



Infrastructure & Cities
for Economic Development

Urbanisation in a Digital World

Opportunities and actions for governments, donors and the private sector

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Executive Summary

The digital revolution provides significant opportunities for developing countries to diversify their economies, improve sector productivity, build their human capital and enhance governance and public services. This is particularly true for cities where much of this innovation will occur. However, whilst the digital and concurrent ‘fourth industrial revolution’ have the potential to improve the lives of the urban poor, this is by no means guaranteed. There is therefore a key role for donors and governments who are able to influence and support the adoption of digital technologies in urban contexts, with the explicit aim of improving inclusion. This paper is therefore intended to inform donors and governments currently considering programming or interventions, so that the digital revolution can be harnessed as a transformational opportunity for developing country cities.

The paper begins by examining the technology-influenced risks and opportunities that are emerging for developing country cities. It then sets out the role that digital solutions have in a) growing inclusive urban economies, b) improving urban infrastructure services and c) improving urban governance. The paper provides a wide range of case studies from developing country contexts, making the case that mindful integration of digital solutions is vital to delivering efficient inclusive urban solutions that enable inclusive economic growth. Finally, the paper presents high level recommendations for governments, donors and investors whose leadership is required if the digital, and associated fourth industrial revolution, is to translate into prosperity for all.

Cities currently generate more than 80% of global GDP, with 100m people expected to move to cities by 2025 in Africa alone. However, whilst diversified urban economies have delivered increased productivity and pulled people out of poverty, the rapid urban growth seen in many non-diversified cities in emerging economies is not yielding such outcomes. In towns in non-diversified economies, 84% of jobs are vulnerable, versus 55% in large cities in the handful of economies that have managed to diversify. The majority of the urban workforce is in the informal sector (61%), contributing up to 80% of GDP in some countries. Women are particularly disadvantaged by the lack of formal employment opportunities, with informal jobs making up 92% of opportunities outside of agriculture. A key driver of low productivity in cities is under-development of government policy and services, and consequent under-investment in infrastructure needed to support businesses and households. This results in poor productivity, with annual labour productivity growth being low at 2-3%, however new technologies and technology-enabled business models may offer opportunities to improve productivity.

The Fourth Industrial Revolution (4IR) is a global phenomenon rapidly changing how economies and societies function. New technologies ranging from nano-technology to advanced digital technologies are rapidly changing how products and services are delivered, and how our global economy functions. This is creating threats to and opportunities for inclusive growth, which have been well documented in the World Bank’s Development Report 2016: Digital Dividends paper. In Ethiopia, Thailand, India and Nigeria, 65-85%¹ of jobs are estimated to be prone to automation, and job losses will also be experienced unequally by men and women. Men are projected to gain one job for every three lost to technology advances, whilst women will gain only one for every five lost². In addition, the 4.2bn people currently without internet access are being excluded from many of the potential benefits of this revolution³. However, whilst clear threats exist, new digitally-enabled business models are taking hold in developing regions, with countries successfully leapfrogging the inefficient technologies and business models entrenched in the developed world. On-demand services such as Rwanda’s SafeMoto service, Digital Matatus in Kenya, and Uber and EasyTaxi are providing cheaper, safer, more accessible urban transport. India has a successful cohort of businesses innovating solid waste services for households and businesses. City governments across the world from Dar es Salaam to Bishkek and Jakarta are connecting with their citizens through apps and social media, providing more responsive, transparent and inclusive services.

¹ IDS Digital Development Summit Background Paper

² Amerasinghe 2016

³ World Bank: World Development Report 2016: Digital Dividends

As global centres of growth and production, cities will be at the forefront of harnessing the digital opportunity. Adoption of digital solutions to support urban development has been promoted by the ‘Smart Cities’ movement for the last decade, initially focusing on the use of digital solutions to improve infrastructure services. More recently, the term has come to encompass a whole range of approaches, from the broad use of digital solutions to improve the lives of citizens and urban economies, to the notion of a ‘Smart’ city as one which adopts strategic integrated planning principles. However, whilst this paper takes many cues from solutions and approaches developed by Smart City proponents, consultation revealed that for many the term is overly broad and too often associated with a ubiquitous championing of technologies to effectively aid this discussion paper. Instead, this paper sets out the broad risks and opportunities for digital and frontier technologies to support more inclusive urban development.

Whilst the adoption of digitally enabled solutions in cities could result in more inclusive growth, this is by no means assured. Section 1 of this paper therefore explores the risks and trade offs that digital solutions pose, exploring the broad economic shifts that ‘digital’ and the ‘fourth industrial revolution’ may support. It examines how issues such as automation, skills and training, labour policy, cyber security, and traditional gender divides may narrow or widen the existing digital divide, and highlights the key issues that donors and governments should consider when designing interventions.

To close section 1, the authors set out a high level theory of change for how the mindful integration of digital solutions in urban settings could theoretically result in improved urban market productivity, services, economic empowerment and inclusion. Noting that if developing countries do not embrace the digital opportunities with the explicit aim of promoting inclusion, jobs are likely to be lost to automation; a lack of skills may hamper development of new economic sectors; and infrastructure services will continue to fail to meet the needs of businesses and citizens.

There are significant sectoral opportunities for governments, and investors. Section 2 identifies the need for governments to help build for digital economies. In particular, governments can support development of new digital sectors, develop digital services for the informal sector, and promote digital skills needed for all, including the poorest. Section 3 sets out the opportunities to use data and digital solutions to enable better energy, transport, water and sanitation access in cities, noting the importance of using data to understand the service delivery needs of the most disadvantaged, and to enable financial sustainability of service models. Section 4 examines how city governments can use digital solutions to help them engage citizens, manage budgets and revenues, and control services and investments. The chapter focuses on the importance of increasing transparency and accountability, and enabling more effective investment in much-needed urban services. It also explores opportunities for cities to lead by example by building their own digital capacity, using data to enable decision making and adopting the digital development principles that promote inclusion and openness.

Actions for stakeholders: Section 5 identifies key actions for governments and donors and argues that governments and donors alike should not see the digital transition as a luxury, but as a necessity if cities and nations wish to maintain competitiveness, avoid productivity decline and secure the inclusive growth and poverty reduction outcomes they hope for.

Section 1: Digital Disruption and the Fourth Industrial Revolution

The velocity of global economic change is dramatically increasing, driven by innovation and technological change, from nanotechnology to advanced digital technologies⁴. Advanced 'digital' solutions include ubiquitous connectivity and the Internet of Things, standalone digital products and services, and the use of big data and artificial intelligence in delivery of non-digital products or services. This change has been called the Fourth Industrial Revolution and is characterised by new ways of creating value for businesses and societies, creating new opportunities for lower income economies to prosper. Characterised by innovations such as mobile payments systems like M-PESA which have millions of people without bank accounts or electricity to transact and participate in local economies⁵.

The impact of the revolution, however, has been felt unevenly across developed and developing countries. Developing economies are more vulnerable to the job losses, and negative growth potential associated with the transition. Whilst also being less equipped with the digital connectivity, skills and markets that would enable them to benefit from digital disruption, and its inclusive growth and poverty reduction potential. There is therefore a growing urgency to devise policy and programme interventions to ensure that such benefits are identified, supported, and scaled, with the aim of explicitly enabling those who live under the poverty line of \$1.80/day to escape the poverty trap, and poorer urbanites to benefit from new economic opportunities that would enable them to take a step up into the emerging middle class. This holistic approach would then ensure that the Fourth Industrial Revolution brings with it the Digital Dividend articulated in the World Bank's 2016 Development report - creating what may be a hugely significant turning point in global development.

This chapter therefore addresses four key questions that governments and donors must ask as they develop policies and programmes, if they wish to ensure digital technologies support inclusive development:

1. How impacts may the fourth industrial revolution have on developing economies?
2. What are the key risks and opportunities associated with digital solutions?
3. Why are digital solutions particularly important for inclusive urban economic development?
4. What is the theory of change for how digital solutions deliver inclusive growth?

1. The Fourth Industrial Revolution



So, what is the fourth industrial revolution? What role will digital play in this revolution? And how might the revolution restructure our economies?

New technologies are restructuring the foundations of markets: What the frontier technologies from nanotechnology, and biotechnology to artificial intelligence will enable is not yet certain, but according to tech analyst Gartner's latest predictions, we are increasingly blurring the line between digital and physical worlds, with major near term implications for who we glean our information from and how we work, produce and consume.⁶

Foundational elements of markets are being shifted by exponentially growing industries such as sensors, artificial intelligence, data processing and computing. These exponential growth curves confound traditional models

⁴ Jeremy Rifkin's 'Zero Marginal Cost Society' and 'Third Industrial Revolution'

⁵ <https://www.kachwanya.com/2017/11/03/half-year-results-m-pesa-data-continue-beat-traditional-telco-growth/>

⁶ Gartner's Top Strategic Predictions for 2017 and Beyond: Surviving the Storm Winds of Digital Disruption, Dec 2016

of technology adoption, not only in the digital space but also in 3D printing and synthetic biology. Solar technologies also are showing rapid growth, dramatically outpacing the International Energy Agency's linearly modelled predictions.

A major shift is underway which may result in economic growth being driven less by natural resources and more by data and information made possible by these new frontier technologies. The World Economic Forum's research on global employment highlights the major shift underway, showing that jobs in Mathematics and Computing, Architecture and Engineering are growing roughly 3% annually to 2020, while administrative (-5%) or manufacturing (-1.6%) prospects are declining.

Digital technologies now enable us not only to connect people through voice calls, text messages, and online information, but to animate and control the world around us using data from almost all aspects of our lives. Internet of Things (IoT) is expected to grow 23% annually to 2020⁷, and machine-to-machine (M2M) connections are expected to be nearly half of total connected devices by 2020⁸. These capabilities can be applied to optimise energy consumption in buildings, notify service operators of critical infrastructure faults⁹, and create new businesses such as on-demand transit or new mobile payment systems for energy.

New technologies are creating new market interactions: The next logical step in the fourth industrial revolution is a new transaction capability to take humans out of everyday market exchanges. Experts point to blockchain as this new marketplace enabler, and the rapid innovation of 'blockchain' ledgers¹⁰ is demonstrating that a future of distributed transactions verified by machines rather than institutions, is possible today. However, this potential for IoT or M2M interactions to transform markets should not overshadow other concurrent trends. The digital age also enables exponential growth in businesses rooted in human or human-to-machine interactions, through tools that enable faster access to innovation, untapped value, customers and finance, such as crowdsourcing, online marketplaces or crowdfunding. Digital can tap into 'excess capacity' such as the empty seat of a vehicle, as early ride sharing solutions such as Zipcar discovered, with this success mirrored by Airbnb. Or can leverage 'cognitive surplus'¹¹ via open source media creation platforms such as Wikipedia where people spend their time -- unpaid -- to create a service, because they gain reputational or other intrinsic value.

The 'new' networked economy models based on peer-to-peer transactions generating value beyond pure economic gain could also be of significant value in developing contexts. Such models mirror commons-based informal economic structures, where a broader notion of value can unlock new market interactions and business models. Digital platforms that allow people to share physical assets and human capital quickly, efficiently and transparently, could also unlock under-utilised resources adding significant value in the asset-constrained contexts of growing cities. (See pullout box)

New technologies are creating new business models: The work of Clay Christensen on 'disruptive' technologies defines more specifically the impact that some new digital business models are having in developed and emerging markets. 'Disruptive innovation' is defined as finding new customers for simpler, cheaper services in markets that have been either dominated by one industry so long that innovation has slowed, or provide a solution that customers previously didn't have access to.

