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A resilient future for cities

How technology and co-creation can
propel a better future for cities.

Executive Summary

A resilient future for cities

Cities have developed with the support of communities and societies, continually evolving to respond to newer urban challenges. In their current stage of development, cities are becoming “smarter”.

By leveraging cutting-edge technology, cities can deliver a new possibility of connected infrastructure and layers of intelligence that will continuously learn, adapt, and respond to our individual needs and consequently provide citizen-centred experiences and services.

Cities need to evolve towards empowering co-creation where all stakeholders—citizens, private sector, academia, and government take part in creating the future of their city, alongside driving civic innovation. This strategy allows the city to accelerate the impact of citizen-centred approaches, in turn, improving all inhabitants’ quality of life.

Now, Covid-19 is driving a new wave of changes, and these recent behavioural changes have created new challenges. Nevertheless, it has unlocked new opportunities for innovation both in urban and rural areas and drive further integration between these areas.

This document concludes by looking at how a holistic approach is essential when driving sustainable developments, as well as how the future of a resilient city is to believe in an ecosystem where all stakeholders and the environment have a symbiotic relationship. Furthermore, as the world transitions to adopt the learnings from recent responses to emerging challenges at scale, we come to see more resilient and sustainable strategies to drive the growth of cities around the globe.

Table of contents

01 From A Citizen's Perspective

02 Evolution Of Cities

03 The Next Step

04 Technology is The Enabler

05 Cocreation a Future

06 Examples of smart services around the world

07 Future Vision for Smart City in Japan

08 Challenges Along The Way

09 Looking Into The Future

01

From a citizen's perspective



Changing the perspective when thinking about cities is essential if we want to understand new ways to support the people that reside there.

Humans are by nature social animals

Beyond survival

We are all 'by nature social animals' as Aristotle put it. The reason seems to be obvious, considering the fact that the world used to be much more severe place to live. Living in groups allowed us to protect each other and share food, water and knowledge. It gave a survival advantage to those who belong to groups, and eventually, they could achieve development and advancement of their civilization as a collective.

The ability to work and live in a community has created an evolutionary advantage for the human race, and became embedded as something at the core of humanity. Creating the need to belong to a community as a deep desire inside every human.

In Maslow's hierarchy of needs, the sense of belonging is considered to be one of the psychological needs, which arises naturally after we get fulfilled with the physical needs such as water, food and security. We need to have regular contact with others who we feel connected with to avoid the feeling of isolation.

Consequently, there is no surprise that with the evolution of humans, there would be the creation of tools, structures and systems to enhance the benefits of living in a community.

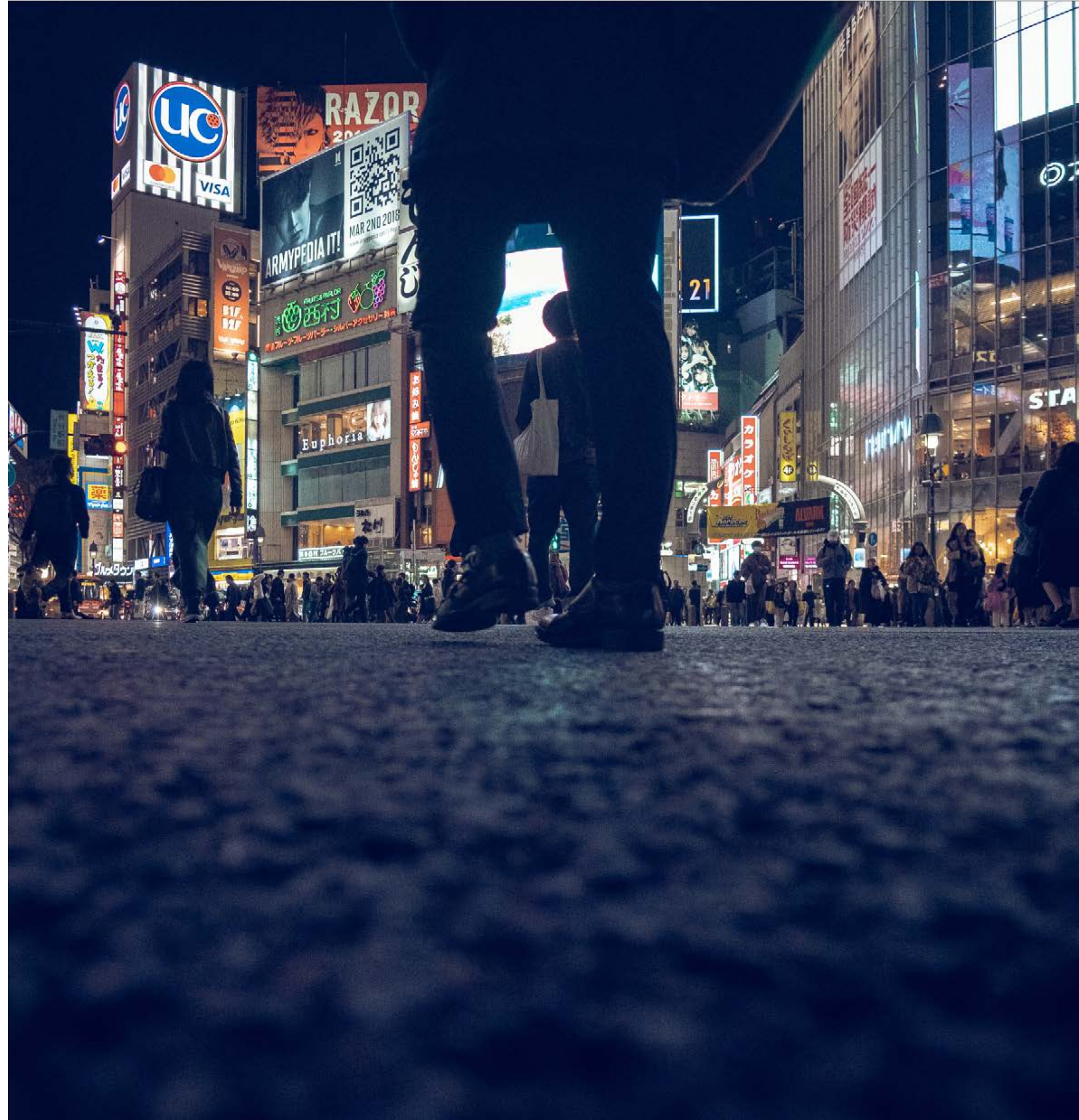


The city, a structure to support and serve its community

Cities are a consequence of human evolution, a structure created over thousands of years to support human & societal needs and propel further development of technology, culture and intellect.

The complexity of cities has increased throughout history and the need to establish ways of working, regulations, and infrastructure has changed the perspective of who is at the centre of the relationship between the citizen and the city. Modern society has implemented city management roles to efficiently run the city and left behind the real citizens' point of view.

There is a need to go back to the original role of the city in order to create a future that works in a symbiotic way for all city stakeholders, the collective community, and especially the people.





The challenges we are facing today reveal a growing demand for rebuilding our cities with a **citizen-centric approach**



02

Evolution of Cities

Cities have developed over the thousands years to support growth of communities and societies. Dealing with an increasingly challenging environment, cities continue to evolve and respond to newer modern demands.

Evolution of Cities - from hunting society, to post information society



How cities were born and evolved overtime

About 5,000 years ago, our ancestors finally got released from the burden of the hunter-gatherer nomadic lifestyle by developing agriculture and irrigation techniques. This steady food supply allowed them to settle in a specific place, one that eventually became a city over time. The development of cities accelerated, especially with the advent of industrialization and modernization, enabling them to fulfill human needs more efficiently and broadly.

However, demographics in the 21st century look different to how they did in the past. Because of the urbanization and the expansion of the global population, we have many more people living in cities today than what our current infrastructure can comfortably accommodate. Alongside this, an aging global society exacerbates the need for reformation of infrastructure.

In 2016, the Japanese government announced the plan for the post-information society, also known as Society 5.0. Society has evolved over time from hunting society and agrarian society, to industrialized society and now to the information society. As the challenges we face are getting even more severe, there is a growing need to take our society to the next phase, leading to the emergence of a post-information society.

Cities at the forefront of global challenges

The role of the city in achieving Global Goals

The 11th goal of the 'Sustainable Development Goals' established by the United Nations General Assembly in 2015, is to build "Sustainable cities and communities". Achieving its aims – to make cities inclusive, safe, resilient and sustainable places – will significantly impact the other goals that address the social, economical, and environmental challenges we face globally.

Because of the accelerated urbanization that has progressed in the past decades, cities face a large number of today's global challenges. For example, cities significantly impact climate change. Urban areas are calculated to account for approximately two-thirds of the demand of primary energy and produce 70% of the global carbon dioxide emissions, making them responsible for reducing CO² emissions and improving energy efficiency.

Cities are expected to contribute to solving the most critical global challenges by cooperating with national governments and international organizations, as they are the decision-makers closest to people.





Cities begin to take action

Cities are in a unique position to drive change

Cities themselves are also becoming aware of their missions and responsibilities.

In 2017, when President Donald Trump announced the USA withdrawal from the Paris Agreement on climate change, cities in the USA quickly took action.¹ They implemented new policies and programs for climate action to show their positive stance and commitments to the agreement. This was a significant turn of events that demonstrated their leadership at a local level.

Amsterdam has published roadmaps for circular economies, showing their leadership to demonstrate how the future city should be. They began to put the necessary policies, partnerships, and infrastructure in place. In Barcelona, more than 800 organizations participated in citizen-led initiatives on climate action.

As cities are directly responsible for issues faced today and have a closer relationship with their citizens, they have started to make a difference in this world by embracing their unique position.

03

The Next Step



Technological advancement in human history has had a significant impact on our lives. Smart cities will take us even further, not only with technology but also with the power of communities and data-driven governing.

Smart Cities use connected technology and data to improve the efficiency of city service delivery, enhance quality of life for all, and increase equity and prosperity for residents and businesses.



Combining technology, citizen-centric solutions, and data-driven governing to tackle the challenges that cities face while providing for basic human needs more efficiently.

A city consists on a set of layers that serve its citizens directly and indirectly


Each layer holds essential parts for a service to come to life, additionally, it faces its own challenges.

When looking at ways that a smart city can come to life, each layer can benefit from “smart” technologies to perform more efficiently and effectively support citizen’s lives.

However, when communication and data transcend each layer, a city can behave and grow in a new way.

City Layers



An aerial night view of a city skyline, heavily tinted with a dark blue color. The image shows numerous skyscrapers and buildings, with some lights visible from the windows and streets. The perspective is from a high angle, looking down on the city.

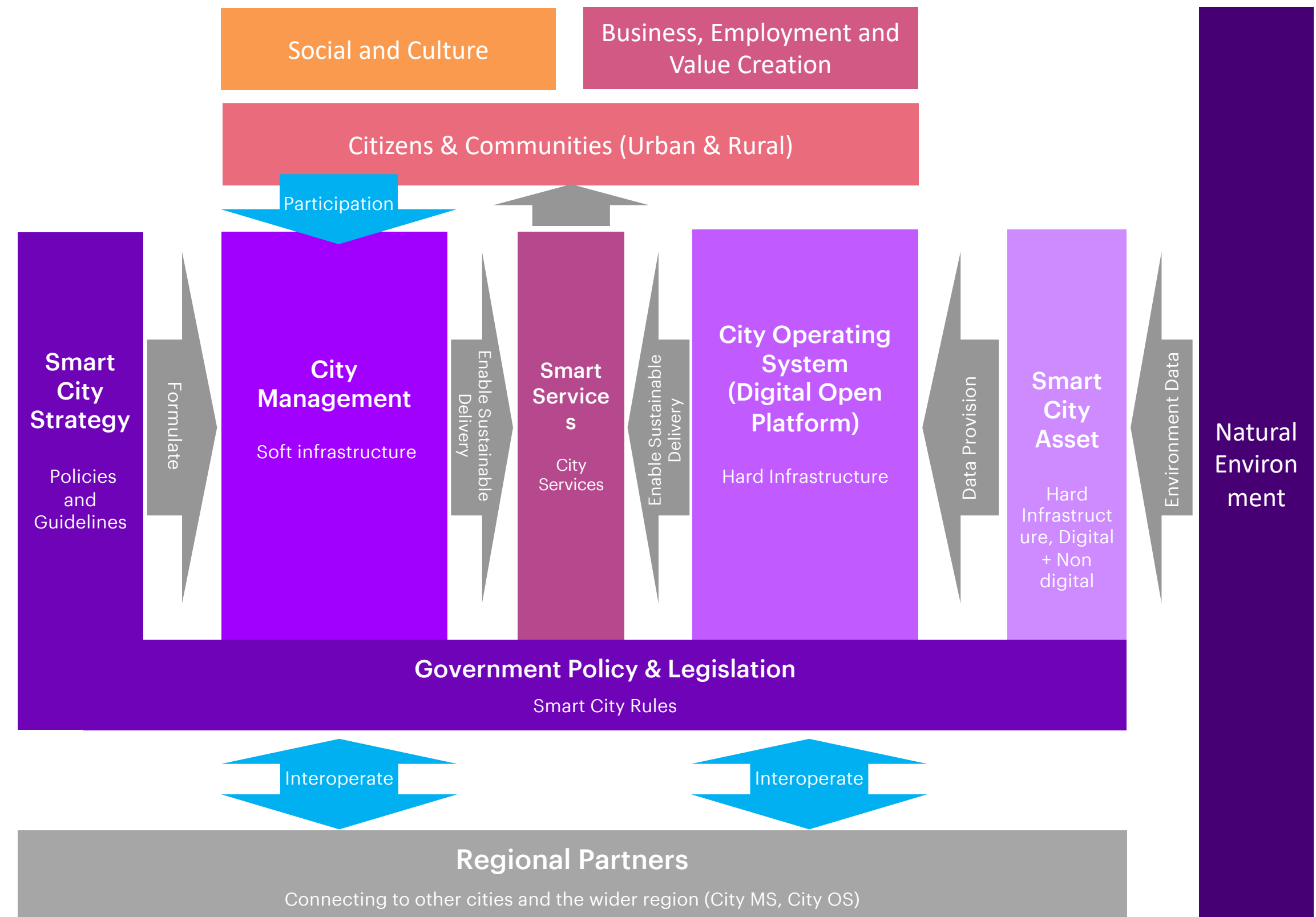
A smart city can leverage its layers to build a future where they sense, think, collaborate and respond cohesively to further enable citizens to live a more fulfilling life.

