

# Curb Value Capture:

## Tech Enabled Infrastructure on Sidewalks for Community Equity Goals

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COMMUNITY EQUITY **GOALS**

## Abstract

We are amidst a digital transformation in our cities. Both private and public sectors are eager to deploy emerging technologies to improve efficiency of processes, infrastructure systems, and quality of life. At the same time, distribution of resources and implementation of new technologies has historically and presently been unequal, typically leaving socially vulnerable populations behind while wealthier and more politically empowered communities advance. Client WSP asks “how can we develop a framework for implementing tech-enabled infrastructure (TEI) to address social equity issues? Can we create a roadmap that empowers municipalities and communities to recognize the benefits of TEI in their own neighborhoods and implement in a way that prioritizes social equity?” **The Capstone “Curb Value Capture: Tech Enabled Infrastructure on Sidewalks for Community Equity Goals” applies an equity lens to TEI to fill the existing gap between smart cities and equitable cities practices.** Through analyzing three precedents, the COSMOS<sup>1</sup> testbed in Harlem, Sidewalk Toronto in Quayside, small cell in San Francisco, the Capstone developed a set of recommendations for implementing TEI including how to build the relationships, innovate the processes and bridge the capacities.

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<sup>1</sup> COSMOS stands for Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment

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## Executive Summary

Urban sidewalks have recently seen unprecedented level of active use that stretches beyond their past role in public space and transportation into a new type of land use. **The most visible of sidewalk uses is tech enabled infrastructure which formed an “urban interface” and new frontier in planning.** The increasingly prevalent tech enabled infrastructure has generated debates.

Underneath the debates and scrutiny of tech enabled infrastructure on sidewalks is a gap in the planning field between smart cities and equitable cities practices. “Smart city” separate from “Equitable city” is at risk of tech for tech sake with no regard to communities and causing inequitable consequences for the most vulnerable groups. “Equitable city” separate from “Smart city” is at risk of losing out on precious opportunities to solve long-standing problems and achieve goals through innovative urban technologies.

Community equity needs to be at the center of the process to re-configure the sidewalks with urban technologies. **The Capstone aims to bridge the smart cities and equitable cities gap and use tech enabled infrastructure for community equity goals.**

The Capstone defines community equity goals based on American Planning Association (APA) Planning for Equity Policy Guide 2019.<sup>2</sup> Ten goals are directly derived from the guide, including *Environmental Justice, Community Engagement and Empowerment, Neighborhood Stabilization, Climate Equity and Resilience, Education Equity, Equitable Energy and Resource Consumption, Health Equity, Affordable Housing, Mobility and Transportation Equity, and Inclusive Public Spaces and Places*. Six additional goals are added, including *Gender Equality, Privacy Protection, Universal Access, Inclusive Economic Development, Inclusive Culture and Art and Digital Equity*.

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<sup>2</sup> American Planning Association Policy Guide – Planning for Equity Policy Guide, 2019.  
( <https://www.planning.org/policy/guides/adopted/equity/> )

The Capstone’s analysis focuses on *three precedents* of tech enabled infrastructure deployment and supplements with research on other deployments such as curb-side EV charging stations. The three precedents each has varying emphasis on *relationships, processes and capacities*.

#### ***Precedent 1: COSMOS Testbed in Harlem***

COSMOS stands for Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment.<sup>3</sup> COSMOS aims to deploy a one square mile testbed in West Harlem, by placing radio-nodes that will establish an advanced wireless platform to be used for the development of applications, data transmission, and 5G network connectivity. COSMOS is also founded in the needs and interest of one of the most diverse and culturally rich communities in the world and helps bridge the “digital divide” that often plagues low income communities and communities of color.

#### ***Precedent 2: Sidewalk Toronto in Quayside***

The Sidewalk Toronto’s Quayside project was a planned smart city project to redevelop the 12 acres waterfront district Quayside in Toronto, Ontario. As of May 7, 2020, the Sidewalk Toronto project is no longer moving forward. The formerly proposed Master Innovation and Development Plan (MIDP)<sup>4</sup> aimed to create jobs and inclusive economic impact, a climate-positive district, an affordable and inclusive community, expansion in transit, walking and cycling and an ecosystem of urban innovations.

#### ***Precedent 3: Small Cell in San Francisco***

The “small cell” wireless refers to small radio and antennas that could be placed on street lights and utility poles in the public rights of way. It is different from “macro cells” which refer to the tall cell towers on rooftops and along highways. 4G small cell have been installed around San Francisco and concentrated in Downtown and South of Market Street. 5G small cell are being installed first on poles with existing 4G small cell. Small cell wireless deployment in San Francisco aims to provide faster data capacity and coverage for cell phone and device users.

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<sup>3</sup> COSMOS – COSMOS Testbed Main Site, 2018. (<https://cosmos-lab.org/>)

<sup>4</sup> MIDP - Sidewalk Toronto, 2019. (<https://www.sidewalktoronto.ca/midp/>)

The Capstone's recommendations are focusing on the areas of relationships, processes, and capacities.

## **Build the Relationships**

Relationships are at the center of equitable deployment of tech enabled infrastructure

*Engage variety of stakeholders, connect with people through community partners and take into considerations the need for public culture and behavior shift; adapt to the variety in tech providers and curb assets, map and evaluate the different typologies, streamline multiple ownership and regulatory agencies and create function-based committees*

## **Innovate the Processes**

Processes innovation is even more important than tech innovations and really makes or breaks a project.

*Use a variety of engagement channels, conduct two-way conversation and co-decision, include missing voices and protect communities with oversight on surveillance; combine direct benefits (e.g. connectivity) and ripple effects (e.g. telehealth), co-locate uses and require public improvements, standardize and humanize design, invest as infra.preneurs<sup>5</sup> in gigaprojects<sup>6</sup>*

## **Bridge the Capacities**

Capacities gaps need to be bridged to bring technologies to people and achieve impact.

*Use jargon-free language and concrete cases to be relatable, build digital literacy and community agency, offer workforce and education programs; use urban piloting and testing to mitigate risk, plan for future phases and life cycle of technology, scale up impact and replicate the model, form integrated network (e.g. curb payment network) and hubs (e.g. mobility hubs)*

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<sup>5</sup> Hybrid of infrastructure investment and tech venture

<sup>6</sup> Project with repurposable gigabit/ tech

## Background

### *Challenge*

#### Sidewalks as Land Use and New Frontier

“Sidewalks are performing more like a land use.”<sup>7</sup> Nisenson captured in this observation the emerging trend and transformation of the use of sidewalks in our time. Step onto city sidewalks in the age of sharing economy, experiential retail, micro mobility, and urban technologies, we would notice the mushrooming of bike share docks, pop-up stores, electric scooters, EV charging stations and many other new uses. Though long considered part of the public realm and pedestrian transport, city sidewalks have recently seen unprecedented level of active use that stretches beyond their past role in public space and transportation into a new type of land use. **A large variety of uses competing for the limited supply of sidewalks space creates tensions and poses the challenge of planning for the “sidewalks use”.**

One essential aspect of the challenge of planning for the “sidewalks use” is that the prevalence of tech enabled infrastructure on sidewalks has formed a new frontier. Sensors that detect traffic patterns, small cell wireless facilities that provides internet connections, cameras that facilitate public safety are some examples of tech enabled infrastructure on sidewalks. The reason that tech enabled infrastructure is so prevalent on sidewalks could be explained by the “urban interface” nature of sidewalks. Every urban dweller walks or wheels on sidewalks in person and in daily living. Every aspect of cities intersects with sidewalks in one way or another. Public activities happen through sidewalks. Tech enabled infrastructure engages with these activities for applications and urban users access the infrastructure applications through sidewalks. The essay “Rise of Innovation Districts” proclaimed that sidewalks are becoming “living labs to flexibly test new innovations, such as in street lighting, waste collection, traffic management solutions and new digital technologies.”<sup>8</sup> The experimental nature of tech enabled infrastructure

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<sup>7</sup> Nisenson, Lisa. “Sidewalks: The New Planning Frontier”, Alta Planning + Design, 2017. (<https://blog.altaplanning.com/sidewalks-the-new-planning-frontier-74c85f2d610>)

<sup>8</sup> Katz, Bruce and Julie Wagner. The Rise of Innovation Districts, Brookings Institute. 2014. (<https://www.brookings.edu/essay/rise-of-innovation-districts/>)



challenges planners, often with limited technologist training, to respond with cutting-edge planning initiatives. **Managing the tech enabled infrastructure on sidewalks has therefore also become a new frontier for planning.**

In the event of COVID-19, sidewalks as a new frontier takes on additional meanings. Many voices have called for adaptive planning initiatives such as opening up streets so that residents could safely enjoy activities while social distancing.<sup>9</sup> The indoor restaurants, gyms and shops are seen as places where coronavirus could easily spread. Relocating workout, dining, shopping and recreation to the open street would redefine sidewalks. If previously, sidewalk cafes and pop-up stores are extensions of the hosting use in buildings, now the open streets and sidewalks are taking the center stage.

The need to plan for the programming of sidewalks has never been greater. If done right, street museums, vacation streets, fitness streets, and restaurant streets will be the place for culture, entertainment, health, and dining in post-COVID cities. A new series of tech enabled infrastructure and planning initiatives will likely emerge to satisfy these new activities on sidewalks.



Fig 1. Dutch Vacation Street <sup>10</sup>

## Smart City and Equitable City Gap

Another essential aspect of the challenge of planning for the “sidewalks use”, especially the tech enabled infrastructure on sidewalks, is the highly public and visible nature of sidewalks. The publicness and

<sup>9</sup> “Social distancing, also called ‘physical distancing,’ means keeping a safe space between yourself and other people who are not from your household” to reduce the spread of COVID-19. CDC. 2020. (<https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html>)

<sup>10</sup> Vakantiestraat 2020 (Holiday Street 2020), 2020. (<https://www.vakantiestraat.nl/>)

visibility of sidewalks combined with the attentions drawn by innovations have generated significant publicity and debates around tech enabled infrastructure on sidewalks. For example, electric scooters were featured in the episode “The Scoots”<sup>11</sup> in popular TV show South Park in 2018. Planetizen’s writer James Brasuell reacted to the TV episode by calling electric scooters “the most hotly-contested signifiers of contemporary urban living.”<sup>12</sup>

The debates are often very split. For example, the Public Policy Polling of 2019 found through its poll that residents living in Nashville, Tennessee were evenly split on attitudes toward scooters with 44% supporting with the condition of having guidelines in place and 41% opposing with the position of banning it altogether.<sup>13</sup> Supporters of tech enabled infrastructure on sidewalks usually rejoice at innovative problem solving and skeptics are concerned of negative implications. The heightened public scrutiny is warranted. Unlike private optional platforms such as an app or a website or even an indoor building technology, tech enabled infrastructure on sidewalks is usually embedded in city assets, occupying essential public spaces and interacting with every person. These unique characteristics demand technologists and planners to put public benefits first.

The inclusive allocation of space and equitable use of infrastructure need to be prioritized in the deployment of tech enabled infrastructure on sidewalks. **Human values and community equity need to be at the center of the process to re-configure the sidewalks with urban technologies.** Planners need to not just respond to tech enabled infrastructure on sidewalks with cutting-edge planning initiatives but also make sure that the deployments are equitable and human-centric to a level that might be unfamiliar to technologists using other private platforms.

Underneath the debates and scrutiny of tech enabled infrastructure on sidewalks is a gap in the planning field. “Planning seems to be going into two directions at once: the smart city and the equitable city,”<sup>14</sup> says David Vega-Barachowitz in a lecture he gave at Columbia GSAPP Lectures in Planning Series

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<sup>11</sup> Episode 2205 “The Scoots” Press Release, South Park, 2018. (<https://southpark.cc.com/blog/2018/10/29/episode-2205-the-scoots-press-release>)

<sup>12</sup> Brasuell, James. Friday Funny: South Park Rides the E-Scooter Revolution, Planetizen, 2018. (<https://www.planetizen.com/blogs/101350-friday-funny-south-park-rides-e-scooter-revolution>)

<sup>13</sup> Choi, Joseph. Poll: Nashville evenly split in hotly contested scooter debate, The Tennessean, 2019. (<https://www.tennessean.com/story/news/2019/07/03/nashville-scooter-ban-residents-survey/1641296001/>)

<sup>14</sup> Vega-Barachowitz, David. The Six Migration, GSAPP Lectures in Planning Series (LiPS), 2019. (<https://www.arch.columbia.edu/events/1575-david-vega-barachowitz>)

(LiPS). The smart city practice in urban planning pursues next-generation innovation such as autonomous vehicles and the equitable city practice tackle long-standing social issues such as gentrification. The debates and scrutiny are ways to keep smart city practice accountable.

**The gap between “the smart city” and “the equitable city” is limiting the potential of either.** “The smart city” separate from “the equitable city” is at risk of tech for tech sake and causing inequitable results. “The equitable city” separate from “the smart city” is at risk of losing out on precious opportunities to solve long-standing problems and achieve goals through innovative urban technologies. **The Capstone aims to bridge the smart city and equitable city gap and use tech enabled infrastructure for community equity goals.**

#### The Ask: A Framework for TEI to Address Equity

The Client of the Capstone asks: **How can we develop a framework for implementing tech-enabled infrastructure to address social equity issues? Can we create a roadmap that empowers municipalities and communities to recognize the benefits of TEI in their own neighborhoods and implement in a way that prioritizes social equity?**

In order to specifically solving the client problem. The Capstone will make sure to address the following key areas:

- Who can use such a roadmap?
- What are the major challenges to implementing TEI in low income and socially vulnerable communities?
- How can capacity building through such a roadmap help close the gap between neighborhoods and cities that do not feel they have the resources (both financial and human) to implement TEI and practical application of TEI.

