

CONNECTED CITIES: DRIVING DIGITAL TRANSFORMATION IN COMPLEX ECOSYSTEMS

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Digital technologies are fuelling the evolution of connected cities of the future. Our research in Copenhagen with organisations that are leading the digital transformation agenda, reveals that there are four critical and self-propelling factors that are essential to meeting the future demands of cities and its citizens.

By 2050, 68 percent of the world's population will be living in cities.¹ This will no doubt put pressure on public services, resources, and timelines. Across the world, public-private partnerships are being hailed as the answer to this increasing challenge. We believe that these partnerships need to embrace digital technologies and move beyond the current structures, processes and ways of working. It is important for businesses, entrepreneurs, policy makers, and others to better understand the complexities that exist within the wider city ecosystems, not only to be in a position to contribute positively, but also to identify and make the best use of the emergent opportunities.

In this context, we undertook research in Copenhagen, Denmark to explore how the city is spearheading an innovative approach to meeting current and future needs and working with multiple partners to provide cutting-edge digital solutions. As part of a wider research project, we spent time with digital transformation leads at Copenhagen Solutions Lab (CSL). CSL is Copenhagen's innovative incu-

bator for driving smart city initiatives and serves a dual purpose of propelling the city's digital competencies through living labs and governance platforms, and serving to meet KPIs of the City of Copenhagen.

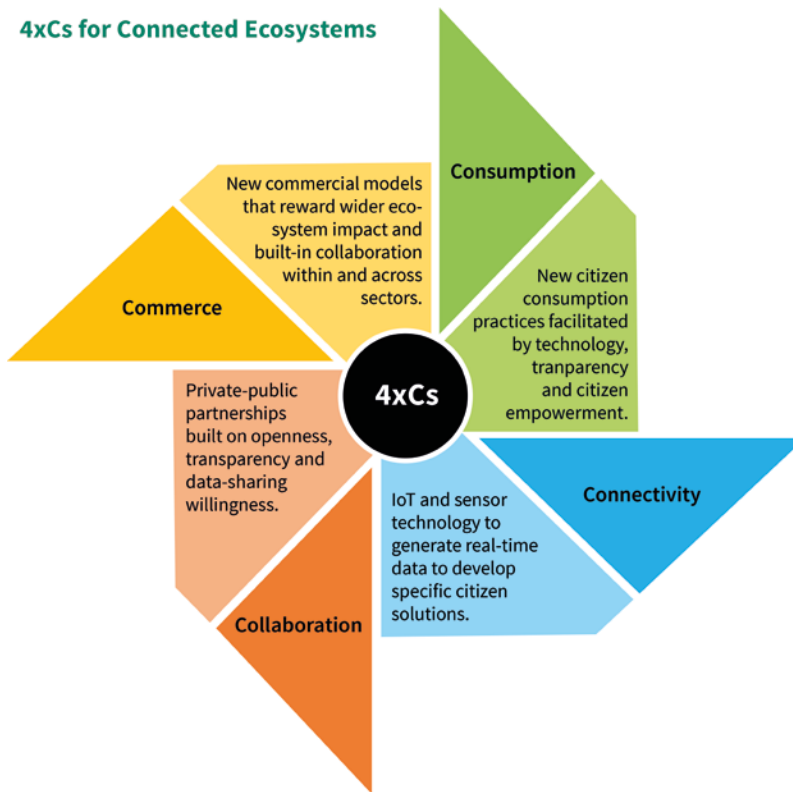
We also met with representatives from TDC Group (major telecoms and Internet of Things provider), LeapCraft (provider of clean air solutions and analytics), the City of Copenhagen (traffic solutions and city strategy), and Cisco (network solutions). Based on our findings, we present a digital transformation framework of 4xCs that can be useful for cities and organisations across the world.

We see the 4xCs as a self-propelling framework as partners across the ecosystem contribute with knowledge, share expertise and innovate by challenging the status quo.

