Open by design:

How open source can drive sustainable urban development

Knowledge Partner

AWS INSTITUTE

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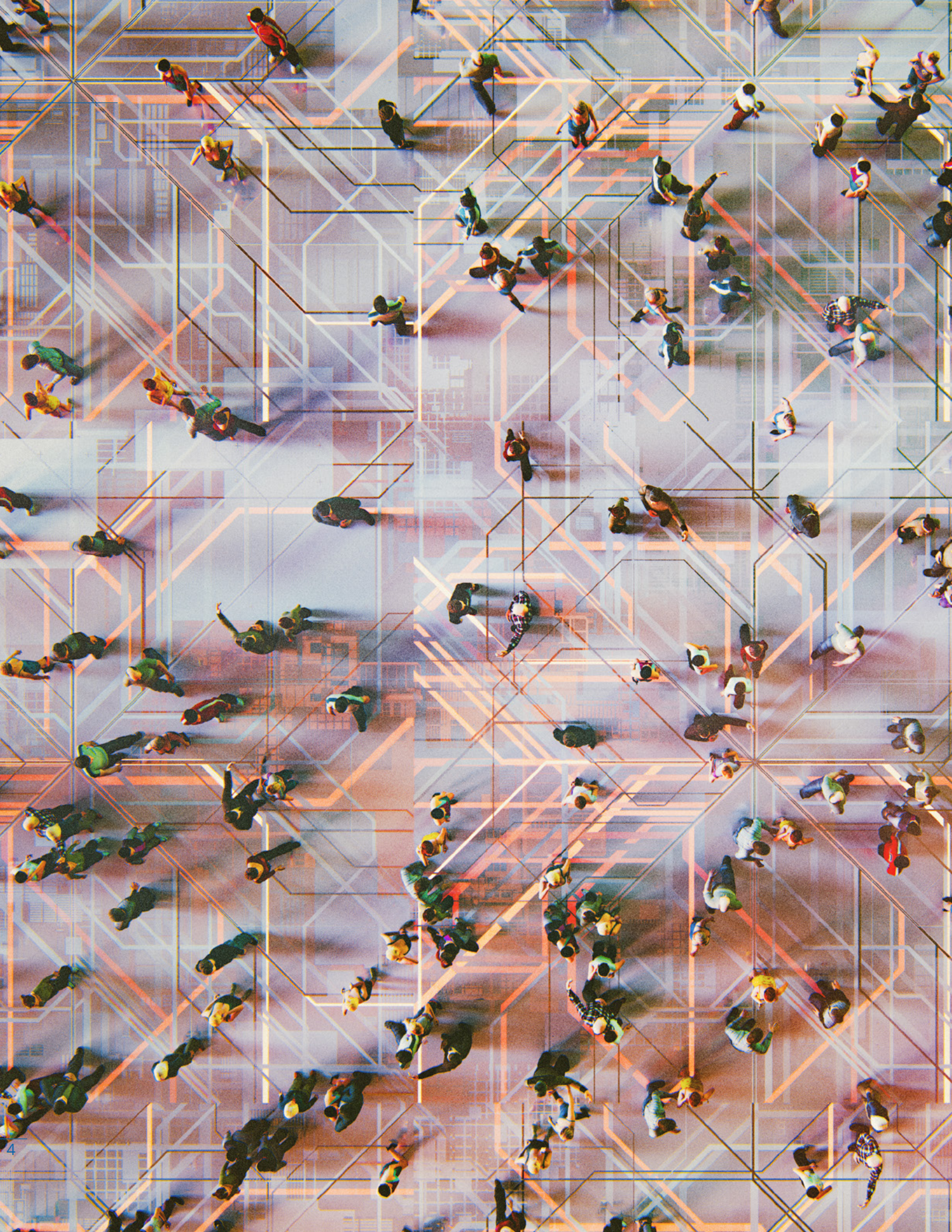

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EXECUTIVE **SUMMARY**

Cities are essential actors, platforms, and drivers of sustainable development. With 2.5 billion more people living in cities by 20250, there is an urgent need to ensure that these urban spaces are liveable, sustainable, resilient, inclusive, and connected. This is the notion of a 'Future City', one founded on new ways of thinking and working – and driven by the needs and aspirations of its residents.

In shaping this new typology of cities, an expanded digital and innovation toolkit is needed. At the centre of this is the importance of open source technologies, approaches, and processes. 'Open source' emerged from the software and technology community, and focuses on software (and hardware) that can be reused and adapted without cost – and where all core components, including any underlying computer code, are fully visible. Open source tools and technologies can have a wide range of benefits for municipal governments, including:

1. Saving cities time and money, by increasing the digital products and services available to governments, and reducing the risk of being 'locked-in' to expensive contracts or digital solutions.

2. Institutionalising crucial digital skills, enabling cities to build in-house expertise that can allow them to more effectively meet the needs and realities of their residents – and tackle key local issues and priorities.

3. Improving the effectiveness and efficiency of digital public services by leveraging open standards, proven digital components, interoperability, and other technical features that can drive a more joined-up digital approach.

4. Shaping a vibrant local digital sector, creating greater urban prosperity. This also provides municipal governments with the potential

photo credit: UNDP Maldives

to leverage this local digital talent to deliver important urban outcomes.

5. Creating a global community of urban leaders and innovators. Enabling cities to learn from the successes, challenges, and experiences of each other – as well as adopt, adapt, and re-use digital solutions that have worked in other urban settings.

6. However, open source is also about individual and organisational behaviour. This includes the potential of open source to increase the transparency of processes and decisions, enable agility in decision-making and delivery, and build feedback loops with residents to ensure that cities continue to meet their needs and requirements. When embedding open source approaches more broadly, municipal governments can improve their responsiveness to the rapidly-increasing range of urban challenges faced by cities, shape more resilient and focused institutions and processes, and strengthen their local digital and innovation ecosystems.

Recognising the technical and organisational shifts required in exploring open source approaches, municipal governments will need to:

- **Understand the role and relevance of open source for their city, and residents.** Including the opportunities for open source to shape new digital and delivery skills within the local government, drive interoperability between digital components and services, and leverage open source to improve key outcomes such as transparency, trust, efficiency, resident engagement, and ecosystem development. Engaging with urban, national, and global open source communities can also add value – including civic tech and digital innovators within the city.

- **Shape an initial direction of open source.** Exploring or implementing open source will not happen overnight, and will require positive shifts in the organisational culture and processes of municipal government. Leadership and strategic clarity will be important, and the usefulness of identifying 'quicker wins' to encourage open source momentum can also drive broader behaviour change. Governments, and their leaders, should also ensure effective communication regarding the benefits of open source: raising awareness, and encouraging consideration of open source software and approaches by default.

- **Manage culture change.** Open source will present new challenges and considerations for municipal governments, but with strong potential for a wide-range of benefits. This journey will require broader change management within the public sector – from defining clear roles and responsibilities, to building processes to effectively leverage and embed open source digital solutions. This should also extend to broader levers within the municipal government, particularly procurement which can be a powerful vehicle for change – enabling open source vendors to meet the digital needs of the city, and its residents.

- **Explore the potential for deeper digital transformation.** Open source can drive broader opportunities for even more impactful digital transformation. It can encourage in-house digital development, institutionalise digital skills within municipal government, and shape a broader focus on openness and engagement – from open data, to using collective intelligence processes to engage city residents. When introducing open source software and ways of thinking, municipal governments should also consider the potential for longer-term and systemic digital transformation.

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Despite its considerable benefits, open source is not a panacea. It is not a solution to issues of ineffective or incoherent local governance, and cannot mitigate the impact of municipal governments not involving city residents in policymaking, decision-making, or service design and delivery. And although open source is founded on technology, municipal governments must avoid taking a technology-centric approach. Neither open source nor proprietary solutions are inherently 'good' or 'bad'. Both have value, and both can meet the needs of cities – depending on the problem being tackled.

With this in mind, and recognising the considerable challenges that municipal governments are facing, a broad digital and innovation urban toolkit is needed. Open source tools and technologies are important additions to this toolkit, as are more open ways of working: founded on resident needs and engagement, and agility and openness in decision-making and delivery. Open source is having real and positive impact on cities around the world, with a number of global case studies in this report highlighting a number of near- and longer-term benefits.
Open source can also provide municipal governments with two other important advantages. First, an opportunity to engage local digitally-skilled residents in supporting key city priorities. Providing a 21st-century angle to the civic participation that has been a key foundation of cities for many years. Second, open source software and digital components are open by-design. This allows them to be re-used and adapted by other cities. In a context where cities are engaging with climate change, conflict, and other forms of crisis, it is essential that they do not make the mistakes of others – and instead learn from, and leverage, existing solutions and best practice. Open source could be an essential catalyst in shaping Future Cities that improve lives and livelihoods, and enable sustainable development.

QUICK
REFERENCE GUIDE

Open source is not a new concept, but it is a newer way of working and thinking for cities. This paper aims to provide city leaders, policymakers, and urban innovators with a detailed 'primer' on how to leverage open source tools, technologies, and processes to improve how cities meet the needs of their residents. It explores an extensive range of technical, organisational, and strategic aspects relating to open source and urban development in order to meet the varying priorities of these different audiences.

If you are a:

City leader keen to understand how open source can support your city in achieving key outcomes, you may be particularly interested in: section one **'Defining Future Cities'**, which unpacks the exciting and important role of cities in improving lives and livelihoods, and the third section of the paper (**'How cities can benefit from an open source approach'**) which provides important insights and case studies exploring how open source is having a real and positive impact in cities around the world. Whilst the fourth section of the report – '**Putting it into practice**' – sets out the key processes, behaviours, and other factors you may need to shape in order to leverage the power and potential of open source.

Policymaker looking to learn how to start using open source to improve public service delivery, resident engagement, or tackle key priorities such as healthcare, education, and improving urban sustainability, you may want to particularly explore the second section of the report: **'Open source and Future Cities'**. Building on this, you may also want to consider browsing the third section of the report – **'How cities can benefit from an open source approach'** – which shares more about how open source is improving the ways in which municipal governments around the world are responding to the needs and priorities of their residents.

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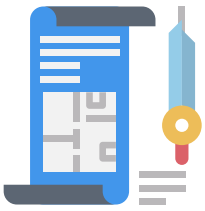


Urban innovator aiming to understand more about how best to support municipal governments on their digital transformation and open source journey you may find the third section of the report - **'How cities can benefit from an open source approach'** - particularly relevant in finding ways of aligning with the realities, contexts, and nuances of municipal governments. Related to this, you may also want to read the first section of the report – **'Defining Future Cities'** – which highlights the importance of digital, technology and innovation (and open source) for sustainable urban development.

In addition, **city leaders – and policymakers** managing digital public service delivery and resident engagement - should **consider this 10-point checklist** as a reference guide to open source implementation in municipal government: (see pages 12-13)

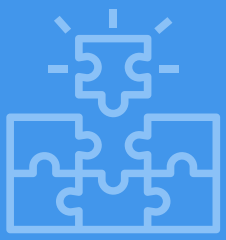
Open source tools, technologies, and approaches are having considerable impact and value in cities around the world. This report aims to guide municipal governments in starting, advancing, or deepening their open source journey – both for the benefit of their residents, and to shape 'Future Cities' founded on inclusivity, liveability, sustainability, and connectivity.

