SMART TECHNOLOGIES FOR MORE EQUITABLE CITY ECONOMIES

Cities Alliance
Cities Without Slums

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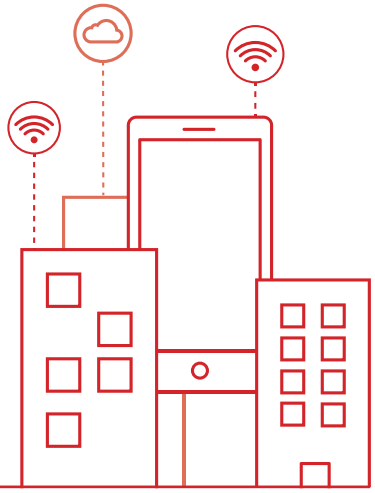

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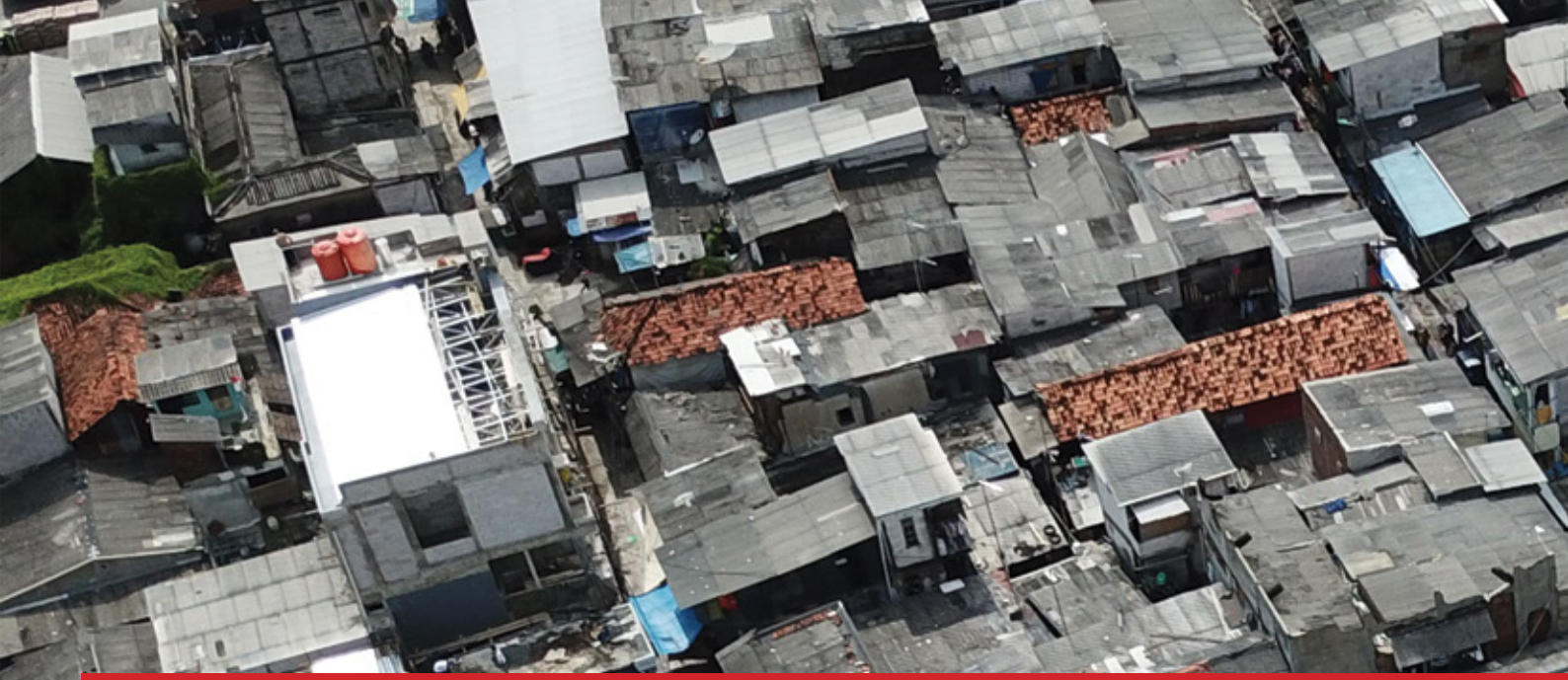


ABBREVIATIONS AND ACRONYMS

AFD	Agence française de développement (French Development Agency)
AI	Artificial Intelligence
CBO	Community-Based Organisation
CRM	Customer Relationship Management
CSR	Corporate Social Responsibility
DFID	Department for International Development (UK)
DRM	Disaster Risk Management
DWCC	Dry Waste Collection Centre
EPR	Extended Producer Responsibility
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSMA	GSM Association
ICT	Information and Communication Technology
ICT4D	ICTs For Development
IoT	Internet Of Things
ITU	International Telecommunication Union
M2M	Machine-To-Machine
MRF	Material Recovery Facility
PAYG	Pay-As-You-Go
QR code	Quick Response Code
SDG	Sustainable Development Goal
SHS	Solar Home System
SIDA	Swedish International Development Cooperation Agency
SME	Small and Medium Enterprise
UCLG	United Cities and Local Governments

EXECUTIVE SUMMARY

For the last decade, there has been a real interest in and enthusiasm for smart city initiatives, fostered by the deployment of information and communication technologies (ICTs) and related innovations. Mobile phones are the key drivers of the digital revolution in the Global South: 5.1 billion people around the world had subscribed to mobile services by the end of 2018. This trend has spurred many policies and projects all around the world based on technologies and data. These technologies and projects are rarely context-sensitive, however, and are little adapted to the urbanisation characteristics of the Global South.

In parallel, concerns on the equity or inclusivity of urban economic growth between different kinds of cities and for the poorest and most marginalised segments of societies have arisen in order to "leave no one behind". As a matter of fact, smart initiatives mainly take place in primary cities, which concentrate economic, social, and political resources, and benefit connected populations. Equitable access to ICTs, among cities and particularly for women and elderly populations, is not guaranteed. **The link between digital innovation and urban inclusion is far from obvious.**

This report looks at the way smart technologies can contribute to the inclusion of the urban poor in developing and fast-growing cities. It tackles the following questions: **what is the real potential and impact of new technologies in rapidly urbanising cities? Are the conditions met to achieve the promises of the digital revolution? To what extent do technology-related changes actually contribute to the inclusion of the urban poor?** Based on literature reviews of "smart city" and "ICTs for development" and two in-depth case studies, this study proposes a revised understanding of the smart city in the Global South and a theory of change that combines technological inputs, inclusive outputs, transformative processes, and risks. It concludes by highlighting the conditions of a multistakeholder governance framework that fosters inclusive digital innovation.

To do so, this exploratory work adopts a bottom-up perspective on actual uses of ICTs driven by the needs and agency of the urban poor, departing from idealistic visions. In cities of the Global South, where municipal capacities are constrained, most of the innovations are driven by third-party actors. Consequently, innovation happens in autonomous, unplanned ways, often out of the scope of local authorities. The paper offers evidence and courses of action to capitalise on these trends.

ICTs can be considered a "core" service, requiring infrastructures, equitable access to all and adequate regulatory framework; but they also impact the provision of other urban services, livelihoods and living standards of the urban poor. In cities of the Global South, the expected inclusive outputs of ICTs for urban development and inclusion can be categorised as follows:

- **Economic inclusion** and better livelihoods: access to employment, formalisation of enterprises, social security, tax and payroll e-payments, increased business performance and opportunities;
- **Sociospatial inclusion**, better access to and quality of urban services: online platforms, mapping of providers, e-payment and e-management of client relations and remote monitoring of infrastructures;
- **Political inclusion** in urban planning and management, thanks to the generation of data and maps on informal settlements and for crisis and disaster risk management.

The transformative effects unfold into three main functions: operational uses by removing barriers to entry on formal markets, transactional uses by reducing transactions costs and asymmetries of information, and informational uses by bringing evidence and "putting on the map" informal dynamics. However, the state of the art on smart cities and ICTs for development also shows that **technology is no silver bullet, and that local political economy and multistakeholder**

governance are key conditions for success. Over reliance on new technologies can have side effects such as technological determinism, substitution of public responsibilities, and the exclusion of the poorest of the poor, and can lead to economic and urban trade-offs that are critical in fast-growing cities where local authorities have little capacity.

The expected results shall therefore be tempered, as illustrated by the following two case studies on e-management of waste in Bengaluru (India) and pay-as-you-go solutions for off-grid solar systems in Arusha (Tanzania). The **inclusive impact of digital initiatives is still uncertain**, with fragile business models, a limited "trickle down" effect to the poorest of the poor and women, and dependence on the commitment of social intermediaries.

Given these limited results and cautions, the role of public authorities appears critical. Obviously, they are responsible for deploying telecommunication infrastructures, ensuring equitable access and digital literacy for all, and designing an appropriate regulatory framework for data management. But beyond creating an enabling environment — similar to the one necessary for any urban service — specific conditions appear critical when looking at ICTs:

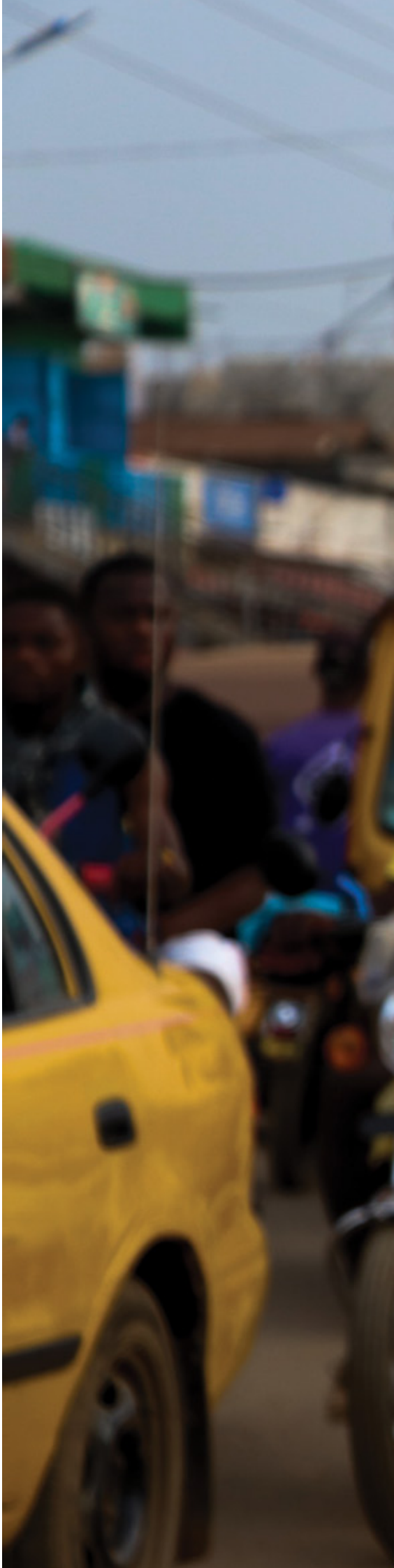
- ICT uptake is dependent on a pre-existing entrepreneurial or empowerment dynamic. To include the poorest of the poor in the digital transition, it is therefore important to develop location-based approaches for non-organised citizens. It relates to a **willingness to consider the legitimacy of grassroots digital solutions** for, with and from the urban poor.
- Digital stakeholders are not necessarily concerned by the needs of the poor, and when they are, they rely on fragile business models. Local policies and incentives, such as dedicated calls for projects, can **spur the interest from the private sector to develop digital solutions for the base of the pyramid**, and thus mitigate cherry-picking strategies.
- Data issues are overlooked, both by the private and the public sector. More broadly speaking, creating a **transparent and trustworthy environment, and making information publicly available** will importantly influence the willingness and trust to use digital services and solutions, especially in contexts of pervasive informality.

Furthermore, digital solutions have to be adapted to the target users — in our case, the urban poor. Specific **actions ought to be conducted by dedicated intermediaries**. The latter can train and increase productive digital literacy among the urban poor and ensure their involvement in a participatory process of designing digital solutions. Reciprocally, through public tenders or calls for projects, authorities can **direct the**

private sector towards relevant solutions that tackle an actual need or demand to consolidate their business models, and ensure that technologies remain simple, frugal and constantly adapted to facilitate uptake.

To do so, local authorities have a role to play in encouraging other stakeholders in collaborating. In other words, local authorities can make a difference in the way ICTs contribute to urban development, not only by developing infrastructures and regulations, but also by creating a **multistakeholder governance framework**. They can move from using technologies for strategic management to promoting data as the base of an open government. The collective provision of digital solutions may particularly be structured around data sharing. In that sense, **data become a common good, to be under the responsibility of local authorities**.

All in all, smart technologies **present a double challenge for urban authorities: ICTs constitute a basic service to be provided as such** — like energy, water and mobility — to foster economic, social and political inclusion; hence they are subject to the same challenges in rapidly urbanising contexts and require the same kind of specific design and management targeted to the urban poor. On the other hand, ICTs also have a **leverage effect on the provision of other urban services** by third-party stakeholders (private enterprises or NGOs/CBOs). To ensure the inclusion of all, and particularly the poorest, in the digital transition requires a **favourable environment and governance framework, even more than technologies and resources. This is within the reach of local authorities in the Global South**, provided they open decision-making processes and collaborate with all stakeholders, in a user-driven perspective.

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INTRODUCTION

TECHNOLOGIES AND URBAN INCLUSION IN THE GLOBAL SOUTH

For the last decade, there has been a real interest in and enthusiasm for smart city initiatives, fostered by the deployment of information and communication technologies (ICTs) and related innovations. This trend has spurred many policies and projects all around the world based on technologies and data. These however are rarely context-sensitive and are little adapted to urbanisation characteristics of the Global South.

In parallel, concerns on the equity or inclusivity of urban economic growth between different kinds of cities, and for the poorest and most marginalised segments of societies have risen. As a matter of fact, smart initiatives mainly take place in primary cities, which concentrate economic, social and political resources, and benefit connected populations. **The link between digital innovation and urban inclusion is far from obvious.**

This report looks at the way smart technologies can contribute to the inclusion of the urban poor in developing and fast-growing cities. It tackles the following questions: **what is the real potential and impact of new technologies in rapidly urbanising cities? Are the conditions met to achieve the promises of the digital revolution? To what extent do technology-related changes actually contribute to the inclusion of the urban poor?**

1.1. ICTS IN THE GLOBAL SOUTH

Smart technologies developed at an unprecedented rate in the world over the last decade; they encompass a wide range of technological and technical tools (Box 1), but also entail and require innovations and investments in human and social capital (United Cities and Local Governments, 2017). More particularly, information and communication technologies (ICTs) are the locus of innovation, have the fastest rates of penetration in the Global South and attract the efforts and support of international donors.

1.1.1. The exponential access to ICTs in the Global South

According to the Global System for Mobile Communications Association, 5.1 billion people around the world had subscribed to mobile services by the end of 2018, i.e., a worldwide mobile penetration of 67%. **Mobile phones are the key driver contributing to the explosion in the use of ICTs in developing countries** (Walsham, 2017). More specifically, the International Telecommunications Union (ITU) findings showed that the African continent has, since 2005, leaped from 12 mobile subscriptions per 100 inhabitants to 76.

This accessibility continues to expand: by 2025, nearly 5.8 billion people will have a mobile phone (i.e., 71% of the population), 50 to 80 billion objects will be connected, and data traffic will increase tenfold as well as active-mobile broadband subscriptions (Figure 1). The number of Internet users globally increased from 1 billion in 2005 to 4.3 billion in 2019 — representing 57% of the world's population.

FIGURE 1 | Mobile subscriptions (millions, * Estimate) Source of data: ITU World Telecommunication/ICT Indicators database. Higher subscription level in Asia & Pacific is due to demographics

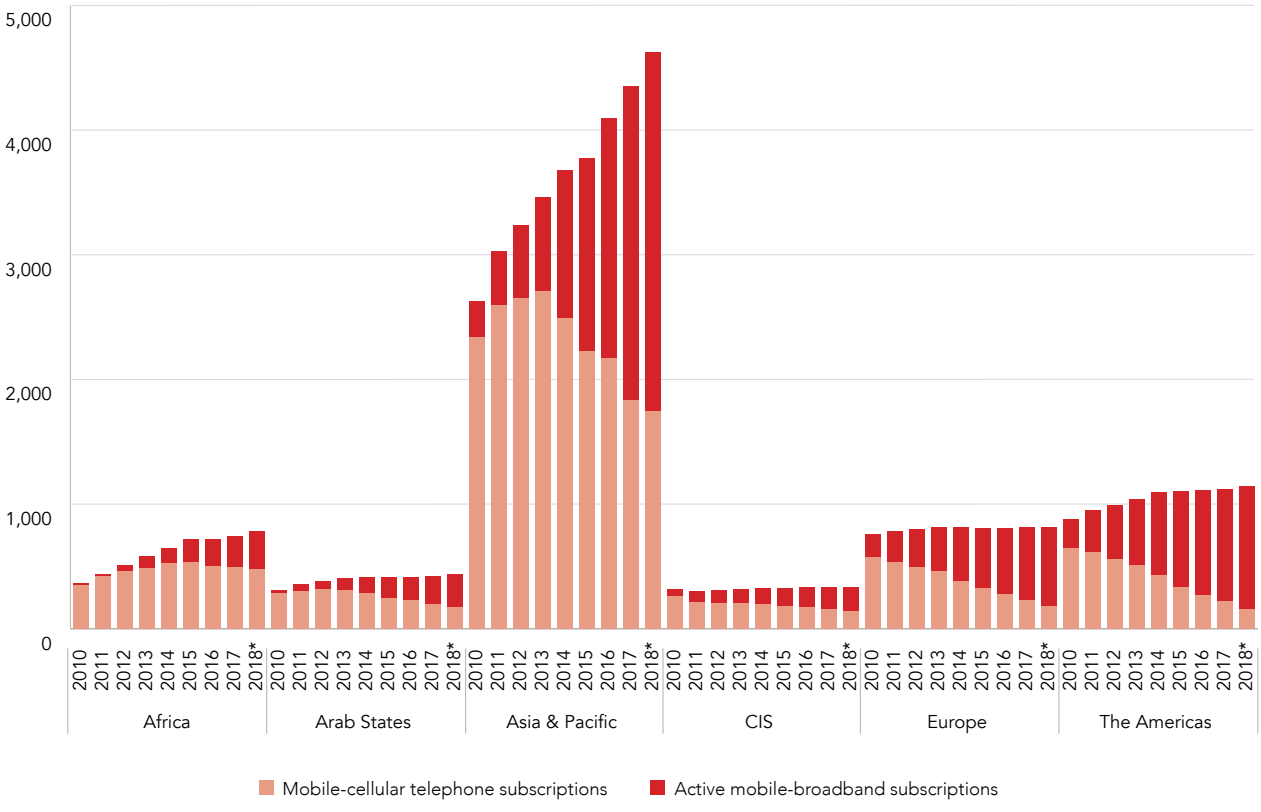
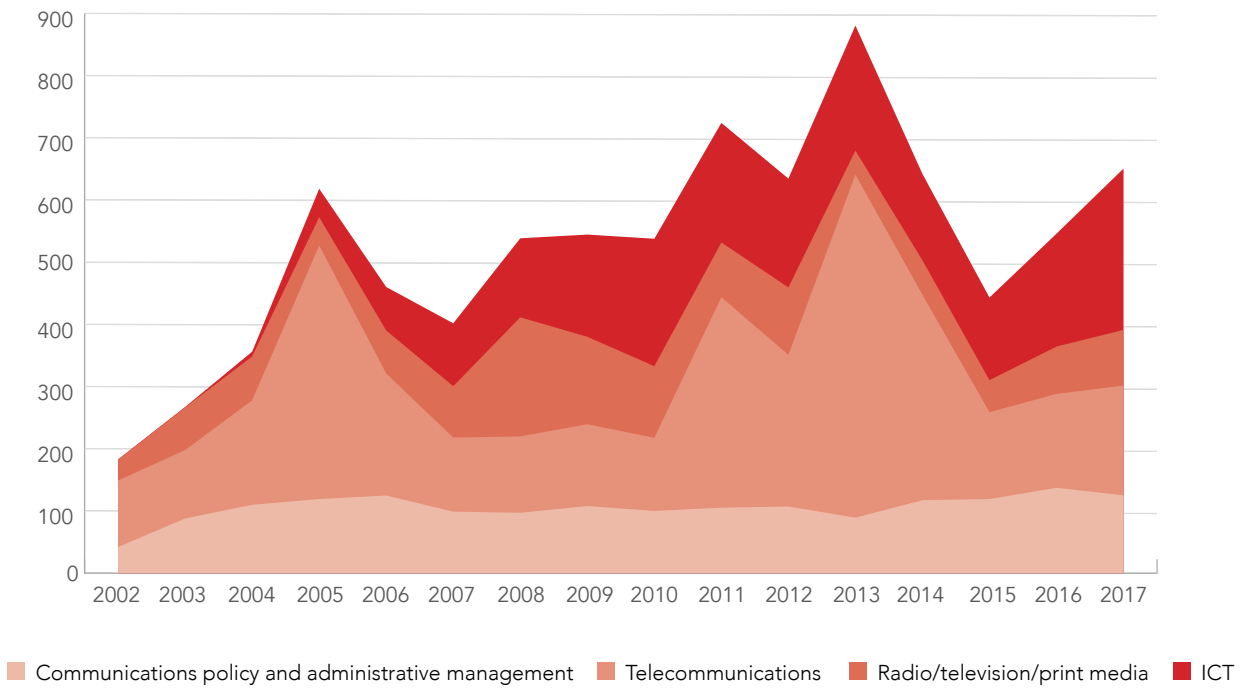


FIGURE 2 | Official development assistance disbursed to sub-sectors of communication (2017 constant USD million) (Source of data: OECD-DAC, ODA statistical database)



While the digital revolution is taking place at an unprecedented scale and speed, many challenges remain, particularly in the Global South. **It requires large infrastructure facilities, connectivity and access, i.e., financial and physical but also human and social investments**. The extension of equipment, services, start-ups and applications is still recent, and it mainly begins in primary cities before reaching out to the rest of countries. Most secondary cities still have limited connectivity, which may hinder the development of smart technologies.

However, data- and investment-scarce situations do not necessarily mean the digital transition is not on its way. As a matter of fact, it may happen out of the scope of public authorities, through autonomous, unplanned initiatives similar to informal urbanisation trends. The digital sector is no exception to self-help, bricolage and petty trade, businesses and services. Besides, IT clusters, universities, and international firms may create environments that foster private investments in developing IT infrastructures and services for urban dwellers.

1.1.2. ICTs in international development strategies

The UN's Sustainable Development Agenda 2030 recognizes ICTs and digital technologies as essential to accelerate human progress, and transversal to all the Sustainable Development Goals (SDGs). These changes have led international donors to innovate in their approaches for ICTs, progressively shifting from financing telecommunication infrastructure for connectivity to providing assistance for digital capacity-building and supporting entrepreneurship ecosystems: institutional readiness, business models, data management, automation, digitisation (Annexure & Figure 2). This trend dates back only to the early 2000s, but increasingly takes over traditional approaches.

As to the allocation of the efforts, mainstream initiatives target one kind of stakeholders in adopting digital solutions: conventional digital capacity-building directed at public authorities to deliver services, support to entrepreneurship for the private sector (start-ups, innovators, etc.), or improving digital literacy to empower vulnerable communities (Annexure).

Box 1: New, smart, frontier technologies and ICTs

There is no definitive list of smart technologies. "Frontier technologies" can encompass big data and blockchain; the Internet of things (IoT), such as censors or drones; bio- and nanotechnologies; artificial intelligence (AI); additive manufacturing (3D printing); renewable energies; drones and satellites (OECD, 2019; UNCTAD, 2018; UN-DESA, 2018). More particularly, ICTs are at the convergence of telecommunications (radio, TV), broadcasting and multimedia.

