Interactions with unreliable infrastructures could be key to smart city design

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The advance toward smart cities promises improved quality of life through vast networked computing systems and integrated technologies that connect major public systems and infrastructures.

While the push toward smart cities appears to promote monolithic, centrally managed infrastructures, research from a team at Penn State's

College of Information Sciences and Technology shows that one-size-fits-all solutions could be met with resistance if they don't consider the daily experiences of citizens or allow them to adapt their own solutions, particularly in areas with historically unreliable infrastructures.

"We make a lot of assumptions about infrastructure, like the water supply, particularly in wealthy countries," said Jeffrey Bardzell, professor and associate dean of undergraduate and graduate studies at the College of IST. "We assume that there's a single infrastructure, like an electrical grid; that it's reliable; and that we want to make it smart."

But even in places like the U.S. where these assumptions often hold true, infrastructures are increasingly vulnerable to climate events that are often more impactful than what they were designed to accommodate. And when they do break down, how will citizens respond?

To study this challenge, the researchers interviewed residents and analyzed local media coverage about individuals' interactions with the unreliable water system in a single, non-western community—Pune, India.

Due to rapid population growth and the infrastructure's inability to keep up, not just in physical materials but also in its management, Pune cannot reliably provide water to every resident. Despite this unreliability, city officials are pushing for Pune to become the next smart city. However, Pune is far more likely to have embedded sensors and computational management—thus making it smart—before it will ever reliably provide water to all the city's residents.

As a result, residents have created their own patchwork system of municipal water, tanker services and unregulated borewells to get the water they need.

"It may be as simple as just adding a bucket to store water, but that becomes part of the infrastructure," said Shaowen Bardzell, professor at the College of IST. "This resourcefulness is important because rather than waiting on the municipal system to fix the issues like we might do in the U.S., Pune residents will come together with ad hoc and lightweight solutions."

Ultimately, these layers of innovative, resource-sensitive workarounds—or jugaads—built from residents' efforts to maintain access to water reflect a coevolution of citizens and infrastructures that more closely reflects the community's history, culture and daily practices.

The researchers also suggest that Pune residents are likely better equipped than individuals in wealthier areas to handle this unreliability because they are used to managing its effects and have ownership in ensuring the infrastructure remains functional.

This can lead to citizens resisting municipal intervention that may take away the individual's agency in the system by further legitimizing the system—for example, by automating reports on individual water usage.

The researchers note how this convergence between being a citizen and being a user is critical in the design of smart cities. As cities become smart and individuals become not only residents but also users, some may be left out.

"When we design technology, we make assumptions around an ideal user about what they know and what they're trying to do. But who is the ideal user of smart cities?" asked Tejaswini Joshi, a doctoral student in Penn State's College of IST. "Our research shows that public utilities are a lot more flaky and that citizenship is often more sophisticated, which needs to be accounted for when we design smart cities."

Added Shaowen, "Technologists tend to think about system design as creating something that's perfect, that will stand the test of time. But we should design in such a way that's open and that allows for jugaad, for people to appropriate the system in such a way that they can do what they need with the system to actually enable them to live."

To the researchers, this decentering of Western thinking is key to expanding what smart cities mean and how we view them. Ultimately, these solutions should be made visible to encourage citizen participation in the co-creation of infrastructures and leading toward a redefinition of citizenship.

Concluded Shaowen, "If you only think about something like creativity or infrastructure in Western-based cases—particularly when you talk about smart cities—then you will only conceptualize Western-based solutions."

The work will be published in the October 2021 proceedings of the ACM Conference on Computer-Supported Cooperative Work and Social Computing, and is supported by the National Science Foundation.

More information: Conference: cscw.acm.org/2021/

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