Open source Implementation Checklist

1

Ground open source in the Future City pathway.
Identify areas where open source solutions and thinking can support key aspects of inclusivity, sustainability, resilience, liveability, and connectivity. Consider measuring a 'baseline' of current digital spend, or key digitally-enabled outcomes (such as transparency, citizen engagement, or agility).

2

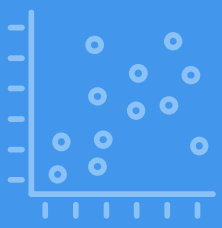


Unpack open source and its relevance.
Engage with the characteristics of open source software, open data, and open source thinking – including opportunities (both technical – such as improved interoperability, and broader outcomes), costs and potential challenges (including the 'health' of any open source community of relevance), and potential collaborations.

3

Develop (or refine) digital and service standards.
Standards are an essential tool in embedding and institutionalising digital ways of working – from service design to delivery. Municipal governments should have clear and effective digital standards, which can be augmented by open source approaches.

4



Map internal digital skills and knowledge.
Open source can enable municipal governments to draw on, and institutionalise, digital skills and expertise. Map existing abilities, and gaps – and consider open source exploration as an opportunity to tackle digital skills priorities.

5

Identify key urban outcomes for open source implementation.
Open source solutions and approaches can improve transparency, resident trust and engagement, the efficiency and agility of the municipal government, and the shaping of a local digital ecosystem. The municipal government should be alert to these broader outcomes, particularly when seeking support for open source exploration and implementation.

6

Shape an initial direction of open source.
City leaders should identify opportunities to drive a direction toward open source. From identifying 'quicker-wins' and prospects to demonstrate the value of open source, to raising awareness of the importance of open source and the need to position it as a 'default' approach to procurement, design, and delivery.

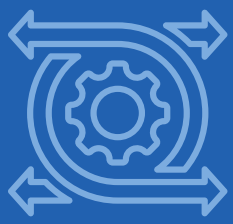
7

Support culture change.
Open source is as much about culture and process as it is about technical tools and concepts. City leaders will need to shape skills, workflows, and teams to maximise the benefits of open source – from changing procurement processes to encourage local vendors, to ensuring the safety and security of open source solutions (including code audits), and shaping technical support approaches.

8

Consider deeper digital transformation.
Open source can provide municipal governments with new and unexpected opportunities. From improving the vibrancy of the local digital ecosystem, to building and institutionalising digital skills and knowledge. These are broader strategic considerations that should be explored by city leaders.

9



Understand when (and when not) to use open source.
As highlighted above, open source is not a panacea – and commercial solutions still have important value. Whilst some open source solutions are also managed and maintained by commercial vendors. Municipal governments should shape a process to identify when – and when not – to use an open source solution. This could be driven by funding or skill constraints, or the importance of avoiding vendor 'lock-in'. City leaders should consider the value of an 'open source by default' approach.

10

Engage with your local CivicTech community.
Cities are founded on civic engagement: from volunteers supporting marginalised and vulnerable urban communities, to parents managing local sports teams. Municipal governments should extend these civic virtues into the digital space: tapping-into the often-extensive range of digital talent within the city – and leveraging this to support the exploration and implementation of open source.

Section One: DEFINING FUTURE CITIES

Today, over half of our global population lives in cities. Cities feature agglomerations of people and the exciting interplay between economic, social, and cultural activity. Cities are continually evolving, and growing organically in often unexpected ways. By 2050, 2.5 billion more people will inhabit the world's cities, comprising 68% of the world's population.[1] Cities offer hubs of potential opportunity, prosperity, and wellbeing for residents, and they are also often the closest administrative actor to people and businesses – and lives, and livelihoods.

Cities are a key development priority, and opportunity. Sustainable Development Goal 11 recognises the importance of inclusive, safe, resilient, and liveable cities and communities that leave no one behind. And, as reaffirmed by the New Urban Agenda, urbanisation can be a powerful and positive driver of sustainable development for both developing and developed countries. Digital tools and technologies, and open source in particular, can play a key role in shaping, supporting, and amplifying the efforts of all five of the pillars set out in the Agenda. From shaping innovation in urban planning and design, to supporting local implementation. And when planned and managed well, cities can drive outcomes across all 17 Sustainable Development Goals (SDGs) – from tackling poverty (SDG 1), to improving gender equality (SDG 5) and protecting and restoring natural ecosystems (SDG 15).

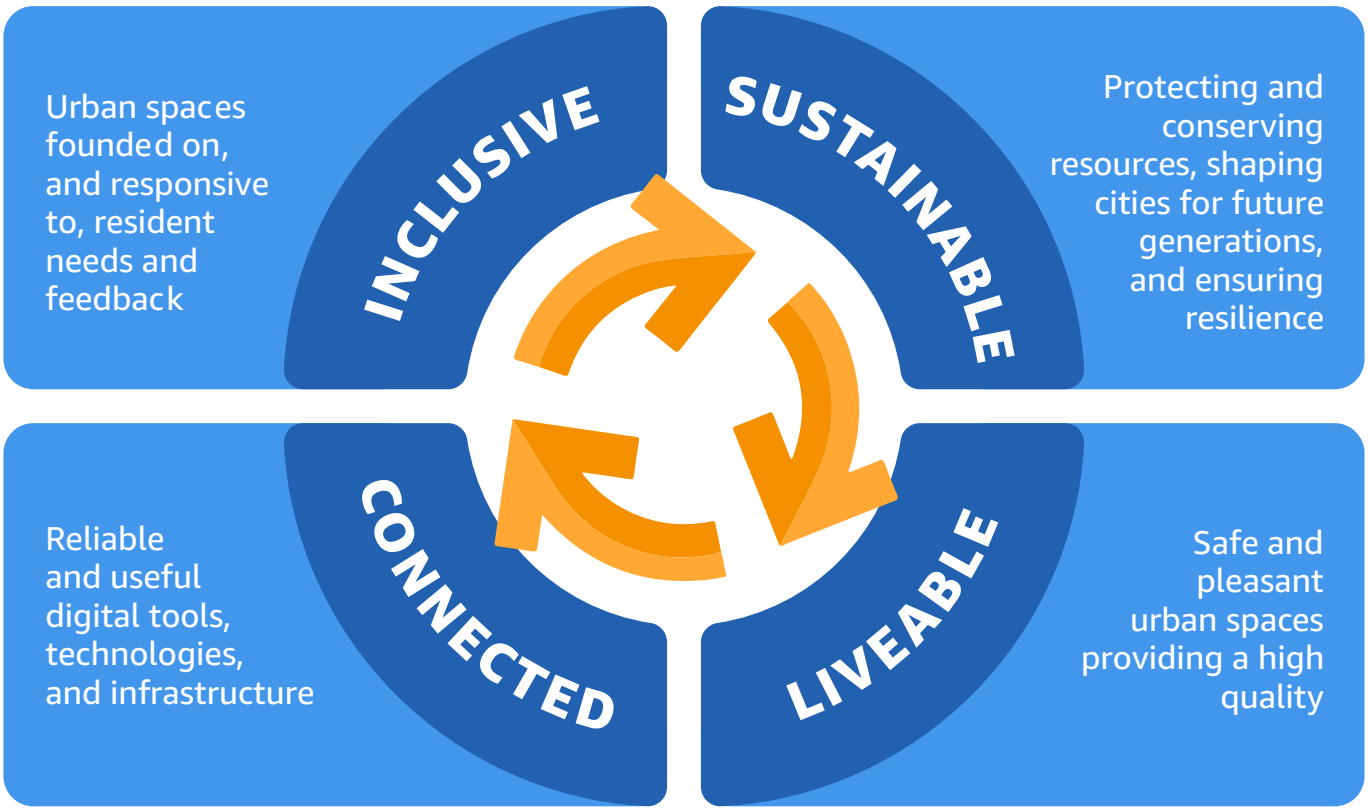
Urbanisation can be a powerful and positive force for development, when shaped in an inclusive and sustainable way. From providing employment and economic opportunities to tackle poverty and inequality, to delivering services and initiatives that lead to better education and health outcomes. However, city growth can pose challenges for officials and residents who are concerned about the sustainability, liveability and integrity of the cities they are helping to shape. These efforts are complicated by the specific characteristics of each and

every city, which are conditioned by a range of factors including location, demography, history, culture, and socio-economic context. In attempting to grapple with this challenge, new paradigms for what constitutes a city of the future are emerging across the world. In this context, cities need to leverage new technologies and innovations – including high-tech, low-tech, and no-tech[2] – to deliver public and private services, manage the movement of people and products through cities, improve sustainability, and enable all residents to enjoy a uniformly high quality of life.

To theorise and better understand Future Cities, urbanists and innovators are exploring how to make cities liveable, inclusive, and sustainable – including resilient to natural hazards and a range of other natural and human-created challenges and risks. This involves unpacking a variety of conceptual and applied thinking. For example, the now-ubiquitous concept of the 'smart city' emphasises the role of connectivity, digital, and data to improve the functioning of a city – from day-to-day urban service delivery and governance, to responding to challenge and crisis. Meanwhile, a focus on liveability foregrounds aspects that make city living pleasant for residents, including safety, convenience, resilience, and overall quality of life. Whilst the sustainability-focused (or 'eco-city') approach focuses on sustainability as a governing principle for urban planning.[3]

A 'Future City' – or a 'truly smart' city[4] – brings together these different strands to advocate for cities that are liveable, sustainable, and inclusive founded on high-quality and catalytic digital (and physical) infrastructure.

The Future City



Cities need to be liveable

Cities are about people – and their lives and livelihoods. A focus on liveability entails putting people and community well-being at the core of governance and urban outcomes, including ensuring access to job opportunities and the provision of public services. It involves making safety, access to culture and community,[5] and way-finding central to urban design and management, whilst also considering sustainability, accessibility, and competitiveness. It is about creating and shaping pleasant and enjoyable urban places and spaces – and improving the health and environment of residents and the city.

Future Cities can offer a range of approaches, tools and services to improve liveability. Technological solutions such as those that leverage real-time crime data or route data can help to make walking routes safe, especially at night[6]. In addition, artificial intelligence can lead to improved urban mobility[7]. However, it is not just about technology. Resident engagement and responsive urban governance can be pivotal in improving the welfare of residents – whilst better planning and urban thinking can 'design out' many of these issues and challenges. A 'tech stack' can only succeed – and is always augmented and amplified by – a 'human stack' of empowered residents, inclusive and resilient institutions, cultures, and processes. With people at the centre of local decision-making, liveability concerns can be continuously addressed.