**Capstone output ultimately would help city agencies deploy TEI in a transparent, just, and socially equitable way.** This will happen in one of two key ways:

1. Screening existing TEI projects in the pipeline against a framework to ensure implementation strategy is socially equitable; and
2. Serving as an educational resource for advocacy groups or municipalities to learn what TEI is all about and how they can develop and implement TEI plans in a way that specifically address social equity issues

## ***Application***

### Pre-Deploy Plan and Screen

The Capstone products and recommendation could be used before deployment. For example, a TEI project team is selected in a city-wide Request for Expressions of Interest (RFEI) to build broadband for New York City Housing Authority (NYCHA). Public housing residents have been subjected to over-promise and under-delivery of services in the past. The TEI project team is planning to uplift the public housing resident community and seek resident buy-in for its free broadband pilot project. The team could pick up the Community Equity Goal Roadmap and select the goal “Community Engagement and Empowerment”. The Roadmap will take the team to a variety of ways that the deployment can achieve the goal “Community Engagement and Empowerment”.

The team could pick and choose among the different recommendations. They could decide to explore resident co-op model for community agency (resident will profit from the internet and claim ownership of the network), develop workforce development programs (youths in the neighborhoods would be trained to become digital stewards to assist with equipment installation and onboarding) and offer digital literacy classes to public housing resident (residents will learn valuable employable coding skills and gain digital literacy to advance in career).

The city agencies could also use the recommendations to screen proposals submitted for the Request for Proposal (RFP) issued after RFEI to scale up broadband connection across NYCHA footprints. During

economic downturns following a global pandemic, city agency staff could select the goals “Health Equity” and “Inclusive Economic Development” and try to screen project proposals that align with actions that further these two goals.

### In-Deploy Adjust and Supervise

The Capstone products and recommendation could be used during deployment. For example, a TEI project team is in the middle of deploying a project that has an online marketplace feature to finance the infrastructure component of the project. The City’s Mayor’s Office of the Chief Technology Officer (CTO) read through the proposals of the marketplace and expressed privacy concerns. The Office of the CTO scheduled a meeting and asked the project team about their privacy policy, terms and conditions, and the right for residents to opt in and out of advertisement and the marketplace platform. The project team could pick up the Community Equity Goal Roadmap and select the goal “Privacy Protection”. The Roadmap will take the team to a variety of ways that the deployment can achieve the goal “Privacy Protection”.

The team could pick and choose among the different recommendations. They could decide to reach out to subject matter experts in Privacy to collaborate on throughout the process, inform users in plain language by developing accessible terms and conditions in different languages, ensure opt-in and opt-out and the right to choose by adding these features into the online marketplace platform. The city agencies could also use the recommendations to supervise TEI deployments.

City agency staff could select the goal “Privacy Protection” and check if TEI project teams have adopted actions that further the goal “Privacy Protection” and follow the recommendations to be clear on which agency/ department holds providers accountable in contentious and sensitive decisions such as extent of data collection.

## Post-Deploy Improve and Evaluate

The Capstone products and recommendation could be used after deployment. For example, a TEI project team has already helped a retail store install beacons and tags that use ultra-wide band (UWB) to detect proximity of shopping carts in order to practice social distancing. The project team wants to make sure they adopt the right long-term actions to improve the inclusiveness of the installation. The project team could pick up the Community Equity Goal Roadmap and select the goal “Inclusive Public Spaces and Places”. The Roadmap will take the team to a variety of ways that the deployment can achieve the goal “Inclusive Public Spaces and Places”.

The team could pick and choose among the different recommendations and decide to not collecting data on individual tag position so it won't be mis-used for surveillance, use physical postings on the street and in the retail store to inform customers that beacons and tags have been installed, and use environmental friendly charging infrastructure for the tags.

The city agencies could also use the recommendations to evaluate TEI deployments. If a constituent has filed complaint of the beacons and tags installation in retail store to the city council Technology Committee, city council members could select the goal “Inclusive Public Spaces and Places” to evaluate of the TEI project has adopted actions to ensure the store has adopted measures to be inclusive.

## Production

### Client and Partners

The Capstone project is a collaborative initiative of client [WSP](#), partner [Silicon Harlem](#) and partner [Digital Equity Lab](#).



*Fig 2. Capstone client WSP and partners Silicon Harlem and Digital Equity Lab*

WSP is a forward-looking multinational engineering and design firm. Its “Future Ready” program sets the goal to “see the future more clearly, and to work with clients to design for this future.”<sup>15</sup> The published Future Ready insights cover a wide range of themes including mobility, technology, climate, places, resources, society, and most recently COVID-19. These insights helped guide the thinking of the Capstone. Alyssa A. Curran represents client WSP and offered tremendous help and guidance throughout the process including finding data and best practices from internal knowledge platforms, offering technical production support, and reviewing.

Silicon Harlem is a social venture founded to transform Harlem into a technology and innovation hub to fully engage in the digital economy. Its digital literacy programs, broadband design and deployment, and cutting-edge research projects along with scholarly conferences, educational workshops and community outreach initiatives<sup>16</sup> have reached diverse audience from different backgrounds and generations. The community equity indicators throughout the chapters have drawn upon the best practice of Silicon Harlem. Silicon Harlem is also a community partner of the COSMOS project, a major case study featured in the Capstone. The role of Silicon Harlem as a central community engagement entity in COSMOS is analyzed in the Capstone. The co-founders of Silicon Harlem, Clayton Banks and Bruce Lincoln have guided the Capstone from the very beginning to every step of the way and offered experiential learning, invaluable insights and suggestions.

The Digital Equity Lab is a laboratory based at The New School that “uncovers and addresses structural inequities that persist and evolve as technology transforms our cultural, social, and political systems.”<sup>17</sup> It has published indicators that rate the equity and digital privacy of New York City’s major consumer internet service providers (ISPs). The methodology of its indicators was based on “Ranking Digital Rights”, an initiative that “creates global standards and incentives for companies to respect and protect users’ rights.”<sup>18</sup> The rating scheme of the Capstone’s community equity indicators has drawn upon the

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<sup>15</sup> Future Ready, WSP, 2019. (<https://www.wsp.com/en-US/who-we-are/future-ready>)

<sup>16</sup> About Us, Silicon Harlem Website, 2013. (<https://www.siliconharlem.com/#about-us>)

<sup>17</sup> The Digital Equity Laboratory Website, 2018. (<https://www.newschool.edu/digital-equity-lab/>)

<sup>18</sup> About Ranking Digital Rights, Ranking Digital Rights Website, 2013. (<https://rankingdigitalrights.org/about/>)

indicators of Digital Equity Lab. There was initially a plan for the Capstone to be part of the New School Spring 2020 “Anthropology of the Networks”<sup>19</sup> course, but it did not actualize due to external circumstances. The co-director of the Digital Equity Lab Greta Byrum has offered suggestions and guided the thinking of the Capstone.

## Experiential Learning

The Capstone is informed by experiential learning of writer in practice. The writer was a member of the COSMOS team within the “Community Outreach and Engagement: A Harlem Practicum”. The team was led by Victoria Mason-Ailey, the Associate Vice President for Planning and Community Affairs at Columbia University and community engagement coordinator of the COSMOS project. The team engaged with the stakeholders to explore the barriers and opportunities of COSMOS community outreach and engagement activities and developed recommendations.

The writer also attended the guest lecture by Andrew Winters (Chief Operating Officer, Development, Sidewalk Labs) at the “Urban Public Infrastructure Practicum” and the two presentations by Nerissa Moray (Associate Director, Planning & Development, Sidewalk Labs) at the Digital Urbanisms Conference<sup>20</sup> and the Future of Design Symposium.<sup>21</sup> A site visit to Quayside was planned but canceled due to external circumstances.

Last but not least, the writer completed an internship at the San Francisco headquarters of Modus, LLC, a site acquisition firm helping telecommunication companies such as Verizon and AT&T deploy 5G and 4G small cell wireless facilities. The internship entailed preparation of GIS zoning analyses, reviewing of plans, CEQA exemptions, Noise studies, Electromagnetic fields (EMF) reports, etc. for permitting, and trainings in site visits, public hearings and public noticing. **These experiential learning help ground the findings of this Capstone in real life practice.**

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<sup>19</sup> Byrum, Greta. Mattern, Shannon. Anthropology of the Networks, 2020. (<https://courses.newschool.edu/courses/LANT2900/>)

<sup>20</sup> Infrastructures: Digital Materiality Session, Digital Urbanisms Conference, 2019. (<https://www.arch.columbia.edu/events/1454-digital-urbanisms-conference>)

<sup>21</sup> Design for the People Presentation Series, Future of Design NYC 3<sup>rd</sup> Annual Symposium, 2019. (<https://fodnyc.org/program/>)



## Research and Literature Review

The Capstone utilized supplementary research of online resources and reports on curb-side EV charging stations and other aspects of tech enabled infrastructure. For example, curb-side EV charging stations contents draw upon New York State Energy Research and Development Authority (NYSERDA)'s report "Curb Enthusiasm: Report for On Street Electric Vehicle Charging"<sup>22</sup> and W X Y architecture + urban design's report "Curb Enthusiasm: Deployment Guide for On-Street Electric Vehicle Charging"<sup>23</sup>.

Mobilities contents draw upon WSP's reports such as "Future Mobility"<sup>24</sup>, "Optimizing Digital Asset Data in Transport & Infrastructure", "Blending Physical and Digital Worlds in Transport & Infrastructure", and "Data Mining, Engineering Solutions in Transport & Infrastructure"<sup>25</sup>. Supplementary research further illustrates the relationships, processes, and capacities analysis of tech enabled infrastructure.

The Capstone also utilized literature review to inform the analysis of TEI. The following literature from different fields were referenced in the capstone:

### Field - Urban Planning

Barth, Brian. "Smart Cities or Surveillance Cities?" Planning Magazine, 2019. American Planning Association Knowledge Center.  
(<https://www.planning.org/planning/2019/mar/smartcities/>)

This article scans the broad landscape of smart cities and points out the "significant disconnect between the technologists" and "the sort of public engagement process that...familiar with as a planner" and the "connection between the surveillance aspects of smart cities and the challenge of engaging vulnerable communities". This article informs the challenges and gaps to be filled by planners in the community engagement process of technological improvements and the grounding of technologies into everyday life.

### Field: Accessibility & Technology Design

John Brownlee, Why Accessibility Is the Future of Tech Designing solutions for people with disabilities offers a peephole into the future, Modus Publication, 2019. (<https://modus.medium.com/why-accessibility-is-the-future-of-tech-a3f535cc4f0e>)

This article discusses that many technologies started out as solutions for people with disability. The article makes a manifesto statement that "accessibility teaches the most important skills a

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<sup>22</sup> Curb Enthusiasm: Report for On Street Electric Vehicle Charging, New York State Energy Research and Development Authority, 2019. (<https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/19-11-Curb-Enthusiasm.pdf>)

<sup>23</sup> Curb Enthusiasm: Deployment Guide for On-Street Electric Vehicle Charging, W X Y architecture + urban design, Barretto Bay Strategies, 2018. ([https://www.wxystudio.com/uploads/2400024/1550074865953/Final\\_Curb\\_Report\\_Nov2018\\_web.pdf](https://www.wxystudio.com/uploads/2400024/1550074865953/Final_Curb_Report_Nov2018_web.pdf))

<sup>24</sup> Future Mobility report, WSP. (Provided by client)

<sup>25</sup> Digital Transformation in Transport & Infrastructure, WSP, 2019. (<https://www.wsp.com/en-GL/insights/digital-services-transport-infrastructure>)

designer can have. That skill is empathy. *Because what is design if it is not the practice of giving empathy a form?*" This article informs a perspective of identifying the accessibility function and benefit of tech-enabled infrastructure when evaluating equity.

Field: Technology & Psychology

Webster, David. "The next big winners in tech will be the companies that choose heart over head", Quartz, 2017. (<https://qz.com/1075296/the-next-big-winners-in-tech-will-be-the-companies-that-choose-heart-over-head/>)

Webster believes that tech companies need to win over heart. For example, "the act of casting a ballot in person had immense *emotional significance*" so IDEO designed the processes of scanning the devices and printing out physical ballots at polling stations to cast by hand for users that recorded choices online. For private companies to win over their users, it's advised to mind "*the emotional revolution in technology*" and to "stay relevant, connect, and create value for society." The equity evaluation section could emphasize that companies benefit from creating social value and winning the heart.

Field: Geographic Information System & Telecommunication

Truth in Broadband: Access and Connectivity in New York City, Mayor's Office of the Chief Technology Officer, 2018. (<https://tech.cityofnewyork.us/wp-content/uploads/2018/04/NYC-Connected-Broadband-Report-2018.pdf>)

This study analyzed the data and maps out the difference in access among the different socioeconomic status and have compelling data analysis results on the equity, affordability, performance, privacy and choice of broadband in New York City. The study informs the inequities that exist through the tech companies' provision of services.

Field - Geographic Information System & Telecommunication

Callahan, Bill. "AT&T's Digital Redlining" National Digital Inclusion Alliance (NDIA), 2017. (<https://www.digitalinclusion.org/blog/2017/03/10/atts-digital-redlining-of-cleveland/>)

NDIA used FCC broadband availability data to do a mapping analysis of Cleveland neighborhoods demonstrating that AT&T discriminates low income neighborhoods. The report calls the systematic failure to provide equitable internet access to low income neighborhoods as "digital redlining". The FCC Chairman used this report to advocate for "Gigabit Opportunity Zones". The mapping demonstrates the inequities of service coverage and level in low income neighborhoods.

Field- Information Society & Community Development

Building Resilience with Community Technology, Global Information Society Watch Community Networks, 2018 United States Report, Association for Progressive Communications (APC) and International Development Research Centre (IDRC) Report. ([https://giswatch.org/sites/default/files/gw2018\\_unitedstates.pdf](https://giswatch.org/sites/default/files/gw2018_unitedstates.pdf))

Greta and Diana wrote about the limitation of the US telecommunication industry and the existing "techies" and "geek publics" instead of "community public". The report describes the emergence of the Detroit Community Technology Project founded on principles of "access, participation, common ownership, and healthy communities. The coalition have been training local residents to be the digital stewards of the network. This report gives examples of working with community partners to provide technology for equity goals.

