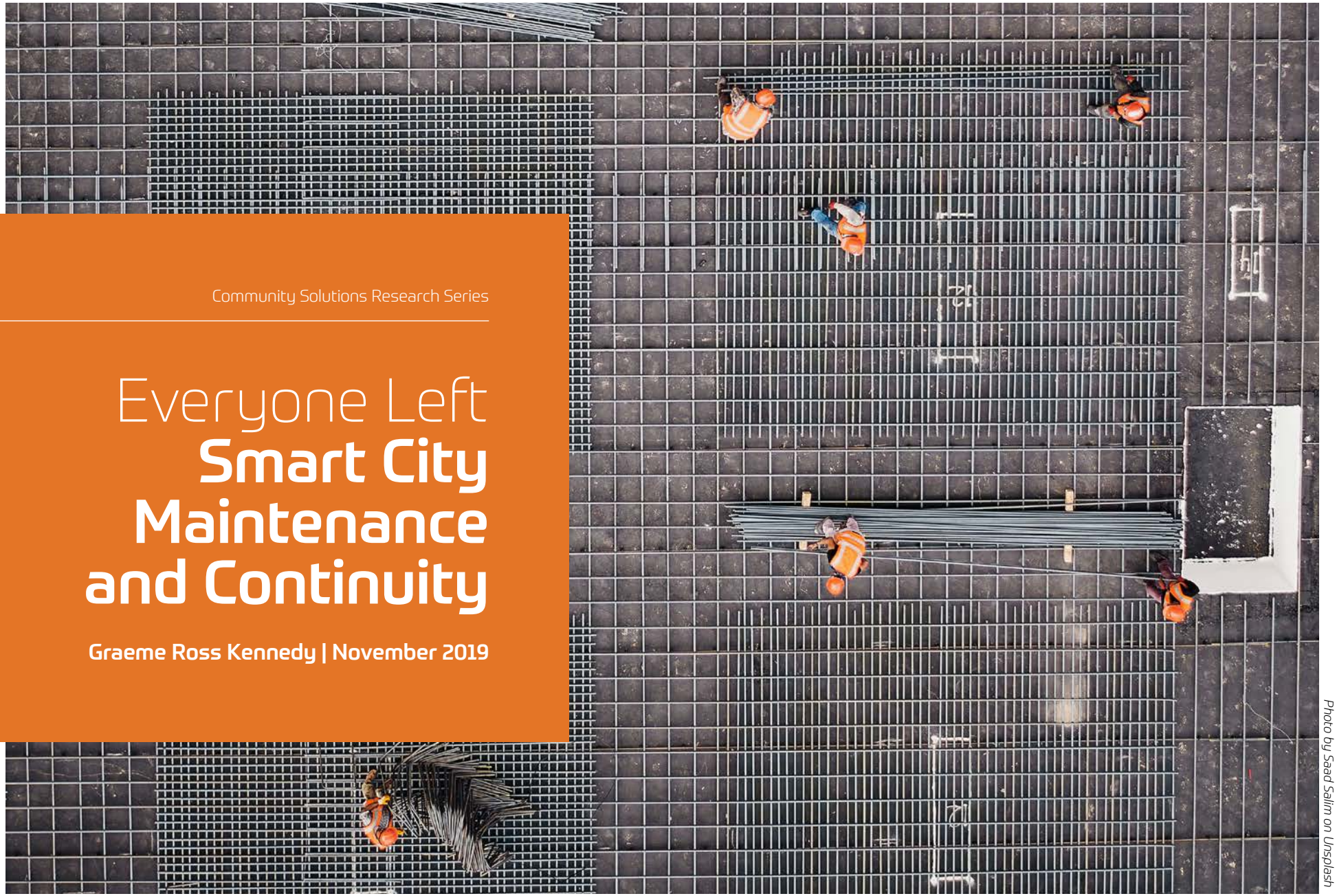
Community Solutions Research Series

# Everyone Left **Smart City Maintenance and Continuity**

**Graeme Ross Kennedy | November 2019**



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# Introduction

***These papers frame early insight into smart city thinking by Canadian municipal governments and their community members. If future rounds of the SCC are issued, these lessons learned from Round One should help future applicants build more successful submissions.***

In the last two years there has been a flurry of activity when it comes to smart city technology and its potential role in Canadian communities. From the project on Toronto's waterfront to the Government of Canada's Smart City Challenge (SCC), since 2017 this conversation has gained momentum and audience.