The key factors for smart services

City operating system and city management

Seen from the municipals' perspective, the most critical components within a smart city project are the city operating system as hard infrastructure and city management as soft infrastructure. Based on Smart City Reference Architecture introduced by the Japanese Cabinet Office in 2020², the diagram shows that those two play essential roles in enabling smart services.

City operating system realizes the integration of data and services brought from smart city assets, allowing the freedom of cooperation across different fields. City management is equally important to deliver smart city services continuously and sustainably.





Blurring the boundary between rural and urban, neighboring cities

With a standardized platform, smart cities in rural and urban areas, as well as neighbouring cities, will be more connected, blurring the boundaries of cities. This will allow all areas to be connected in several layers, enabling them to share resources, collaborate for better services, and support each other.

Regional collaboration enhances services like traffic congestions management, smart mobility, smart lighting, and smart grid energy. The scale of projects multiplies the effect of the success of smart city initiatives. Collaboration across regions will bring the advantage of scale, and at the same time, will give cities the opportunity to work together across borders on regulations, and test service ideas on the experimental stages.

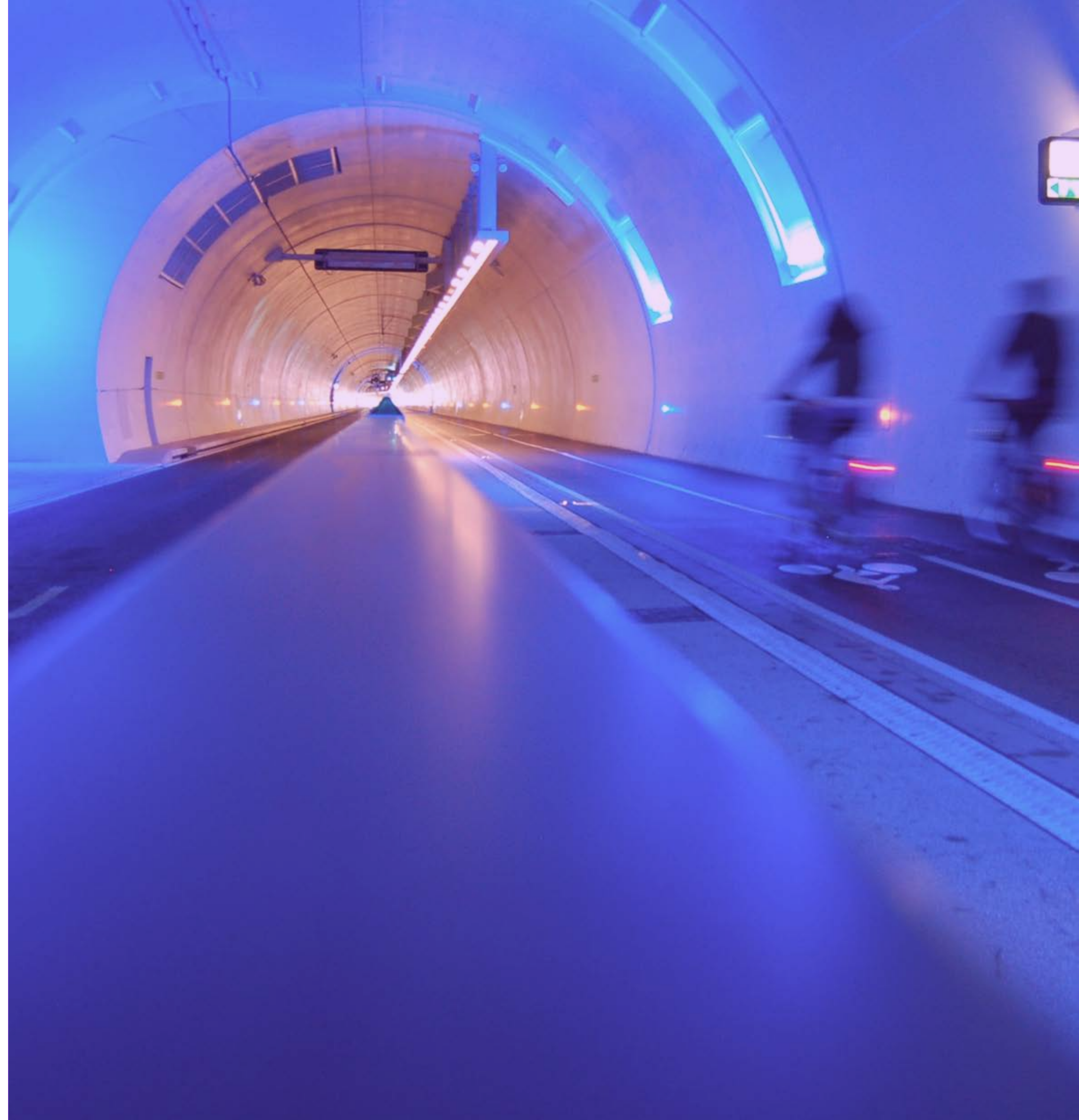
Smaller cities suffer from insufficient resources, lacking of know-how, rudimentary infrastructures, and funds to invest in smart city initiatives. However, larger cities can help them deliver smart services by sharing the knowledge and resources that they otherwise couldn't get access to.

One must also be resilient

The concept of leveraging new technologies within a smart city environment improves and accelerates the governing, economic, social, and environmental decision-making alongside delivery of services to enhance the benefits of its inhabitants.

A city that can detect, adapt, and respond to changes in its environment will produce smart solutions to the layers, resulting in resilience and, consequently, providing more intelligent services.

Also, cities can share resources and knowledge, and give support to each other through smart city infrastructure. The collaboration accelerates the progression of services and digital governing. It will also make it easy to help each other in an emergency, making them more robust and resilient.



04

Technology Is The Enabler

A smart city relies heavily on technology to improve the lives of its inhabitants. Playing an essential role in enabling optimization and delivering smart services and pushing the frontier of capability.



Technology powers smart services, making them **more coherent and data-driven**

Smart digital technology enables us to gain insights, monitor and manage city activities, and make better use of current city infrastructure. The Internet of Things is proliferated with new emerging digital devices and bringing new connected experiences to citizens' daily life activities.

Sensor technology can collect data; City OS uses that data and makes it accessible to the public on an open platform. Smart city initiatives can utilize this open-sourced data to improve the quality of inhabitants' lives, help governments make decisions, and deliver improved intelligent infrastructures in the city.

"Fairest way for technology to advance is for local communities to be included in its development, and rewarded by clear evidence of how technology can improve their quality of life"

Francesca Bria,
Chief Technology Officer for the City of Barcelona³

Technology & data infrastructure in three core parts:

Smart Sensors / Data collection

For smart cities, collecting data and comprehending what is happening within a city for big data analysis makes them intelligent and different.

Smart sensors can collect data from parking and transportation, to trash collection, air quality, and parkland irrigation, as well as a platform for citizens for opt-in data.

Open Platform - City OS

Collecting, processing and making data accessible is essential to creating value from the data collected in a city or region. In the future, a growing number of technologies will become available at a lower cost, which provides a requirement that any solution in this space is open, easy to integrate and scalable to ensure a future-proof smart city.

City OS is a platform that fits those requirements as it integrates the data with horizontal platforms allowing data flows across different domains creating opportunities for innovation.

Interfaces for analysis

This is the most visible layer for citizens where solutions enable easier access to the data and allow citizens to take action.

It could take various form, from data visualization on a city's website, to a healthcare app or to a hazardous map providing guidance in the case of an emergency. Additionally, the easier city data is to access, the more transparent it is to citizens.

City OS is a core for digital sovereignty

The realization of the digitalized government requires the incorporation of smart sensors and big data analytics. City OS is an open, new public management system that enables the integration of pre-existing municipal information systems. It improves efficiency using AI to better understand the inhabitant's behaviors and using collected data through sensors to improve the government's decision making.

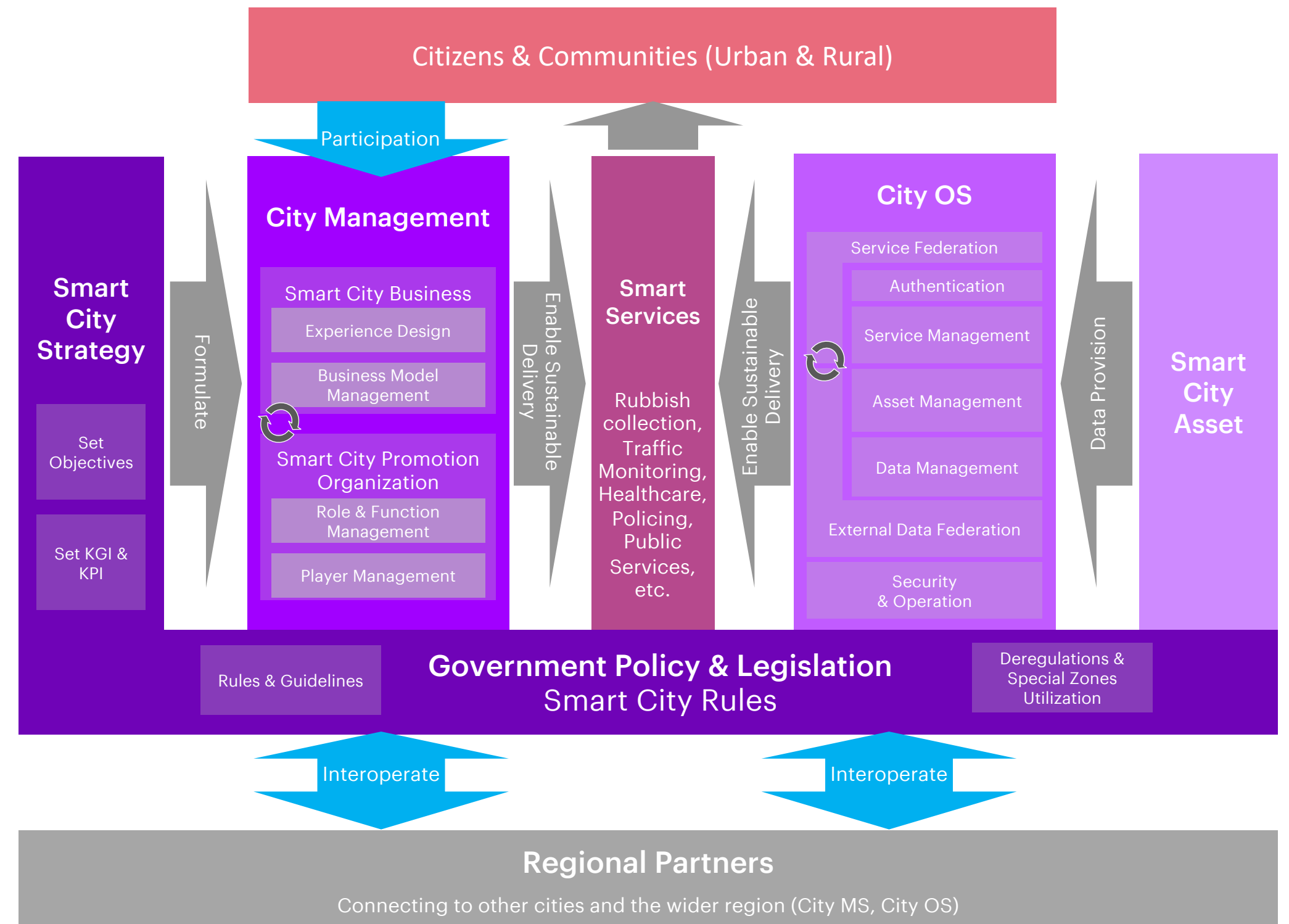
Therefore, City OS, which integrates data from various input sources and analyzes for more intelligent solutions, is one of the vital elements for smart cities. The use of available data strengthens open government policies and enriches the ecosystem of smart city solutions.



City OS also plays a pivotal role within smart city architecture

City OS plays a vital role as hard infrastructure, which is pivotal in Smart City Reference Architecture². City OS takes over data management and the management of assets and services within cities as well as the federation of service and external information, enabling the collaboration between different stakeholders.

City OS provides standard functions needed for smart cities, enabling cities to save time and resources and focus on responding to citizens' needs.



Technologies that make cities 'smarter'

The constant evolution of technology and the ongoing reduction in its cost, allows cities to adopt and adapt technology for their benefit. The encouragement of technology that enhances the smart city layers and experiences is indispensable in delivering smart services.

It is not only data sensing or analysis that technology can bring. But also, from transforming old infrastructure into new, to offering the simulation of city's future, technology contributes to making city 'smarter' in various perspectives.