⁷ Ericsson Mobility Report 2016 (<https://www.ericsson.com/res/docs/2016/ericsson-mobility-report-2016.pdf>)

⁸ Cisco Visual Networking Index 2015 – 2020 (<https://newsroom.cisco.com/press-release-content?type=press-release&articleId=1771211>)

⁹ Interview with Siemens (Julie Alexander)

¹⁰ A blockchain ledger, is a digital accounting ledger hosted on a distributed network. For more information see <https://www.thersa.org/discover/publications-and-articles/rsa-blogs/2016/07/think-blockchain-is-all-about-bitcoin-think-again?>

¹¹ Clay Shirky, Cognitive Surplus: How Technology Makes Consumers into Collaborators, 2011

Iterative digital disruption creates new market value

The creation of Skype in the 00's, which suddenly made long distance video calls free, brought families closer together and making business deals faster. WhatsApp may further disrupt this paradigm as it plans to roll out an Africa-focused payments infrastructure, providing a seamless communications and transaction tool. On-demand transit company Uber started in San Francisco and New York, but it is now available in 29 cities in SE Asia, 27 in South Asia and 10 in Africa including Accra and Lagos. New digitally-enabled business models with cheaper offers to consumers have ignited controversy -- such as Uber or Airbnb -- because they capture new market value but disrupt labour markets, politics and incumbent industries, and can do this faster than traditional business models.

2. The Digital Dividend: 8 Key risks and opportunities

Regardless of country or income level, governments are grappling with how to embrace technology shifts to achieve better outcomes for citizens. However, in emerging economies, governments will need to play an even more significant role to ensure economic models promote inclusive development. This section therefore sets out 8 key issues that governments and donors should be cognisant of in designing policy and programmes: Automation and Jobs; Labour Policy, Inequality; The Youth Bulge; Disability; Women's Economic Empowerment; Data, Privacy and Cyber-security; and Digital Monopolies.

Balancing Automation and Job creation: The spectre of automation, enabled by the digital revolution and frontier technologies, looms large across the globe. However, with susceptibility to automation shown to be inversely proportional to GDP¹², there is a risk in lower income countries of zero-job growth in key sectors, and job losses in traditional sectors such as agriculture where the poorest men and women work. In addition, more autonomous factories make plants less reliant on cheap labour, enabling plants to be relocated to the regional markets they serve. For example, Adidas is currently moving some of its manufacturing back to Germany to shorten production chains. New digital industries are also labour-poor - Facebook, with a valuation greater than Exxon, has just a quarter of the employees - highlighting just how capital-intensive but labour-poor new digital industries can be. Governments and donors therefore need to consider scenarios for transition, that enable them to build new sectors and sectoral capabilities which will enable jobs to be created and sustained.

Evolving next generation labour and social policy: Whilst the private sector is rapidly evolving new markets and service models, governments are struggling to evolve labour and social policy, and support skills development at a comparable pace. The explosion of the gig economy has created jobs, but ones that are fundamentally insecure and fail to provide reliable incomes and social protection. If citizens and economies are to benefit from new labour models, governments and donors must in parallel develop policy and advocacy models that serve these workers. 'Digital trade unions'¹³ and universal income are just some of the models that may be needed to support the new world of work. Innovative examples of new types of collectivism include the browser extension Turkopticon developed by labour advocacy groups, which enables online workers to alert other online workers of clients who fail to honour agreements.

Avoid re-enforcement of traditional divides: Whilst digital solutions can narrow traditional divides between urban and rural, men and women, the young and the disabled, digital access can also exacerbate real world divides unless governments proactively promote inclusive digital development. Four billion people remain 'offline'¹⁴, and 51 countries are not getting affordable internet access¹⁵. Addressing this challenge requires new business models such as Swift Networks free wifi network in Lagos, funded by requiring users to watch adverts in order to access services. But access is not merely an infrastructure challenge. 'Demand side' initiatives are also needed to help the poorest develop digital skills and

¹² World Bank Development Report 2016: Digital Dividends

¹³ <http://www.wired.co.uk/article/gig-economy-digital-unions>

¹⁴ GSMA, <http://www.mobileconnectivityindex.com/>

¹⁵ <http://a4ai.org/affordability-report/report/2015/>

awareness the opportunities provided by digital services, enabling them to benefit from digital access. Such initiatives must also be tailored to the differentiated learning needs of marginalised groups such as female entrepreneurs, young people, and people with disabilities.

Transforming the youth bulge into a youth dividend: Youth are at the forefront of digital adoption with 70% of global youth aged 18-25 online, 67% in developing countries and 30% in Least Developed Countries (LDCs). But with LDC youth representing a larger share of total online population than in developed or emerging economies, young people are uniquely placed to benefit from the digital dividend. Despite this, employers feel African youth lack the digital and analytical skills needed for the workplace, and digital exposure for many is limited to engagement on Facebook, WhatsApp and Instagram. Improvements in digital connectivity must therefore be matched by digital skills development support to young people, aligned with needs of entrepreneurs and enterprises. Google's recent pledge to train 10 million young African's in digital skills is a sign that the private sector sees the huge value here¹⁶. However, for these initiatives to translate into poverty reduction, they must be replicated at scale, built into mainstream education and designed to target the poorest in all emerging economies who may not be present in traditional education settings.

Promoting disability inclusion: 15% of the global population live with disabilities, and this number rises significantly for over 55s. Digital access can improve employment opportunities, ability to access urban infrastructure services and enable civic engagement. However, digital access is significantly lower for people with disabilities (little data exists for developing countries, but 23% of Americans with disabilities are not online, vs 8% of general population). Only 40% of government websites, and 18% of commercial websites are accessible in countries who have ratified UN Convention on Rights of Persons with Disabilities. Text to speech and screen reader availability is available in the main language in only 70% and 56% of countries respectively, and in minority languages in only 23% and 21% of countries, meaning that lesser abled people are significantly disadvantaged in accessing simple digital tools¹⁷. Therefore whilst digital tools and solutions could provide huge benefits to the disabled, they will not do so unless products and services are designed with the disabled in mind. Examples of good practice for disability inclusive design are integrated in the following chapters. In addition the 'Smart Cities for All' initiative has developed standards to support cities in assessing their disability inclusion maturity, adopting ICT accessibility standards and procurement approaches¹⁸, and governments and donors can play a significant role in promoting their uptake and iterative improvement.

Supporting Women's Empowerment: Digital technologies have the potential to empower women, giving them access to work, and enabling them to shape the world around them through digital advocacy. For example, the global Safetipin app enables women to report safety issues, with governments using this data to improve the safety of cities and services. However whilst the digital gender divide in developing and least developed countries has gradually decreased, the divide in Africa has grown¹⁹. Women who own mobile phones in urban areas are 50% less likely to access the internet than men²⁰ and evidence from Tanzania shows that female entrepreneurs are less likely to use mobile phones for businesses than men. However when products and services have been designed with women in mind uptake can be strong, as was seen in Bangladesh where Grameen micro-credit models saw rapid uptake when women used mobile handsets to access the service.²¹ Greater research is needed to understand how to effectively design and market digital services for poorer women if the digital gender divide is to be closed. As evidence available suggests that whilst solutions designed for working women such as Safetipin²² can bring great benefits, current product design and marketing approaches do not take into account women's needs or reach female audiences.

¹⁶ <https://www.blog.google/topics/google-africa/making-internet-work-better-everyone-africa/>

¹⁷ Data from misc recent Smart Cities for All presentations www.smartcities4all.org

¹⁸ <http://smartcities4all.org/english-toolkit/>

¹⁹ <https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf>

²⁰ <http://webfoundation.org/research/womens-rights-online-2015/>

²¹ http://siteresources.worldbank.org/INTEMPowerment/Resources/14648_Grameen-web.pdf

²² The Safetipin app enables women to report street-based violence or harassment. Data is then shared with police, government agencies and civil society groups enabling them to plan urban safety initiatives or support. www.safetipin.com

Managing Data, Privacy and Cybersecurity: With high profile ransomware and other cybersecurity attacks on the rise in 2017, not to mention corporate losses of customer data, concerns over security as we digitise critical infrastructure and personal data cannot be ignored. Cybersecurity is a booming industry, growing 13x since 2004, and expected to reap some \$1 trillion in profits from 2017-2021.²³ Without doubt, data security will become increasingly important and governments everywhere are pressed to keep pace with rapidly evolving technologies, such as blockchain (the underpinning technology behind Bitcoin). Blockchain today is in theory nearly invulnerable to attack, but each application has yet to be stress-tested in enterprise-scale rollouts.²⁴ As high on the political agenda today is how to govern data in a world in which 90% of all the world's data has been created in the last two years.²⁵ (Europe and Australia are both reviewing basic public and private data access and portability principles and regulation.) Governments and donors can learn from trailblazing countries such as Estonia, which has issued all citizens with a digital ID, providing them their own data portal so that only with citizen consent can doctors or third parties be granted access.

Addressing the spectre of digital monopolies: Because network effects mean that a service is more valuable if your neighbour or colleague is also using the same platform, some corporates will win (or have already won) significant market share (think Microsoft, Google, Facebook). As a result, new market entrants may often struggle to gain traction. Whilst such monopolies create economies of scale and service interoperability, they also pose significant risks around who controls and can harness the value of information such as geospatial data needed for urban planning. In an ever expanding world of information, there is potential to harness data to support data-enabled planning, citizen-focused service design and 'smarter' infrastructure services that could deliver public services to the world's growing cities. However, to harness these opportunities, governments and donors alike must rapidly engage in dialogue with industries and firms about the role of monopolies and data in contributing to delivery of public goods. A good example of such collaboration includes the Open Transport Partnership, where donors are collaborating with global ride sharing companies such as EasyTaxi and Grab to share transport data.

3. The Digital opportunity in cities

Why is the fourth industrial revolution, and the opportunity for the digital dividend particularly critical for cities? Cities are at the front lines of private sector innovation, new market creation, service delivery, and citizen engagement. Cities are where demand-led solutions that utilise new digital and frontier technology building blocks have the greatest potential to improve productivity, services infrastructure and enable new markets. This section therefore sets out the three key arguments for why governments and donors should pay particular attention to ensuring policies and programmes promote digital technologies as key tools for inclusive developing in urban areas.

Cities as loci of productivity: Cities generate 80% of global GDP. When cities function effectively, a doubling in population results in an 11% increase in productivity.²⁶ However, when cities are unable to effectively manage growth, deterioration in urban services results in increased costs and poor business and living environments, locking businesses and citizens into low-productivity, low-opportunity cycles. Digital and frontier technology solutions can help cities and citizens break out of this vicious cycle, 'Smart Cities' movement has championed the role of digital in shaping urbanization for nearly a decade, and whilst 'smart city' initiatives were originally technology-led, newer proposals focus on the impacts of digital technologies on the lives of citizens and are being adapted to developing economy contexts. Equipping young people and entrepreneurs with digital skills and access can create a new generation of workers able to deliver new service models and present significant employment opportunities. In Austria strong skills

²³ Cybersecurity Ventures, 2017 <http://cybersecurityventures.com/cybersecurity-market-report/>

²⁴ <https://www.cnet.com/news/lockheed-martin-bets-on-blockchain-for-cybersecurity/>

²⁵ <http://www.iea.org/digital/>

²⁶ <https://www.economist.com/news/books-and-arts/21721895-non-linear-scaling-explains-everything-productivity-cities-safe-dosage>

availability means more than 30% of workers are employed in knowledge intensive services or medium-high tech manufacturing, with high skilled services accounting for 44% of Vienna's industry employment²⁷). Investments in smarter energy, buildings, street lighting, and transport provide huge direct and indirect benefits, attracting 4x to 32x returns on investment with viable business cases and payback times that are attractive to investors²⁸. Digital technologies can improve urban sectoral productivity and enable sector formalisation by providing transparent business environments, accessible capital, and digital business management, marketing and service delivery tools. City governments have a key role to play here in creating supportive policy environments, providing infrastructure and investment support services which enable local business productivity, and by reducing corruption and increasing accountability - ensuring that local taxes are well spent.