Field- Human Services & Information Technology

Williamson, Chris. Liu, Elisa. Cion, Jason. Simion, Michael. Ryken, Ross. Smart Cities – Life Intentions Initiative Business Case. Streetohome Foundation, 2019. (shared by Streetohome Foundation project lead for the Smart Cities – Life Intentions initiative via email)

Streetohome Foundation is focused on homelessness and often implement innovative models. The Smart Cities- Life Intentions project concept is to create a digital interface that will include a personal story repository where homeless individuals can share their story & history and a real time, continuously updated database of support services and opportunities to provide pathways to realizing life intentions and goals. This project provides an example of possible use of digital interface in built environment for the benefit of socially vulnerable groups.

Field - Telecommunication & Education

Connecting Our homes, Businesses and Communities Educational Handout, Verizon, 2019. (shared by Modus, LLC Verizon Team Regional Manager via email)

Verizon's educational handout included compelling data that show the impact of a tech enabled infrastructure. "76% of 911 calls originate from a cell phone". "70% of teens use cellphones to help with homework". "20,000 learning apps are available for iPads. 72% of iTunes top selling educational apps are designed for preschoolers and elementary students." These numbers inform the direct benefit from TEI's service provision.

Field: Urban Planning

American Planning Association Policy Guide – Planning for Equity Policy Guide, 2019  
(<https://www.planning.org/policy/guides/adopted/equity/>)

The guide calls for planners to promote equity and remove barriers that perpetuate inequities. The issues discussed include: Gentrification; Environmental Justice; Community Engagement and Empowerment; Climate Change and Resilience; Education; Energy and Resource Consumption; Health Equity; Heritage Preservation; Housing; Mobility and Transportation; Public Spaces and Places. It helps defining the community equity goals in the capstone.

Field - Urban Planning & Transportation

Nisenson, Lisa. Preparing for New Mobility: Writing Effective Resolutions, Alta Planning + Design, 2017.  
(<https://drive.google.com/viewerng/viewer?url=https://altaplanning.com/wp-content/uploads/preparing-for-new-mobility-writing-effective-resolutions.pdf>)

This whitepaper calls for communities to prepare now for the autonomous technology in transportation so they can "harness the benefits of technology while limiting risks". The whitepaper includes the examples, different contexts of community and a model resolution. The whitepaper is helpful in demonstrating the importance of writing of a resolution and preparedness.

Field - Urban Planning

Marshall, Aarian. "To See the Future of Cities, Watch the Curb. Yes, the Curb", Wired, 2017.  
(<https://www.wired.com/story/city-planning-curbs/>)

Mapping public asset helps with the site selection of curbside deployment. Coord and Urban Footprints have done curb and sidewalk mapping in major cities to make the curb context available for considerations. Some cities are also leading the way. Lincoln, Nebraska has developed a database of their existing right-of-way infrastructure assets, such as water, power and broadband lines in the city. These examples inform suggestions on mapping public asset for tech enabled infrastructure deployment.

McConnell, Paul. "How Designers For Physical Spaces And Digital Services Can Create Better Experiences Together" IxN, The Intersection Blog, 2017. (<https://ixn.intersection.com/how-designers-for-physical-spaces-and-digital-services-can-create-better-experiences-together-797d02569374>)

The article is responding to the blurring line between physical spaces and digital experiences. As a designer, McConnell is calling for a shared vision to help people understand the new digital-physical hybrid space. UX designers and physical environment designers should come together. This article echoes with Sidewalk Toronto's set of visual icon reminders to notify the public when there are sensors and other digital devices in the environment. This article is relevant to capstone's discussions on communicating visually and transparently to humanize technology.

## Analysis

# Chapter 1. Current Conditions

### *Precedents*

#### COSMOS Testbed in Harlem

COSMOS stands for Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment.<sup>26</sup> COSMOS aims to deploy a one square mile testbed in West Harlem, by placing radio-nodes that will establish an advanced wireless platform to be used for the development of applications, data transmission, and 5G network connectivity.

Columbia, Rutgers and New York University formed the primary team leading the project along with partners including New York City, The City College of New York (CCNY), the University of Arizona, Silicon Harlem and IBM. The project was funded by the National Science Foundation (NSF) grant of approximately \$22.5M.

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<sup>26</sup> COSMOS – COSMOS Testbed Main Site, 2018. (<https://cosmos-lab.org/>)



Fig 3. COSMOS testbed area in West Harlem<sup>27</sup>



Fig 4. COSMOS Project Team and Funding Organization

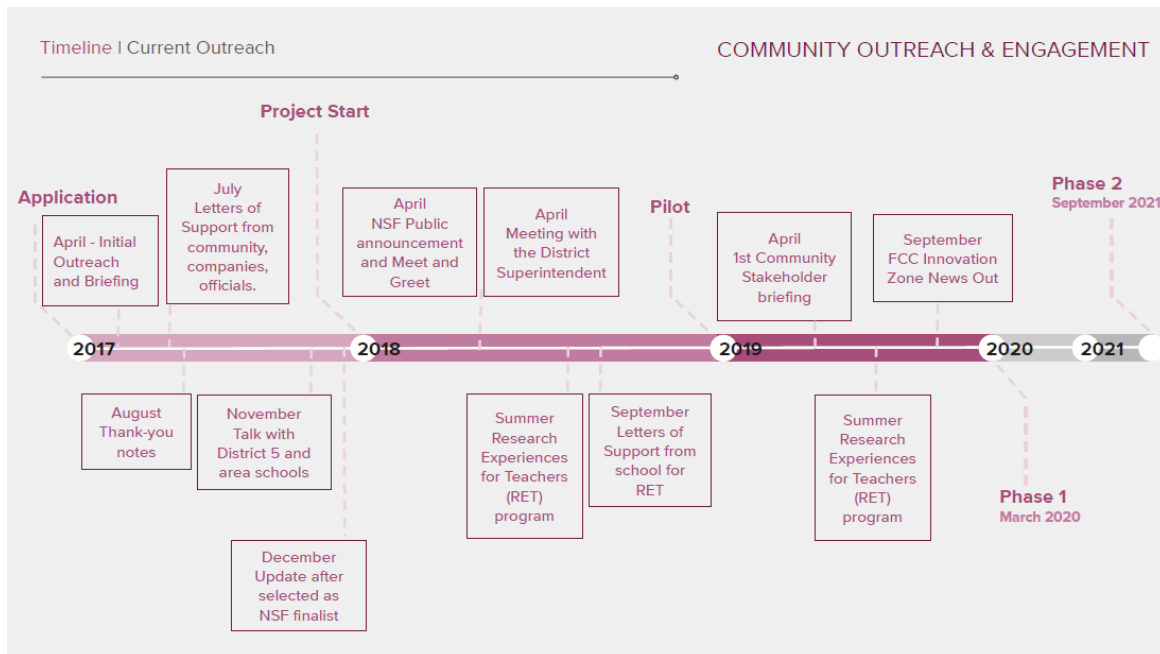


Fig 5. COSMOS Project Timeline<sup>28</sup>

The timeline (Fig. 3) of the COSMOS project spans several years. The application process started in 2017 and the initial outreach and briefing occurred in April 2017. In July 2017, community organizations, companies, officials, researchers and more sent letters of support for the project. The deployment started in 2018 when NSF announced the award of grant to the testbed. The COSMOS team was also awarded a

<sup>27</sup> Community Outreach and Engagement: A Harlem Practicum Group Final Presentation Slide, 2019.

<sup>28</sup> Community Outreach and Engagement: A Harlem Practicum Group Final Presentation Slide, 2019.

separate grant for the community engagement component of the project, Summer Research Experiences for Teachers (RET) program. The RET program was first held in 2018 and continued in 2019. The first Community Stakeholder briefing took place in April, 2019. In the same year, Federal Communications Commission (FCC) declared Harlem to be an Innovation Zone. The Phase 1 of the project started in March, 2020 and the Phase 2 was projected to commence in September 2021.

The technical focus of the COSMOS is ultra-high bandwidth, low-latency network with edge computing that can support important new classes of real-time applications. Researchers around the world can run experiments on the COSMOS testbed by logging into the web-based portal and test in real-world dense urban setting how their applications can serve cities.

The community engagement of the COSMOS project focuses on education. RET program trains ten k-12 school teachers from NYC during six weeks of summer intensive programs. The teachers are first equipped with orientation class and lab-based experiments and then go on to conduct experiments and demonstrations in the classroom. COSMOS Education Toolkit was also developed to scale up the educational effort.

The Capstone built upon the COSMOS practicum experience and analyzed COSMOS project materials such as letters of support submitted by the various organizations, information about COSMOS project and community engagement efforts gained from meetings with the project stakeholders, communications, updates, news, proposals, and information gained from Silicon Harlem, both a partner of the Capstone project and a partner of the COSMOS project.

Clayton Banks and Bruce Lincoln of Silicon Harlem talked at length about how important it is for tech ventures to build relationships with public sector, private sector, stakeholders such as YMCAs and churches that touch citizens' everyday life, citizens themselves and academics. **Relationships are at the center of equitable deployment of tech enabled infrastructure.**

## Sidewalk Toronto in Quayside

Sidewalk Toronto's Quayside project was a planned smart city through redevelopment of the a 12-acre waterfront district, Quayside, in Toronto, Ontario. Led by Sidewalk Labs and Waterfront Toronto, the project launched in 2017 and was in motion until its cancellation in May, 2020. The concept aspires to be a model for urban innovation and inclusive growth in the digital age. The proposed Master Innovation and Development Plan (MIDP)<sup>29</sup> aims to create jobs and inclusive economic impact, a climate-positive district, an affordable and inclusive community, expansion in transit, walking and cycling and an ecosystem of urban innovations.

Sidewalks Labs works along with Waterfront Toronto as an Innovation and Funding Partner, a role different from a traditional developer in the Quayside project. Waterfront Toronto represents three levels of government, City of Toronto, Province of Ontario and Government of Canada. The two partners formed a third entity "Sidewalk Toronto". The partnership aims to fulfill Waterfront Toronto's priority outcomes and achieve commercial viability, to "generate \$14.2 billion in annual revenue to government by 2040."<sup>30</sup>

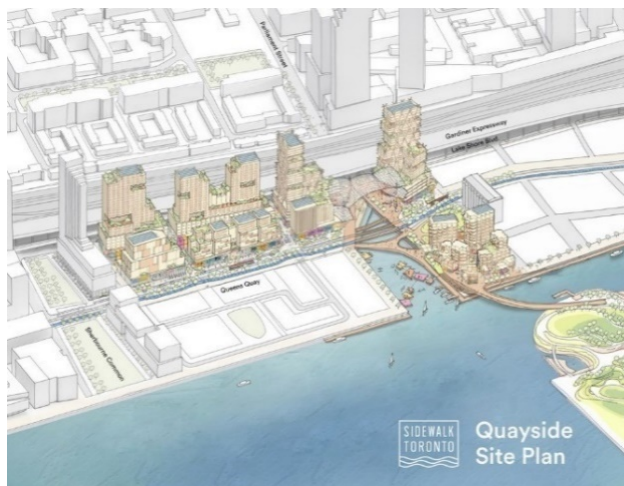


Fig 6. Sidewalk Toronto's Quayside Site Plan<sup>31</sup>



Fig 7. Quayside Project Partners



Fig 8. Governments represented by Waterfront Toronto

<sup>29</sup> MIDP - Sidewalk Toronto, 2019. (<https://www.sidewalktoronto.ca/midp/>)

<sup>30</sup> The Partnerships, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/partnership/>)

<sup>31</sup> Vincent, Donovan. Sidewalk Labs reveals plans for housing in Quayside district on city's waterfront, The Star, 2018. (<https://www.thestar.com/news/gta/2018/11/29/sidewalk-touts-unprecedented-level-of-affordable-housing-at-quayside.html>)



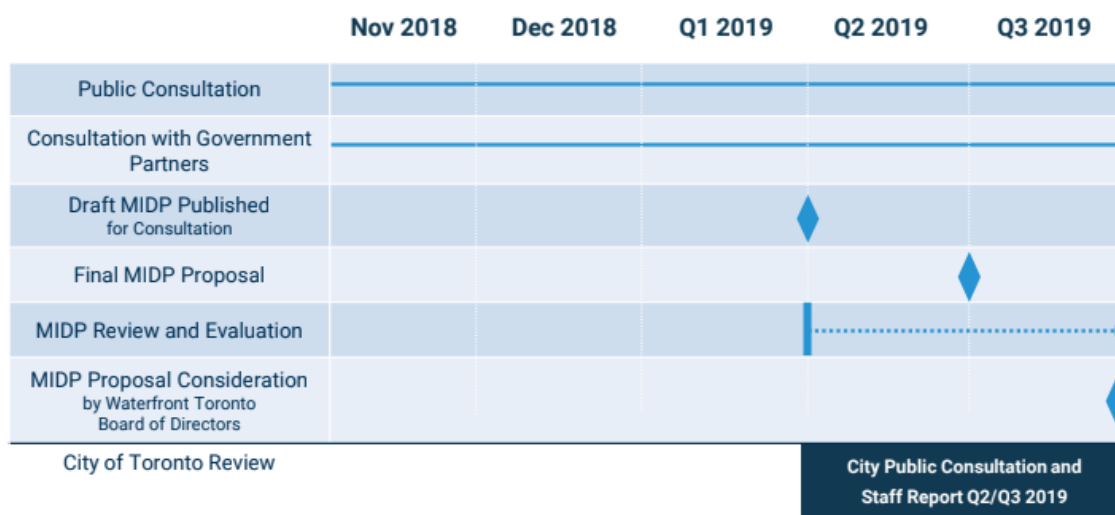


Fig 9. Quayside Project Master Innovation and Development Plan (MIDP) Timeline<sup>32</sup>

The timeline of Sidewalk Toronto's Quayside project spans two years. In 2017, Waterfront Toronto launched a Request for Proposals (RFP) to look for an innovation and funding partner internationally and Sidewalk Labs was announced as the successful proponent. In November 2017, the first Town Hall was held to introduce the project. In 2018, four public roundtables were co-hosted by Waterfront Toronto and Sidewalk Labs. In April 2018, Waterfront Toronto formed Digital Strategy Advisory Panel (DSAP).<sup>33</sup> In June 2018, '307' was opened as a Sidewalk Labs' Toronto office and experimental pavilion. In July 2018, Waterfront Toronto approved a Plan Development Agreement (PDA) with Sidewalk Labs. Sidewalk Toronto released the draft site plan for Quayside in November 2018. The Master Innovation and Development Plan (MIDP) draft and the Digital Innovation Appendix were submitted in 2019. In early 2020, Waterfront Toronto extended decision date and initiated a Preliminary Human Rights Impact Assessment (pHRIA).<sup>34</sup> In March 2020, decision date was further extended in view of the COVID-19 pandemic. In May 2020, Sidewalk Labs withdrew from the Quayside Project, naming project financial feasibility challenge during COVID-19 to be the reason of withdrawal.<sup>35</sup>

<sup>32</sup> Davis, Meg. Sidewalk Toronto Quayside Smart City Update Presentation, Waterfront for All AGM, 2018. (<https://www.slideshare.net/waterfrontforall/sidewalk-toronto-quayside-smart-city-update-presentation-meg-davis-at-waterfront-for-all-agm>)

<sup>33</sup> Background, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/project-background/>)

<sup>34</sup> Quayside Blog, Waterfront Toronto, 2020. (<https://quaysideto.ca/blog/>)

<sup>35</sup> "Why we're no longer pursuing the Quayside project — and what's next for Sidewalk Labs", Sidewalk Talk, 2020. (<https://medium.com/sidewalk-talk/why-were-no-longer-pursuing-the-quayside-project-and-what-s-next-for-sidewalk-labs-9a61de3fee3a>)



The technical focus of the Quayside project includes key innovations in mobility, public realm and digital innovation, i.e. self-driving vehicles, adaptive traffic signals, dynamic curbs, self-driving delivery dollies, an underground tunnel network for the dollies, a freight logistics hub, heated pavement, modular pavement, outdoor comfort system, and public realm assets map.