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| Consumption | Cities are required to respond to changing citizen consumption trends, emerging needs and new demands. |
| Connectivity | Citizens, businesses, and public services are intimately connected through mobile and other IoT devices. Many systems and solutions are reliant on this hyperconnectivity, data and user adoption. |
| Collaboration | Organisations have to learn how to collaborate with multiple partners with different interests and priorities, while co-creating solutions that meet new demands. |
| Commerce | Cities are compelled to reformat and rethink commercial processes, systems, and policies to facilitate multiple partners to work together, drive innovation, and implement new solutions. |



4xCs for Connected Ecosystems



Consumption

Consumption reflects the dynamic change of citizen practices as they interact with city services. In order to drive sustainable and conscientious consumption, technology will be expected to assist in the provision of citizen services, such as water, energy, healthcare and transport, that is transparent and consumer-driven to meet the needs of communities and individual citizens. Many citizens no longer wish to be passive consumers directed by the city, but seek to be empowered² and active participants in the exchange of services between the city, suppliers and communities.

With the rise of Internet of Things (IoT), transparent platforms, and empowered consumption, public sector provision will require a

clear-glass-box mode of working. No longer will it be possible for essential service providers, such as gas, water and electricity suppliers, to make extraordinary profits³ by using continuously rising fee structures. Opposition to retaining citizens on a higher, standard tariff will be rife, as consumption-led tariffs will force a change in their business models.

Suppliers, service providers and other businesses will be required to adopt more agile, consumer-responsive business models that can not only respond, but also negotiate terms according to individual consumption, personal circumstances and, in the case of energy, the contribution citizens make to the smart grid through own solar panels and other renewable energy sources. This will be a new economic model that disrupts established organisational norms, habits and practices.

In Copenhagen, EnergyBlock, a collaborative initiative between CSL, the Technical University of Denmark, BLOC (Blockchain Labs for Open Collaboration), The District refurbishment initiative of Fuglekvarteret, Picodat and EnergyDemocracy, and funded by Climate KIC, experiments with the production of renewable energy within an existing urban environment and connecting this supply through an open Blockchain. The Blockchain can provide a decentralised energy supply, offering more transparency of costs to citizens. The challenge lies in the time it will take to build awareness and instil knowledge and trust with citizens, ecosystem partners and providers, as this new democratised consumption practice gains traction.

Similarly, as changes in consumption of other urban services, such as roads, local parks, leisure and healthcare, begin to adopt demand-led models, these providers will need to attain critical understanding of local and regional needs. Consumption data, along with investment and resource deployment information, will increasingly be open and shared with



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wider groups of participants and citizens.⁴ Citizens will therefore be in a position to actively contribute to policy formation, governance and innovation. As such, consumption will be driven, not just by availability and access, but also through participation, ability to contribute and accountability.

Connectivity

Responsive, personalised, and adaptive technology has become ubiquitous and we see always-on connectivity as a central “boulder” of connected cities. The miniaturisation and wider application of sensor technology has created greater opportunities for wiring cities and connecting devices, objects, platforms, and people. Gartner (2018) predicts that 20 percent of all citizens⁵ in developed nations will use AI assistants to help them with an array of operational tasks.

With the invariable assistance of AI, identifying the best technology for the provision of demand-led parking, intelligent waste collection, emergency services, and the management of traffic and transport will be of priority for those who govern connected cities. With enhanced processing power, battery life and “athleticism” of smart phones, tables have turned for city governance. Always-on citizens expect the city to provide instantaneous responses⁶ to facilitate their on-demand lifestyles.⁷ This has a viral-like spill-over effect on the city and other public service providers, as they strive to create dynamic management systems that are able to predict citizen needs and plan accordingly.

In 2016, CSL launched Copenhagen Street Lab, a living lab in the heart of Copenhagen with TDC Group (telecom) Citelum (street lighting), Cisco (network solutions), LeapCraft (environmental and air quality solutions) and the Copenhagen Municipality. The Street Lab provides state-of-the-art digital