Cities as centres of innovation: Cities have traditionally been centres of innovation. Physical agglomeration enables the clustering of businesses, research and innovation facilities, human capital and market demand required to innovate new products and services. Cities have a track record of leadership and innovation, demonstrated by the global mayors who took leadership positions on climate change long before many of their national governments. The same is true for supporting digital innovation, where cities such as Barcelona, Bogota, London, Cape Town and Bengaluru have fostered new digital economies, supported piloting of smart infrastructure technologies and led the way in developing e-governance services. The same could be true for cities across the developing world, as is being demonstrated by early initiatives in Nairobi, Accra and Lagos. While city governments may not have the legal jurisdiction over all elements of digital leadership such as national infrastructure investments, they can influence other areas of digital development and encourage the services that utilise it. City governments indirectly influence this by attracting private sector companies that make R&D investments, by training a digital workforce, implementing 'smarter' infrastructure and increasing affordable connectivity.

Virtuous cycles in urban systems: If city governments and stakeholders choose to adopt, adapt and innovate using digital technologies they can enter new virtuous cycles of inclusive growth. As complex systems, the deployment of new solutions in urban settings can enable huge direct and indirect benefits, and support development of intersecting markets and services which accelerate leapfrogging. Case studies on Los Angeles and India in this paper highlight how investments in street lighting or transport can support improved business connectivity, reduce congestion, promote manufacturing growth, and improve public safety and health. Localised urban energy generation and trading solutions such LO3 enabled by agglomerations of users (see case study), keep dollars within the city economy where it can be re-invested. Cities are also uniquely placed to provide both supply side infrastructure for digital connectivity (See Los Angeles and Lagos Swift Networks cases), whilst also enabling demand side factors such as workforce training and market demand creation²⁹. Combined, these complex network effects, when managed by pro-active coalitions of urban governments, private sector and civil society, can create more livable, inclusive and productive cities that attract talent and investment, enabling a virtuous cycle of inclusive growth.

Urbanisation in a digital world: Theory of Change

The final section of this chapter considers the theory of change for how use of digital solutions can translate into inclusive economic growth. It sets out the problem statement that faces governments and donors (the challenge), the opportunity that digital solutions pose, how digital interventions can promote improved productivity and inclusion, and how this can translate into inclusive economic growth impacts. The theory of change is intended for government and donors to adopt and adapt as they consider how digital solutions can create not only short term local outcomes, but long term inclusive growth impacts.

Challenge: Urbanisation is linked to increased productivity and, when supported by economic diversification and accessible public services, can enable poverty reduction. However, the negative

²⁷ Job Creation and Local Economic Development, OECD (2014)

²⁸ <https://www.siemens.com/customer-magazine/en/home/cities/the-business-case-for-smart-cities.html>

²⁹ <http://industryofthingsvoice.com/wp-content/uploads/2017/02/Huawei-2016-Global-Connectivity-Index.pdf>

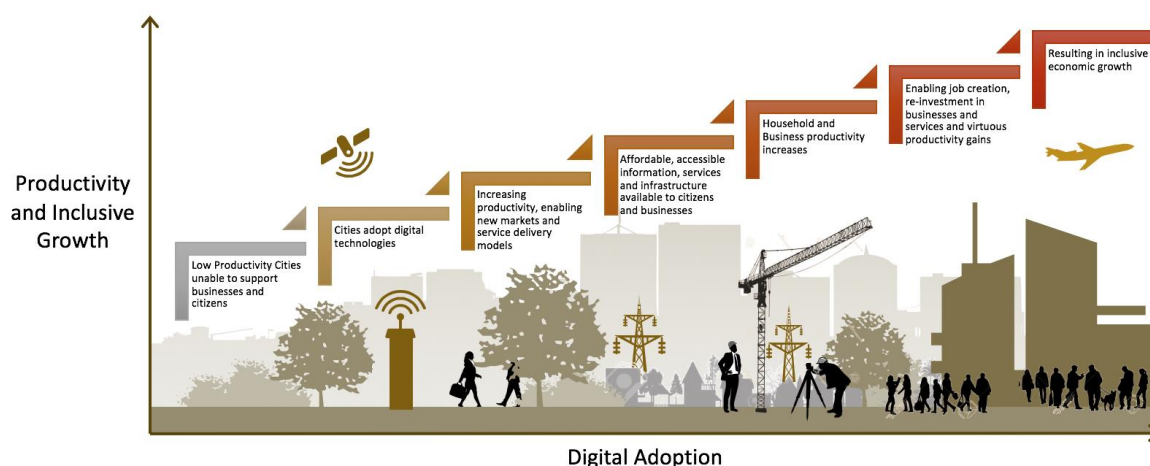
impacts of high population growth can create the opposite effect, where cities suffer from congestion and lack of basic services. Businesses productivity is low as they are overwhelmed by high costs and are unable to access capital, enterprises fail to grow, much economic activity remains in the informal sector as the costs and knowledge capital needed to formalize are high, and households remain poor as costs of living outstrip household income.

Opportunity: An emerging body of evidence shows promising benefits to increased connectivity and digital platforms, such as improved inclusion, service delivery and productivity for households, businesses and government. According to Huawei's connectivity index, a 1-point increase in the Global Connectivity Index rating equates to a more than 2% increase in competitiveness, innovation and productivity in a country's economy.

Intervention: This paper sets out how a range of digital interventions, each with different drivers and objectives, which have the potential to: improve the productivity of urban markets, promote sector growth, job creation and innovation (See section 3); improve the efficiency, affordability and accessibility of urban infrastructure services (See section 4) and; improve how governments engage with citizens, plan for more inclusive services, and manage their finances and investments effectively (See section 5).

Outcome: The wide range of interventions proposed result in improvements in urban market productivity, economic empowerment and inclusion, urban service delivery, accessibility of services for all (including poor and marginalised groups), better governance and a more skilled and innovative population.

Impact: These outcomes in turn trigger a range of economic growth mechanisms, with macro-economic network effects, lower costs, and improvements in social welfare and human capital (for more information please see ICED Evidence Paper: Urban Productivity linkages to economic growth). These may result in a virtuous cycle of productivity gains, profitability, government revenue generation and re-investment which enables sustainable, inclusive economic growth.



Assumptions: This theory of change (ToC) assumes that adoption of digital solutions is supported by attendant policy and enabling environment programmes to ensure that the risks outlined in chapter 2 of this report are mitigated, and that impacts of digital solutions are therefore inclusive. It also assumes a linear path of adoption-to-impact, whereas most digital solutions will require gradual iterative development to ensure they meet the needs of the poor and provide the most inclusive outcomes.

Counterfactual – Analogue development in a digital world: In the counterfactual scenario, if developing countries do not embrace the digital opportunities, then jobs are likely to be lost to automation, new economic sectors may not develop if local skills and investment is not available and infrastructure services will continue to be inefficient and fail to meet the needs of businesses and citizens. Governments will increasingly struggle to manage urban revenues and services, and cities in the developing world will continue on their current pathways of low-productivity, low-job growth.

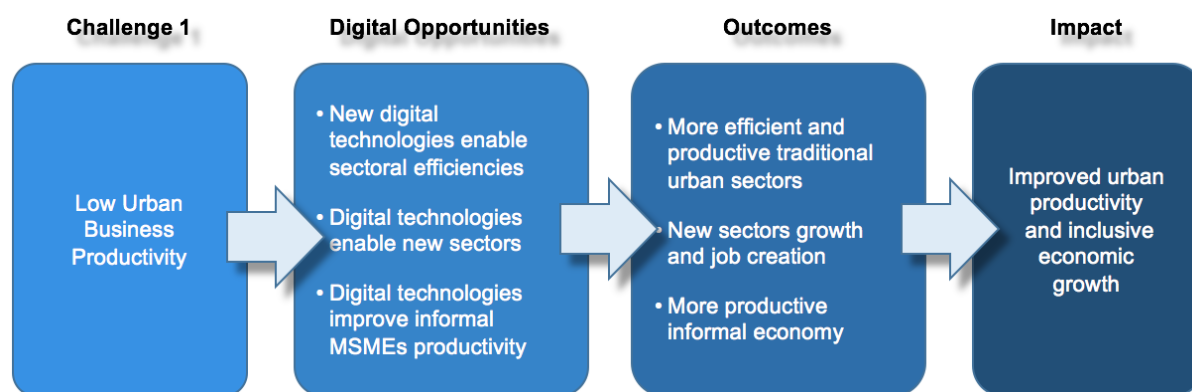
Section 2: The digital urban economy

The digital revolution provides significant opportunities for developing countries to diversify their economies, improve sector productivity, create informal sector support services and enable formalisation, build human capital and promote localised innovation.

However, in order for such opportunities to enable inclusive growth and poverty reduction, governments and donors need to: support local innovation ecosystems; support development of new digital sectors; enable equal access to digital job opportunities; help develop the digital tools needed by the informal sector to improve productivity and enable formalisation; and empower young people with digital skills needed in the 'new digital economy'.

Urban economies in developing countries do not currently provide the diversified economic opportunities needed to lift urban dwellers out of poverty. Cities currently generate more than 80% of global GDP with 100m people expected to move to cities by 2025 in Africa alone. However, whilst diversified urban economies have delivered increased productivity and pulled people out of poverty, the rapid urban growth seen in many non-diversified cities in emerging economies is not yielding such outcomes. In towns in non-diversified economies 84% of jobs are vulnerable, versus 55% in large cities in the handful of economies that have managed to diversify. The majority of the urban workforce is in the informal sector (61%), contributing up to 80% of GDP in some countries. Women are particularly disadvantaged by the lack of formal employment opportunities with informal jobs making up 92% of opportunities outside of agriculture. A key driver of low productivity in Africa in particular is the reliance on resource exports, and lack of infrastructure to support higher productivity sectors. Annual labour productivity growth is low at 2-3%, and low-income countries will be particularly susceptible to automation (shown to be inversely correlated with GDP) with the potential for low income countries to undergo premature de-industrialisation and zero-job growth.

However, if effectively leveraged, digital technologies can improve urban productivity, promote sector diversification and enable inclusive economic opportunity, growth and poverty reduction.



Opportunity 1: Support Clustering for Economic Innovation

Governments and donors can support the development of vibrant urban innovation ecosystems. National governments as diverse as South Korea, Finland, Denmark, and China have created clusters of industrial, academic and government institutions to drive economic innovation. Meanwhile in Africa Ethiopia is development of industrial nodes, around which broader innovation ecosystems could evolve if research institutions, tech innovation hubs and other support ecosystem services were 'designed in' to policy and near term plans.

Such clusters are often located in a city or urban region, and city governments have a significant role to play in supporting local innovation ecosystems, which in turn support urban economic diversification, job creation, and inclusion. Innovation labs, shared workspaces, innovation networks and events can all support entrepreneurial activity, provide peer learning, targeted entrepreneurship support for marginalised groups such as low-income youth, disabled and women, and improve urban competitiveness. Leading 'digital cities' such as London and New York have dedicated digital policies which support digital innovation, and 'Livings Labs' bringing together city officials with citizens, private sector and potential customers to design, pilot and testing of new technologies in urban environments from Barcelona to Mexico City. National and city governments can provide investor tax breaks, accessible innovation spaces, access to loans, supportive procurement frameworks, and city-level policy commitments that support a range of sectors and ecosystem players to achieve common outcomes.