Several unique innovations emerged from the Quayside project including Collab the platform for community public space programming, CommonSpace the app for data collection on public space use, underground pneumatic tube system that vacuums waste, Koala the standardized mount for sensors and other equipment, Urban Data Trust and ubiquitous connectivity.<sup>36</sup>

The community engagement effort of the Quayside project was most visible in the initial public townhall and four public roundtables co-hosted by Sidewalk Labs and Waterfront Toronto. The two partners also co-hosted three design jams for the local residents to shape the project. Throughout the process, Sidewalk Toronto on their end organized the resident's reference panel to gather feedback, granted fellowship for young Torontonians to go on study trips and offer recommendations, opened up 307 to display prototypes, participated in co-design sessions with accessibility community, and heard from the experts through advisory working groups meetings. Waterfront Toronto on their end hosted civic labs to open up discussions and build digital literacy, initiated round one consultation to gather feedback on the proposed MIDP, hosted a public briefing to explain issues and next steps for evaluation and initiated round two consultations to gather feedback on its evaluation of the MIDP.

The Capstone built upon the exposure to Sidewalk Labs presentations and analyzed the engagement materials<sup>37</sup> of Sidewalk Toronto such as the four post-event surveys and transcribed notes from the events (from Roundtable 1 through 4), events workbooks and slides, reports on Public Participation Strategy, Public Engagement Process, and Townhall Feedback.

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<sup>36</sup> Innovations, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/>)

<sup>37</sup> Documents, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/documents/>)

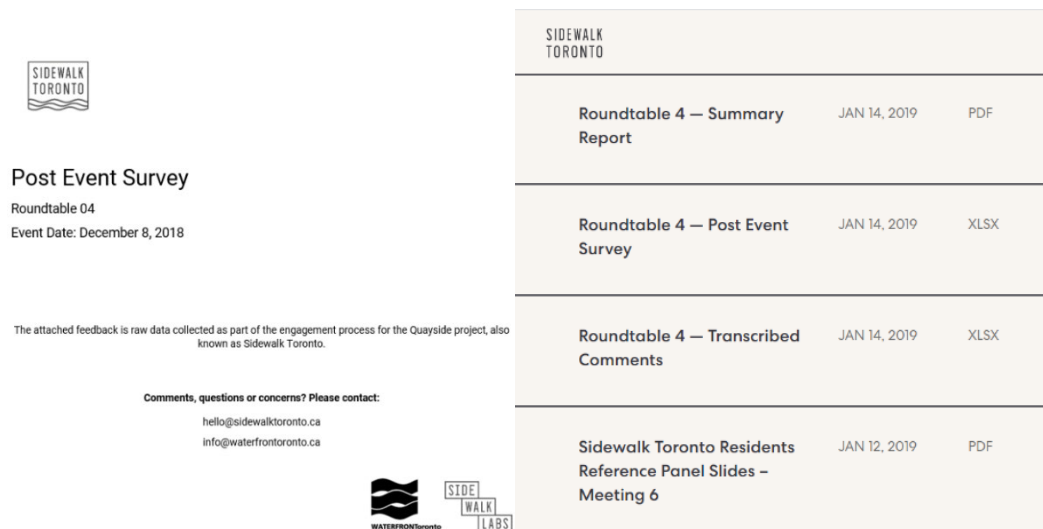


Fig 10. Sidewalks Toronto Events Surveys and Transcribed Notes are Open to Public<sup>38</sup>

Sidewalk Toronto was navigating uncharted path in its planning of the Quayside project and much feedback Torontonians gave were concerns about the process. Processes seem to be the bottleneck and the biggest challenges of the Quayside project, much more so than technical capabilities. The mindset of technologists tends to be preoccupied with and labor over tech innovations. However, public feedback of Sidewalk Toronto's Quayside project points to the essentiality of processes. **Processes innovation is even more important than tech innovations and really makes or breaks a project.**

## Small Cell in San Francisco

The “small cell” wireless refers to small radio and antennas that could be placed on street lights and utility poles in the public rights of way. It is different from “macro cells” which refer to the tall cell towers on rooftops and along highways. 4G small cell have been installed around San Francisco and concentrated in Downtown and South of Market Street. 5G small cell are being installed first on poles with existing 4G small cell. Small cell wireless deployment in San Francisco aims to provide faster data capacity and coverage for cell phone and device users.

<sup>38</sup> Documents, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/documents/>)

Verizon, AT&T and T-Mobile are the main telecommunication companies deploying small cell wireless in San Francisco. City agencies such as Department of Public Works, Planning Department and Department of Public Health regulate the design and siting of the small cell. City agencies that are pole owners have licensed hundreds of poles to the telecom companies to install the small cell on their poles (see section 6. Multiple Ownership and Regulatory Agencies).

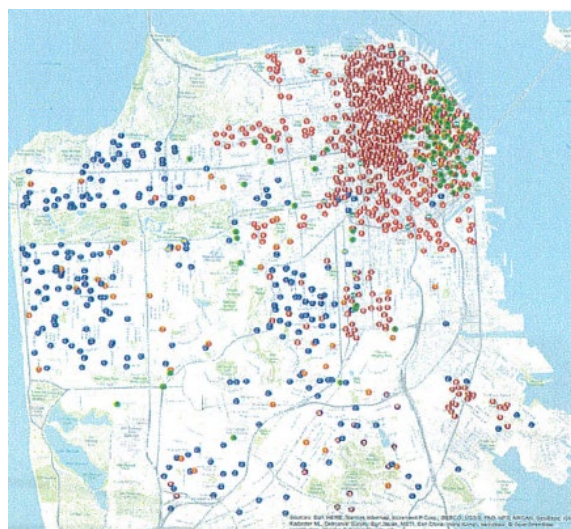


Fig 11. San Francisco 4G Small Cell Map<sup>39</sup>



Fig 12. Major Telecom Companies & Regulatory Agencies in SF

#### Current Article 25 Timeline



#### New Timeline



5

Fig 13. Small cell wireless timeline changed to comply with FCC Shot Clock

<sup>39</sup> Different colors represent different telecom applicants

The timeline (Fig. 13) of the small cell wireless deployment has changed due to a 2018 FCC shot clock which requires municipalities to approve or deny small cell wireless deployment within 90 days if the installment is new or 60 days if it's added to an existing facility. Article 25 in San Francisco Department of Public Works (DPW) code is regarding the discretionary permit process of small cell wireless. days if it's added to an existing facility. Article 25 in San Francisco Department of Public Works (DPW) code is regarding the discretionary permit process of small cell wireless. The previous Article 25 permit process in San Francisco spanned 90 to 180 days. It took 15 to 30 days for pole license agreement application and review. Then the review and permit process took 30 to 90 days. The review and permit process included CEQA analysis, permit application submission to Public Works, after which the permit could be referred to Planning, Recreation & Park, Bureau of Urban Forestry and Public Health, and then the tentative approval is issued and conditions are imposed. Once the applicant receives the tentative approval, they are required to notify the public, specifically residents within 150 feet of the pole and neighborhood groups within 300 feet of the pole. The public was given 60 days to protest the deployment. After the FCC shock clock<sup>40</sup>, small cell wireless deployment timeline is targeting to complete in 45 to 60 days. The protest process and Planning Department review was eliminated to comply with FCC order that requires the applications for small cell added to existing infrastructure to be processed within 60 days shot clock and 90 days for facilities using a new structure.

The technical focus of the small cell wireless is transmitting data using mid-and high-band spectrum which send larger quantities of data at higher speeds. The higher band wireless such as 5G has a shorter range and cannot travel as far, therefore, needs to be placed with high density and close to the users.<sup>41</sup> The strategy so far has been installing small cell on streetlight poles and utility poles and that was made possible by the size of small cell which, according to the Federal Communications Commission (FCC), can be "fit into a pizza box."<sup>42</sup>

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<sup>40</sup> "FCC Small Cell Order requires that applications for 'small wireless facilities' (as defined by the FCC) must be processed within the shot clock period of time." New FCC Shot Clocks and Other Rules Preempting Local Authority Over Wireless Take Effect Today, BB&K Legal Alerts, 2019. (<https://www.bbklaw.com/news-events/insights/2019/legal-alerts/01/new-fcc-shot-clocks-and-other-rules-preempting-loc>)

<sup>41</sup> Sullivan, Anderson. "What is a Small Cell? A Brief Explainer", CTIA blog, 2018. (<https://www.ctia.org/news/what-is-a-small-cell>)

<sup>42</sup> "Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment", FCC Order, 2018. (<https://docs.fcc.gov/public/attachments/DOC-353962A1.pdf>)

The community engagement of small cell wireless deployment in San Francisco include public hearings at Public Works and Board of Appeals, city hall meetings, protests to Public Works before FCC shot clock took effect, public noticing of tentative approvals, and the publishing of Frequently Asked Questions flier from Planning Department.

The Capstone built upon the San Francisco internship experience and analyzed materials of San Francisco small cell wireless deployment such as City Hall meetings, public hearings, public complaints to San Francisco Department of Public Works, site visits and noticing trips, process information, policy documents, and information gained from working with stakeholders.

Small Cell wireless deployment uses many jargons. Presentations at public hearings is more accessible to “tech-savvy” audiences. Regular graduate students like the writer herself had difficulties understanding the terms. The capacity gap in digital literacy was shown to be a barrier in bringing technologies to people. **Capacities gaps need to be bridged to bring technologies to people and achieve impact.**

## Chapter 2. Ecosystem Stakeholders

### Community Partners

**Community partners are essential for engaging the “community public”, not just the “geek publics”.** Byrum and Nucera wrote about their solution to build outreach that reached to the “community public” in the Detroit Community Technology Project: the coalition trained local residents to be the digital stewards of the network.

#### COSMOS Testbed Precedent

The community partner of COSMOS Silicon Harlem is deeply embedded in the “community public” with “a proven ‘go-to-market’ methodology”<sup>43</sup> of engagement while also having tech expertise and connection with the “geek publics”, allowing for well-rounded engagement of both. Silicon Harlem works both with research team and community to transform the COSMOS testbed into a “replicable model for digital inclusion and opportunity.”<sup>44</sup> COSMOS was the first National Science Foundation (NSF) project to have included a significant community engagement component, inspiring future NSF projects to follow its path. Silicon Harlem’s role as an anchor community partner and its expertise in the development of community-based technologies supporting digital inclusion are essential in bringing COSMOS to the community.

**Community partner acts as a social interface that help coordinate wide range of relationships and situate deployment in local context.** Clayton emphasized the role of Silicon Harlem in the middle of five components of ecosystems that include:

- public sector;
- private sector;
- stakeholders such as YMCAs, churches that touch citizens’ everyday life;
- citizens themselves; and
- academics.

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<sup>43</sup> Silicon Harlem Website, 2013. (<https://www.siliconharlem.com/>)

<sup>44</sup> Silicon Harlem Letter of Support, Community Outreach and Engagement: A Harlem Practicum Class Material, 2019.

Silicon Harlem works to engage these stakeholders, assess their needs, host local meet ups “to galvanize the community around the benefits of broadband,”<sup>45</sup> coordinate with schools in applications, with the community board in program launch and with NYCHA building management to distribute literature, and finally measure satisfaction and overall engagement.

**Engaging the “community public” is important to serve the real needs of community.** The “community publics” have knowledge of social problems that needs to be tapped by technologists to serve real needs and avoid mismatch between resources and needs.

### **COSMOS Testbed Precedent**

Silicon Harlem works with Columbia’s Office of Government and Community Affairs in the organization of a “hyperlocal ecosystem representative of key anchor institutions and community stakeholders.” These key anchor institutions and community stakeholders include the large number of New York City Housing Authority (NYCHA) public housing residents, Department of Education public school. educators and non-profit community-based organizations (CBO’s) which are all important part of the social fabric of Harlem community. [Embedding COSMOS testbed in the context of this hyperlocal social fabric of community helps incubate community-minded innovations that serve real community needs.](#)

One superintendent of school district advocated for expanding broadband internet connection for students and “bridge the homework gap for our neediest students,”<sup>46</sup> COSMOS’s Research Experience for Teachers (RET) program did target low income students (see section 17. Workforce and Education as Bridge) and could be a first step in bridging the homework gap. The City College of New York (CCNY) advocated for increasing minority participation in engineering and science. COSMOS’s partnership with consortium member CCNY, one of “the top ten producers of underrepresented minority B.E. engineering graduates in the nation”<sup>47</sup> helps increase representation.