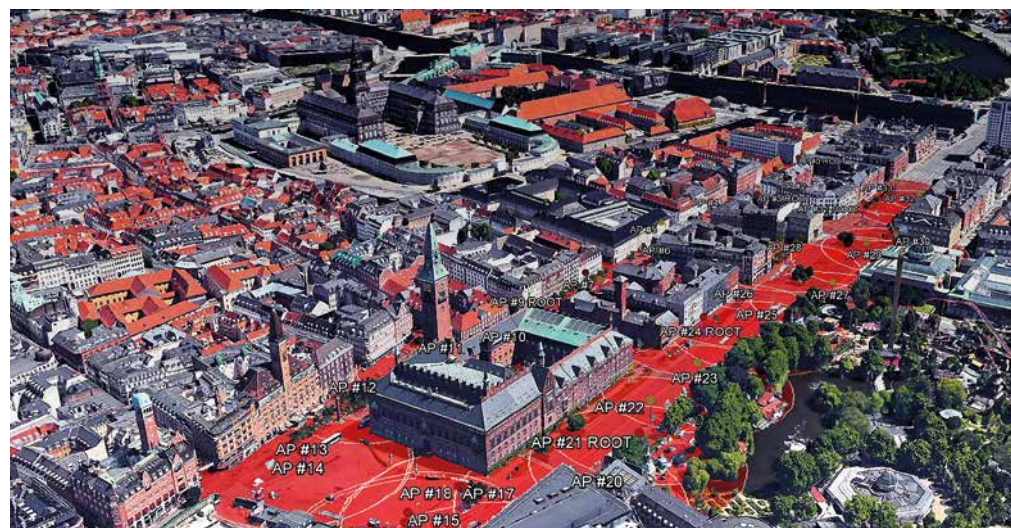
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infrastructure to the city’s busiest roads and surrounding area. The Lab tests solutions that can personalise citizens’ experiences, provide real-time data to facilitate responsive governance, and, most importantly, tests the viability of systems for implementation within existing city infrastructure. This is a live testing area that also provides proof-of-concept prior to scaling to other parts of the city.

One project that was kick-started in Street Lab was to find an innovative solution for citizens to access available parking spaces in the city in real-time. This required a multi-partner collaboration between CSL, the IT University, Copenhagen University, TDC Group and the Copenhagen City IT teams. After testing and subsequently rejecting a hardware-based

solution, a machine learning approach that uses predictive models based on multiple data sources was developed. The availability of parking spaces can now be predicted with 85 percent accuracy using an algorithm, which will increase as citizens use it. This API has been made freely available to providers of digital parking payment and navigation systems to integrate into existing or new applications.

When presenting technology solutions to city users, decision-makers must not only consider, but also test how varied segments of citizens can engage and what hurdles exist. While the more tech-savvy users embrace new technology-led solutions, others may find it frustrating and hard to adapt. This can ultimately result in overall inefficiencies that restrict new system integration. By understanding the citizen composition and their propensity to engage, it will enable decision-makers to plan towards scaled solutions that are connected and can be built on. In some cases, by understanding the intricacies of connectivity by citizen segment, behavioural clusters and technology usage, connected cities are able to leap frog technology waves.





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Collaboration

The third critical pillar of connected cities is collaboration. Truly open collaboration between private, public and other organisations will be the hallmark of successful connected cities.⁸ Through collaboration, resources, expertise and knowledge can be shared to develop dynamic solutions that benefit a wide range of stakeholders. Private and public organisations, such as CSL, TDC Group, LeapCraft and Citelum operate within a complex political and governance structure. The City of Copenhagen comprises of seven departments with centralised responsibilities. Each department is led by a mayor who represents a different political party. As such, propeller-organisations, such as CSL, find themselves positioned in the centre of a heptagon, where opposing political priorities compete. Our research finds that the central positioning of CSL is a more amiable ground as its steering committee includes executive members from three departments: Technical & Environment, Culture & Leisure and the Economics department, paving the way for CSL to play a crucial role in accelerating initiatives that digitally transform the city.

One of the key players in the digital transformation of the city is TDC Group. TDC Group has recently run a number of pilot projects to push (narrowband-IoT) connectivity across the country. NB-IoT provides low power wide area connectivity for devices in the city IoT network, such as water meters, central heating meters, air pollution sensors and garbage bins. TDC Group is working with a number of partners who are given access to the NB network and currently 70 companies are online. The first priority was to build a community of companies with an interest in testing their technology on the

network, which provided learning to the companies as well as to TDC Group. The TDC Group IoT team initiated meetups and provided sim cards and development kits to enable a range of companies to participate. These partners include smart meter suppliers, waste control agencies, healthcare companies, and many more. One project experiments with a connected healthcare wristwatch that uses sensors to collect and monitor patient activity and vital signs, which are shared automatically and in real-time with relevant healthcare professionals.