Opportunity 2: Diversifying Economic Sectors

Digital opportunities can promote economic diversification, and improve productivity in traditional sectors. Governments, donors and the private sector can all play a role in supporting this transition. Technology, digital content and digital business services sectors are under-developed in emerging economies, but are a huge potential source of jobs and productivity growth. There is very limited local content available in Africa, with the majority of internet searches routing back to US or France and only 8 African countries where search engines provide access to majority local content³⁰. Opportunities for local content creation include development and distribution of cultural media, and educational and informational content for citizens and businesses. Huge opportunities exist to support private and public sector content digitization and creation. Such activities are 'job rich', and activities such as public record digitization offer low-skilled work suitable for young people entering the job market and people with disabilities.

New gig working platforms also offer employment opportunities, however studies have shown there is often a significant bias against workers from many emerging economies and that unpaid time spent in securing work translates into very low per hour incomes³¹. Tech sector growth also provides opportunities for economic diversification. However there are many developing countries where users are unable to download or pay for apps and developers are unable to register or monetize their products due to app-store restrictions³². Government and donors therefore have a critical role to play in working with the private sector to ensure that youth, entrepreneurs and local businesses are able to access these new digital opportunities, through direct support to sector development, by working with private sector to enable equal access to marketplaces and developing policy which protects and provides safety nets for digital workers.

Opportunity 3: A productive, formalised 'informal' economy

Digital services can help improve informal sector productivity and promote formalisation. 61% of urban employment is informal and makes up up to 80% of economic activity in some countries. Much informal sector activity revolves around small retail and low-value adding services. Studies have shown that small-scale entrepreneurs use their mobile phones to support business administration, customer support and businesses payments. As smart phones become increasingly accessible, there are huge opportunities to support entrepreneurs with digital services adapted to local markets. India has already led the way in developing local cloud accounting apps, financial services, and improved business advisory services and this model could be replicated. Design of such services with specialist user needs in mind can also ensure productivity and income gains are experienced by all. Evidence from recent ICED studies for instance have shown that women entrepreneurs are less likely to access such services, unless they are

³⁰ Annals of Association of American Geographers, Digital Hegemonies: The localness of search engine results, Ballatore, Graham and Sen <http://www.tandfonline.com/doi/full/10.1080/24694452.2017.1308240>

³¹ Graham, M., Hjorth, I., Lehdonvirta, V. 2017. [Digital labour and development: impacts of global digital labour platforms and the gig economy on worker livelihoods](#). *Transfer: European Review of Labour and Research*

³² The Mobile App Divide (internet Society) https://www.internetsociety.org/sites/default/files/report-MobileAppDivide-20151117-en_0.pdf

designed with lower literacy levels in mind, are available in local languages, products meet women's business needs and their benefits are marketed clearly to women consumers.

Governments can also use digital solutions to help informal businesses formalise. Many small businesses also struggle with confusing local licensing and taxation requirements, citing these as key constraints to business growth. By making information on business environment issues easily accessible to entrepreneurs via digital platforms, and providing online support for business registration, tax and licensing payments via mobile money services governments can significantly reduce barriers to formalisation.

Opportunity 4: A skilled workforce for the 21st century

Developing country governments must promote the skills needed to support digital opportunities.

Automation and digital technologies are creating significant shifts in how businesses create and sustain jobs. In Ethiopia, Thailand, India and Nigeria 65-85%³³ of jobs are estimated to be prone to automation, and job losses will also be experienced unequally by men and women. Men are projected to gain one job for every three lost to technology advances, whilst women will gain only one for every five lost³⁴. The impact on cities will be most profound with low-skilled manufacturing, and back-office functions being most affected. In response donors such as DFID are already supporting less developed countries to invest in manufacturing, in sectors which are adopting frontier technologies. However, countries will also need to pivot their education and training systems to meet the needs of modern manufacturing plants and urban business as they adopt new technology solutions. Here again donors must play a role.

This requires innovation not only in traditional education, but targeted skills development for young people, entrepreneurs and businesses. Foundational and functional digital skills must be built into primary and secondary education. Young entrepreneurs need training in e-commerce, digital marketing, use of online business and financial services. Women entrepreneurs and business owners may require additional support in finding the right services and gaining skills to meet their needs. Skills training for disabled people could enable them to access a much wider range of work opportunities, including gig-work, and remote business service roles enabling them to enter the workforce. Finally, tertiary education institutions need to embrace the wide range of digital tools that support professional development, from GIS, to data analytics tools and financial management software. Examples of private-sector led innovation include the vocational training programmes developed by such large Indian companies as TATA and INFOSYS who have established training academies for IT Services, electrical and operations technicians. However, such a step-change could also benefit from the support of donors who possess sector-specific digital expertise, such as expertise supported by UK Future Cities Catapult.

India's Urban Economic Revolution

Increased urban productivity in India has been driven by a dynamic network of universities, three decades of national policy and funding support for urban development, continuous improvement in local government capacity, and a new generation of Indians who have innovated products and services to meet the needs of urban dwellers. Indian businesses have innovated business service products, in local languages and which are compliant with local tax and licensing laws. The technology sector, founded in Bengaluru, has grown rapidly, provides millions of jobs and ICT market hubs have now emerged across India. Most importantly, India's vibrant education, research and innovation ecosystem has helped India design, pilot and scale a wide range of urban infrastructure solutions and ICT governance platforms which have helped transform cities.

Digital platforms enable education-to-employment brokering

The Edukasyon.ph Employment Platform in the Philippines lists every course available in the country and curates thousands of scholarships. By brokering partnerships with paying private schools and

³³ IDS Digital Development Summit Background Paper

³⁴ Amerasinghe 2016

government organisations, it also shifts the growing cost of education and training from the individual to the large corporation. More than 200,000 students have used the online platform, the first education-to-employment tool in an emerging market.

Section 3: Smarter Infrastructure Services

Digital solutions are our route to better service models and better data in almost all forms of infrastructure. The affordable collection of data is having a transformative effect on modelling everything from water systems maintenance, to revenue and passenger flows in public transport, in turn enabling the design and delivery of services that are accessible for all.

However, for such opportunities to enable inclusive growth and poverty reduction, governments and donors need to: Promote open data to support design and delivery of infrastructure services; Improve inter-actor co-ordination of data collection in the urban environment; Support the use of open technology platforms that ensure long term sustainability and innovation; Support the transfer of proven technology and service models from other utilities and sectors; Provide a conducive enabling environment for new infrastructure service models; and balance financial support for new models with technical assistance to market development.

Poor provision of infrastructure services is constraining urban economic growth, and the ability of poor urban dwellers to run households, access work and run productive businesses. Slums are home to 880 million people, 25% without access to electricity or sanitation. Many urban dwellers spend 30-50% of their income on transport which prevents households and SMEs from increasing productivity. Poor energy supply alone is cited by 92% and 87% of businesses in Islamabad and Punjab³⁵ as their largest barrier, and is estimated to drag down African GDP growth by 1-3%. Costs of premature deaths from air pollution, unsafe water and sanitation in Africa are estimated at \$854 billion³⁶. In India, not only does traffic cause 150,000 deaths annually, but hours of time spent in traffic compounds productivity losses. Powering transportation vehicles also drains economic resources from the country with 80% of fuel imported in 2015-16.³⁷

Digital solutions have a significant role in addressing these challenges. Whilst these challenges cannot be solved with digital solutions alone, data and digital technologies can enable the more efficient planning of infrastructure to meet the needs of the poor. Solutions can enable new infrastructure service delivery models, reduce investment needs, and make services more affordable and accessible to citizens and businesses. In addition, they can also enable better use of resources, fixed assets or sharing of private infrastructure, such as taxis or buildings for co-working and examples of such solutions are outlined in this chapter.

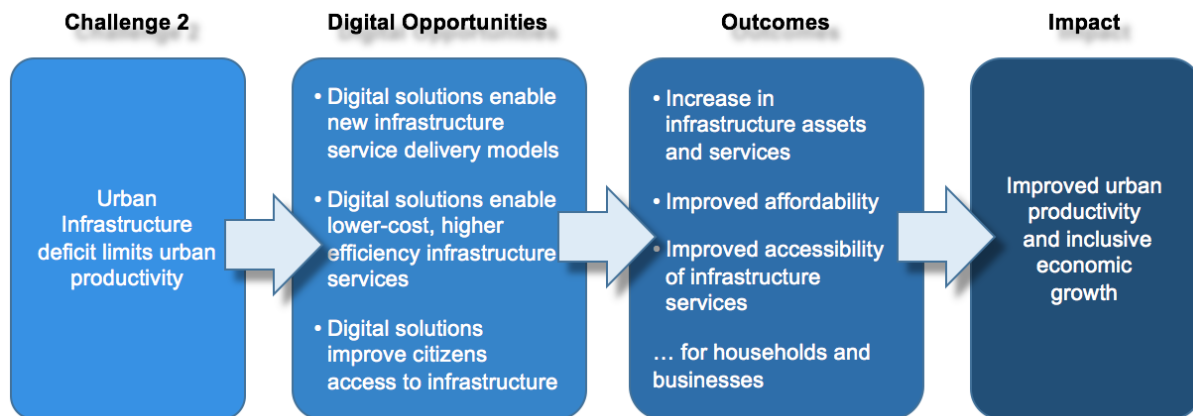
For infrastructure in particular, the rewards of digitally enabled solutions in emerging countries are beginning to be analysed by the private sector, governments and development specialists, and are increasingly recognized by the public sector in tenders for new infrastructure. For instance, in 'smart' LED street lighting procurement³⁸. It is often once projects are tendered that the private sector will be able to engage and provide expertise, which puts the onus on governments, development banks, donor or philanthropic organisations to increase capacity for cities to evaluate options for infrastructure and services that include 'digital' in the mix.

³⁵ World Bank Enterprise Survey 2013, Pakistan

³⁶ OECD, Economic Outlook 2016: Sustainable Cities and Structural Transformation

³⁷ India Leaps Ahead, Transformative Mobility Solutions For All, NITI and RMI, May 2017

³⁸ <https://economictimes.indiatimes.com/industry/energy/power/indias-smart-street-lighting-market-to-touch-1-8-bn-by-2022/articleshow/53196644.cms>



‘Smarter’ digitally-enabled infrastructure solutions offer value for money: Installing smart meters in 75% of Lima-Callao residences cost \$60 million, and paid back in energy savings within one and half years. Industrial sites paid back the cost of smart meter installations in just a few months. In Kolkata, the most cost effective investment the city could make to save carbon emissions is ‘smart’ parking demand management³⁹ due to its strong revenue raising capacity, ranking higher than purely infrastructure solutions such as automobile energy efficiency standards, industrial waste heat recovery or solar PV installations. Opportunities are therefore diverse, and this is an area where innovation is rapid, with ever more opportunities for forward thinking emerging economies to leapfrog to new solutions, such as pay-as-you-go home energy systems leapfrogging large scale electric power grid infrastructure.

Opportunity 1: Efficient integrated transport services

Digital transport solutions can enable the planning of services with the poorest in mind, and improve the accessibility and interoperability of services. Perhaps the most visible benefits of data utilisation in a city are the mobility apps and smart cards. Smart transport cards are now in use across many major cities, and enable poor transport users to undertake complex journeys for a single integrated (cheaper) fair, and to transfer between transport modes more quickly. Transport apps are less prevalent in developing countries, but have the potential to enable users to more seamlessly navigate their transport systems and to improve transit safety for vulnerable users. Apps can be developed either by public entities, or if public agencies share data then local tech entrepreneurs have been shown to be highly capable of developing revenue generating apps which offer citizens timely access to journey information.

Behind this, better use of data to design and manage complex services, integrating and adapting transport systems to meet the needs of the poorest is increasingly viable. The Digital Matatus project in Kenya used people’s mobile phones to track informal matatu (privately owned minibuses) routes. The data was then used to design formal services routes and schedules that would meet the need of the city’s poorest transport users, particularly benefitting women who tend to rely on paratransit solutions.