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<sup>45</sup> Ibid

<sup>46</sup> School District Letter of Support, Community Outreach and Engagement: A Harlem Practicum Class Material, 2019.

<sup>47</sup> CCNY Letter of Support, Community Outreach and Engagement: A Harlem Practicum Class Material, 2019.

## Tech Providers

The variety of tech providers is typical in tech enabled infrastructure deployment. This has results in TEI of different designs. For example, Different EV manufacturers design charge ports in different locations of the vehicles.<sup>48</sup> Tesla Model S places its charge port on the driver's side rear while Ford Focus Electric's charge port is on the driver's side front. Nissan Leaf and Kia Soul both have their charge points on the front. According to NYSEDA's EV charging station deployment guide,<sup>49</sup> slightly more than half of the EV manufacturers chose to use driver's side for charge port locations.

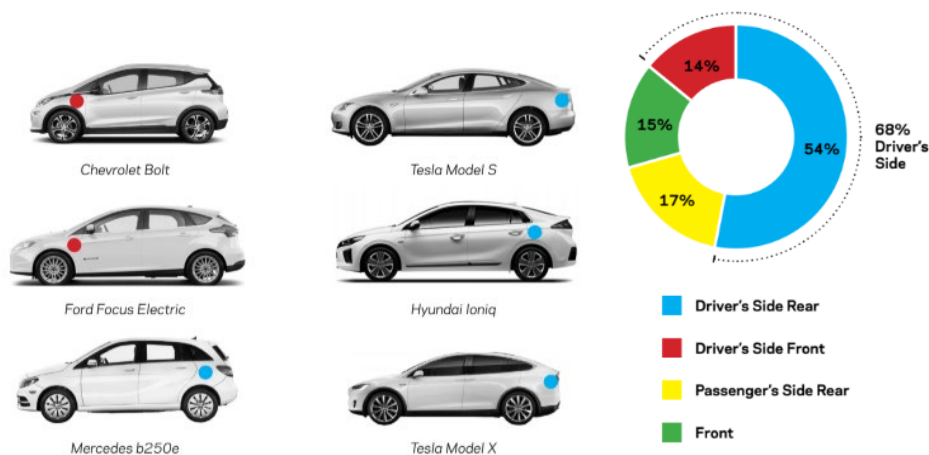


Fig 14. Variability in EV Charge Port Locations<sup>50</sup>

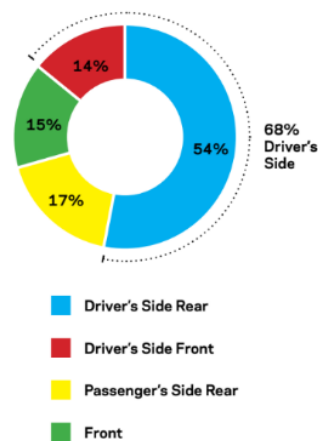


Fig 15. Most EV Use Driver's Side Charge Points<sup>51</sup>

## Small Cell Precedent

Different wireless providers have distinct facility designs with antennas mounted on pole top or side mounted around a pole. Different levels of adaptation and accommodations are needed to coordinate deployment on different pole assets.

<sup>48</sup> Curb Enthusiasm: Deployment Guide for On-Street Electric Vehicle Charging, W X Y architecture + urban design, Barretto Bay Strategies, 2018. ([https://www.wxystudio.com/uploads/2400024/1550074865953/Final\\_Curb\\_Report\\_Nov2018\\_web.pdf](https://www.wxystudio.com/uploads/2400024/1550074865953/Final_Curb_Report_Nov2018_web.pdf))

<sup>49</sup> Curb Enthusiasm: Report for On Street Electric Vehicle Charging, New York State Energy Research and Development Authority, 2019. (<https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/19-11-Curb-Enthusiasm.pdf>)

<sup>50</sup> Ibid

<sup>51</sup> Ibid



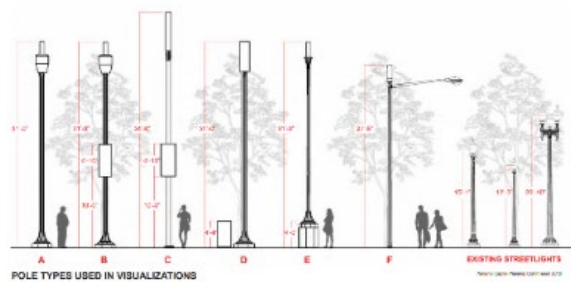


Fig 16. Different Heights and Spacing of Pole<sup>52</sup>

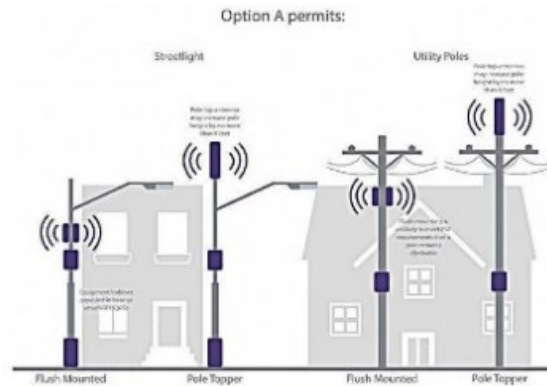


Fig 17. Side Mount vs. Pole Top Antennas<sup>53</sup>

**Training on the variety of tech providers is needed for agency staff.** For example, only a quarter of US firefighters have had EV training. Different EV manufacturers publish their own versions of safety guidelines. Tesla has a guidebook for first responders<sup>54</sup> responding to accidents involving Tesla vehicles, while Chevrolet has a first responder rescue sheet<sup>55</sup> corresponding Chevrolet vehicle. Different responses are needed depending on which chords are fine to cut and which high pressure components to stay away from for safety. This added-on complexity is challenging for firefighters to respond to fires caused by EV since safety guidelines varies depends on the manufacturers. Training and knowledge of the variety of EV manufacturers help firefighters make safe, informed decisions facing emergencies.

## Public Agencies

The agencies and entities involved in the deployment of tech enabled infrastructure on sidewalks are numerous.

## Small Cell Precedent

<sup>52</sup> The Cranmer Park/Hilltop Civic Association, 2019. (<http://denverhilltop.com/new-cingular-wireless-att-small-cell-facilities-and-towers/>)

<sup>53</sup> Wireless Facilities Policy & Permit, City of Lake Oswego Public Works, 2019. (<https://www.ci.oswego.or.us/publicworks/wireless-facilities-policy-permit>)

<sup>54</sup> First Responders Information, Tesla Website, 2017. (<https://www.tesla.com/firstresponders>)

<sup>55</sup> First responder rescue sheet, Chevrolet, 2017. (<http://135jik1bbhst1159ri1ax2pj.wpengine.netdna-cdn.com/wp-content/uploads/sites/20/2010/11/2016-Chevrolet-Bolt-Rescue-Sheet.pdf>)

In San Francisco small cell wireless providers need to work with four major pole owners. Wood utility poles are owned by Pacific Gas and Electric Company (PG&E). Steel and concrete light poles are owned by Public Utilities Commission. Poles with traffic signals or streetcar lines attached are properties of Municipal Transportation Agency (SFMTA). Other poles belong to Northern California Joint Pole Association (NCJPA). Each pole owner has its own database of poles, making pole selection and alternative analysis daunting tasks.

Wireless providers need to navigate different processes when sites are in the jurisdiction of different agencies. For example, application and approval process of sites in the jurisdiction of Port is very different from those in the jurisdiction of Caltrans.

The permitting process of deployment is also a winding path involving multiple agencies. Application materials (typically including site survey and plan, construction drawings, CEQA exemption, photo sims of before and after, EMF report, noise study, and pollution insurance) are first sent to Department of Public Works, then referred to Department of Public Health and Planning Department to issue tentative approval and final determinations.



Fig 18. Pole Owners in San Francisco

Fig 19. Poles May be in Jurisdictions of Caltrans or Port

Similarly, in NYC's curbside EV charging stations deployment, New York City Department of Transportation (NYCDOT) has jurisdiction over most sidewalk and roadbed but some areas near highway entrances, exits and under the viaduct are under the jurisdiction of New York State Department of Transportation (NYSDOT). A jurisdiction map that clarifies where one jurisdiction ends and another begins would clarify regulatory process for different sites, saving time and resources.



Department of  
Transportation

*Fig 20. EV charging station maybe in Jurisdictions of NYCDOT or NYSDOT*

Additionally, different departments are involved in permitting.<sup>56</sup> Department of Buildings need to approve electrical installations. Public Design Commission (NYCPDC) needs to review station design. Landmarks Preservation Commission needs to review in case that stations will block the view of landmarks. The many turns of the permitting process call for a flow chart of different scenarios and steps to follow. It could make the process straight forward and reduce time spent on coordinating with different agencies.

Consultations with additional parties are needed and can come in at any steps when a new issue arises. This is shown in NYC curbside EV charging stations deployment. Con Edison needs to be brought in to provide electric power and connection to the grid. Department of Finance needs to be involved to plan for fee collection. When a street tree is affected, Department of Parks and Recreation needs to be consulted. If a water sewer is affected, Department of Environmental Protection will be involved. When a station potentially affects a fire exit, Fire Department (FDNY) needs to be consulted.

Cross-agency collaboration is also necessary for local agency-led deployment. FDNY works with NYCPDC for the approval of its ambulance pedestal charger. New York State Energy Research and Development Authority (NYSERDA) also works with city agencies for its Taxi of Tomorrow DC Fast Charge stations. Early built-in consultations could safeguard an inclusive resilient and sustainable public right of way and strengthen cross-agency initiatives.

Infra.preneurs

**Tech entrepreneur venture and traditional infrastructure investment converge in investment of tech enabled infrastructure, giving birth to a new type of investors, the infra.preneurs<sup>57</sup>.**

<sup>56</sup> Curb Enthusiasm: Report for On Street Electric Vehicle Charging, New York State Energy Research and Development Authority, 2019. (<https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Transportation/19-11-Curb-Enthusiasm.pdf>)

<sup>57</sup> The term was originally generated by Jaya Chanchalani. Chanchalani. Chanchalani thinks that infrastructure professionals should become “infra.preneurs” and make use of innovative financing mechanism to incentivize private sector participation. Chanchalani,

The emerging traits of the infra.preneurs are present in the examples of Sidewalk Infrastructure Partners (SIP),<sup>58</sup> The Platform for Advanced Wireless Research Project Office (PPO)<sup>59</sup> and Quayside Venture Partners (QVP).<sup>60</sup>

Sidewalk Infrastructure Partners (SIP) is a holding company formed by Alphabet Inc. and the Ontario Teachers' Pensions Plan (OTPP) that "focuses on owning, acquiring and investing in technology-enabled infrastructure, particularly in urban areas."<sup>61</sup> The approach of SIP is a unique one. The company identifies big sector-wide infrastructure problems and needs, then utilizes C-level executives and convenes experts in technology, policy, infrastructure and other sectors to develop a master plan to deploy capital, technology and physical assets on solutions.<sup>62</sup>

The Platforms for Advanced Wireless Research program (PAWR) is the research platform funded by the National Science Foundation (NSF) and an Industry Consortium of 30 companies and associations. The Platform for Advanced Wireless Research Project Office (PPO) manages the PAWR's "\$100 million public-private partnership to deploy and manage up to 4 city-scale research testbeds."<sup>63</sup> So far, PPO has funded the testbeds in Salt Lake City (POWDER), New York City (COSMOS) and North Carolina (AERPAW). The PPO is co-led by US Ignite, Inc., a non-profit organization and Northeastern University, an experiential research university.

Quayside Venture Partners (QVP) is an urban tech fund formed out of a partnership between Sidewalk Labs and Plaza Ventures. QVP plans to invest in "early-stage Canadian urban technology companies that are focused on addressing urban challenges like traffic congestion, housing affordability, and sustainability."<sup>64</sup> QVP will also utilize "advisory networks of Canadian industry experts" and "C-level

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Jaya. "An aspiration for Self-reliable Infrastructure Development !", 2020. (<https://www.linkedin.com/pulse/aspiration-self-reliable-infrastructure-development-jaya-chanchalani/>)

<sup>58</sup> Sidewalk Infrastructure Partners | The Future of Infrastructure, 2019. (<https://www.sidewalkinfra.com/>)

<sup>59</sup> About PAWR Project Office, PAWR, 2019. (<https://advancedwireless.org/about-pawr-project-office/>)

<sup>60</sup> "Quayside Venture Partners Announcement", Plaza Ventures, 2019. (<https://plaza.ventures/our-partnership-with-sidewalk-labs/>)

<sup>61</sup> Elias, Jennifer. "CNBC: Google Parent Company Alphabet Hosted Secret 'Logistics Summit' Last Week", SIP, 2020. (<https://www.sidewalkinfra.com/cnbc-google-parent-company-alphabet-hosted-secret-logistics-summit-last-week/>)

<sup>62</sup> Stutts, Jordan. "Infrastructure Investor: Big Tech Is Coming For Infra 3.0 by", Infrastructure Investor, 2019. (<https://www.infrastructureinvestor.com/deep-dive-big-tech-coming-infra-3-0/>)

<sup>63</sup> About PAWR Project Office, PAWR, 2019. (<https://advancedwireless.org/about-pawr-project-office/>)

<sup>64</sup> "Quayside Venture Partners Announcement", Plaza Ventures, 2019. (<https://plaza.ventures/our-partnership-with-sidewalk-labs/>)

executives with deep experience.”<sup>65</sup> The fund is a product of Sidewalk Toronto’s proposed idea of catalyzing Canada’s urban tech ecosystem in partnership with Canadian investors and scale up the Quayside project. It’s unclear what the fate of QVP will be now Sidewalk Labs has withdrawn from Quayside.