The Smart City Challenge is different from other vendor-driven smart city projects. In Round One of the SCC, the Government of Canada required municipal and Indigenous applicants, from the outset, to work with their community members. The intention here was to make sure that the technological aspirations pitched in the proposals were aligned with local goals and objectives, and not just funding for what technology vendors wanted to sell. Applicants were also required, at the time of submission, to share their applications on their local websites so that community members could review what was proposed. This decision to make the applications open facilitated research on the SCC, its applicants, and their approaches, and it provides an easy way for communities to learn from each other.

The Community Solutions Research Series includes four papers from a community-university research partnership between Evergreen and my research group in the School of Urban and Regional Planning at Ryerson University in Toronto. This research was funded by the Social Sciences and Humanities Research Council of Canada. These papers explore four different, yet complementary dimensions of the SCC. Drawing from a comprehensive review of the Round One submissions, the public participation (Toth), maintenance (Kennedy), circular economy (Simovic) and public health (Ramsaroop) dimensions of the SCC proposals are explored.

In innovation challenges much attention is paid to the winners. These papers are informed by a larger vantage point that comprises the range of projects proposed in Round One. By having this focus, these papers frame early insight into smart city thinking by Canadian municipal governments and their community members. If future rounds of the SCC are issued, these lessons learned from Round One should help future applicants build more successful submissions.

Pamela Robinson,
*Director, School of Urban and Regional Planning, at Ryerson University*

# Smart City Maintenance - **What's the Big Idea?**

**in·no·va·tor**
[/ 'inə, 'vādər/] *noun*
Groups of people that emerge in every generation whose use of emerging technologies changes the underlying economies, operations, and regulations of large parts of society.

When smart city projects lift communities out of their existing state, they do so by telling the stories of their future. The common narrative around smart city initiatives is that they are projects led by innovators to address pressing social challenges and efficiently make use of resources to create a better life for all. Innovators are groups of people that emerge in every generation whose use of emerging technologies changes the underlying economies, operations, and regulations of large parts of society. Innovation occurs in all sectors of society; however, the technological innovations that lead to transformative smart city infrastructure projects tend to be sourced from the private sector. Such a transformation requires a process of conversion which involves unwinding old systems and deploying new ones, which may still be experimental. Smart city projects are initially successful when innovators are dedicating their attention to specific sites, but what happens when innovators move on? A lack of attention can lead to things falling apart and experimental systems failing faster than expected.

Technological solutions must be capable of plugging into existing systems of practice while mitigating the volatility normally associated with systems change. When cities engage in a process of transformation, they are procuring new infrastructure that needs to last anywhere from 25 to 100-plus years. This means the technology procured will need to outlast both the attention span and possibly the life of its creator. Either the vendor will need to have a maintenance plan in place, or it will fall upon the cities to maintain their new infrastructure. The process of ensuring that a technology will be sustainable in perpetuity begins at the project inception and carries on long after the innovators have moved on.

***Smart city projects are initially successful when innovators are dedicating their attention to specific sites, but what happens when innovators move on?***

# The Case for Why: **Opportunity and Risk**

New technologies and infrastructure can be transformative but can also be quite brittle. Communities are most vulnerable when they are in the process of changing over to new forms of infrastructure. Any disruption during development or volatility afterwards, such as unexpected errors or incompatibilities, can have long-lasting impacts on a community. Within the confines of a visioning and procurement process, like the Smart Cities Challenge, local governments have more control over what technologies are used and how they are deployed in the community. Smart city proposals are no different from visioning exercises already embedded in the processes of municipal and Indigenous governments like the development of Official Plans, transit network plans, or strategic plans for economic development. Such exercises create an opportunity for local decision-makers to take a leadership role in ensuring the right processes are in place to guarantee long-term systems sustainability from a project's outset. To that end, the complex nature of these projects creates opportunities for different community members to take responsibility and excel in maintaining different components of the system locally. The following five lenses each outline technological risks and opportunities for building sustainable practices into smart city plans.