Digital is also enabling on-demand transit – or mobility as a service – through services such as Uber and other local services. Some start-ups such as SafeMoto, Rwanda are also using ride hailing technology to solve transport challenges that disproportionately affect the poor, with SafeMoto providing a motorbike ride hailing app which also tracks the behavior of its drivers to ensure its customers get a safe ride. Similar ride hailing schemes for the disabled are in place in higher income countries and could be replicated.

Governments and donors have significant roles to play in delivering smarter transport for all. Governments can work to ensure data used to design, and resulting from, transport services is made accessible via open data, enabling the design of new transport services and information for consumers. Governments must

³⁹ Climatesmartcities.org The Economics of Low Carbon Cities: Kolkata, India 2017

also ensure that 'smart' control systems used in cities use open platforms enabling future innovation and service expansion. Donors, as major funders of transport infrastructure in the developing world must then commit to better donor co-ordination around data gathering, analysis and service design if countries are to truly benefit from their support, and avoid the significant levels of data duplication and incompatibility seen today, which presents extremely poor value for money for both donors and their recipients.

SafeMotos: Using Human Centred design to create safer transport⁴⁰

Road accidents are the second biggest killer in Africa after HIV/AIDS, and in Rwanda 80% of accidents involve the motorcycles relied upon by poor city dwellers. The SafeMoto app enables motorbike ride hailing app, but also records driver's speed, acceleration, GPS and gyroscope information and customer feedback and drivers must maintain a rating of over 90%. The app was designed with both drivers and riders in mind – SafeMotos found that most drivers couldn't read apps so developed a bespoke landmark-based navigation system. The founders see their dedication to human-centred, and locally-oriented design at the heart of their success, and the app has delivered 120,000 rides to date⁴¹.

Transforming India's transport nightmare into an economic opportunity

India's mobility challenge is daunting. Nearly 50,000 new vehicles are registered daily. 80% of fuel is imported, and traffic causes 150,000 deaths annually. But NITI's (National Institute of Transforming India) recent report sets out how shared mobility and digitally 'connected' transport systems could save 64% of energy demand, yield economic, environmental and social benefits and enable India to leapfrog to a new mobility paradigm⁴². Key opportunity areas include: Mobility as a Service; Interoperable transport data; Mobility oriented development; Vehicle-grid integration; Product manufacturing and electric vehicle deployment. Whilst some opportunities may be decades away for the most fragile countries, mobility as a service and interoperable transport data are being trialed in Africa's larger economies⁴³, and trailblazers such as Ethiopia have demonstrated that mobility-oriented development is possible.

The potential to leapfrog to digitally-enabled next generation transport services is therefore possible, and would yield huge inclusive growth benefits if governments are willing to take on the challenge. Though many innovations may be developed by private sector entities, city governments can be part of the solution by supporting foundational digital skills and access, supporting city infrastructure upgrades, and engaging with private sector on apps and shared mobility solutions to ensure these more 'disruptive' solutions continue to improve social outcomes such as reducing pollution, increasing safety and ensuring productive jobs.

Smarter Transport on the horizon in Dar es Salaam, Tanzania

Supported through a mix of donor and private sector funding through a PPP, the BRT in Dar es Salaam is a forerunner in digital service delivery. It is already using an intelligent transportation system (ITS), an automated fare collection system (AFCS) and traffic control for its 140 buses, supporting live tracking of buses, route planning and scheduling. Some 75% of the BRT drivers are former local bus, i.e. daladala, drivers who have been trained up in the use of ICT systems as well as of the new, bigger bus platforms. Amid network expansion plans, improvements are still required in the BRT passenger information system and in broader traffic information sharing among operators in Tanzania's commercial capital. Other examples of digital solutions being rolled out in Tanzania include CCTV traffic monitoring in Arusha and vehicle jam-sensing traffic lights in Dar es Salaam, while Uber and local competitor Twende provide on-demand transport. Tanzania is also exploring the opportunity for more

⁴⁰ <http://www.huckmagazine.com/perspectives/reportage-2/safemotos-rwanda-tech-startup-taking-africas-second-biggest-killer/>.

⁴¹ www.safemotos.com

⁴² India Leaps Ahead, Transformative Mobility Solutions For All, NITI and RMI, May 2017

⁴³ Examples include Nairobi's digital Matatu project, evolving smart transport solutions in Dar and the success of EasyTaxi and Uber in Lagos.

real-time customer-facing transport information and data-sharing among transport providers.

Opportunity 2: Securing reliable energy access

Digital energy solutions can enable new service models and improve the efficiency and connectivity of grids. Smart energy needs differ dramatically by country, and urban areas tend to be more connected than rural. For instance, fossil fuels comprised over 52% of Ghana's total energy consumption in 2014. Access to energy has doubled in 20 years to 2014 so that over 70% of the population is connected. In contrast to Ghana, average national electricity access in Tanzania is 15%, but just 4% in rural areas. In India, overall access is near 80%, or 70% in rural areas. What the statistics hide are the emerging initiatives by the private sector to provide access to energy directly to consumers, through a range of services from pay-as-you-go home solar services, to more continuous access provided by microgrids. Digital plays a crucial role in energy access, mainly through digital payment and distribution systems and new off or on-grid energy monitoring and management.

Government and donors have significant roles to play in providing a conducive enabling environment for new service models - regulations in many countries, for instance, prevent energy sales between 'peers' rather than via a licensed electricity supplier, which would prevent some of the new blockchain-enabled business models. Where private companies do find a way around regulation, as seen with shared taxis, governments may need to respond to the innovation rapidly. Donors then need to tread a fine balance between subsidising radical new business models and creating market imbalances, by being cognizant of the tipping point at which business models become self sustaining, and tailing off subsidies accordingly.

Ecoligo rolls out digital energy for businesses in Ghana

Ecoligo, founded in 2016, finances and operates solar projects for industrial and commercial customers, managing all financial transactions, asset management, operation, maintenance and administrative measures through its fully digital, 4G connected platform to ensure a safe and reliable operation of the PV plant to its customers. Beyond the intended business case of resolving brownouts and increasing reliability of power on site, installing their solution yields 10-15% efficiency savings alone, as tracking software enables the customer to measure the energy they buy from the utility.

Street lighting catalyses internal investment in Lagos

Iyana Ipaja and Oke-Odo markets, situated in the largest local government in Lagos State, are home to 4,000 businesses, and are visited by >80,000 people each day. Lagos State Electricity Board (LSEB) and local stakeholders designed and implemented a market-wide lighting scheme which resulted in extension of market operating hours, over 16% increase in incomes for market traders and new jobs created by 1 in 7 MSMEs. Improved security in the marketplace particularly benefits women shoppers, who benefitted from more flexible shopping hours and safer markets and transport interchange.

Local energy trading improves urban resilience

Urban households and businesses in low-income countries spend significant proportions of their income on energy. If power can be generated and bought locally this income can remain in the local economy enabling re-investment and growth. A start-up LO3 Energy has developed the Brooklyn Microgrid, making it possible to directly buy power from your neighbour and to 'island' the community off the grid during storms, like Hurricane Sandy, improving resilience. LO3's solution relies on a set of technology layers including distributed ledger technology, blockchain, (the underpinning of cryptocurrency Bitcoin), which allows for 'smart' verified contracts without the need for a utility or bank to settle the transaction.

'Smart' lighting investment enables multi-sectoral benefits

100 Smart Cities initiative has invested in a significant number of Smart Lighting services across India. Projects involve installation of LED lighting and smart controls on 'smart poles'. Revenues are generated by leasing space on poles to advertisers and telecoms, and cost-savings are accumulated due to energy efficiency. One important lesson noted however is the relative short lifespan of revenue models, as some Wi-Fi providers leasing space have become quickly displaced by improved 4g mobile services. It is therefore important to conceptualise adaptive business models for smart lighting projects to guarantee financial viability.

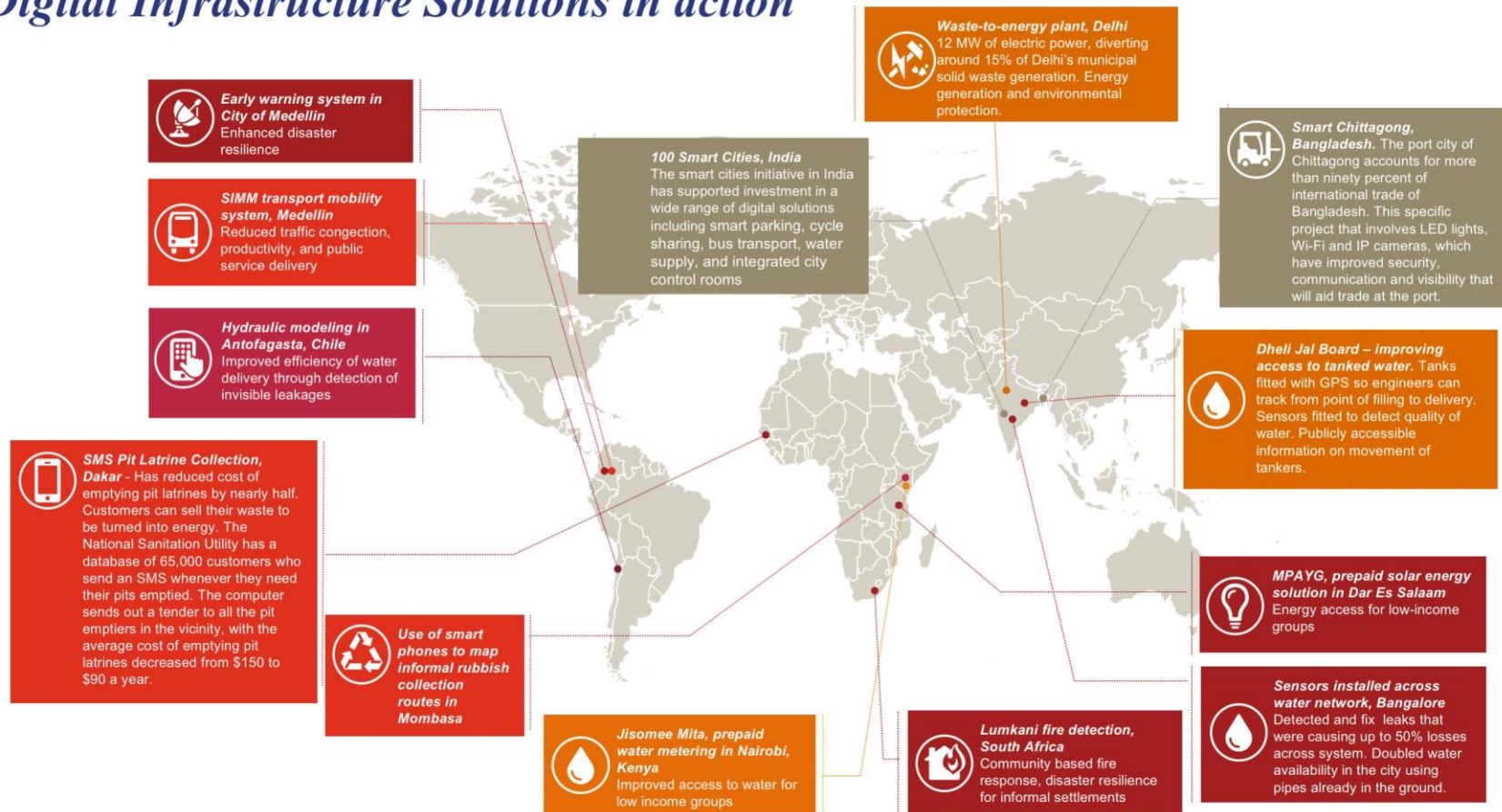
In Los Angeles, 80% of the 215,000 public street lights have been replaced with low energy LED lighting at a cost of £57 million, with an annual payback of £9 million. Because circuits have been upgraded, and lights consume less energy, the city has been able to install 30 new electric vehicle charging points. Working with mobile phone carriers, LA will replace 600 poles with 4G LTE (Long term evolution) wireless technology 'smart poles' that carriers lease from the city for \$1,000, improving mobile coverage. These early investments will enable the city to install solar panels on the smart poles, sell power back to the grid, and introduce smart parking and safety features for citizens.⁴⁴ Not limited to developed countries, the Indian Smart City projects also include many smart lighting LED projects where revenue for the city comes partly from shared savings on consumption, and partly from smart poles with leased facilities for advertising and internet connectivity. Cities must be prepared for fast changing technology that quickly makes the system redundant, unless it is possible to replace the smart pole facility with mobile connectivity upgrades, for instance, from 3G to 4G.