**Public-private partnership and cross-sector collaboration are prevalent in connecting capital with tech enabled infrastructure.** Sidewalk Infrastructure Partners (SIP) draws on the technological expertise of Alphabet, Google’s parent company and the infrastructure investing experience of the Ontario Teachers’ Pensions Plan (OTPP), an institutional investor with net assets of \$153.8 billion and diversified infrastructure portfolio.<sup>66</sup> Alphabet “has never owned or operated complex infrastructure systems”<sup>67</sup> but its subsidiary Sidewalk Labs has ventured into tech enabled infrastructure. OTPP has “pushed the frontiers of infrastructure investing, from becoming a direct investor in the early 2000s, to an investor in greenfield infrastructure a few years ago, and now tech-enabled infrastructure.”<sup>68</sup>

The Platform for Advanced Wireless Research Project Office (PPO) works closely with the National Science Foundation (NSF) and the research community while also leverage the industry expertise in the “design, development, deployment, and initial operations of the research platforms.”<sup>69</sup> When tech entrepreneurs and infrastructure investors move towards each other, infra.preneurs are formed.

### Sidewalk Toronto Precedent

A proposed profit sharing of technology products demonstrated such partnership. Sidewalk Labs proposed to develop a number of technology products at its own cost and when the product is sold in other cities outside Toronto, the public sector could share 10 percent of the profits.<sup>70</sup> A well-organized

<sup>65</sup> “Press Release: Sidewalk Labs and Plaza Ventures Team Up on Next Steps to Establish an Urban Tech Fund for Canadian Companies”, Plaza Ventures, 2019. (<https://plaza.ventures/press-release-sidewalk-labs-and-plaza-ventures-team-up-on-next-steps-to-establish-an-urban-tech-fund-for-canadian-companies/>)

<sup>66</sup> Infrastructure portfolio, the Ontario Teachers’ Pension Plan, 2012. ( <https://www.otpp.com/sandbox-highcharts-infrastructure-portfolio>)

<sup>67</sup> Stutts, Jordan. “Infrastructure Investor: Big Tech Is Coming For Infra 3.0 by”, Infrastructure Investor, 2019. (<https://www.infrastructureinvestor.com/deep-dive-big-tech-coming-infra-3-0/>)

<sup>68</sup> Ibid

<sup>69</sup> About PAWR Project Office, PAWR, 2019. (<https://advancedwireless.org/about-pawr-project-office/>)

<sup>70</sup> The Partnerships, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/partnership/>)

public private partnership could help cities become future-ready and take advantage of the emerging disruptions.

**Taking on technology risks is another feature of infra.preneurs.** Sidewalk Infrastructure Partners (SIP) co-CEO Brian Barlow described that SIP “takes on a lot more risk that is otherwise excluded from more traditional procurement processes.”<sup>71</sup> SIP’s collaboration with the Ontario Teachers’ Pensions Plan (OTPP) is also through OTPP’s Teachers’ Innovation Platform rather than its infrastructure group. The Teachers’ Innovation Platform is more growth equity-focused and can tolerate more technology risk.

Similarly, the Platform for Advanced Wireless Research Project Office (PPO) run wireless testbeds that are typically experimental, exploratory and revolutionary. The COSMOS testbed is described as “allow for experimentation at a scale that could not be achieved previously”<sup>72</sup> and the AERPAW testbed is described as “first-of-its-kind.”<sup>73</sup> These testbeds are deployed to sustain “US leadership and economic competitiveness for decades to come.”<sup>74</sup>

**Disruption to traditional infrastructure is also a big part of considerations of infra.preneurs.**

Disruption could happen in the financing, delivery and procurement process. It could also happen in the transforming of “the efficiency of traditional infrastructure and energy assets.”<sup>75</sup> Different infrastructure assets may be exposed to different levels of disruption at different paces.

Move too early, there are risks of making “a bad bet on new technology”<sup>76</sup> meaning unwisely risk investment in immature emerging technology. Move too slowly, the infrastructure assets are disrupted or even obsolete and the investors are left behind the trend. SIP’s co-CEO Jonathan Winer observed that

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<sup>71</sup> Stutts, Jordan. “Infrastructure Investor: Big Tech Is Coming For Infra 3.0 by”, Infrastructure Investor, 2019. (<https://www.infrastructureinvestor.com/deep-dive-big-tech-coming-infra-3-0/>)

<sup>72</sup> New York City, COSMOS-Cloud Enhanced Open Software-Defined Mobile Wireless Testbed, PAWR, 2018. (<https://advancedwireless.org/new-york-city/>)

<sup>73</sup> Research Triangle, AERPAW- Aerial Experimentation and Research Platform for Advanced Wireless, PAWR, 2019. (<https://advancedwireless.org/research-triangle/>)

<sup>74</sup> Platforms, PAWR, 2019. (<https://advancedwireless.org/platforms/>)

<sup>75</sup> Infrastructure Investor: Big Tech Is Coming For Infra 3.0 by Jordan Stutts, Infrastructure Investor (<https://www.infrastructureinvestor.com/deep-dive-big-tech-coming-infra-3-0/>)

<sup>76</sup> Ibid

“for institutional investors with larger infrastructure portfolios, they have to ask themselves: ‘Do I also need to have exposure to technologies that may be disruptive to those legacy portfolios?’”<sup>77</sup>

Other than the shared characteristics, there are different investment paths for infra.preneurs. For example, SIP invests both in urban technology companies and also “develop or acquire and hold large-scale infrastructure projects.”<sup>78</sup> PPO invests in neighborhood-scale testbeds that are usually developed by universities and industry partners. QVP only invest in the companies with technologies that can solve urban infrastructure issues but not infrastructure projects. Investing in an asset usually involves a multi-year contract while investing in urban technology companies would be more similar to tech venture investment in its quick return approach. **Further investigation on how technology investment and asset investment could be best structured for infra.preneurs is needed.**

## Missing Voices

**There are many missing voices in tech enabled infrastructure deployment that also have the most at stake.** These missing voices including seniors, disability community, immigrants and non-native speakers, low-income people, vulnerable populations experiencing homelessness, mental health issues, the formerly incarcerated, residents living outside central locations and indigenous community.

**Seniors are uniquely challenged by the technological transformation of society and face intergenerational gap in an increasingly tech-heavy world.** Ubiquitous social media, digital payments, online census and other features that young people are used to are not easy for seniors, creating barriers in day-to-day life. One best practice of including seniors is Silicon Harlem’s Technology for Seniors: Demystifying Technology for Seniors (DTS) workshop. The DTS is a popular workshop that’s “geared toward making seniors comfortable with technology in a way that works for them.”<sup>79</sup> It has exposed over 200 seniors to Virtual Reality, a great demonstration of the belief that technologies are for all.

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<sup>77</sup> Ibid

<sup>78</sup> Sidewalk Infrastructure Partners, 2020. (<https://www.sidewalkinfra.com/why-sip-why-now/>)

<sup>79</sup> Demystifying Technology for Seniors (DTS), Silicon Harlem Website. (<http://staging.siliconharlem.com/program/technology-for-seniors/>)





Fig 21. Demystifying Technology for Seniors Workshop<sup>80</sup>



Fig 22. Silicon Harlem VR for All<sup>81</sup>

**Disability community has a lot at stake in a tech enabled world, potentially benefiting from tech advancements that make their life more convenient, though their voices are not heard enough in deployments.**

### Sidewalk Toronto Precedent

Residents thought the engagement events were not accessible enough. Suggestions include to install “a screen with real time captioning for people who are hard of hearing” and “an American Sign Language (ASL) interpreter on the stage”<sup>82</sup> and “more space in between the table for wheelchairs to move around”.

Although Sidewalk Toronto’s co-design program has collaborated with the Ontario College of Art and Design University’s Inclusive Design Research Centre and engaged over 200 members of the disability community to draft its accessibility principles.

<sup>80</sup> Ibid

<sup>81</sup> Silicon Harlem Website, 2013. (<https://www.siliconharlem.com/>)

<sup>82</sup> Documents, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/documents/>)



**Immigrants and non-native speakers face the challenge of language barrier in tech enabled infrastructure deployment.** Information about technologies in the US are typically in English. English default is in the way of immigrants and non-native speakers who are trying to understand new technologies.

### COSMOS Testbed Precedent

Research Experience for Teachers (RET) program does not have lesson plans in languages other than English. Translating the lesson plans into Spanish which is widely spoken in the Harlem area could be a great step forward to include students who speak English as a second language.

### Small Cell Precedent

The public noticing stage of the approval process requires wireless providers to include translations of notices in languages spoken most frequently in the neighborhoods, typically Cantonese, Spanish and Tagalog. This translation requirement benefits the immigrants and non-native speakers in diverse neighborhoods since they would be able to read the notices in their first languages and aware of installations in their neighborhoods.

最後裁定興建個人無線服務設施據點許可  
之申請案的公告通知

AVISO DE DETERMINACIÓN FINAL PARA APROBAR LA  
INSTALACIÓN DE UN EMPLAZAMIENTO DE SERVICIO  
MÓVIL PERSONAL

PAUNAWA NG PANGHULING PAGPAPASIYA UPANG  
APRUBAHAN ANG ISANG PERSONAL WIRELESS SERVICE  
FACILITY SITE PERMIT

Fig 23. Noticing in Cantonese, Spanish and Tagalog<sup>83</sup>

**Low-income people are part of the missing voices that are often excluded.**

### Sidewalk Toronto Precedent

<sup>83</sup> Screenshots taken by Capstone writer on internship

Residents felt that the engagement events excluded lower-income people. Some comments were that people at the event seemed to be “from the same strata in society (i.e. well educated, tech savvy)”<sup>84</sup> and the event was “echo chamber-y”. Suggestions included to involve residents from the low-income areas in Scarborough and Rexdale and working with local organizations such as ACORN (Association of Community Organizations for Reform Now), an independent national organization of low- and moderate-income families. Including residents from low-income areas could better represent Torontonians as a whole and working with organizations such as ACORN could help provide the services and models needed for low-income families.

**Socially vulnerable populations such as people experiencing homelessness, mental health issues and the formerly incarcerated are another part of the missing voices that need to be heard.**

Making sure that social service organizations were able to leverage technologies for the benefit of vulnerable populations are essential. A best practice is the Smart Cities – Life Intentions Initiatives<sup>85</sup> of the Streetohome Foundation. The Life Intentions project creates personal story repository of homeless individuals and real time, up-to-date support services database to provide opportunities and pathways for homeless individuals to realize their life intentions and goals. Expanding outreach of tech enabled infrastructure deployment to include vulnerable populations experiencing homelessness, mental health issues and the formerly incarcerated could help foster innovative solutions of shelter, supportive housing, and other social services.

### Sidewalk Toronto Precedent

Residents thought that it was ineffective that the events addressed affordable housing but people participating in the events didn’t have experience living in public housing and were not affected by

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<sup>84</sup> Documents, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/documents/>)

<sup>85</sup> Williamson, Chris. Liu, Elisa. Cion, Jason. Simion, Michael. Ryken, Ross. Smart Cities – Life Intentions Initiative Business Case. Streetohome Foundation, 2019. (shared by Streetohome Foundation project lead for the Smart Cities – Life Intentions initiative via email)

affordable housing programs. Suggestions include holding engagement events at organizations such as Toronto Community Housing (TCHC) and Centre for Addiction and Mental Health (CAMH).

**Residents living in less central locations are also overlooked in deployments.**

### Sidewalk Toronto Precedent

Residents thought the panel was downtown-centric and there was a “lack of suburban voices on the committee.”<sup>86</sup> Suggestions were to hold the events in the outskirts, from the inner suburbs, or in different parts of Toronto, and bring the consultation and workshops to communities that can’t get out, “for instance in public libraries, community centers, senior centers, friendship houses.”<sup>87</sup>

**Indigenous community is another part of the missing voices with a lot at stake in deployments, especially to protect sites with historic heritage and natural environment.** The lawsuit United Keetoowah Band of Cherokee Indians In Oklahoma V. Federal Communications Commission and United States of America<sup>88</sup> is an example of conflicts between indigenous community and tech enabled infrastructure deployment. The indigenous community in Oklahoma challenged and won against the Federal Communications Commission (FCC) order which would have exempts the historic preservation review and environmental review of the wireless installations. These reviews are mandated by National Historic Preservation Act (NHPA) and National Environmental Policy Act (NEPA).

### Sidewalk Toronto Precedent

Quayside sits on the treaty lands of the Mississaugas of the Credit First Nation (MCFN) and is close to many indigenous organizations. The project team organized meetings with MCFN and other indigenous organizations, invited planners to introduce indigenous approaches to planning to a Residents Reference Panel and collaborated with an indigenous design studio. It’s important to consult with indigenous community in deployment of cutting-edge technologies especially regarding deployment close to heritage sites.