Cities need to be sustainable

Future Cities aim to provide for the present needs of their residents, whilst also being able to meet these needs into the future – including in a context of new priorities, and in the face of emerging risks and challenges. However, as hosts of industry and drivers of significant productivity, cities account for over 70% of global greenhouse gas emissions.[8] As a result, there is real urgency for cities to pivot towards sustainable policies and practices. This can include emphasising and embedding energy efficiency, minimising water usage, and implementing effective waste management. It may also include deeper policy shifts, including approaches such as 'Doughnut Economics' that are increasingly being explored by cities[9] - and innovations such as nature-based solutions[10].

Future Cities spotlight sustainability, using technology and broader innovation, to improve the urban environment. Instruments such as the Tool for Rapid Assessment of City Energy (TRACE) and the City Greenhouse Gas Emission Index help cities identify the drivers of energy consumption and emissions – and begin to address them.[11] Water and waste management are particular priorities, with urban water sources coming under increased pressure due to climate change[12]. Neighbourhood-based water plants can respond quickly to shifts in demand, and forward-thinking zoning practices can render the re-use of water in various systems more straightforward.[13] Cities may even use reclaimed water, creating clean water from wastewater, as is achieved in Singapore.[14] Greater visibility over the system can inform decision-making and make resource recovery a more effective process – prompting transitions towards circular economies, severely reducing waste, and extending the lifetime of products.[15]

Cities need to be inclusive

Future Cities are oriented towards making the urban setting as open and accessible as possible – a safe and enjoyable space for all residents and visitors. Accessibility is a key feature of Future Cities since these cities provide transport options and need to deliver public and private sector services to all. Universal accessibility requirements for new buildings, repurposing old infrastructure, and supporting vulnerable groups who are struggling to adjust to old age, helps to prime cities for an ageing population[16] – given that 16% of the global population will be over 65 years old by 2050.[17]

All municipal government services should be accessible to people of any background, and the economic opportunities associated with cities should be available to all. If a city government offers services digitally, then the accessibility of these services improves. This access should include opportunity for offline or human interaction – or intermediated access to services – to ensure that no one is left behind.

However, inclusivity is not solely about access or inclusion but also about empowerment. Local governance systems need to enable and encourage political and social participation of all members of society. Importantly, many cities now measure their own success based on their achievements in terms of inclusion and accessibility.[18] This, coupled with robust feedback mechanisms and true participatory processes (including participatory budgeting, and other processes being explored by cities), help to ensure accountability and transparency, and that policymaking and service delivery meet resident needs. Creating this dialogue is crucial in ensuring that cities continue to meet the needs and aspirations of their residents – at all moments of their lives.

Cities need to be connected

Connectivity is a critical enabler of the Future City. It encompasses broadband and mobile Internet, but also the capacity for interconnection beyond that – through applications, services, and platforms. Wired and wireless digital infrastructure, connection and communication between devices and innovations, and real-time cloud and data exchange platforms, can play a major role in enabling various models of the Future City. And this digital infrastructure is also increasingly open-by-design.[19] Although not explored in this paper, connectivity also includes physical aspects such as transport infrastructure. And it is not just about access, but also about ownership of devices and the inclusion of digital infrastructure. For example, the concept of 'Meaningful Connectivity', in ensuring high-quality internet access for remote-working, learning, and other core tasks.

In turn, connectivity creates economic and social opportunities for urban residents by driving public and private service delivery, and puts in place the backbone for smart urban innovations and readily accessible government services that can make urban living more efficient and coordinated.[20] It can improve the inclusion of service delivery – for example, reducing the number of 'unbanked' individuals

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without access to financial products or services. It can facilitate access to government services and healthcare, which can be delivered through government portals or other digital services.[21] Cloud technology can also improve the scalability, cybersecurity, and the effectiveness of these services.

Furthermore, greater connectivity is linked to increased innovation, an increase in opportunities, and a reduction in poverty[22]. The rollout of public and private sector digital platforms widens access to digital goods and services. Greater connectivity also has a positive effect on innovation and entrepreneurship, at both firm and household levels.[23] Connectivity can be seen as an asset, conferring a wide range of benefits on cities and residents. It is also a crucial prerequisite for leveraging more advanced digital and data propositions, including the ability to calibrate services, allocate resources, and provide up-to-date information to residents and decision-makers. However, in a context of billions of people still offline, Future Cities also need to be alert to, and mitigate, any digital divide – adapting their services to local technology penetration.

TOWARDS FUTURE CITIES

Across all of these concepts, city residents are at the centre – with a focus from local government on improving the lives and livelihoods of residents, and a desire on the part of local governments to maximise the benefits and minimise the drawbacks to urban life. Regardless of the nuances of their definition, Future Cities are conceived as dynamic, sustainable, globally integrated in cultural and economic terms, and above all, responsive to the needs and circumstances of residents on the ground.[24] And even proactively addressing these requirements, in terms of scheduling services and benefits to be delivered without resident intervention – including aspects such as proactive maintenance of infrastructure.

It is from this element of responsiveness that all other benefits associated with the Future City must arise. In this context, the cultivation of strong and reliable consultation and engagement mechanisms (and feedback loops) with local communities, robust digital connectivity, access to high quality data, collaboration across sectors, and a commitment to knowledge sharing are paramount to any successful implementation of a Future City. All of these elements – transparency, collaboration, inclusivity, and community – are also core to open source principles first codified in the software development space and exported to many others.

Section Two:
OPEN SOURCE AND FUTURE CITIES

Cities are leaders in exploring and implementing technology and innovation. As the closest administrative actor to people, they are using digital tools, channels, and other assets to deliver public services, shape vibrant local digital ecosystems, and to improve the urban environment. Open source can play an important role in deepening and accelerating the positive impact of digital - from reducing the costs and complexity of digital transformation, to enabling cities to leverage digital solutions that have worked well in other cities and contexts.

What is open source?

Open source is both a technology approach, and a way of thinking and working. In a strict, technology-based sense, software is considered open source when its underlying code is designed to be freely available. Anyone may access it, use it, alter it, or combine it with other solutions for their own purpose. This allows cities to have full visibility of digital solutions – including their features, dependencies, and risks. It also enables re-use of other digital solutions (see boxout: 'Digital Public Infrastructure and Digital Public Goods'). Open source components also feature in many fully-fledged but not fully open source solutions – including commercial products and services. Free and open source software constitutes 70-90% of any given component of modern software solutions[25].

Open source can also extend beyond software – for example, open source hardware is a key component of the 3D printing and 'makerspace' movement.

One of the earliest articulations of a precursor to open source, in 1985, described it as an attitude towards sharing software that is 'hospitable to everyone'; in which developers cooperate, rather than compete based on their employers' commercialised versions of software.[26] Open source encompasses software of all sizes, from as large as an operating system (such as Linux) to as small as a spell checker (like GNU Aspell), and innovations such as the online content management system Wordpress. Open source can be contrasted with closed-source software, which is proprietary and for which licensing prevents any

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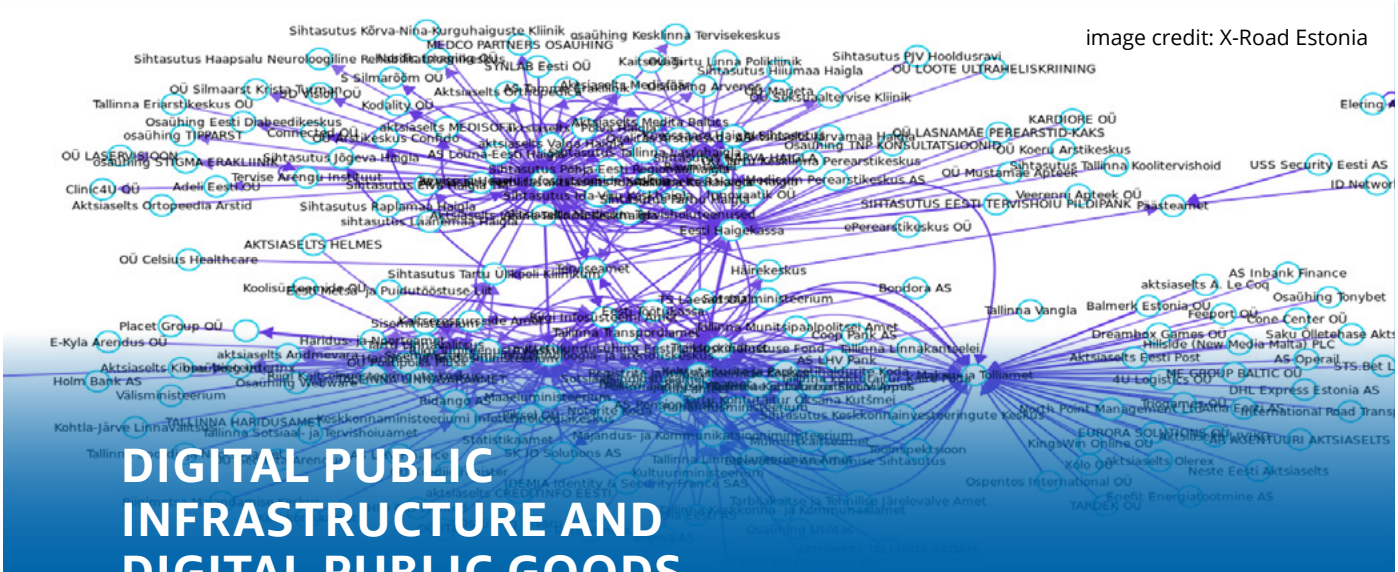
adaptation or modification beyond its stipulated use. Moving beyond the software or hardware focus, the open source definition can also be broadened to describe more open and participatory methods of urban engagement and governance – including approaches such as collective intelligence, which focus on opening-up innovation processes to new and diverse voices. These aspects can enable cities to be more responsive to the needs of their residents. In this context, open source approaches can be characterised by their consultative nature, seeking to embed feedback loops at several stages of administrative, design, and delivery processes. This gives voice to as many residents, organisations, government agencies and businesses as possible, allowing policymaking and governance to draw on the insights and intelligence of a wide and diverse group. It prioritises the leveraging of high-quality data – whether quantitative or qualitative – drawn from people's lives, livelihoods, and lived experiences. This data can provide urban policymakers and innovators with the opportunity to engage thoroughly and self-reflexively with the processes, the institutions, and potentially the biases within design, delivery, and decision-making.

This openness can result in better products and services for city residents, improved outcomes in the urban context, and can contribute to shaping more inclusive, liveable, and sustainable places and spaces. Open source technologies and mindsets are a key foundation of Future Cities.



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DIGITAL PUBLIC INFRASTRUCTURE AND DIGITAL PUBLIC GOODS

Cities cannot function without infrastructure. From the sewers and water management infrastructure created by Joseph Bazalgette, that improved health outcomes in Victorian London, to the standardisation of roads, sidewalks, and other urban components that make cities navigable, cities can be uplifted through 'public goods'. Public goods are owned or led by governments, in recognition of the lack of market forces that would otherwise enable their delivery by the private sector.