The recent, global, fast and widespread penetration of mobile phones (simple handsets, features phones or smart phones) have shifted the trend from PC-based solutions to wireless telephony and uses from text to basic voice communication (Donner, 2007). On these, the Internet and other digital applications are linked, generating an exponential amount of data. The notion of digital technologies thus encompasses the mobile-based or mobile-plugged solutions that contribute to the digitalization, datafication, and dematerialisation of processes. Lately, the interest in technologies in cities, urban policies and planning has shifted to focus more particularly on ICT development (United Nations Conference on Housing and Sustainable Urban Development, 2017).

1.2. EQUITABLE ECONOMIES IN ORDINARY CITIES

Equitable economic growth has been defined as:

> Long-term sustainable economic growth that creates economic opportunity in the form of decent and productive employment in both the formal and informal sectors that may be accessed by all of society regardless of economic status, gender or ethnicity, thus enabling all of society to both benefit directly from and participate in economic activity and future growth.
>
> — Rodríguez-Pose & Wilkie, 2015

1.2.1. Equitable economic growth and urban inclusion

The notion of equitable economic growth contributes to the SDGs' commitment to "leave no one behind". The idea that economic growth shall "*benefit the poorest segments of society to a greater extent, and thus reduces inequalities and exclusion, although not at the expense of the rest of the society*" (Rodríguez-Pose & Wilkie, 2015) asserts that the main focus shall be the most marginalised.

Further conceptualization has highlighted that "*national and local governments need to prioritise poverty reduction through the provision of basic infrastructure and services*" (Colenbrander, 2016), and that "*prioritising the delivery of services and infrastructures is a key component of a long-term urban strategy that considers economic and social development along with environmental protection*" (Beard et al., 2016). From that perspective, the contribution of public services to urban development is not limited to the economy, hence inclusive growth should not be

measured only through income generation: it also encompasses social dimensions of wellbeing and living standards. Equitable access to land, housing, water and sanitation, energy, and transportation will have a transformative impact on economic productivity; conversely, "*when large segments of the urban population suffer from inadequate access to core services, there are economic and environmental consequences*" (Beard et al., 2016).

Considering that about one quarter of the global urban population lives and works in slums — including up to two thirds of the population of Sub-Saharan Africa — **this paper adopts a broad understanding of equitable economic growth, looking at livelihoods, employment and economic opportunities on one hand, but also at access to basic services and inclusion in planning and policy design on the other**. The premise is that urban poverty and exclusion is multidimensional: the urban poor will be sustainably and equitably included in the city through the improvement of living standards, both social and economic capital and opportunities, i.e., by tackling altogether economic and socio-spatial exclusion.

1.2.2. Actual and ordinary digital practices

Measures to promote equitable economic growth can be either spatially blind, focusing on individuals or socioeconomic groups, or place-based. The latter approach is more appropriate when considering cities of the Global South (Rodríguez-Pose & Wilkie, 2015). Indeed, the heterogeneity of urban environments and the necessary mobilisation of local potential will vary from city to city (Rodríguez-Pose & Wilkie, 2015). More particularly, secondary cities with scarce resources and capacities face specific challenges that call for policies tailored to territories.

Depending on contexts, the constraints local authorities face may be overcome or circumvented. Above all, this requires **abandoning "best practices", ideals and fantasies or models emerging from Northern or primary cities** (Bhan, 2014; Watson, 2014). Indeed, the so-called "fourth revolution" has led to the emergence of a dynamic digital sector in the global economy, anchored in primary cities. It is based on the concentration of economic, social and political power and on the density of populations, businesses and capital. Though it may contribute to make cities centres of creativity, innovation and productivity, it can also have negative effects on jobs, trade opportunities and revenues (UNCTAD, 2017).

Besides, the greatest increase in population is expected in secondary cities of the Global South. There, the urban economic and institutional environment may not be attractive enough for the digital sector *per se*. **Secondary cities may be relatively disconnected from the "digital economy" vibrancy.** Nonetheless, new technologies are not limited to the digital economy or tech-clusters. They have also percolated into all sectors and geographies, are permeating telecommunication uses, opening new business opportunities, changing the way urban services can be provided, facilitating relations between administration and population, generating information of urbanisation patterns, and more.

To account for these understudied, scattered but also pervasive changes, this paper focuses on **actual uses of ICTs by urban dwellers in ordinary cities** (Robinson, 2006), embedded in local dynamics. By doing so, it looks at what is happening — and not what might happen — in terms of ICT uses (Heeks, 2010). In this way, it informs what constitutes a "real" (Hollands, 2008), "alternative" (McFarlane, 2016) or "actually existing" smart city (Kitchin, 2015; Shelton et al., 2015), taking into consideration the context of ordinary cities of the Global South.

The actual impact of widespread penetration of ICTs in informal urban contexts calls for further evidence and a revised understanding of smart cities in the Global South. This paper aims to **investigate the extent, dimensions and ways ICTs can contribute to urban inclusion** to explore what could and should be done to **transform the promises of the smart city into realities** in the Global South. Through a theory of change, the purpose of this paper is to look at how to enhance the role of ICTs for urban inclusion. This entails two sets of sub-questions:

- How can ICTs influence livelihoods, access to services, and habitat standards and opportunities for the urban poor? Are they indeed relevant tools? What uses and impacts can be observed? Under which conditions and with which limits do they deliver positive results?

- What can stakeholders do to foster this potential? How can they rely on ICTs to facilitate inclusion of urban informal economy and settlements into city development and governance? How can they partner to enhance existing resources, skills and solutions in data- and investment-scarce contexts?

1.3. A BOTTOM-UP PERSPECTIVE ON DIGITAL INITIATIVES

1.3.1. Initial assumptions on enabling environments

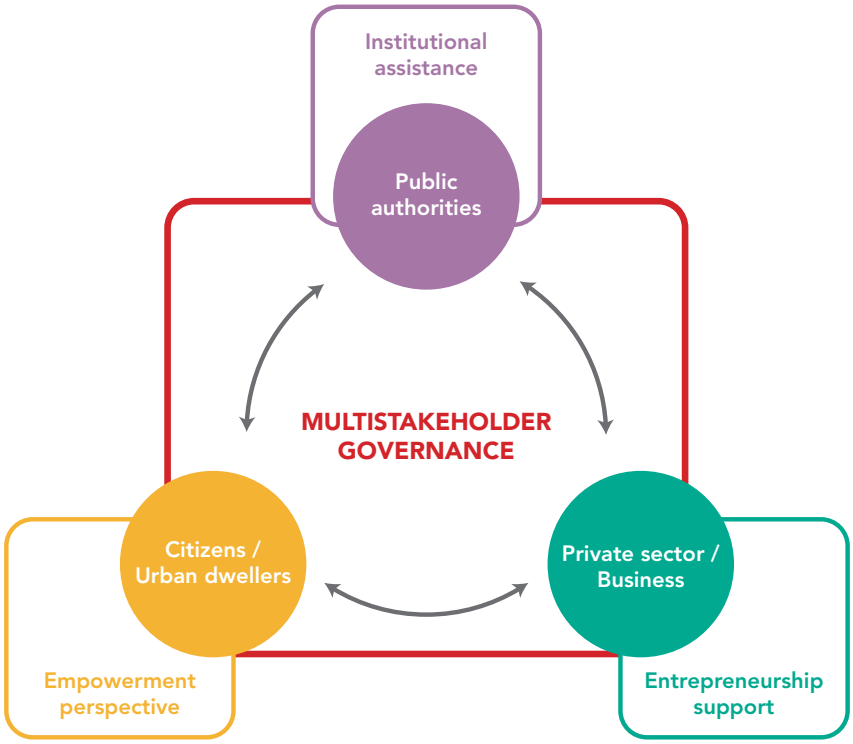
The institutional and sectorial contexts must meet some preconditions for digital initiatives to be relevant and fruitful for urban development. They can be defined as an ICT-enabling environment (United Nations Conference on Housing and Sustainable Urban Development, 2017) and include the following:

- **Infrastructure and platforms** (digital solutions, public data, telecommunication infrastructure and networks): the deployment of supportive technical infrastructure for ICT, the existence of a digital economic sector *per se*, and the quality (reliability and affordability) of connectivity are the underlying physical support for digital innovations. The deployment of networks and connected services depends on dedicated large-scale projects and financing (cf. Figure 2). It is not studied in this paper, which tackles the changes and possibilities created by the arrival of ICTs in already existing urban activities or traditional urban sectors (income-generating activities, housing, service provision, etc.).
- **People – resource and capacity** (digital literacy, civic engagement): first of all, physical access is still unequal in many parts of the Global South; second, ICT availability does not necessarily mean affordability, literacy, and uses by all, and it depends on individuals' social status. Specific initiatives directly focus on the digital divide. This study does not tackle the issue of digital inclusion, but analyses evidence on uses based on the assumption that the urban poor and their counterparts (clients, banks, administrations) are digitally equipped and literate, at least with a mobile phone — even if without a broadband connection, which is often the case (Figure 1).
- **Transparent governance** (ICT regulatory frameworks, accountability, transparency): last but not least, an adequate regulatory framework for ICT networks, markets and data management is decisive in order to foster the development of digital initiatives, services and solutions. The implementation of such a framework often benefits from dedicated technical assistance projects (cf., Figure 2). Likewise, at the local level, local authorities can be supported in adopting e-governance and e-administration tools and processes. However, these approaches are limited to the public sector and follow a specific institutional capacity-building logic that has already been studied, and hence is partially left aside in this paper.

These three preconditions relative to ICTs are quite close to those that influence the provision of other urban services, such as water, sanitation, and electricity. Indeed, all require a physical infrastructure to distribute the public good, whether water, energy, or data; carry social accessibility challenges, particularly for slum and informal settlement residents and workers; and need institutional frameworks to regulate public and private provision. From that perspective, **ICTs can be considered a core service like the others** (Beard et al., 2016).

In the Global South, these preconditions mainly depend on national regulatory frameworks, large capital investments for infrastructure and long-term digital education that are often beyond local authorities' capacities and responsibilities. It is therefore considered as initial assumptions that

FIGURE 3 | A multistakeholder perspective at the crossroad of public, private and community approaches towards technologies



these minimum preconditions are met, in order to further explore the contributions of ICTs for urban development and inclusion. In other words, this paper does not analyse ICTs as a core service *per se* (deployment of infrastructures, social dimension of digital inclusion, adequacy of regulations), but focuses on the uses that can stem from these, the way **ICTs can contribute to the provision of other urban services**.

1.3.2. A multilevel and multistakeholder perspective

In cities of the Global South where the public provision of services is insufficient or deficient, and where informality is pervasive, the lines between public and private provision are blurred through the multiplicity of actors (Cohen et al., 2019). In the digital sector, **the scale, recent character and speed of disruption is particularly acute; it mobilises a variety of new stakeholders and generates autonomous unplanned uses**.

Successive waves of digital technology have deeply transformed multistakeholder governance arrangements, and entailed specific approaches to accompany the digital transition, either per technology (Figure 2) or per actor — empowering citizens, supporting entrepreneurs or building public capacities (Figure 3).

On the one hand, new business models and efficiencies driven by digital technologies enable the private sector to deliver basic services; on the other, civil society makes use of digital technology as a tool to build capacity and strengthen participation in decision-making. Over the last five years, the entrepreneurship ecosystem, through incubators, accelerators, and tech hubs, has grown tenfold in Africa. All these actors use ICTs, but with their own resources, skills, and interests.

In order to grasp the new dynamics, a more horizontal and even bottom-up perspective is needed. The focus on public authorities at the core of local governance models, from a top-down perspective, is undermining and too restrictive. Public authorities constitute one stakeholder

among others; their place, role, and responsibilities have to be reconsidered along with — and not ahead of — those of third-party initiatives and agents. In fact, public authorities may even lag behind, in terms of digital transition, and thus face the risk of being overwhelmed by new trends (Criqui, 2017). **In order to understand how ICTs can contribute to urban development, this paper will therefore focus on the new relationships that emerge** directly between third parties (urban dwellers and businesses), before analysing the potential role for local authorities and more generally the structuration of a multistakeholder governance framework (Figure 3).

1.3.3. Outline

The following section consists of state-of-the art practices related to new technologies in cities of the Global South (section 2). It examines the literature on smart cities and on "ICTs for Development" to identify useful methodologies and lessons (section 2.1). Most of digital initiatives are still early stage; however, desk review of reported evidence from practices allow the mapping of a series of ICT-related changes in various urban sectors (section 2.2). Thereafter, technological inputs and inclusive outputs, transformative processes, and risks are synthetized in a conceptual model that offers a revised understanding of the smart city in the Global South (section 2.3).

Inspired by this conceptual model, two in-depth case studies then provide evidence on local factors of success, challenges, and developmental impacts of new technologies (section 3). Based on these, general lessons can be drawn as to the conditions of change and actions to be taken (section 4.1). The conclusion draws initial recommendations to develop a multistakeholder governance framework towards ICTs for inclusive urban development (section 4.2). The annexure presents a benchmark of some recent international initiatives to situate the work and how it features in international agendas.

2 CONCEPTUAL MODEL

ICTS FOR URBAN DEVELOPMENT IN THE GLOBAL SOUTH

Two literature corpuses — on smart cities and on ICTs for development (ICT4D) — offer promising avenues towards understanding how ICTs can contribute to urban inclusion in the Global South. Smart city studies shed light on political economy and institutional factors, while ICT4D studies focus more on micro-level empowerment and poverty issues. Both fields argue for more evidence-based and empirical works to question hegemonic narratives.

This paper does not go into epistemological debates on what constitutes a smart city or whether ICTs do or do not contribute to social inclusion. Instead, it aims at contextualising further the existing findings: anchoring smart city debates within contexts of the Global South and translating ICT4D lessons into urban settings. Linking evidence with considerations of equitable economic growth and outputs, the model aims to propose a conceptual framework for ICTs for urban development.

2.1. STATE OF THE ART: LITERATURE REVIEWS

> The 'smart city' discourse has not really been considered in the development studies literature […] there is little literature on smart cities in the Global South, with the premise that such a focus does not necessarily fit into the ICT4D literature.
>
> — Odendaal, 2016

Smart city narratives have appeared primarily in the Global North, and narratives on ICTs for development have mainly emerged from rural experiences. Although still subject to epistemological scrutiny and evolution, the review of these two streams highlights some knowledge gaps related to the role of ICTs for urban inclusion in the Global South.

2.1.1. "Smart cities": buzzword or keyword?

The notion of the "smart city" has emerged over the last 10 years under the impetus of major private digital corporations. Progressively, best practices or smart city models have gained normative strength, popular acceptance, and traction among policymakers and in the media. This enthusiasm should be cautiously considered, however, since it can veer towards fantasies of "smart utopias" (Anthopoulos, 2017) that may be neither relevant nor desirable in terms of social justice (McFarlane, 2016; Watson, 2014).

COMPETING NORMATIVE VISIONS

As initially understood, a smart city uses ICTs to increase efficiency and performance in urban management, thanks to censors, data, algorithms and automation. This approach draws the ideal type of a technologically enhanced and rationalised city (Townsend, 2013) using big data to inform decision-making (Bouskela et al., 2016); e-government to better manage taxes, transactions and services; social accountability tools to improve citizen engagement; and online marketplaces to foster economic competitiveness.

However, some critiques have highlighted the lack of critical analysis and ambiguity of the concept:

- The term "smart city" conveys underlying **neoliberal assumptions** (Kitchin, 2015; Lombardi & Vanolo, 2015; Nam & Pardo, 2011). Since initially coined by the private sector, the values of high-tech entrepreneurial cities may prevail, in a logic of new public management and efficiency (Odendaal, 2016), where local authorities would favour infrastructures or businesses at the expense of social justice and environmental sustainability agendas (Hollands, 2008).
- The model appears to be **top-down and supply-driven**, with service offers made by large technology firms to local authorities, disseminating one-size-fits-all and corporate-driven solutions, disconnected from application contexts, **ignoring the complexity of social and political power relations within cities** (Shelton et al., 2015), **bottom-up initiatives** and the way urban dwellers themselves perceive and seize digital opportunities (Kitchin, 2015).
- The **technology bias** tends to underlie claims of neutrality and depoliticization regarding urban issues. It is based on the hypothesis that an upstream information value chain, along with the addition of digital technologies into urban settings and of data in decision-making, would be enough to deliver urban development (Heeks & Shekhar, 2019). However, beyond the volume of data produced, the institutional arrangements for coordination, regulation, and management of data are critical (Edwards et al., 2016).

Therefore, the notion of "smartness" has been progressively enriched by **adding "soft" (i.e., social) dimensions to "hard" infrastructure** (Angelidou, 2014; Neirotti et al., 2014) to cover

issues of governance, sustainability and well-being. This vision includes participation, collaboration and construction of a consensus. In this perspective, **new technologies can only be transformative if they are accompanied by organizational, regulatory and political changes** (Edwards et al., 2016; Rodriguez-Bolivar, 2015).

These visions illustrate diverging and constantly evolving normative conceptions of what smart urbanism or smart urban planning ought to be and pursue.

IMPRECISE POLICY ORIENTATIONS

Since there is no one, single type of smart city, **smartness depends on the way smart city agendas are implemented:**

- **Smart city agendas are actually aligned with, dependent on and serve broader political agendas** and choices of development pathways (Odendaal, 2016).
- **Smart city agendas focus on goals or promises**, but do not bring clear orientation as to the appropriation and implementation modalities of digital solutions and tools, depending on local contexts and capacities (Criqui, 2017).

Research on the smart city has thus attempted to open the black box to grasp how ICTs deploy into and impact urban contexts (Albino et al., 2015; Nam & Pardo, 2011; Neirotti et al., 2014). Several cross-cutting proposals coexist to conceptualise the smart city; they can be synthesised along three main lines:

- **Normative approaches to explore the names and attributes** of the smart city, resorting to alternative or complementary adjectives to circumscribe what "smartness" is: digital, connected, hybrid, informational, creative, intelligent, learning, progressive, entrepreneurial, and more;
- **Listing the content and domains of applications** of the smart city by identifying the dimensions, facilities, and services impacted: people, economy, governance, mobility, environment, quality of life, natural resources, housing, etc., revealing that all urban sectors are affected by the introduction of ICTs;
- **Focusing on the internal processes and performance of governance and planning** of the smart city, to explore the success conditions — management, organisation, partnerships, public policy — influencing the way smart technologies are implemented (Chourabi et al., 2012; Criqui et al., 2018).

Beyond the definitional impreciseness (Hollands, 2008), a common denominator remains in all smart city approaches: **ICTs and the production of data**

Box 2: Digital tools for e-governance, social accountability and e-administration

Smart city approaches predominantly focus on digitalization and the introduction of e-government tools, their impact on administrative efficiency, management and governance (OECD, 2019), and the need to adapt policies to reform administrations and build capacities to drive change. These digital tools encompass the following (Relhan et al., 2012):

- *E-governance tools*: e-revenue (e-billing, e-taxes), e-authorization (e-registration, e-permits, e-contracts), e-procurement (financial management systems), e-citizen development (e-employment, e-health, e-education), e-municipalities;
- *Social accountability tools*: surveys, citizen outreach, digital publication of performance data, e-participation mechanisms (blogs, discussion groups, social networking);
- *Administrative tools*: GIS, databases and data management solutions to monitor and optimise the provision of services and increase the efficiency of administrations and decision-making.

Besides advanced strategic management, digital tools can be used to foster more open governments, creating new spaces for citizens' participation. This logic of open government relies on increased transparency and accountability, public participation that goes beyond simply asking opinion to co-designing with citizens, a deepened collaboration with private sector and other stakeholders, and open data (United Cities and Local Governments, 2020).

These complementary approaches are critical for local authorities not to fall behind in digital transitions and innovations (Criqui et al., 2018). Smart city programmes based on e-governance are proposed by most donors (Annexure), but mainly through the prism of institutional assistance support to internal and administrative management *per se*. Besides, e-governance initiatives are also strongly dependent on national regulatory frameworks, laws and policies, related to both decentralisation and the ICT sector.

in and on cities (Hasler, 2017). On that basis, key stakeholders have drafted working definitions in which **ICTs — and data — are not considered as a goal in itself, but rather as tools and enablers to enhance the provision and access to urban services, housing and livelihoods**.

KNOWLEDGE GAPS FOR THE GLOBAL SOUTH

Existing works on smart cities cover almost exclusively Western cities, although they sometimes include Asian cities such as Taipei, Songdo or Singapore and large emerging capitals in Africa (cf. Anthopoulos, 2017; Backhouse, 2015). The proposed visions and tools are consequently very intensive in terms of capital, data, and

> A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects.
>
> — International Telecommunication Union, 2016

technology. **In ordinary cities of the Global South, where capacities and challenges differ, little knowledge exists on this trend.**

This geographical bias leads to a **functional bias** focused on the performance and efficiency of public services and administrations and/or improving citizen participation, i.e., relatively sophisticated uses (Odendaal, 2016). The relevance of these uses for investment- and data-scarce cities, where informality is predominant, can be questioned. Combined with the general criticisms towards smart city agendas, even more crucial shortcomings appear:

- **Demands from local authorities for smart solutions are still very timid, and when they exist, they often mirror digital fantasies** (Bhan, 2014; Watson, 2014). Moreover, a lot of concrete projects are initiated by international donors (Annexure) and/or directly emerge from the business sector and civil society. City authorities run the risk of embracing visions and tools that are irrelevant within the context of their cities.
- Debates have focused on grasping the meaning of "smart", without sufficiently questioning the term "city" in a model. Indeed, what is considered a "city", by default, is the local authority and its political and administrative institutions, assuming it has the capacity to conduct and implement a full digital transformation and engage for effective smart urban planning. This perspective therefore remains relatively top down and inward looking. However, **many cities of the Global South face challenges in implementing public policies due to financial, human, and organisational constraints, while initiatives from third-party entrepreneurs and communities are equally and sometimes even more dynamic** (Criqui, 2017). These specific constraints are largely overlooked by current literature.
- Finally, very few works analyse the contribution of ICTs to urban inclusion and the fight against urban poverty. Most ignore the new relations that ICTs foster at the base of the pyramid and for businesses, and their impact on access to basic services for all (Odendaal, 2016). Moreover, **basic data on the urban poor is still often unavailable** and difficult to collect (Edwards et al., 2016). Yet, the lack of data does not mean that there are no issues to be tackled; over-reliance on data can lead to ignoring critical — if technologically invisible — social issues. Hence it is necessary to adopt **location-based approaches to incorporate non-organised citizens** in processes of digital innovation (United Cities and Local Governments, 2020).

Considering these limits, empirical investigation on the actual uses of ICTs in ordinary contexts for urban development remains to be produced, i.e., to look at smart realities (Anthopoulos, 2017) in cities of the Global South, from neither an idealistic nor a critical point of view (Kitchin, 2015; McFarlane, 2016).

2.1.2. From "information for development" to ICT4D 2.0

In order to enrich the smart city approach by viewing it through an international development lens, contributions from the field of ICTs for development are inspiring. Though not stabilised yet (Heeks, 2007), the framework and lessons from ICT4D allow researchers to tackle some of the limits of smart city knowledge.

MAINSTREAMING ICTS FOR DEVELOPMENT

The emergence of ICTs on the international development agenda follows a "4Is" chronology (Heeks, 2010):

- **Ignorance**, until the 1990s with ICT4D mainly limited to computers and information systems (Walsham, 2017).
- **Isolation** from mainstream development policies in the 1990s, limited to the provision of information technology and tools for governments, for better internal public management. The dimensions of communication and social capital were not included.
- **Idolisation** in the late 1990s, inspired by modernisation theory in which leapfrogging opportunities would automatically appear with pervasive penetration of ICTs (Zheng et al., 2018). ICT4D interventions focused on technology-as-invention rather than technology-in-use, and a supply-driven

approach rather than an inclusive pro-poor perspective. Attention was given to the foundations of ICTs (availability of technology and readiness to use them — digital literacy) rather than actual uses by people.