<sup>86</sup> Documents, Sidewalk Toronto Website, 2019. (<https://www.sidewalktoronto.ca/documents/>)

<sup>87</sup> Ibid

<sup>88</sup> United Keetoowah Band of Cherokee Indians in Oklahoma v. FCC, No. 18-1129 (D.C. Cir. 2019) (<https://law.justia.com/cases/federal/appellate-courts/cadc/18-1129/18-1129-2019-08-09.html>)

## Chapter 3. Development Process

### *Problem Areas*

The Capstone summarizes the following key problem areas from precedents and research:

#### 1. Relationships Silo

##### Equity Problems:

**Lack of Diverse Perspective**  
**Out of Touch with Community**  
**Fail to Serve Real Needs**  
**Public Acceptance Issue**  
**Varied Expectation for New Tech**  
**Behavioral Side Effect**

##### Infrastructure Problems:

**Tech Provider Variety Puzzle**  
**Lack of Curb Information**  
**Multi-factor Curb Evaluation**  
**Scattered Ownership & Jurisdictions**  
**Agency Outdated Structure**  
**Exclusion of Outsiders**

#### 2. Process Peril

##### Equity Problems:

**Limits of Individual Engagement Channels**  
**One-sided Conversation**  
**Pre-determined Design**  
**Unclear Decision-making Framework**  
**Missing Voices with Most at Stake**  
**Surveillance in Vulnerable Communities**

##### Infrastructure Problems:

**Hard-to-Comprehend Innovation Ripple Effects**  
**Visual Clutter and Disruptive to Surrounding**  
**Costly Installation**  
**Sensitivity of Human Lived Experience**  
**Perception of Being Overly Programmed**  
**Different Language of Physical and Digital Designer**

#### 3. Capacities Gap

##### Equity Problems:

**Incompatible Design Language**  
**Filled with Jargons**

##### Infrastructure Problems:

**Unprecedented Approval Process.**  
**Difficult Implementation in Urban Setting**

#### Technocratic Perception Disconnect

Lack of Concrete Cases

Scripted Tone

Lack of Digital Literacy

Need for Tech Support

Conflict of Interest of Engineering Assessment

Lack of Community Agency

Removed from Educational Environment

Difficulty Secure Local Hiring

#### Feasibility Hard to Evaluate

High Cost of New Technology

Site Selection without Thinking Affordability

Digital Redlining

Quick Obsolescence of Tech and Path Dependencies

Maintenance of Un-tested Technologies

“One and Done” Project or “Enclave”.

Limited by Scope

Service Overreach and Overload

#### *Vision Statement*

The Capstone arrives at the following vision statement following the analysis of problem areas:

“Apply an **equity lens** to tech enabled infrastructure on sidewalks to fill the existing **gap between smart cities and equitable cities practices**. **Build the relationships** at the center of equitable deployment. **Innovate the processes** more than just technologies to really make a deployment succeed. **Bridge the capacities gaps** to bring technologies to people and achieve impact.”

## ***Community Equity Goals***

The Capstone defines community equity goals based on American Planning Association (APA) Planning for Equity Policy Guide 2019. The guide provides “policy guidance through an equity lens on cross-cutting topics and areas of planning.”<sup>89</sup> The ten goals directly derived from the guide are *Environmental Justice*, *Community Engagement and Empowerment*, *Neighborhood Stabilization*, *Climate Equity and Resilience*, *Education Equity*, *Equitable Energy and Resource Consumption*, *Health Equity*, *Affordable Housing*, *Mobility and Transportation Equity*, and *Inclusive Public Spaces and Places*. Six additional goals that are added including *Gender Equality*, *Privacy Protection*, *Universal Access*, *Inclusive Economic Development*, *Inclusive Culture and Art* and *Digital Equity*. The Capstone designed a set of icons (Fig. 24) to visualize these community equity goals similar to the way SDG goals were visualized by UN 2030 Agenda for Sustainable Development.

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<sup>89</sup> American Planning Association Policy Guide – Planning for Equity Policy Guide, 2019.  
(<https://www.planning.org/policy/guides/adopted/equity/>)



## COMMUNITY EQUITY GOALS

*Designed by Claire Liu Yang*

*Fig 24. Icons Designed for Community Equity Goals*

## Chapter 4. Indicators and Tools

The Capstone developed a set of Community equity indicators for equitable deployment. The Community Equity Indicators have been organized into Relationships Scoreboard (R1, R2, R3), Processes Scoreboard (P1, P2, P3), and Capacities Scoreboard (C1, C2, C3) to evaluate the projects.

### *Community Equity Indicators*

<p><u>Relationships Indicators:</u></p> <p><b>Variety of Stakeholders and Tech Ecosystem (R1)</b></p> <p><b>Community Partners and Social Interface (R2)</b></p> <p><b>Public Culture and Behavior Shift (R3)</b></p>	<p><u>Related Goals:</u></p> <p>Community Engagement and Empowerment, Inclusive Economic and Development, Equitable Energy and Resource Consumption, Digital Equity, Education Equity, Inclusive Culture and Art, Climate Equity and Resilience, Privacy Protection and Mobility and Transportation Equity</p>
<p><u>Processes Indicators:</u></p> <p><b>Variety of Engagement Channels (P1)</b></p> <p><b>Two-Way Conversation and Co-Decision (P2)</b></p> <p><b>Missing Voices and Surveillance Oversight (P3)</b></p>	<p><u>Related Goals:</u></p> <p>Community Engagement and Empowerment, Digital Equity, Inclusive Public Spaces and Places, Privacy Protection, Universal Access, Education Equity, Inclusive Economic Development, Affordable Housing, Health Equity, and Gender Equality</p>
<p><u>Capacities Indicators:</u></p> <p><b>Jargon Free Language and Concrete Cases (C1)</b></p> <p><b>Digital Literacy and Community Agency (C2)</b></p> <p><b>Workforce and Education as Bridge (C3)</b></p>	<p><u>Related Goals:</u></p> <p>Inclusive Culture and Art, Digital Equity, Community Engagement and Empowerment, Education Equity, Digital Equity, Gender Equality, Inclusive Economic Development, and Neighborhood Stabilization</p>

*Table1. Community Equity Indicators developed in Analysis*

### *Tech enabled Infrastructure Tools*

The tech enabled infrastructure tools are formatted as actionable methods to use by the deployments. Project teams could use the preparations to familiarize with potential bottleneck or issues of deployments.



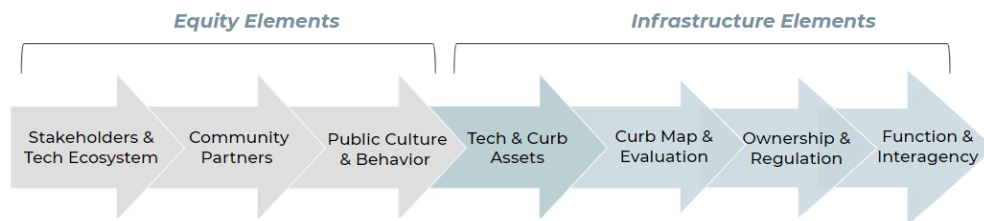
Short-term actions are geared towards rapid response with tactical urbanism in mind while long-term actions need more resource allocation and investment to carry out over time.

<p><u>Relationships Tools:</u></p> <p><b>Variety of Tech Providers and Curb Assets</b></p> <p><b>Curb Typology Mapping and Evaluation</b></p> <p><b>Multiple Ownership and Regulatory Agencies</b></p> <p><b>Function-Based Interagency Committee</b></p>	<p><u>Related Goals:</u></p> <p>Climate Equity and Resilience, Health Equity, Inclusive Public Space and Places, Equitable Energy and Resource Consumption, Mobility and Transportation Equity, Inclusive Culture and Art, Universal Access, Environmental Justice, Inclusive Economic Development, Privacy Protection and Community Engagement and Empowerment</p>
<p><u>Processes Tools:</u></p> <p><b>Direct Benefits and Ripple Effects</b></p> <p><b>Co-locating and Public Improvement</b></p> <p><b>Standardized and Humanized Hybrid Design</b></p> <p><b>Infra.preneurs and Gigaproject</b></p>	<p><u>Related Goals:</u></p> <p>Digital Equity, Education Equity, Climate Equity and Resilience, Health Equity, Universal Access, Environmental Justice, Community Engagement and Empowerment, Inclusive Economic Development, Privacy Protection, Mobility and Transportation Equity, Equitable Energy and Resource Consumption, Inclusive Culture and Art, Privacy Protection goal, Inclusive Public Spaces and Places</p>
<p><u>Capacities Tools:</u></p> <p><b>Urban Piloting and Testing</b></p> <p><b>Future Phases and Life Cycle of Technology</b></p> <p><b>Scaling Up Impact and Replicability</b></p> <p><b>Limits of Scope and Network-Hub Integration</b></p>	<p><u>Related Goals:</u></p> <p>Community Engagement and Empowerment, Inclusive Economic Development, Climate Equity and Resilience, Digital Equity, Equitable Energy and Resource Consumption, Universal Access, Neighborhood Stabilization, Mobility and Transportation Equity, Health Equity, Inclusive Public Spaces and Places, Affordable Housing</p>

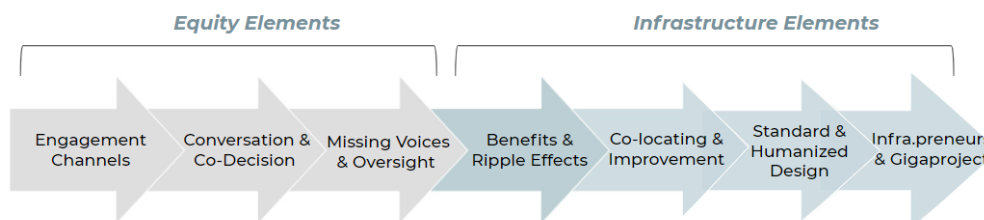
Table 2. Tech enabled Infrastructure Tools developed in Analysis

Equity Indicator and Infrastructure Tools work together to achieve vision and goals

## ***BUILD THE RELATIONSHIPS***



## ***INNOVATE THE PROCESSES***



## ***BRIDGE THE CAPACITIES***

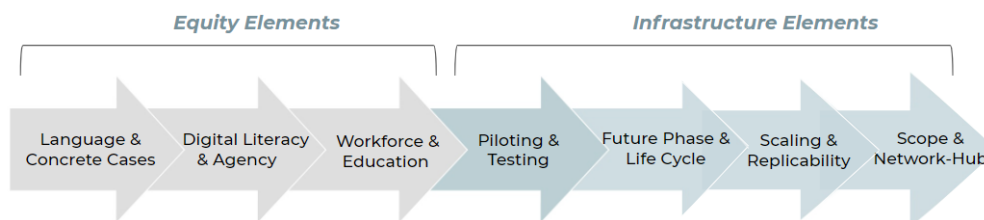


Fig 25. Flow Charts Designed to Demonstrate how Equity Indicators and Infrastructure Tools Work together

## Recommendations

### Build the Relationships

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Relationships are at the center of equitable deployment of tech enabled infrastructure.

#### Variety of Stakeholders and Tech Ecosystem

- The outreach coordinator should gain support from large number of stakeholders with diverse perspectives and leverage the networks of local community and venture organizations to build effective outreach.
- The technology team should foster mutually beneficial collaboration with industry and academic partners and work with researchers on concept development.
- The project manager should build strong relationship with municipal partners to utilize city resources.
- Relevant goals:



#### Community Partners and Social Interface

- The outreach coordinator should engage the “community public” not just the “geek publics”,<sup>90</sup> lean on anchor community partner to facilitate conversations with “community publics” and as a social interface to coordinate relationships and embed in local context.

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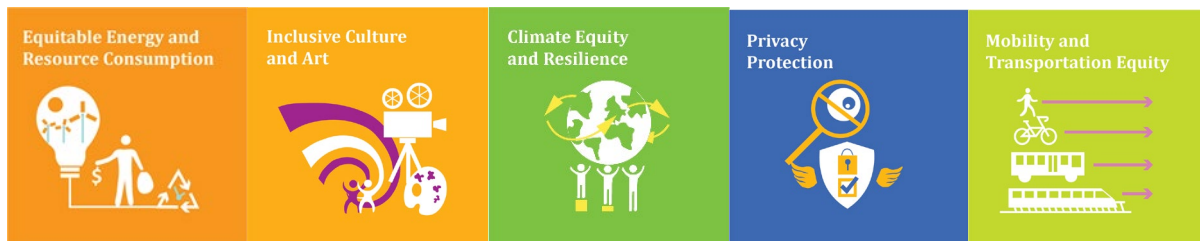
<sup>90</sup> Building Resilience with Community Technology, Global Information Society Watch Community Networks, United States Report, Association for Progressive Communications (APC) and International Development Research Centre (IDRC) Report, 2018. ([https://giswatch.org/sites/default/files/gw2018\\_unitedstates.pdf](https://giswatch.org/sites/default/files/gw2018_unitedstates.pdf))

- The technology team should tap into the knowledge of social problems from the “community public” to serve the real needs, incubate community-minded innovations in the context of local social fabric, and foster weak-tie innovations<sup>91</sup> among social entrepreneurs in different fields.
- Relevant goals:



### Public Culture and Behavior Shift

- The outreach coordinator should be aware of public acceptance issue, has a nuanced strategy for sections of population that have different levels of acceptance of technology, leverage art and culture to familiarize the public with the technology, and utilize the visibility of technologies to raise awareness.
- The technology team should study human interactions with the technology, account for the behaviors, incentivize positive social behaviors, be emotionally intelligent, try to connect with and empathize with users.
- Relevant goals:



<sup>91</sup> Strong ties occur as “relationships within similar fields” and weak ties occur “between people or firms working within different contexts or economic clusters where there is infrequent contact”. Katz, Bruce and Julie Wagner. The Rise of Innovation Districts, Brookings Institute. 2014. (<https://www.brookings.edu/essay/rise-of-innovation-districts/>)

## Variety of Tech Providers and Curb Assets

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Know Variety of Tech Providers	Train Staff on Varied Safety Guidelines	Ensure Regular Maintenance for Safety
Understand Variations in Assets	Install Flexible Street Infrastructure	Adapt Facility Design to Assets

