Smart Cities: A Force of Innovation and Concern

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According to the World Health Organization (WHO), in 2010 approximately 80.8% of the American population lived in urban areas (WHO, 2019). In 2014, WHO reported that "urban population … accounted for 54% of the total global population, up from 34% in 1960" and these numbers are rising (WHO, n.d.). Rising urban populations can strain water supplies and waste disposal capacity, and increase energy consumption (National Geographic, n.d.).

Smart cities may manage such stresses more efficiently. According to CISCO, a leading provider in smart city technology: "a smart city uses digital technology to … enhance the lives of citizens" by "collect[ing] and analyz[ing] data from … sensors and video cameras" (CISCO, n.d.). A smart city network, the Smart Cities Council, claims that its goal is "to create smart, sustainable cities with high-quality living and high-quality jobs" (Smart Cities Council, 2015). Grow Smarter, a smart city interest group, claims that "in total 52,000 citizens have directly benefitted" from its projects (Clement et al., n.d.). CTIA, a trade association that "bring[s] together … companies that enable consumers to lead a 21st Century connected life," asserts that "smart cities will power economic growth and produce significant benefits" (CTIA Mission, n.d.; CTIA About, n.d.).

But smart cities' implications are complex and controversial. Social groups are competing to influence perceptions smart cities. Participants include companies, like CISCO, that sell the requisite technology. Trade associations and interest groups, such as CTIA, "advocat[e] for policies to support smart city growth (CTIA About, n.d.). Some citizens are

enraged in the smart city movement; others are critical of it. Smart cities will disappoint if residents do not use “all the potential that is offered” (Klimovsky, Pinteric, & Saparniene, n.d.).

Smart cities can improve urban sustainability, efficiency, security, and social services. However, they can also induce public distrust and encode bias against minority groups.

Review of Research

Cities produce “60 percent to 80 percent of energy consumption, and 75 percent of carbon dioxide emissions” (Barrionuevo, Berrone, & Ricart, 2012). According to Barrionuevo Berrone, and Ricart (2012), cities “can function as habitable and sustainable ecosystems.” Promoters of smart cities contend they will contribute “long-term sustainability … by tackling pollution, managing water efficiently, and supporting green buildings and alternative energy.” However, success will require that residents “be invited to participate at every step of the way” (Barrionuevo, Berrone, & Ricart, 2012). Smart cities will disappoint without citizen engagement. Klimovsky, Pinteric, and Saparniene (2016) find a “correlation between education, occupation and age and the use of” information and communications technologies.”

Technology can disadvantage some social groups. Older people tend to reach technological barriers due “lack of instructions and guidance, lack of knowledge and confidence, health-related barriers, and cost” (Clausen, Gow, & Vaportiz, 2017). Study subjects have reported that they “just want the simplest” devices (Clausen, Gow, & Vaportiz, 2017). Minority groups tend to be disadvantaged too, because “many poor neighborhoods lack the infrastructure that is available in affluent areas” (Dayton, 2001). Technology is essential to smart cities and “without basic knowledge of [technological] skills, one can be lost” (Dayton, 2001).

Technology can "drastically modify human behavior" (Bavelier, Green, & Dye, 2010). According to Bavelier, Green, and Dye (2010), "a direct causal relationship has been established between the action game experience and the behavioral outcomes." In some cases, "good" technologies, such as baby learning DVDs, "report negative effects," whereas "bad" technologies, such as video games, produced benefits, like improved short-term memory (Bavelier, Green, & Dye, 2010).

The benefits of technology can be seen in the COVID-19 pandemic. The virus caused a shift online as "companies [are] forced to embrace remote working" (Hern, 2020). According to Twitter's head of HR, "working from home doesn't change your day-to-day work, it just means you'll be doing it from a different environment" (Hern, 2020). The increased reliance on technology allows people to mitigate in unforeseen situations.

In cities, transportation is a major concern. City transportation "must serve a growing population and cope with worsening highway congestion" (NASEM, 2018). Transportation is vital to a cities' society and economy and a conversation "about how the country should respond to these challenges is urgently needed" (NASEM, 2018).