- **Integration** of ICTs into development interventions, or ICT4D 2.0 for the last decade, taking advantage of the exponential penetration of digital solutions, the time-space compression and the shift from public / shared uses of communication to individual / private uses. In terms of conceptualisation, it also shifted from positivism to critical realism (De´ et al., 2018; Heeks & Wall, 2018), thus moving away from the implicit acceptance that ICTs necessarily contribute to socioeconomic development.

This last stage is under way and may still open new avenues for development. Technologies, but also social change related to their adoption and policy frameworks are still early stage, and any attempt at taking stock of these is necessarily provisional.

METHODOLOGICAL APPROACHES FOR ICTS

The field of ICT4D is based on an underlying foundation: **ICTs are sociotechnical systems, i.e., technology and society influence each other; ICTs are not just hardware and software, they involve people, processes and institutions** (Heeks, 2016).

Lately, the ICT4D field has also drawn largely on new developmental approaches such as social business and corporate social responsibility (Hart & Christensen, 2002); the notion of the "base of the pyramid", where the poorest but largest socioeconomic groups are not only potential customers, suppliers, and markets to be valued, but also creative and innovative agents for development (Foster & Heeks, 2013; Simanis & Hart, 2006); and Sen's human capabilities and livelihood approaches (Avgerou, 2010; Loh, 2015). **These works thus propose to adopt a user-driven approach, where the poor or digitally excluded are not beneficiaries of developmental charity, but agents for change**. Consequently, works should give less emphasis on what might be used: Internet and PCs, fundamental technical innovation, and piloting and sustaining new applications, and more emphasis on what is actually used: mobiles, radio, television, application and business model and innovation, assessing and scaling existing applications (Heeks, 2010).

There is therefore an increasing consensus towards adopting micro-focused, bottom-up approaches (Adera et al., 2014). The call for contextualised evidence on how ICTs are embedded in socioeconomic structures leads to giving more importance to social, political, and economic determinants of access, use, and appropriation of ICTs by the poor. More particularly, it defends empirical and user-oriented approaches (Andoh-Baidoo, 2017), which take into account social actors' agency in the processes, as well as the politico-institutional contexts (Walsham, 2017).

TRANSFERRING LESSONS FOR DEVELOPING CITIES

Case studies on ICT4D have mainly been conducted in rural areas; access and literacy were central to ensure the rural poor could benefit from the opportunities offered by ICTs, **and most of the initiatives cover the fields of education, healthcare, finance/business and agritech**. A few case studies in urban contexts have likewise looked mainly at access and literacy divides (Barrantes, 2008; Bowora & Chazovachii, 2010; Mariscal & Martínez, 2014; Nair & Vaithilingam, 2013; Omole, 2013; Rangaswamy & Nair, 2012; Sarin & Jain, 2009).Without pretending to completeness, these works converge towards unravelling some myths about ICT4D (Loh, 2015) and defend a few key lessons:

- The focus of ICT4D shall remain **on reducing poverty and vulnerability rather than on ICTs**; ICTs are a tool rather than a need in itself (Njoki & Wabwoba, 2013). They can have positive or negative impacts, depending on the local political economy, governance framework, and commitment of concerned stakeholders to foster inclusion of the poor. Up to now, ICT4D has not produced universal and uniform conclusions on whether ICTs alleviate poverty or, on the contrary, may deepen exclusion in particularly unequal societies (Adera et al., 2014).
- There is a broad consensus that **ICTs alone cannot provide simple and linear solutions to complex social problems**; each action requires a nuanced understanding of the socio-technical processes and context (Zheng et al., 2018). Particularly, the poorest of the poor do not engage with technologies spontaneously but with support from intermediaries and through targeted action.
- There is a large predominance of mobile phones usage over other equipment such as PCs, GPS, and tablets (Bowora & Chazovachii, 2010). Though mobiles are prevalent in the Global South, **their use may lack sophistication**. At the early stage of use, people may use mobile phones mainly for traditional communication with their relatives (Ilavarasan, 2019). The use of mobile phones as professional tools can often be delayed (Ilavarasan & Otieno, 2018).

These warnings echo the limits and knowledge gaps in the smart city literature as to the context of the Global South. Indeed, many underlying theories of technology diffusion and innovation were originally developed in Western countries and appeared irrelevant when exported to the Global South (De´ et al., 2018). Likewise, the transfer of solutions and processes from rural to urban areas requires specific attention, considering the social, economic, political, and spatial differences in contexts.

2.2. STATE OF PRACTICES: ICT IMPACTS IN URBAN DEVELOPMENT

Very little work has been conducted on urbantech, e-cities, or ICTs for urban development and poverty reduction *per se*. Nevertheless, there is a real excitement around digital solutions in cities of the Global South[1]. Initiatives have spured interest, but to date there is a lack of hindsight and of a comprehensive conceptual framework to take stock and consolidate lessons on actually existing smart cities. The observed impacts of ICT4D in urban settings may be explored by first categorising the outputs per sector/dimensions of urban inclusion found in the literature.

2.2.1. Economic inclusion: employment and entrepreneurship

Smart city literature deals with new economic opportunities and threats at the city scale but does not go down to the micro-level of changes. Although recent studies on the future of work in the digital economy highlight that urban economies offer large job opportunities, in the Global South, access to formal jobs is a challenge for the urban poor. However, ICT4D literature contends that mobile phone ownership impacts livelihoods of the urban poor (Casey, 2015); it shall be noted that since most of the informal economy is constituted of micro- or small enterprises with self-employed workers, issues of employment and entrepreneurship may overlap.

Besides, **comparing the promises of ICTs in formal organisations (efficiency, profitability, growth) with the informal sector — where small-scale, social embeddedness and reciprocity prevail** — is to be cautiously handled, and may actually demand different perspectives (Seetharaman et al., 2019).

ACCESS TO JOB MARKETS

Online platforms for advertising job openings and for applying to jobs have developed, allowing for reduced time and distance constraints in job searching (Njoki & Wabwoba, 2013). Increased transparency reduces barriers to entry and dependence on relatives in recruiting processes (Sarin & Jain, 2009), hence **facilitating access to formal job markets for people in informal settlements** (Casey, 2015).

E-education and e-training solutions also contribute to **increasing human capital and thus employability of low-skilled workers** (Choi et al., 2019). Likewise, small entrepreneurs can engage in self skill-building through ICTs (Rangaswamy & Nair, 2012). These dynamics, however, require one to be digitally equipped and literate.

It shall be noted that within urban communities, formally employed people tend to have better access to cell phones (Bowora & Chazovachii, 2010), thanks to exposure at the workplace. This draws the possibility of a virtuous loop of empowerment, with the risk nevertheless of keeping women — who are often less formally employed than men — out.

FORMALISATION OF EMPLOYMENT AND ENTERPRISES

Recently, the International Labour Organisation has looked at the way new technologies affect labour markets, particularly in informal economies. It has analysed **how some governments promote technologies to facilitate the transition from informal to formal and has labelled these policies "e-formality"** (Chacaltana et al., 2018). A series of ICT-based solutions exist: electronic registration of workers, upgrading labour inspection, unification of employer and employee data, mainstreaming of a compliance culture (attendance tracking apps), e-service and

[1] The following survey does not pretend to be exhausitive. It presents selected findings and evidence from literature and operational projects to highlight key representative features of ICTs in the urban development field.

e-payment for social protection contributions, e-pay roll, automated taxation, and more. These solutions could then be extended to hard-to-reach workers such as migrants and isolated or domestic workers (Chacaltana & Leung, 2019) who constitute a large share of female employment in the Global South.

Similarly, as for employment, **e-government services can facilitate the formalization of economic units** through electronic registration or payment mechanisms for enterprises (Chacaltana et al., 2018), facilitating staff management and increasing productivity of workers (Choi et al., 2019). Process transparency is in itself an incentive, since it reduces the possibilities of bribery, hence reducing some hidden costs; it simplifies procedures and coordination between different public authorities through a one-stop shop, hence reducing the time-costs associated; and it provides information on tax uses, hence contributing to willingness-to-pay (Chacaltana et al., 2018).

Until now, however, there still has been limited success of e-formalisation policies, and it seems therefore more promising to focus on leveraging the productivity for SMEs (Choi et al., 2019).

INCREASED PERFORMANCE OF BUSINESS MANAGEMENT

Increased performance can come from reduced management costs and/or from increased revenues. ICTs can facilitate the dissemination of basic management tools to move from day-to-day survival to profitability and sustainability:

- Mobile-money and printing allow for registering transactions, ticketing, and invoicing (Casey, 2015). Thanks to **instant and secured mobile payment, the risks of non-recovery for shop owners are reduced** (Thompson & Walsham, 2010). The cashless move can nevertheless have side-effects by excluding the unequipped poorest from financial transactions.

Box 3: eServices Techniques helps street vendors get access to the public space

The municipality of Abidjan (Côte d'Ivoire) is currently developing an open-source software that speeds up the issuance of permits for the occupation of public space for informal vendors and small businesses.

Obtaining and renewing occupancy permits is a time-consuming and therefore costly procedure for street vendors; but without a permit, vendors are under threat of eviction. This situation discourages investment decisions in market stall upgrading. This problem primarily affects informal vendors, particularly women, who represent around 60% of the informal traders in Abidjan.

The innovative eServices Techniques application allows a vendor to apply for a permit online and schedule an appointment for a municipal agent to visit the site. The vendor can receive a pending permit confirmation through the web application, as well as make a fee payment by mobile money or other means. The project is currently in its pilot stage in Abidjan and has already benefited 140 small vendors: the processing time required to obtain a permit has been reduced from 8 weeks to 22 working days.

Developing solutions tailored to the needs of its beneficiaries is a key success factor. Moreover, community involvement increases the chances of reaching a high adoption rate. The project was carried out by a local association; the team spent 6 weeks as an immersion period visiting technical departments of several municipalities in Côte d'Ivoire and informal vendors in public spaces. This allowed them to capture the entire permitting process, including the pain points experienced by informal vendors related to the obtention of permits. The team utilised this field evidence to develop the main useful functionalities of the web application. It was also decided to design a simplified and user-friendly application to respond to the needs of vendors with varying levels of literacy.

Source: Cities Alliance's Innovation Programme & eServices Techniques website, 2020

- Mobile-banking systems also facilitate **savings and access to credit** (Choi et al., 2019). Though some side-effects of **indebtedness** can accrue when ill-managed, financial inclusion and capital accumulation can facilitate upgrading of informal SMEs.
- Thanks to basic software, business owners can also better manage their activity: follow-up on debtors (Bowora & Chazovachii, 2010), on their own credits and stocks, and thus avoid waste of unsold items and save time from inventories.

These expected results shall be nuanced, however: the adoption of such solutions requires (i) technical, digital, administrative and financial skills; (ii) time to familiarize; (iii) some investment in basic devices; (iv) increased business perspectives; and (v) regular activities and flows of goods and services. Occasional street vending, for example, may not be relevant for enhancement through ICTs (Bhattacharya, 2019). Until now, uncertain returns on investments did not justify a systematic introduction of ICTs for all informal SMEs (Ilavarasan, 2019).

EXPANDED BUSINESS OPPORTUNITIES

Business owners manage commercial relations with customers on the one hand, and with suppliers on the other. **The promises of on-line platforms or e-commerce are to reduce barriers to entry and thus expand access to marketplaces.** In the situation of informal SMEs, more particularly:

- First, face-to-face relations with walk-in customers prevail:
  - E-commerce platforms are little used by the urban poor (Casey, 2015). Indeed, most informal SMEs are proximity shops or services, with poor communities as the customer base; considering the density and proximity offered by street vendors and shops of the informal economy, the **demand for online shopping tools is low**.
  - Digital marketing or advertisement, online complaint services, or order placement are part of the promises of ICTs to expand market opportunities. But they require sophisticated devices, software, or marketing skills that are rarely within reach of informal SME owners. Very **few entrepreneurs express the need for digital services** (Choi et al., 2019; Ilavarasan, 2019).
  - Manual-intensive work or sales in small SMEs may **neither be relevant** for automation (ambulant activity is not compatible with proper electricity supply to charge devices), **nor appealing** enough for businesses.
- Second, it seems, however, that relations with suppliers are evolving thanks to mobiles:
  - Mobile phones provide better access to information on quality, availability, and price of products and facilitate contacts, contracts, and payments with distant suppliers (Casey, 2015). Even in poor slums, some businesses have begun using computers to interact with formal economy stakeholders (Rangaswamy & Nair, 2012). Facilitated communication **reduces travel needs for trading** (Thompson & Walsham, 2010), thus saving time – especially in cities where transport is insufficient.
  - Mobile phones also facilitate orders and transport monitoring and delivery of products, increasing **certainty and flexibility** in managing stocks.
  - These two elements combined entail reduced price volatility and thus uncertainty, and **empowerment in negotiation, thanks to increased transparency** (Donner, 2007). A reduction in information asymmetries can decrease the chances of well-informed large firms in extracting rent and exploiting less-informed SMEs (Adera et al., 2014).

ICT4D literature therefore highlights that traditional relations at least coexist with dematerialised ones: mobiles are used for commercial transactions, but not for client services (Ilavarasan & Otieno, 2018). Rather than a disruption of business models, one can observe increased efficiency and frequency of exchanges on one side of the value chain only. It shall be noted as well that in practice, the use of mobile phones by entrepreneurs remains most of all for personal matters and **communication with relatives, rather than for productive or commercial uses** (Ilavarasan, 2019).

Last but not least, these effects are not uniform: the **use of ICTs strongly depends on the status of the considered enterprise, whether it is**

a settled "growth enterprise" developing its activity or a vulnerable self-employed "livelihood enterprise" (Duncombe & Heeks, 2005). The former engages with ICTs to increase its business opportunities and performance, while the latter does not (Bhattacharya, 2019). This trend may also reinforce gender bias, considering that women may fall more often in the latter category.

2.2.2. Sociospatial inclusion: improved access to services

Either through extending coverage or improving existing offers, ICTs can enhance the access of the urban poor to basic services. **The introduction of ICTs in urban services has mainly occurred for urban mobility, energy, and waste.**[2] Deficiencies in public services have created niches in the provision chain where new stakeholders and intermediaries can position themselves.

TRANSPORT

When thinking of ICTs and mobility in cities, **the most disruptive innovation has come from Uber-like platforms**, including in secondary cities of the Global South, and has been applied for two- and three-wheelers. These platforms have various effects when matching supply and demand (Medeiros et al., 2018):

- For drivers, using such platforms generates higher incomes, longer average trips, and more independence on working hours. Drivers are not working for a cab company anymore, but can combine this job with other income-generating activities.
- For passengers, safety and security are the key arguments. These systems allow for last-mile connectivity with public transports systems, but are affordable for middle- and upper-income groups only.

Another ICT-based trend in the sector is **mapping informal/paratransit transport systems and producing extensive databases**. In Accra or Nairobi for example, a tailored data-recording app, has been installed on collectors' or drivers' mobiles, using the integrated GPS tracking function. With very limited time and resources (Saddier et al., 2016), the data collected indicates the routes, stops, schedules, attendance, and fares practiced by paratransit buses and is easily translated into the General Transit Feed Specification (GTFS) standard (Williams et al., 2015). These initiatives have several social and political impacts:

- They have *de facto* "put on the map" informal transport, which is subsequently incorporated by public authorities into city-scale planning and databases, and encourages further development of other applications;
- They mobilise workers, users, developers, and decision-makers in a collaborative process of knowledge production, which thereafter creates empowerment and institutionalisation (Williams et al., 2015);
- They offer comprehensive, free, and updated information on multimodal solutions for journey planning to all citizens, which can be particularly strategic for people in remote or ill-served areas of the city.

It should be noted nevertheless that such initiatives are generally supported, organised, or financed by external stakeholders, either international donors or large corporate firms. To manage open, participatory, innovative, data-based projects requires technical, financial, and organisational capacities that few local authorities of the Global South currently have. Peer-to-peer dissemination is also based on international networks for knowledge exchanges.

ENERGY

In the energy sector, **new technologies have spurred the innovation of new forms of distributing (smart grids) and producing energy sources** (solar systems, biogas plants, waste-to-energy, etc.). On the distribution side, ICTs which will impact the urban poor more directly are **smart meters** that encompass a range of solutions with prepayment systems, mobile payment, and distant monitoring.[3]

[2] For water and sanitation, little research exists (except for Guma & Schramm, 2019); problematic issues in the water sector appear limited to metering, while problems with sanitation are closer to those of waste issues (although this sector has been even less studied until now).
[3] The in-depth case study (section 3.2) on smart and prepaid meters in Tanzania provides further details on the issue.

- New technologies can contribute to the **expansion and improvement of existing networks**. In Nairobi, the utility company introduced ICTs for self-meter reading, mobile billing and payment, and a complaint system. The urban poor have resisted using the new meters, however, feeling that the operation of meters is externalised to them and that they have been forced to use them — illustrating how appropriation can be socially embedded (Guma & Schramm, 2019).
- But ICTs can also offer remote solutions that are free from the constraints of centralised infrastructure models (Pueyo, 2013) and allow for disruptive, **decentralised off-grid access to energy** (Casey, 2015). Several enterprises have entered the market to provide electricity services to unconnected households or ambulant workers, combining new energy sources, remote-control systems, and online client services. On the customer side, autonomous systems bring more coverage of the service, better reliability of energy provision, and better management of consumption patterns leading to the potential reduction of energy budget at the household level.

WASTE

In the waste sector, the most visible innovations are **new valorisation solutions** such as 3D printing from recycled materials, waste-to-energy power plants, and using data from connected bins and trucks to manage waste flows.[4] In terms of ICTs, initiatives tend towards the idea of Uber-like online platforms for collection services (Relix in Brazil, Wecyclers in Nigeria). The underlying logic is to integrate informal workers into the waste value chain, and to generate data to coordinate municipal and independent providers in hybrid systems. Such initiatives show mixed results:

- Business models are fragile, due to little demand from households for waste collection;
- Tracking waste flows often highlights important deficiencies in municipal services that may generate their reluctance in increasing transparency or even conflicts in data processing (McFarlane, 2016);
- The revenues of waste pickers are not necessarily improved, but their registration on an app, visibility, empowerment, and training enhance their social status, improve relations with customers, and therefore contribute to reducing stigmatisation and marginalisation (Coelho et al., 2019).

Furthermore, the waste sector is manual-intensive and may not be particularly prone to ICTs, since innovations are rather mechanical (Casey, 2015): conveyor belts, shredding and baling machines, etc., facilitate the transformation of raw plastics into valuable recyclable material, and reduce volumes and thus transportation costs.

New technologies also include **waste-to-energy plants**. However, they divert available waste for informal waste pickers and/or ban them from the landfills where they find their livelihood. Moreover, this technology is limited at the end of the value chain and does not offer solutions for the collection and transport currently performed by informal workers (Casey, 2015). From that perspective, this technology is a threat to the inclusion of the poor workers.

2.2.3. Political inclusion: policy design and planning

Smart building solutions or connected homes appear of little relevance or too marginal in cities of the Global South. However, new technologies can contribute towards officially putting informal settlements on the map; this digitalization is one of the most immediate ways through which smart city approaches engage with informal settlements (McFarlane, 2016).

MAPPING INFORMAL SETTLEMENTS FOR LEGITIMACY

Based on the premise that "knowledge is power", several initiatives aim at **generating data on informal settlements to raise the voice of the urban poor**. The goal is to gain visibility for informal settlements that otherwise fall out of the scope of public policies due to their official "invisibility". The effects can be summarised as follows:

[4] The in-depth case study (section 3.1) on ICTs in waste management in India will provide further details on the issue.

Box 4: Participatory digital mapping of informal settlements

The most well-known initiative to map informal settlements was launched in Kibera, Nairobi, Kenya in 2010. It has inspired a global campaign, "Know Your City", led by Slum Dwellers International and supported by United Cities and Local Governments (UCLG) and Cities Alliance. Community-mapping projects have since been implemented in more than 450 cities in Africa and Asia.

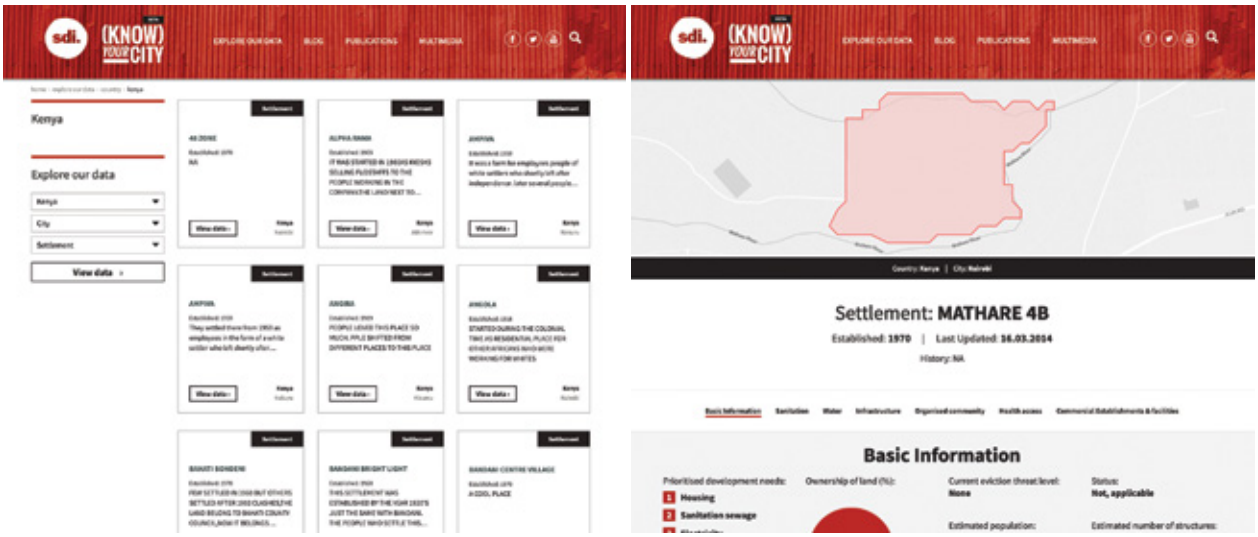
The Map Kibera project started in response to the lack of available maps and data on built-up areas and facilities in Kibera slum, hence making it invisible in the sphere of public decision making. Even though multiple external organisations had intervened in this area, they kept their own data, jeopardising citizens' ownership and sharing.

The community information project relies on digital mapping, a community news website including SMS reporting, and a video journalism project. Digital tools are allowed to circumvent traditional complexity and large investment costs needed to generate information through crowdsourcing techniques: GPS data feeds OpenStreetMap, satellite images are taken by affordable drones, and website inputs come from SMS. It thus has generated up-to-date, evidence-based, and user-friendly dashboards representing the actual living standards of urban dwellers.

Community participation and involvement has happened throughout the whole project, with dedicated training for volunteers by international NGOs and experts. This support has contributed to digital skill enhancement and empowerment. It has also conveyed positive images of the neighbourhood through crowdsourced journalism, undermining negative stereotypes.

The long-term sustainability and success of such initiatives nevertheless depend on engaging in partnerships with local authorities for the acknowledgement and use of the co-produced data. This actually undermines conventional top-down and technocratic policy design and planning processes. The willingness of elected officials and public agents in recognising such initiatives is therefore a requirement for slum crowdsourcing to have effects, in terms of improving living standards beyond community empowerment.

FIGURE 4 | Screenshots from the database Know Your City



- The **process itself** of mobilising communities in participatory enumeration of public facilities, roads, premises, etc., is **empowering**. The urban poor thus learn to master ICTs and create evidence to support their social claims and demands, as well as gain pride and confidence (Patel et al., 2012);
- The production of data on and by the urban poor is easily feasible with basic GPS mobile-apps, OpenStreet Map platform, drones, and satellite imagery. **There is no technical constraint**, undermining the idea that data generation is a challenge in informal areas (Chakraborty et al., 2015);
- Data is incrementally enriched. It offers the possibility of up-to-date information on the city as it is, encompassing land, public space, private building, facilities, infrastructure, and services. Though raw **data does not indicate what should be done, it can inform policymaking on critical assets and needs** expressed directly by the concerned populations (McFarlane, 2016);
- The **interface between community-led exercises and authorities nevertheless remains limited** and fragile. The appropriation of crowdsourced data does not necessarily entail improvement, inclusion in decision-making, and responses to the expressed demands of the urban poor; in other words, the production of data **does not automatically create accountability** (Pfeffer et al., 2013);
- A political issue has emerged concerning who controls and owns the data produced. Indeed, projects are supported by NGOs, who use them for advocacy purposes. The **production of data may actually benefit these intermediaries more than the urban poor themselves** (Heeks & Shekhar, 2019). Likewise, data is mostly used by NGOs or international donors rather than by local authorities, hence it is not changing mindsets and policy design and decision-making processes at the local level.

