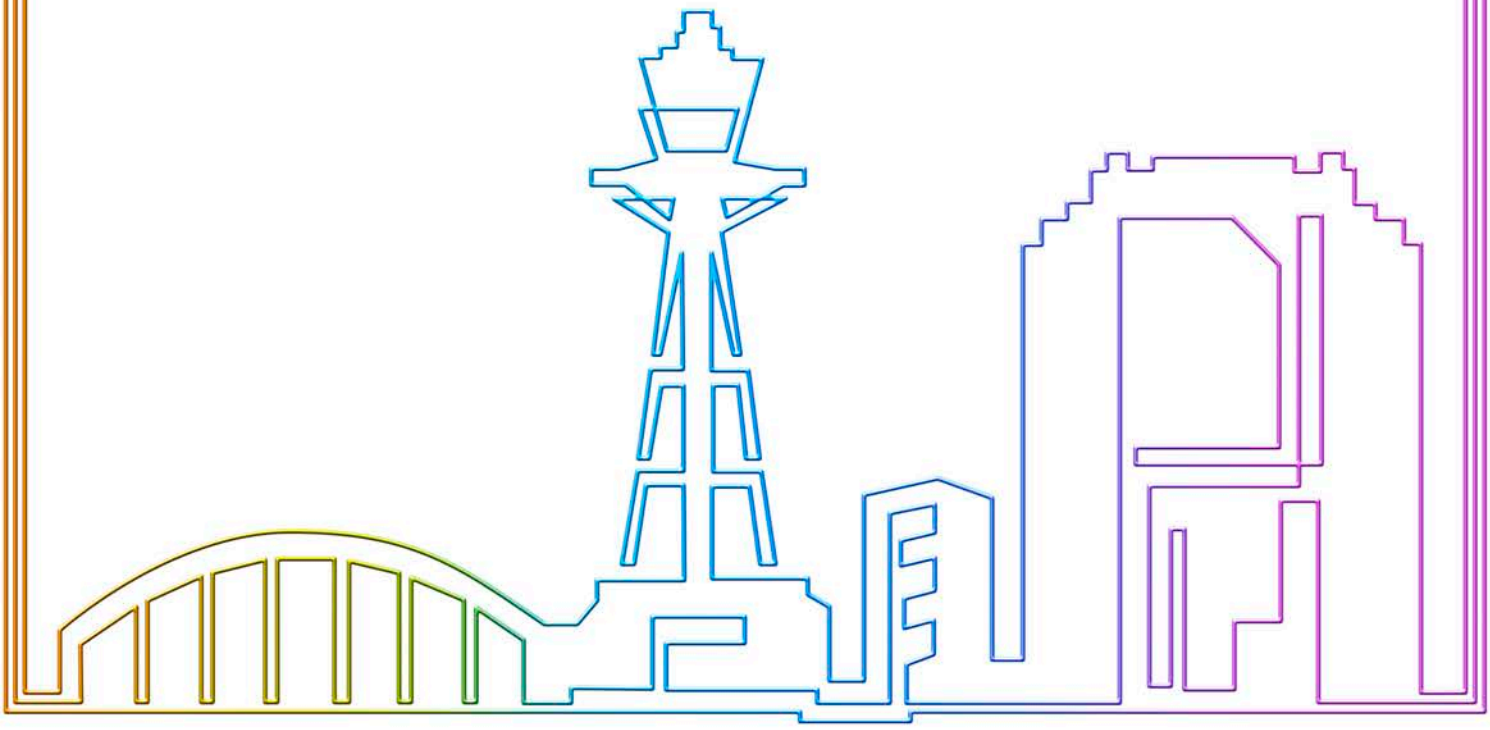
DIGITAL REALTY

Powering your digital ambitions

DIGITAL CAPITALS OSAKA REPORT

NOVEMBER 2019



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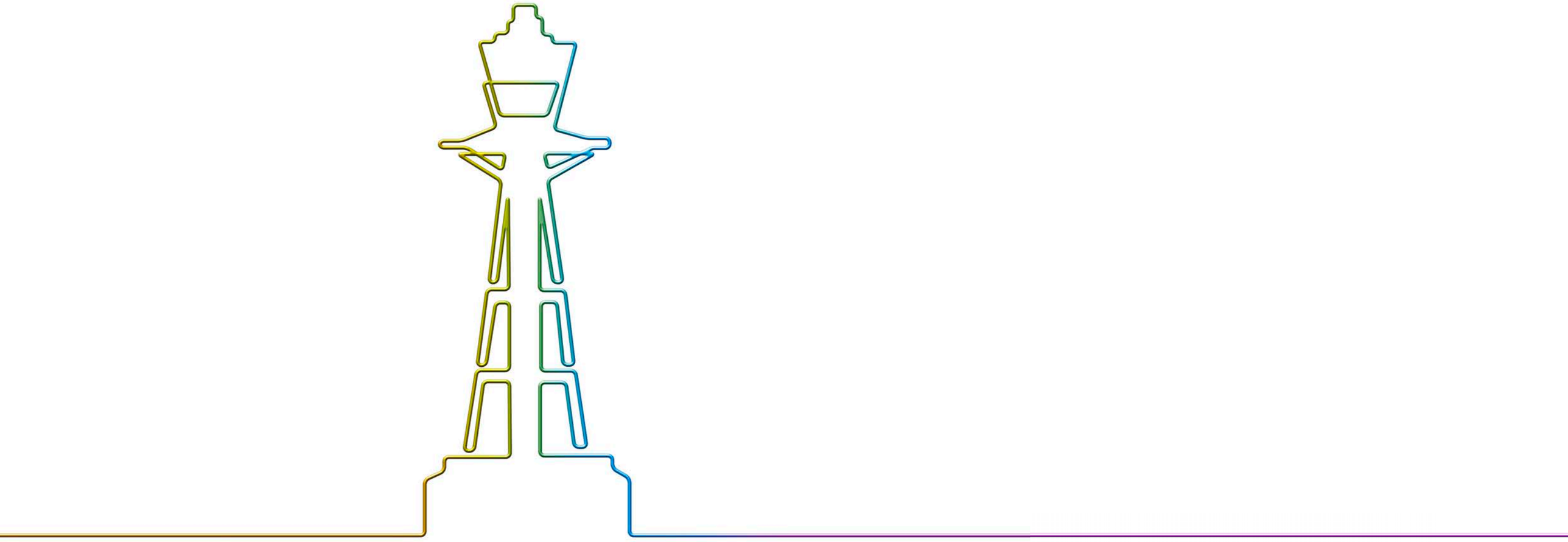

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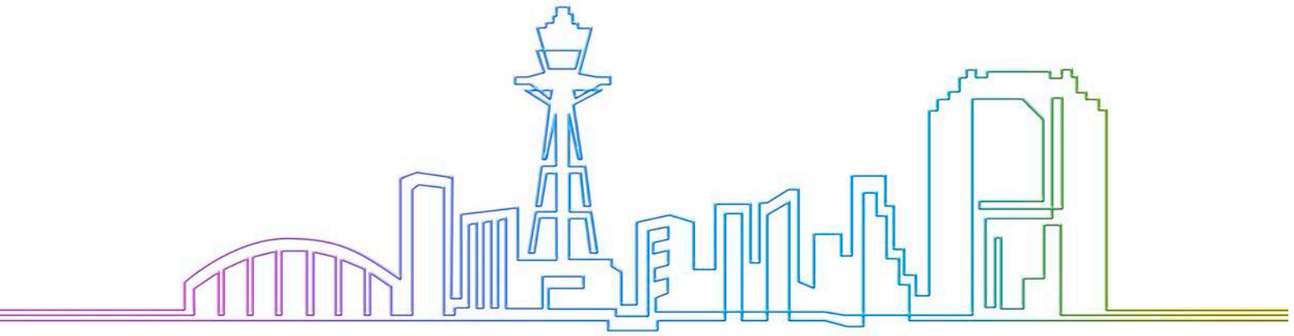
Introduction



The creation and sharing of data is central to both economic and social activity. However, in recent decades there has been an enormous increase in the rate at which data is created, stored and used for commercial purposes, and for other uses such as in healthcare and entertainment.

The rate at which data is being created continues to grow at astounding rates, driven by data-intensive technologies in business, government and in the home. The growth in data is also expected to be further stimulated by new or evolving data-intensive technologies such as Artificial Intelligence (AI) and the fifth generation of mobile communications technology (5G).

The economic contribution of digital information has previously been termed the 'data economy':[1] the financial and economic value generated by the creation, storage, retrieval and use of highly-detailed business and organizational data at high speeds. The economic contribution of the data economy to national economies has been previously examined in an earlier study also commissioned by Digital Realty (dating from 2018), which focused on the current and potential future size and value of the digital economy in a number of European countries.

The world's leading cities are major hubs for the data economy because they typically have very high densities of commercial activity stimulated by data and digital technologies. This leading role is linked to the concentrations of knowledge-intensive and data-fuelled industries, such as financial services, professional services, and media and communications. Of course, the largest cities are also very often the location for command and control functions for governments, major corporations, universities and other entities.

The leading cities – the digital capitals – also possess some of the world's richest digital skills resources, research and development (R&D) assets, and digital and supporting infrastructures that make it easier for entrepreneurs and skilled workers to share ideas, collaborate and develop new forms of technology and applications.

To explore the status of Osaka as one of the world's digital capitals, Digital Realty has commissioned a new report that assesses 60 major global cities in two ways:

1. How much data – from that used by a smartphone to advanced robotics and financial trading – contributes to the city's economy, creating an index of the world's most successful data economies today and in the next decade
2. Quantifying the current, and assessing the potential future, contribution of today's 4 most talked about technologies – AI; Blockchain; the Internet of Things (IoT); and 5G - to those data economies across the next 10 years.