Opportunity 3: Delivering affordable, reliable WASH services

Digital innovations are creating opportunities for more affordable water services, and are key to enabling private sector waste, water and sanitation services (WASH). Whilst the water sector has not seen the scale of innovation demonstrated in the energy sector, the pace of innovation in the sector has increased rapidly in the past 2-3 years. The sector is benefitting from the relative maturity of the smart energy metering market, with mobile operators introducing water metering and digitally enabled customer services in South Africa. Smart hydraulic modelling in Antofagasta, Chile, has enabled significant improvements in water delivery through detection of leakages. Digitally-enabled water services are being piloted in Zanzibar, Tanzania to increase information availability on water and sanitation services and to improve customer service. Meanwhile India is at the forefront of digitally enabled solid waste services with 'I Got Garbage', Let's Recycle and Karma Recycle alone employing over 6,000 workers and serving 26 cities across India. Governments and donors have the opportunity to embrace new ways of working in this traditionally slow-moving sector. Embracing technology transfer in the utilities space and promoting knowledge transfer around new PPP or private sector led models for solid waste management and sanitation services.

⁴⁴ Need a more academic reference? <http://www.techrepublic.com/article/how-la-is-now-saving-9m-a-year-with-led-streetlights-and-converting-them-into-ev-charging-stations/>

Digital Infrastructure Solutions in action



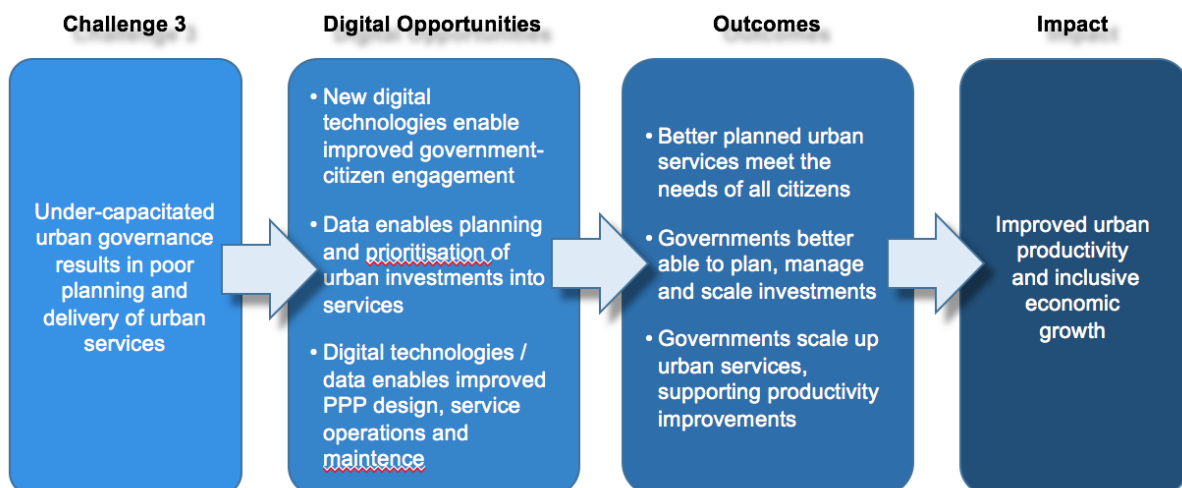
Section 4: Governance and citizenship in a digital world

Digital solutions can improve city government-citizen engagement, promote improved prioritisation of services, support data-driven decision making, enable greater revenue generation, improve viability and delivery of investments, and support asset management.

However, for such opportunities to enable inclusive growth and poverty reduction, governments and donors need to: Support inclusive design of citizen services and communications; Improve their own management of data; Develop data analytics skills; improve data-led policy making capacity and be more committed to investing in data collection to support investments.

Many urban governments in the global south are struggling to keep pace with change. Most city administrations do not have economic and spatial development plans, or the ability to manage these resulting in sprawl. Consequently, some of Africa's largest cities are half the density needed to effectively sustain public services, with cities setting aside only 1/3 of the land needed for future services due to poor planning⁴⁵. If African cities are to address their infrastructure deficits they need to invest 5-7% of GDP, or approx. \$30 billion per annum. However, revenue generation in many cities is so low (only \$1 per person in intermediary cities, and \$40 per person in capital cities) that governments are both unable to pay for services, and unable to gain the credit ratings needed to leverage capital to invest in hard infrastructure.

E-payment services, data-led planning tools and e-governance services all offer opportunities for cities to raise the revenues needed invest in infrastructure, and to better plan and deliver the accountable, inclusive and accessible services citizens need.



⁴⁵ Area Based Regeneration Schemes in India are all designed to promote mixed-use high-density concepts with greater walkability and improved services and supported by part grant part development led funding based on land value capture principles.

Opportunity 1: Enabling government-citizen engagement

An urban area's biggest asset is its citizens. But for many cities in the developing world, limited budgets and capacity often mean public servants focus on simply maintaining the limited services they are able to deliver - rather than focusing on planning and prioritising service improvements and responding to citizens needs. This can constrain and endanger future growth for two reasons. Firstly, when citizens feel they are not being served, they are reluctant to pay the very taxes needed by the city to improve services. Secondly, as a huge volume of digitally connected urban youth reach voting age in developing countries, poor support and engagement between local government can result in feelings of disenfranchised and discontentment with governance. A situation which can cause localised conflicts, in already fragile contexts.

Digital solutions offer huge opportunities to improve government-citizen engagement, with significant benefits. By listening to their citizens, cities can prioritise services that are important to users and can ensure the needs of the poor, and excluded groups such as the disabled are taken into account. Engaged citizens who get the services they need are in turn more likely to pay tax, which cities can re-invest in growth and services. Automated building plan approval systems for instance enable land or building owners to gain automated approval for works, safe in the knowledge that their application will be assessed in a timely and transparent manner, enabling them to safely plan for building investments. Finally, transparent and accountable city governments are better able to attract inward investment.

To ensure that digital citizen engagement initiatives have the best inclusive growth and poverty reduction outcomes possible governments, with the help of donors, must ensure that services are designed to engage and meet the needs of all businesses and citizens. Governments can consider adopting accessibility standards such as the 'Smart City for All' standards on disability access. Human-centred design, local language and user-experience experts with an understanding of the local context should provide support to service design. Most importantly governments should ensure that tools provide meaningful engagement and genuine empowerment of citizens and are not seen as 'tokenistic'.

Providing information for citizens

Tanzanian local authorities are working hard to improve their engagement with citizens. They are investing in local authority websites to provide information service access. They are innovating new portals to enable online business licencing. Trailblazers such as Kinondoni Municipal Council in Dar es Salaam has an active Facebook presence, an online form for complaints and uses SMS to respond to online queries. Its commitment to e-citizen services is matched by its resourcing commitments, with 20 people dedicated to supporting e-governance services, and a dedicated social media officer.

Digitally-enabled One Stop Shops

Many countries have now developed semi-automated service centres, either via online portals or combining physical services centres and online services. India's municipal e-governance systems have long included semi-automated citizen service software. Meanwhile 300 townships in Myanmar now have a One Stop Shop service centre where digital services accessed via local helpdesks gives better service accessibility.

Promoting budget accountability

Bengaluru led the way in promoting transparency with its pioneering open data campaign, creating city service level benchmarks, which were then used by civil society organisation Akshara to create 'WardWorks' enabling even the poorest of citizens to view ward accounts, monitor works in their community and engage in decision making.

LA's disabled citizens can now 'ask Alexa'

In January 2017 Los Angeles's Information Technology Agency enabled an Amazon 'skill'. Now Angeleno owners of Amazon's Echo or Dot can 'ask Alexa' about upcoming city council meetings, events at nearby libraries, receive city news flashes, and will soon be able to request emergency services and report infrastructure faults. Whilst such services may seem futuristic, it is likely that smart phones will increasingly provide such voice services. If emerging economy governments design online service information with this in mind, they could leapfrog to new models of hyper-accessible citizen services which will particularly benefit those with disabilities.

Promoting participatory planning

Many cities around the world now invite citizens to participate in planning their city. This can range from inviting ideas for new solutions, to prioritising solutions, or inviting feedback on new initiatives with suggestions integrated into proposals. In Bogota, the platform 'My Ideal City' was setup to enable the developer of a large city centre regeneration project to ask citizens questions and receive suggestions via a Facebook page. Ideas and comments received were then integrated into proposals.

Monitoring and improving service delivery

A wide range of apps have been developed that enable citizens to report problems with urban environments and services. In Jakarta the Qlue app enables user to report flooding, crime, fire or waste disposal issues. City officials respond through the CROP Jakarta smartphone application, enhancing service delivery and citizen participation. In India a range of safety apps including Safetipin, Raksha, Himmat, Smart 24x7 and bSafe are aimed at improving the safety of women and the elderly in urban environments. Apps include GIS location and SMS alerts for police or relatives, and some such as the Delhi Himmat app can transmit audio-video on incidents to police control rooms. Data from the apps is also used by some police forces to inform city planning and service provision.

Opportunity 2: Supporting data-based decision making

Data is a critical enabler of inclusive service design, and government decision making. Whilst the academic community is correct in noting that there is less data in developing country contexts, there has been a significant increase in data availability in the last 5 years. In Dar es Salaam, drones are being used to undertake digital mapping of slums and communities are using Open Street Map to map street, drainage and inundation patterns in order to develop resilience strategies. Meanwhile in Madhya Pradesh, India, a city-wide e-governance system which systematically pools data from all government sources is enabling bureaucrats to use inter-agency data to improve service delivery. In addition, by linking payment services across all departments the software has enabled a significant reduction in tax avoidance, and improved revenue raising. These examples highlight the importance of not only making data available, but of creating systems that can uniformly draw on and benefit from the vast data assets available.

Open source urban mapping and data gathering tools is mirrored across other urban communities around the world. Open data portals for nations and cities are increasingly common, and many governments are investing in data collection and digitization of existing data. Civil society organisations such as Twaweza in Tanzania are increasingly of the opinion that issues relating to data are no longer focused on data supply, but on demand for data. A study of Tanzanian government officials' uses of the national open data portal found a lack of awareness of its potential, and low capacity for using the analytical tools needed to interpret data. Support is therefore needed to upskill urban management professionals in the collection, management and interpretation of data to support inclusive service design.

There are significant complexities in getting the right regulatory frameworks and approach for managing data. Whilst open data can create huge value, many nations are concerned about data protection and national security – with concerns only heightened by recent cyber attacks. But data sharing between the public and private sphere, and between layers of government, will soon be critical if cities are to benefit from the amazing advances in big data analytics. Citymapper, a London-based tech startup, is running adaptive

bus routes in London powered by needs based analytics, whilst Google's Sidewalk Labs is investing in Doppelganger, a big data tool capable of modelling complex demographic needs of theoretical urban populations – meaning the big data urban revolution is near.

Governments and donors can promote the use of data to support decision making by: working to improve the management and quality of existing government data sources; supporting centralised, or city-level data initiatives to collate and manage datasets; improve the capacity of government staff to collect and analyse data; and improve the capacity of policy makers to use city data to support decision making.