Sentilo, open-source sensor network platform

Sentilo is a real-time open-source IoT sensor network platform designed to allow Barcelona's citizens to monitor, control, and manage an active and diverse community. Barcelona installed thousands of sensors to track energy usage in public spaces and street lighting. By using this collected data, the city succeeded in reducing 30% of its energy consumption.⁴ Barcelona's smart bins detect the amount of waste, and workers can plan their collection route according to the data they receive from bins.⁵



Singapore prototypes city with digital twins

Virtual Singapore is using 3D semantic modeling to create a virtual replica of the physical city, enabling the urban planners to test solutions and prototype on the virtual city. By having real-time information, planners can optimize traffic and improve the urban system. For example, the height of buildings and the rooftops' surface area can calculate the estimated amount of sunlight generated in Virtual Singapore. This allows urban planners to see where the potential solar panels can be placed.⁶



Zhaga socket transforms streetlight lamps in Brescia

In Italy, the province of Brescia has managed to group 28 small municipalities to connect a "smart light" transition on 23,000 light poles. For individual remote management, they installed the Zhaga sockets and transformed streetlights into smart lights. It enables completely autonomous lighting and detailed street lighting information alongside real-time malfunction alerts to increase their capacity to identify, repair, and even anticipate lighting malfunction.⁷



05

Co-creating a future

Beyond establishing technology and capturing data, a smart city needs to adopt different ways of working to drive positive impact for its citizens.



Co-creation is the key to accelerating a citizen-centred approach and driving innovation

The blend between technology, citizens, the private sector and academia is key to driving success, accelerating a human-centered approach, and driving innovation led by citizens for regional revitalization. Leading to the next step towards a future of the resilient smart city.

The protagonists of a smart city are the citizens, not the government or corporates.

Shojiro Nakamura

Center Lead Accenture Innovation Center Fukushima

Using technology to enable **citizen participation and transparency**

The increasing amount of data being captured in cities allows the government to sense, understand and respond to citizens' needs in a more relevant, connected and agile way.

'Smart-ness' builds on the sum of individual active citizens contributing to the community that enables the creation and adoption of solutions, which leads to an efficient transformation of the local community to be a strong smart city solutions ecosystem.

Open data is a powerful tool to facilitate citizen innovation and to foster citizen participation and co-creation.

Transparency refers to the availability of information the government shares with its citizens. As more governments ensure citizens' data is safely analyzed and reused, it leads to greater civic engagement and trust between government and citizens.

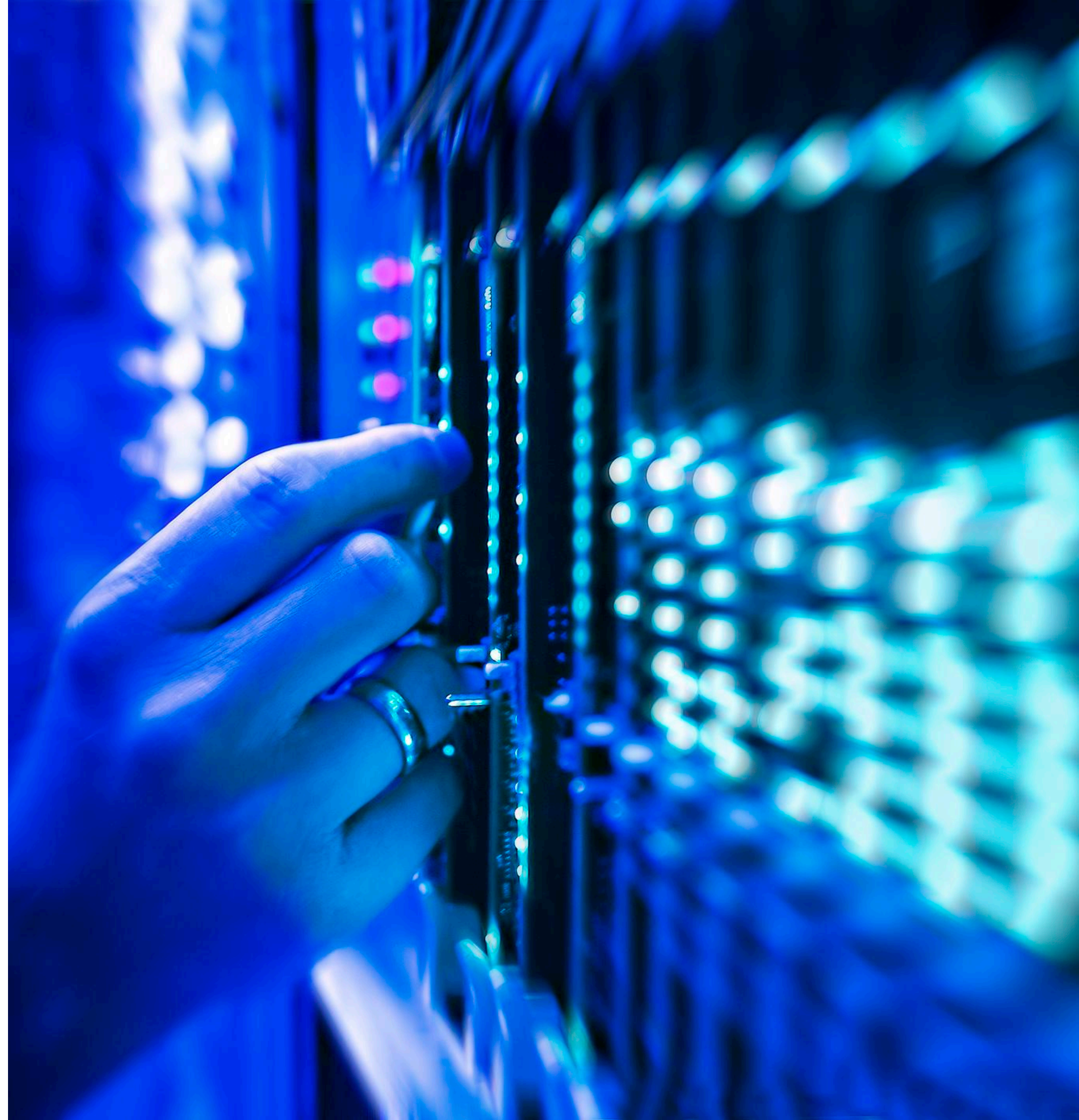


Ownership of data and transparency in Estonia

Estonia is one of the most forward-thinking countries in the area of digital governance, being famous for X-Road infrastructure and more recently its e-citizenship. Estonia has built a secure, efficient and transparent ecosystem where 99% of the services are online.

E-service infrastructure runs on X-Road, which is a data exchange platform authorized by users and organizations. Data remain confidential and protected from unauthorized parties. Users can access an overview of what data the government has on themselves to ensure transparency within the systems.⁸

Everyone in this digital nation: citizens, residents, and e-residents own their individual personal data, not the government. The inhabitants have control over who can access their data. Estonia builds trust in their digital society by using technology as a tool and make the process as transparent as possible.





The importance of **opt-in data** and **participation**

What we can learn from a failure

Sidewalk Labs, Alphabet's smart city subsidiary, decided to walk away from its Toronto project in May 2020. They confronted privacy concerns by attempting to collect data from unwilling citizens. What we can learn is that it was a pricey and dangerous road to go down, and the necessity of listening to citizens' voices while respecting their privacy is essential.⁹

Citizens are willing to help each other

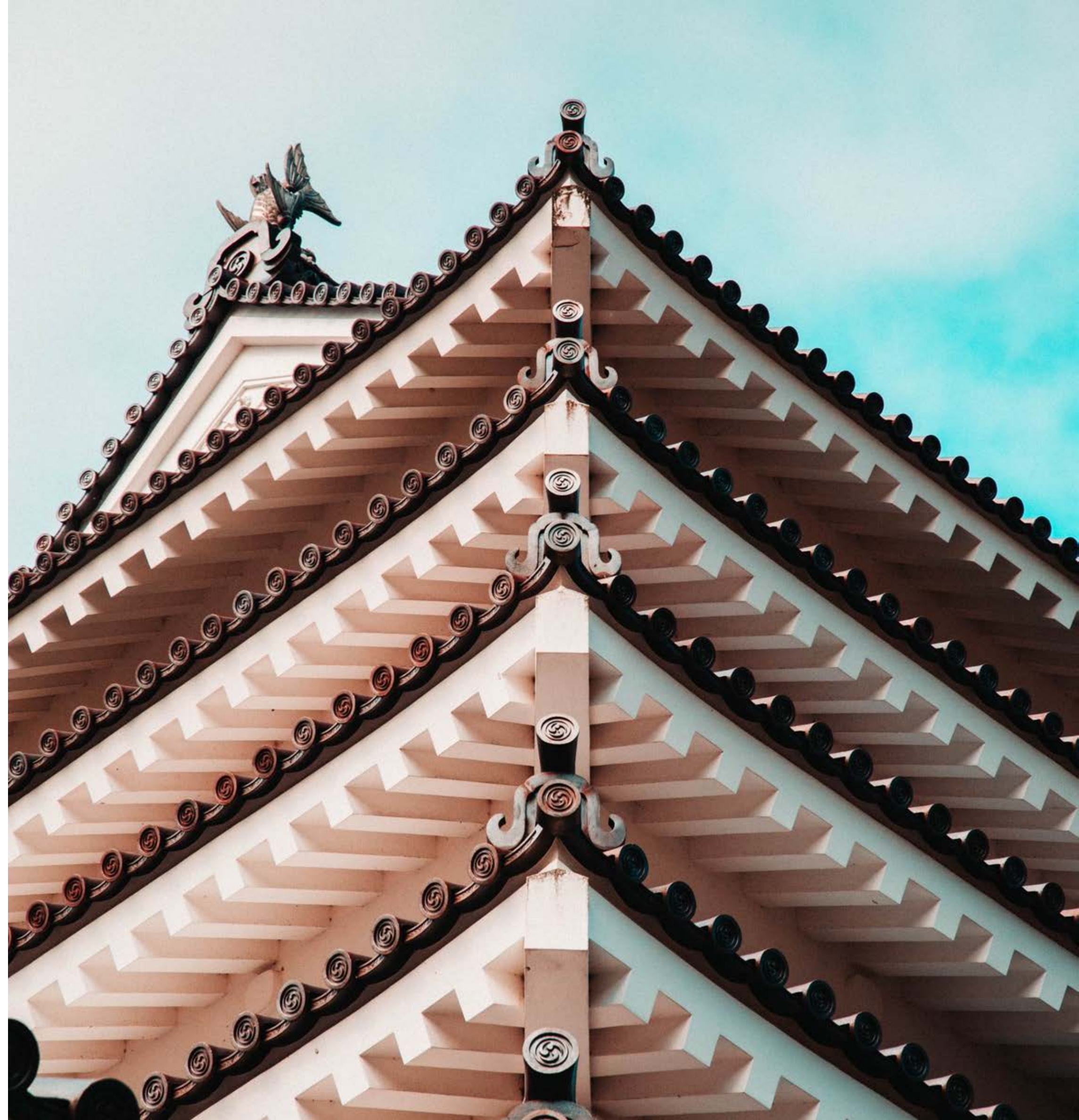
Residents can and will provide valuable personal data on their own if municipal authorities make the platform more convenient. People are willing to help themselves by sharing information with the rest of the city, and that can be a way for them to participate and become a contributing part of the change in city services.

Opt-in data to shift mindset in AizuWakamatsu

In AizuWakamatsu, residents control data, making the sharing of personal information optional. In order to build residents' trust, one needs to state the benefits of opt-in, increasing transparency, and assuring people that their personal information will not be misused.

Through the AizuWakamatsu+ portal, citizens can share any information, and the more they share, the more tailored the services will become in the future. Currently, more than 18% of local citizens have opted-in.¹⁰

The increase in participants who opted-in data means there is an increase in the number of people whose mindset has shifted. Those are the ones who provide their own data for benefit of their neighbours and the next generations. This is also becoming another way to participate and contribute to city development in addition to more traditional ways such as voting.