[1] Digital Realty: The Data Economy Report, 2018

Main Drivers

There has been a huge increase in data generation over the past decade – driven by advances in digital technology – which have led to the proliferation of connected devices and sensors in both business and household situations. The growth in the rate at which data is being generated currently shows no signs of diminishing, driven by an increasing range of industrial, government and consumer applications. The amount of data generated each day is expected to be further boosted as emerging or fast-growing digital technologies – including AI, virtual reality (VR) and autonomous vehicles (AV) – become widespread in their usage.

Various predictions of the scale of data generation are available, all of which anticipate continued huge increases in the volume of data production. For example, IDC in 2018 predicted that there is likely to be a world-wide annual growth rate for data generation of 61% per annum (p.a.) up to 2025.[2]

This global growth is being driven by ever larger numbers of people being connected to digital devices for an increasingly large number of uses and applications. However, it is expected that the creation of data by businesses will become even more important than that by consumers as the number of sensors and devices in industrial, commercial, infrastructure, healthcare, transportation and many other situations increases very rapidly.

The continuing increase in the generation and sharing of data is being further boosted by the emergence and development of 4 interlinked digital technologies: AI; IoT; Blockchain; and 5G.

Digital Capital – Osaka

Osaka is the 2nd largest financial center within Japan after Tokyo and is the home for important financial institutions such as the Osaka Securities Exchange. Osaka is also a major commercial center, with many large corporations based there, such as Panasonic and Sanyo.

Osaka is the 2nd largest financial center within Japan after Tokyo

Osaka is also the 2nd largest urban area in Japan in terms of population, and it therefore possesses a very large population of relatively high-income consumers demanding digital products and services. The city also benefits from a very large and highly-skilled workforce with skills and specialisms relevant to the digital economy.

An important component of Osaka's economy is the contribution of the city's financial sector. It has long been Japan's 2nd most important financial center, and technologies such as AI and Blockchain are already important in the provision of financial services and their use and importance can be expected to grow significantly over the next decade or so.

Osaka is currently ranked 34th among the world's leading digital cities

As highlighted in the Digital Capitals Index, Osaka is currently ranked 34th among the world's leading digital cities. Osaka is predicted to lose 1 global ranking position place by 2024, and a further ranking place by 2029, when it is expected to lie in 36th position. This loss of position places is explained partly by faster growth occurring elsewhere. It is also influenced by an expectation of relatively sluggish growth across Osaka's economy related to demographic factors (such as a fast ageing population) and by the potential migration of some higher order business functions (including corporate headquarters) to Tokyo.

As a major location for media industries, including TV, radio and print media, Osaka is a center for a wide range of professional and business support services industries, including legal, accountancy, business consultancy services, property management and IT support services. All of these industries are at the forefront of the adoption of – and innovation in – digital technologies.

Osaka is an important center for the design, development and manufacture of advanced technologies, including electronic and electrical devices, computer hardware and software, and communications equipment. The city is a significant hub for R&D in science and engineering, including in renewable energy technologies and advanced robotics. Many of these developing technologies can be expected to drive further growth in digital technologies such as AI, IoT and 5G.

Osaka is predicted to lose 1 global ranking position place by 2024, and a further ranking place by 2029, when it is expected to lie in 36th position

[2] https://www.networkworld.com/article/3325397/idc-expect-175-zettabytes-of-data-worldwide-by-2025.html

Osaka is also a key place for higher education and research. Osaka's universities include those with a range of specialisms in fields that are central to digital industries, including in AI, advanced engineering, renewable energy and robotics.

Value of AI, IoT, Blockchain & 5G to the Osaka Economy: 2019

The anticipated continued growth of Osaka as a digital capital over the next decade is expected to be driven in part by the increasing importance of data intensive, interconnected technologies including AI, IoT, Blockchain and 5G. With that in mind, the economic contributions of these 4 high-potential, data-led technologies have been examined to provide a baseline against which the future potential for growth in Osaka's data economy can be compared.

The current contribution of the 4 digital technologies to the Osaka economy in 2019 is estimated to be worth ¥197 billion, with IoT alone estimated to be currently contributing ¥105 billion (53% of the total). AI is estimated to contribute a further ¥60 billion (31%) while a further ¥28 billion is contributed by Blockchain (14%). The current contribution of 5G – as the newest technology – is estimated to be a comparatively modest ¥4 billion.

The 4 technologies in aggregate are currently estimated to contribute ¥197 billion annually to the overall economy of Osaka

The 4 technologies in aggregate are currently estimated to contribute ¥197 billion annually to the overall economy of Osaka, which amounts to an estimated 1.74% of the city's overall economy.