Opportunity 3: Managing revenues and investments

Better data is providing a transformative breakthrough in revenue generation, and understanding and managing the risk inherent in budgets and investments. Given perceived risk and asymmetric information are significant drivers of cost premiums for finance in the developing world, data poses a significant positive opportunity to unlock barriers to investment. Tech companies such as African e-Commerce company Jumia has used its database to effectively raise capital, and similar examples exist with smart ticketing. Data and digital solutions are able to improve procurement, enable PPP investments, and improve the management of city assets.

There is huge potential for cities to use data to more effectively design and manage PPPs. With African cities requiring approximately \$30 billion per annum to invest in infrastructure, much of this finance will need to come from private investment, in the form of public-private partnerships. However, many governments are cautious about such partnerships, having been party to unsuccessful PPP ventures or because information asymmetries mean they are poorly equipped to negotiate or enforce contracts. Improved use of data and data-led monitoring systems can correct these asymmetries, and if facilitated by skilled professional empowered to enforce and manage contracts could significantly increase the viability of a huge range of PPP models.

Digital solutions can also enable improved asset management and operation and maintenance planning. In Tanzania a simple combination of QR code stickers, and simple Excel tracking tools are enabling improvements in asset inspection and management, without the job losses that might be associated with more complex expensive systems. More automated systems can also support improved service delivery, for instance predictive ordering of vehicle parts can ensure that bus parts are in stock, and services are not affected by slow import processes.

Governments and donors can invest effectively in the collection and use of data to design and manage city revenues, investments and assets. They can leverage digitally enabled payments mechanisms to increase city revenues, and use ICT systems and data analytics to manage city budgets. Donors can support more effective investment in data collection to support donor investments and PPPs, in order to reduce risk, and can ensure more effective donor collaboration around investments to reduce the costs of such data. Automated data collection and analysis should be built into delivery plans for investments as standard so that governments are able to monitor performance of service providers or assets. Finally, governments could benefit from adopting challenge-based procurements which enable co-innovation of service solutions more likely to meet city needs.

Using data to enable effective PPPs

The Tanzanian bus licensing authority (SUMATRA) is rolling out a GPS tracking platform and will require private sector licensees to fit GPS trackers to all buses. This will enable them to monitor road safety and service performance, enabling them to revoke licenses, invoke penalties or report legal infringements to the police authorities such that the privately delivered service is managed effectively.

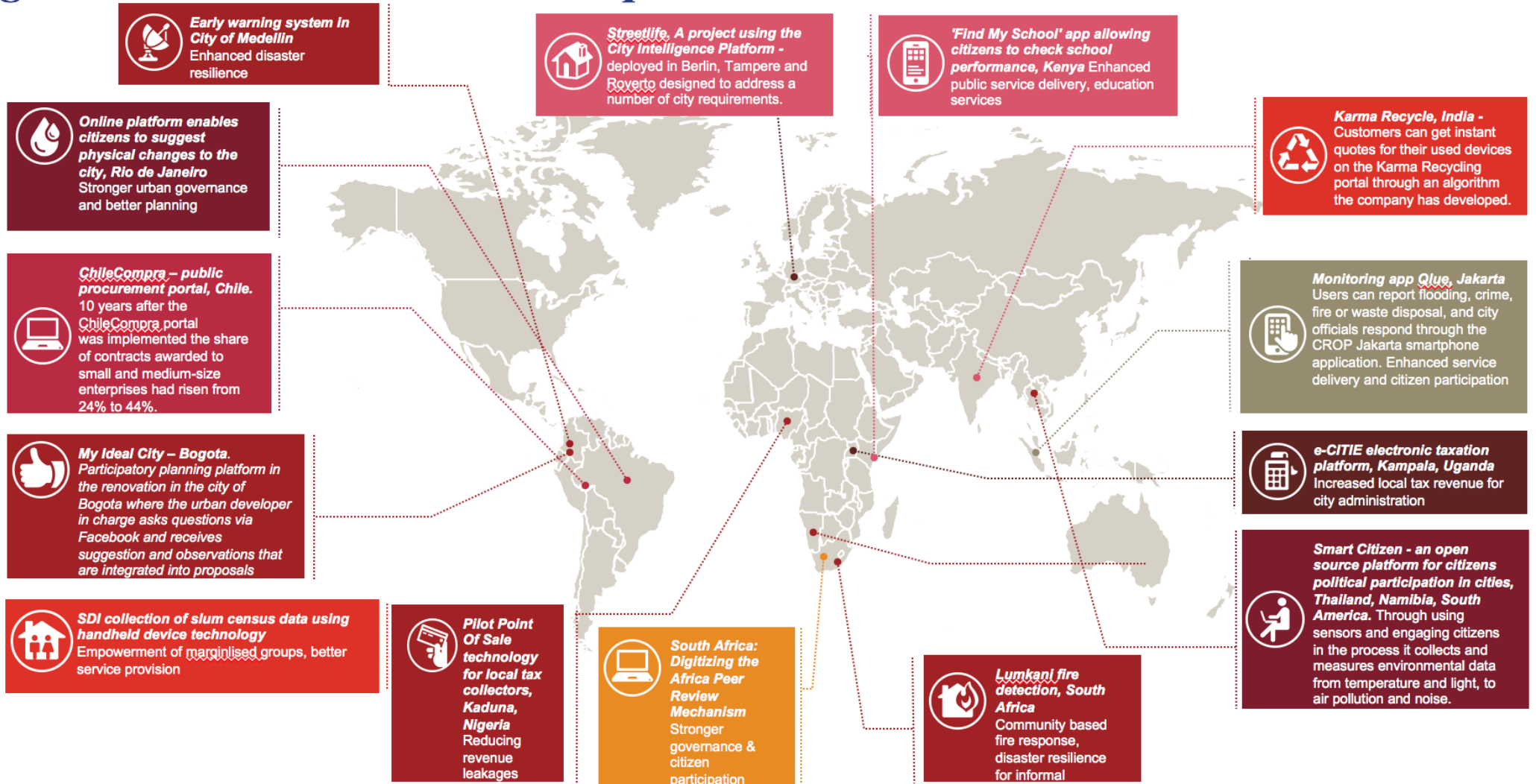
Digital solutions drive up city revenues

Urban governments are using data, digital tools and e-services to raise and manage revenues. Cities across Asia and Africa have pioneered electronic taxation platforms, innovated methods of tax collection, and increased their revenue base using digital tools. In Kaduna, Nigeria local governments have trialled Point of Sale technology for local tax collection to reduce revenue leakage. The e-CITIE electronic taxation platform in Kampala, Uganda increased revenues by 20% in just two years. Transport smart cards used from Bangkok to Lagos ensure reliable revenue collection, and Nairobi uses mobile payments for parking. E-governance budgeting tools are then also being deployed widely, improving city budget management, and enabling strategic budget planning.

Innovating through procurement

Innovations in procurement can enable increased participation of local SMEs in city service value chains, and can enable better design of innovative urban services. The Chilean procurement portal Chil-e-Compra enables businesses to bid for public sector tenders, with a rise in the share of contracts awarded to small and medium-size enterprises from 24% to 44% within 10 years. Exeter City through its innovation arm 'Exeter city future', uses challenge-based procurement and pre-commercial partnership arrangements to enable the city and sectoral innovators to co-develop city solutions. The CivTech incubator based in one of Europe's fastest growing Tech hubs, CodeBase, provides a space where city administrators can experience the start-up environment, and facilitates challenge based procurements which enable selection and contracting within 7 weeks.

Digital Governance and Citizenship Solutions in action



Section 5: Actions for Stakeholders

The preceding chapters have concluded that developing countries cannot view the digital transition as a luxury, but as a necessity if cities and countries are to avoid being trapped in cycles of productivity decline and wish instead to be a part of the new global economy. To support this transition governments, donors and the private sector each have a role to play, with key actions for each stakeholder group set out in this chapter. In addition, actions must be led by a vision for a digital transition that is succinct, measurable and must be supported by investments in stakeholder capacity. Therefore, the final section of this chapter sets out some high-level opportunities for co-ordinated action that all stakeholders can support.

Actions for Policy Makers

1 - Market enablement – Governments have a clear role in enabling and promoting the new markets and business models needed to improve urban service delivery, and drive economic productivity. This will require creative thinking on the part of policy makers about the use of and access to public data, resources and assets, and development of a coherent suite of policies that will provide tax incentives, stimulate markets and provide the skills and expertise needed to drive innovative solutions.

2 – Using Data for their own government operations - With more data available governments primary challenge is no longer a lack of data, but poor capacity to manage and utilize data. Governments therefore need to plan for the systematic capturing and utilization of data, whilst ensuring future systemic interoperability. This will require data services, and support for data management to be made available across government, and a culture of evidenced based policy making and service design to be supported.

3 - Projects/services - City managers will need to pinpoint and prioritise the problems that need solving and guide service delivery solutions whether that involves deploying digital technology as an incremental innovation to an existing service, (i.e. day to day

management and updates of transport data) or responding to ‘disruptive’ solutions that create new opportunities for citizens and challenge existing legal frameworks. Utilising evolving standards for smart cities, such as those developed by the British Standards Institute can help city leaders prioritise and sequence projects and avoid future redundancy.⁴⁶

4 – Keep focused on citizens and outcomes – Fourth Industrial Revolution frontier technologies will continue to advance faster than traditional governance or policy making can keep pace. Rather than try to play catch up, governments that focus on outcomes will be more likely to incentivise appropriate uses of technology to achieve the social or environmental benefits that citizens are calling for.

5 – Strategic, not piecemeal, delivery– Governments should consider early on how they will oversee their support for digital solutions and ensure coherence. Lead agencies at national and city level should be nominated, and must be supported by senior leadership. Overarching data, privacy and cyber-security laws should be developed or updated, and support for digital solutions must be woven through sectoral policy and regulation and national and local strategies.

⁴⁶ <https://www.bsigroup.com/en-GB/smart-cities/>

Actions for Donors

1 – Capacity – In order to help developing countries leverage the digital opportunity, donors need to build their own skills and awareness of the policy, project and business models innovations that digital and 4IR solutions will drive. In particular, donors need to foster sectoral expertise that can ensure they promote real innovation, and agile, human-centred design skills that are critical to developing robust digital solutions.

2 – Digital Readiness - Donors can work with governments and policy makers to define national and local policy, priorities, delivery strategies and projects which enable digital solutions to transform urban economies, infrastructure and governance. Support could range from development of cyber-security and online privacy policy, to development of Smart City strategies, or the integration of digital solutions into city governments or utility providers.

2 – Solution Design – Donors can bring knowledge of global solutions, and design skills to support co-creation of locally appropriate services which meet user needs. In particular, donors should support governments in human-centered design of services that meets the needs of women, youth and the disabled to ensure that the digital future is inclusive.

3 – Supporting public-sector leadership - Donors can help ministries and agencies lead the way in leveraging digital solutions, through innovative public procurement which actively creates a demand for digitally enabled solutions, supporting creative public-private partnerships which harness data and digital platforms to effectively manage service

delivery and by championing open data, open source and open platform solutions.

4 – Enabling private-sector innovation – Donors have a strong role to play in fostering local innovation ecosystems, through support to R&D institutions, business and technology accelerators, by providing patient capital for piloting and scaling of emerging solutions, and by supporting city challenge processes that enable urban managers to find the right solution.

5 – Fostering digital skills – Increase in supply side availability of digital solutions needs to be met with demand-side support for improved digital skills, especially for excluded groups such as vulnerable women and the disabled. These would range from basic use of mobile phones, to creative use of information, web-based service and more complex data modelling and coding skills. Such support will be critical to ensuring the digital dividend is inclusive and does not exacerbate existing inequalities. In addition, significant support is needed in building the capacity of city and elected officials to develop effective policy frameworks and manage the often-complex projects that will enable governments to truly benefit from digital solutions.