Last but not least, the communities that are able to secure the support of a project to map their settlements tend to already be well organised, well known, and dynamic communities. The **most vulnerable communities, however, may fail to enter such a process, and their exclusion may be reinforced by their difficulties in seizing the tools and opportunities to produce data and make social and environmental issues more visible** (Heeks & Shekhar, 2019).

CRISIS AND DISASTER RISK MANAGEMENT (DRM)

The provision of emergency response — fire, earthquakes, flooding — in informal settlements is a challenge: the lack of maps complicates the

FIGURE 5 | Digital solutions and expected outputs in key domains of urban vulnerability

INPUTS	OUTPUTS	OUTCOMES	IMPACT
Platforms for job listing E-applications Information on companies E-education and e-training	Access to job markets	Employment	**Equitable economies and urban inclusion:** **Improved livelihoods and living conditions**
Working hours / attendance tracking E-payroll and cashless salary payments Automated pensions and health schemes Communication with labour inspection	Social protection		
E-formalisation services / one-stop-shop E-procurements and e-contracts E-tax payments	Formalisation of business	Entrepreneurship	
Instant and secured mobile payments Management and accounting software Apps. for staff & stock management	Increased performance		
Information on markets Distant contracting / supply Online advertisements and marketing	Business opportunities		
Mapping informal networks Smart meters and prepayment Off-grid solutions Dematerialised customer relations	Extension of services	Basic services	
Remote monitoring of networks Optimised routes for vehicles Censors on deficiencies Mobile-payment & smart meters	Improved quality of services		
Drones and satellite imagery GPS-based enumeration Crowdsourcing Access to information	Mapping urban needs	Policy design and planning	
Early-warning systems Social media communication Crowdsourcing Optimised responsiveness	Crisis and disaster risk management		

provision of services to targeted population that cannot be localised. Related to climate change, disaster risk management (DRM) becomes more and more important, considering the increasing frequency and magnitude of natural hazards. Participatory tools, such as Ushahidi platform and OpenDRM (Annexure), have been developed to ensure **proper crisis management based on digital solutions**. Most of these are inspired by humanitarian contexts and based on **crowd-sourcing mechanisms and SMS messages** (Okolloh, 2009). They include early-warning systems and crisis response solutions based on social media, such as lifesaving messages through SMS, Facebook "safety check", and microblogging.

However, **the extraction of accurate location information and its translation into usable supports for emergency services require high-level and intensive technological developments** (McClendon & Robinson, 2013), which are out of reach of the urban poor themselves. They may provide the information to the platform, and they can benefit from improved response, but they cannot be agents of this digital process *per se*. Consequently as well, these systems are **highly capital- and technology intensive** and may not be accessible for most local authorities in the Global South without support from international donors.

TOWARDS "ICTS FOR URBAN DEVELOPMENT"

The various uses of ICTs in cities of the Global South allow the mapping of a variety of solutions and outcomes to tackle urban inclusion issues (Figure 5). When confronting these initiatives with the promises of the smart city and with ICT4D in rural areas, it appears that

- Unlike in rural areas, access and uses of mobile phones are pervasive, and access is mostly individual rather than through shared computers and/or telecentres. Data-oriented projects, however, appear more ambitious and require external support that goes beyond micro-level individual capacities of the urban poor. Some training and empowerment may be needed for specific social groups, but there is no structural challenge related to accessing devices or connectivity in urban contexts;
- Personal communication uses are much more widespread than productive uses for economic, social, or political purposes of empowerment and inclusion. Basic voice communication through mobiles is more prevalent than access to the Internet, and more generally, frugal solutions (GPS, drones) spread faster than IoT, AI, or datacentres.
- Most of the initiatives directly emerge from third-parties: SMEs, CBOs, NGOs, social

enterprises, businesses, and community organisations. Even though they may benefit from donors' support and later be incorporated into public policies, the urban poor and supporting organisations do seize for themselves the opportunities offered by ICTs.

- Therefore, although some ICT-based solutions enhance the livelihoods of the urban poor, this improvement does not necessarily go hand in hand with social and political inclusion. Economic changes are faster than socio-political ones: digital solutions are plugged into existing systems to enhance their extent or quality, but ICTs do not deeply or directly change urban informality characteristics on that account.

2.3. PATHWAYS FOR CHANGE IN IMPLEMENTING ICT-BASED URBAN SOLUTIONS

However large the array of ICT-related outputs may be (Figure 5), the processes through which they may happen present some constant mechanisms, underlying logics, and potential risks (Figure 6). These processes are the main drivers that foster or hinder change; however, they are far from silver bullets or black boxes, and it is important to clarify the expected effects of the transformations they may bring.

2.3.1. Expected transformative processes

Three main processes broadly reflect the basic components of ICTs (information, communication, and data) and fulfil distinct functions (Koh et al., 2008):

- **Operational uses** through new mechanisms for conducting business operations and integrating information systems, human intelligence, and other resources: facilitating access to marketplaces and the **removal of barriers to entry**;
- **Transactional uses** that support coordinated sequences of user and system activities to provide services and transfer value: addressing market failures through the reduction of **transaction costs** and asymmetries of information;
- **Informational uses** to disseminate information to educate, entertain, influence, or reach citizens/clients: digitizing **data, hence bringing evidence** on informal urban dynamics and activities.

Presented as such, these processes mimic in nature those that can be expected in the formal sector (Seetharaman et al., 2019) or in Western cities. When applied to cities of the Global South, salient features appear particularly critical to including the urban poor (Figure 6).

ACCESS TO NEW MARKETPLACES AND LESS BARRIERS TO ENTRY

Thanks to online or dematerialised communication made possible through mobile phones, **there is a form of time-distance compression**. Even if geographical isolation is not critical in urban areas, this time-distance compression facilitates social inclusion for unemployed people and unserved households or to expand business relations. New commercial opportunities emerge, both from service/product providers and customers.

Mobile-money — payment and banking — particularly has deeply contributed to financial inclusion and has allowed for new transactions. It removes some physical constraints by securing remote dematerialised transactions and institutional ones by facilitating access to credit or employment without necessitating a formal address, for example.

It shall be noted nonetheless that these new marketplaces are often little regulated:

Box 5: The digital divide and literacy across geographies, social groups and uses

Digital literacy relies on multiple factors: the demand component, affordability; the capability dimension, literacy; and the supply component, infrastructure accessibility (Adera et al., 2014). But the "digital dividends" are not spreading equally (World Bank, 2016): 60% of people in the Global South do not have access to the Internet, and this number rises to 85% in the least developed countries. It is estimated that the lack of basic digital skills concerns 230 million Africans — who live within reach of a broadband network, but do not use the Internet, despite increasing coverage.

This digital divide is also persistent within populations, depending on gender, age, education, and level of isolation. In a dynamic approach, **each individual's digital exposure can be positioned on a "digital role ladder"**, where one can move along different roles depending on engagement and capability: delinked, indirect user; intermediated consumer; passive consumer; active user; producer; worker in the IT sector; entrepreneur; innovator (Heeks, 2016). Indeed, not owning a mobile phone does not necessarily mean being digitally excluded, thanks to shared, public, community-access options. Hence, those who may be considered excluded, or across the digital divide, may actually have a place on this continuum.

When considering cities, it must be noted that even in precarious settlements, access to ICTs is pervasive. There may be inequalities in literacy and uptake among social groups, but the availability of technologies is not the immediate challenge that it was in rural areas some years ago. This penetration of ICTs has happened through mobile phones, which are now considered the cornerstone of any intervention.

competition is increased, hence potentially threatening fragile businesses; cherry-picking strategies from service providers can keep the poorest of the poor excluded; and there are no safeguards on over-indebtedness.

REDUCED TRANSACTIONS COSTS AND ASYMMETRIES OF INFORMATION

Better access to information on prices and products, but also on policy frameworks, entitlements, and rights can empower the urban poor. **Accessing new knowledge can reduce potential exploitation by more powerful stakeholders, and providing evidence on needs can legitimise claims.** Moreover, increased transparency reduces uncertainty and thus vulnerability.

There are however tampering forces that hamper increased access to information, first, the way information is produced and its content can be biased and can ignore critical elements for the poorest of the poor. Second, transparency creates great expectations of better accountability, and it opens the door for social claims. Information flows go both ways, but public authorities or employers for example, may be reluctant to acknowledge such bottom-up crowdsourced data to avoid being compelled to respond.

EVIDENCE AND LEGITIMACY OF AND ON MAPS / DATABASES

In the specific situation of urban informality, invisibility is an important source of vulnerability. Initiatives show that to produce data on the urban poor's challenges is technologically feasible, financially reasonable, and socially meaningful and empowering. **Mastering digital solutions — an app by informal workers, a drone for informal inhabitants — heightens skills and social status.** Besides, social media and communication allows for better mobilisation of social movements and advocacy campaigns.

Nonetheless, the production of data to bring evidence on urban issues does not necessarily mean that policies will address it. It can even create a form of backlash: putting informal or

sometimes even illegal dynamics on the maps can highlight activities and risk subjecting them to repression.

2.3.2. Political risks and trade-offs

The model described above is still largely conceptual. Due to the early-stage character of digital initiatives, there is little hindsight for fully evaluating the reality of these processes. Yet, initial feedback has allowed the identification of counter-mechanisms or side effects that may dampen the promise of ICTs in cities of the Global South (Figure 6).

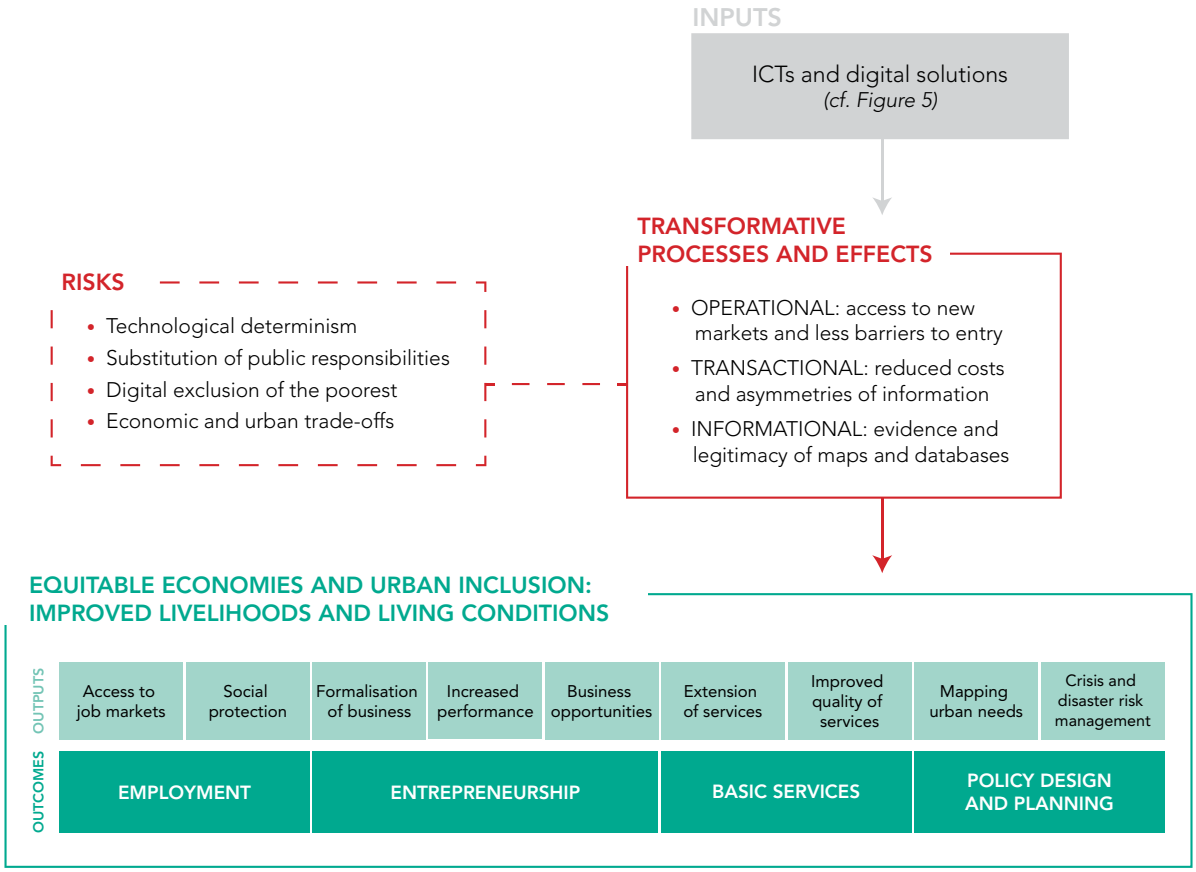
TECHNOLOGICAL DETERMINISM

Globally, the risks associated with smart city approaches mainly highlight the tendency towards technological determinism. These risks have clearly been identified in the ICT4D literature as well, which promotes the idea that ICTs are sociotechnical solutions. Shedding light on the **social and political determinants of ICT deployment**, appropriation, and usages is particularly important when cities with limited human, administrative, and financial capacities turn to digital solutions. The relevance of and coherence between digital and political agendas are of foremost importance.

SUBSTITUTION OF PUBLIC RESPONSIBILITIES

Increased corporatisation in the context of weak regulations presents a risk in itself for socioeconomic inclusion. Smart city programmes often promote private capital investments and public-private partnerships to develop large-scale infrastructures. Many initiatives emerge to

FIGURE 6 | Pathways for change: Transformation processes and risks in implementing ICT-based solutions



compensate for deficiencies of public services and planning, facilitated by ICTs, for example, to provide basic services or produce maps on urban settlements. Nevertheless, this **facilitation should not lead to an increased substitution process by third-party actors of public responsibilities**.

The arrival of new stakeholders on the one hand and the increased circulation of information on the other percolate with local political economy and vested interests. Traditional actors — firms or public administrations — can be threatened by these new trends and thus tend to ignore or resist change. Reciprocally, digital solutions create expectations of increased accountability, performance, and responsiveness. These **expectations must be properly managed to avoid creating frustration and hence social tensions**.

DIGITAL EXCLUSION OF THE POOREST OF THE POOR

Smart cities have been criticized for being corporate, technologically determinist, and elitist, in other words, reserved for "smart people". Indeed, improvements for the urban poor do not necessarily reduce inequalities. In cities of the Global South with major socioeconomic inequalities, middle- and upper-income groups also increasingly use digital solutions. They may even use more sophisticated ICTs, thus widening the digital divide and strengthening their vested interests. This does not necessarily mean that the urban poor cannot take advantage of digital innovation, but that the equitable character of such innovation is not a given and that it may bypass the poorest of the poor.

ECONOMIC AND URBAN TRADE-OFFS

Finally, the capital requirements of introducing sophisticated technologies is in itself a political choice. Beyond the question of whether some digital solutions are relevant, public authorities ought to remain well aware that to deploy smart meters or implement e-formalisation services is based on a **trade-off between "smart upgrading" and the classic expansion of public services to the under-served**. Technological innovation may allow for progressively cheaper solutions that would counter these trade-offs; but as for any technological solutions, technical operation and maintenance capacities, skills, and resources shall also be considered to ensure sustainability.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3

CASE STUDIES

SUCCESSES AND CHALLENGES IN IMPLEMENTING ICT-BASED URBAN SOLUTIONS

The deployment of ICTs and digital innovations is far from uniform. Mainly led by the private sector, it primarily occurs in capital and primary cities, where economic vibrancy, institutional frameworks, and foreign investors are the most present. As a recent trend, ICT solutions are therefore concentrated in large cities, before spreading to secondary cities. Yet, the **provision of urban services — and similarly the potential for developing digital solutions — depends on city-specific factors:** city size (density and socioeconomic heterogeneity of the population), economic resources (vibrancy of the private sector, financial capacity), levels of informality (and further on, peri-urban expansion beyond administrative frontiers), and political and administrative structures (human resources, intergovernmental transfers) (Cohen et al., 2019).

Nevertheless, digital change is also happening in secondary cities, particularly those that offer specific economic conditions, such as a concentration of tech firms and clusters (e.g., Bengaluru) or the presence of foreign investors and company founders (e.g., Arusha). These **particular conditions are decisive; they may not be met yet in smaller cities, but considering the exponential penetration of ICTs globally, they may soon apply to other secondary cities as well**.

3.1. APPLICATIONS FOR WASTE MANAGEMENT IN BENGALURU, INDIA

The case in favour of a circular economy is strongly impacting the waste management sector. In parallel, there has been an increased interest in the potential of Uber-like platforms for door-to-door trash collection services. In many cities, waste collection is performed by informal workers, members of a vulnerable group with uncertain livelihoods and dire working conditions, who are socially marginalised. Many initiatives — carried out by start-ups, social enterprises, or cooperatives — have emerged to promote the integration of informal workers into the waste value chain. **This case study focuses on urban domestic waste, particularly dry recyclable waste, to analyse the relevance and potential of ICT-enhanced services**.

FIGURE 7 | Map showing location of Bengaluru in Karnataka, India (Source: Wikipedia)

3.1.1. Context: Waste management in Bengaluru

Bengaluru is a city of approximately 8.5 million inhabitants in the state of Karnataka, India. It is considered the "Silicon Valley of India" due to the high presence of IT and electronics firms. Nonetheless, rapid demographic and economic growth have put tremendous pressure on the urban infrastructure. In 2012, a crisis caused by mounting quantities of uncollected waste spurred protests from villages near dumping sites and a strike from street sweepers. Bengaluru, which used to be called the "garden city", was renamed the "garbage city". This crisis triggered the mobilisation of civil society and the adoption of municipal byelaws making segregation at the source (wet/organic, sanitary/rejected, dry/recyclable) compulsory for waste generators. Despite an adequate regulatory framework, however, the "produce and dump" habits have changed very little.

The system is organised into different streams along the value chain depending on users' status (Figure 8).

It is estimated that Bengaluru generates about 5,000 tons of solid waste per day, of which less than a third is segregated, and less than half is collected and disposed of in proper dumping sites. About 25,000 informal waste pickers operate in the city, collecting around 1,500 ton of waste per day. Two main NGOs and social enterprises have engaged in tackling this issue: Hasiru Dala (Box 6) and Saahas Zero Waste (Box 7).

In 2018, the United Nations Development Programme (UNDP) launched the Plastic Waste Management Programme, in partnership with Hindustan Coca-Cola Beverages Private Limited and Hindustan Unilever Limited, to be deployed in several Indian cities over six years. The programme relies on local "implementing partners" (NGOs, trusts, or social enterprises) for the inclusion of waste workers and one technical partner (Mindtree) in charge of developing an app and dashboards for e-governance, transparency, and traceability. The tailor-made app, "I enterprise," will be based on "I Got Garbage" (Box 8) to ensure technology-supported knowledge management.

FIGURE 8 | Options along the waste management chain in Bengaluru

Box 6: Hasiru Dala and Hasiru Dala Innovations, Bengaluru

Hasiru Dala is a cooperative trust of more than 200 waste workers. Launched in 2011, its goal was to enforce the recognition of waste pickers in the city through the delivery of ID cards and access to education, healthcare, skill development, markets, and employment. It also conducts awareness and advocacy campaigns to promote waste segregation at the source and recycling. The trust is present in several other Indian cities and is the implementing partner for UNDP's Plastic Waste Management programme for the component on social protection and security of informal workers.

In 2013, Hasiru Dala was given the responsibility to accompany waste workers in running 33 of the 189 municipal dry waste collection centres (DWCC). It resorted to a model of franchisees: waste pickers are organised in self-help groups of 4-5 people. They use the facilities, equipment, and machines of a DWCC (Figure 9c&g). Social security and safety equipment is facilitated by Hasiru Dala; trucks are available under a leasing system. Their revenue comes from a fixed fee, and the product of selling material. Hasiru Dala partnered with the I Got Garbage (IGG) app suite (Box 8) to ensure monitoring and traceability of the operations. The IGG app is also used in Hasiru Dala Innovations' large facility in Electronics City Industrial Township (ELCITA), where individual data is collected through QR codes and GPS and automatically registered on the general dashboard of ELCITA's authority.

In 2014, Hasiru Dala Innovations was created as a profit-for-purpose social enterprise to engage into contractual agreements with what are now 400+ bulk generators. Though sales of products are negotiated either through direct phone calls or long-term contracts with registered recycling companies, the produced data facilitates the tracing of materials. Hasiru Dala Innovations is currently looking for a customized integrated digital solution that would allow both monitoring of waste-specific information and general management.

Box 7: Saahas and Saahas Zero Waste, Bengaluru

Saahas was started in 2001 as an NGO, and with the addition of a social enterprise, became Saahas Zero Waste (SZW) in 2013. As an NGO, SZW conducts awareness and advocacy campaigns on recycling; as a social enterprise, it employs 300 persons in compliance with labour laws, minimal wage, and health and safety requirements to provide waste management services to bulk generators, such as on-site dry and wet waste collection and sorting for recyclable waste.

The business model relies on 80 contracts with bulk generators in 4 cities, sales of recyclable materials to recycling partners and textile recycled products, and consultancy for extended producer responsibility (EPR). SZW opened its own material recovery facility (MRF) in 2017. This MRF is equipped with a conveyor belt and a baling machine, which have allowed the performance of the sorting process to triple and reduced transport costs.

All SZW activities are digitally recorded, including the attendance of employees, through biometric identification; waste weighing; GPS tracking of trucks; sales; and invoicing. The digital solutions are monitored through a classic enterprise management suite. All activities are reported on a single platform managed by the main office.

The integrated IT approach allows SZW to send comprehensive monthly reports to clients, who increase their willingness to pay when feedback is digitalized. Providing evidence appears to be in itself an incentive, since clients have moved from 70% of waste rejected to 5% in only three months. SZW won the Swachh Bharat ("Clean India") Award in 2018.

3.1.2. ICTs along the waste value chain

The recyclable waste value chain is organised into four levels: generation/segregation at source, collection, transport/sorting, and disposal/recycling. In Bengaluru, most of the initiatives based on **new technologies happen at the intermediary levels of the chain in waste collection centres and material recovery facilities** managed by social enterprises.

LOW DEMAND AND INTEREST IN ICTS AT THE WASTE GENERATION LEVEL

The use of ICTs in the waste sector by the municipal corporation focuses on **tracking down trucks and workers with GPS and closed-circuit television (CCTV), without tackling the issues of salaries, working conditions, improving the whole waste management chain, or incentivising waste generators**. Likewise, some citizen groups, primarily middle- and upper-income, use civic tech and apps for complaint management. These tools tend to raise expectations as to service quality. However, since the whole waste chain is not being improved altogether, this creates frustration and discontent towards vulnerable waste workers, rather than contributing toward improving their situation.

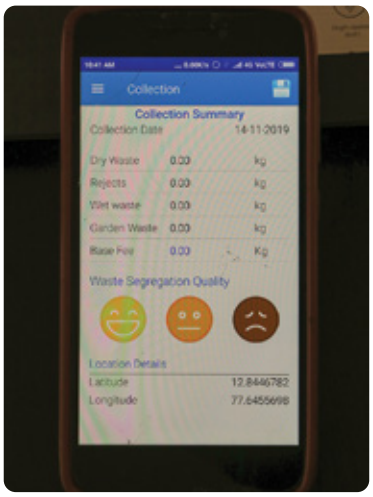
Although they are located in the most technology-oriented city of India, waste stakeholders attract **very little attention from IT-companies or even in terms of developing sector-specific digital solutions**. For example, the annual hackathon, "REimagiNEWaste", has been organised since 2016 on a voluntary basis. Despite having attracted around 700 participants, it has struggled to find financial support to ensure incubation, and some of the selected projects have been abandoned due to the lack of funding.