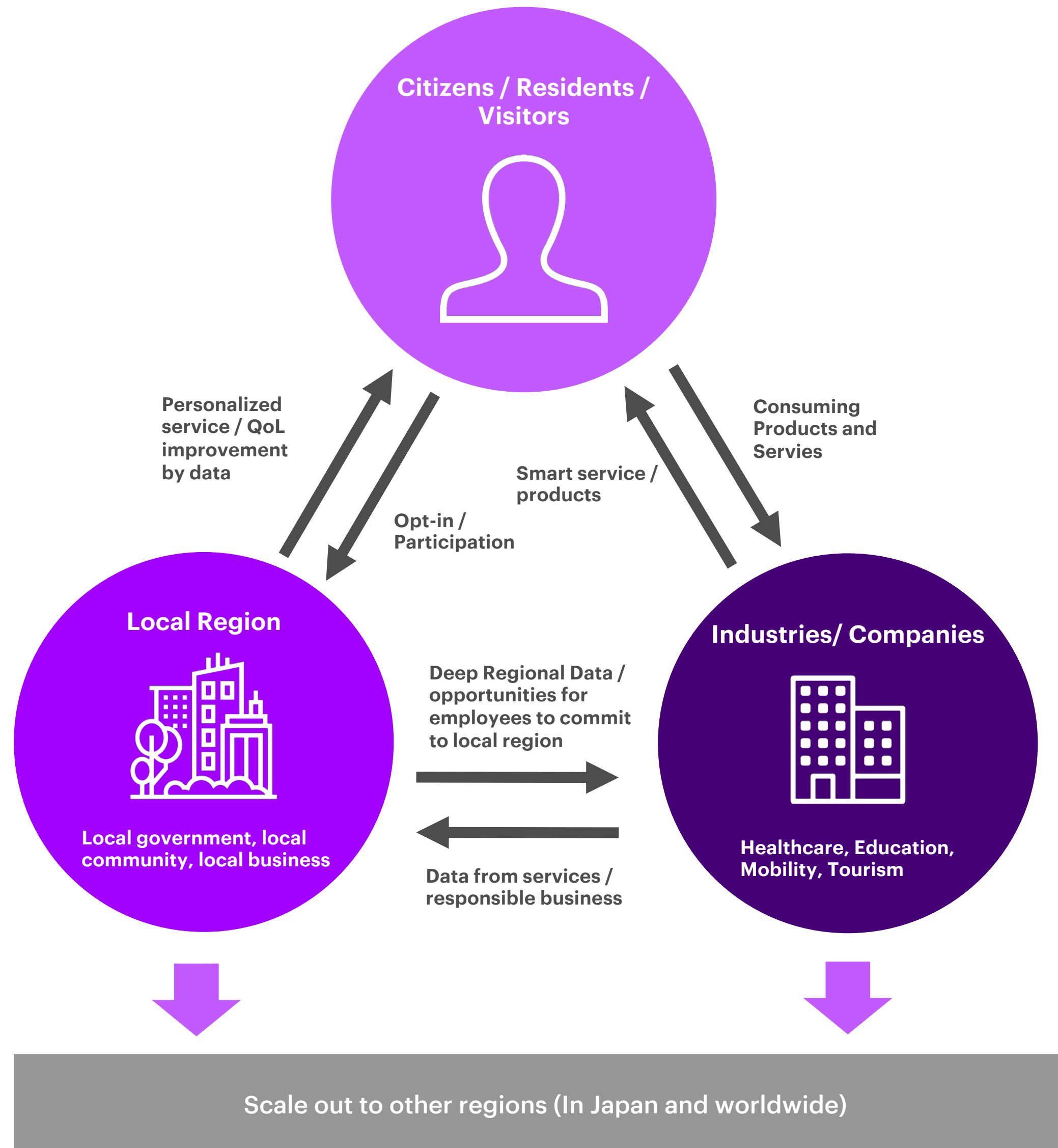
3 way satisfaction mutual benefit philosophy

Japanese business principles of shared success

3-way satisfaction is a Japanese business principle of triple success. Referring to the meaning of ensuring benefits for all stakeholders: citizens, industry, and the local community. The mindset of 3-way satisfaction is vital for smart city services, focusing on improving civil life with data and intelligent technologies.

Data utilization will lead to regional revitalization, by using the public- private data, citizens will benefit by receiving personalized services in return. Companies service areas use the analysed data to create functional services. AizuWakamatsu values this mutual collaboration and new framework for human-centric development.

The key to realize the 3-way satisfaction is a system architecture. Smart City Architecture enables city management that connects all the stakeholders, and makes human-centric approach possible.



All city stakeholders must come together and leverage technological developments to solve the problems cities are facing today

The technology sector is advancing at a rapid pace, but that also means it's accompanied by citizens' expectation of 'smarter' services. Redefining the boundaries between government and citizens will help to provide transparent, inclusive and valuable services.

Introducing more citizens to cutting-edge technology while embedding transparency into the journey will reshape the citizens' mindset and a step towards gaining their trust. It is important to promote active co-creation participation among citizens, private sectors, and academia' contribution will be the backbone to the smart city innovations.

Valuing the co-creation process

We are currently in the age of human-centered society, it balances economic advancement with solving social problems by incorporating innovations brought by the fourth industrial revolution.

Newly acquired digital technologies, combined with data and citizen-centric approach, can develop smart services for citizens, enabling new value co-creation opportunities. Collaborative creation is a way to successfully give back ownership to citizens and solve society's challenges together.

Involving citizens in the creation process, from beginning to end, will result in creating a more robust service through a diversity of thinking and experiences.



“Government has to stop treating citizens as customers or as recipients of a service and allow them to be co-creators of a city”

Lauren Macpherson
Head of UK Eli5¹¹



Melbourne is empowering a Smart Community

Open Innovation Competition inviting communities to problem-solve together

Melbourne's local government focuses on the changing needs of the community, environment, and economy. They have built a system where it empowers community where creativity flourishes.

Melbourne is developing its understanding of the community engagement process, looking out for co-created solutions with communities to address the local challenges and empower communities with the skills they need to thrive in the future.

Every year, the Open Innovation Competition invites community members and encourages participants to incorporate city data and smart service ideas to address urban challenges. These initiatives are also critical in bridging the divide between disability and accessibility while designing inclusive city experiences.¹²

Barcelona is fostering a participative culture

Decidim: Empowering local communities and decisions

Residents can detect the city's requirements far quicker than administrators can. By working collaboratively, they can come up with the solutions faster.

Provides an experimental, open, secure, and free democratic digital platform to crowdsource ideas and test their viability; citizens can participate directly in government by suggesting ideas, debating them, and voting with their thumbs.¹³



One of the key players is the private sector by leveraging technologies to improve city services and infrastructure all while driving economic growth

The private sector can assist governments by supporting startups, developing local capabilities, and establishing a smart city ecosystem. Technology service providers allow startups to expand their networks. The company is also uniquely positioned as a partner to governments, finding the best answers to policy changes.

A partnership between government, cities, and private companies will benefit citizens and help accelerate the momentum of change and adopt desired smart infrastructures that meet peoples' basic needs and local economic development.

“Investing in public-private partnerships that enhance the economic vibrancy of our communities will be core to stabilizing and increasing our population because residents feel like they have what they need to succeed in their City. Citizens are more likely to stay to see more and more businesses choosing Chicago as their home, people will follow.”

Lori Lightfoot

The City of Chicago Mayor Lori Lightfoot¹⁴

Amsterdam accelerating collaborative nature

Startup Amsterdam Ecosystem

Currently, there are 1500 - 2000 startups in Amsterdam directly involving citizens in collaborating with creatives and developers to accelerate the innovation processes. Startup Amsterdam aims to build and amplify the startup ecosystem and connect them to key players, mentors, investors, engineers, and launching customers.¹⁴

One of the initiatives is 'Startup in Residence', the municipality evaluates the people's concerns and creates social challenges for startups to solve using the open-city data.¹⁵





Innovation hubs to drive regional revitalization

AizuWakamatsu promotes human-centric development and regional revitalization

Smart cities need a local environment of collaboration, putting innovation hubs in the center. In 2019, Aizu opened the Smart city AiCT office, attracting investment from global companies including Accenture, SAP, Mitsubishi corporation, Microsoft, NEC, Softbank, and Coca-Cola Bottlers Japan etc.

Shojiro Nakamura, Lead of Accenture Innovation Centre said, has once said “we need to create opportunities to encourage talent to stay in the region and further their careers locally.” Attracting talents into the city will drive innovation and build strength in the local area.

Accenture Innovation Center is collaborating with a local university and private companies making citizens the drive of open-innovation and success in their city and choosing Aizu as their home.



Providing the private sector with an opportunity to work with governments and smart city initiatives is a mutually beneficial partnership.

Universities play a neutral yet catalytic role in social innovation and the knowledge economy

Education is at the heart of smart cities; these institutions prepare students to innovate within the smart cities of the future. Universities can become testing grounds to test out new technologies, turn ideas into prototypes, and experiment before implementing large scale smart services to the city.

By seeking out specific opportunities, Universities can attract students from other parts of the country to work and live in the city. Increasing the synergy between universities, government, and businesses, in turn promoting a thriving knowledge economy.

Smart research powers the smart city of Adelaide

The University of Adelaide launches smart city Consortium, working with governments, industry, and entrepreneurs to improve the city experience

University faculties understand the civic role of helping social and economic activities, being a good neighbour, and positively shaping the city they are in by strengthening their teaching and research.

The University of Adelaide plays a vital role in transforming the city into a smart city. The consortium allows anyone to bring their ideas and problems and work together with experts to produce a intelligent service outcome.¹⁶

There are also intelligent communities which approach societal problems and aim at developing long-term solutions. They are citizen-driven through engagement with the community, educational institutions and industry in the planning and implementation of project. This approach does not only save money and time but also generate a return on investment.





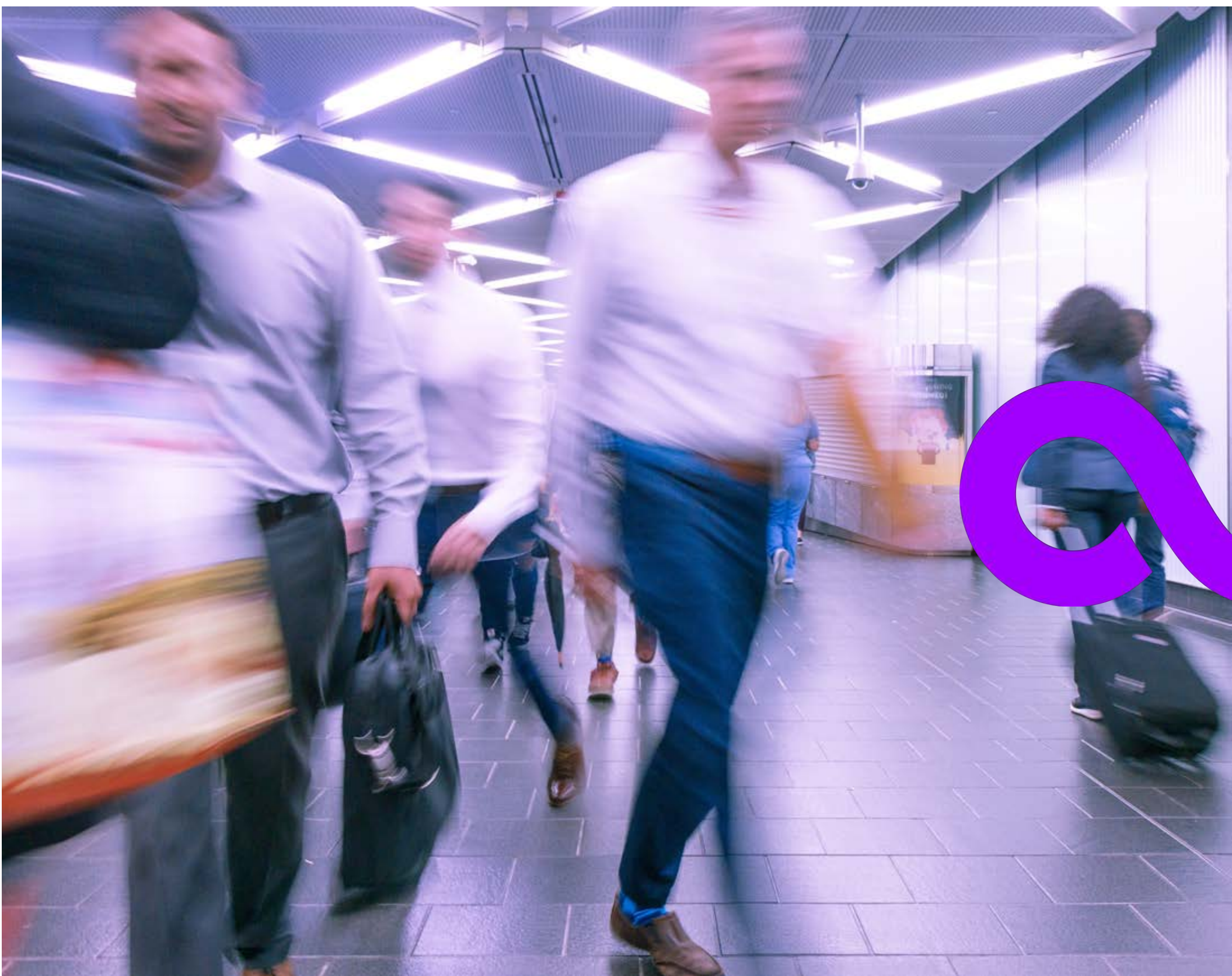
Promoting University-Industry Collaboration

The University of AizuWakamatsu is enhancing the partnership with industries

The University of Aizu has talent development programs allowing students to have an opportunity to take up an internship program with partnered up companies.

One of the programs the student can join is the Innovation & Start-up Education Program, supporting students to apply their newly learned skills in the form of a startup. Students can receive support for ideas, financial support after completing this program, promoting university-based entrepreneurial ecosystems.¹⁷

They also host innovation meetings called Aizu Open Innovation meeting(AOI), where citizens, students, and people from both the public and private sector come together and discuss possible solutions for all sorts of topics. There are usually about 10 working groups, and more than 300 meetings are hosted annually. AOI meeting has created different kinds of projects within AizuWakamatsu, enabling university-industry collaboration.



Universities play a pivotal role in a smart city's future success by being a neutral party in the co-creation process to generate opportunities that are beneficial for all stakeholders

“As a city, we’ve built active and collaborative relationships across all levels of government, universities, and the private sector. This has supported innovation and entrepreneurship, fueling investment and economic growth”

Sandy Verschoor

Lord Mayor of Adelaide¹⁸

06

Examples of smart services around the world

Smart cities have a relatively short history, however, learning from the failures of the past, smart city initiatives have started to drive changes for realizing a the citizen-centric society. This section focuses on 4 areas: healthcare, education, agriculture and disaster management.

Healthcare

These smart city innovations have great potential in improving and redesigning the future of healthcare services. Companies are focusing on launching new applications in order to establish smart hospitals through AI. According to Coherent Market Insight (CMI)'s analysis, it is expected to drive the growth of the global smart hospitals market, surpassing \$103billion by 2027.¹⁹ When smart cities' stakeholders use cutting-edge technologies, healthcare challenges will turn into opportunities, making the future of healthcare efficient and effective. Furthermore, rising demand of home related healthcare products like smart pills and remote patient monitoring will be the driver of the market.