6 – Managing donor collaboration – In such an emerging space it will be critical for donors at global, regional and local level to co-ordinate efforts in order to promote synergies and avoid duplication. There are sadly numerous examples of un-sustained or incompatible technology based initiatives and only effective local collaboration can ensure that digitally disruptive initiatives add value.

Actions for Private Sector and Investors

1 – Look beyond technology – Success of new business models in emerging economies will depend on either a disruptive solution taking hold because it solves an acute challenge, or a savvy business that can build

out the accompanying distribution or business processes they will need to scale. Governments will be looking for the solutions to their citizen's challenges they do not need to pay for alone, and the private sector has a key

role to play in identifying and proving that new customers exist and are willing to pay or access a reliable service, regardless of the technology that delivers it.

2 – Co-create not dominate – Ensure that solutions are adapted to local contexts, where possible working with local governments, citizens and private sector delivery partners to ensure that solutions meet local needs, are inclusive and do no harm.

3 – Foster local talent – Build local talent, suppliers and innovators into product/service development and roll out strategy. Longer term viability of services will depend on local skills and innovation so that the specific product can evolve in the market.

4 – Foster markets – Some of the lowest income regions are the best sites for

innovation globally, because the opportunities to create new services for citizens currently without access to them is highest. This potential growth opportunity can outweigh challenges of operational risk or lack of infrastructure or distribution channels. However, the only way to succeed in the long term is to invest in the business environment and ecosystem around these new services, by supporting diversity, creating local ecosystems through working with local research institution, producers and suppliers. Educating new consumers is no small task and may require partnerships including those with donors, as the success of M-PESA demonstrates.

5 – Help build trust – Open up data, be transparent, work collaboratively with governments where possible, co-develop new standards with governments, providing them support not opposition

Embracing exponential futures

In addition to stakeholder-focused recommendations for donors, policy makers and investors, a step change in how cities approach digital innovation is needed. This will require collaborative innovation and the following four recommendations were viewed by authors as key to unlocking a future of continuous innovation at city-level.

Recommendation 1: The Future City Department: As we have seen, the future looks different for each urban environment from Los Angeles to Dar Es Salaam as cities prioritise their own challenges and solutions from its citizens and private sector. The integration of knowledge and innovation throughout government departments is not the task of each department on its own. A mayor-level Innovation Unit supports the integration and pace that is needed for these multiple futures as they are emerging. This supporting unit would address all three urban agendas – digital economy, smart infrastructure and citizen engagement. It would provide a place for the private sector to approach the city and be directed to appropriate departments, it could champion accelerating innovation approaches that may faster tackle complex challenges, and set out goals around adult education or voluntary agreements with the private sector that can then be supported in addition to day to day service delivery and operations. It could liaise with national and regional governments to tackle the issues beyond what a city alone can manage. It could provide crucial strategy and training programmes, or other priorities identified as specific initiatives or actions by the city.

Recommendation 2: Cross-government strategies for a new regulatory wave of change: Cities do not only need technical or infrastructure strategies, their governance and regulatory bodies may need to fundamentally rethink building capacity not only at national but at city level to manage the urban transitions of a digital age. This governance approach will need to include relationships with regional and national legislatures, the private sector and national level regulators. The governance strategy should be the work of the city itself, supported by stakeholders, otherwise it will not have the political buy-in or relevance required for delivery. The innovation unit of the city could coordinate this.

Recommendation 3: The Future Readiness Index: Connectivity, Market Creation, Equality & Productivity: How much better are cities getting at growing the digital economies, new smart infrastructure and digital governance solutions that are needed to ensure the best outcomes from connectivity? A new way to measuring the way urban agglomerations is increasing the demand for connectivity aligned with development goals. This would enable comparison, knowledge sharing and benchmarking of city strategies, in how they respond to potential 'disruptive' solutions and their proactive strategies to absorb and adapt services alongside new technologies and capabilities to improve the lives of citizens, particularly the urban poor.

Recommendation 4: From Workforce to Futureforce: A major component of creating the ability to transition is an entirely new way to think about work, labour and marketplace interactions or 'digital economies'. Already many of the highly skilled workers globally are in cities or in high tech centres, manufacturing sites, labs and financial centres. Missing out on the billions of citizens already in – or rapidly moving to – urban environments where they can more rapidly access the global economy leaves us far short of the skills we need to tackle 21st century challenges. And though oversimplified, the danger exists that a rise in youth unemployment also increases other crime or unrest. City governments have a small direct role to play in employing people who work for government, but could create the incentives for sectoral diversity, job creation and opportunity brought by the private sector or other partners. However, these workers need technical, cognitive and soft skills. A series of initiatives supported by donors to educate not just youth but adults toward this future would resonate with challenges the G20 are facing, not only the lowest income countries.

Section 6: Glossary of terms

App	A computer application, typically a small, specialized program downloaded onto mobile devices. Often developed by online businesses or entrepreneurs as a way of providing personalised data or services to individuals.
Artificial Intelligence	The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.
Automation	The creation or application of technology (hardware or software) to control the production and delivery of products and services. This includes the automation of both manufacturing and professional services (i.e. accountancy). Automation is associated with attendant restructuring of value chains, including job loss and job creation, the impacts of which will be felt by low-skilled, medium and higher skilled workers. The eventual impacts of automation are not currently fully understood, but are the subject of intense research and debate.
Bitcoin	Bitcoin is a form of digital currency, created and held electronically. It is commonly referred to as a digital currency, digital cash, virtual currency, electronic currency, or cryptocurrency. The currency uses the decentralised edge computing technology known as blockchain to secure payments according to a centrally created set of transactional rules obviating the need for an agent such as a bank to validate the transaction.
Blockchain	A blockchain is a decentralized and distributed digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the collusion of the network. Constantly growing as 'completed' blocks (the most recent transactions) are recorded and added to it in chronological order, it allows market participants to keep track of transactions (such as transactions of the digital currency Bitcoin) without central recordkeeping.
Blockchain Ledger	A blockchain ledger, is a digital accounting ledger hosted on a distributed network. For more information see https://www.thersa.org/discover/publications-and-articles/rsa-blogs/2016/07/think-blockchain-is-all-about-bitcoin-think-again?
Cognitive surplus	The surplus of time, energy, knowledge and creativity which individuals can use to create and share knowledge or physical assets. The term was coined by Clay Shirky in the early '10's who asserted that the increase in available time outside of formal work, combined with increased use of the internet and social media leads to increased creation and sharing. Be it for personal, communal, public or civic ends. Examples of cognitive surplus in action include the creation of Wikipedia via public sharing, or the free exchange of goods via sites such as craigslist or freecycle.
Commons-based peer production	Commons-based peer production is a term coined by Harvard Law School professor Yochai Benkler to describe a new model of economic production in which the creative energy of large numbers of people is coordinated (usually with the aid of the internet) into large, meaningful projects, mostly without traditional hierarchical organization or financial compensation.

Crowdfunding	The practice of funding a project or venture by raising money from a large number of people who each contribute a relatively small amount, typically via the Internet. Prominent crowdfunding sites include Kickstarter, Indiegogo, Circleup, Angellist, Seedrs amongst others.
Cybersecurity	Cyber security comprises technologies, processes and controls that are designed to protect systems, networks and data from cyber attacks. Effective cyber security reduces the risk of cyber attacks, and protects organisations and individuals from the unauthorised exploitation of systems, networks and technologies. Cyber attacks can disrupt and cause considerable financial and reputational damage to even the most resilient organisation. The ability of governments, firms and individuals to manage their own cyber security has become increasingly important as much of the worlds public and private services move online, and is reliant on both national and international legal frameworks for its design and implementation.
Digital Development Principles	The Digital Development Principles were created in a community-driven effort, the result of many lessons learned through the use of technology in development projects. They set out key principles for how digital solutions should be adopted by stakeholders in order to support development, and are part of an ongoing effort among development practitioners to share knowledge and support continuous learning.
Digital dividend	The digital dividend refers to the radio spectrum which is released in the process of the digital television transition. However the phrase was also adopted in the 2016 World Bank Development Report to describe the potential economic dividend that developing economies could receive if they adopted digital solutions to aid development.
Digital inclusion	The ability of individuals and groups to access and use information and communication technologies. Reducing digital exclusion involves 1) ensuring people have the capability to use the internet to do things that benefit them day to day - whether they be individuals, SMEs or VCSE organisations, and 2) supporting access to digital technologies and services for all regardless of wealth, vulnerability, disability, location, gender, age or education.
Digital Trade Unions	New online advocacy groups and worker protection services which enable digital workers to vet potential clients, report clients who fail to pay for online services, or who mimic traditional trade unions in advocating for digital workers labour rights
Disruptive innovation	Disruptive innovation, a term of art coined by Clayton Christensen, describes a process by which a product or service innovation creates a new market and value network and eventually disrupts an existing market and value network, displacing established market leading firms, products, and alliances.
Fourth Industrial Revolution	The Fourth Industrial Revolution (4IR) is a global phenomenon rapidly changing how economies and societies function. New technologies ranging from nano-technology to advanced digital technologies are rapidly changing how products and services are delivered, and how our global economy functions creating threats to and opportunities for inclusive growth

Frontier technologies	New areas of technology that are emerging from R&D, and have the potential for disruption, but not at mass market commercial adoption yet. In a recent study IDS identified 10 technologies as having the potential to disrupt current development pathways. These included 3D printing, collaborative economy tools, Internet of things, Alternative Internet delivery, Unmanned aerial vehicles (drones), Solar desalination and mass energy storage.
Internet of Things	The network of physical devices, vehicles, home appliances and other devices embedded with electronics, software, sensors, actuators and network connectivity which enables objects to connect and exchange data. The analyst firm Gartner estimates that by 2020 there will be over 26 billion connected devices. This will enable an unprecedented level of interoperability between devices, enabling smart homes, smart cars, remote working, a wide range of e-health services and many other life changing solutions.
M-PESA	M-Pesa (M for mobile, pesa is Swahili for money) is a mobile phone-based money transfer, financing and microfinancing service, launched in 2007 by Vodafone for Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania. It has since expanded to Afghanistan, South Africa, India and in 2014 to Romania and in 2015 to Albania. M-Pesa allows users to deposit, withdraw, transfer money and pay for goods and services (Lipa na M-Pesa) easily with a mobile device.
Nano-Technology	Nanotechnology is the design, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale. Nanotechnology is providing an unprecedented understanding of materials and biological processes and is likely to impact many fields creating new materials and organisms
Online marketplaces	An online marketplace is a website or app that facilitates the exchange of goods or services between individuals, organisations or businesses. The operator of the marketplace does not own the goods or provide any services, but instead provides access to a catalogue of goods or services to potential users and facilitates transactions.
Peer-to-peer transactions	Where assets, currency, data or services are exchanged directly between people (peers), often facilitated by a digital or physical intermediary.
Ransomware	Malicious software from cryptovirology that threatens to publish victim's data or perpetually block access unless a ransom is paid
Smart City	The term 'Smart City' has been used to define both cities that utilise technology, and cities that are planned in a 'smart' or coherent manner. The term was initially used by technologists and large technology companies promoting the use of digital solutions to improve traditional city utilities and transport networks. In the '10's however the focus of the 'Smart' city has been on the use of technology to improve the lives of citizens in a holistic manner.
Synthetic biology	Design and construction of new biological entities (enzymes, genetic circuits and cells) or the redesign of existing biological systems
Ubiquitous connectivity	The ubiquitous interconnection of people and objects on a global network, which is likely to enable disruption of common business models e.g. by enabling peer to peer transactions