The demand for proper waste collection services is low: **waste collection is not a primary need, which lessens the possibility of e-commerce platforms being developed for trash**. In other words, there is **no valid scalable platform to match the supply and demand of domestic waste services** at the household level. Third-party initiatives based on these models have been reoriented towards higher levels of the supply chain (management of transportation and sorting facilities).

However, **providing information on individual waste generation seems more promising as a way to change behaviours.** Indeed, through a

FIGURE 9 | Work and technologies on waste processing chains (Source: © Laure Criqui)

(a) Manual entry of weighed waste



(b) Collection monitoring interface

(c) Most workers on the conveyor belt are women

(d) Interface to register weights

(e) Male carriers / Female sorters

(f) Entrance blackboard with daily prices

(g) Bales of waste bundled with baling machine

pilot app developed for REimagiNEWaste, waste pickers rated the quality of segregation by each household. This data, individualised thanks to QR codes supported with photos, was then published, thus creating incentives for being better rated, which happened over a few weeks. Other stakeholders similarly improved segregation when regular feedback was provided and was aligned with billing.

Therefore, feedback from waste workers towards households seems more efficient than citizens' complaints to the municipality. The generation of personalised, evidence-based, legitimate and benchmarked data thanks to ICTs can contribute to improvements in waste collection without putting the blame on informal waste workers, and even can enhance their credibility as useful service providers. This assumes a complete shift in social relations: from citizens' opinion on waste management to waste workers' appreciation of citizens' compliance with rules; for the latter, public support and rule enforcement is however a critical condition, which is not yet met.

TECHNOLOGICAL SOLUTIONS FOR WASTE COLLECTION, AGGREGATION AND SORTING

The first task of workers is to collect the waste from households. The identification of the premises can be done through a QR code, and the vehicles' routes tracked by GPS. One smartphone per team equipped with the adequate app is enough to do so; individualised information as to the amount and quality of waste segregated can as well be registered (Figure 9b) in order to provide feedback and establish invoices, and reciprocally for customers to evaluate service quality. All the data is then transmitted to the **general dashboard** of the concerned intermediary.

Once collected, dry waste goes either to a municipal DWCC or material recovery facility (MRF). It is weighed, sorted, packaged, and shipped away for processing.

- While weighing is critical both at the entry and exit, this is still done with mechanical scales. Several **prototypes of connected or intelligent scales have already been tested, but none of them has proved adapted** or efficient for large volumes and little capital investment. Some operators have considered looking further into this issue, but that has yet to happen. **Weights are therefore still entered manually into the apps**, with dates, prices, and truck number (Figure 9a).
- Sorting recyclable material by categories is done manually. Some facilities are equipped with a conveyor belt (Figure 9c&g), which increases efficiency two- to three-fold. Each

company uses different categorisation, with up to 128 possibilities (Figure 9d). This is one of the pain points to further increasing efficiency and sale opportunities of materials thereafter. Some **contemplate the potential of artificial intelligence (AI) to automatically recognize different kinds of plastics**, for example. However, for being socially engaged, operators are also cautious with such automation, which **could negatively impact related jobs**. This option is however costly, and therefore not a priority today.

- Material is then packaged. Some facilities are equipped with a baling machine, which reduces the volumes and thus the cost of transport (Figure 9g).
- The sorted materials are weighed again when they leave the premises, often with **registration of the data in the app or spreadsheet**. When compared, these figures indicate the amount of rejected waste remaining, the process efficiency, and the revenue incurred. The waste is sent to recycling processors; these companies may be contracted out on a regular basis, or negotiations may be made directly by phone, mainly through WhatsApp.
- General dashboards thus present data on truck routes, quantity and quality of waste, invoicing, weights, and prices. In general, **digital monitoring is doubled with paper registries**, either because workers may not be comfortable with digital tools, or because connectivity is not stable enough. Manual registries are still maintained in parallel (Figure 9f); this also allows for cross checking.

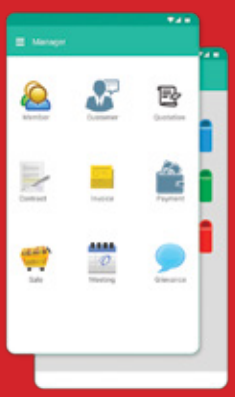
The collection, aggregation, and sorting processes are labour intensive: manual operations can be enhanced by mechanical rather than digital technologies. Connected scales, 3D printing, or AI for automatic sorting have not yet been introduced. ICTs have been introduced to monitor information and improve management and efficiency. The technologies used are simple monitoring and management apps, used directly on smartphones; computers are only available in large MRF to follow up via the app dashboards.

EXTENDED PRODUCER RESPONSIBILITY AS AN INCENTIVE TO PRODUCE DATA

The creation of **online marketplaces between sellers and buyers of recyclable material is still limited.** Some attempts have been made — for example by IGG — but until now, the prices have not evolved; second, it is unlikely that vulnerable workers will use an app in English; third, these platforms often require large volumes that informal workers do not meet. For these reasons, social enterprises are dubious about the impact of online marketplaces for small-scale informal waste workers.

FIGURE 10 | Screenshots from the app, I Got Garbage (Source: I Got Garbage website)

"Zero Waste Cities" modules to accompany urban local bodies



"Waste Picker Livelihood" modules for micro-business management

EPR platform for traceability and incentivization

Interface for product identification

Box 8: I Got Garbage, Bengaluru

I Got Garbage is a corporate social responsibility initiative from the tech-company Mindtree. It was launched in 2013, and it is integrated in UNDP's Plastic Waste Management Programme.

The objective of IGG is to improve waste sector governance through digital tools, to create a marketplace where transparent information on prices would generate certainty and bargaining power for workers. The cloud- and mobile-based application suite and tools include payment and invoicing; tracking collection and weighing; tracking vehicles with GPS; facility, performance and workforce management; data analytics; and dashboards.

In Bengaluru, the app is used in one of the DWCC managed by Hasiru Dala and in the MRF of ELCITA, mainly for internal management. Each user has specific authorisations, depending on its roles and responsibilities (processor, buyer, seller); s/he is identified through a badge with a QR code.

In other cities, IGG supports door-to-door collection based on QR codes, tracking and optimising truck routes. IGG also offers an EPR platform to trace back waste along the value chain. All the data is centralised into a dashboard accessible by the implementing partner (Figure 10). Mindtree is responsible for storing the data, but is not authorised to sell it for commercial purposes.

However, extended producer responsibility (EPR) has been included in the 2016 India Municipal Solid Waste management regulations. To show their compliance with EPR, **waste-producing firms must trace the volumes of waste they contribute to be recycled** and circled back into the material loop. The **need for data is currently a market driver** in the sector, opening new business opportunities for social enterprises who either sell data or provide EPR consultancy services. Waste operators and social enterprises nonetheless notice some shortcomings:

- EPR is limited to the environmental impact of valuable materials such as plastics. It requires **data on the volumes only and does not take into account the social dimension** of waste management (e.g., respect of labour laws, minimum salary, and safety requirements). In other words, a waste-producing firm may comply with EPR requirements even though it makes people work in undignified conditions.
- EPR covers only the end of the value chain and **not collection, disposal, or sorting, i.e., the levels where vulnerable workers intervene.** The recycling of material is thus treated in isolation from the social conditions of collection at the beginning of the chain, and there is no guarantee that the opportunities at the end of the chain do trickle down to informal workers.
- **Data provided by organisations is not checked.** Nothing can guarantee that the figures provided actually change the whole waste management chain.

Finally, waste-to-energy incinerator projects are under consideration. Many of the local stakeholders see there a clear contradiction: though **waste-to-energy can be considered a new technology to reduce landfill dumping, it threatens waste pickers' livelihoods in accessing materials, and does not encourage segregation at source nor recycling.** It discourages citizen awareness towards reducing waste generation, hence undermining the principles of the waste management rules themselves.

3.1.3. Digital processes and challenges for waste social enterprises

The potential of "uber-like" platforms for trash does not seem developed enough to make sense in the context of rapidly growing cities, where waste management still relies on informal and manual practices. The **actual digital processes and uses are more pervasive, but also more fragile and humble than sophisticated apps.** Social enterprises, as empanelled waste service providers for bulk generators, are the most

innovative in introducing technologies in the sector. Nevertheless, their initiatives are still early stage and face challenges related to the larger social, economic, and political context of Bengaluru.

SIMPLE TECHNOLOGIES IN WASTE MANAGEMENT OPERATIONS

The new technologies used in the waste sector in Bengaluru are not profoundly disruptive yet, due to the characteristics of the waste sector and the paucity of adequate offers:

- **New technologies are primarily introduced as digital solutions to increase the efficiency of monitoring and management within social enterprises** (data recording and dashboards). To do so, they rely on classic entrepreneurial management suites for internal management, since they have difficulties in partnering with IT companies able and willing to understand the specific needs related to a predominantly informal sector (with the exception of the IGG app).
- **Technological innovations that make a change for waste workers are mainly mechanical** (conveyor belts, baling machines) to facilitate and increase the performance of predominantly manual work. Up until now, the relevance of the promise of access to online information had not been recognized.
- **When digital solutions are introduced, simplicity and accessibility of interfaces are prioritised so that vulnerable users feel comfortable in using them:** very simple tools' design, icons, and photos can be conceived for use by illiterate people; paper registries can be kept in parallel with digital spreadsheets to ensure progressive learning (e.g., Facebook and WhatsApp are actually more used than any other apps); and **continuous and inclusive training** is then provided by the social enterprises.
- However, all these initiatives are still very limited to **pilot phases**: proofs of concept exist for connected scales, AI for sorting, and apps for management, but they are still in testing phases. This is due to the lack of investment capacity, but also to a willingness to look for *ad hoc* solutions for waste-management specific activities.

Besides, social enterprises pay specific attention to the **potential detrimental effect of sophisticated solutions on employment.** For example, AI for sorting waste may have a two-sided effect on female jobs: on the one hand, facilitating their work, but on the other, reducing the number of workers needed on conveyor belts. Likewise, waste-to-energy schemes may be environmentally sound but jeopardise livelihoods for thousands of street waste pickers. New technologies can turn against the goal of developing high-intensity, low-skilled labour operations, which is one of the drivers for these social enterprises.

SOCIAL DIFFERENTIATION IN DIGITAL EXPOSURE

First, the decentralised approach of waste management in India reflects social disparities in a segmented market: contracted-out services are limited to bulk generators, i.e., affluent complexes and gated communities, while low-income groups depend on inefficient municipal services. The ability to pay for digitised waste services has little relevance for the latter.

In terms of social inclusion, visibility and recognition of informal workers, and improvement of their working conditions, Bengaluru shows contrasting trends:

- On the one hand, civic tech solutions for complaints raise expectations and lead to **increased discontent from concerned, English-proficient, digitally connected, and formally housed citizens against waste workers**. Furthermore, these have not led to profound changes in waste segregation behaviours at the source nor spurred a demand for quality door-to-door services on Uber-like platforms. There is no natural on-boarding on behalf of households who would have a capacity to pay. Indeed, these civic tech solutions focus on visible issues as black points without considering the whole waste management chain or the difficult working conditions and vulnerabilities of workers.
- On the other hand, integrated social and environmental approaches of waste issues are pursued by dedicated social enterprises. Due to the regulatory framework and their contracts with bulk generators, they enjoy increased activities and revenues, and can thus invest in new technologies to improve working conditions. These **technologies are relevant for dynamic social enterprises in a trend of entrepreneurial performance, but this logic is much less probable in the case of isolated informal waste** pickers. Employees or franchisees who are

the most exposed to and use digital solutions can indeed improve their revenues, working conditions, and status, but they are rarely the poorest of the poor.

Last but not least, the array of waste jobs is quite gendered: sweepers and sorters are mostly women, while men occupy the roles of drivers and carriers or team supervisors and managers (see Figure 9). This gendered repartition of roles influences the exposition to digital solutions. Indeed, women mostly perform manual tasks that are somehow irrelevant to the introduction of ICTs. Men, on the contrary, oversee weighing and registering collection data on phones and dashboards, follow trucks through GPS, and check biometric systems of attendance. Therefore, since **digital solutions currently used are mainly oriented towards better management of waste flows, rather than handling the waste *per se*, men are more exposed to technologies than are women.**

SHORTCOMINGS OF A "DIGITAL WASTE ECONOMY"

Even though most initiatives are around a decade old, the promises of disruptive business models due to the introduction of new technologies in the waste sector are not yet fulfilled.

- **The business models of generating revenue from service collection fees — Uber-like models — and selling material on online platforms have fallen short.** The specificities of the waste sector, with low demand and labour-intensive techniques, do not allow for directly importing solutions from other sectors, such as transportation. Meanwhile, the goal of facilitating transactions between supply and demand for waste relies on long-term arrangements negotiated through phone calls, Facebook, or WhatsApp. Existing apps can be used to track or register information on prices, but they do not create a marketplace for new kinds of transactions.
- Likewise, in general, the expected "technical" circularity in the waste sector is not the challenge; but the financial circularity, or equilibrium of business models is. In order to perform, both Hasiru Dala and Saahas Zero Waste combine a trust with a social enterprise. Their business models rely on grants on the one hand and contracts with bulk generators on the other. Similarly, IGG is financed by CSR of Mindtree. The **economic equilibrium of these new stakeholders is not guaranteed and requires a mix of funding types.**

However, EPR regulations have indeed spurred new business and funding opportunities around data generation, from which social enterprises do benefit. Their investments in data tracking allow them to increase revenues, and since they are committed to social inclusion, there has been a trickle-down effect on waste workers' conditions and revenues. **A form of "digital economy" based on data generation does exist** in the waste sector, but is limited to material products at the end of the chain; **its inclusive character is contingent upon the good will of waste management operators** to improve the whole waste management chain and integrate informal workers into it.

3.1.4. Key lessons as to ICTs for waste management in Bengaluru

There is a real emulation in the waste sector in India, at the crossroad between circular economy and digital innovations. Initiatives are nevertheless quite isolated and dependent on engaged stakeholders who struggle with scaling-up and getting adequate institutional and financial support.

THE LACK OF PRIVATE IT STAKEHOLDERS

The fact that Bengaluru is an IT-city with an important presence of technology firms does not seem to facilitate the development of appropriate solutions entrenched in local urban challenges. Waste is not a socially attractive sector that fosters interest in investments from large private firms. Unless specific incentives are created, there is little prospect of larger financing streams for non-profit initiatives directed at informal workers.

Waste domain experts have little connection with the IT sector, and they face **difficulties in finding technology partners** who share the same concerns and understand the specificities of waste workers; thus, they may fail to adapt their solutions. Most of the digital solutions

— apart from the IGG app, which is from CSR and not a core business of Mindtree — are **classic management platforms** that have been marginally tailored for a few tasks, and social enterprises hence are actually considering developing internally adequate tools.

Nonetheless, an **adequate regulatory framework — such as EPR regulations — has forced waste-producing firms into socially and environmentally sensitive issues**. That is why Coca-Cola and Unilever have engaged with UNDP in a six-year programme and why gated communities contract out waste management to social enterprises. Reciprocally, waste management operators have to turn towards private partners to ensure the viability of their business models because of the low demand from households. In the medium term, it could be expected that the involvement of large waste-producing firms may spur the interest of IT-firms into developing adequate digital tools for waste operators, but this is far from the case yet.

THE ENGAGEMENT OF SOCIAL INTERMEDIARIES

The introduction and use of ICTs in a marginalised sector such as waste management appears to make sense when they are used by and for domain experts who are aware of the working conditions, needs, and wishes of informal workers; cautious about employment and livelihood perspectives; able to advocate for their logics of intervention; and appear trustworthy for private or public partners.

As a matter of fact, considering the current state of digital technologies in the waste sector in Bengaluru, it also appears that these intermediaries are the ones who benefit from increased performance in operations, opportunities in transactions, and visibility. The impact on employed or franchisees waste workers is indirect and depends on internal strategies of empowerment, training, and inclusion on behalf of waste operators.

The existence of these active intermediaries in Bengaluru, exchanging and collaborating in the voluntary Solid Waste Management Round Table, offers a platform for waste workers, but also creates opportunities for advocacy, such as contacts for public and private partners who may not reach out to informal workers otherwise. Likewise, it is through their activities that digital technologies are progressively introduced in the sector.

DISCONNECTION FROM MUNICIPAL INITIATIVES

In Bengaluru, public authorities focus on **technological solutions as problem-solvers but do not really tackle the integration of the collection level** into the value chain, hence the improvement of livelihoods for waste workers. Most of the social enterprises have few relations with municipal authorities: though empanelled to service — private — bulk generators, they have little room in municipal waste management decisions. The latter follow on with their regulations and projects on their own. For example, Bengaluru municipal corporation has announced a scheme to map waste collection

LESSONS

All in all, the added value of ICTs in waste management in Bengaluru is still limited. They are mainly used for monitoring and management by a few committed actors and do not cover the whole chain; thus, the trickle-down to the poorest workers is marginal. Furthermore, the low demand from households has not been impacted by the introduction of new technological solutions, threatening the economic equilibrium of tech-using non-profit stakeholders.

points in partnership with the Chennai-based start-up Kabadiwalla Connect instead of consulting the Bangalore Solid Waste Management Round Table. It has also announced the launch of a blockchain pilot to address the complaints related to waste management, which seems, according to most experts, a too sophisticated — and costly — technology for such a purpose. Besides, the crucial need for large-scale awareness campaigns, towards all waste generators — citizens and companies — is jeopardised by the complaint-oriented civic tech apps.

The adequate regulatory framework is in place, but the incentives and enforcement of these rules are lacking. Thanks to the use of ICTs and EPR regulations, data is now available on waste production and management. Though this **data may not be used by public authorities, there is not *per se* a scarcity of data on the sector**, as marginalised as it may be. However, local political will and socioeconomic structures — little inclined towards improving the whole waste management chain in Bengaluru — limit the possibilities to ensure legitimacy, sustainability and scaling-up of third-party initiatives.

3.2. PAY-AS-YOU-GO AND OFF-GRID SOLAR SYSTEMS IN ARUSHA, TANZANIA

In the energy sector, multiple innovations emerged over the last decade thanks to ICTs: smart grids, mini-grids, and new energy sources from waste, solar, and wind. In parallel, a myriad of new private stakeholders entered the sector and developed decentralized service offers. This case study focuses on how new electricity providers increasingly resort to a combination of pay-as-you-go business models (PAYG), mobile payment, digital platforms, and dematerialized customer relations and services to sell off-grid solar home systems (SHS). **PAYG is the payment method used by close to 80% of all SHS sold globally.** These mobile-enabled solutions aim to facilitate access to electricity services in contexts of informality.

FIGURE 11 | Map showing location of Arusha, Tanzania (Source: Wikipedia)

3.2.1. Context: Electricity access in Arusha

Arusha is the second city of Tanzania, with approximately 416,000 inhabitants in 2012 within its administrative boundaries. Population growth has led to widespread horizontal urbanization of surrounding rural areas, in informal and under-serviced settlements. Officially, **80% of the population (both rural and urban) in the Arusha region have access to grid electricity; however, it is also estimated that only 17% of Tanzania's rural population has access to electricity.** Considering the spatial expansion of the city towards under-serviced peripheries, and that 42% of urban households report moderate, high, or very high **power interruptions**, the demand for efficient electricity services is high.

The Government of Tanzania has announced ambitious electrification programs: since 2012, the public Tanzania Electric Supply Company

Box 9: Zola Electric

Zola Electric was founded in 2012 in order to make clean, reliable, affordable energy available to all. Zola pioneered "Pay as you go" finance to deliver electricity off-grid in Africa by reducing upfront costs: the business plan relies on customers buying their own solar and storage power systems over time.

The three cofounders met in Oxford University and moved to Tanzania in 2012, after raising seed funding, and they launched a company, then called Off-Grid Electric. The engineering team is based in San Francisco, with operations headquartered in Amsterdam. A third of the 180 staff is located in Arusha.

Today, Zola's investors include Tesla, Vulcan Capital, DBL Partners, Helios Investment Partners, EDF, Total, GE Ventures, and Energy Access Ventures. The company has also leveraged funds from donors such as USAID, the Finnish Government, and the Africa Enterprise Challenge Fund. The business model relies on PAYG, cash-and-carry schemes, and partnerships.

Zola Electric currently operates in Tanzania, Rwanda, Ghana, Nigeria, and Côte d'Ivoire. In Tanzania, it is the leading PAYG solar company, with over 140,000 active users, and it is perceived by most stakeholders as a bit cheaper than the others.

Zola Electric offers solar systems for home or business ranging from 40 Wp to 80 Wp, powering lighting, radios, stereos, TVs, or other household appliances such as refrigerators, etc. These devices function with three main mobile technologies: GSM-based machine-to-machine (M2M) connectivity, mobile money for customer payments, and mobile services for communication (customer care hotline and SMS notifications).

Box 10: Mobisol

Mobisol started its first pilot programs in 2012; it launched commercial operations in Tanzania in 2013 and then expanded its operations to Rwanda, Kenya, and Nigeria. The headquarters are in Berlin, but 85% of the 300 staff operate in East Africa. Mobisol has been supported by USAID's Power Africa initiative. Due to financial difficulties, it was acquired by ENGIE in 2019. The business model combines PAYG, cash-and-carry schemes, and partnerships.

Mobisol provides solar systems ranging from 40 Wp to 200 Wp, with the same use of technologies for GSM-based M2M connectivity, mobile payments, customer care hotline, and SMS notifications. In Tanzania, 95% of Mobisol customers are using PAYG and mobile money.

Though perceived as the most expensive SHS, Mobisol systems are also reputed for their quality. Mobisol is the dominant player when it comes to more complete solutions and upmarket product segment. Its customer base represents half of Zola's, but its installations are valued at twice as much.

(TANESCO) has added over 800,000 connections to its network, bringing its total customer base to 1.9 million; the Rural Energy Agency also plans to increase rural and peri-urban household connectivity to 50% in 2025 and 75% in 2033. However connecting the whole country to the grid will require huge investments, reaching amounts going beyond the current allocated budget.

In that context, the off-grid solar market expanded rapidly, initially driven by sales of small solar lanterns. Between 2013 and 2017, innovation in SHS allowed a market growth for products beyond lighting only. This growth was also largely driven by the development of the **PAYG model** through which customers access higher levels of energy service by paying over time.

In parallel, as a regional headquarter city, home to various international organizations, and transit point for popular safari circuits, **Arusha has attracted expatriates and foreign entrepreneurs who kick-started impactful and innovative initiatives in the field of decentralized energy, thanks to their ability in leveraging international funds.** These initiatives also capitalized on the very rapid adoption of mobile technologies in Tanzania: 55% of Tanzanian people have a registered mobile money account, rising to 70% in urban areas. Consequently, **Arusha is home to some of the leading PAYG solar companies**, such as Zola Electric (Box 9) and Mobisol (Box 10) — both founded by foreigners.

3.2.2. ICTs to bring energy services to unconnected users

3.2.2.1. MOBILE TECHNOLOGIES TO RUN OFF-GRID SHS AND SERVICES

New technologies — both solar home systems and mobile payment — have unlocked business models and reduced the technical and economic entry barriers in the off-grid energy sector. PAYG solar providers offer two service models to their customers:

- A *rent-to-own* (or *lease-to-own*) scheme: timed payments go towards paying off the system, so that customers become the owners of their SHS over one to five years;
- An *energy-as-a-service* scheme: customers pay for access to a reliable service, similar to a utility.

The majority of off-grid customers prefer asset ownership, hence the success of the rent-to-own (or lease-to-own) business model in Tanzania and in Africa at large.

SHS systems are equipped with a **SIM card enabling a two-way communication between the provider and end-users**, data exchange, and real-time monitoring and control of the system.