Denmark universal preventive healthcare

Denmark focuses on providing free and equal universal access to healthcare. Considering the health and well-being of all Danish citizens. The Danish healthcare system is undergoing a transformation focusing on reinforcing primary care and population health, and preventing diseases before they become severe. Denmark also focuses on early detection and supporting mental health, reducing the taboo associated with mental illnesses.²⁰



Estonia's e- health and e-ambulance solutions

The Estonian insurance system is a solidarity-based social insurance system, providing healthcare for everyone. Estonia's healthcare is using innovative e-solutions, ensuring data integrity. The e-health records can be tracked anywhere. Patients can access the e-patient portal with an electronic ID. In case of an emergency, a patient can call an e-ambulance, a quick-response solution that can detect and position the phone call for the ambulance within 30 seconds. A doctor can use a patient's ID code to read time-critical information.²¹



mHealth Lifepod Cardiac care: Improving remote patient monitoring

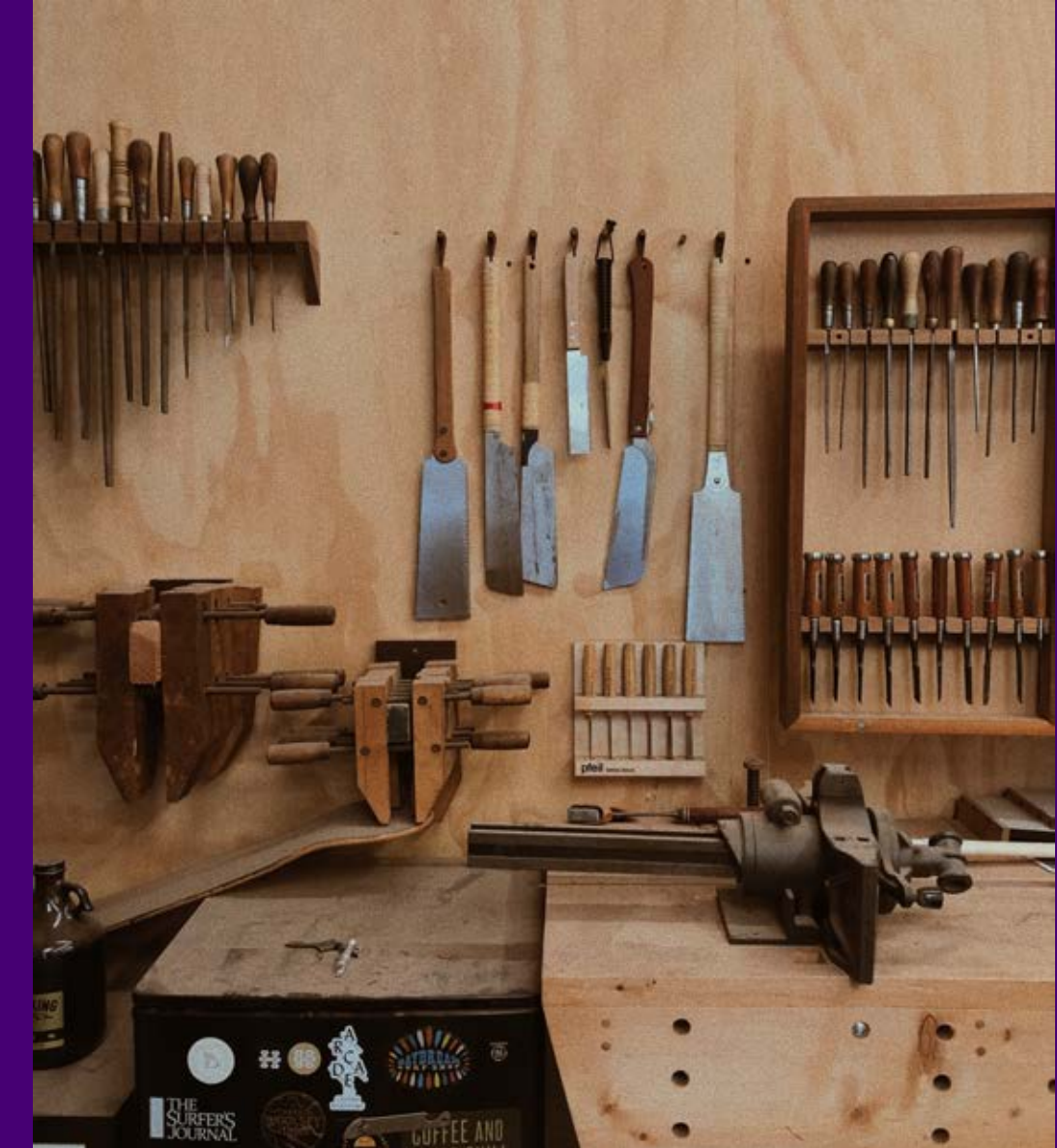
mHealth's Lifepod partnered up with the American Heart Association to use an interactive voice-powered platform to improve care management for patients living with chronic heart conditions. This AI-powered health platform enables virtual interactions with doctors, family, and friends.²²

Education

Smart education is one of the critical ingredients in smart city development. Smart education will be enabled by virtual learning, digitalization, and augmented reality making the learning experience more interactive and collaborative, while also increasing student engagement. A smart city needs to implement e-learning infrastructure and universities inclusively, leaving no one behind.

Fablab

Fablab is digital fabrication laboratory where individuals can create, mentor, and invent a place for learning and innovation. Fablab provides access to 21st-century skills, materials, and advanced technology to allow anyone to turn their ideas into a real product.²³



Vincles BCN

A social innovation project designed to strengthen the social connections of elderly people over 65 who feel lonely, improving their well-being by using new technologies. The elderly people on this programme will learn how to use a tablet independently.²⁴



Huawei Digital education partnered with Shenzhen government

“With a unified teaching cloud platform, Huawei provides an End to End (E2E) solution” making real-time interactive teaching possible from home.²⁵ The tablets are sold to schools for use in class and at home. By 2022, the Chinese government aims to create a unified platform that combines internet with education. This could change the future of education forever.

Agriculture

According to United Nations projections, the world's population will reach 9.7 billion by 2050, causing global agricultural production to rise by 70%.²⁶ The industry is increasingly facing global challenges to meet food demand, which can be addressed by information technologies. Using cutting-edge technology, the future of agriculture can have access to real-time information about planting, harvesting, and predicting the food quality and quantity in turn decreasing food loss.

Milan's intervention model of sustainable food system

Milan city hall, Politecnico di Milano, and other partners co-created a hub for stocking and distributing food. The aim is to cut food waste and child food poverty in Milan. This university conducted feasibility study, monitors the hub and the impact of the project, building logistical models that can be replicated to other part of the city.²⁷



Smart Farm Area X.O in Ottawa, Canada

Smart farm Area X.O is a future-plex of collaboration and innovation. By using cutting-edge AI and data analytics technology, it accelerates productivity, performance, and profitability of producers. Sensors monitor soil conditions and crop performance, while on-farm weather stations track important weather conditions like temperature, wind speed, and rainfall etc. Together this support more sustainable agriculture and build resilience.²⁸



Nara Spread-Vertical farming

Spread Co. is making the world's largest automated leaf-vegetable factory. The robotic arms transplant lettuce seeds, grown under LED lights, in a sterile environment. A sealed room protects the vegetables from pests and diseases, and dirt, creating a perfect condition for the vegetables while also reducing waste to almost zero.²⁹



Disaster Management

Japan is particularly vulnerable to natural disasters, experiencing countless earthquakes, tsunamis, typhoons, floods, etc., every year. The city must be prepared for future catastrophes, monitoring the environment, responding to recover quickly, and designing a connected and manageable community during the disaster.

Linux and IBM collaborating with Mexico City Earthquake detector, Grillo

Grillo gives early warning for everyone, generating real-time alerts when an earthquake is detected. An open-source community can accelerate social impact, contributing to advancing the sensor hardware design, while improving detection and characterisation of earthquakes through machine learning.³⁰



Fujisawa Off-grid Energy

If there was a natural disaster that created a power outage in Japan, Fujisawa system, which stores 3 days worth of power in off-grid operation, would come to effect. This allows communities to run independently of the main grid during disasters, providing extra layers of security to the infrastructure and inhabitants in that area.³¹



The Department of Transportation (DOT) in Iowa estimate future flooding

Working with Iowa State University and the University of Iowa Flood Center, the DOT uses historical data of rainfall, climate forecasting, and streamflow modeling to forecast peak discharge and estimate future flooding. This enables the DOT to identify risky roads, bridges, and other infrastructure to reduce their vulnerability to future flooding.³²

Mobility

Smart mobility can be any transportation mode, such as an autonomous vehicle, public transit, bike, bicycles, scooters, car-sharing, etc. The future of mobility will be transformed by cities and people's lifestyles. As urbanization has increased, traffic congestion has become a big problem. By using AI and cutting-edge technology, smart mobility solutions can identify collision spots and recommend a safer route for users. The future of mobility will make citizen's journey safer and provide a better quality of life.

NEOM's The Line project creates an invisible transportation infrastructure

The Line extends over 170km providing an underground sustainable transportation system, creating the connection between 4 communities and powered by an AI system that continuously learns ways to improve citizens' quality of life. The AI system also enables autonomous transportation by harnessing city-data. Citizens will use the ultra-high-speed transportation system to transit, logistics of cargos, and diverse mobility solutions running under the city. Citizens can access their nearby communities within 20 minutes, and all the essential daily services on a pedestrian layer will be accessible within 5 minutes walking distance.³³



Mayo Clinic uses autonomous shuttles to help transport covid-19 tests

Jacksonville Transportation Authority (JTA) has partnered up with Beep and NAVYA to transport covid-19 tests collected at a drive-through testing location to Mayo Clinic. This reduces physical contact, exposure to the virus, and reduces labour costs. This community partnership and collaboration has strengthened all of the teams during this uncertain time.³⁴



Muji Gacha autonomous shuttle bus in Espoo, Finland

The driverless Gacha bus uses digital maps and sensors to function in all weather conditions. The Gacha shuttle self-navigates in heavy traffic and urban surroundings, offering safe and smart on-demand transit anywhere. This is a new kind of public transportation that anyone who lives in the area can use easily.³⁵

Smart Offices / Buildings

Smart offices and buildings show us the future of working experience and how buildings will contribute to energy reduction for both the environment and city management. Offices and buildings are also becoming smarter, learning and enhancing services, and bringing a better experience for people.

Watson IoT Headquarters, Munich

The headquarters of IBM's IoT department and cognitive computing system is situated Munich. The building utilizes a system to manage building services, and fulfill tenants' needs by consistently learning what is best for them. It can learn the preference of brightness and temperature in rooms, as well as identifying which person is sitting where throughout the floorplan.³⁶



The Edge in Amsterdam

According to Bloomberg, the Edge is described as "the smartest building in the world"³⁷, the building uses renewable energy that makes it remarkably sustainable. The building also provides services like guiding visitors to an available parking space automatically.



Marina bay sands in Singapore enhances its efficiency through technology

One of the most famous hotels in the world, Marina bay sands, utilizes sensors and data to monitor electrical usage and the status of facilities. The system reduced energy consumption by over 15,900,000kWh and lowered their carbon footprint by over 9% in 2013 as compared to 2012.³⁸

Payments and Commerce

The power dynamics in the payment industry are changing as consumers shift from cash to digital payment methods. Nowadays, digital payments have been reshaping the retail landscape with consumers moving towards a cashless society. The tech-savvy generation, like Generation Z, is digitally literate and has a high dependency on technology and automated seamless services. As a result, the demand for digital payment systems will grow in the coming years.

Amazon Go's palm reader payment

In Amazon Go stores, customers can use their palms which are pre-scanned into the system to pay with their digital signature. The customer can hold one or both palms in front of the cashier and make the shopping journey seamless and replace the need to scan or tap physical payment methods.³⁹



'Smile to Pay' facial recognition payment system in Hangzhou

In China, the digital payment system is becoming the 'new normal,' and now, Alipay uses a 3D facial recognition camera and biometric identification technology for payments.⁴⁰ Alipay users can authenticate their payment through facial scanning and their mobile number. The user don't even need to bring their wallet or smartphones to pay for what they ordered.



CapitaLand and Shopee collaborate to accelerate the digitalization and offline activation of Singapore retailers

CapitaLand is partnering with retailers to adapt to the new normal, creating a holistic retail ecosystem integrating offline and online channels. CapitaLand mall is using gamification to drive offline sales and engagement with customers to their physical stores and online. CapitaLand's digital twin platforms empower retailers in enhancing their in-store customer experience with pre-ordering and click-and-collect options."⁴¹



Tourism

It is not easy for visitors who are not familiar with their holiday destinations to enjoy and get the best out of it in such a short stay. However, utilizing data and delivering an integrated experience is the key to increasing their satisfaction. The collaboration between different stakeholders, again, is vital to realizing a stress-free experience.