Over a century after the above infrastructure defined cities, attention is focusing on *digital* public infrastructure: the data, digital, and technology foundations and components that in turn can accelerate the work – and positive outcomes – of the public and private sectors. Digital Public Infrastructure comprises digital building blocks that can enable effective public and private service delivery. This includes components such as digital ID, digital payment infrastructure, and data exchange layers. It is founded on open standards, governance processes, and a focus on shaping an ecosystem of local and broader innovators to meet the needs of cities – and countries.

More broadly, DPI can also be created by combining individual and discrete open source digital components – also known as Digital Public Goods. Digital Public Goods are '*open source software, open data, open AI models, open standards, and open content that adhere to privacy and other applicable laws and best practices, do no harm by design, and help attain the Sustainable Development Goals.*'[27] There is an exciting opportunity to leverage Digital Public Goods and Digital Public Infrastructure to support national and local governments on their digital transformation journeys – improving inclusion[28] and accelerating the digital journey of cities, by adapting and adopting solutions that have been proven in other contexts.

photo credit: UNDP Ukraine

Open source software

Open source gives municipal governments ownership of digital products, components, and solutions – enabling them to use and re-use them as they see fit, and to build 'technology stacks' to deliver key public services often more efficiently and effectively than when procuring commercial solutions. Technology 'stacks' are combinations of software, programming languages, data storage mechanisms, and frameworks, which developers can use to shape applications. For example, a service to deliver local government payments to city residents could require combining foundational data on who is eligible for the payment, then connecting together different platforms to link payment details with other characteristics, and adhere to principles around data privacy and security. This service could therefore include an:

- Identity database to confirm eligibility for the payment, based on a particular characteristic (e.g., age, income-level, or location);
- A payment platform to process the payment to the resident; and
- A website to allow residents to request the payment, which could also be linked with other databases to confirm their eligibility – as well as a number of other components.

The combination of these assets is 'stacked' – including featuring programming languages, interfaces, and other technical components - in order to build the service.

These 'stacks' comprise a number of different and discrete digital products and services – including databases, interfaces and other aspects of interoperability, and modules such as payment mechanisms. They can also require connections with other parts of the local government administration, national government components, and even private sector digital assets. Conventionally, businesses, organizations, and government agencies develop these 'stacks' in-house – either combining different

commercial solutions or buying an end-to-end solution from the market. However, increasingly cities are turning to open source components and solutions in building these stacks – including to improve interoperability, as commercial solutions may not be easily combined with other products or services.

Open source software can be single components – but broader platforms and initiatives can also be founded on open source. For example, to facilitate digital government, Singapore's GovTech agency created the open source Singapore Government Tech Stack (SGTS). Rather than making it incumbent on each government agency to roll out digital infrastructure and services to match their needs and purposes, GovTech provides a common platform that allows other agencies to use a suite of tools founded on shared infrastructure.[29] This means that government websites and services are consistent and of high quality.

Open source software is often community-led, or at least community-maintained. If parts of the tech stacks in a government agency are open source, then developers within the municipal government can modify solutions to meet the local context – and the shifting needs and priorities of city residents. This can be a powerful differentiator to commercial solutions where municipal governments need to request – and often pay for – changes in functionality, and where the solution may not be able to be tailored as effectively to local needs. There could also be scope for developers to be 'shared' across cities or municipalities, particularly for smaller cities – providing economies of scale and greater collaboration, which may not be possible through commercial contracts. And, as discussed later, there is also exciting opportunity to leverage the civic interest of local digital experts in shaping open source solutions.

THE FUTURE CITY 'STACK'

The 'stack' in relation to open source, and digital more broadly, has often focused on software and other digital components. From programming languages, to payment modules and databases, and interfaces to connect different systems or functions. These are stacked together and comprise the end-to-end technologies to deliver a digital product or service.

However, in the context of a 'Future City', and the potential enabled by open source, there is an opportunity to broaden the stack to include non-technical components. In particular, the residents within the city. From ensuring the digital inclusion of people through skills development and other key aspects of accessibility, to shaping the regulation and governance of the urban digital (and offline) space, to involving residents and local digital talent in co-designing and delivering digital products and services. The 'stack' can also extend to the broader digital ecosystem: including the incentives, drivers, and features to enable local digital innovation, entrepreneurship, and sustainability[30].

Open data can be an important driver of open source - but the data needs to meet certain criteria

Source: World Development Report, 2021

Open data and open source

Open source can also drive broader digital outcomes for cities, including supporting cities in developing open data policies, processes, and practices. Many components of open source Future City 'stacks' rely on receiving a wealth of data – and this need is only increasing as digital products and services become more complex. This includes data from sensors and citizen applications, but also qualitative and other insights from direct public engagement. However, 'data' is not a single concept. For data to add value, it needs to be useable and reliable – including of a frequency, quality, granularity, and interoperability to ensure that it can play a useful role for local government decision-making, private sector innovation, and civil society transparency (see Figure 2.1).

Beyond building data foundations, open source efforts can be catalysed by cities making data publicly accessible. 'Open data' is the process of making data held by the public sector freely available, in machine-readable format, and building tools such as 'application programming interfaces' (APIs) that allow connection between different products and platforms[31]. Open data initiatives can lead to greater transparency in government, and more effective as well as more efficient services. They also facilitate data sharing between agencies, meaning that cumbersome processes of data transmission can be improved. Part of the open data journey centres around identifying data that can be made publicly available – as highlighted in the ODI Data Spectrum[32].

However, data sits within a broader workflow and process – including the collection of data, standardisation, analysis, and visualisation – to ensure that it correctly and usefully informs decision-making.

Better data can lead to better decisions, and better cities. This process includes initiatives such as city data portals, to improve the accessibility of data. For example, Ajman Data, a platform that publishes data from public sector agencies in the United Arab Emirates including the police, the tourist board, and healthcare providers has improved public service design and delivery – and the overall urban experience[33]. Increasingly, open data portals such as Ajman Data are themselves open source – allowing other municipal or national governments to re-use such platforms.

Open data can also have even broader multiplier effects. The European Strategy for Data Spaces envisages data being shared between different cities, businesses and research institutions to enable the analysis of comparable data across different geographies and policymaking levels to improve policymaking, service design and delivery, evaluation, research, and business approaches. This highlights an exciting collaboration opportunity for Future Cities: municipal governments providing the foundations and catalysts for private sector service development and delivery. Whilst private sector engagement with open data can also highlight data gaps and other issues to be addressed by municipal government - thereby improving the quality of data.

Robust data protection and other privacy measures need to underpin data collection and usage. However, this highlights a tension in relation to Future Cities. Laws and other guidelines defining and shaping data are often set at the national level – by national governments and regulators – and cities are often unable to shape these protections. However, cities are where data-driven services are increasingly being explored and deployed. This provides an opportunity for cities to shape feedback loops, where the experiences of the city can inform national-level government perspectives and best practice. Cities can be seen as the 'testbeds and marketplaces' for data and data governance.[34]

CASE STUDY: REPUBLIC OF KOREA'S OPEN DATA PORTAL

The city of Seoul's use of the national government's Republic of Korea's Open Data Portal represents an exciting demonstrator of open data and data sharing. The Portal makes administrative data derived from government data collection exercises freely available online. This includes urban housing data, smart mapping, and construction permit issuance. As a result, it increases transparency of the permit issuance process, and allows for greater transparency over public health, too. The portal was particularly instrumental in the monitoring and management of the COVID-19 pandemic across the country, and in Seoul. The system grants access to anonymised datasets related to infections, hospitalisations, recoveries, and vaccinations.[35]

This complements the over 1,000 public service applications that have already been developed at a national level, with applicability in Seoul, including the Food Poisoning Prediction Map service and the Integrated Disaster and Safety Information System.[36] After establishing in 2014 that 72% of food poisoning cases originated from restaurants and takeaway restaurants,[37] the Ministry of Food and Drug Safety[38] spearheaded pan-governmental efforts to strengthen public sector responses. More frequent inspections and more robust poisoning prevention activities were carried out in areas found to have a high number of cases, in order to prevent an upswing in cases. The Integrated Disaster and Safety Information System uses data from this portal, supplemented by data sent from other relevant ministries, in order to steward a system linking human and animal health data. This system was created in response to the limitations of the system of information sharing between public sector agencies during the MERS epidemic of 2015.[39] This new system provides real-time data for inter-agency coordination and communication. This was particularly valuable in facilitating contact tracing during the COVID-19 pandemic.[40]

The Open Data Portal highlights the exciting and important potential of data – informing and improving decision-making, shaping more effective policymaking, and driving solutions and innovation within and beyond local government. A range of services supplementing those offered by the government are generated through the opening up of data, with a range of benefits accruing to the public.

photo credit: UNDP Ukraine

Shaping standards for open source

Prior to adopting open source solutions in municipal government, officials need to explore governance structures and processes in order to maximise its potential. This could include instituting guiderails and guardrails for the usage of open source software, including creating processes for use of personal data, adhering to any open source licensing requirements, engaging with cybersecurity protections, and setting clear lines of authority and accountability.[41] Policy and regulation will also play a role throughout these areas. Although much of this regulation – particularly in areas such as cybersecurity, data protection, and connectivity – will be set at a national level, municipal governments can shape 'feedback loops' themselves to ensure these tools support urban realities and priorities. In particular, cities will often be leaders in implementing digital and innovation and can support national legislatures in testing, trialling, and validating digital policies and protections shaped at a central level[42].

Part of such governance is the adoption of open standards, which set the common language of a topic or domain. Open standards are free to use by anyone, and their adoption can boost the interoperability of open source technology stacks. In the context of open source, open standards typically refer to specifications for software and interfaces, plus reference implementations. They ensure compatibility and interoperability between different digital products and services, and reduce duplication and confusion – leading to broader benefits for residents. More interoperable systems can lead to more effective service delivery, improved accessibility, and a smoother digital experience. Using the same standards as others around the world can also increase the potential for open source creations from cities to be developed and implemented elsewhere. More broadly, cities also need to ensure the joint adoption of both knowledge and technical standards in any given domain – for example, ensuring that land planners are using the same terminology and concepts to those found in planning software (and vice versa).

Shared standards can also extend to sourcing and procuring open source solutions. For example, the Open Contracting Partnership promotes the use of open data standards to improve transparency and accountability in national and local government procurement. It offers the Open Contracting Data Standard (OCDS) for anyone to use, which sets out data fields, structure, guidance, and toolkits so that data on public contracts is transparent, comparable, and more reliable over time. This means that contracts can be compared over time, unusual patterns can be detected, but also improves the trust of local innovators when bidding for government contracts and partnerships.

