslo	6.25	35
Berlin	6.25	Adelaide	6.23	Johannesburg	6.25	36
Hong Kong	6.22	Brisbane	6.2	Seoul	6.2	37
Marseilles	6.18	Hong Kong	6.07	Adelaide	6.13	38
Johannesburg	6.18	Seoul	6.04	Brisbane	6.13	39
Seoul	6.16	Kuala Lumpur	6.04	Hong Kong	6.11	40
Osaka	5.89	Birmingham	5.95	Kuala Lumpur	6.09	41
Taipei	5.86	Osaka	5.78	Birmingham	6.03	42
Kuala Lumpur	5.55	Taipei	5.74	Osaka	5.95	43
Tokyo	5.16	Yokohama	5.61	Yokohama	5.84	44
Yokohama	5.11	Tokyo	5.42	Tokyo	5.42	45

The editors

Charles Ross, Editorial Director

Charles is currently director of thought leadership research for Asia, where he covers a territory spanning from Australia to India. His team works with many Western multinationals from the Fortune 500 but increasingly with Asian multinationals, governments, SMEs and high-growth technology firms as well.

A native Australian, Charles is currently based in Singapore and has most recently managed the regions technology research practice. Leading a number of projects analysing the implication for business of new technology trends such as Industry 4.0, smart cities, big data, cloud computing, entrepreneurship and the internet of things, for Hitachi, Cisco, Telstra, Microsoft, Wipro, Akamai and the Singapore government. He is a frequent speaker at technology events, recently giving keynote presentations at events in Singapore, Australia, Jakarta and Kuala Lumpur.

Prior to joining the Economist Group, Charles ran an investor communications consultancy where he managed stakeholder research projects and developed an index which tracked the corporate governance practices of emerging markets companies. Prior to that he founded a firm which manages initial public offerings across Europe, North America and Asia.

Charles holds a masters in business administration, focusing on strategy and organisational change, from the University of Oxford.

Denis McCauley

Denis is a writer, editor and speaker with particular expertise in how businesses, governments and individuals use technology. In the past two years he has written reports on, among other themes, artificial intelligence, cloud-native software, the app economy, data analytics, innovation ecosystems, technology innovation in upstream oil & gas, and digitisation of the arts and heritage sector. Denis spent much of his career with The Economist Intelligence Unit in a variety of roles, including as Global Director of Technology Research, as well as Editorial Director, Thought Leadership, EMEA. He also worked with Pyramid Research, a telecoms research firm, where he managed its global analysis and forecasting operations in fixed and wireless markets.

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Written by

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