**Five lenses:**

01 Innovation Policy and Community Participation

02 Volatility and Response Development

03 Sovereignty and Public Governance

04 Technical Maintenance and Labour

05 Cultural Continuity and Techno-Determinism

## 01

## Innovation Policy and Community Participation

Top-down government policy initiatives could shift smart city policy-making towards visionary planning processes that can sustainably increase the pace of change in cities and avoid unexpected disruption. However, not all local governments have the capacity, knowledge-sharing, and technological understanding to compile a smart city vision on their own. Grassroots initiatives allow for community stakeholders to become unexpected champions that can help to mitigate volatility and fill in public sector resourcing gaps. Through statutory consultation processes government can hold space for grassroots movements to emerge that can help to broaden commentary, represent a diversity of perspectives, and imagine how new technologies can benefit different communities.

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### A Tale of Two Kansas Cities

The Kansas City, Kansas (KCK) top-down and Kansas City, Missouri (KCMO) grassroots responses to Google Fiber's Request for Information[1] were both successful but through very different advocacy approaches. KCK's proposal was put together by the mayor and a small group of advisors while KCMO's proposal was drafted by 120 collaborators from the city's startup and business incubation community. Post-proposal, both cities teamed up to guide the community through a visioning process for their future. Aaron Deacon, a local researcher and technology advocate, followed the innovation process through to deployment, concluding that the messiness required to prepare for new innovation fell within neither the domains of top-down nor bottom-up advocacy.[2] Deacon found that both forms of advocacy were required for success. Discovery of unexpected leaders, breaking down bureaucratic processes, and the formalization of informal processes from business networks aided in Fiber becoming a catalyst for economic development in both cities. Co-creation processes led to a successful deployment so powerful that other cities visited to learn more about how to attract Fiber to their own city.

***Discovery of unexpected leaders, breaking down bureaucratic processes, and the formalization of informal processes from business networks aided in Fiber becoming a catalyst for economic development in both cities.***

### Normalizing Innovation

Smart city development is not a "one time only" event. Recurring conversations around innovation can help to normalize its inclusion in traditional planning processes. Co-creation models like the one used in KCK/KCMO can help to temporarily fill in public sector knowledge and capacity gaps, ask important questions, and assign responsibility for the answers. Sustainability and maintenance must be embedded in the traditional visioning processes of municipal and Indigenous governments. Future uncertainty has always been accounted for in our current plans. Visioning documents such as Official Plans lay the groundwork for ongoing systems stability and assign different responsibilities to the public sector, private sector, and communities to fulfill this vision. Normalizing innovation as part of ongoing planning exercises leverages traditional tools to detail the choreography required to turn disruption into graceful civic transformation.

***Visioning documents such as Official Plans lay the groundwork for ongoing systems stability and assign different responsibilities to the public sector, private sector, and communities to fulfill this vision. Normalizing innovation as part of ongoing planning exercises leverages traditional tools to detail the choreography required to turn disruption into graceful civic transformation.***

## 02

## Volatility and Response Development

The potential for volatility when integrating new technologies into existing infrastructure, or completely replacing old methods of practice with new technologies, requires developing responses to both the acute shocks and chronic stresses of long-term systems operations. Gendron and Rudner, who compiled an infrastructure report for the Canadian Security Intelligence Service, cite "pace of change" (p. 37) as the top risk towards maintaining the integrity of critical infrastructure and service delivery.[3] The rapidly changing nature of systems within interdependent networks, reliance upon owner-operator maintenance, and lack of resilience mechanisms leaves our cities susceptible to common-cause, cascading, and escalating failures (Appendix 1). Vulnerabilities in smart city systems are as much due to internal errors as external faults. Small changes can have spillover impacts on a local government as systems become more integrated and co-dependent. It is important that all smart city plans include an analysis of the three kinds of failures and redundancy measures.

