How the Cloud Helps Cities Become Sustainable and Inclusive

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Introduction

Cities are expected to be home to two-thirds of the world's population by 2050, according to the United Nations[1]. As the population expands so does the imperative to make sure that urban infrastructure and services can accommodate growth. Cities are adopting innovative technology to meet rising demands on public services and infrastructure, as well as to address urban challenges related to the environment, national security, and public health, among others.

Information and communications technology advances of the 1990s gave rise to the smart city, or a city that continuously enhances quality of life for its residents, providing efficient and effective services, using technology and data. Today's technology—including cloud services and the Internet of Things (IoT)—promises to unleash a new wave of innovation and transform cities into economic hubs that serve as safe and healthy homes for their residents. It offers solutions not just to economic and logistical challenges but also to social and environmental issues plaguing cities around the world, including public health crises and natural disasters.
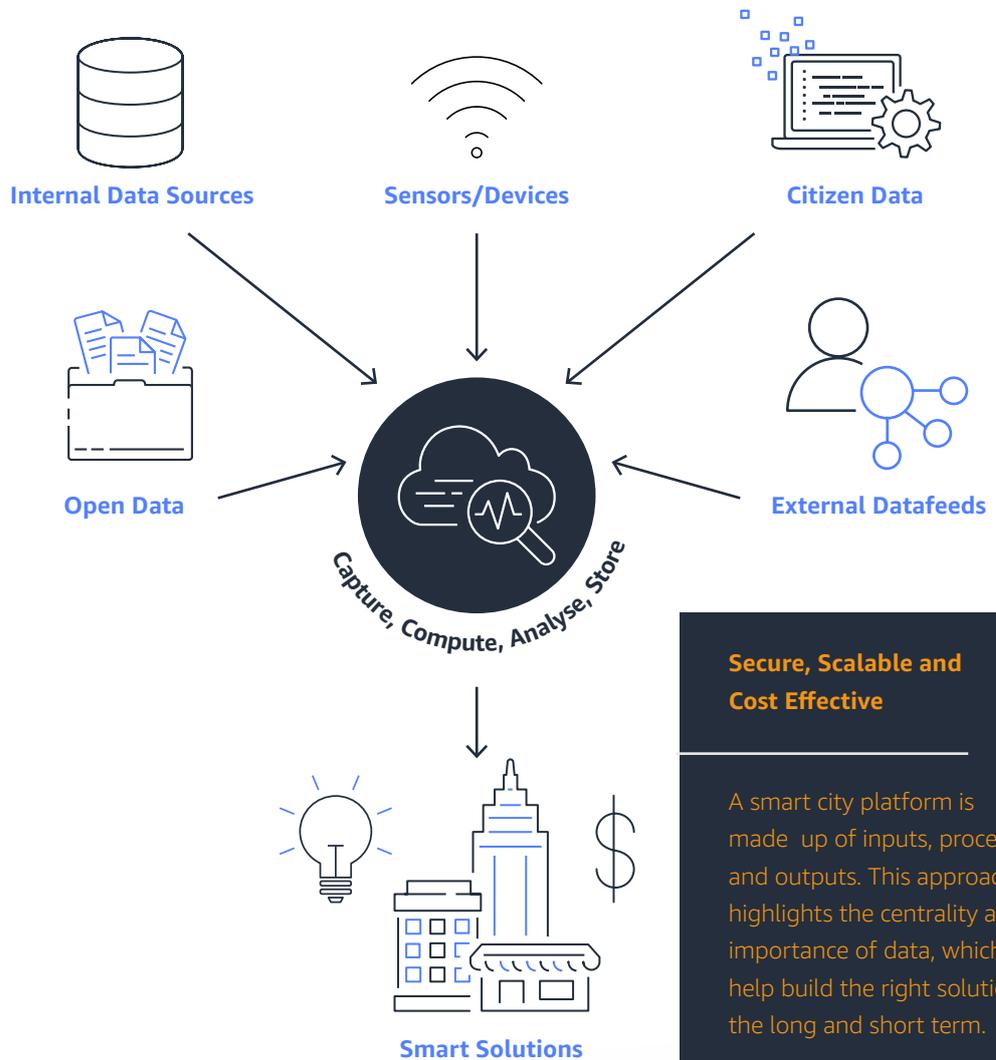
Data, and the technology used to collect it and turn it into insights, are a means to an end: to better serve residents. Cloud technology offers a reliable infrastructure to administer services. The cloud provides data privacy and allows leaders to focus their time and resources on innovating for their residents. And even though cloud technology helps optimize resource allocation and improve decision-making, the process of transforming cities requires the leadership and active participation of citizens.