Technology	Annual value (in ¥ billions), 2019	% of overall city economy, 2019
AI	60	0.53%
Blockchain	28	0.25%
IoT	105	0.93%
5G	4	0.03%
Total	**197**	**1.74%**

Table 1: Osaka – Estimated value of the 4 digital technologies: 2019 (¥ billions, 2019 prices)

In terms of international rankings, Osaka is currently ranked in 27th position internationally with respect to the specific financial contribution made by each of the 4 technologies.

Predicted Future Value: 2024

By 2024, the value of the technologies to the annual value of Osaka's economy is expected to have grown to ¥400 billion p.a. This represents real growth of ¥203 billion compared to 2019, which translates into predicted growth of 103% compared to 2019 levels. By 2024 the 4 technologies are expected to contribute 3.30% to the city's overall economy, up from 1.74% in 2019.

Technology	Annual value (in ¥ billions), 2024	% of overall city economy, 2024
AI	162	1.33%
Blockchain	50	0.41%
IoT	151	1.25%
5G	38	0.31%
Total	**400**	**3.30%**

Table 2: Osaka – Estimated value of the 4 digital technologies: 2024 (¥ billions, 2019 prices)

In absolute terms, the largest component of growth is expected to be from AI: this segment is expected to contribute around ¥162 billion p.a. by 2024, compared to around ¥60 billion p.a. in 2019, representing an annual increment in value amounting to around ¥101 billion p.a. (i.e. a proportionate increase of 168%).

However, the strongest growth – in proportionate terms – is expected to come from 5G, with the contribution from this technology expected to reach ¥38 billion p.a. by 2024, up from just ¥4 billion during 2019. This represents growth of annual value amounting to 775% from this technology. This is because while 5G is currently a newly-emerging technology, by 2024 the use of 5G is expected to be widespread among both consumers and businesses across Osaka.

With respect to international rankings for the annual value contributed by these 4 digital technologies, by 2024 Osaka is expected to be in 31st position. This represents slippage of 4 positional places between 2019 and 2024. This is mainly because faster growth is expected to occur in other international cities, such as Mumbai (Bombay).

Predicted Future Value: 2029

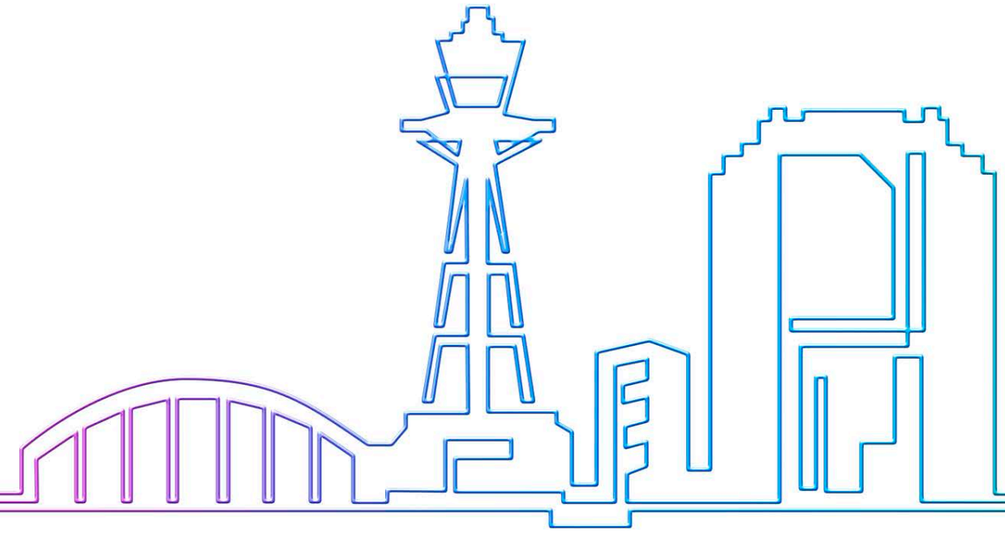
The overall contribution in terms of value to Osaka's economy of the 4 technologies by 2029 is expected to grow to ¥638 billion, representing an increase in real terms of ¥238 billion p.a. compared to 2024. The overall increase in annual value when the 2029 predicted values are compared to those for 2024 is expected to amount to 60%. By 2029, the contribution of the 4 technologies to the Osaka economy is expected to increase from 3.30% in 2024 to 4.91% in 2029 (and from just 1.74% in 2019).

The overall contribution in terms of value to Osaka's economy of the 4 technologies by 2029 is expected to grow to ¥638 billion

Technology	Annual value (in ¥ billions), 2029	% of overall city economy, 2029
AI	269	2.08%
Blockchain	72	0.55%
IoT	185	1.43%
5G	111	0.85%
Total	**638**	**4.91%**

Table 3: Osaka – Estimated value of the 4 digital technologies: 2029 (¥ billions, 2019 prices)

Compared to 2024, the largest component of growth is expected to be from AI, with an anticipated increase in the annual contribution of around ¥108 billion by 2029 (an increase of 67% compared to 2019). However, the most significant change is the relative contribution of 5G, which is expected to provide an increase of ¥73 billion p.a. (i.e. an increase of 194% compared to 2024 levels).