THE MULTIPLIER EFFECT OF OPEN STANDARDS: FIWARE

FIWARE, an open source framework around which a community has coalesced, aims to create 'an open sustainable ecosystem around public, royalty-free and implementation-driven software platform standards that ease the development of new Smart Applications in multiple sectors'.[43] It drives vital open standards, enabling the development of interoperable smart solutions. For instance, the FIWARE catalogue features Idra, a web application able to federate existing Open Data Management Systems, to search and discover open datasets. FIWARE technology and open data have assisted in the rollout of smart urban innovations as diverse as improving beach safety in Montevideo,[44] to structuring chatbots,[45] and bringing together diverse Internet-of-Things products and services[46] – all within a framework to replicate and scale solutions across different urban contexts.[47]

Section Three:

HOW CITIES CAN BENEFIT FROM AN OPEN SOURCE APPROACH

Open source can be defined both in a strict technological context, but also in the context of broader processes, workflows, and institutions. With this in mind, there are different kinds of openness that municipal governments can consider incorporating into their procedures and ways of working. Some of these approaches are also relevant when using closed-source and proprietary software too. For instance, governments can prioritise seeking and acting on feedback, to ensure that residents' needs are addressed as best as possible. They can work with open technology standards, to maximise the interoperability of their systems and ease any processes involving external stakeholders. They can adopt open data approaches to stimulate economic growth and innovation, allowing the private sector to offer supplemental and complementary services to those provided by the local government.

Institutionalising skills and knowledge

Recognising that open source solutions are not owned by commercial entities, and therefore not requiring proprietary skills and knowledge, municipal governments have an opportunity to institutionalise digital skills and knowledge. From coding, to product development. Building skills and approaches internally is important for developing staff and institutions, and can lead to longer-term solutions and successes – including strengthening digital capacities. Institutionalising open source skills and knowledge can also have a powerful multiplier effect. Many digital and open source implementations are themselves founded on earlier development of open source components. This highlights how previous investments in skills and capacity can shape new solutions and approaches in the longer-term. Municipal governments can also leverage the expertise of a global community of governments that are also using the software, providing further opportunities for staff upskilling and development.

CASE STUDY: EYÜPSULTAN MUNICIPALITY, TÜRKIYE

The municipality of Eyüpsultan in Türkiye benefited from robust planning and training during its transition to open source software in 2015. Having selected the Debian GNU/Linux-based Pardus operating system, the Zimbra email server and the PostgreSQL database as target open source software, the municipality opted to plan ahead with comprehensive skills workshops for staff.[48] Pardus, developed by the Turkish government, gave the municipality independence from IT vendors, fulfilling one of the chief objectives for the municipality's transition.

This independence would only be secure, however, with excellent skills training. The first phase of training familiarised all staff with LibreOffice on Linux, since this would form the bulk of daily productivity software for most staff. After a year of settling into LibreOffice on existing devices, the municipality then installed the Linux operating system on all computers. There were repeated instances of training to make sure staff were acclimatised to each change, and welcomed all feedback when members of staff said they were struggling. After offering assistance widely, the municipality as a whole successfully transitioned.

There was a firm step-by-step process to migration, coupled with robust training at each step, maximising the chances of success. The early analysis steps included an assessment of staff anxieties, as well as the technical aspects of digital service provision. This helped the municipality offset the preponderant fear of the unknown that was felt before the training and transition began.[49] As a result, the municipality was well-positioned to build competencies in-house and achieved its stated aim of reducing its dependence on external IT vendors, with estimated savings of US$1m in 2022.[50]

Interoperability

Open source software, built on the foundations of open standards, has interoperability at its core.[51] By contrast, licensing may prevent closed-source solutions from being completely accessible to developers – constraining opportunities to build connections with other city digital platforms and services, and sometimes making it difficult to identify any risk of dependency. This latter issue can lead to 'vendor lock-in', where a lack of interoperability or opportunity to substitute a commercial solution for another commercial or open source product (due to dependencies relating to functionality, or the features or mechanics of a proprietary solution) keeps a city reliant on a commercial solution due to the difficulties in moving to a new product or service.

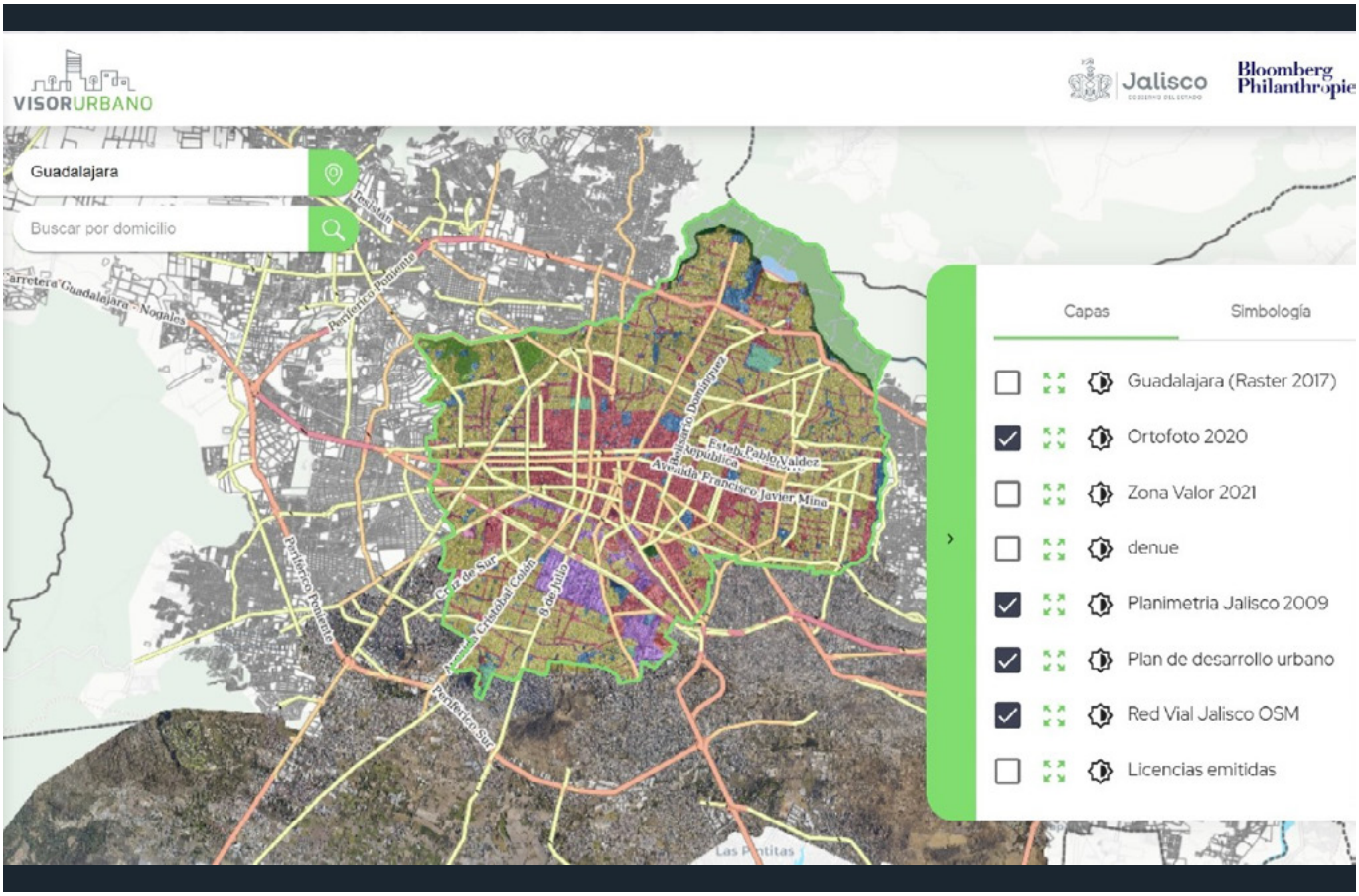
Since open source software can be developed and used by a wide range of people and organisations, there are several deployment choices to be made. There is also often greater scope for open source components to be substitutable, with new products and services developed by the community using the above common standards. For municipal governments, there are also options to tailor open source software offerings to their needs. However, interoperability ensures that different components and solutions 'talk' to one another – providing an opportunity for joined-up digital service delivery (and more effective digital government).

CASE STUDY: CAMDX, CAMBODIA

CamDX is an open source, decentralised, secure data exchange solution. It allows data to be exchanged between different information systems and data registries held by government and other actors.[52] The platform is an adaption of Estonia's X-Road open source data exchange layer, and it was customised to meet the needs of the Cambodian government.

Its core components leverage the codebase of X-Road, whilst the trust and security components were built from scratch for the Cambodian context.[53] The platform focuses on ensuring confidentiality, integrity, and interoperability in data exchange, and enables straightforward access to data in government databases. It is an important foundation to the broader and ongoing digital transformation efforts in the country.

By drawing on existing open source core components proven during Estonia's digital development, the CamDX team were able to benefit from robust data and digital foundations that were attuned to the needs and realities of the public sector. This meant that the team could proceed with confidence in the resilience of the essential components of the platform, and develop additional aspects to address other local priorities.



The open source Visor Urbano public online platform is improving city land-use management in the state of Jalisco, Mexico

Transparency and trust

Transitioning to open source approaches can confer a range of advantages on municipal governments in terms of fostering transparency and building trust. As residents place increasing expectations on cities, administrations need to be open and responsive to these needs. More broadly, open source can improve confidence in how funds are being used by government and the effectiveness of procuring and building the right solutions[54]. The collective use of open source software by several municipal departments can also incentivise further data sharing. This means that open source can prompt a reduction of silos, so that data is shared more productively and proactively, leading to greater transparency for government data.

In addition, the openness of open source is a particular asset for cities. The opportunity to view every nuance and attribute of a digital solution, and its codebase, supports cities in ensuring that the required (and sometimes, legally-mandated) functions, roles, responsibilities, and services that cities must adhere to are in fact reflected in the algorithms, code, and other components powering some or sometimes all of those services. In the context of Artificial Intelligence, cities can also use publicly available AI models as a basis for building products and services – another open source component that can increase their digital abilities and opportunities. However, although some algorithms may be open source, they cannot solve any underlying bias within datasets, processes, or organisational cultures, meaning that municipal leaders and staff must remain alert and proactive in dealing with biases.

CASE STUDY: VISOR URBANO PLATFORM, MEXICO

The Visor Urbano public online platform for city land-use management in the state of Jalisco, in Mexico maps businesses, land use plans, and payments and allows the digital processing of construction permits and business licences for residents interested in opening a shop or constructing a building.[55] The platform was first implemented in Guadalajara, and 34 additional cities in the country have since adopted it due to its positive impact and success in saving time and money for residents, and in ensuring a more principled approach to urban planning. It is now being explored by municipal governments overseas – including in Honduras.

By clearly displaying permits, licences and payments, transparency is increased and thus the risk of corruption is offset. The Visor Urbano platform also streamlined the licensing process to render it less bureaucratic and more accessible.[56] With a more straightforward process, accessible online and visible to any resident who chooses to log in, there was less opportunity for corruption. For municipal governments, dedication to training has been vital. Visor Urbano estimates that its team has driven more than 3,000km to deliver 450 hours of training to over 700 public servants, increasing the chances that the software is well-received by other municipal governments,[57] facilitated by a prize from the Bloomberg Foundation.[58]

According to senior staff overseeing the Visor Urbano platform, after its implementation, the city experienced 74% fewer bribery offers through the licensing process, and users enjoyed an average time reduction of 84% in processing licences. All licences are now issued through this online system.[59]

Efficiency and agility

A further benefit of open source software, and the wider open source approach, is that it is customisable to user needs. Municipal governments who adopted open source can often enjoy greater flexibility to select from vendors to provide relevant supplementary services, rather than staying with the owner of any proprietary software. This boosts agility and flexibility as the municipality's digital or service requirements shift over time. It can even save money. Sometimes commercial solutions can require cities to pay in order to access data. Increasingly, data access is an important driver of open source explorations by cities[60].