This paper examines how cities are using cloud technology to address public challenges with the framework of the Smart Cities Council global coalition. This framework promotes three core values for smart cities: **livability**, providing clean, healthy living conditions without pollution and congestion; **workability**, providing an enabling infrastructure (energy, transportation, internet connectivity) and high-quality jobs; and **sustainability**, doing so at no cost to future generations, as the Council puts it. This paper proposes a fourth core value, **inclusivity**: provisioning services to all city residents regardless of their background.

[1] United Nations Department of Social and Economic Affairs

Data Alone Is Simply That

Internal Data Sources

Sensors/Devices

Citizen Data

Open Data

External Datafeeds

Capture, Compute, Analyse, Store

**Secure, Scalable and
Cost Effective**

A smart city platform is
made up of inputs, processes,
and outputs. This approach
highlights the centrality and
importance of data, which can
help build the right solutions for
the long and short term.

Smart Solutions

**Cities generate overwhelming amounts of data. This provides opportunities as well
as challenges, including how disparate types of data are integrated and used.**

Existing systems data, historical trend data, and other relevant data from third-party
sources offer valuable insights. Decision-makers can tap into this data to visualize, explore,
and build sophisticated analytics using machine learning (ML) and artificial intelligence (AI).
These real-time insights can help government and business leaders make smarter choices,
respond more effectively to the needs of city residents, and offer better solutions to
unforeseen incidents, from weather to security threats.

Cloud technology facilitates the collection, secure storage, analysis, and dissemination of
data to aid this process. It does this in an affordable and secure way that helps leaders
meet their goals and ensure compliance with the appropriate regulations.

Livability

Smart cities use data produced by internet-connected devices to derive insights and improve residents' quality of life, measured by health, work-life balance, education, social connections, personal security, civic engagement, environment, and subjective well-being.

That's according to the Organization for Economic Cooperation and Development (OECD)[2].

> **Cities worldwide are using AWS Cloud to manage public transportation, street lighting, healthcare delivery, resident payments, and more.**

Same data, more intelligent insights

Technology offers city leaders new ways to derive value from data. Travelers to Sydney, Australia, have many choices when it comes to public transportation. From ferries to metro lines to buses and light rail, the state of New South Wales (NSW) maintains one of the world's largest public transportation systems in terms of geography, in addition to regional roads. Transport for NSW, the government agency responsible for managing this system, issues Opal RFID transport cards that are used by most passengers for public transport services. Passengers can also tap onto the Opal network using their credit card, debit card, or linked device. From 2018 to 2019, Transport for NSW's train patronage alone comprised 424 million passengers, followed by bus patronage at 349 million.

AWS helped Transport for NSW gain visibility on public transport networks, including platform level, forecast planning for operational efficiency and customer experience, near real-time insights, and an agile innovation funnel delivery framework.

To improve the customer experience and better connect communities, [Transport for NSW](#) continually invests in technology, especially big data processing. AWS is a partner of the [Future Transport Digital Accelerator](#). The Accelerator facilitates direct collaboration between the public and private sectors by connecting teams from the NSW transport cluster with industry partners and startups in the digital space.

Cities such as Jakarta, Semarang, Melaka, and others across 35 countries use the AWS Cloud to manage their street lighting. They leverage web applications to analyze, plan, and maintain workflow management with [Philips CityTouch](#), a lighting management system for public lighting. CityTouch helps provide immediate and up-to-date information to help cities monitor how much energy streetlights are using and which ones need maintenance services. It helps municipalities make decisions for the better use of resources by monitoring, controlling, and measuring their light management system.

[2] [OECD Better Life Index](#)

A new vision for the data-driven city

In India, the Ministry of Housing and Urban Affairs (MoHUA) launched its **Smart Cities Mission (SCM)** with the goal to develop 100 smart cities in India. As the solutions were being implemented across the country, they felt a need for a central platform that would plug into a vast array of sources, analyzing both real-time and archival data to deliver actionable insights for the cities. This led to the concept of India Urban Observatory, which is now the heart of SCM's vision. Hosted on AWS, the solution can seamlessly integrate a wide range of solutions and sources. This decision also enabled MoHUA to launch fast— moving from idea to execution in just five weeks, while giving it the flexibility to scale from 500 datasets to 500,000. Now, MoHUA can collect and analyze data from many sources to build more accurate insights across cities and improve governance and public services. This helps develop new best practices, future strategies, and new policy frameworks.