Overall, in proportionate terms, AI is expected to provide 42% of the increase in annual value (when 2029 levels are compared to 2024 levels), with IoT providing 29% and 5G a further 17%.

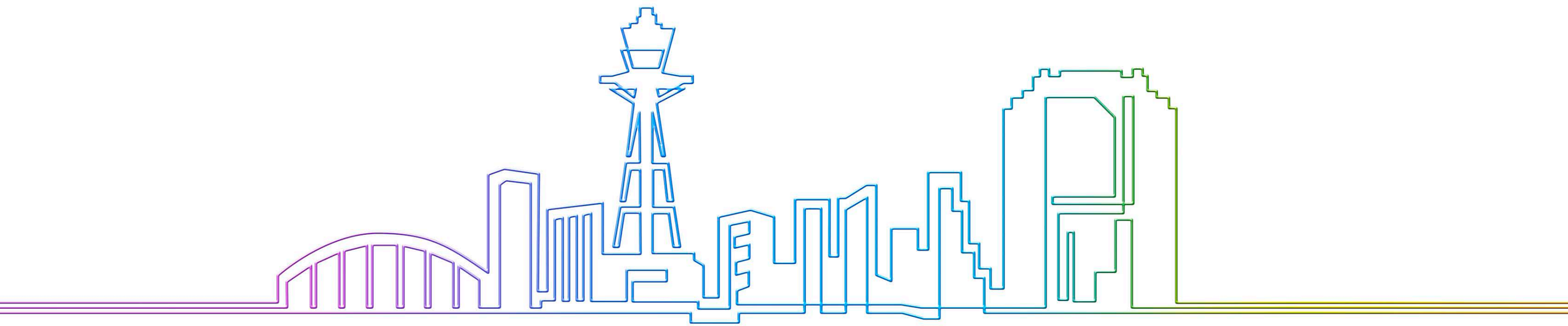
Compared to other cities in the global Digital Capitals Index, by 2029 Osaka is expected to be in 41st position overall, down from 31st in 2024. One of the key factors why Osaka is expected to grow its contribution relatively more slowly is expected demographic change, with slower overall growth in demand from households and consumers.

Overall Performance: 2019-2029

The overall expected situation with respect to the contribution of the 4 technologies to the economy of Osaka is summarized in the table below.
Note, some columns or row totals may not sum exactly due to rounding of decimals.

Technology	GVA 2019	GVA 2024	GVA 2029	Total increase in GVA: 2019-2029	% contribution to aggregate growth
AI	60	162	269	209	47.4%
Blockchain	28	50	72	44	10.0%
IoT	105	151	185	81	18.3%
5G	4	38	111	107	24.2%
Total	**197**	**400**	**638**	**441**	**100.0%**

Table 4: Osaka – Annual value of the technologies: 2019, 2024 & 2029 (¥ billions, 2019 prices)



The predicted overall value from the 4 digital technologies is predicted to increase from ¥197 billion in 2019 to ¥638 billion by 2029. Just over 47% of the overall predicted increase in value is expected to be contributed by AI, with 5G contributing just over 24%.

Conclusions

The current annual contribution of AI, IoT, Blockchain and 5G to the Osaka economy is estimated to be ¥197 billion in 2019.

When we look more closely at how well Osaka is adapting to new data-led technologies, very substantial growth potential can be predicted. Indeed, the predicted annual value is expected to grow to ¥638 billion p.a. by 2029.

This substantial increase in annual contribution can be expected to be driven across all leading sectors and industries in Osaka, from financial and professional services, media and communications, applications in digital entertainment, technology-focused manufacturing, transportation, renewable energy, higher education and scientific research.

By 2029, these 4 technologies in combination are expected to contribute just over 4.9% to the overall economy of Osaka, up from around 1.74% in 2019. The greatest share of this growth (over 47%) is attributable to AI with just over 24% also coming from 5G.

Recommendations and Opportunities for Businesses

If businesses want to benefit from, and even help increase, the ¥638 billion p.a. that AI, IoT, Blockchain and 5G are estimated to contribute to the Osaka economy by 2029, they need to act today. The economies of digital capitals around the world will only continue to grow, albeit at different speeds depending on a number of factors such as economic and government stability.

For Osaka, it is essential that the city and the businesses associated with it take all the right actions that see this digital capital continue to invest in and take advantage of the new technologies that will help them thrive and grow.

Already, the transport and logistics industry regularly make use of sensors installed in their vehicles to help schedule maintenance and ensure drivers optimize fuel consumption when out on the roads. Financial services organizations are already using AI-powered fraud detection programs to sift through huge amounts of records and find anomalies quickly, preventing illegal activity. Now is the time to plan how businesses can harness the potential these innovative technologies are offering.