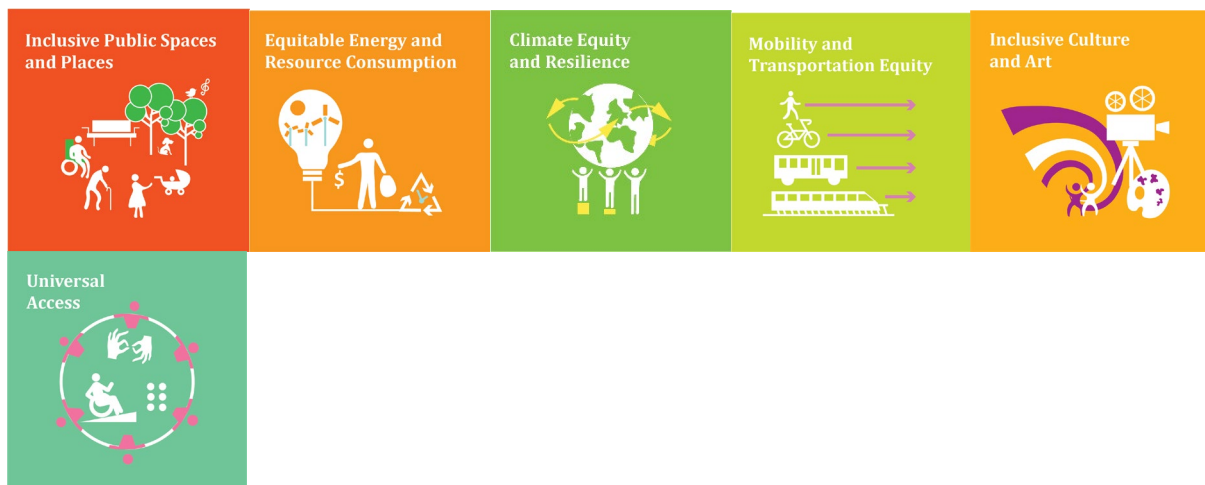
- Relevant goals:



## Curb Typology Mapping and Evaluation

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Evaluate Assets based on Policy Goals	Coordinate Flex Uses at Different Times	Survey Underground Conditions for Utilities
Balance Multiple Factors and Conflicts	Use Real-Time Digital Twins for Predictions	Let Curb Use Hierarchy Signal Policy Priority
	Account for Detailed Operation and Barriers	Allow Simulated View with Immersive Tech
	Contextualize with Land Use Street Types	Map High Resolution Regulation & Land Use

- Relevant goals:



## Multiple Ownership and Regulatory Agencies

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Include Early Built-in Consultations	Plot Permitting Scenarios Flow Chart	Create Jurisdiction Map for Site Regulations
		Build Integrated Municipal Asset Ownership Database

- Relevant goals:



## Function-Based Interagency Committee

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Recognize Need for Streamlining	Leverage Expert Oversight in Areas of Concern	Regroup/ Relocate Staff based on Function
	Involve Public-facing Entity	Cross Jurisdiction for Large-Scope Mandate
		Update Community Advisory Group
		Hold Group Meeting for Policy-making

- Relevant goals:



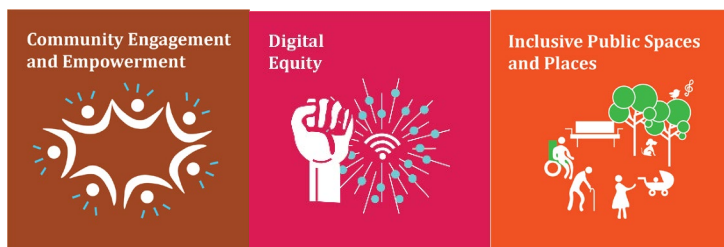
## Innovate the Processes

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Processes innovation is even more important than tech innovations and really makes or breaks a project.

### Variety of Engagement Channels

- The outreach coordinator should use variety of engagement channels for different purposes: physical posting in neighborhoods where deployment happens for a pro-longed period of time; inter-personal social network for targeted outreach that requires expertise and specialty; audio-visual mediums to engage the public and make technology accessible; online interactive tools while aware of digital divide and compensate through other channels; in-person events for the public to get to know the project and have direct dialogues with tech providers and pick. The coordinator could also choose different types of in-person events based on the purpose, experiment with mixture of different channels in one setting to combine strengths and provide physical spaces to anchor engagement, either short term pop-ups or long-term pavilions with regular programming.
- The technology team should engage the public with gamification and demonstrations while avoiding over-gamification and gimmicks that distracts from real issues.
- Relevant goals:



## Two-Way Conversation and Co-Decision

- The outreach coordinator should host events with short formal presentation, long and early time for in-depth questions, in formats such as breaking up presentations with mini discussion breaks or focus groups, with skilled and informed facilitators and staff to moderate, take notes, encourage questions and dialogues, follows up with surveys to gather feedback and offer business cards for further follow-up on the use of feedback.
- The project manager should clarify details of who votes, what qualifies them, who decides what, who holds the team accountable, listen to the public desire to let certain stakeholders make decisions in areas that are contentious and sensitive, use representative governance with multiple stakeholders to decide clear items together in joint stewardship, and educate the public to make own decisions.
- The technology team should use less pre-determined proposals, allow the public to co-create and users to challenge designers' decisions
- Relevant goals:



## Missing Voices and Surveillance Oversight

- The outreach coordinator should demystify technologies for seniors and help them adapt, ensure that events are accessible and co-design with disabled communities, help immigrants and non-native speakers through translating lesson plans, public noticing and other information, include low-income area residents and organizations to hear input on services and models needed for them, work with populations experiencing homelessness, mental health issues, the formerly incarcerated, include residents living outside central locations and hold events in different parts of cities, consult with indigenous community on historic preservation and environmental planning



- The technology team and the project manager should ensure oversight on surveillance to protect vulnerable communities from misuse of technologies, utilize methods such as notification, registration, optionality and categorical ban of technologies and data and work with specific city agencies on oversight on surveillance and communities on oversight implementation.
- Relevant goals:



### Direct Benefits and Ripple Effects

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Align with City Initiatives	Bring Direct Benefits of Service Provisions	Buddle with a Range of Ecosystem Ripple Effects
Aware of Ripple Effects	Increase Capacity and Offer Alternatives	Improve Sustainability through Innovation
	Provide Resilient Services in Disasters	Achieve Universal Access through Innovation
	Organize Community of Practice for Sharing	Equalize Online Ed for Low Income Students
		Equalize Access to Public & Private Systems

- Relevant goals:



## Co-locating and Public Improvement

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Prepare Resolution to Set Condition	Beware of Risks and Liabilities of New Assets	Use Smart Mount for Smartification
Recognize the benefits of co-locating	Retrofit Existing Assets with Add-on Use	Use Smart Mount for Privacy Control
Pick Co-locating Approach	Beware of Spatially-Specific Functions	Require Services to the Underserved
	Pair Passive and Active Uses	Capture Fees to Fund Digital Inclusion
		Require Infrastructure Improvement

- Relevant goals:



## Standardized and Humanized Hybrid Design

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Confirm Validity of Regulation	Aim for Less Visual Intrusion to Surrounding	Collaborate to Work towards Design Standard
	Reduce Workload through Predicable Standard	Apply Standards Universally Across Strata
	Innovate with Co-locate and Flexible Design	Equalize with Standards for Mass Adoption
	Use More Media Art and Less Ads	Use Visual Icons to Help Adjust & Make Sense
	Empathize with Human Lived Experiences	Humanize Experience Being in Tech Space
	Listen to Health Concerns of New Tech	Use Green Environmental-Friendly Design
		Minimize Noise and Vibration for Comfort

- Relevant goals:

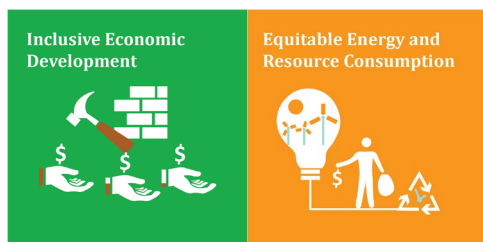


## Infra.preneurs and Gigaproject

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Understand Hybrid Infra.preneurs	Join Tech & Infrastructure Expertise	Structure Deal of Tech Equity & Asset Contract

Recognize Tech Risks	Heed Disruption to Traditional Assets	Navigate Municipalities' Complex Role
	Repurpose Technology for Other Development	Use P3 to Buffer Tech Risks & Share Profits

- Relevant goals:



## Bridge the Capacities

Capacities gaps need to be bridged to bring technologies to people and achieve impact.

### Jargon Free Language and Concrete Cases

- The outreach coordinator should address communication problem to bridge the gap between communities and technology, use appealing design language, avoid heavy branding, use renderings with details such as street life, incorporate language that addresses vulnerable populations and is engaging to connect with the community, use natural, dynamic tone and resonating message in presenting and avoid being overly scripted.
- The technology team should explain technical jargons and acronyms in accessible language, educate when introducing new concepts, use concrete cases to be relatable, clear, grounded in everyday life, and present statistics, visible plans, prototypes, examples and scenarios to demonstrate visions for the community.
- The project manager should use specific language that is actionable, context-sensitive, and detailed, instead of general, vague and ambiguous, use easier proxy terms to help people understand complex

non-technical concepts and terms, be culturally sensitive of different meanings of concepts in different societies and provide a glossary of terms and acronyms to explain in plain language and assume no previous knowledge.

- Relevant goals:



### **Digital Literacy and Community Agency**

- The technology team should address digital literacy and community agency, provide tech support staff to solve technical difficulties and assist the use of technology, select independent and local engineering firms to avoid conflict of interest and low stake in local environment and give individual user right and agency to control technology and make choices.
- The project manager could provide physical space with constant tech support staff and public classes, experiment with community ownership such as community broadband and energy cooperatives and make sure all genders are well represented in the deployment and tech-centric educational program.
- The outreach coordinator should enable community organizations to bargain with conditional support, tell stories of community identities and memories to build agency of current innovation and empower a locality and let local players, thinkers and young people claim ownership of project work.
- Relevant goals:



### Workforce and Education as Bridge

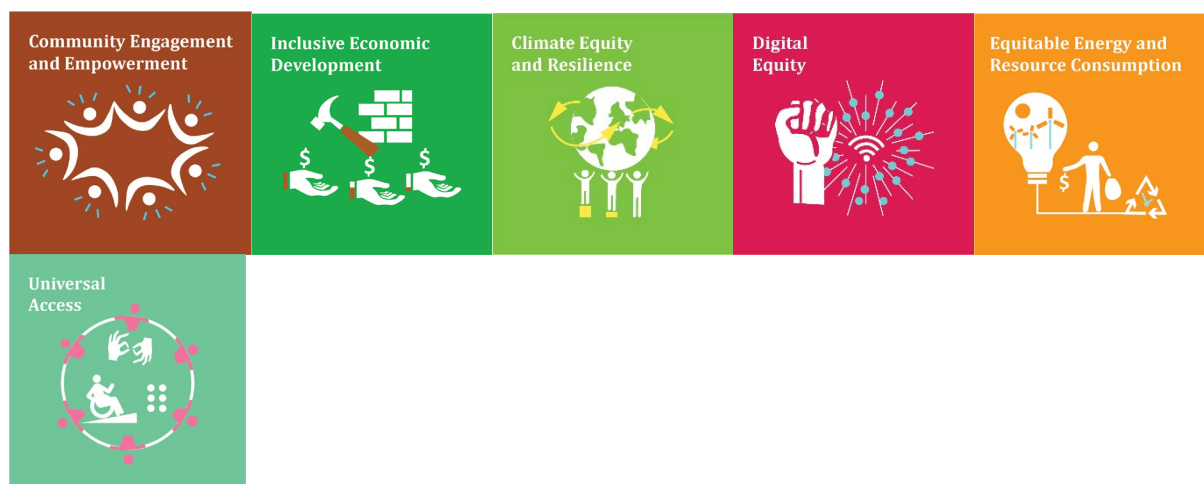
- The project manager should leverage the range of job creation arising from the deployment and develop workforce training programs, use Community Benefit Agreement (CBA) to secure local and inclusive hiring, utilize programs such as training, apprenticeship, fellowship, mentorship and digital skill building.
- The technology team should partner with education community to be responsive and relevant to real needs, and scale up education outreach by building accessible toolkits and instructions.
- The outreach coordinator should tap inherent educational values of emerging technologies for local students to gain exposure, include low income students in public schools, keep the lesson plans and program website open and accessible, and leverage the real-life relevance of deployment to enrich learning and inspire career aspirations
- Relevant goals:



## Urban Piloting and Testing

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Recognize Opportunities of Urban Piloting	Use Technology to Help Regulate	Pilot in Diverse Low-income Communities
Prepare Back-up to be Resilient	Partner with Municipality for Support	Sign Agreement to Mitigate Approval Risks
	Adopt Rules for Innovation Zone	Create Sustainable Business Model
	Measure Demo to Prove Concepts	Balance Phasing with Scale and Connectivity
	Underwrite Tech Proven at Small Scale	Account for Affordability in Meeting Demand
	Plan Implementation and Transition	Leverage Partner Assets and Standards
	Rethink Usability Testing for Communities	Change Digital Redlining of New Tech

- Relevant goals:



## Future Phases and Life Cycle of Technology

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Be Aware of Urban & Tech Time Gap	Calculate Life-cycle Tech Costs	Plan for Long-term Feasibility
	Tie Payment to Social Responsibility	Ensure Environmentally Sustainable Upgrades

	Combine Multiple Revenue Streams	Ensure Affordable & Equitable Upgrades
		Gather Feedback & Attract Buy-in

- Relevant goals:



### Scaling Up Impact and Replicability

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Aim to be a Model for the Region	Encourage Early Adopters to Share Findings	Organize Study Trips & Tell Stories
	Map out Replicable Process & Model	Advance Aspirational Policy Reforms
	Build Open & Flexible Tech Framework	

- Relevant goals:



### Limits of Scope and Network-Hub Integration

<i>Preparation:</i>	<i>Short-term:</i>	<i>Long-term:</i>
Recognize Limits of Scope	Connect Nodes for Resilient Mesh Network	Structure Longer Investment Return Time
Recognize Financial Bottom Line	Situate as Catalyst for Later Initiatives	Use Net Positive Distributed Energy System



Be Cautious of Overload Assets	Test Different Locations to Respond	Form Network from Standalone Tech
	Integrate Curb Assets Payment as Package	Facilitate Movement between Subcenters
	Plan Hubs for Shared & Micro Modes	Issue Tech enabled Curb Bond for Finance
	Collaborate on Mobility Hubs Planning	Place Hubs to Expand Transit Catchment Area
	Organize Hubs as Last-Mile Access Points	Build Warehouses & Lockers in Mobility Hubs
		Build Small Health Center in Mobility Hubs

- Relevant goals:



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# COMMUNITY EQUITY GOALS

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