To drive its Smart Cities Mission, India's Ministry of Housing and Urban Affairs launched a new cloud-based data analysis platform in just 5 weeks.

Selangor, Malaysia, collaborated with AWS to scale and make the most of the data the state collected. With AWS user and data management services, the state gained insights. The AWS-based **CEPat platform** aimed to incorporate all state and local government services with multiple e-payment channels from credit cards, online banking, and 46 e-wallets that currently operate in the state. It caters to four million users in Selangor, and later enabled transactions between e-wallets and the development of a government marketplace to drive the cashless economy in Selangor. The aim is to give citizens a seamless experience in their cashless transactions. CEPat allows users to make a payment on all government services on one platform. This includes assessment bills, parking summons, and applying for a trader's license. The app can also be used to make payments for parking as it is linked to the local councils' database. Users will be notified whenever their payments are due, ensuring they make a payment on time and avoid penalties.
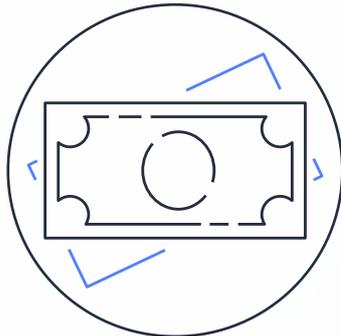
Improving city and healthcare services

Regardless of their level of economic development, countries find it challenging to meet the health needs of their populations. One of the challenges is making sure people living in remote locations or who are more vulnerable to traveling to physically visit a doctor have access to trained health workers. Scalable telehealth applications proved to be beneficial to patients during the COVID-19 pandemic, which accelerated the demand for telehealth for remote consultations.

Another example of rapid communication with citizens is NSW Health Pathology, which provides effective public pathology services to citizens. It is an integral part of the New South Wales public health system (known as NSW Health). They developed an SMS solution that reduced negative test result wait times from seven days to just hours. This helps to relieve anxiety for citizens and allows clinicians to dedicate more time to assisting patients who test positive. By automating this process, NSW Health Pathology saved the equivalent of three years in the manual time it would have taken to individually contact tens of thousands of people with their negative test results and makes sure that focus is maintained on those most in need. NSW Health has transformed many of its business and clinical support services, as well as its healthcare services in response to COVID-19. Video conferencing and other forms of telehealth have become important tools for NSW Health during the pandemic. They are being used to provide care for patients with COVID-19 and services to patients whose care would have otherwise been delayed or disrupted because of COVID-19. Video conferencing services enabled many staff who provide business and clinical support services to work from home, allowing services to continue while keeping staff safe. Compared to the same period last year, NSW Health has seen an 18-fold increase in the use of its video conferencing platform. The accelerated adoption of many of the technology initiatives to support the COVID-19 response has created opportunities for longer-term changes to the health system. NSW Health's digital arm, eHealth NSW, is already drawing up plans on how to sustain and accelerate these changes.

3 years of manual time saved with an automated COVID-19 test result reporting solution that notifies patients by SMS

In Thailand, Doctor Raksa offers patients access to affordable, convenient, on-demand, and secure healthcare consultations in minutes, compared to an in-person hospital visit that would often require hours of traveling and waiting time. The majority of Doctor Raksa's infrastructure runs on AWS, which allows the organization to focus more on delivering the best patient experience possible by tapping into more than 700 registered doctors across 30 specialties, and integrating with hospitals, insurance providers, and pharmacies to keep patient data consistent and online prescriptions within reach. Doctor Raksa currently has more than 400,000 active patient users and conducted more than 100,000 consulting sessions in the past three years. They continue to look at new ways to innovate through the use of ML to assist physicians in performing preliminary diagnoses.

In India, Dozee has been working with the Chennai Municipality, Ministry of Ayush, and the All India Institutes of Medical Sciences (AIIMS) to provide remote patient monitoring during COVID-19. This helps keep nurses safe from infection and reduce their workload. It is also working with leading hospitals and telemedicine companies to accommodate quarantine COVID-19 patients. Dozee uses the Amazon Simple Queue Service (Amazon SQS), Spot Instances, and the Amazon Simple Storage Service (Amazon S3), which give its core operations of computing and healthcare data processing reliability and scalability. The pay-per-use model provides for cost-effectiveness and allows Dozee to focus on optimizing its core operations. As a result, they are able to make better solutions for the healthcare problems they are tackling.