Open source development can also make shrewd use of cloud services. Cloud can offer value to municipal governments due to its scalability, accessibility, and cost efficiency. Additionally, cloud services can offer testing, collaboration and community building, as well as deployment to municipal governments looking to build robust and responsive smart urban innovations. Municipal governments can run through collaborative software development, testing, deployment, and storage of key data through cloud services, meaning that these can be expanded or contracted as the load changes.

CASE STUDY: OPEN DIGITAL COOPERATIVE, UNITED KINGDOM AND IRELAND

Open Digital Cooperative is an initiative that develops and maintains a version of the open source content-management system Drupal, customised for managing local council websites in the UK and Ireland. It was founded in 2019 as LocalGov Drupal, a partnership between the London Borough of Croydon and Brighton and Hove local councils. It was renamed in 2023 to Open Digital Cooperative, as a group of 30 councils.[61]

At its inception, LocalGov Drupal addressed the need for local councils to have a digital presence and offer municipal services online. It was estimated that the digital needs of councils across the UK and Ireland varied by less than 10%,[62] so it was considered sensible to pool resources and develop municipal digital infrastructure together. The councils shared code and best practices for how to enhance their websites and digitise their services. As a result, projects were delivered faster, and ongoing updates required less time and fewer resources. Additional councils joined this collective, and pooled resources under the 2018 Local Digital Declaration coordinated by the UK's central government. This Declaration outlined the ambition to prioritise user-centred design, software reuse, and transparency in the development of municipal digital infrastructure.[63]By signing up to this pledge, councils can then apply for funding at a national level, and share it to develop resources collectively.

The Cooperative estimates that this approach can reduce the cost of developing a new council website by up to 80%.[64] Local councils also ensure the resilience of their services by hosting them on the cloud. Cloud service providers are familiar with the LocalGov Drupal initiative, and offer service monitoring systems, disaster recovery, and high levels of security at steady rates.[65]

Since the local councils working on developing their sites together have a shared purpose, they organise ad hoc project-based working groups drawing on participating municipalities. These groups self-organise into product and technical committees, working to improve the shared resources in one- and two-week code development sprints. This maximises the value of code contributions.[66] There are further savings to be made in the open source approach, since the councils can draw on a shared list of accredited suppliers. They monitor shared codebases for pull requests and identify vendors that could be invited to participate. Pre-screening vendors in this manner means that individual councils make savings, freeing up resources for the councils to reinvest or repurpose.[67]

Ecosystem development

Open source is a valuable way to build skills and knowledge in government, and also in catalysing skills in the wider society and economy. By adopting open source software, municipal governments can stimulate the local supply of IT developers and services to provide maintenance and support – and hopefully increasing the possibility for more cost-effective and flexible technical support. Government investment in open source software can lead to cascading benefits, including stimulating economic growth and the emergence of SMEs associated with the opportunities of open source. It can also lead to improved competition and innovation in the economy, and greater technological independence on the part of agencies adopting open source.[68]

Cloud technologies can also play an important role here. Cloud services provide the 'soft infrastructure' necessary for open source software development, including resources, document sharing and other platforms for collaboration. Open data can also spur innovation[69] and catalyse a local ecosystem. When businesses can access this data, the private sector can be empowered to build services wherever gaps and opportunities exist in public sector coverage – thereby generating innovative products and services. Although open data at a city level is unlikely to generate digital 'Unicorns' – companies with a valuation of at least US$1bn – it can drive a local CivicTech and digital community tackling real and pressing local problems, including in collaboration with larger digital actors.

DIGITAL DEVELOPMENT FOR CIVIC GOOD

Open source tools and technologies are founded on community engagement – with digital solutions and components built by volunteers and others focusing on public good. Similarly, many cities are shaped by civic participation. From members of the community volunteering as first responders, to coaching young people's sports teams, and donating time and resources to support marginalised and vulnerable communities within the city. There is an exciting opportunity to recognise this alignment when considering open source and future cities.

Residents may consider local city digital services to be 'transactional': with a service provided by the city, to themselves – the customer. However, there is an opportunity for residents to play a role in building and shaping these services through open source. In the same way that members of the public contribute their expertise, time, and passion to community activities, technical talent can also play an important civic role. Recognising this, cities should be alert to the digital experience and expertise of their residents and identify ways to tap into and leverage these skills.

photo credit: UNDP Guinea-Bissau

Enabling engagement and feedback

Future Cities are at their best when they receive and leverage rapid feedback from residents and other stakeholders. Open source software and systems can often provide faster feedback loops, due to fewer challenges of interoperability – and sometimes provide this feedback at lower costs. Feedback can be gathered on the functions and dynamics of the city, including any civic issues such as accessibility, crime, and green spaces, as well as issues like transport reliability or public events. These kinds of inputs help city leaders calibrate their management of the city, in both the long- and short-term.

Community engagement mechanisms can operate at the heart of deliberations to optimise outcomes for residents and boost the utility of feedback for policymakers and municipal decision-makers. For instance, the open source platform Ushahidi has been used to tackle issues of urban harassment faced by women[70]. Such open source approaches can be extended into technological feedback loops, meaning that automated systems benefit from up-to-date relevant data. This can include areas such as waste management, traffic management, and water usage, among other municipal systems. However, it is essential that feedback mechanisms do not prioritise – or exclusively represent – online and digital populations. Mechanisms that surface and empower marginalised, vulnerable, and under-heard voices – many of whom are often digitally excluded – are crucial in ensuring that cities develop policies, services, and innovations that meet the needs of all residents.

CASE STUDY: DIGIT URBAN STACK, INDIA

The Digital Infrastructure for Governance, Impact and Transformation (DIGIT) Urban Stack is a set of Open APIs, services, and reference implementations, set up as a public good by the eGovernment Foundation in Bengaluru.[71] It allows government entities, businesses, start-ups, and civil society to use a unique digital infrastructure and build solutions for urban India at a large scale. It provides a set of open standards, specifications and documentation to enable ecosystem players to innovate on the stack. This goes some way towards lowering costs for small organisations seeking a digital presence, whilst also allowing larger organisations to tailor the services to their needs.[72]

As a Digital Public Good, the platform can be deployed by other cities across India – and around the world. The eGovernment Foundation acknowledges that 'technology is only one piece of the puzzle'[73] and situates its role in the ecosystem as one of facilitating and amplifying the efforts of cities and citizens. Additionally, it places emphasis on transparency, and publishes annual roadmaps to add new capabilities requested by users, whilst retaining data privacy and security.[74] As a result, user requests are addressed, and participation in the open source software is more informed and comprehensive. eGov Foundation are keen to emphasise the collaborative nature of solutions via the DIGIT Urban Stack:

> We place great emphasis on collaboration and co-creation because urban governance is an inherently complex problem. We think of the ecosystem in terms of three sectors: samaaj (society), sarkaar (government), and bazaar (market or industry). The ecosystem first approach is what differentiates eGov from organisations that seek to identify "what works" and then scale that solution. We aim to create networks of trust and partnership that enhance local capacity to solve – so that the diverse challenges of urban India can be met by a wide range of local solutions, each effective in its own context.[75]

DIGIT Urban Stack has enjoyed success in India. It has been adopted by over 1,000 cities, and thus had an impact in terms of the accessibility of public services for 180m people, many of whom have accessed streamlined municipal services directly.[76] A 2022 impact assessment found that where documentation of issues previously took 4 days, with DIGIT-enhanced services, it took 1.35 days.[77] DIGIT's aggregation of data also offers further opportunities for start-ups, who can use the data to generate value-added services beyond those currently offered by the municipal government.[78]

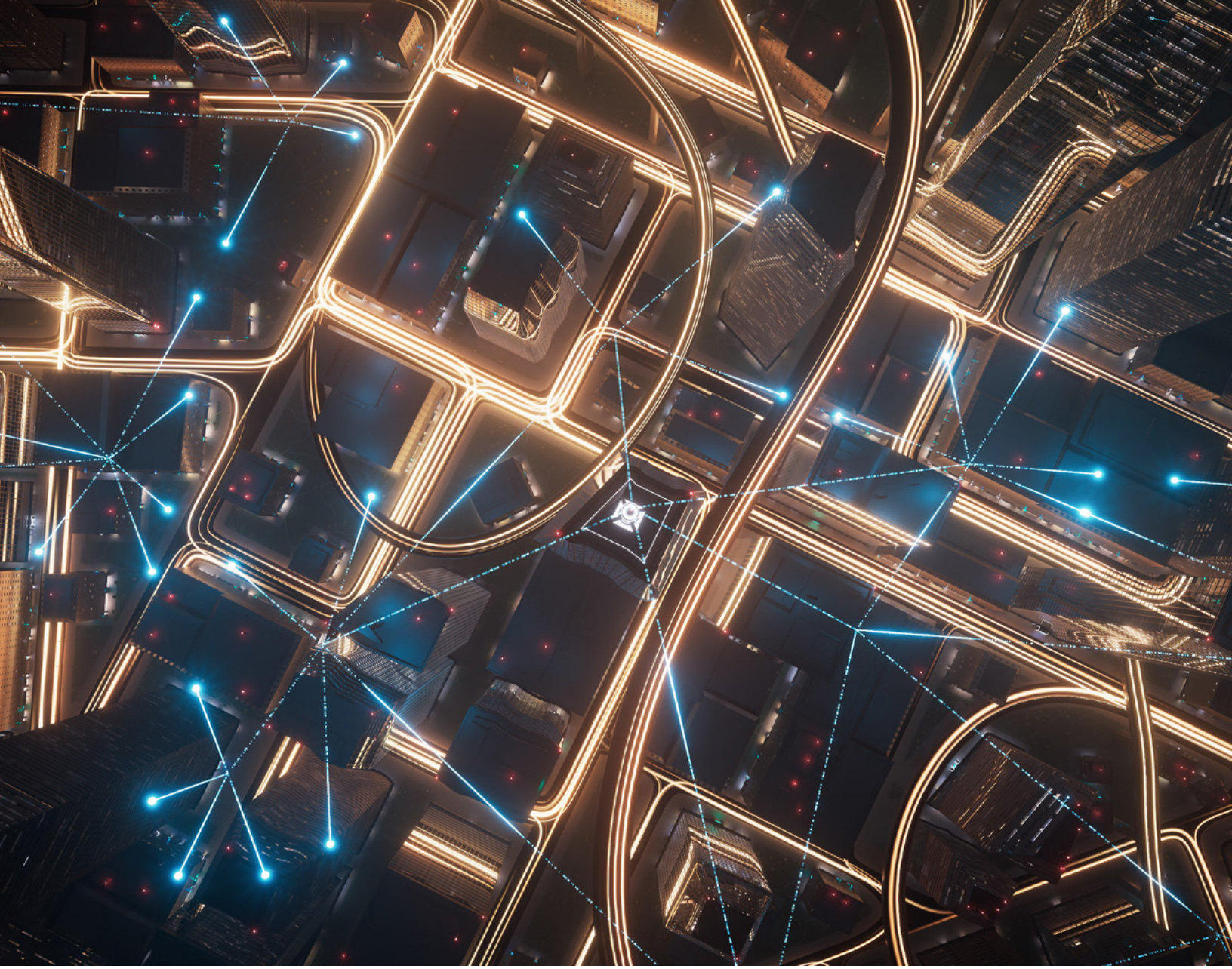
Section Four: PUTTING IT INTO PRACTICE

A transition to an open source approach is an opportunity that can be achieved through visionary leadership, responsive processes, strategic clarity, and a whole-of-society effort. There may be obstacles and detours, which should be carefully considered in advance of the transition, but a strong and positive direction of travel is possible – and has been walked by a number of cities. Many challenges can be offset or mitigated by priming municipal governments to establish readiness and flexibility amongst teams, and putting procedures in place that facilitate, rather than hamper, the progress of embracing open source for smart urban innovations. Often, the technology is the comparatively easy aspect of change. The harder aspects are changing behaviours, mindsets, and cultures of organisations.