Compared to rural areas, "the carbon footprint is consistently higher in cities" (Baiocchi et al., 2013). Bigger cities have higher emissions as carbon footprint size "generally correspond[s] with" a city's "share of the population" (Jiborn et al., 2018). While fast "growing cities … contribute a minority share to the global footprint," this "can be expected to change as [these] cities grow in … infrastructure, population, and affluence" (Jiborn et al., 2018).

Promoters of smart cities

Quality of Life Improvement

Smart cities can improve the quality of life for residents. A good quality of life "means attracting new residents" and "will … boost a city's economic prospects" (Coolfire, 2019). The main goal of smart cities "is to respond more effectively … to the needs and desires of residents" (Peeples, 2018). "Smart cities need to focus on … enlisting … active participation in shaping the places" their residents "call home" (Peeples, 2018). Smart systems "allow cities to better understand and provide for their citizens' wants and need (Coolfire, 2019). Improvements can be seen in a reduction of "urban fatalities by 8 to 10 percent" and a reduction of "their health burden by 8 to 15 percent" (Andrews, 2018).

Transportation Efficiency

Smart transportation aims to fix transportation issues in cities. Smart systems aim to do this by "incentiviz[ing] city residents … to switch from private to public transport" (HereMobility, n.d.). Smart transportation systems use cars that "share real-time data about road conditions and … surroundings" which can give the smart city data, "enabling incident response, traffic optimization, and traffic re-routing." Other systems enable commuters to choose transportation that "brings them to their destination at the speed, convenience, and price they desire" (HereMobility, n.d.).

Smart transportation systems also increase safety. They can "alert the driver to hazards" and "keep the driver aware of what is in the blind spot" (Fourtané, 2018). These systems "could mitigate traffic collisions … by exchanging basic safety information" and "facilitate cooperative maneuvers between automated vehicles" (Fourtané, 2018).

Smart cities can use systems to create efficiency in parking. Cities have issues of "not enough parking spaces," "poor use of available parking spaces," "difficulty finding vehicles," as

and several other problems (IoT For All, 2019). IoT For All (2019) asserts that "smart parking will reduce fuel use" and that "drivers will … save money and time with denser, easier parking." The systems will "also serve to reduce traffic and help the city run more efficiently" (IoT for All, 2019).

Environmental Benefits

Smart city systems are environmentally beneficial. Smart applications "can produce results such as 10-15% fewer GHG emissions" (Johnson, 2018). Applications "translate … data into alerts, insights, and actions" which "inspire better decisions and behavior change" (Johnson, 2018). Non-environmental focused improvements, such as transportation, "lead to fewer GHG emissions" and other secondary benefits (Johnson, 2018).

Smart cities enable a sustainable use of natural resources. San Diego took the revolutionary approach to sustainability with "intelligent street lights and solar-powered charging stations" (Iqbal, 2018). Sensor usage in cities allows "citizens and government to review and make changes swiftly to improve city services and amenities" (Iqbal, 2018). Smart garbage "prevent[s] overflows and eliminat[es] unnecessary … pick-ups" and attempts to "limit … dependence on rubbish bins" (Iqbal, 2018).

Better Healthcare

Smart city improvements enable better health care services for residents. Technology "improve[s] healthcare effectiveness and lower[s] … cost for" residents (Cook et al., 2018). Data collection "helps healthcare be smarter" and allows city services to "respond promptly to urgent health needs and make decisions to avoid unhealthy situations." Monitoring at the community

level “allow[s] physicians to access additional records … for a population of individuals with similar health conditions.” The adoption of technology “can reduce costs for the city and its citizens.” In home technology can “aid in determining if there are changes in a resident’s health” and “also offer insights on the effects of known conditions in daily life” (Cook et al., 2018).

Smart healthcare can improve the overall healthcare system. The connectivity “help[s] … citizens … to communicate with authorities …and … help[s] authorities … gather more health data … which … can be used to inform further city and service planning” (Choudhary, 2019). Technologies, like artificial intelligence, “are very critical in making healthcare … a service that is pertinent to the lifestyle of the modern citizen” (Choudhary, 2019). Smart systems “help to make [healthcare] an area of constant enhancement that will … invent new ways of keeping people … healthier (Choudhary, 2019).