ENABLING PAYMENT THROUGH MOBILE MONEY

For the stakeholders, the development of mobile money has been a precondition to the development of off-grid SHS in the Arusha region. Most of the users would simply never have purchased SHS without the possibility of proceeding to small payments through mobile money. Mobile payment has underpinned the solar PAYG model with in-chain effects:

- For users,
  - Mobile payment reduces the time cost of long trips from peripheral settlements to city-centre shops and allows instantaneous payments;
  - Rent-to-own schemes reduce the timely amounts to be paid to compensate for unaffordable, upfront cash-and-carry purchases;
  - However, the PAYG business model increases the global cost of the purchased system compared to the cash-and-carry model. The costs of consumer financing via PAYG is accounting for around 20% of the final price.

Nonetheless, some few users prefer cash-and-carry acquisition for fear of contracting debts and being liable to the private company. Besides, when acquired through PAYG schemes, appliances are to be connected solely to the battery/system provided by the same company, while they can be used freely once fully acquired.

- For the companies,
  - It makes it easier to track payment history and follow up the work of call centres;
  - It reduces the costs linked to the mobilization of staff in shops or for payment collection.

However, the reduced costs appeared to be partially **compensated with investments to develop new skills** among the staff to manage digital payments and to keep teams to recoup payments and proceed to repossessions.

Reducing transaction costs also implied developing partnerships with mobile operators. Zola Electric, for instance, initially partnered with Vodacom Tanzania to use M-Pesa platform to enable customer payments for its services, as well as with Airtel Tanzania to use its mobile payment offer. For SHS providers, it is highly important to make their services economically attractive to telecom companies, as some of their rates can affect the economics of the service (such as minimum charges for businesses when dealing with small payments). These partnerships do not solely serve the solar PAYG companies but also the mobile network operators themselves. Indeed, mobile operators are looking to expand their customer base in underserved locations and PAYG solar incentivizes and drives the adoption of mobile money.

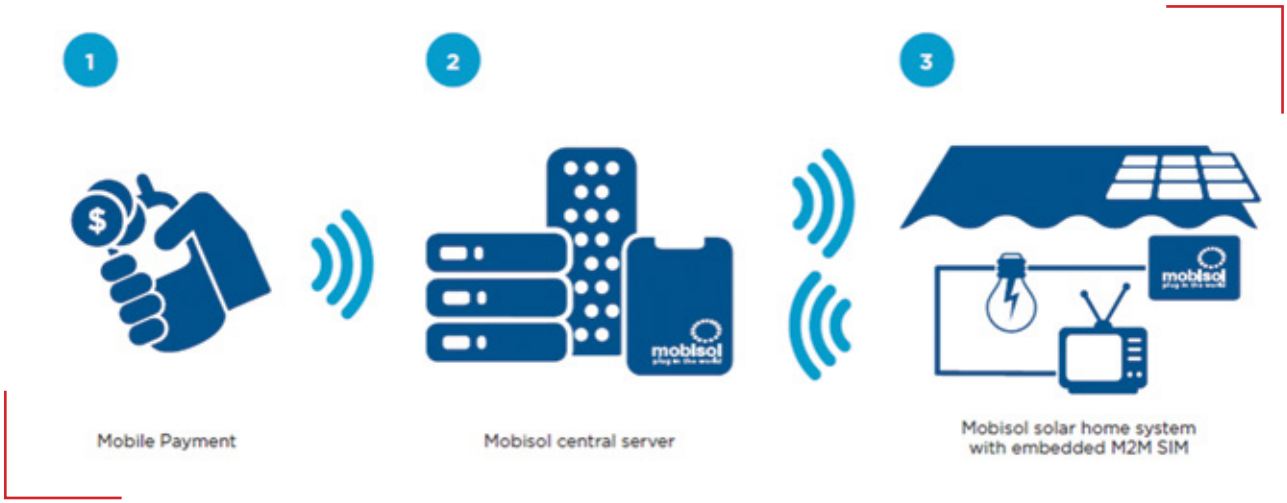
CONTROLLING ASSETS AND SERVICES THROUGH M2M

The SIM card incorporated in SHS systems enables a two-way machine-to-machine communication: **end-users complete payments through mobile money**; once the payment is received by the PAYG solar company, the system is automatically and remotely unlocked until the amount/time paid for is up (Figure 12).

M2M technologies also allow remote monitoring of operational parameters:

- **General monitoring of the systems' operations**, with product performance reports, energy consumption patterns, and customer usage data. This is identified as a key feature of the business model of PAYG solar companies, as **data collection helps with understanding customers' behaviours and builds trust, hence making it easier for companies to receive funds and investments** from the private sector and international donors. Through due diligence processes, investors for instance use these data to complete predictive analysis and evaluate refinancing options.
- Real-time access for staff to all the information related to the functioning of the system (e.g., information is collected by the system's controller every 10 minutes and sent to a Central Server and database).
- **Detection of defaults, malfunctions, and improper or overuse in real-time.** Reciprocally, when users call to place a complaint, call-centres can immediately identify the problem. According to Mobisol and Zola, this **lowers the operation costs**, as most of their clients

FIGURE 12 | Mobisol PAYG process through mobile money. Source: Mobisol PAYG Solar for Entrepreneurs in Rwanda, Mobile for Development Utilities, GSMA (2016)



are in isolated areas, where it would be costly to send technicians every time an issue is raised that could be dealt with remotely. If it is not possible to fix it remotely, the call-centre can quickly send a technician to the geo-localised premises — even if not formally addressed — and optimise travels.

In general, clients appreciate the efficiency of this system, as it allows the company to quickly find a way to fix any technical issue. Once again, this is time-optimizing for end-users, as they do not have to wait for technicians or go to a shop to get answers to their questions.

However, some end-users reported that they **were irritated by the remote monitoring system, as they were feeling under the watch of the company.** Some reported for instance that the only time the company called them was not to fix defaults or malfunctions, but to point out that the system/battery was overused, that new appliances from other brands were plugged into the device, or that the system had been moved within the house. From information shared by end-users, the company installs and sets up the systems in the customers' homes (Figure 13), and the end-users do not have the right to move the systems somewhere else, otherwise it would consist in a breach in the contract. This leads to some frustration by the end-users and reduces their sense of ownership of the system.

ENABLING COMMUNICATIONS BETWEEN SERVICE PROVIDERS, LOCAL AGENTS AND USERS

Mobile technologies also play a key role in optimizing business management tasks:

- A **fully digital customer relationship management (CRM) system helps to overcome issues related to the challenging distribution of SHS in remote areas.** It makes communication between companies and local agents, field staff, and retailers much easier, enables improvements in the efficiency of sales, distribution, and marketing, and supports market expansion to find new potential customers. Companies use CRM platforms to map field partners and agents and to have a shop and a contracted technician/agent allocated to each end-user or area of intervention.
- **Internal apps for the use of sales agents** allow the company to efficiently schedule field agents' daily tasks. In both companies, sales agents are enrolling potential clients through internal apps. The application is then automatically sent to the headquarters based in Arusha, where the credit assessment process is performed in order to definitely enroll the client.
- The platforms also optimize service management by **speeding up the after sales and assistance services to the users**. For users, on-going payments ensure reliable after-sales services. Communication with the users is conducted through calls or SMS services. Users can also be contacted by the PAYG companies to provide them with assistance regarding the use of the device. In particular, Mobisol users reported receiving SMS to warn them in case of extreme weather forecasts, and to give them advice on how to make the best use of their system in case of storms, sand, or cloudy weather.

3.2.2.2. MOBILE PAYG TO EMPOWER AND BUILD CAPACITIES OF USERS

The expected benefits of off-grid solar are extensive: improved health, safety and security; improved education[5]; increased savings otherwise spent on candles, batteries or kerosene; economic opportunities for entrepreneurs, such as extension of working hours, enhanced productivity, and increased revenues. On behalf of users, the introduction of SHS combined with PAYG schemes seems to contribute to both financial and digital inclusion.

INCREASING FINANCIAL INCLUSION AT THE BASE OF THE PYRAMID

One of the major impacts of mobile PAYG schemes is the **opportunity to increase financial inclusion for the unbanked**. Indeed, the PAYG business model has been widely recognized as a critical innovation in microfinance, particularly in countries

[5] Thanks to the extension of time for children to do their homework for instance or through the exposition to new sources of information through mobile technologies or TVs.

FIGURE 13 | Energy appliances and technologies in peri-urban housing (Source: © Blanche Varlet)

(a)
Battery storage system for mini-grids

(b)
Mobisol's MobiCharger appliance

(c)
Peri-urban house equipped with Mobisol's system

such as Tanzania where only 9% of the population owned a bank account in 2017. In this context, the digitalization of the off-grid sector unlocked two new services for the unbanked:

- **Access to "formal" credit for the first time through a non-punitive approach:** indeed, this model offers some flexibility as to the frequency of the payments, in particular for those with volatile, seasonal, and less-predictable incomes, who can make payments based on cash availability. Mobisol for instance reported having rescheduling possibilities if the client encounters specific issues, such as a personal problem within the family or drought affecting revenues.
- The **accumulation of a credit profile**: Zola and Mobisol offer their customers, once they have completed payment for their SHS, the possibility to finance new products through additional credit. Thanks to the data collected, clients get a credit score based on the continuity and regularity of their payments, making them later suitable for a new range of products: bigger systems and appliances, for instance. This is a first step towards the financial inclusion of these clients, as payment history certifies their ability to pay off a debt/credit.

This business model is also beneficial, as it addresses the problem of a lack of productive uses of electricity — one of the main barriers to overcoming poverty involves the impacts of limited electricity consumption. Through upgrades to larger systems, users can gradually afford productive systems (e.g., sewing machines) and can use electricity for income-generating activities, helping them earn their way out of poverty.

INCREASING TECHNOLOGY LITERACY FOR WORKERS

PAYG solar companies capitalize on large networks of local and field agents. As key assets to their business model, the agents receive training related to the technical aspects of off-grid energy, business or financial management, and digital skills. **Mobisol launched the *Mobisol Academy*** in Arusha, **and Zola established the *Zola Academy*** in both Tanzania and Rwanda, training institutions for sales agents and technical staff. Trainings include marketing, customer communication, business management, and solar electrics installations, but also IT, digital and mobile platforms.

In addition, other companies such as Greenlight Planet launched a dedicated "women club"

Box 11: Solar Sister

Solar Sister is an East African social enterprise created in 2010, which opened its office in Arusha in 2013. It invests in women's enterprises in off-grid communities, as an opportunity to empower women and to reach entrepreneurs disconnected from the grid. Solar Sister is one of the flagship initiatives in Tanzania: it is a women-led clean energy enterprise that recruits, trains, and mentors women, building women-to-women networks to achieve last mile distribution of SHS.

Solar Sister affirms that women perform as well or even better than men as entrepreneurs, and that women's networks seem to be particularly powerful for diffusing information, hence for marketing and promotion of PAYG companies' offers. The rise of the PAYG model and mainstreaming of mobile technologies have led them to consider new forms of training, taking into account the progressive digitalization of the sector.

Solar Sister is currently working on a new program called WE SOLVE, in partnership with BRAC MFI and Signify (formerly known as Philips Lighting): Solar Sister Entrepreneurs sell clean energy product, Signify provides solar products, and BRAC offers microloans. These microloans should also lead to small instalments through mobile payment. According to Solar Sister, this new project will then allow women to get training related to business and financial management, as well as trainings related to the use of digital platforms and mobile technologies (for instance CRM platforms). Mobile technologies then offer new opportunities for women workers to acquire new digital skills.

among the staff to assist them in working their way up through the different hierarchy ranks. **This strategy recognizes that while women are a preliminary beneficiary of clean energy, they have been under-represented in the business.**

SPECIFIC IMPACTS ON FEMALE USERS

Women usually are the most affected by energy intermittence and endure the worst effects of energy poverty: kitchen air pollution disproportionately affects women and girls; and traditional sources of light, such as kerosene lamps, candles, and open fires turn daily tasks such as studying or cooking into challenges. Access to electricity can also have a key role in empowering women and girls by allowing exposure to new sources of information through mobile communications or televisions, positively impacting their economic activity, and improving access to jobs and business opportunities. Some solar PAYG companies, such as Greenlight Planet, also reported they are currently developing **productive-use systems specifically designed for women**, such as sewing machines. The development of these solutions is believed to open new economic and business opportunities for women.

Furthermore, the use of mobile payment in itself seems to have positive impacts on women, who **are often responsible for managing the household and cash payments, even though they do not make the purchase decisions in the first place.** Those who are not proceeding to mobile payment on their own acknowledge that their husbands were taking care of mobile payment because it was quick and easy; others reported that if mobile money did not exist, they would have had to travel to the shops to make cash payments themselves. Mobile payment is then an opportunity for them to save time for other activities, such as entrepreneurial/business activities (e.g., working extra hours on the market) or managing the household.

3.2.3. Digital processes and challenges around SHS companies

Mobile payment has underpinned the solar PAYG model by profoundly changing and facilitating the processes of delivering off-grid, dematerialised, and individualised basic services to poor populations in peri-urban settlements. It appears that although technical challenges are few,

economic and institutional dimensions still require some fine-tuning in business models.

THE OPERATIONAL GAINS OF MOBILE TECHNOLOGIES FOR ALL

On the user-side, **mobile technologies have reduced entry barriers to the service by allowing the most vulnerable to access SHS through small and flexible payments**. Most of the users, and particularly women, would simply never have had access to this kind of service without the possibility of using mobile money.

However, the use of mobile technologies and ICTs seems to be much more attractive to the service providers themselves, as it favours the **commercial viability of the business model**. More specifically, the use of digital platforms and mobile technologies have made it easier for PAYG solar companies to manage various aspects of their businesses (Figure 14).

FRAGILITY IN FINANCING MODELS AND TRANSACTIONS

PAYG solar business is highly capital-intensive and faces financial fragility. PAYG companies have to cope with currency exchange volatility, since most appliances are manufactured in China; operating costs, especially associated with call centres; high repair and maintenance costs; and the risk of defaulters.

Even though companies do not have or may not share data on default payment, the number of defaulters is not negligible. Challenges of repayment by users are due to an array of variables:

- Customers "vote" through timely mobile payments: if they are not satisfied with the service, they simply stop paying for it;
- Most of the users have **seasonal sources of income**, and monthly instalments for SHS can become a source of anxiety and difficulties. Some of the non-PAYG users reported that they preferred to pay cash for the system, as they feared having debts while having irregular sources of revenues;
- As the clients pay for the devices themselves and not for the energy consumed, Mobisol and Zola reported facing resistance from clients, who might not be willing to pay for a service they own but **do not use**;

FIGURE 14 | Role of digital tools and mobile technologies in the solar PAYG business model

- Some of the clients that were connected to the **national grid** immediately after acquiring a SHS stopped using it and consequently paying for it;
- Women who are still **dependent on their husbands** face difficulties in managing payments while their husbands are away;
- Some of the companies also reported that they faced some **fraud** in the past, which has now decreased thanks to the improvement of the monitoring technologies (i.e., use of universal GSM chip).

Additionally, operating costs due to defaults is high. For example, after 30 days of non-payment, Mobisol automatically calls its clients; after 60 days, again; after 90 days, a local agent pays a physical visit to the customer; and after 120 days of non-payment, the client is dispossessed of the equipment. The repossessed SHS are sent to refurbishing and used as replacement systems in case of a technical issue with another user's system. However, in many cases, the battery is low and cannot be used anymore — it is then sent to recycling.

DATA COLLECTION AND INFORMATION MANAGEMENT

Remote asset monitoring involves amassing a significant amount of data, notably on electricity usage patterns. While these data are yet kept confidential, **companies acknowledge that monetizing them could be a key asset for their business and industry's valuation.**

The collection of data can lead to some positive benefits for the urban poor as well. **Paying on a regular basis allows them to obtain positive credit scores**, and thus to access a variety of other services such as health insurance, for example. Some PAYG solar companies hand certificates to users who have paid off their systems, as a proof of their ability to repay a debt and to counter the perceived insolvency risk of low-income customers.

On the other hand, the collection of this data raises some issues of privacy, and the Tanzanian microfinance regulations from 2019 emphasize transparency when signing up a customer. Companies need to make sure that end-users fully understand the contracts and provide their consent. The regulations will apply to microfinance business, but there is a possibility that PAYG companies will fall under it as well. **However, locally, a few concerns still arise as to the full acknowledgement of customers** who are required to sign contracts when registering for a SHS/credit, with a high chance they do not understand the nature, impacts, and value of the information they consent to provide.

3.2.4. Key lessons as to PAYG for SHS

When Mobisol and Zola both started their operations, they presented themselves as socially conscious and impact-driven businesses. Financial challenges led them to gradually shift from the base of the pyramid to clients with higher ability to pay. Nonetheless, they are still torn between their aspirations for a positive social impact and their imperatives to achieve a certain economic viability.

RISK OF A "CHERRY-PICKING" STRATEGY BY PRIVATE PROFIT ORIENTED COMPANIES

In a country where most of the customers do not have stable monthly salaries or bank accounts, it is a challenge for companies to determine whether a customer is creditworthy or not. PAYG companies **strengthened their credit-screening processes and hired staff with a background in microfinance**. The credit-screening process consists of an interview to estimate income level (status, job, sources of income, personal assets, etc.), the presentation of a national ID card, an introduction letter from the community leader and/or an employer, and checking of the public Credit Reference Bureau database to determine if the prospective client has any registered loans.

To achieve financial sustainability, **PAYG actors also increasingly tend to prioritize densely populated and relatively wealthy communities** to minimize non-payment. In parallel, they have **gradually upgraded their offer from simple and relatively basic systems (lights, radio) to more complete ones (comprising TVs, stereos, etc.)** to target and match expectations of relatively wealthier households. The predominantly market-based interactions and individualised access modalities, facilitated by off-grid and mobile technologies, thus present the risk of **cherry-picking strategies favouring reliable and**

promising clients at the expense of the most vulnerable. In this perspective, new technologies will no longer contribute to inclusion, but rather exacerbate exclusion and electricity access inequalities.

THE SEARCH FOR SOCIAL INTERMEDIARIES

To overcome the tension between social impact and economic prospects, companies are contemplating innovative collective partnership schemes. Indeed, individualization created by the use of mobile technologies undermines tariff solidarity and jeopardises access for the poorest who are facing difficulties in paying their debts.

Both Zola and Mobisol now intend to **capitalize on the strong social ties linking both formal and informal communities together in Tanzania**, and particularly try to develop partnerships with cooperatives. Mobisol is starting new projects with Tanzanian cooperatives in the coffee and cashew nuts sectors. The revenues of these cooperatives' members are highly seasonal and have prevented them from individually accessing SHS and credit. Mobisol is therefore currently testing new schemes in which the company is providing SHS and unlocking credits through cooperatives. Individuals can then guarantee each other's payments. Zola also pointed out the high potential of partnering with SACCOs (savings and credit cooperative organizations).

Both companies are quite confident in the potential of these social ties, especially as these cooperatives are still regulated and registered by ministries (e.g., agriculture or finance). **Informal groups, such as women's groups, are also quite powerful and are identified as another potential lever to increase social inclusion through PAYG.** Some of the interviewed women users indeed reported being part of such groups, through which women are lending money to each other. Furthermore, providing several SHS to groups could also allow solar companies to adapt the costs and the payment schemes to the needs and capacities of their members.

POSITIONING OF PUBLIC AUTHORITIES

New electricity providers and SHS companies are not seen as competitors by TANESCO and the Government of Tanzania, but rather as **providers of complementary services**: for the moment, these companies are allowed to circumvent large investments required for traditional network infrastructures and offer energy access to households still not connected to the national grid.

Consequently, some international donors based in Tanzania are considering **subsidy-driven programmes specifically targeted to the poorest** as a complement to their financial support for the extension of the national power grid for rural electrification. Nonetheless, the Government of Tanzania might be willing to better **regulate** these new service providers, though new laws such as the microfinance act might also apply to these companies.

LESSONS

Access to energy services, thanks to PAYG SHS, offers similar impacts as regular electricity connection: education, home-based enterprises, communication, etc., all contributing to improved livelihoods and living standards. The difference or added-value of ICTs for equitable growth, however, lies in the possibility to service remote households through off-grid solutions, and the side effects related to financial inclusion, mainly due to mobile-payment and pay-as-you-go schemes.

3.3. SYNTHESIS OF CASE STUDIES

The contribution of ICTs for waste management in Bengaluru and to off-grid solar energy systems in Arusha are summarized in Figure 15. These digital initiatives offer opportunities to contribute toward equitable economic growth; at the same time, there are challenges going forward with support for and the maintenance and expansion of these programs, and for the inclusion of the poorest of the poor.

FIGURE 15 | Synthesis of case studies: Contribution of digital initiatives in urban informal contexts

ICTs FOR...	WASTE MANAGEMENT IN BENGALURU	OFF-GRID SOLAR ENERGY IN ARUSHA
Factors of success	• Engagement of intermediaries to empower informal workers • Cautious approach to choose appropriate and simple technologies • Regulatory framework spurring data generation opportunities	• High penetration of mobile payment • Adequation of remote technologies for distant / isolated customers • Digital and financial empowerment of users
Challenges	• Early-stage projects and fragile business models • Little demand from households and interest from private IT sector • Disconnection from municipal policies and political will to scale-up	• Ability to pay from vulnerable households • Tendency towards cherry-picking from private companies • Regulation of personal data management and use
Contribution to equitable economic growth	• Improved visibility, relations, and respect of stigmatised workers • Trickling down effect from data-related commercial opportunities to improved working conditions	• Potential for users to obtain a credit profile (financial inclusion) • Digital training and capacity-building of employers

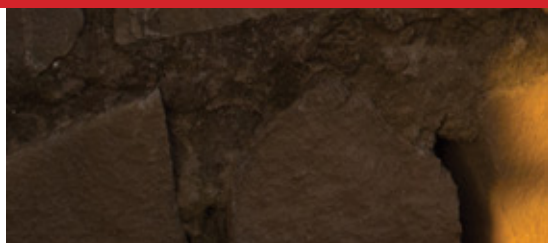
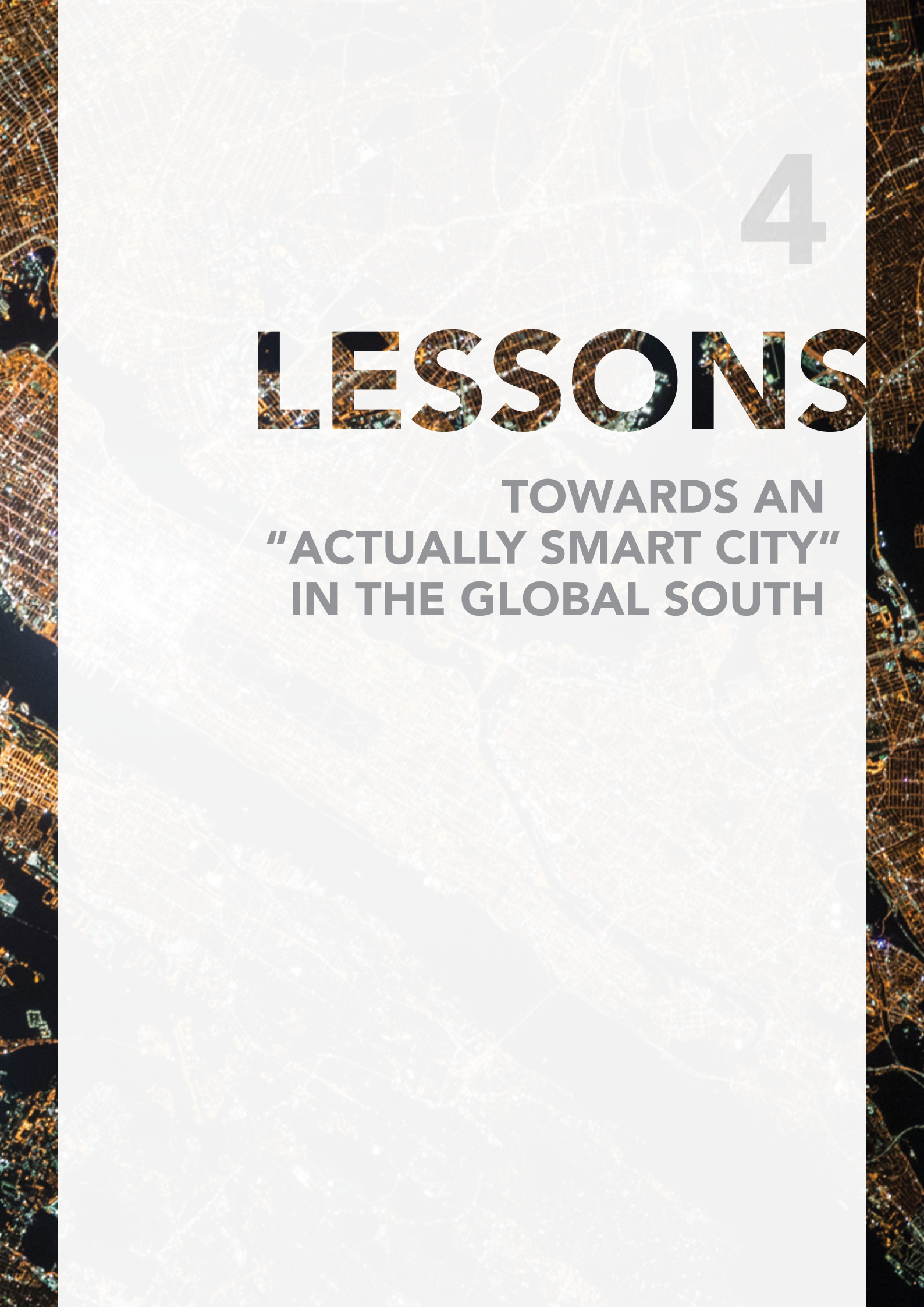


Photo by NASA on Unsplash



4

LESSONS

TOWARDS AN "ACTUALLY SMART CITY" IN THE GLOBAL SOUTH

4.1. COURSE OF ACTION FOR ICTs THAT FOSTER URBAN INCLUSION

As stated by ICT4D research, "*using the wrong technology or using it wrongly may lead to further exclusion*" (Njoki & Wabwoba, 2013). Besides, access to information, production of data, and digital innovations are deeply embedded in wider political economy and urban contexts; from that perspective, "*the digital divide [is] not as the root cause but rather as a symptom of inequality and poverty*" (Adera et al., 2014). Reciprocally, the success of technological solutions is context-sensitive and does not go without risks, trade-offs, or side effects. Therefore, to avoid the perils of the smart city, different kinds of actions are needed (Kitchin, 2015), such as:

- Creating **general conditions and favourable environments for the inclusive uses of new technologies**, which are related to an approach of ICTs as a core urban service;
- More specifically, promoting **dedicated inclusion-oriented actions, adequate to the initial context of vulnerability, and the digital assets of the urban poor** (prevalence of mobile phones, personal uses, third-party initiatives, and pre-existing empowerment dynamics).