Juniper manages aged care facilities in Western Australia and is able to support business continuity and connect residents with family and clinicians by rolling out AWS remote work and learning solutions. The organization uses Amazon Chime to facilitate communication between its communities. With Amazon Connect, they can distribute recorded information. And using Amazon WorkSpaces, they can enable employees to work from home.

Cloud-based telehealth and virtual care solutions help providers offer affordable, convenient, on-demand, and secure consultations – during the COVID-19 pandemic and beyond.

Workability

Cities must ensure that residents have opportunities to learn relevant skills, find jobs, and gain access to educational resources. Data is critical to understanding and addressing challenges in education and workforce development, as well as in identifying industry needs and creating career pathways that begin in K12 and extend to the workforce.

Data is also important to developing apprenticeship and training programs and designing partnerships with educators, employers, and non-governmental initiatives. Increasingly, cities are looking to bridge the chasm between the skills of today's graduates and the skills required by the job market. The skills gap currently prevents many cities from reaping the benefits of technology and embracing the process and impact of digital transformation. Governments, private enterprises, and educational and nonprofit organizations all have a role to play in bridging this gap.

The skills gap

In India, the National Skill Development Corporation (NSDC), a nonprofit set up by the Ministry of Finance under the public-private partnership model, helps Indian citizens develop the skills they need to succeed. Their mission is to promote the development of skills among Indian students through the creation of large vocational institutions, and they have trained more than 5.2 million students to date. NSDC needed to find a scalable and agile technology platform to cater for the skilling and re-skilling needs of over 400 million people in India. They also needed to find cost-effective support for internal enterprise resource planning (ERP) systems. NSDC now uses AWS to run applications for their Skill India Portal Learning Management System (LMS), Skill Management and Accreditation of Training Centres (SMART), as well as its SAP S/4 HANA ERP system. They can now handle high transaction volumes on their applications and manage their internal systems in a cost-effective manner.

> **The cloud is powering a scalable, agile technology platform that addresses the up-skilling and re-skilling needs of more than 400 million people in India.**

In the Philippines, AMA University is innovating in education and workforce development. AWS helps AMA University service their students through Amazon Elastic Compute (Amazon EC2) for their Moodle learning management system (LMS). This makes it available to their full-time students as well as to cross-enrollees from other schools to help completion of failed subjects, Overseas Filipino Workers (OFWs) for continuing education, and the Professional Regulatory Commission (PRC) for citizens looking to get a professional license.

Innovation in education

In Australia, EdTech company Arludo built a library of almost 30 mobile apps hosted on AWS that are designed to improve students' engagement with science, using augmented reality (AR) and analytics technology. Its founder, UNSW Associate Professor Michael Kasumovic, planned that its next step would involve the creation of an eight-week in-person program to bring his science technology into schools. When that idea was curtailed by the COVID-19 outbreak, he taught himself the essentials of webcasting instead.

> **"Now we have a full online immersive course where we bring scientists to students wherever they are, and they can do experiments with scientists in real time. Our goal from the beginning was to create a system where kids who live in remote areas can interact with science online, so when COVID-19 came along, we were already prepared."**
>
> Michael Kasumovic, Associate Professor, UNSW

Kasumovic said he has had a great response to the course, which uses gaming techniques to help students learn about topics ranging from how memory works to how animals forage. One course lets students build and study animals like fiddler crabs by using augmented reality so there is no need to bring them to kids in the classroom.

In Indonesia, EdTech startup **Simak Online** is currently adopted by 510 elementary and high schools and adding hundreds more since the Indonesian government transitioned schools to an online teaching environment during the COVID-19 pandemic. By leveraging Amazon Aurora and Amazon EC2, Simak is able to scale quickly and reliably during peak access of 45,000 concurrent users per hour to facilitate communications between parents, teachers, and students. They have migrated over 100 new schools to AWS since the start of March to cater to this increased demand.

Simak provides an online education and administration platform to help parents keep track of their children's progress in schools and conduct surveys. They use AWS to provide an online exam platform that enables teachers to customize examination questions for individual students according to their competencies, and this has helped them in their learning. To date, Simak has generated more than 2.3 million exams and over 600,000 exam questions for Indonesian schools, with 1.5 million homework tasks completed by students.