SHAPE AN INITIAL DIRECTION OF OPEN SOURCE

Establish leadership to provide a strong foundation for open source

Strong leadership is crucial in driving digital transformation, and new ways of thinking and working. In the context of open source, there may be a fear of the unknown among municipal teams, in which some risk averse decision-makers may prefer closed-source solutions by default. Particularly ones which are backed by larger corporations. Senior decision-makers understandably want to ensure longer-term support for solutions, which can be included in subscription packages when procuring proprietary solutions. Consequently, they are not simply buying a solution – but buying confidence and the perception of outsourcing risk to a commercial



supplier. Bold leadership can help offset this and help gain momentum on the path towards an open source approach. This leadership also extends to bringing in new and diverse voices into the decision-making process, giving further legitimacy to decisions. Excitingly, open source can also strengthen leadership by enabling municipal government leaders to learn from the successes – and challenges – of other cities, through adopting and adapting digital solutions that have worked elsewhere. This can also lead to shaping a community of open source local government leaders, providing mutual support and candid guidance for their respective local digital transformation journeys.

Raise awareness of open source to start building momentum

Within organisations that have become accustomed to using proprietary software, an adjustment to open source will require concerted effort from senior, mid- and junior level members of staff, as well as other stakeholders. By readying members of staff in advance, and the broader open source community, efforts will become more directed, precise and purposeful, and so drive the organisation further in its movement towards an open source approach. Raising awareness of the distinctions between proprietary and open source solutions, and the long-term benefits that can accrue to users of open source, and members of open source communities, can supplement the

processes and procedures that govern adoption. In particular, it is important to combat any perceptions that open source lacks the support of proprietary software, and highlight the customisability and accessibility of the underlying code. This can further ingrain the use of open source technologies within a municipal government. Practical strategies for raising awareness – including campaigns, workshops, and training sessions – can all be important.

Establish strategic clarity to enable broader digital transformation

Offering strategic clarity for a transition to open source can help mitigate risks and prime municipal teams to face any challenges associated with the new processes and procedures for open source. This entails creating alignment and purpose on key issues, avoiding ambiguity in communications and purpose, focusing on clear and achievable outcomes, and bringing in key stakeholders (from within and outside of the organisation) early in order to create a shared understanding and direction. There should also be a willingness to adapt quickly to changing circumstances, and communicate effectively through existing or new channels to embed strategic clarity as thoroughly as possible. Everyone in the organisation should know the direction of travel, how the collective will reach its destination, and how they will know they have reached the destination. Whilst leaders, and their teams, need to be supported and empowered to deliver the longer-term – multi-year – change management required, and not focused solely on delivering in a context of short sprints without a longer-term vision.

Identify quick(er) wins to encourage direction and commitment

It is also vital that the optimum open source software is selected for migration. Whilst there is no vendor lock-in associated with open source software, it is important that staff feel the benefits of transitioning to a more suitable software, rather than feeling like they are compromising in terms of utility or quality in order to move to a lower-cost solution. A process of identifying organisational needs and desires, coupled with an appropriate timeline for milestones in advance of the transition process, can ensure that staff feel the benefits of open source software early. It can also be useful for leadership figures to decide on the optimum time for the transition to take place, with consideration given to existing subscriptions, anticipated events and targets for the municipal government, the number of staff who need to familiarise themselves with the new software, and the maturity of selected software. With strategic clarity in terms of timelines and targets, there will be greater confidence in the success of the transition.

Promote open source by default in order to change behaviour

Open source should be framed as a key way to achieve municipal priorities – and to deliver for city residents. This approach helps to allay concerns that proprietary software carries fewer risks, and eventually shape new perceptions about the value and utility of open source. For instance, in 2006, the government of South Africa adopted the Policy on Free and Open source Software Use for South African Government, which stated that the South African government will implement Free and Open source Software (FOSS) unless proprietary software is demonstrated to be significantly superior.[79] Any departure from this policy would need to be justified by the agency opting for proprietary software, showing how the choice better suits the agency's needs.[80] With the example set at the national level, municipal authorities followed suit in their embrace of open source. In a similar vein, the US's 2016 Federal Source Code Policy requires agencies to "release at least 20 percent of new custom-developed code to the public as OSS [open source software]."[81] This signalled to agencies that they should open their source code for mutual development between federal agencies, leveraging several of the benefits of open source, on a pathway towards a more in-depth open source approach.

CASE STUDY: CAPE TOWN'S CKAN DATA PORTAL, SOUTH AFRICA

CKAN (Comprehensive Knowledge Archive Network) has been adopted by the City of Cape Town, in South Africa, in order to help share data between government departments and non-government entities. CKAN is an open source data management system that is used to manage over 2,000 data hubs and portals around the world.[82] It is used by over 30 major government organisations, and hosts over 15 million datasets.[83] Stewarded by the Open Knowledge Foundation, its code is hosted on the developer platform, GitHub, and is accessed and updated by a global community of developers.[84] By customising CKAN for its own purposes, the City of Cape Town was leveraging the network effects from this sizeable and diverse community, with various levels of expertise and investment in the software.

Investments in data capabilities were safeguarded by the early development of a data strategy in 2018, and the earlier establishment of a Data Science Unit in 2016 to facilitate data sharing and the use of analytical tools. This was part of a deliberate and holistic development process on the part of the City government.[85] By charting a pathway to transitioning to open source software, centralising expertise and rendering it accessible across the whole organisation, the groundwork was laid for the use of open source software, and by extension, more informed decision-making.

The main aim of facilitating data sharing between public sector agencies and private sector entities has been achieved. The City has tackled the 'data siloing' issues that were identified prior to adopting the open source approach. This data sharing is carried out both by people using via the web user interface, and programmatically, through data pipelines updating datasets via the API. This has boosted collaboration across departments within the City government, and also with outside parties such as service providers and provincial government colleagues. The City has adopted CKAN through plugins, and has taken advantage of cloud-based services. Several extensions have been provided by cloud service providers to render the storing of data via CKAN more straightforward, since they are cognisant of the large CKAN user base.[86]

MANAGE CULTURAL CHANGE

Focus on behaviours, culture, and processes – not technology

A transition to open source requires more than simply a switch in software on staff devices. Rather, it requires cultural change. Often, new challenges are not about software but about resistance to change, whether this is structural or individual. This includes the pressures or concerns of new ways of working, reaffirming the above importance of clear processes and communication. Raising awareness and providing capacity building to use open source software within municipal government teams is important. Teams need to be prepared for the transition by understanding what it will entail and how the organisation itself functions already. Centralised and shared message boards can be useful to streamline communications on common issues and plans for the future, including 'what to expect' information pages. There must also be a route for feedback to be shared with relevant technical teams, and with leadership groups that can help reshape workflows as changes alter dynamics within an organisation.

Abbreviated versions may also be effective if the transition is urgent. For instance, the mayor of the rural Portuguese municipality of Vieira do Minho issued directives requiring the local government to provide citizens with the best possible experience in the shortest time, whilst achieving cost savings, reliability, safety, and independence from IT vendors, as far as possible.[87] With these objectives in mind, the municipality capitalised on software and services provided by the local university in a nearby town, and helped shift services to open source. With this

success story established, the municipality gradually transitioned all of its software from proprietary to open source between 2000 and 2017. It continues to introduce new open source innovations to boost transparency and increase liveability.[88] So long as the chosen strategy suits the situation and the organisation involved, it can be leveraged to make change management a more straightforward process.

Leverage procurement as a catalyst and vehicle for change

Procurement can be a powerful entry point to broader digital transformation,[89] recognising the importance of procuring the right products and services – but also the value of open data and other components in improving the transparency and effectiveness of procurement efforts. Recognising this, procurement teams can lead open source implementation through improving the likelihood of open source vendors submitting for municipal tenders. This could even extend to prioritising open source solutions when procuring for relevant assets – or setting clear guidelines for commissioning open source (as undertaken in the UK[90]). This may require some change, as many municipal procurement processes are difficult to navigate for the smaller entities that are found in the open source community. Procurement processes need to be recalibrated to recognise a broader range of solutions and suppliers, including engaging with these smaller or developer-led entities from the open source community. Similarly, they may also need to engage with the different mechanism of open source development – including product iteration, and funding code development.

Outline clear responsibilities to maintain direction

Key to the transition to open source is establishing a strategy, and ideally a framework or roadmap, to make sure that teams are oriented towards achieving realistic and desirable goals, with methods to achieve these goals. This also extends to ensuring there is clear support internally. In some cases, the authority with greatest responsibilities to manage the change need not be a new entity. If it has experience from previous waves of digital transformation or cultural changes, this can be leveraged to facilitate change again. For instance, the City of Cape Town's Data Science Unit, established in 2016, was initially tasked with developing data pipelines to render data into more usable forms. When the Data Strategy was established in 2018, the Unit switched its focus to the technical and architectural components of the strategy.[91] As a result, it became the knowledge hub for staff across the municipal government, and was sought for its expertise internally. Developing clear responsibilities, alongside the wealth of experience accumulated, meant the Unit was well-positioned to facilitate the transition.

Build maintenance and other processes to sustain open source

Maintenance is a key issue to address before committing to open source software. Transitioning to open source means that there is access to an online community that sustains the software, and which offers regular updates – but this only applies so long as the selected software is currently used by a wide user base, and has a pool of developers attached to it (whether these are privately commissioned or in-house at a peer organisation using the software). There is more intense scrutiny on software that is in wider use, and consequently, there tends to be more responsive troubleshooting. An organisation embracing open source should be careful to avoid adopting software that is not in use by many others, or which is not attended to by committed developers. Such software, known as abandonware, risks jeopardising municipal government services through unaddressed vulnerabilities. Regular maintenance can be commissioned by external parties or by in-house teams, but there must be plans in place for how this maintenance will be sought, carried out and assessed or stress-tested – including in a context of unforeseen stresses and shocks.