Provided overleaf are some recommendations that businesses should seriously consider if they are to remain competitive in this rapidly growing technological environment.

Take Advantage of Competitive Digital Platforms

There are as yet unrealized opportunities for businesses that have not yet created adaptable technology platforms that, working with key partners, allow them to deploy each of these specialized technologies to gain competitive advantage:

- The 4 technologies explored are only growing in importance, enabling businesses to create and gain intelligence from their data in ways that have never been achieved before
- An adaptable technology platform will differentiate a business' agility by reducing the time to connect to partners, providers and markets using the latest technologies
- This will enable companies to tailor their technology deployments at speed and to meet, and even exceed, their needs in an increasingly competitive environment.

Invest in Talent

This report highlights one key area where investment is crucial: a skilled workforce. It is clear that cities and businesses should incubate and invest in technology talent to ensure they continue to have the skills to operate, deliver and capitalize on innovative technologies.

Major cities are vital in creating and hosting high value and innovative commercial activity through their role as locations for knowledge-driven business clusters. As a result, the high density of business networks in the city means the availability of talent and the presence of key infrastructure is also usually found in those places. With today's new technologies, this can very quickly lead to a major skills shortage and prevent businesses from being able to harness the power of their technology innovations.

Investing in digital apprenticeships and supporting college and university digital training programs is essential to the future success of all digital capitals and especially in Osaka.

Think Urgently About Your Future Technology Strategy

Businesses should continuously invest in upgrading and expanding their technology strategies to stay ahead of business need.

The business that is not ready to take advantage of these technologies is the one that is going to rapidly lose ground against its competitors.

Identify the Partners, Suppliers and Key Players That Should Be In Your Competitive Ecosystem

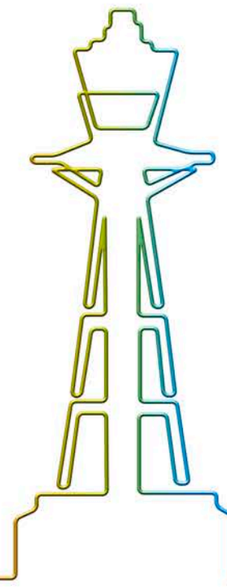
Cities and businesses having technical networks that can be rapidly and seamlessly connected to a global digital ecosystem is vital to fostering innovation and enabling a wider, global connection.

There is good evidence that major cities like Osaka are likely to be increasingly important in creating and hosting high value and innovative commercial activity through their role as locations for knowledge-driven business clusters or ecosystems.

Ecosystems are geographically concentrated networks of interconnected companies and allied organizations (such as universities and research institutes; financial services corporates and suppliers) operating within a specific industry or sector.

Successful ecosystems are usually characterized by a high volume of interactions. For example, where companies work collaboratively to create competitive advantage, exchange ideas, develop innovative products or processes, and go onto to launch joint ventures, a competitive service or new businesses together.

Cities and businesses should incubate and invest in technology talent



Appendix

Approach to the Study

DATA ECONOMY RANKINGS

As the first step in the research process of Osaka's data economy, a desk-based review was undertaken of the evidence regarding the business benefits of digital technology. This review also identified potential sources of the latest available data covering the city's business and economic datasets.

Second, a set of potential digital economy indicators was proposed and agreed with Digital Realty. The 10 selected indicators covered the following:

1. The overall size of the city-level economy
2. The scale of activity of businesses operating in data-intensive business sectors plus the rate of adoption of digital technology among other businesses
3. The scale of consumer demand for data and digital applications
4. R&D: the presence of a leading university or universities in the city
5. The quality of telecommunications infrastructure
6. Human capital: the proportion of workforce with advanced data skills
7. The stability of the local political environment, levels of crime and other metrics of governance
8. Quality of life indicators, such as the quality of health, public education, the efficiency of public transport and environmental indicators
9. Support for the data sector such as through open data policies
10. The quality of the environment for business (i.e. the ease of doing business, including for international companies).

Development Economics gathered quantitative data relevant to each family of indicators, as far as possible using single sources to facilitate consistent scoring and ranking on each indicator.

Future predictions of the absolute and relative rankings for the data economy were also developed in the study. These were developed by harnessing information on – amongst other things – the expected trajectories of change with respect to the size and structure of the city's economy; demographic and labour market forecasts; expected trajectories of growth in digital adoption by both businesses and consumers; recent trends in performance of universities; and trends in digital infrastructure provision.

CONTRIBUTIONS OF THE 4 TECHNOLOGIES

Apart from ranking the current and potential contribution of Osaka as a digital capital, the study also quantified the current and potential future economic contribution – in the form of GVA – of the 4 specific digital technologies: AI, IoT, Blockchain and 5G.