Simak's online teaching environment can scale quickly and reliably during peak access of 45,000 concurrent users per hour.

Sustainability

City leaders must consider the social, economic, and environmental impact at the core of their planning. Cities must create resilient environments for growing populations and make it easy for future generations to uphold these sustainable behaviors.

Cloud technology plays a key role in sustainability: its inherent environmentally friendly services help organizations reduce their carbon footprints. It also supports emergency preparedness and disaster response.

It's greener in the cloud

Cloud technology helps organizations in the public and private sectors cut their environmental footprint by making more efficient use of servers. Customers use only the services that they need, which prevents them from wasting capacity and power. In fact, AWS chief evangelist Jeff Barr estimates that using AWS represents an 88-percent reduction in carbon emissions for customers when compared to on-premises data centers.[3]

In addition to helping organizations globally meet their sustainability goals, AWS has committed to achieving 100 percent renewable energy usage for its global infrastructure and it is already halfway there.

> **Using AWS represents an 88 percent reduction in carbon emissions for customers when compared to on-premises data centers.**

Disaster response

When disasters strike, information can mean the difference between life and death. In Jakarta, Indonesia—one of the most densely populated cities in the world—citizens are using social media to report and obtain information on extreme weather conditions.

The University of Wollongong's PetaBencana platform utilizes the power of social media combined with government agency validations to gather, sort, and display real-time information for disaster risk management. It produces city visualizations of disasters in Indonesia that harness the heightened use of social media and instant messaging during emergency events to gather confirmed situational updates from street level in a manner that removes the need for time-consuming data processing. The tool integrates crowdsourced data with data from other origins, including government agencies and water level sensing devices, enhancing data accuracy. The cloud enables immediate collection and analysis of data from various sources, as well as the transfer for mapping and decision-making. In 2017, the US Federal Communication Commission recommended the project as an example of best practice for disaster information crowdsourcing.

[3] Barr, Jeff. Cloud Computing, Server Utilization, & the Environment, AWS News Blog, June 5, 2015.

Powered by AWS, in order to filter through the noise of social media and collect verified crowdsourced disaster reports, the software listens for specific keywords in social media posts (such as "flood") and sends programmatic invitations asking users if they would like to contribute to community disaster mapping. Humanitarian chatbots guide users to submit anonymous flood reports through four steps: verify their location, record flood heights, add photos, and add descriptions.

PetaBencana uses AWS IoT services to manage sensor devices and collect data from deployments in the field. Specifically, it uses the Amazon Relational Database Service (Amazon RDS), AWS Elastic Beanstalk, and Amazon EC2 instances to collect social media and flood gauge data. It also uses Elastic Load Balancing, Auto Scaling, and Amazon Route 53 to securely transmit data for mapping; and Amazon Rekognition to sort images submitted by community members via social media. These reports are displayed on a public map in real time, alongside relevant emergency data collected by local agencies (such as river water levels). Government emergency management agencies monitor the platform to assess the disaster situation, respond to resident needs, and, as part of a transparent two-way communication system, update the map with time-critical information in order to alert residents to the severity of the flood. By integrating localized knowledge from a variety of sources into a single, robust platform, PetaBencana is able to provide a comprehensive overview of disaster events, enabling residents, humanitarian agencies, and government agencies to make decisions that are more informed during emergencies. Since its launch in 2013, PetaBencana has been used by millions of residents to make time-critical decisions about safety and navigation during emergency flood events, and it was adopted by the National Emergency Management Agency to monitor flood events, improve response times, and share time-critical information with residents. PetaBancana has proved so powerful a tool that it has expanded to four cities in Indonesia, reaching more than 50 million residents.

PetaBencana's AWS-powered solution is used by four cities and more than 50 million residents to make time-critical decisions about safety and navigation during emergency flood events.

Emergency preparedness

In the government of the Australian Capital Territory (ACT), the Emergency Services Agency (ESA) is the organization charged with providing emergency management services to the Canberra community and works closely with its counterparts across the country. The ESA operates cutting-edge specialist intelligence gathering (SIG) that allows for live video streaming and spatial data collection of fires. With both standard and infrared camera capabilities, SIG provides fire line and hot spot information directly to the ESA incident management teams in real time.