Data platform that integrates sightseeing experience in Valencia

Since 2015, Spain's national government has been researching smart tourism following announcement of a smart tourism destination project. The city of Benidorm in Valencia is working with national government, the Valencian community, local universities, hotels, and start ups, to deliver integrated experiences to visitors by utilizing data.⁴²



Dunhuang in China drives its city development by smart tourism

Working with tech giant, Huawei, Dunhuang has been constructing a new model through which they can maximize the limited resources available with communities and corporates working together. In Dunhuang, digitalization is happening rapidly – from selling 35% of tickets online and to using facial recognition for entrance. Resulting in high visitors satisfactions of 96.5%.⁴³



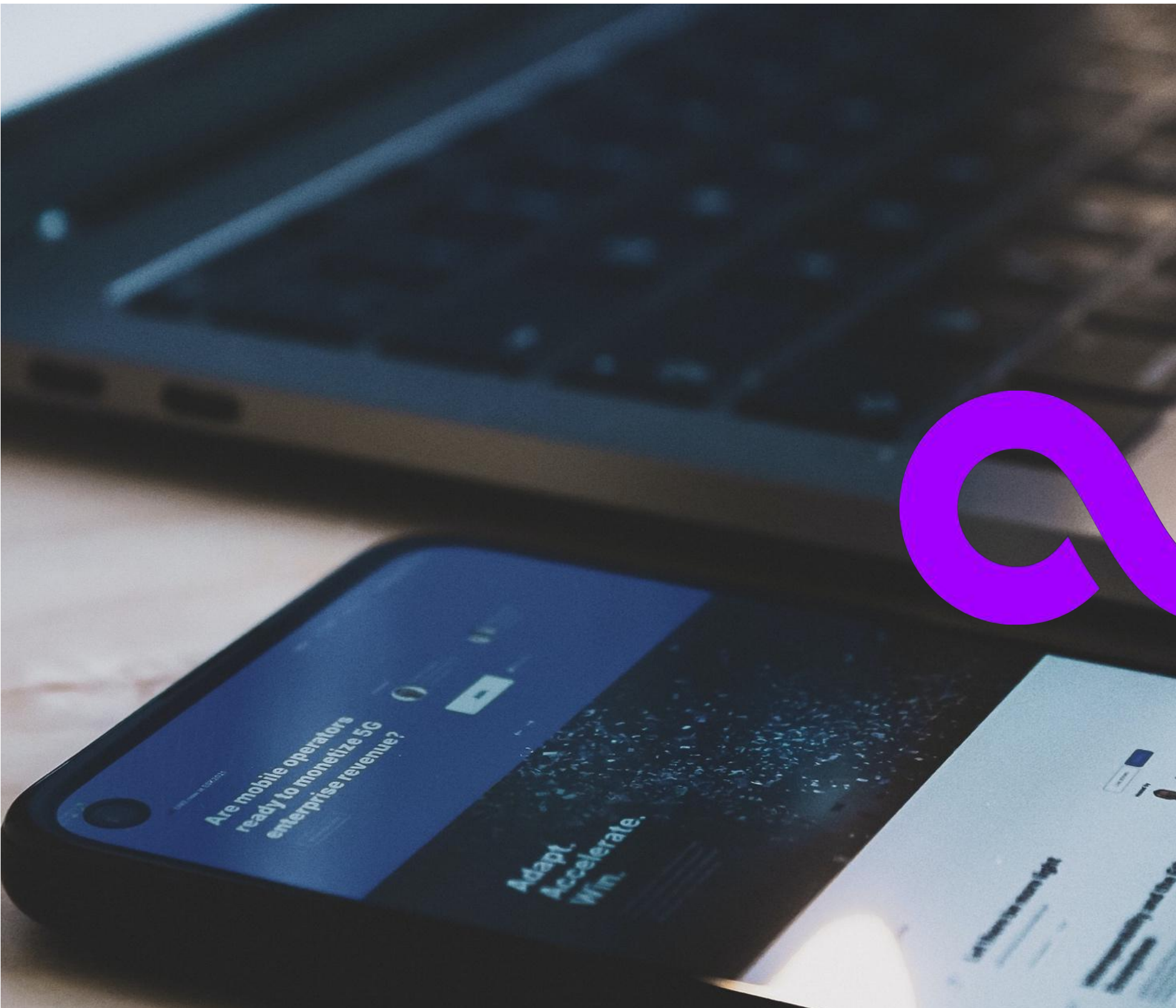
Visi+Aizu supports visitors through the whole journey

Visi+Aizu, a Destination Management Organization, in AizuWakamatsu is utilizing data for better promotion and marketing, in addition to providing services from users' point of view. It suggests sightseeing spots tailored to the users' profile, while supporting travel planning and helping them with any language problems. Through this, they are enhancing visitors' experiences.⁴⁴

07

Future Vision for Smart City in Japan

Citizen-centric cities will empower people even further, enabling them to achieve things beyond imagination. We can learn from other countries' smart city case studies and design better future smart city services for the future of Japan.



A future vision of smart city services

Taking inspirations from other case studies, Japan can drive changes and create a future vision for smart cities. For a smart city to be truly smart, one must use diverse approaches to leverage technology to improve citizens' overall quality of life.

The smart reference architecture brings city layers together to build the smart city of the future in Japan. Each areas needs to achieve individual goals in order to obtain the four main points of smart city advancement:

1. All smart city project participants must be aware of citizen-centric principles.
2. To sustainably manage Smart city, the city needs a governance and management mechanism.
3. Smart city services via city OS, data and services must be regulated.
4. In order to efficiently develop and implement Japan-wide smart cities, City OS and City management must be interoperable with other rural regions.

Innovative **life-cycle platform** to better manage community health

Personal Healthcare Record (PHR) improving healthcare experience and patients' well-being

In the PHR platform, medical records, and DNA test data from beginning to end of life stages will be stored in one unified medical record system, allowing patients smarter and better healthcare experiences.

When the patient's body and/or mental state worsens, the patient will receive a notification through PHR to consult a healthcare expert. By using an app, the patient will have options of an in-person consultation, online consultation, or order over the counter medicine. When the patient decides to go for an in-person consultation, the patient will book the consultation and enter symptoms online. Only having to stay in the hospital for 15 minutes to receive their consultation and medicines, eliminating waiting time. After consultation, the PHR will record the consultation data to improve personalization of patient care, better managing community health, and encouraging patients to live healthier lifestyle.





Preventative Healthcare for everyone

Preventing diseases and improving quality of life

The future of healthcare should shift its focus on to preventative healthcare, detecting and preventing diseases, and at the same time improving healthcare experts' efficiency, and decreasing healthcare costs. Preventive care is a vital step to manage and enhance an individual's quality of life.

Technologies can enable universal healthcare to the patients at a low cost, improving individual health quality outcomes and independent living wellness solutions with remote healthcare and telemedicine. By utilizing AI and voice recognition, medical records can be automatically filled out in a matter of minutes, making the whole experience smoother.

Citizens should manage, secure, and access their electronic health records and e-prescriptions, sharing them across borders. By sharing health data, it will benefit patient treatment, diagnosis, and also help to prevent future diseases. Furthermore, future healthcare should facilitate feedback and interaction between patients and healthcare providers to empower them to take responsibility for their own management of health.

Seamless learning ensuring continuity of education

Smart education can be accessed anywhere, anytime

Every student learns in different ways and paces; and they will benefit from individually personalized tasks in mixed digital and physical environments continuously learning across different scenarios. The future education will seamlessly integrate private and public learning data in a virtual learning system. Seamless learning uses immersive, collaborative and interactive virtual learning platforms; designed for better student engagement, making continuous learning possible.

Education needs to equip students with the 21st century skills to thrive in the future's world. Which means, technology is at the heart of the future's education. With distant learning becoming the new normal, the learning environment is not limited to classrooms anymore, so students can learn anywhere, anytime. Some educators and technology evangelists believe that eventually, education will be an entirely digital pursuit fortified by artificial intelligence and virtual learning. AI can play roles as diverse as checking homework to voice identification. Students can simply communicate through voice recognition to ask questions, making their learning experiences better.





Tailored learning experience for all children

Utilising Life Time Data to deliver tailored education model

In the future of education, connecting the regional integrated education model using children-centered approaches could mean all of the education data can be stored and accessed in a unified platform. This will involve kindergarten to secondary school, private tutoring schools, universities, and industries. Collecting lifetime data in Learning Record Store (LRS) allows students to receive a tailored education model fitted to the individual's needs.

Digital learning infrastructure will allow students who are ill or refuse to attend school to get tailored learning experiences fitted to their unique environment. Computer-based modules enable students to participate in remote lectures from the 'best' teacher online.

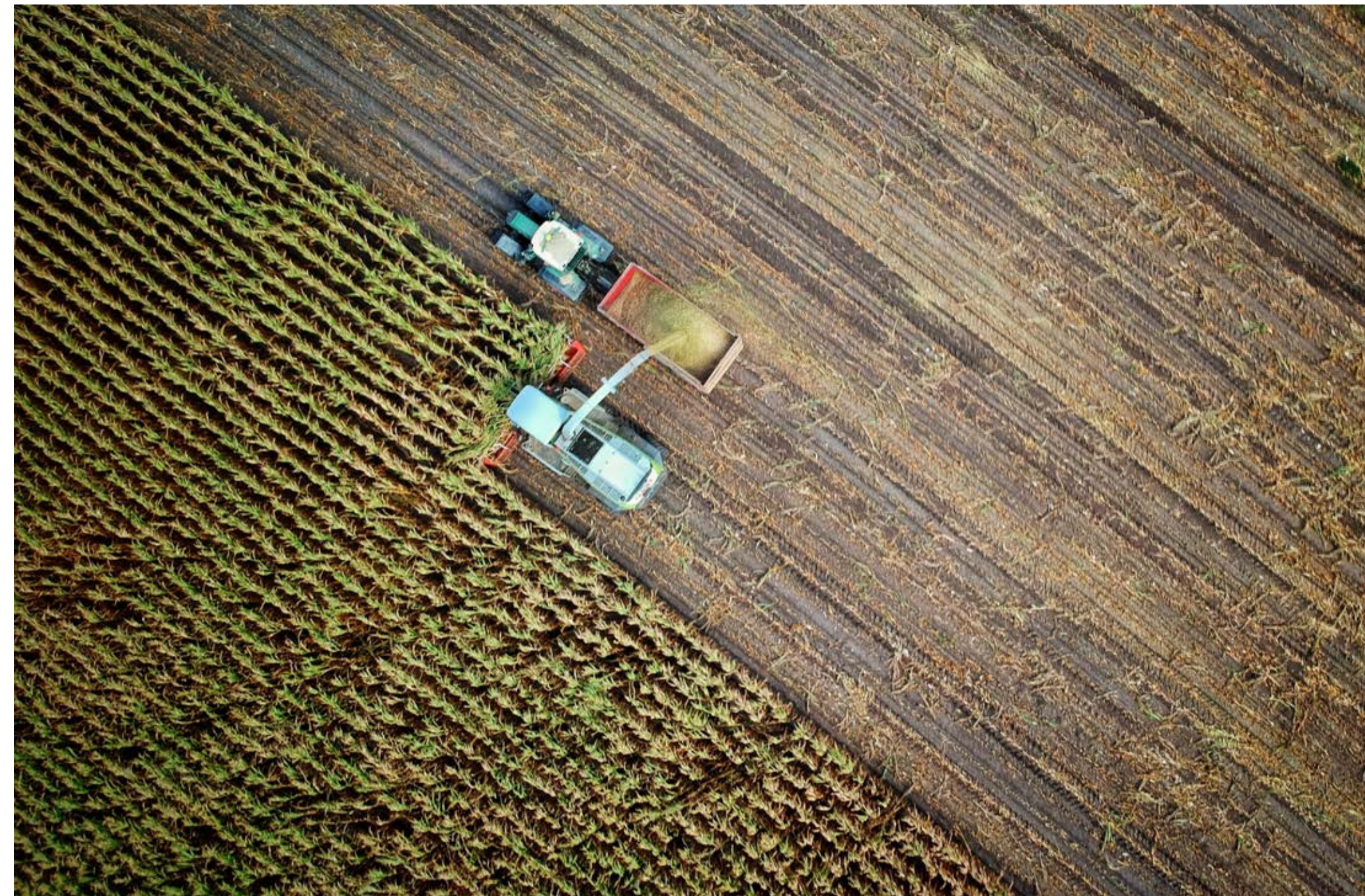
Additionally, safety net model will detect neglect and abuse at home. This same model also allows parents to check their children's GPS history and check if he/she is walking home safely from school. When in trouble, the emergency alarms go off and prevent kidnapping before it happens.

Using data-driven farming to create efficiency in agriculture

Using data to increase efficiency and production quality and quantity

The farming industry will become more critical than ever in the next few years. To feed the growing population amid labor shortages, IoT can play a role in increasing efficiency, reducing human labor, and cutting down food wastages by involving them in the farming processes.

The internet of things, including sensors, will collect information to monitor soil conditions, define weather forecasts that can predict conditions like temperature, wind speed, and rain, and detect and monitor infestation through drones and AI. By making the whole process transparent and visualized from production to consumption, society can respond to the food loss problem efficiently and attract young successors through productivity development, making them more willing to work as farmers. The future of smart agriculture will be more sustainable, increasing production quantity and quality all while minimizing environmental impact.





Digitalized food supply chain model will benefit producers

Delivering products to those who need them directly

The problems related to agriculture in this country are getting ever more severe, due to the downsizing of the domestic farm production market, as the country's population is decreasing, and the farmers are aging.

The supply chain of farm products is not digitalized, which leads to a mismatch of supply and demand as well as inefficiency within the system, eventually causing a significant amount of food loss.

Digitalization allows the optimization of the food supply chain. Instead of aggregating farm products to central location, they can be sent to each area directly, including the local area that they are produced.

By connecting the digital supply chain with City OS, producers and consumers can match directly supply and demand, enabling a better understanding of production in order to reduce food loss.

Building **robustness and redundancy** in cities makes them become a safer place to live

Smart services shine in the occurrence of a disaster

Smart cities also bring a difference to those who live in the area in the event of an emergency. Utilizing opt-in data and reading the situation, governments can give people live updates on the status of an emergency, personalized instructions for evacuation, and rescue if they happen to be unable to evacuate by themselves or go missing.

Smart cities also store resources and energy for an emergency that are saved by its efficient system in every day's operation. This enables cities to function during emergencies and provide essential services to citizens.

In the future, the system will predict an incoming disaster and give citizens instructions beforehand. Some cities have already started to use climate and environmental data to predict possible disasters to create a more resilient city.