Smart Manufacturing

Smart systems allow manufacturing to be more efficient. These systems allow “insight to the business at every link in the supply chain” (Kennard, 2016). Using smart systems both “increase safety and efficiency, as well as … decreas[e] cargo journey time and” improve “in logistics efficiency.” Instead of replacing human labor, smart manufacturing “give[s] increase in several other types of career” to support the technology (Kennard, 2016). Kennard (2016) asserts that manufacturing can work with smart cities to revolutionize the buying and selling of goods.

Smart manufacturing helps smart cities to exist. Smart industry “enable[s] effective applications and reduce[s] dependences on overburdening infrastructure through … focus on efficiency and effectiveness in its production” (Hobcraft, 2019). Smart city data collection enable[s] a planner to make more informed decisions, and design new … business model

alternatives that are cleaner and immersive" (Hobcraft, 2019). Hobcraft (2019) assert that "the lessons and practices from Industry 4.0 will give Smart Cities integrative capabilities."

Critics of Smart Cities

Unnecessary Complexity

Smart cities introduce the issue of technology failing and becoming out dated. Technology is constantly evolving which will cause smart cities to "be exceedingly complex to manage" (Saxe, 2019). Saxe (2019) asserts that "tech products have a short reliable life span" which is unacceptable in infrastructure that "is designed to last decades or centuries and must always work." Necessary replacements cause a "disruption and cost" as well. Smart cities are an "unnecessarily complicated approach to solving challenges with more direct solutions." Saxe (2019) argues that "excellent dumb cities" are the better route because while "tech has a place in cities, … that place is not everywhere."

Smart city proposals show ideas that seem better than they are. Smart cities can result in "projects that are … outright useless from a practical standpoint" (Mitchell & Truschel, 2020). Government officials are presented with "cost-benefit analyses … that seem too good to be true" because "estimates and cost projections … fail to account for the unexpected" (Mitchell & Truschel, 2020).

Data Risks

Smart cities may introduce new privacy risks. "Technical or design solutions" can neglect "citizens themselves and their privacy concerns" (Zoonen, 2016). Lee Tien, a lawyer for the Electronic Frontier Foundation, claims that "Cities don't know enough about data, privacy or security" (Williams, 2019). In March 2018, the city of Atlanta's internal computer system was

hacked, causing “outages on various internal and customer facing applications”; the network was “compromised” (Deere, 2018). Smart cities gather vast information. Companies such as Sprint “collect data from users … including their home ZIP codes, internet searches and location” (Williams, 2019); companies seldom disclose data collection practices, inducing distrust. In San Francisco, civil liberties groups “express unease about…potential abuse by government” of facial recognition systems, claiming they may lead to an “oppressive surveillance state” (Conger, Fausset, & Kovaleski, 2019).

Future of Privacy Forum, a nonprofit aiming to protect privacy in the face of emerging technologies, warn of smart cities’ threat to data privacy, such as “revealing personally identifiable information to the public” and the risk that algorithms “reinforce existing societal bias … and block opportunity for diverse populations” (Future of Privacy Forum, n.d.) The Future of Privacy Forum also warns of surveillance, data spills, and unexpected uses of data. Such threats must be addressed because the “success of particular applications … may depend more on citizens’ perceptions of privacy and security risks than on the actual technological, design or policy guarantees of privacy” (Zoonen, 2016).

Smart health care systems put confidential patient information at risk. Smart home systems bring new “ways for intruders to hack into these homes” (Cook et al., 2018). Smart houses allow burglars to potentially “obtain details about residents living patterns in order to more effectively break into a house.” Mobile health apps collect information that can “identify the user” and “also track [the user’s] current location and predict future locations” (Cook et al., 2018).