The approach taken to producing current estimates involved the gathering and analysis of information on the size, structure and productivity of the business sectors and workforces operating in the digital economy of Osaka. The quantification of future predicted estimates of contributions harnessed a range of forecasts, both for the economy and labour market, but also the likely rates of adoption of each digital technology by the city's business base, its public sector and the householder population of the city.

Indicators and Data Sources

The information is constructed by gathering the most recent available data for 10 families of indicators of the current economic, business, demographic, infrastructure and other characteristics that influence the scale and level of participation in the modern Digital Economy. More details on each of the criteria and the indicators used are provided overleaf.

SIZE OF THE ECONOMY

The first criteria used is a measure of the overall size of the city's total economy. This is measured in terms of the scale of economic output (GVA) produced by the city annually, with adjustments made to reflect productivity and local currencies using a purchasing power parity approach.

One challenge is that usually there are a variety of definitions available for the geographical and population coverage of any one city, such as the municipal area, the urban area or agglomeration, through to the wider urban area surrounding major cities. Here it was decided that the most appropriate for which consistent data was available corresponded to the 'middle definition' (i.e. the urban area/agglomeration).

Data on the human and business population in the city, plus the annual value of production per capita was then used to estimate the current annual value of economic activity taking place.

BUSINESS DIGITAL ADOPTION AND ECONOMY

This criterion is a blended indicator that considers several aspects that relate to the extent to which digital technologies are important to the economy of the city.

- First, the score considers the extent to which digital technologies have been adopted by all businesses and other employers (including government organizations) in the city.
- The second aspect that was covered is the estimated extent of the take-up by businesses and public agency users of the 4 digital technologies (AI, IoT, Blockchain and 5G) included in this study.
- The third aspect is the extent to which companies that are part of the supply chain for digital technologies are locally present in the city. This was taken into consideration through estimation of the annual value of delivery of digital technology services by supplying businesses located in the city.

CONSUMER DEMAND FOR DATA

Having considered the supply side, the third indicator considers the demand for data on the part of the city's urban population. This is based on the estimated annual per capita demand for digital data multiplied by the estimated size of the city's population. The demand for data considers a number of sub-indicators, including number of mobile phone subscriptions; fixed broadband data usage; and social media usage.

HIGHER EDUCATION + OTHER R&D ASSETS

This indicator involved the gathering of information on the scale, quality and relevance of the research and teaching resources available at universities and other higher education institutions in each urban area. If specialist research institutes relevant to any or all of the 4 digital technologies were known to be present in the urban area, this was also reflected through a manual upwards adjustment to the city's scoring. Essentially, scores were awarded for the scale (e.g. number of students, value of research grants awarded) and quality of the research and higher education institutions located in each urban area.

DATA INFRASTRUCTURE

This indicator takes account of the estimated capacity and efficiency of the city's fixed and mobile data infrastructure. This was assessed using current data on average mobile and fixed broadband data download speeds.

HUMAN CAPITAL

This indicator considers the size, skills and qualifications of the city's working age population. There are two aspects included within the scoring and ranking process:

Firstly, there is a general assessment of the qualifications of the city's working age population, considering the proportion and size of the workforce that is educated to degree level or equivalent, and also considering the proportion (and number) of workers that have no qualifications.

The second aspect considers the proportion and size of the workforce that are 'digital workers' (i.e. the number of workers) and proportion of the workforce that are IT professionals (covering occupations such as computer systems designers and analysts, software developers, database administrators, information security analysts, etc.).

GOVERNANCE

This is a measure of the efficiency of municipal governance provided in the city, including aspects such as crime rates, corruption levels, etc.

QUALITY OF LIFE

This criterion considers the ability of the city to attract and retain technology-based businesses, investment and skilled workers in 'knowledge economy' industries such as information and communications services, professional services and digital media. This is assessed by producing an overall score based on a range of quality-of-life based indicators, such as the quality of the city's primary and secondary education and public health systems, the efficiency of the city's public transport system, and the quality of the city's environment (based on air quality readings).