### Common Cause and Cascading - Nest

On June 2, 2019, a Google Cloud outage triggered a cascading, common cause impact across multiple first-party and third-party Google-integrated services. While YouTube and Gmail were inaccessible, so too were thousands of Nest thermostat users finding themselves unable to adjust their thermostats, turn on their air conditioners, access Nest security cameras, or unlock doors equipped with Nest-compatible smart locks.[4] A lack of localized redundancy measures, such as failover to a local network/offline mode or a manual override, degrades trust in the vendor, requires unsustainable server uptime, and could harm users who depend on the proper functioning of the technology.

### Escalating - Louisville

Google Fiber was scaled to Louisville, Kentucky, and the City of Louisville accommodated experimentation with a new "shallow trench" deployment method. Louisville residents advocated for government approval. This required the municipality taking the existing internet service provider to court to secure permission for the install, a process which cost the municipality hundreds of thousands of dollars. On February 7, 2019, an acute shock hit the city: Google would be unwinding their experiment.[5] This shutdown would turn off Fiber internet access within two months, abandon miles of fibre-optic hardline, and leave the roads in a state of disrepair. Such a failure had escalating impacts as it forced residents back to their existing system and hindered local economic development initiatives. The same benefits that such an initiative had given to KCK/KCMO were forfeited by Louisville despite their best efforts.

**Scenario Planning and Scaling Best Practice**

The high-profile pilots for Google Fiber in KCK/KCMO are contrasted against the disastrous results of scaling to Louisville, KY. Closer to home, the pilot of Metrolinx's Presto system did not face the same difficulties in Ottawa as its implementation in Toronto.[6] In both cases, a change to a crucial part of the technology compromised its ability to integrate with the new locale. Attention needs to be paid to ensuring that the same level of quality baked into a successful, high-profile pilot is extended to other participating communities. Capacity unlocked through scaling an already successful pilot must be dedicated to scenario planning exercises for the three types of system failures. Successfully scaling a technology lowers overhead costs and should act to create a more resilient system.

***Small changes can have spillover impacts on a local government as systems become more integrated and co-dependent.***

# 03

## Sovereignty and Public Governance

Smart city projects sell cities on a vision. When delivery of such a vision seems slow or is delayed by governance processes, private sector or community actors can pressure government to bend regulations, expedite the public-private partnership (P3) decision-making process, or cede control over the functions of government to private actors to turn said vision into a reality. Mitigating disruption from a foreign actor inserting themselves into local systems, as in the case of blockchain, Airbnb or Uber/Lyft, is difficult. However, procurement is where the public sector can require technology companies to play by their rules.

It is not now, nor has it ever been, a requirement of government to be experts on a technology. A lack of domain-specific expertise should not mean that sovereign control is ceded to the technology vendor. What the public sector does excel at is applying rigorous accountability mechanisms to vendors and themselves. Existing public-private partnership processes account for a lack of expertise by requiring rigorous answers regarding partnership and systems governance to be answered at each stage of the process. Where the public sector can assert itself, and advance the public interest, is in how P3 agreements are negotiated, developed, and executed. Harry Kitchen's guidance on public-private partnerships for municipal finance in Canada lists fundamental questions, relevant to smart city development, that should be answered prior to engaging a development partner (Appendix 2.1).[7] Similarly, Deloitte's research, informed by Waterfront Toronto's Queens Quay P3 process and other international case studies, outlines a specific order of operations for a smart city P3 (Appendix 2.2) which lists "understanding the business model" as needing to occur four steps prior to forming any kind of governance agreement or partnership.[8] Well-established partnership and governance requirements ensure that new technologies being procured do not interfere with local responsibilities. Following such processes improves accountability, creates greater transparency, and can act to make space for public sector professionals to work with technology vendors to ensure a successful implementation that decision-makers are able to support.