This collaborative network with an incumbent organisation, such as TDC Group, at the centre and a number of entrepreneurial companies in the collaborative web, is not an unusual setup for partnerships that drive future cities. The large and experienced organisations offer much expertise, resources and knowledge to help lay the infrastructure, while agile, responsive, and entrepreneurial companies are perfectly placed to inject new innovations, digital solutions and rethink established business models.

At the same time, collaboration is great in theory, but often difficult to execute successfully, especially at scale. Marius Sylvestersen, the smart city programme manager at CSL, emphasises that collaborations have to be built on transparency, the willingness to share data and be driven by the same set of values. CSL is introducing a collaborative culture amongst their partner organisations, where key service providers are required to share data, contribute to the entire project process, and drive innovation together. This collaborative culture enables the creation of robust and citizen-responsive solutions that adapt to demand and changing consumption behaviour. Partners are invited to become long term investors in the city.

Commerce

For the formation of successful connected cities, our research found that understanding consumption, heightening connectivity and facilitating open collaboration are of critical importance. However, when analysed, our data crystallised that the success of connected cities will also rely on organisations adopting a new-to-the-world commercial

mindset. This new model of commerce requires suppliers, service providers, partners and other wider ecosystem contributors to break free from the transactional format to embrace a model of collective equity. Connected city partners, such as Hitachi, TDC Group, Cisco and new entrepreneurial ventures, work in collaboration to gain rewards that extend beyond profits. With its dual-purpose role, CSL encourages partners to value expertise, knowledge, relationships and joint innovation as equally rewarding as profit for their organisations.

CSL vehemently oppose suppliers who wish to draw contracts to retain the exclusive ownership of citizen-generated data and IP. This is a break away from the commercial model we are used to and requires organisations and contributing partners to not only shift their mindset, but also to transform their organisational processes, costing and pricing, data and IP ownership and overall commercial model.

As an important link between solutions provided by the market and priorities set by government departments, CSL plays an active role in facilitating the rise of new innovative solutions to city challenges. This typically does not happen through traditional tendering processes, but through open calls that allow anyone to propose a possible solution. A current initiative focusses on the collection and analysis of flow data in the city to predict the impact an extended metro network will have on the movements and activities of its citizens. The selected supplier will be funded to undertake the pilot project as part of an innova-

tion partnership. The outcome for the supplier is expected to be a business case and possible scaling to the rest of the city. This innovation partnership is not based on long-term contractual agreements, but rather on the mutual opportunity that it provides to the selected supplier, CSL, the City of Copenhagen and other partners.

The open and collaborative environment between partners in the city also enables up-and-coming ventures to test and trial their technology, and develop use cases to further improve the technology and gain access to new markets. Entrepreneurial company, LeapCraft, provider of clean air solutions and analytics, has worked closely with the City of Copenhagen, Cisco and CSL, which has allowed the continued enhancement and expansion of the product portfolio. By being part of the smart city ecosystem of Copenhagen, the company has since gained access to foreign markets including Norway, US, Greece, Mexico, and latest, Finland.

New commercial models require a significant mindset shift for organisations and their leaders. This includes rewarding employees for their ability




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to collaborate internally and externally, adopting demand-led innovation, creating new long-term, value-based partnerships and for identifying opportunities where the organisation can make significant contributions to its wider ecosystem.

Conclusion

Connected cities around the world are storming ahead, taking on the challenges of meeting new citizen and organisational demands. We believe those responsible for delivering on the connected city agenda can benefit from the 4xCs approach. It can be used as a strategic tool for driving forward digital transformation in complex ecosystems by understanding new technology-driven consumption trends, empowering connectivity, driving impactful collaboration and instilling breakthrough models of commerce that value not only profit, but also the organisation's ability to innovate, be transparent and engage with citizens. 

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