CASE STUDY: CITY OF SAULT STE. MARIE, CANADA

Confronted with increasing costs for software licensing, and facing a limited budget, the City of Sault Ste. Marie opted to pivot to using open source solutions. Since 2017, these have been developed in-house, with source code being released to the public via GitHub.[92]

The Canadian national-level Directive on Management of Information Technology of 2009 (updated in 2018) recommends that public sector departments contribute source code modifications made to open source software back to the community,[93] and the City of Sault Ste. Marie has been no exception. With its modifications and new innovations uploaded to GitHub,[94] the municipal government benefits from the input of a global developer community that is free to contribute to the development of functions or components identified as priorities by the City (through 'pull requests'). It also leads to the prospect of ad hoc collaboration with programmers in other municipal governments around the world, without each municipality needing to 'reinvent the wheel'.

In June 2023, the City reached the milestone of creating 100 open source repositories on GitHub, testifying to their openness with source code and collaborative spirit.[95] The City continues to roll out software to support municipal functions,[96] boosting the liveability of the city though widening access to government services, and by prioritising the needs of the city through in-house developments.

EXPLORING DEEPER TRANSFORMATION

Explore how open source can drive more outward-looking working

Teams adopting open source approaches can embed a team that proactively designs and shares open source software to maximise the value of the approach, whilst a number of cities and other organisations are exploring formal setups such as Open source Program Offices[97]. Without being tied by licence to a particular vendor or proprietary software model, organisations are able to pursue software updates and changes at their convenience and on their own terms. Development can be staggered across longer timelines or pushed through with greater urgency as befits the situation. If it is released publicly, as is done by public sector agencies around the world, including the UK's Government Digital Service,[98] then in-house teams can benefit from a wealth of input and feedback from a potentially global user base. Nurturing a global community around the software is a productive way to gather more data on its use, and potentially repurpose the software to new uses. Others can adapt and modify the software for their own purposes, and share learnings about the code as they do so.

Often, one of the stated aims of transitioning to an open source approach is to achieve independence from IT vendors. It should be noted that a transition to open source does not guarantee such independence, and in any case external expertise may also be desirable in some circumstances (particularly for highly-specialised areas or priorities). However, well-resourced cities can consider establishing their own in-house open source development teams in order to capitalise on this independence from proprietary software support teams. This has been done by the City and County of San Francisco, who

developed code suited to their needs and the needs of their users in-house.[99] Such a structure allows for greater customisation and responsiveness in terms of updating the code when required. They may still draw on the wisdom of the wider developer community, and paid expertise if needed, but they can attune their learnings to their own context, purpose, and user base.

Build in-house open source development and delivery skills

Investment into skills and competencies for in-house development can help a municipality fully embrace the benefits of open source. Retaining the technical consultncy,advice, and input of external developers should be continued, and indeed the inception of an ecosystem around the public sector's embrace of open source is a net benefit for society, since it promotes economic growth and dynamism. However, shaping a team of developers in-house means that the public sector is no longer competing for the same limited pool of experts on a project-by-project basis. Municipal governments can also face difficulties resourcing for such ad hoc work when dealing with vendors. With this expertise in-house, the availability of expertise is greatly increased, with developers now able to dedicate their time, efforts and creativity to maximising the public good through government services.

Most importantly, when hiring in house technical teams - they should be allowed to operate using an open source and software development culture that is agile and user centric. Requiring adherence to committee-driven or otherwise bureaucratic culture can lead to an exodus of talent, and undermine broader digital transformation efforts. Merely choosing open source licenses without creating space for the behaviours that make it successful can lead to projects, and deeper change, failing.

Municipal governments can also consider upskilling their staff as needs arise. Workshops are at their most effective when they are regular occurrences, and 'top up' staff skillsets rather than requiring them to learn things afresh each time. Training and upskilling is also more sustainable after an initial outlay, since everyone in an organisation needs to be brought up to a baseline level of understanding, awareness and competence on the issues, whilst more specialised members of staff would benefit from further training as needed.

Focus on institutionalising transparency and security

Whilst greater transparency and security may be seen as by-products of an embrace of open source, they cannot be taken for granted, and require continual reinvestment. This means that there must be dedicated funding and planning for transparency functions, as well as robust security infrastructure. Transparency can be achieved through the careful automation of publishing of low-risk datasets or code, but there may need to be greater human input and more insight into which components can be released, and which are more sensitive. However, municipalities should aim to contribute to the open source community wherever possible[100].

Open source software may be seen as more secure because it is code that is often widely available and interrogated by more developers due to its open nature. It is not impervious, however, and there have been instances of open source software users discovering vulnerabilities, such as the Log4j vulnerability in 2021.[101] These issues can be mitigated by having the necessary tools to address vulnerabilities quickly. For instance, municipalities using cloud services would benefit from auto patching via managed infrastructure and software in the cloud, as well as proactive detection and protection, to minimise the radius of any vulnerability. Cloud services can support faster responses to newly discovered vulnerabilities. Broader governance, due diligence, and policies can also play a valuable role in building security and safety into local digital development.

photo credit: UNDP Guatemala

CONCLUSION

Open source has considerable benefits for municipal governments. From improving the effectiveness of public service delivery, and the efficiency of decision-making, to shaping and supporting local digital ecosystems of developers, innovators, and civic tech champions. Beyond technology, open source ways of thinking and working can also support municipal governments to be more agile and responsive to the needs of their residents – and lead to broader outcomes. In particular, supporting cities in becoming more liveable, sustainable, resilient, inclusive, and connected spaces.

Cities are already exploring open source. From Cape Town leveraging an open source solution to accelerate its open data work, to the DIGIT Urban Stack of open source components being used by more than 1,000 cities across India, and the success of the Eyüpsultan municipality in Türkiye in broadening beyond traditional digital and technology vendors. These initiatives are saving cities time and money, improving the resident experience, and encouraging collaboration within municipal government – and with and across the broader ecosystem.
However, open source is not a panacea. It is one tool within the municipal government toolkit. And it cannot fix issues caused by gaps in governance, a lack of engagement or co-design with residents, or broader systemic challenges faced by cities. Similarly, municipal governments should avoid a dichotomy of open source being synonymous with 'good' – and closed-source, or proprietary solutions being seen as the 'wrong' approach. Both open and commercial solutions have important value for municipal governments – as highlighted in UNDP's Digital Standards[102].

Related to this, exploring open source will require a transition for many municipal governments. It requires new ways of working, designing, procuring, and delivering. None of these changes are insurmountable, but city leaders should ensure that they are committed to the longer-term change required in leveraging open source digital solutions and implementing open source principles and processes. This transition is a worthwhile one, but will require bravery in maintaining direction – even in the face of shorter-term challenges. With this in mind,

Open source Implementation Checklist

1

Ground open source in the Future City pathway.
Identify areas where open source solutions and thinking can support key aspects of inclusivity, sustainability, resilience, liveability, and connectivity. Consider measuring a 'baseline' of current digital spend, or key digitally-enabled outcomes (such as transparency, citizen engagement, or agility).

2

Unpack open source and its relevance.
Engage with the characteristics of open source software, open data, and open source thinking – including opportunities (both technical – such as improved interoperability, and broader outcomes), costs and potential challenges (including the 'health' of any open source community of relevance), and potential collaborations.

3

Develop (or refine) digital and service standards.
Standards are an essential tool in embedding and institutionalising digital ways of working – from service design to delivery. Municipal governments should have clear and effective digital standards, which can be augmented by open source approaches.

4

Map internal digital skills and knowledge.
Open source can enable municipal governments to draw on, and institutionalise, digital skills and expertise. Map existing abilities, and gaps – and consider open source exploration as an opportunity to tackle digital skills priorities.

5

Identify key urban outcomes for open source implementation.
Open source solutions and approaches can improve transparency, resident trust and engagement, the efficiency and agility of the municipal government, and the shaping of a local digital ecosystem. The municipal government should be alert to these broader outcomes, particularly when seeking support for open source exploration and implementation.

6

Shape an initial direction of open source.
City leaders should identify opportunities to drive a direction toward open source. From identifying 'quicker-wins' and prospects to demonstrate the value of open source, to raising awareness of the importance of open source and the need to position it as a 'default' approach to procurement, design, and delivery.

7

Support culture change.
Open source is as much about culture and process as it is about technical tools and concepts. City leaders will need to shape skills, workflows, and teams to maximise the benefits of open source – from changing procurement processes to encourage local vendors, to ensuring the safety and security of open source solutions (including code audits), and shaping technical support approaches.

8

Consider deeper digital transformation.
Open source can provide municipal governments with new and unexpected opportunities. From improving the vibrancy of the local digital ecosystem, to building and institutionalising digital skills and knowledge. These are broader strategic considerations that should be explored by city leaders.

9

Understand when (and when not) to use open source.
As highlighted above, open source is not a panacea – and commercial solutions still have important value. Whilst some open source solutions are also managed and maintained by commercial vendors. Municipal governments should shape a process to identify when – and when not – to use an open source solution. This could be driven by funding or skill constraints, or the importance of avoiding vendor 'lock-in'. City leaders should consider the value of an 'open source by default' approach.

10

Engage with your local CivicTech community.
Cities are founded on civic engagement: from volunteers supporting marginalised and vulnerable urban communities, to parents managing local sports teams. Municipal governments should extend these civic virtues into the digital space: tapping-into the often-extensive range of digital talent within the city – and leveraging this to support the exploration and implementation of open source.

city leaders should consider this 10-point checklist – set out earlier in the 'Quick Reference' section of this report - as a guide to open source implementation: Nearly 70% of the world's population will be living in cities by 2050. And, there is no evidence yet that this urbanisation trend is reversing following the COVID-19 pandemic. Cities remain a platform of potential opportunity, prosperity, and wellbeing for residents. They are often the closest administrative actor to individuals and businesses, and a key part of sustainable development. They generate 80% of global GDP, but also consume two-thirds of the world's energy.

In this context, cities remain a key actor in the context of the Sustainable Development Goals – and in supporting and enabling lives and livelihoods. Cities are the drivers of development: from circular economies, to makerspaces; and the role of cities in providing and increasing the above opportunities. With these important functions in mind, it is essential that municipal governments have access to the broadest possible toolkit to achieve the potential of the urban space. Open source can play a key role, through improving the efficiency and effectiveness of cities – and shaping new ways of working, thinking, and delivering.

Importantly, all cities are on a shared journey. Designing their urban spaces to be liveable – and pleasant, and enjoyable. Identifying solutions and approaches to increase their resilience, and sustainability. Increasing the reliability and extent of their connectivity. And ensuring that they leave no one behind. In this context, there is an exciting opportunity for cities to learn from each other on this journey. And this includes re-using, adopting, and adapting digital solutions that have worked elsewhere. This is a unique aspect of open source: it extends the urban development toolkit to encompass global best practice. And leveraging this learning and experience can position cities for the future.

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