4.1.1. An enabling environment: Necessary preconditions in availability of ICTs

The expected changes depend upon **preconditions as to the availability of infrastructure and platforms, the accessibility of services for all, and an adequate regulatory framework**. As for any other core urban service, ICTs require an enabling environment that combines the following:

- **Material support such as telecommunication networks, infrastructure, connectivity, and platforms** is essential. The deployment of such infrastructure still largely depends on national governments, in both the Global North and Global South, and more particularly for secondary cities, considering the large-scale investments needed. Nevertheless, urban areas are generally much better served and connected than rural areas. The case studies and the penetration of mobile technologies show that accessibility is not the prime challenge for urban populations.
- **Uses and appropriation by the people**, including the urban poor (i.e., resources and capacity to take advantage of the technologies) should be enabled. Second-hand markets and the penetration of mobile phones, allowing the shift from texting to audio and images, strongly facilitate uses, even among illiterate populations. The density and proximity of people in urban contexts allow for more shared or indirect uses of phones; furthermore, the youth, who represent the bulk of urban demographics, are better connected. Nevertheless, specific attention ought to be given to autonomous use by women and to training, particularly for elderly populations.
- **Adequate regulatory frameworks:** to ensure the regulation of all private initiatives and providers and to guarantee proper management and protection of personal data, national regulations are needed. Due to the recency of the digital transition, these frameworks may not yet be mature. Besides, local authorities rarely have the competency on telecommunication sectors.

An enabling environment for ICTs to contribute to urban development appears to be highly dependent on national long-term policies. **Local authorities, particularly in secondary cities, have little room to maneuver as to the deployment of new technologies and the governance of the digital sector.** Nevertheless, private digital initiatives do take place on their territories, and they can both steer and capitalise on these.

4.1.2. A favourable environment: Factors of success for inclusiveness

Considering that ICTs are not a panacea, the provision of digital infrastructure, platforms, and services will not automatically solve urban challenges nor contribute to inclusion. Because of the early-stage, market-oriented tendency of tech-actors, initiatives ought to be directed towards inclusive purposes. From that perspective, local authorities do have a critical role to play to tamper the risks and promote inclusive innovation. There are no simple institutional or political solutions that will ensure the inclusiveness of digital processes: solutions are city- and sector-specific and ought to be adapted to the considered expected outputs. However, some generic interventions can create a favourable environment.

WILLINGNESS TO CONSIDER GRASSROOT DIGITAL SOLUTIONS

The uses of ICTs reflect a ladder (Heeks, 2016) or a pyramid (Walsham, 2017), from the poorest of the poor (women, migrants, homeless, daily workers) who have little use of ICTs to entrepreneurs, activists, and community leaders who know how to access information and communicate, and who are willing and able to seize digital opportunities. **Therefore, it seems a pre-existing entrepreneurial or community-empowerment dynamic has a leverage effect on ICT uptake.** Unfortunately then, if ICTs contribute to improving livelihoods for some of the urban poor — who can mobilise and develop their enterprises or map their needs in terms of services — the most vulnerable that remain unconnected and data-less are at risk of being even more excluded.

To counter this risk of exacerbated exclusion caused by exponential penetration of ICTs, there is a need for specifically targeted programmes to contribute to socioeconomic inclusion of these vulnerable groups. **Location-based action to incorporate non-organised citizens** (United Cities and Local Governments, 2020) is a condition for digital solutions to make sense in their context of vulnerability. In other words, regardless of the technological dimension, a socio-political framework favourable to empowerment is the necessary background basis for urban inclusion.

More specifically, **some communities and NGOs do use technological tools and data to provide evidence on the needs of these vulnerable groups and to make their claims heard**. This bottom-up uptake of technological opportunities may be ignored or considered illegitimate because of its crowdsourced character. However, this digitalised evidence represents a highly valuable source of information and knowledge on territories and may help in creating adequate solutions to the needs of the urban poor. Acknowledging and capitalising on these crowdsourced data may allow local authorities to grasp actual, and sometimes informal, dynamics and may inform the political decision-making process towards more inclusiveness.

POLICY AND INCENTIVES FOR INCLUSION-ORIENTED DIGITAL SOLUTIONS

The avenues opened for businesses or for e-formalisation by ICTs are likewise dependent on a favourable environment for inclusion. Third-party initiatives run on fragile business models, blending finance sources. They are compelled to combine some financial profitability with social concerns that may not be cost-effective. External support is therefore needed, whether from international donors, CSR, or public schemes. **To ensure their sustainability, encourage looking at the base-of-the-pyramid, and mitigate cherry-picking strategies, local authorities can accompany inclusion-oriented initiatives through the following:**

- Creating incentives through subsidies, calls for projects or grants for technological solutions which offer services or products to the poorest of the poor;
- Offering opportunities for collaboration between conventional private sector and start-ups in dedicated public collaborative premises, in events such as hackathons and calls for projects;
- Using local and grassroots digital innovations in public policies and projects and administrative services.

ACCOUNTABLE GOVERNANCE OF LOCAL DATA AS A PUBLIC GOOD

The dematerialisation of transactions or the production of data-based evidence on informal dynamics assumes that users trust their counterparts. Transparency is a potential positive force, but enforcement of contracts, respect of privacy, and secured financial platforms are equally critical.

The case studies illustrate that though an extensive amount of data is actually produced by third-party actors, the management of this data — protection of individual information, possibilities of valuing it, publicity and sharing of data — is off the radar for now. There is no business model based solely on data, regulatory frameworks on data management are still fragile, and users have little information and concerns about their data.

Besides, when dealing with informal dynamics, the issue of making users visible and mapping can itself be tricky for fear of attracting attention and repression (Heeks & Shekhar, 2019). **In contexts of weak governance, inequalities and exclusion of the poorest, producing, collecting, protecting, and sharing data on informal urban dynamics will fill a critical knowledge gap.**

Local authorities could position themselves as the warrant of local spatial data. They can promote common standards of data format for interagency sharing of public data within all local agencies, mainstream specifications on the publicity of data in public tenders, and promote transparency and trust in public databases.

4.1.3. User side: Empower the urban poor to seize ICTs

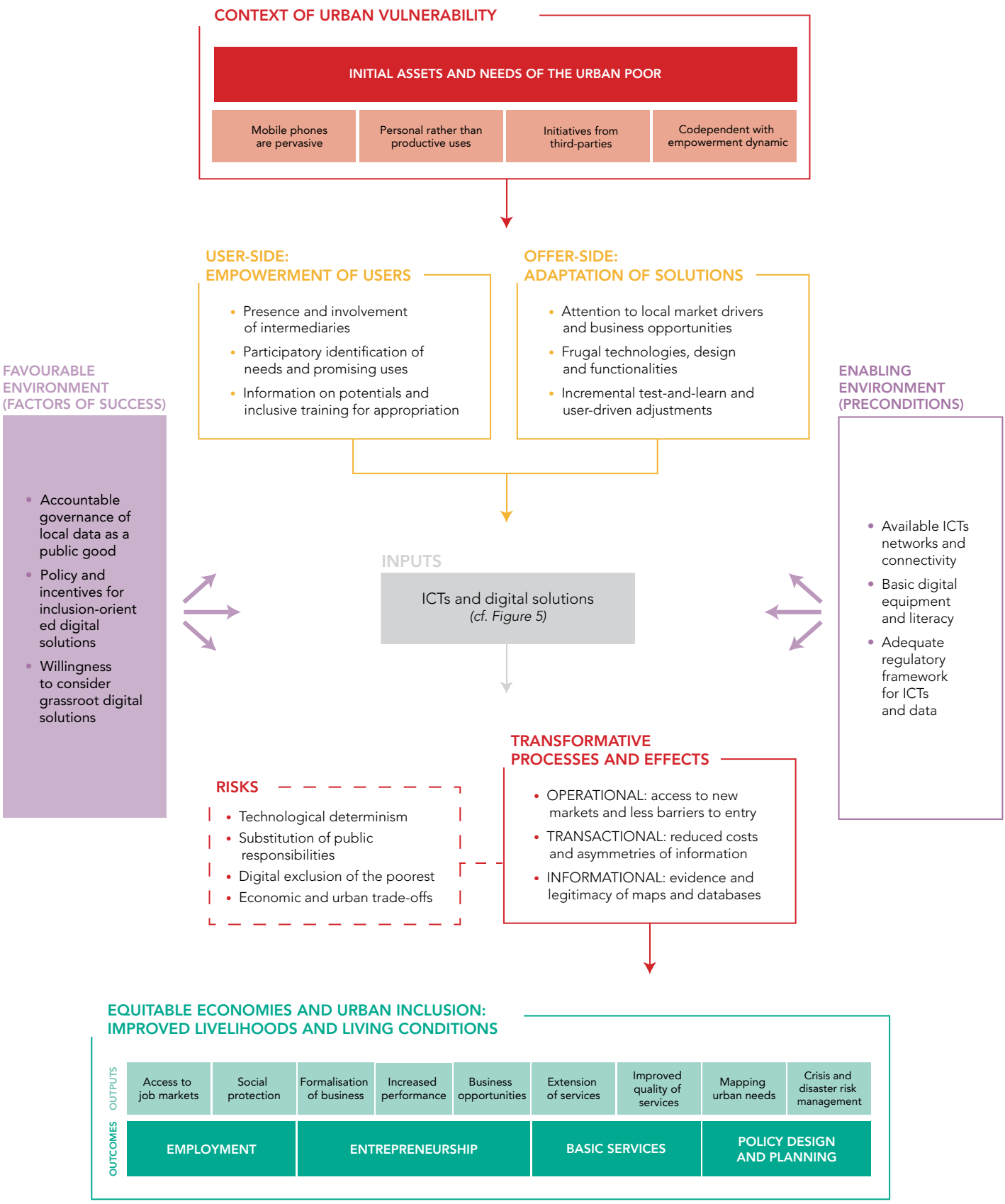
Although the urban poor are generally equipped with mobile phones, the predominant use is for communication with relatives. **To use their phones as a tool for empowerment, entrepreneurship, or political claims is not self-evident:** entrepreneurs may not see the potentials, inhabitants may feel intimidated. Some specific actions are needed to spur productive uses of livelihood-related digital solutions:

- The challenge ICTs impose on skills and practices should not be overlooked (Seetharaman et al., 2019). As a matter of fact, **successful uptakes are mediated**, either by an NGO, the employer, a specific digital inclusion programme, a university project, a start-up, or a tech-community. These mediators work at presenting the opportunities, training and accompanying the adoption, and encouraging the willingness and capacity to use the new tools (Adera et al., 2014). The role of these intermediaries is crucial in ensuring that the voice of the urban poor is taken into account.
- The relevance of introducing ICTs in urban informal contexts cannot be pre-decided. The transfer of technological solutions from other contexts — Western countries, other urban sectors, or rural areas — may not tackle the actual expressed needs and demands from the targeted users and may not be aligned with actual practices and socioeconomic structures. **End-users — in our case the urban poor — must be included in the choice, design, and features of the digital solution itself**, to be in line with their practices (Adera et al., 2014). If the solution is too complex or does not address actual concerns, the users will have no interest, willingness, or incentive to use it. On the contrary, participation in the design of technological solutions has a strong potential for change.
- Last but not least, information on the potentials of ICTs to improve living standards and livelihoods is still needed to shift from personal to productive uses. Beyond information, inclusive training to enhance **digital literacy and confidence ought to target both women and elderly populations**.

4.1.4. Offer-side: Adapt technological solutions to socioeconomic context

To ensure the sustainability of new solutions, the adaptation of technologies to socioeconomic contexts is decisive in designing solutions and business models. Very often, technological challenges are easily overcome, while commercial and business difficulties are more critical. Most of the studied solutions have fragile business models and rely on international financial support from donors and/or external private investments (CSR, impact investment, etc.). In investment-scarce situations, technologies have to be aligned with a thorough scrutiny of the market drivers and possibilities:

FIGURE 16 | Theory of change: Multilevel sociotechnical challenges related to ICTs for urban development



- In contexts of widespread poverty and informality, the needs assessment and market drivers ought to take into account the base of the pyramid. Demand and uses, particularly from the urban poor, is contingent upon their ability to pay in the long-term. **The relevance and opportunity of an innovation — which can justify resorting to digital solutions — is to be defined by and with the end-users themselves.** For example, designing a platform for on-demand trash collection does not make sense if there is no demand from households; likewise, digital marketing campaigns are often irrelevant for small, walk-in proximity shops (Ilavarasan, 2019).
- **Frugality is also a factor of success to ensure financial sustainability. Frugal innovations, tailored and crafted to respond to local contexts, are more widely utilised** (Casey, 2015). The functionalities should therefore not mimic the high-tech promises conveyed through external best practices, but rather be fine-tuned to fit with the specific social problem to be tackled (Omole, 2013). Technologies ought to be accessible — not too complex, and supported with training — both for potential customers and working users; in many cases, SMS notifications may be more relevant than an English-language app.
- Last, and in coherence with the participation fostered by social intermediaries, functionalities of the considered digital solutions ought to be continuously adjusted depending on users' needs. In socially and economically unequal contexts, inefficiencies or negative side effects related to the introduction of technologies should lead to **reorienting technological and commercial solutions** towards the needs of the urban poor. IT stakeholders may have a technological bias in designing solutions; involving such end-users is critical to ensure constant adaptation and flexibility.

4.2. GOVERNANCE OF "ICTS FOR URBAN DEVELOPMENT"

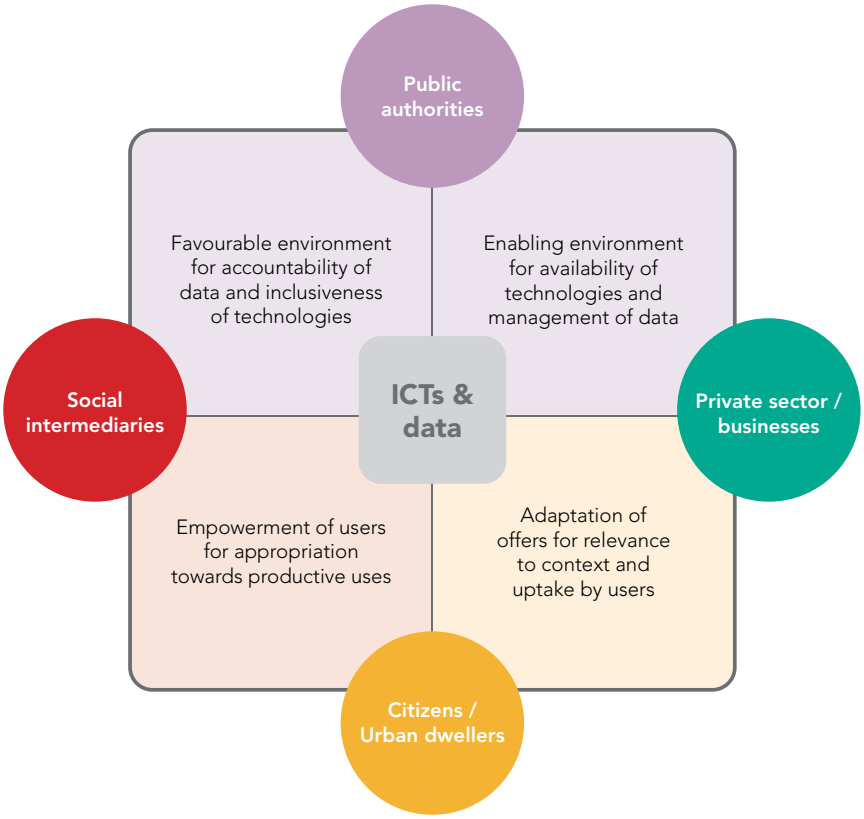
This paper's theory of change is focused on the way third-party actors can develop ICT-based solutions that contribute to urban inclusion (Figure 16). Since ICTs appear both as a core service *per se* — to be delivered, managed, and used by all like other urban services — and a tool to support and improve the provision of other urban services, they gather attention and action from all urban stakeholders.

Transformative urban change, particularly in cities of the Global South, which have constrained resources and capacities, relies on **cross-sectoral solutions and coalitions of urban change agents** (Beard et al., 2016). To create sustainable innovative and equitable solutions altogether, social and technological dimensions have to be aligned; and public, formal private, informal, and community stakeholders must cooperate. Building such coalitions will enable the conditions for success to be met and decrease the risks of further exclusion due to digital technologies (Figure 17), while also gathering resources and lowering the financial and technical burden. From that perspective, **the collective provision of digital solutions may particularly be structured around data sharing; and in that sense, data ought to be considered a public good**.

4.2.1. Creating incentives for public good-oriented digital enterprises

In cities of the Global South, markets and infrastructures are mostly and increasingly present. But the arrival of new stakeholders — digital businesses, start-ups — disturb traditional governance frameworks. **There is a myriad of small-scale, quick-win, and unregulated initiatives emerging, thanks to ICTs that compensate for public deficiencies.**

FIGURE 17 | Sociotechnical and political alignment in a multistakeholder governance framework



"Tech4good" start-ups, incubators, fablabs, etc., are increasingly committed to do so. **These third-party actors are crucial, in the model and on the field**, to facilitate the emergence of locally adapted **digital solutions** that actually address the needs of the urban poor. These structures are often more present in capital cities, but may be replicated in secondary cities, with the support of donors or at low-cost by starting with opening data or spaces for multistakeholder dialogue that will spur innovation.

However, digital entrepreneurs run for-profit enterprises, even though they may have social concerns. The tension between economic and social goals ought to be considered: **blended finance as well as regulation and incentives** are needed to orient private initiatives towards public good. Data can as well be a market driver, both as a valuable asset and as a way to provide information on the profitability of the investments.

4.2.2. Strengthening the positioning of inclusive intermediaries

In urban contexts, the goal to create a favourable environment goes beyond the preconditions for digital access and literacy and focuses on uptake and outputs. There is a need for dedicated actors that are both socially committed and technologically literate, able to empower the demand of the urban poor for IT solutions and to drive technological solutions towards inclusive outputs.

To ensure that ICT-based solutions deliver their promises in a relevant and sustainable way, **mediation** is needed to ensure a **participatory design process**. Beyond digital literacy training, the challenge is to prepare the urban poor in shifting their uses from personal communication only to considering ICTs as empowerment tools for specific and productive purposes. These intermediaries — CBOs or NGOs, local or international — ought to be capable of interacting

with the urban poor, understanding their needs and constraints, and mastering and promoting the potentials of the chosen digital solutions.

Facilitating and legitimating these social intermediaries in the local governance framework can be a key driver for change: creating spaces or platforms for exchange between IT and social initiatives, organising hackathons, publicising the market potential at the base of the pyramid, and sharing promising data can foster the emergence of innovative partnerships. These can bring financial means to non-profit structures, while giving access to untapped markets for private firms.

4.2.3. Recommendations for local authorities

A bottom-up approach of ICTs for urban development indicates that public authorities also ought to get involved in business-to-business and business-to-consumers relationships. Deepened collaboration with private and other stakeholders allows them to capitalise on and and take advantage of existing initiatives and resources and articulate them towards general problem-solving solutions, even in contexts of constrained public resources.

In terms of methods and approaches, successful bottom-up initiatives offer promising leads to adapt smart city approaches to contexts of the Global South that allow to draft some recommendations:

- Facilitate, gather and ensure **proper use of existing scattered data**, including on informal dynamics to better inform decision-making processes;
- Focus on **frugal, context- and sector-sensitive technical solutions** that are affordable and appropriable by all, and follow incremental and gradual processes of innovation and change management;
- Shift even further in citizen engagement and open government, **from information directed at citizens to demand-driven mechanisms** to address the actual needs of the poorest.

Further on, it appears that a data- and investment-scarce situation of local authorities does not necessarily mean that there is a scarcity of such resources in the city. **A closer look at bottom-up dynamics indicates that data is pervasively produced at the grassroots level, and that private investments do happen.** However, the full potential of data is still not realised, due to denial, indifference, or lack of adequate use in decision-making processes (United Cities and Local Governments, 2020). The challenge is to capitalise on — or at least use and direct — these towards the public good.

To take advantage of these trends, however, requires a shift to smart city approaches: from the top-down approach of providing e-services to multistakeholder collaboration; from a technologically-driven perspective to a user-oriented prioritisation process; from sophisticated, one-size-fits-all solutions to context-sensitive

innovation; from purely strategic management to more open government (United Cities and Local Governments, 2020); and from macro-economic growth goals to micro-level equity and the inclusion of the urban poor.

To ensure the inclusion of all, and particularly the poorest, in the digital transition requires a **favourable environment and governance framework, even more so than technologies and resources. This is within the reach of local authorities in the Global South**, provided that they open decision-making processes and collaborate with all stakeholders in a user-driven perspective.