Reliably streaming live video and data from a helicopter presents many environmental challenges, including limited bandwidth and an ever-changing geographical environment. Fast, efficient processing of information is necessary. Solutions can be expensive and

complex to operate, often requiring costly infrastructure. To meet the needs of emergency services that can adapt with the changing fire seasons, the ESA worked with AWS Partner Network (APN) partner Bigmate to architect a solution that could best service the ACT community and be interoperable with other jurisdictions if required.

They selected AWS because it offered a complete suite of interoperable services, including AWS Elemental MediaLive, and allowed for expansion driven by business need rather than technology.

Underpinned by MediaLive for video transcoding and automatic archiving, the solution processes incoming video to extract, process, and store spatial data using AWS Lambda. All the video files and spatial data are then made accessible securely through private Amazon S3 buckets and applications residing in Amazon EC2. If additional helicopters are added, the solution can rapidly scale to accommodate the required changes.

Sometimes it is not just governments but also nonprofits who are innovating on behalf of the public. Systems to predict extreme weather and improve flood resilience are also valuable in developing countries with limited resources and connectivity. In 2013, Cambodia was hit by floods that affected nearly 1.7 million people, killing 50 and displacing hundreds of thousands. More than a third of those affected had no idea that a flood was coming. In the aftermath of the flood, People in Need, a nonprofit organization, developed a flood detection system to predict future floods and automatically send mobile message alerts to people in affected areas. This open-source, early warning system is hosted on the AWS Cloud and allows for speedy analysis and delivery of messages to thousands of residents.

People in Need is using AWS to scale an early warning system in Cambodia that alerts about 400,000 subscribers when floods threaten. Based in the Czech Republic, People in Need is a nongovernmental, nonprofit organization engaged in humanitarian and development work in more than 20 countries. The People in Need early warning system runs both sensor technology and an open-source IVR solution using Amazon EC2, Elastic Beanstalk, Auto Scaling, and ELB.

In India, Quantela, a provider of smart urban infrastructure automation, has developed the CoVER (COVID-19 emergency response) platform hosted on AWS Cloud. CoVER is used by government authorities across 10 cities in India to monitor, manage, track, diagnose, communicate, collaborate, and prevent the impact of COVID-19. In one of the large cities in South India that has so far reported far fewer COVID-19 cases, they used CoVER to track about 120 hospitals, 600 ambulances, and 400 isolation beds, as well as monitor people in quarantine. Officials quoted real-time access to data and quick decision-making among the key measures that helped the city contain the spread of COVID-19, even in densely populated areas, and significantly reduce the infection rate in the city.

Real-time data from the cloud-based CoVER platform helped city officials contain COVID-19, even in densely populated areas.

Inclusivity

As city leaders look to transform digitally, they must first ensure that new technologies respond to the needs of their constituents. Specifically, the voice of residents should be front and center in new technology adoption.

Leaders must also design their cities in ways that include underserved communities and marginalized groups, such as those struggling with alcohol addiction and those living in remote locations. Cloud technology is facilitating the process of learning about these groups while making sure their data is safe, and offers a diverse array of services to respond more closely to their needs.

Helping people cope

An Australian nonprofit organization Hello Sunday Morning (HSM) is helping people change their relationship with alcohol. It offers users pathways to professional health support and a community of like-minded individuals looking to change their alcohol consumption habits. In 2016, HSM introduced Daybreak, an application designed to facilitate access to this community online. This allowed users to share posts with each other about their sobriety journeys and have one-on-one conversations with health coaches.

Through Daybreak, Australians can anonymously seek personalized around-the-clock support on their mobile devices at no cost. To date, the app has garnered close to 80,000 downloads and serves around 7,000 monthly active users.

The COVID-19 outbreak led to lockdowns across the nation, which led to 25 percent of adults drinking more than what they were consuming prior to the lockdowns, according to a national poll commissioned by the Foundation for Alcohol Research and Education in April 2020.

> **The Daybreak app has been able to support ten times more users since integrating with AWS - with no increase in costs.**

Due to its digital accessibility, Daybreak rose in popularity, as face-to-face support groups for alcohol-related problems were unable to conduct regular in-person meetings.

With its prior experience with AWS, HSM found the all-in migration to be a seamless process. With its workloads consolidated onto one service provider, HSM is now able to meet the needs of more who have found themselves cut off from support—up to 35,000 weekly active users, ten times more than before AWS integration—with no increase in costs.

In recognition of Daybreak's success in supporting Australians struggling with alcohol consumption before and during the pandemic, the Australian Government bolstered Hello Sunday Morning's funding by AU$1.5 million.