*Photo by Andrew Gook on Unsplash*

## Who Owns the Sidewalk?

In October 2017, Waterfront Toronto announced its partnership with Sidewalk Labs to build a "first of its kind" smart city neighbourhood on a 12-acre property known as Quayside along Toronto's Eastern Waterfront area.[9] Dubbed "Sidewalk Toronto," the venture represents a P3 agreement where the public sector did not follow P3 best practices. Section VII of Waterfront Toronto's *RFP 2017-13*[10] did not require answers to key questions (Appendix 2.1) prior to choosing Sidewalk Labs as their partner, an oversight which led to:

- a limited number of companies capable of bidding on the project;
- the vendor defining their own performance standards;
- the vendor making themselves appear to be irreplaceable;
- A critical report from Ontario's auditor general[11] and;
- the Canadian Civil Liberties Association launching a court challenge stating that the project is unconstitutional[12]

However, the project definition is only one part of the P3 process and does not necessarily make the project a failure. However, the process that was undertaken, compared against the order of operations (Appendix 2.2), would appear to show that Waterfront Toronto skipped from steps one and two to steps six and seven. With Sidewalk Labs as the Innovation and Funding Partner for the project, the process jumped back to steps four and five, and is only now beginning to answer important questions regarding proposed outcomes and the business model of the project. In attempting to offload much of the idea generation and risk required by a smart city project to the private sector, Waterfront Toronto abandoned best practices, effectively ceding control of both the project's narrative and governance of the development process to their innovation and funding partner. That a vendor would capitalize on opportunities to assume control of a project and proceed in an order of their choosing should come as no surprise. Sidewalk Labs previously stated that it "would be seeking autonomy from many city regulations,"[13] and the new Master Innovation and Development Plan outlines new authorities, not controlled by the municipality, that would govern the Quayside site.[14] Ensuring that best practices for public-private partnerships are followed serves the dual purpose of developing public sector capacity and maintaining public control of a project despite involving a private sector partner.

### P3 Questions and Regulations

"Moving fast and breaking things" has quickly become the ethos of the innovation community. Government has no such privilege and as such caution is the currency of the public sector. It is important for government not to be too easily persuaded by the promises and speed of new technology. There is little justifiable reason to abandon best practices in procurement and public-private partnership governance. Of the P3 best practices cited (Appendix 2), objective performance measures, the presence of competition, and the ability to replace the vendor are key to ensuring that government does not cede de facto control of public sector infrastructure to their technology partner. Regardless of how complex a project is, if a proposal fails to satisfy the outlined questions or follow the order of operations, it should not be pursued. The public sector should be steadfast in the face of public pressure and trust in the wisdom of their own best practices.

***Well-established partnership and governance requirements ensure that new technologies being procured do not interfere with local responsibilities.***

04

## Technical Maintenance and Labour

Different parts or levels of systems will fail over time. Overlapping maintenance protocols need to be in place to address different types of issues until the infrastructure is replaced. Inclusion of maintenance in smart city plans ensures the long-term sustainability of the technology itself through legible maintenance requirements, maintainable systems, and local labour capacity to perform maintenance.

### Wear and Tear

Dust, Rust, Cracks, and (Code) Corruption (Appendix 2) are four identifiable types of infrastructure maintenance requirements[15] that are easy to count off on your fingers. Mattern's working guide outlines how innovators and maintainers must act to ward off the natural and expected impacts of wear and tear. These create a maintenance plan inclusive of the layers of care required for proper upkeep.