4.2.4. Directions for development and research partners

Finally, both additional knowledge and funding are still necessary to support an inclusive digital transition in secondary cities of the Global South. Donors and dedicated initiatives are increasingly paying attention to such a trend, promoting new governance arrangements that go beyond the lines of social empowerment or business support (cf., Annexure). Since these approaches are still early stage, it would be presumptuous to draw final lessons. However, some key elements can be highlighted:

- **New business models emerge that blend finance sources and tap into the base-of-the-pyramid potential.** These mixed financing solutions entail a fragility, since they have to combine the logics of a wider array of stakeholders. Specific financing for third-party actors, regardless of their for- or non-profit orientation, could be developed to focus on the specific needs of such social enterprises.
- **Capacity-building**, for public agents and entrepreneurs, but also for workers, should include specific digital skill enhancement and training. This would also contribute more generally to enhancing the employability of people, as well as to market opportunities.
- **Data management**, particularly in weak local governance contexts, will become increasingly critical. The promotion of secured open-data schemes could be included in all donor-funded projects, along with the advocacy for adequate data regulatory frameworks to ensure public assets are used for public good rather than corporate purposes.

This paper highlights the need for further knowledge at the crossroads of smart city and ICT4D works: contextualising both research trends in cities of the Global South would certainly generate **evidence on (i) actual uses of technologies by the urban poor; and (ii) new hybrid business models and intermediary actors** that are often overlooked in the literature. These insights could consequently enrich the theory of expected digital changes, considering **new technologies altogether as a core service *per se* and a lever for the provision of other basic urban services**.

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ANNEXURE:
SELECTED INTERNATIONAL DIGITAL URBAN INITIATIVES

GENERAL FRAMEWORK

Global institutions strategies

In 2015, the United Nations General Assembly approved the 2030 Agenda for Sustainable Development. This Agenda recognizes that "the expansion of Information and Communication Technologies (ICTs) and the global interdependence of activities have the potential to accelerate human progress, reduce the digital divide and create knowledge societies". The Agenda 2030 also identifies digital technology as a transversal and essential contributor to achieving all the SDGs.

Following this rationale, two of the top four international donors for the ICT sector launched two ambitious initiatives, setting out priorities for the development of ICTs in the Global South, with the ambition of making new technologies a tool to leverage development in various fields.

- The D4D (Digital 4 Development) Initiative by the EU: launched in 2017, it consists of a comprehensive strategic framework setting out four priority areas of intervention, with a specific focus on Africa:
    - Promoting access to affordable and secure broadband connectivity and to digital infrastructure, including the necessary regulatory reforms;
    - Promoting digital literacy and skills;
    - Fostering digital entrepreneurship;
    - Promoting the use of digital technologies as an enabler for sustainable development.
- Digital Economy Moonshot for Africa — World Bank: launched in 2019, this ambitious initiative's goal is to reach the objective that every African individual, business, and government is digitally enabled by 2030. With this global objective, the program encompasses targets under different broad categories: digital infrastructure, digital skills, digital platforms, digital financial services, and digital entrepreneurship.

Most donors, both bilateral and multilateral, have developed strategic frameworks focusing on digitalization, acknowledging the opportunities and benefits this brings to developing countries. The UK Department for International Development (DFID), for instance, issued a digital strategy 2018-2020 for "doing development in a digital world", and the Agence Française de Développement (AFD) developed a new approach based on the concept of "transitions", with the digital transition being one of the key axes of AFD's scope of intervention. Donors are implementing diversified digital technologies programs, projects, and initiatives along these lines that this annexure seeks to map.

Most donors generally combine a two-fold approach for promoting digital technologies that is based on the following:

- Targeted interventions for the digital sector (e.g., support to information technology-based ecosystems and industries, improvement of access to digital infrastructure or technologies and literacy);
- Mainstreaming of digitalization in priority sectors.

Overall, it seems that donors' support towards the digital sector has gradually shifted from financing infrastructure to providing assistance for digital capacity-building, policy, and mainstreaming.

Existing streams of intervention

More specifically, looking at the programs/ initiatives led by global institutions in the field of smart cities and new technologies supporting urban development and urban services, we can observe four different existing streams of work through which mapping has been organized:

- A sectorial angle: programs and initiatives aiming to mainstream digitalization in specific urban development sectors, such as transport, water/sanitation, disaster risk management, or energy;
- A local economic development / business angle: stakeholders, programs, and initiatives focusing on supporting the development of a digital ecosystem. These programs help start-ups, SMEs, small businesses, or informal entrepreneurs developing or using smart technologies;
- An empowerment perspective: programs and initiatives aiming to support civil society in seizing ICTs to reduce vulnerability and marginalization of the urban poor;
- An institutional angle: programs and initiatives approaching smart cities as a governance challenge, thus entailing mainly capacity-building actions for public and local authorities.

However, it is important to note that most of the donors and global institutions have developed crosscutting positioning.

MAINSTREAMING ICTs IN SECTORIAL URBAN POLICIES

Scope of intervention

The speed of deployment of new technologies is affecting traditional sectors of intervention for international donors. The scale of disruption in the Global South is indeed transforming the way to deliver public services: digital technologies drive new business models, allowing the private sector to more efficiently deliver basic services to informal settlements and poor communities (through mobile payments for instance).

According to this rationale, some international donors have developed programs and initiatives addressing sector-specific challenges and opportunities. These initiatives aim to "mainstream" digitalization and the use of ICTs in infrastructure-based services such as transport, water, sanitation, waste management, disaster risk management, e-government, or electricity. From this perspective, digital tools and new technologies are integrated into international donors' traditional fields of intervention.

Flagship interventions

OPEN DATA FOR RESILIENCE INITIATIVE (OpenDRI) – WORLD BANK

In 2011, the Global Facility for Disaster Reduction and Recovery (GFDRR) launched OpenDRI to apply concepts of the global open data movement to the challenges of reducing vulnerability to natural hazards and the impacts of climate change. OpenDRI works with the World Bank's Regional Disaster Risk Management Teams to build capacity and long-term ownership of open data projects with client countries that are tailored to meet specific needs and goals of stakeholders. OpenDRI engages with client governments in three main areas:

- *Sharing data*: increasing public access to risk information, by engaging with governments on the value of open data through working groups and pilot projects. In this field, OpenDRI provides open-source data sharing platforms such as GeoNode;

- *Collecting data*: engaging communities in the creation of accurate and timely data, by encouraging governments and local communities to use crowdsourcing-mapping tools such as Open Street Map. In this field, OpenDRI also launched the Open Cities Project that aims to facilitate community-mapping activities;
- *Using data*: OpenDRI develops InaSAFE, a software that combines data to provide insights into the likely effects of disaster events.

MOBILE FOR DEVELOPMENT UTILITIES PROGRAM – DFID

Mobile for Development Utilities Program is part of the Mobile for Development Strategic Partnership, an initiative on which DFID partners with the global association of mobile networks (GSMA) to leverage their expertise and market reach, in order to catalyse innovation that benefits the world's poorest.

Mobile for Development Utilities Program promotes the use of mobile networks, infrastructure, and payment systems to open new pathways for affordable and reliable utility services to reach the underserved. Based on the observation that the reach of mobile connectivity is greater than the reach of basic utility services (e.g., electricity, water, sanitation), M4D Utilities comprises activities supporting initiatives in specific sectors (energy, water, sanitation), in particular through the M4D utilities innovation fund, knowledge-sharing and convening activities, and technical advisory to mobile operators.

- In the energy sector, M4D Utilities has funded 21 innovators using mobile technology and infrastructure to provide new or improved energy services to the underserved in Africa and Asia. Some of the funded projects include the deployment of PAYG solar home systems.
- In the water sector, M4D Utilities is funding 11 organizations leveraging mobile technology to improve the efficiency of current water services and extend their reach. Some of the funded projects for instance focus on using sensors to remotely monitor water pumps and trigger timely maintenance.
- In the sanitation sector, M4D Utilities has funded two sanitation service providers trialling mobile-enabled sensors for remote monitoring of public toilets for improved maintenance, and mobile apps for logistics of toilet servicing and mobile payments for toilet subscription services.

Other initiatives

- Digital Transport 4 Africa is an initiative launched by AFD, in partnership with the World Bank and UN Habitat. It consists of an open resource centre for mapping public transport across Africa. This initiative focuses in particular on forms of semi-formal transport that most African cities are relying on. Digital technologies are indeed a tremendous opportunity to address the challenges posed by informal transport (e.g., traffic congestion, pollution, poor road safety). However, public transport data is currently missing for planning public transport, designing passenger information systems, and working with operators to upgrade transit services. This lack of data is the key challenge AFD is trying to address through this initiative. In this context, Digital Transport 4 Africa is a collaborative digital global community, scaling-up and supporting urban mobility projects through open data and peer-to-peer knowledge sharing. It includes a knowledge centre with resources from Digital Transport's global network of transportation.
- Resource Centre for Digital Transport in Cities — IDB: in 2019, the IDB and the MasterCard Centre for Inclusive Growth launched a new resource centre for digital transport in Latin America. The Resource Centre is being conducted through a collaboration between WRI Mexico, MIT's Civic Data Design Lab, and Columbia University's Earth Institute. It should support the development of open digital urban-transport data for and with Latin American and Caribbean cities. It aims to spread and scale data-building efforts through an open platform for collaborative learning by providing access to tools and anonymized data, case studies, and co-produced learning materials. This initiative complements other regional efforts such as the Africa-focused Digital Transport 4 Africa Platform.
- Korea International Cooperation Agency — KOICA: while Korea's level of ODA-giving ranks among the bottom half of OECD nations, it

has been the top national provider of ODA in the fields of ICTs from 2006 to 2014. Though ICT is a cross-cutting issue, KOICA's primary focus is on e-government, with the objective of enhancing the effectiveness of administrative systems in the Global South. Indeed, Korea's dominance in the provision of ICT aid coincided with the nation's climb into the UN's top five e-Government rankings in 2005. Korea's use of e-government to curb corruption and improve government performance has provided an example for its aid recipients. As an illustration, KOICA is currently financing major e-governance programs in Tunisia, Nigeria, Cameroon, Rwanda, and Mongolia. KOICA is also launching programs in partnership with global institutions such as UNDP on similar projects (e.g., in Indonesia).

- Land: Enhancing Governance for Economic Development (LEGEND) – DFID: launched in 2019, this global initiative consists of an open-data land and resource rights mapping platform that helps safeguard rights and opportunities for poor and marginalized people. This is expected to lead to improved land governance as an essential component for economic development and strengthen land and property rights at scale.

BUSINESS ANGLE AND SUPPORT TO ENTREPRENEURSHIP

Scope of intervention

These interventions address specific challenges digital entrepreneurial ecosystems face to develop and grow, due to low public support, regulatory barriers, or lack of digital/entrepreneurial skills. Institutions leading initiatives in this category base their interventions on the assumption that the private sector remains at the centre of the development and spread of digitalization across sectors, including urban development.

The forms of intervention in this field can be very diverse: creation of incubators/accelerators, direct investment in high-impact start-ups, support to venture capital funds, challenging processes to select promising start-ups and SMEs to be supported, innovative financing, etc.

However, through our research, we did not come across specific programs aiming to support innovation and digital tools dedicated to urban services or the inclusion of the urban poor. Urban development is simply one of the thematic areas.

Flagship interventions

DIGITAL AFRICA CHALLENGE – AFD

Digital Africa is promoting open and inclusive innovation that aims to support African entrepreneurial dynamics, drive innovation through digital technology, and support the emergence of entrepreneurs with an impact. Indeed, access to financing remains one major obstacle for African start-ups, with less than 4% successfully able to finance themselves.

Digital Africa is a start-up challenge that rewards promising African and French start-ups each year. The rewarded companies act for the development of Africa through innovative solutions, and the event aims to highlight these promising start-ups. The challenge is open to all the entrepreneurs in the seed phase. Each year, around 10 start-ups are rewarded and benefit from visibility and from the support of a digital ecosystem.

Some of the rewarded start-ups include entrepreneurs developing promising solutions to urban challenges in Africa. For instance in 2017, the mobile app "*Ville Propre*" ("clean city") in Morocco was one of the winners. The app aims to help clean polluted areas in Moroccan cities. Some of the other innovative solutions that were rewarded in the last few years included start-ups developing solutions for sustainable mobility (MoGo for shared mobility solutions), prepayment solutions for drinking water (CityTaps), and digital solutions for urban planning (Wexity).

MEKONG BUSINESS INITIATIVE – ASIAN DEVELOPMENT BANK AND AUSAID

The Mekong Business Initiative (MBI) is a partnership between the Asian Development Bank and the Government of Australia, designed to accelerate growth in four countries of the Mekong area: Cambodia, Laos, Myanmar, and Vietnam.

It was launched in 2015, with the aim of catalysing private sector-led innovation. The targeted countries have strong potential for economic growth but need to improve the environment for private enterprise and innovation to catch up with other ASEAN countries. The expected outcome of the initiative is to improve business-enabling environments for SMEs. In order to do this, the MBI team is carrying out activities targeted toward three areas:

- Business advocacy — improving public-private dialogue on private sector development policies and regulations;
- Access to finance — developing a more robust financing environment for the private sector and entrepreneurs (such as the organization of tours for international angel investors willing to offer funds and advice to promising start-ups and SMEs);
- Support for innovation — developing a more dynamic ecosystem for innovation, such as the setting of incubation or innovation hubs.

In this regard, MBI has aided several local initiatives (through financing or technical assistance) supporting start-ups and innovation.

In Vietnam, for example, MBI helped HCMC in setting up Saigon Innovation Hub, a focal point for start-ups in the city, and collaborated with TNB Ventures to organize the Smart City Innovation Challenge. This challenge aims to source deployable solutions to Vietnam's urban challenges from global innovators.

Other initiatives

- UNICEF Innovation (Venture) Fund — this fund is non-thematic and designed to finance early stage, open-source technology that can benefit children. The aim is to identify clusters/portfolios of initiatives around emerging technologies. The fund has raised 17.9 million USD so far. The investments are focused on three areas: products for youth, infrastructure, and real-time information. This funding can go either to UNICEF country offices or to private sector companies in UNICEF programme countries. Some of the supported projects include solutions for cities and inclusive urban development (such as mapping informal settlements).
- Afric'Innov – AFD: AFD, a consortium of African incubators, and French structures involved in innovation have launched Afric'Innov, a program with the objective of helping professionalize support to structures for entrepreneurship in Africa, through capacity-building activities and networking. Operating for three years, the program tests different support services for innovation hubs in Africa and new funding mechanisms. The initiative is also supported by the World Bank and Orange and comprises different solutions:
    - A SaaS-based incubator management tool (Ubora) to monitor incubated start-ups;
    - E-learning courses dedicated to business development;
    - A training program for the teams in charge of coaching entrepreneurs;
    - The Afric'innov fund to support the incubated start-ups;
    - The Afric'innov label for innovation centres.
- Creative Technology Solution (CTS) program – KOICA: launched in 2015, the five-year program is part of KOICA's effort to establish an open platform for start-ups and innovators. The initiative provides seed money, funding mentoring, business space, and networking opportunities to Korean entrepreneurs and supports the development of tech-based solutions. The CTS program cooperates with the Bill & Melinda Gates Foundation and USAID, as well as a Korean local start-up incubator (D-Camp).

DIGITAL DIVIDES AND EMPOWERMENT PERSPECTIVE

Scope of intervention

Digital divides within countries are also major barriers to digitalization, especially rural-urban divides and gender divides. These barriers are in particular due to a lack of technical and digital literacy in specific contexts. Indeed, if the number of internet and new technology users has tripled in the last decade, these data do not give a clear overview of the level of digital competence of the civil society.

Some global institutions have tailored their interventions on empowering members of civil society, especially some specific users such as women, on the assumption that digitalization is potentially a powerful tool for social transformation, the inclusion of the urban poor, and gender equality.

Fewer international institutions and public organizations have launched ambitious initiatives or programs to reach these goals. Most of the initiatives launched by international donors are limited to funds allocated to NGOs, private

companies, or community-based organizations to support their activities. We also note that businesses and private companies (such as Orange, Nokia, SAP, and GSMA) carry out many initiatives in the field as part of their corporate social responsibility strategies.

Flagship interventions

COMMUNITY NETWORKS – SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY (SIDA)

SIDA is supporting community networks and other community-based connectivity initiatives. The initiative is implemented by APC (Association for Progressive Communications) and builds on its existing local access-related work currently being implemented and the knowledge gained from research projects. The aim of the project is to contribute to an enabling ecosystem for the emergence and growth of community networks and other community-based connectivity initiatives in developing countries.

This initiative's objectives will be achieved through peer learning and exchange, awareness raising, and capacity building to enable the creation of scalable, innovative, and sustainable networks, while contributing to the development of an enabling policy and regulatory environment.

The project focuses on 12 locally managed community networks in Africa, Asia, and Latin America (four per region) to strengthen their impact, reach and sustainability. This group of community networks will form the core of a peer community that can connect and broaden support for community-based connectivity initiatives, nationally, regionally, and internationally. The project has also adopted a special emphasis on women-led initiatives.

CENTER FOR DIGITAL DEVELOPMENT – USAID

As part of the US Global Development Lab, the Center for Digital Development (CDD) seeks to support the innovative use of digital technologies and data for decision-making to help solve development challenges. The initiative pursues two goals: (i) external — enhancing digital inclusion and (ii) internal — accelerating USAID programming. The digital inclusion program seeks to address persistent gaps in developing countries, with respect to digital and mobile access and scale, and barriers that have emerged in this new digital landscape (including privacy concerns and the expanding digital gender divide). As part of the digital inclusion program, USAID announced the "WomenConnect Challenge" in 2017 and published the Gender and ICT Survey Toolkit to provide a framework for collecting and analysing gender-disaggregated data in Agency programs and initiatives. The DadaabNet partnership also provides low-cost internet to the world's largest refugee complex in Kenya.

Other initiatives

- Initiative for Literacy: Improved Livelihoods in a Digital World – UNESCO: as part of the UNESCO-Pearson Initiative for Literacy, UNESCO-Pearson has launched guidelines for designing inclusive digital solutions and developing digital skills. These guidelines aim to help today's technology pioneers build inclusive digital solutions. These solutions aim to help people with emerging literacy skills discover life-changing portals to information, social services, and community engagement, while simultaneously providing reasons and means to improve foundational literacy skills. UNESCO also launched a landscape review of digital inclusion for low-skilled and low-literate people.
- Africa Code Week – SAP: as part of its CSR strategy, SAP organizes a yearly event, the Africa Code Week, with the objective of instilling digital literacy and coding skills in the young generation. The initiative was launched in 2015, has benefitted over 4 million young Africans, and is now also supported by UNESCO. In 2019, 36 countries participated.
- UNICEF and Nokia launched a partnership program during Nairobi Innovation Week 2019 to increase equitable access to digital literacy for some of the most disadvantaged children in Kenya. It builds on the Government of Kenya's investment in the Digital Literacy Project.
- Digital Skills for Entrepreneurial Women – GIZ: in Ghana, GIZ is collaborating with Developers in Vogue. This organization supports graduates who want to become software developers.

The initiative offers coaching and mentoring programs run by women for women who want to set up a digital business.

- Humanitarian OpenStreetMap Team (HOT): HOT is a global not-for-profit organization registered in the USA that aims at putting the world's most vulnerable people and places on the map, thanks to digital tools. In the field of sustainable cities, HOT works with OpenDRI and the World Bank.
- Know Your City campaign – SDI, United Cities and Local Governments of Africa (UCLG-A), Cities Alliance: launched in 2014, this campaign established a digital platform to house data produced/collected by urban poor communities with the aim of anchoring inclusive urban development.

INSTITUTIONAL ANGLE AND GOVERNANCE ARRANGEMENTS

Scope of intervention

Finally, as they are modifying the way cities are run, some international donors have in the last few years conceived ambitious programs and interventions approaching the concept of smart cities as a governance challenge. The programs listed in this section consist of capacity-building programs and activities in all their forms: technical assistance programs, knowledge sharing, the provision of operational guidance, the creation of cities networks, and the launch of specific global taskforces.

Although these programs differ greatly in their forms, costs, and/or operational settings, their approaches converge into two main paths:

- Enhancing the capacities of public authorities in using data to improve policy, planning, and decision-making processes.
- Encouraging new forms of collaborations between stakeholders and facilitating the co-construction of urban action. These programs are very diverse in nature and can encompass technical assistance programs, collaborative knowledge platforms, and the creation of peer-learning cities networks.

Flagship interventions

GLOBAL PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT DATA – DFID

This initiative — mainly funded by DFID, the Hewlett Foundation and PEPFAR[6] — consists of a global network of 300 members, including governments, private sector, civil society, international organizations, academic institutions, foundations, statistics agencies, and data communities.

The core objectives of the partnership include:

- Driving global collaboration to improve the production and the use of data in critical areas;
- Strengthening inclusive data ecosystems by working with governments to develop "national partnerships for sustainable development data";
- Harmonizing data specifications and architectures.

It has led to the set-up of various task forces: Data4Now, Administrative data initiative, SDG National Reporting Initiative, and Citizen-Generated Data Task Team (with resources from OpenStreetMap and Kwanta as co-chairs for the latter). These task forces and teams produce

[6] With additional financial support from the World Bank, the Gates Foundation, Children's Investment Fund Foundation, Columbia University, Ford Foundation, Islamic Development Bank, MCC, and International Development Research Centre.

recommendations and guidance and provide a forum to share experiences and challenges with other stakeholders.

GLOBAL SMART CITIES PARTNERSHIP PROGRAM – WORLD BANK

The Global Smart Cities Partnership program was launched by the World Bank Group in 2018. Its objective is to enhance the capacity of planning and implementing Smart City projects, building on best practices and networks of global Smart City practitioners and experts. It comprises two components:

- Component 1 — Technical Assistance and Operational Support: the objective is to create a smart city component in ongoing projects by supporting strategic planning and technical solutions adoption. This non-financial assistance is provided by international experts to WB clients (at national and/or municipal levels) in order to assist them in smart city projects/ initiatives preparation and implementation;
- Component 2 — Knowledge Sharing and Dissemination: a smart city portal has been developed, comprising a knowledge platform (with smart city projects documents, best practices, and guidance on practical know-how) and a networking platform. This component also encompasses the organization of regional workshops, study tours, and smart city conferences.

Other initiatives

- ASEAN Australia Smart Cities Trust Fund – Asian Development Bank & Government of Australia: the fund was established on April 2019, under the ADB's Urban Financing Partnership Facility. The aim of the fund is to support activities that will enable cities to facilitate the adaptation and adoption of digital solutions, systems, and governance systems in participating cities. In order to do this, the fund supports project preparation and implementation, financing, and associated capacity-building activities.
- Future Cities Approach – Asian Development Bank: this initiative aims to identify new approaches in addressing urbanization challenges in Asia. Its two major components are (i) knowledge partnerships in order to raise Asian cities' technical expertise; and (ii) regional technical assistance programs. In this respect, ADB is leading a technical assistance program promoting smart infrastructure and systems. The technical assistance program identifies smart solutions to improve the living standards of city residents, focusing on the urban poor and women. These solutions could then lead to the preparation of investment projects where ADB could provide further financing assistance. Some of the main achievements so far comprise:
    - Smart city diagnosis that have been undertaken in five cities (Bandung, Mandalay, Suva, Tbilisi, and Ulaanbaatar);
    - The creation of smart city groups in three cities, gathering government, business, and NGO representatives;
    - The identification of some custom-tailored smart solutions such as the deployment of a centralized data platform for better urban planning in Bandung (Indonesia), the implementation of digital land registries in Greater Suva Area (Fidji), or integration of intelligent transport systems in Tbilisi (Georgia).
- African Smart Towns Network (ASToN) – AFD: AFD finances the creation of a network of 12 African cities around smart-city topics, following the methodology set up by the European program URBACT that promotes exchanges, peer-learning, and cooperation between cities within thematic networks. The cities are engaged in designing an integrated action plan, through a participatory process involving a regular local support group with representatives of other government levels, the private sector, and civil society to coproduce local policies. This initiative builds on the Smart city guide – AFD, available online and targeted to local public authorities in order to assist them in leading the digital transition in developing cities, in collaboration with the local digital ecosystems.
- Digital Africa Platform – AFD: after the start-up challenge (see section 6.3.2), AFD decided to launch a Digital Africa platform in 2019. This platform aims at federating various partners, donors, financiers, associations, and private companies in order to collectively build solutions to support entrepreneurial dynamism in Africa.

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