HSM is working on a substantial rebuild of Daybreak, which will include capabilities to facilitate self-reported data collection among users, such as the posts they share within the app's community. This will help HSM better understand how some users—including those who have successfully reduced their reliance on alcohol—use the app in order to design an experience that has increased chances of helping others reduce their alcohol consumption. HSM is exploring the use of AI and ML models to rapidly identify posts shared by users on the app that could indicate a need for intervention, facilitating a quicker response from medically trained professionals.

> **"AWS was best placed to help us manage the Daybreak app in a secure, flexible, and scalable manner."**
>
> Gustavo Gambarini, Lead Software Engineer, HSM

In Singapore, voluntary welfare organization We Care Community Services also experienced an increase in demand for counseling sessions due to the toll that COVID-19 has taken on people's mental health. As a result, it changed out its in-person counseling sessions for video calls and its physical call center for Amazon Connect, which enabled staff to take calls from home and connect people with counselors, doubling the number of therapy sessions to 900 hours during COVID-19 compared to the same period last year. The switch to AWS enables We Care to continue some of their programs online even when the center reopens and potentially benefit people who do not live near the center.

Underserved communities

Simplifying the delivery of citizen services in rural communities is a challenge facing cities around the world. The urban population of the world has grown quickly but that does not mean there is not a significant number of rural populations that are underserved. The global rural population is now close to 3.4 billion, with Africa and Asia home to nearly 90 percent of the world's rural population in 2018. India has the largest rural population (893 million) followed by China with 578 million.

In India, JioVio developed an end-to-end solution that can provide personalized and predictive healthcare using AI, IoT, and wearable technology. JioVio works closely with hospitals and governments. They have developed solutions to address the different needs of old people and pregnant women in urban and rural markets. Savemom is a med-tech project aimed at reducing maternal and infant mortality and morbidity with timely and appropriate care during the first 1,000 days of pregnancy. The kit consists of a physical activity wearable that monitors information about the pregnancy and maintains patients' digital records via an app hosted on AWS.

The Allotricorder is a connected medical device that enables vitals to be collected even in remote locations. Savemom developed and deployed their solution on AWS, which can easily be accessed by remote doctors and hospitals, while they are also using advanced technology from AWS Route 53 for Secure Socket Layer (SSL) and hosting services. The solution has been deployed in over 70 tribal villages in three states of India.

Also in India, Common Service Centres (CSCs) act as access points to digital government services. By bringing these services to rural and remote locations, CSC helps to make India a more digitally and financially inclusive society. In order to deliver these valuable e-governance services, CSC required a scalable, cost-effective solution. They also needed to reduce response times and increase reliability. CSC built a solution that brought together AWS content delivery, storage, management, and high availability services to simplify the delivery of citizen services in rural India. With this in place, CSC paved the way for innovation, giving people in remote areas access to new technology and the benefit this brings.

Empowering underrepresented groups

Cloud technology fuels entrepreneurship by reducing barriers to entry for entrepreneurs. It allows them to build secure, smart, and scalable businesses while staying lean—a key success factor in any startup's early stages of development. From building secure, reliable websites to using ML-powered customer service chatbots, the cloud provides a wide array of solutions. It helps startups eliminate unnecessary spending by first providing services that startups no longer have to build from scratch and, second, by charging only for the services used.

In doing so, the cloud democratizes access to opportunities for entrepreneurs with limited capital or technical backgrounds. It allows anyone with an idea to start building. This makes a huge difference to entrepreneurs who may not have access to capital or networks.

In addition to these services, programs such as AWS We Power Tech helps make sure individuals from underrepresented groups have opportunities to learn skills and pursue careers in the technology sector. It provides training and mentoring opportunities and collaborates with nonprofits who share its mission of empowering diverse groups to achieve their professional goals.

> **The cloud democratizes access to opportunities for entrepreneurs with limited capital or technical backgrounds. It allows anyone with an idea to start building.**

Leading Change

The challenges facing city leaders today are complex. Fortunately, many of the answers lie within the data, and cloud technology is empowering leaders to take action.

While technology alone cannot solve these problems, it is part of a solution that empowers leaders to make timely and effective decisions to improve people's lives. To truly succeed, leaders must engage with residents and ensure they are partners in bringing about change.