### Voluntary Consensus and Standards

Many new smart city technologies are only available from companies selling proprietary solutions, making it hard for standards consensus to be achieved. Smart city projects must ensure that everything from physical sensors and electrical connectors, to the programming languages used to control devices, to data formatting and governance models conforms with agreed-upon standards to ensure interoperability, ease of repair, and access by trusted parties, not just the original vendor. The shift away from open procurement processes—procurement that favours public processes and open bidding—towards sole-sourced, closed-specification models is a marked change in direction for government. An open procurement process will list "generic" specifications or require the use of industry standards, as opposed to proprietary solutions. Achieving consensus on standards is vital to sustaining technologies in perpetuity. "Mundane agreements" transform a new, disruptive world into one that is ordinary, settled, and stable.[16] The ubiquity of technology like SSL-encryption and USB devices shows that standards are something the technology community excels at when it serves corporate interests. Procurement processes should require that applicants conform to, or integrate with, standardized hardware and software specifications to ensure multiple parties can understand the system and perform repairs/upgrades in pursuit of stability.

### Availability of Maintenance Infrastructure and Labour

Vehicles show how maintenance changes with smarter technologies. The (autonomous) sensor-rich vehicle fleets of the future will require new supportive infrastructure and advanced labour practices to sustain them. Driving a Tesla in the winter is not an ideal scenario with a hostile environment, lack of regional charging infrastructure, and decreased battery performance.[17] The work of local repair technicians has also been inhibited due to a lack of regional repair facilities and limited local availability of proprietary parts.[18] However, this issue is not unique to Teslas as semi-autonomous assists in almost all new vehicles have lengthened repair practices.[19] Formerly half-hour fixes now take technicians hours or even weeks to recalibrate a smart vehicle in a specialized facility. This is a far cry from how vehicle maintenance began. Plans for smart city infrastructure systems must include investment in local repair facilities and training for local technicians to expedite repair timelines.

### Prepare for Innovators Moving On

The current expectation is that innovators perform maintenance work. When they do not, things break. Local governments can take over performing the hard work of maintaining new systems, equipping local community members and businesses to handle this work on their behalf, if wear-and-tear requirements, open standards, and investment in local repair capacity are included in visioning processes. Local decision-makers will never regret factoring these into smart city proposal requirements when procuring technologies on behalf of their communities. They will regret not having done this work and being left with a broken system. Part of the planning process requires meeting communities where they are and working with them to lay out where they need to get to in order to self-sustain their smart city infrastructure.

05

## Cultural Continuity and Techno-Determinism

Culture is the manifestation of the collective achievements of a specific group of people. Technology must serve the local community by safeguarding cultural continuity and local decision-making authority. An important component of this is making space for a community to write their own future. In contrast, the decisions vendors make when designing new technologies can shape an "ideal" form of culture or community that conforms with their system. This leaves communities out of the process of writing their future, a theory sometimes referred to as technological determinism. When considering smart city systems, one must recognize the unique qualities of local cultures, so disruption does not lead to a loss of cultural achievement.

*Photo by tribesh kayastha on Unsplash*

### Stories of Our Past Inform the Myths of Our Future

The top-20 pool of Infrastructure Canada's Smart Cities Challenge contained a proposal from the Biigtigong Nishnaabeg of Pic River First Nation. The Biigtigong Nishnaabeg[20] proposal seeks to use eLearning technologies to teach a STEM-focused school curriculum to their youngest generation, spread their adsookanaan (sacred stories), and promote increased participation in cultural events. Integrating open-source technologies into existing methods of cultural practice entrenches traditional practices of intergenerational knowledge transfer into new methods of learning. The goal is that the next generation of Nishnaabe will be equipped to keep up with the pace of change and "bridge between the modern technological world and [their] ancient traditional world,"[21] thus empowering the community to preserve their past while determining their own future.