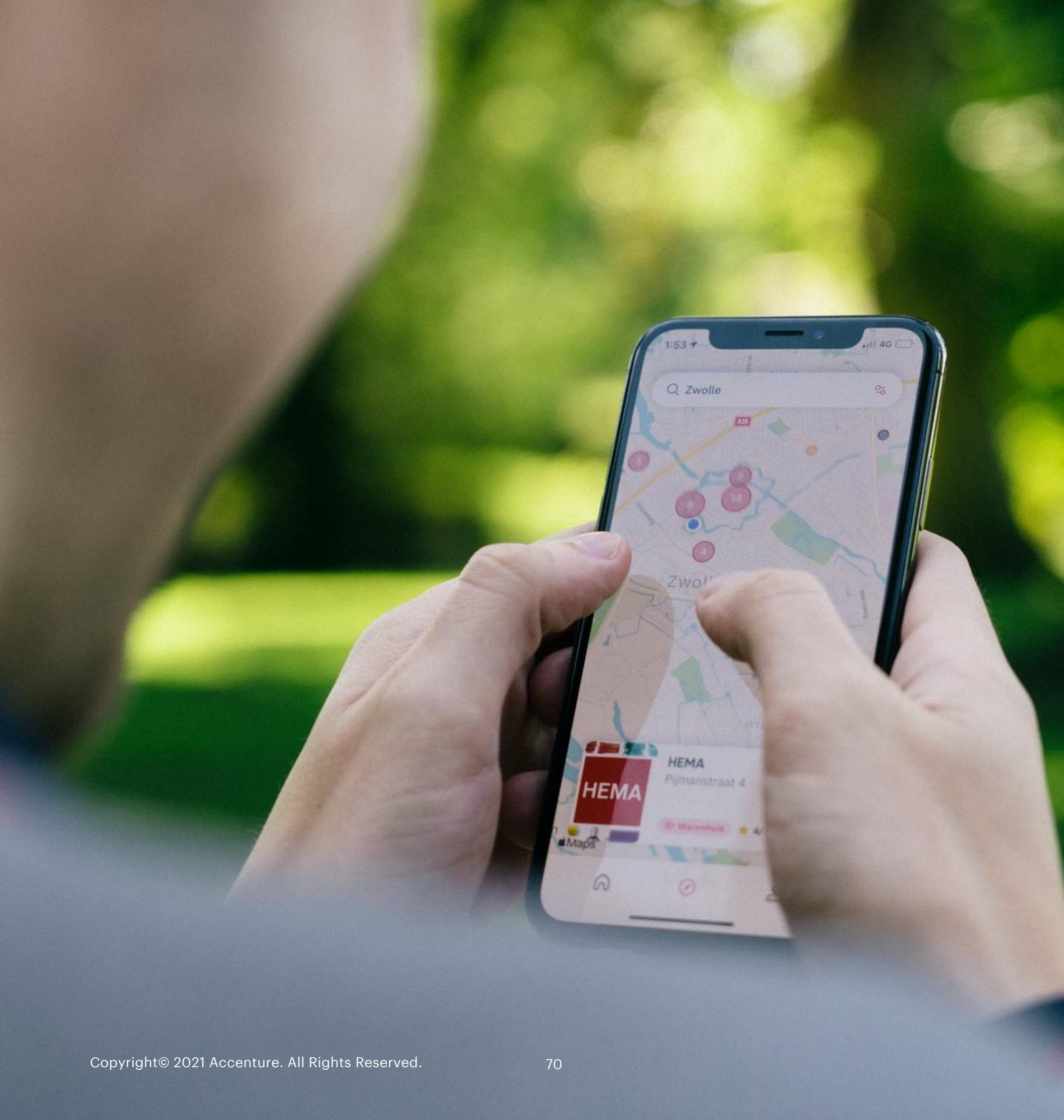
A companion during an emergency

Utilizing GPS information for giving instruction and facilitating rescue

In the case of disaster, local governments only provides generalized updates on the situation, which is often not enough for those who are unfamiliar with the area and local processes.

My hazard app, by utilizing opt-in GPS information gives tailored live updates and instructions of evacuation. The opt-in GPS information can then also be used for rescuing people who are missing in the event of a disaster.

This system is integrated into City OS. Although each city has their own city OS system, these are usually connected to one another. In the event of a disaster, they can run off-grid in order to provide essential services in that area. Furthermore, cities surrounding the hazardous area can provide help.



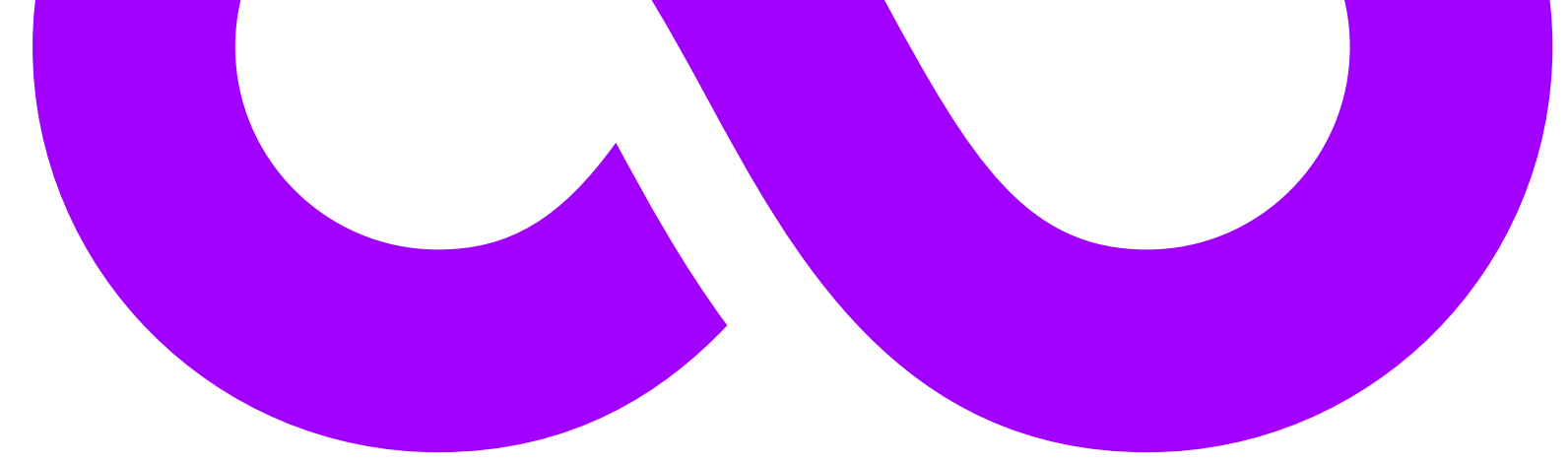
08

Challenges along the way

The need to make cities more resilient has been proven in 2020 with a global pandemic that has tested cities around the globe. Climate is also posing another big treat in the coming years, there is a bigger sense of urgency than ever before.

**COVID-19 has deeply challenged
the pursue for smart cities to be
more resilient.**

People's behaviours and priorities has shifted since Covid-19⁴⁵



The cost of confidence

Pandemics can deeply affect people's lives with decision-making skills becoming an anxious process. An explicit message of covid-19 is that other people/ places can carry an invisible threat. People are postponing purchase decisions due to uncertainty. Individualism has risen, with people adopting a look-after-yourself-first policy.

The Virtual Century

The pandemic enforced a sudden acceleration of virtual technologies, influencing ways of working, communication, transaction, and socializing.

"Covid-19 offers proof of the benefits of smart cities because cities with a digital platform in place, are able to collect and analyze data, can more rapidly understand where adjustments need applying," Gartner predicts that by 2022, digitization, or the internet of things, will save consumers and businesses \$1 trillion a year in maintenance, services and consumables on a global level.

Cocooning

The desire for cocooning has been rapidly increasing since the pandemic, with people spending more money on safety-related products, technology, health products, and masks etc. People tend to retreat to a safe space where the threat is the least. People will stay and enhance the sense of belonging in their local community just to feel safe during this difficult time. Cocooning is making households more prepared for future pandemics and giving them the mental comfort they need. This creates a community-centric society, and community response to a pandemic will be remembered as a vital approach of flattening the curve.



The impact of loneliness and isolation

In the US, more than half of people reported that their mental health had been negatively impacted by social isolation. Also, in one study 19% responded that they felt isolated. The impact of loneliness and isolation should not be understated; research has shown that it can be “twice as harmful to physical and mental health as obesity.”⁴⁶

There’s more people who suffer from mental health issues in Japan as well. According to the ministry of health, labour and welfare, the number of people who seek advice from mental health support centers has spiked in April and May.⁴⁷

Covid-19 is **shifting city priorities**



Covid-19 has played a disruptor role in smart cities, with citizens experiencing different isolation levels, lack of connectedness, and differing response to the pandemic and economic crisis. Cities are responding to the pandemic in very different ways. Governments have implemented measures to address economic impact of the pandemic such as promoting remote work.

Some cities are taking a different approach during this pandemic trying to keep the outbreak under control while providing stable paying jobs during this time.



Inclusion Chicago project helping people in need during this pandemic

The covid-19 pandemic has exacerbated social and economic inequalities in the world. In Chicago, there is a disproportionate impact on the low-income residents of color.⁴⁸ To resolve that, they have increased access to stable paying jobs for residence of color. Chicago has also provided housing assistant for people in need.

Seoul contains Covid-19 by using pre-existed smart city data base

Seoul, South Korea is one of the first countries to bring covid-19 outbreak under control. The South Korean government made all new arrivals download a government app that tracks their location. South Korea is using their existing smart city database that tracks air quality and traffic data, alongside existing infrastructure to track covid-19 patients.⁴⁹



Covid-19 is testing city level **resilience**

Cities are using technology to better manage this pandemic and support citizens during this challenging period. Local authorities are funding the development of a social-support communities, creating a safe space for individuals within the community.

Resilience enables individuals and communities to cope with the stress, promoting well-being, and enhancing the sense of belonging and community together.

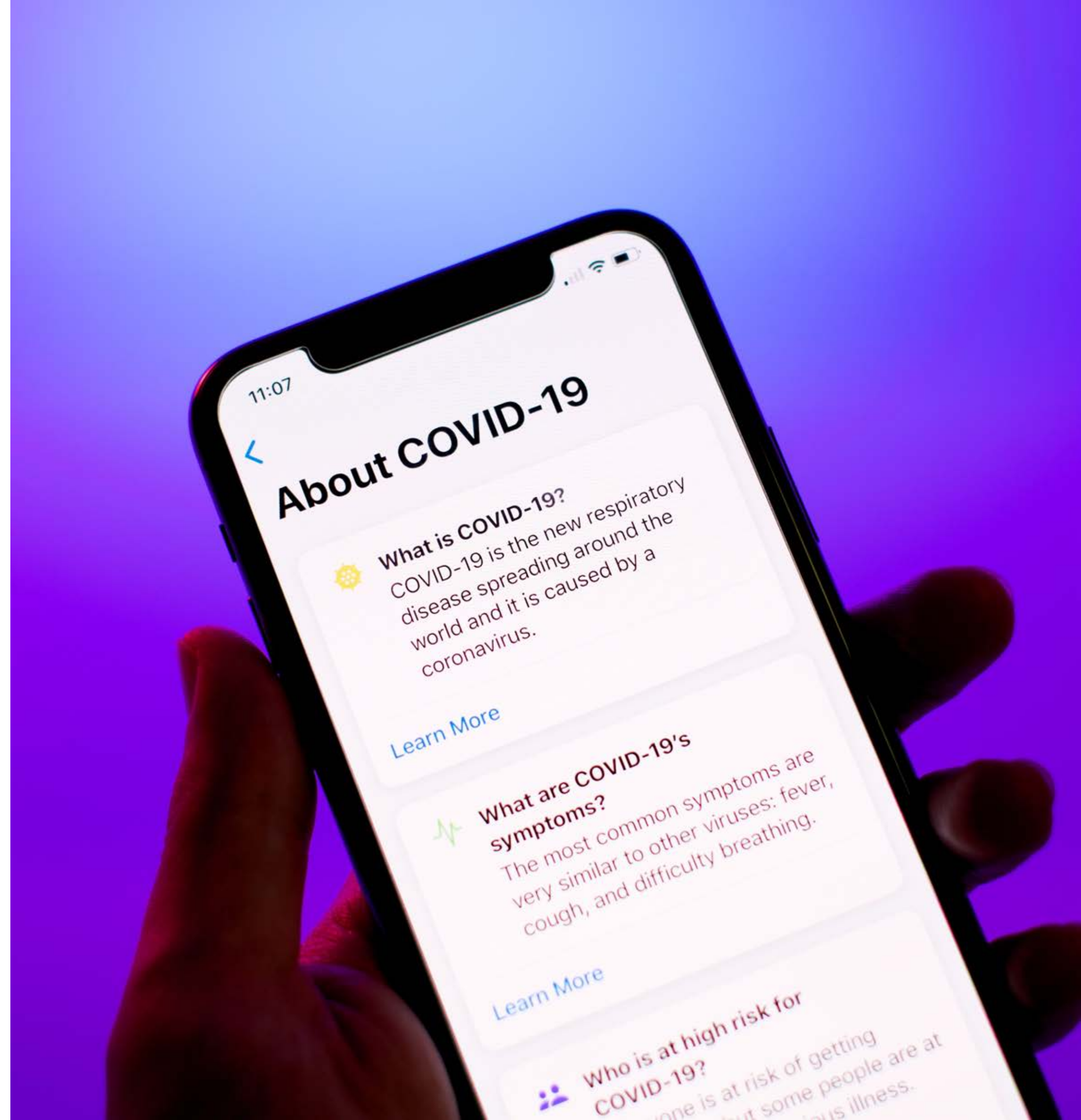
Cities should seize the moment and focus on the new possibilities.