Protecting data

Tsukuba City, Japan, wanted to build an online voting system where anyone can vote at any time. Their infrastructure required a high-spec system that would be able to handle blockchain. AWS was the ideal choice since it allowed Tsukuba City to build the system in a short amount of time, to verify each voter's identity to protect against falsification and loss of voting data, to maintain data integrity, and to securely manage the system by reading a person's ID card when they voted.

Open data in action

Why do we share open data in the cloud? The premise behind open data is that the best way to get value out of data is to make it available to as many people as possible. More real-time data and insights have helped to improve operational efficiency.

The Land Transport Authority (LTA) of Singapore is a government agency responsible for all land transport development, policies, and enforcement. It is key to the economic development of Singapore. Transporting over 2.2 million users a day, the LTA has a lot of activity and touchpoints generating public feedback that must be quickly responded to, which led LTA look at the cloud as an alternative. AWS provided a more cost-effective solution with a faster roll-out time, and the CIO no longer had to worry about disaster recovery. LTA began using AWS for web hosting instead of building their own data center and experienced a 60 percent cost saving when compared to an on-premises infrastructure.

60% Cost savings with AVS compared with on-premises infrastructure (Land Transport Authority of Singapore)

Another example from Singapore is OneMap, an integrated map system for government agencies in Singapore that delivers location-based services and information. Developed by the Singapore Land Authority (SLA), it functions as a collaborative environment for citizens, the private sector, and the community to use open data to create government Geographic Information System (GIS) websites and applications. For example, OneMap apps can help people decide where to buy a house.

In India, SatSure works with the Kerala government to aid its flood relief efforts. The startup's cloud-based data platform provides end-to-end managed analytical services for governments to monitor, track, and plan their resources and programs in the areas of agriculture, forestry, and smart cities.

AWS helps SatSure accelerate analysis and reduces turnaround time by as much as 10 times compared to what is possible using workstations. As satellite imagery is the primary input for SatSure's solutions, using the Registry of Open Data on AWS reduces the transaction cost and time to source the datasets for analysis and their storage. Creating a streaming data ingestion and analytics stack using Amazon Kinesis data pipe has been instrumental in doing field data collection for retraining the AI/ML algorithms built by SatSure using Amazon SageMaker ML services.

The Japanese city of Sabae built an open data platform on AWS and released open data in over 20 categories: statistical data about population and temperatures, locations of disaster shelters, municipal parking lots and spaces for wheelchairs, data about facilities like fire hydrants and AED defibrillators, data about tourism and the local assembly, maps, and more. Citizens and private companies use this open data in a wide range of ways.

Open data use in Sabae is not a one-way street. When a resident discovers a pothole that needs fixing, for example, they can use their smartphone to take a picture of it and upload the image to an app called Sabarepo. The image is used as open data to fuel civil services based on citizen participation. Once the citizen uploads an image, a city employee goes to inspect the site, decides what needs to be done and how urgently it needs to happen, and arranges for repairs.

Sabae's AWS-based open data platform is stable, just like the city wanted.

"Our open data platform offers information about where disaster shelters are located, that sort of thing. If a disaster occurs, more people than usual will try to access the data all at once. If we took the regular approach of building our own on-premises facilities with enough capacity to meet such surges in demand, we'd have to maintain considerable resources that are completely superfluous while nothing out of the ordinary is going on. That would be very costly. With cloud services, you don't have to worry about how to scale up or down to meet demand."

Katsuhito Takashima, Head of Information Statistics Division – Policy and Management Department, Sabae (Japan)

Conclusion

City leaders around the world can consider the examples cited in this paper as they plan for the future. From predicting the weather and improving public transportation routes to mitigating complex public health crises, leaders have a plethora of technology resources available to them. There's no shortage of data to help inform their strategies and ultimately make cities more resilient. What leaders do with this data, and how effectively they involve their constituents in the solution, will determine their success.
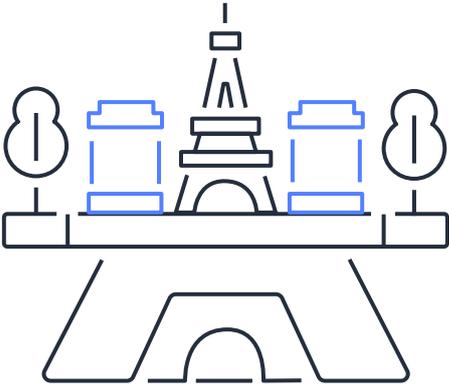
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