***Integrating open-source technologies into existing methods of cultural practice entrenches traditional practices of intergenerational knowledge transfer into new methods of learning.***

### Continuity - Site-specific Solutions

Designing an inclusive smart city requires designing systems specifically, not for a generic "everyone." Hannah Kaner, a researcher with the UK-based interaction design studio Orange Bus, found that designs for "everyone" lean towards benefiting those who are "able-bodied, digitally literate, and financially stable," and fail to make deep improvements that address "citizen safety or engagement with the city."[22] Communicating a compelling site-specific smart city narrative becomes more difficult as the scale of the community increases and higher-complexity technical solutions are proposed to address broader socio-environmental issues. That does not mean there is less of a story to tell, simply more stories. Government needs to grab knotty bundles of data, governance models, policy, social issues, and personal anecdotes in order to tease out stories that, braided together, form a unifying narrative to direct development to where services are most failing residents.

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# Peace of Mind **on the Long Road Ahead**

**par·a·digm shift**
[/'perə'dīm SHift/] *noun*
Transformative change.

Communities are impacted by the very real consequences of ignoring maintenance requirements—consequences such as packed subways, crumbling freeways, and brittle electrical grids with escalating upkeep costs. How cities adapt to innovators moving on is a real and present concern for local governments. Barriers to addressing sustainability requirements and making these conversations a priority are found in the public sector, the private sector, and within communities themselves.

The five lenses each explore a different topic of focus for the relationship local decision-makers establish with a proposed smart city intervention. Within each lens there are steps that can be taken now, and in the future, to ensure that past mistakes do not repeat themselves in smarter and more advanced waves of development. The legibility of a solution, the readiness of a community, government's ability to support the system, and the maintenance required to sustain it, all support the ability of local leadership to be empowered by such an upgrade. If handled correctly, the transformative promise of the smart city carries the potential to empower a paradigm shift in city building. The most evident barrier to accomplishing this is public sector capacity. Implementing and maintaining smart city projects is not a process local governments need to go through alone. Within communities there are members of all stripes capable of providing support throughout the smart city transformation process who are capable of assuming partial responsibility for systems upkeep after the innovators have moved on. However, involving community members in this process requires holding space for them to join government and innovation actors already participating in visioning and planning conversations. Sustaining innovative technologies in cities can only be strengthened by ensuring that the future vision communities are buying into is one of their own making.

***How cities adapt to innovators moving on is a real and present concern for local governments.***

# Appendices

Appendix
# 01

## Gendron and Rudner's Disruption Scenario Model

Common-cause —various systems that have common dependencies/resources (electrical grid) are likely to be disrupted by a single incident.

Cascading —Disruption of a control system in one infrastructure leads to the disruption of a second infrastructure and then a third and so on, even if there is no direct dependence.

Escalating —Disruption of one infrastructure (a communications network) hampers the effort to fix other infrastructures that have been damaged by other entities.

Appendix
# 02

## Public Private Partnership Questions & Operations

**2.1 Harry Kitchen's P3 Questions to Ask Specific P3 questions from Harry Kitchen (2002) that stand out are:**

1. To what extent is it possible to describe objective standards and performance measures for the service?
2. Is competition present in this field?
3. To what extent will the government be able to monitor the contractor's performance?
4. Is private sector involvement in the service legal?
5. Would it be possible to replace the private provider if the firm goes out of business, if performance is below standard, or if the provider chooses to end support of the project?

**2.2 Dovey Fishman and Flynn's Smart City P3 Order of Operations**

1. Define desired outcome at outset of project, clarity around ultimate objective
2. Inventory available assets
3. Understand the business model
4. Appoint a champion with decision-making authority
5. Build local support
6. Develop a business case that lays out value to potential partners
7. Create a third-party entity

Appendix
# 03

## Mattern's Working Guide to Maintenance

Dust — the interiors of systems that maintainers constantly maintain. Systems need to be designed to teach and support such labour. This is where Cracks and Rust are noticed.

Rust — addresses the politics of large physical infrastructure systems. Maintenance requires the availability of labour, political will, and the allocation of capital required for proper upkeep.

Cracks — asks how discrete objects are to be repaired or modified. Can objects be fixed or maintained by their owners? Is specialty labour required? Does the design prohibit human intrusion?

Corruption — recognizes the critical role of software in smart city systems. Fragile software, with its multitude of dependencies, must be maintained to the same extent as the physical assets it runs.

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