Emerging opportunities post Covid-19

More opportunities triggered by Covid-19

Covid-19 has changed the global economy, businesses, and way of life. The normalization of remote work has decentralized the workforce, making it easier for people to work from rural areas. Digitalization has been accelerated by covid-19, and this has triggered changes in online consumption habits forever. Remote and distance learning will provide students to learn in interactive and engaging ways by using technology; this also allows students to study flexibly and re-watch the lectures anywhere they want. Concerts are all held online using cutting edge technology to create an unrealistic sci-fi world, creating a new type of entertainment.

Japan's authorities are promoting a new way of living and rural migration to prevent the spread of covid-19, while making huge opportunities for rural areas to drive rural migration and improve quality of life.





Work from Bermuda certificate

Bermuda took an ambitious response to Covid-19, launched a "work from Bermuda" one-year residential certificate while working and studying remotely on the island.⁵⁰ Bermuda is one of the countries that successfully managed the first wave of pandemic. Now attracting foreign nationals to stay as a tourist to stimulate the local travel-based economy. In coming years, as covid-19 boosts remote working, the digital nomad lifestyle could provide inspiration for new ways of working for location-independent individuals.

Seattle and San Francisco Slow Street project

Due to the pandemic, there's reduced bus services and use of cars, resulting in an overall decreased in traffic on city roads. Seattle and San Francisco took this as an opportunity for people to get out, and be safe and secure, in an urban environment, expanding cycling and pedestrian infrastructure. Discouraging cars from using so-called 'slow streets', pedestrians and cyclists have more space and are not limited to using sidewalks for their journeys.⁵¹



09

Looking into the future

The next decade will be posing big challenges that cities will have to overcome, but with challenges comes opportunities for innovation.



The realignment of priorities

New expectations and opportunities are emerging at a rapid pace

People have become more concerned and vocal about environmental, sustainable, equality and social matters, placing a spotlight on companies, institutions, and governments that are not acting in accordance with the current values that citizens hold to heart.

For instance, the growing trend of governments being sued for climate inaction shows that citizens aren't only concerned, they are taking action to drive government behaviour towards what they consider a better version of the future.

Alongside people's demands and expectations changing, what is possible with new technologies empowers the creation of new solutions that were not possible in the past. Additionally, what is deemed as a viable solution is changing too. New citizen expectations and new technologies enable the creation of new ways of delivering services and governing cities.



Responding with new perspectives

A new approach to create the future of cities

Adopting new ways of working and technologies are essential steps to move forward with addressing the current challenges and emerging needs that we have outlined. Beyond those steps, a more remarkable change in the perspectives considered in future solutions is needed to reflect the complexity of growing needs.

Redefining the voices included in creating a solution for a city is required. This is the space where co-created solutions can shine as they combine perspectives as part of the creation process of a solution. Therefore, providing a more complete view of the city layers will benefit a new solution. This will lead to transparent public participation and co-creation between citizens, the private sector, academia, and government are essential for a smart city's success.



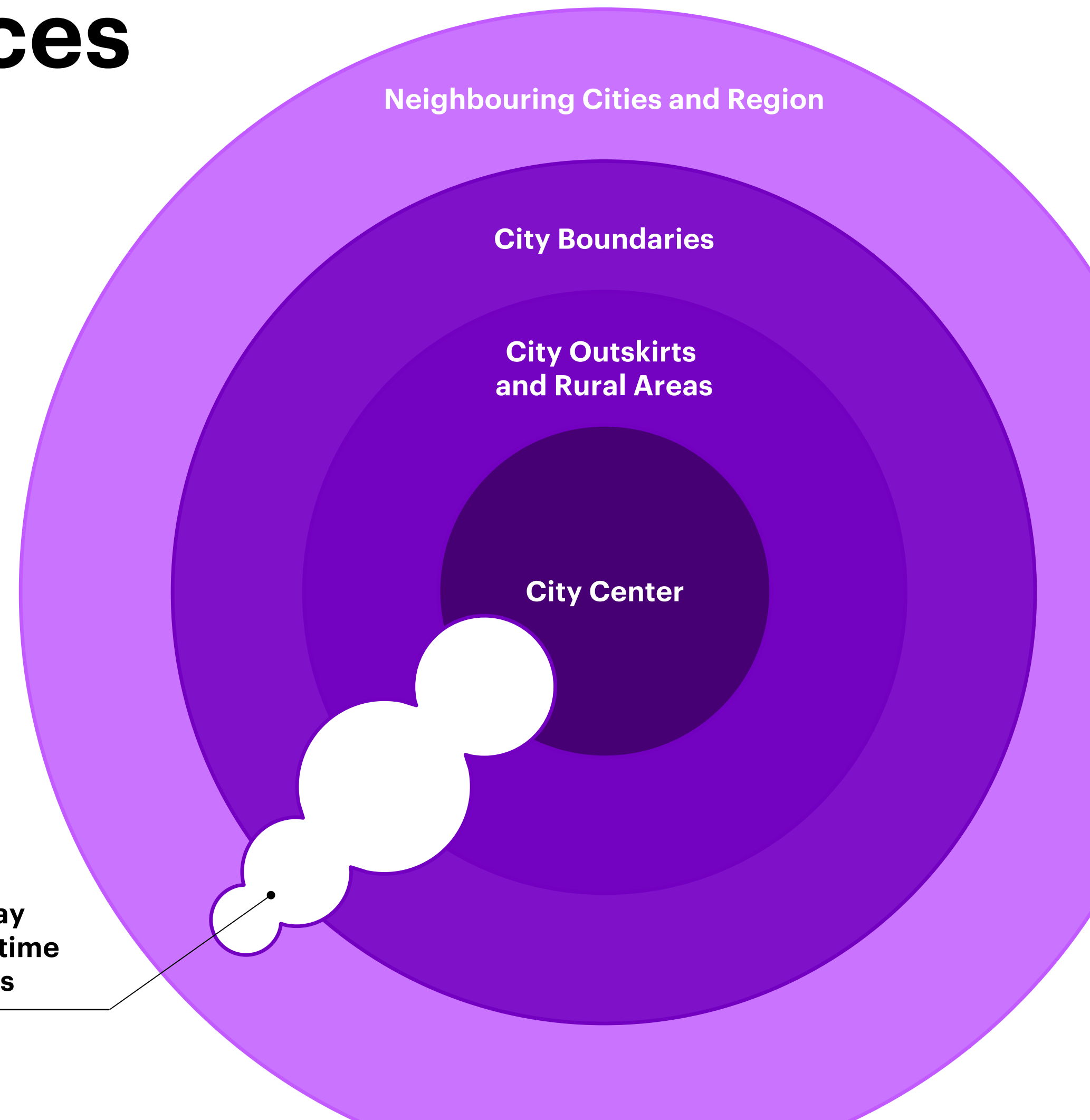
Expanding smart services beyond city borders

Supporting citizens' needs comprehensively

The delivery of smart services tends to be confined within the borders of cities, as it's municipalities that undertake smart city initiatives. However, citizens need to go outside of where they live on several occasions in their daily lives. Many citizens work or may spend their time over the weekend in neighbouring towns. This indicates that citizens can't benefit in the same way as they do within a municipal area once they go outside its borders.

To support citizens' unique needs comprehensively, we need to look at expanding boundaries of smart services across city boundary. Defining citizens' 'living area' to cluster neighbouring cities and provide smart services beyond city borders. Furthermore, this requires collaboration between local municipalities regarding policies, city management, technology, and ecosystems.

**How citizens may
distribute their time
across city areas**



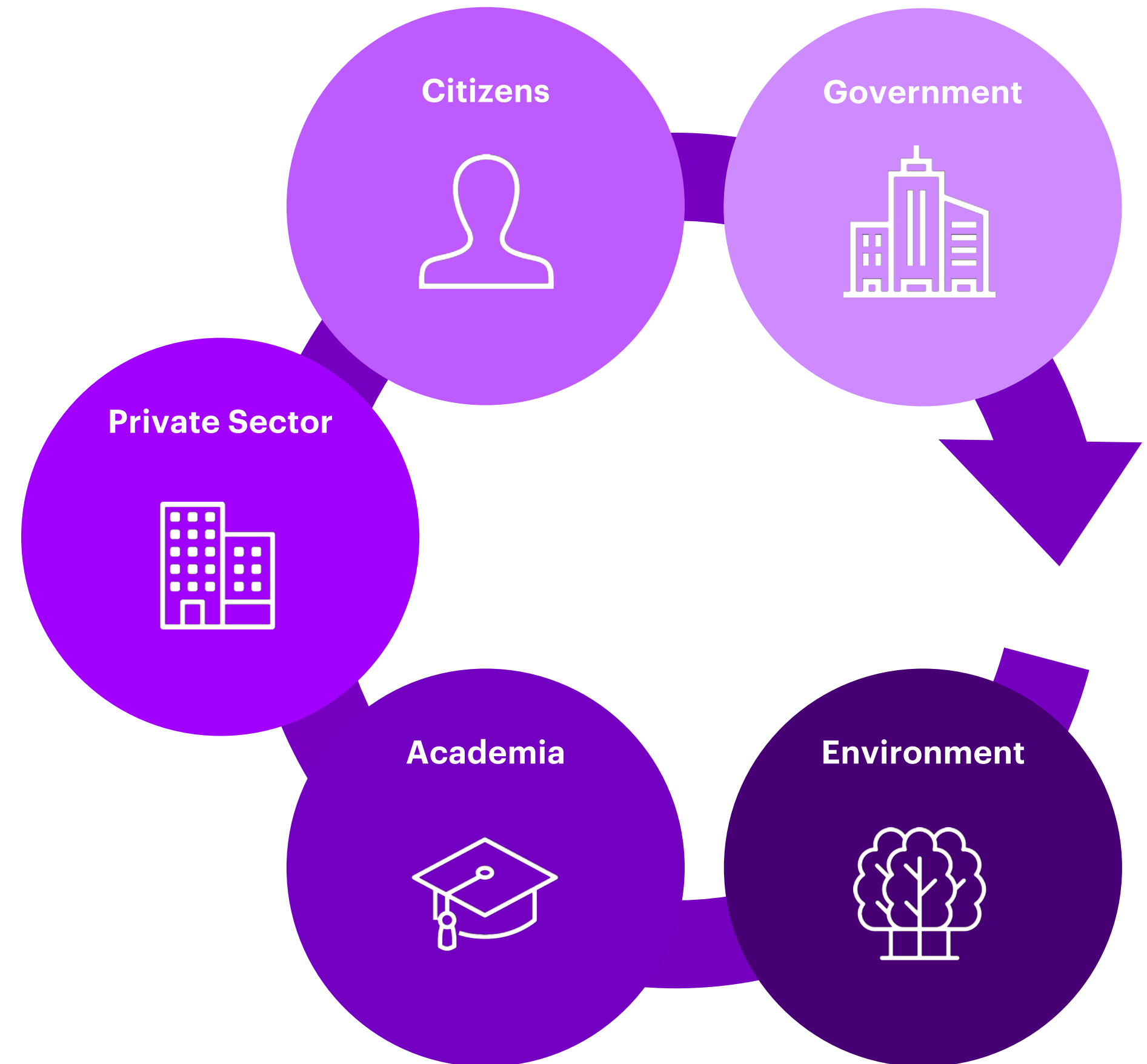
Co-creating ecosystems together

For building resilient cities, all city stakeholders need to fulfill their roles

A new approach requires new roles. Through co-creation between all stakeholders, cities acquire different perspectives to redefine their challenges and gain new opportunities.

Local city governments need to understand their responsibilities in terms of how they impact citizens lives. In doing so, they should embrace new opportunities to transform society. It is time for smart city initiatives to listen to citizens, making the decision-making processes transparent, and using citizen-centred design to address citizens' needs. It is citizens' responsibility to respond to it, participate, and take actions for their future generations, understanding that each voice counts for building resilient communities.

The private sector is also an essential piece in supporting smart city projects. Creating a mutually beneficial partnership with government agencies allows organisation to creating opportunities to encourage employees and members of society to developing local capabilities. Academia has a role in investing for the future by educating future generations and fostering a testing ground for new ideas using cutting-edge technologies.



Living ecosystem that revitalizes communities around the globe

Everyone becomes a problem solver

The challenges we face in the 21st century are quite entangled within the complex system we have established globally. The major organizations' top-down approach has proved that it can not deliver effective solutions anymore.

Rather, we need solutions at a smaller level. The fact that problems vary from person to person and city to city shows that current cities become the main place for devising solutions. The ownership of city governance taken by central governments in modern society should be given back to citizens in order to solve problems together.

By utilizing technology such as City OS, cities now can help each other directly and more efficiently, forming an ecosystem that solves problems more effectively and brings a lively community back to cities.



Seizing the opportunity to go on a new direction

The 2020 covid-19 pandemic has been a once in a century event that disrupted, paused, and redefined many concepts in modern life and shook to a core the definition of “normal life”. The outbreak has radically changed the concept of large cities; the connectedness and density of urban areas were the keys to economic strength pre-covid; now, that concept is the ‘weakness’ that puts citizens at greater risk from the virus.

As the world transitions into the next pandemic phase, we expect long-term changes in societies and economies worldwide. These challenges are significant and can reset the economic approaches in maximizing the chances of developing more resilient and sustainable strategies. There is no better time than now to change the game and take this opportunity to define the processes that determine the “new normal”. Creating opportunities to go beyond collaborating with stakeholders through new ways of working.

Every city is unique and should consider new approaches to transforming smart cities, reimagining a better version of the future. It’s up to us citizens to make bold changes in society, community, and the world.

Thank you

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