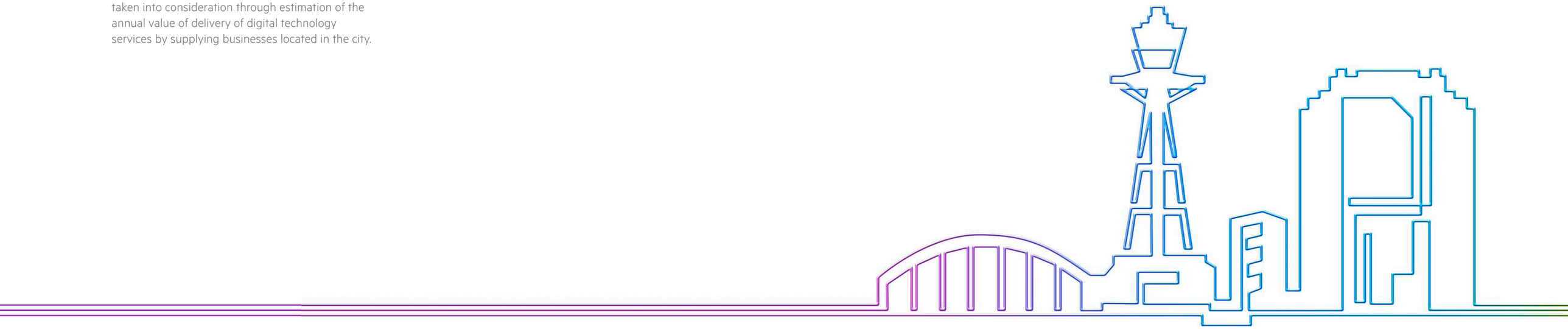
DATA OPENNESS

This indicator is different to those described above in that it applies to the national level rather than the specific city. Essentially, the score applied to the city is the national score achieved for data openness in the current edition of the open data barometer (ODB). This score reflects national policies with respect to the availability of government business datasets and other types of data.

BUSINESS SUPPORT ENVIRONMENT

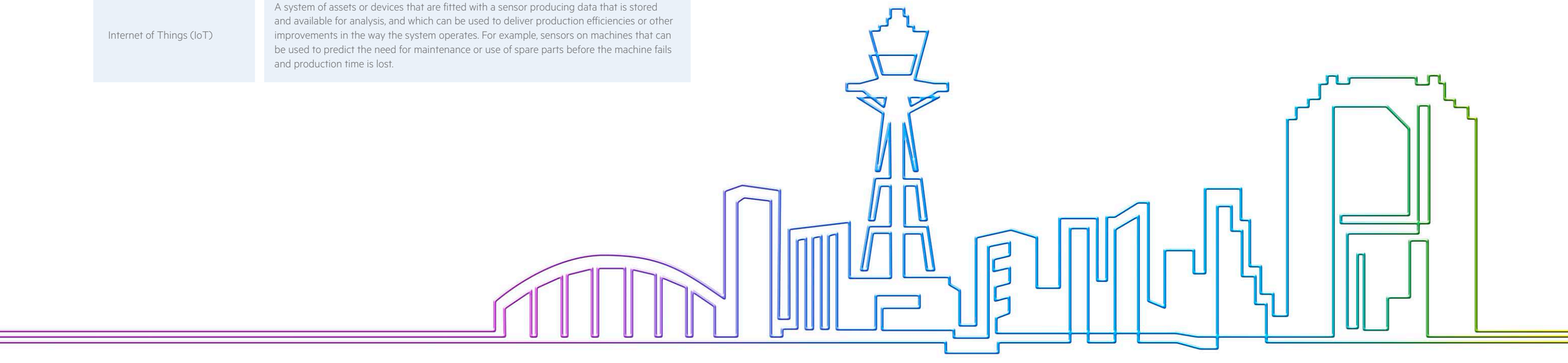
This measure provides an indication of the perceived ease of doing business in the city. The key component parts of this assessment are considered to include the business and personal tax burden, openness to inward investment and property ownership, policies with respect to international movement of digital industry talent, other skilled workers and entrepreneurs, intellectual property protection and levels of corruption.

Because many of these factors are mainly influenced by national policy it was decided to use a single national ranking.



Glossary of Terms

Term used in report	Explanation
5G	The fifth generation of mobile network connectivity, expected to deliver significantly improved levels of network reliability, considerably faster data transfer speeds and improved performance with respect to latency.
Artificial Intelligence (AI)	A range of rapidly evolving computer-based technologies used by machines and devices to simulate elements of human behaviour such as sensing, learning, reasoning and decision-making.
Blockchain	Blockchain is an electronic transaction-processing and record keeping technology that benefits users by decentralising the way that information about transactions is shared. Blockchain provides users with a method of tracking information and transactions securely and by eliminating the need for third-party verification.
Clusters / Ecosystems	Clusters / ecosystems are geographically concentrated networks of interconnected companies and other organizations (such as universities, research institutes and public agencies) operating within a specific industry. Successful clusters / ecosystems are usually characterized by a high volume of interactions and collaborations between businesses and other cluster / ecosystem participants.
Data Economy	The financial and economic value created by the storage, retrieval and analysis via software and other tools of very large volumes of business and organizational data at high speed.
Gross Value Added (GVA)	GVA is defined as the net value contributed to the economy by a company, industry or other economic entity. This includes compensation of employees, company profits and contributions to the Exchequer.
Internet of Things (IoT)	A system of assets or devices that are fitted with a sensor producing data that is stored and available for analysis, and which can be used to deliver production efficiencies or other improvements in the way the system operates. For example, sensors on machines that can be used to predict the need for maintenance or use of spare parts before the machine fails and production time is lost.



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