Minority Discrimination

Smart cities allow for prejudices to be exposed and acted upon. New technologies "provide state law enforcement and security agencies the perfect tools to intrusively track and target ethnic minorities" (Begault & Khazrik, 2019). The use of these technologies to create a "digital police state" can be seen by viewing the Chinese Xinjiang Uighur Autonomous Region's use of the technology to "surveillance and repress … Muslim ethnic groups in the region" (Begault & Khazrik, 2019). A Kansas City Council member, Quinton Lucas, stated his "concern about monitoring inner cities in a different way than other neighborhoods" with a primary concern being "the detriment of young black men" (Williams, 2019).

Studies have shown that technology itself can show prejudices against minority individuals. The American Civil Liberties Union (ACLU) released a study on facial recognition software concluding that "nearly 40 percent of false matches … were of people of color, even though they make up only 20 percent of" the test group (Barrett, 2018). This facial recognition "increases the ability of law enforcement to surveil individuals not suspected of crimes" (Barrett, 2018). This presents problems in minority communities that are already wary police surveillance. It has been observed that "when [a] community is hostile toward a particular minority group, police may feel that discriminatory behavior toward that group is justified" (Encyclopedia Britannica, n.d.). The ACLU asserts that "police abuse is a serious problem … [that] seems to defy all attempts at eradication" (ACLU, n.d.).

Police abuse of surveillance technology can be seen in the use of the Stingray system. Mappings revealed that most Stingray deployments are "overwhelmingly in … cities' most intensely segregated non-white neighborhoods" (Joseph, 2016). In the city of Baltimore, "90 percent of Stingray incidents" were mapped in areas "where residents are overwhelmingly African-American" (Joseph, 2016). Tallahassee mappings also revealed that surveillance "hit

low-income residents disproportionately, especially in … non-white (mostly black) communities" (Joseph, 2016). This "means that … people in … majority-non-white neighborhoods are … more likely to have … locations and call data seized by police, even if they are not suspected of … a crime" (Joseph, 2016). Movement for Black Lives organizer, Maurice Mitchell, claims that surveillance shows that "people … don't value the basic humanity of these folk enough to raise questions about their civil liberties" (Joseph, 2016).

Government Distrust

Some residents suspect manipulation. Technology is "making [them] susceptible to new, dangerous forms of manipulation" (Stanley, 2014). Fears arose "that the government would use" manipulation "to control the beliefs of the population" instead of "reflect … beliefs as it should" (Stanley, 2014). Technology embedded in day to day life causes psychological reactance in residents as it is "more covert … often involuntary, occurring without … awareness or consent" (Marx, 2001).

Some cities collect revenue through deals with suppliers, risking citizen distrust. In Chicago in 2016, vendors shared revenues from red-light cameras with officials. Judge Virginia Kendall stated that such conduct "erodes faith in our government," and trust "takes years to rebuild" (Kidwell & Meisner, 2016). Corruption is a weapon that "undermines livelihoods, justice, health, resilience, safety, and democracy" claims Smart Cities Dive, a journal that shares news on city trends (Zinnbauer, n.d.). Zinnbauer (n.d.) asserts that "efforts to improve public health," a major goal of smart cities, relies "largely on controlling corruption.

Healthcare Detriments

Smart healthcare has the problem of depersonalizing the healthcare field. Technology can "harness data from all patients … in every … hospital in America" (Verghese, 2011). Smart systems create a virtual patient; however, "the real patient in the bed often feels neglected" (Verghese, 2011). Verghese (2011) asserts that the patient becomes "a mere placeholder for the virtual record." The focus on a virtual patient creates a barrier between patients and doctors as the traditional "examination of … patient[s]" can be "the key to earning … their trust." Verghese (2011) asserts that "it is paramount that doctors do not forget the importance of … ritual" that patients expect.

Smart healthcare also poses ethical risks toward patients. If artificial intelligence is used in the healthcare industry "before it has been well validated for clinical use" it could "produce bad outcomes for patients" (Ward, 2019). There is concern that "AI systems may assume authority they don't deserve" and that they "may control clinicians' decisions and workflow." Sometimes doctors must "use things that [they] do not understand and cannot explain" and it would be dangerous to hold "algorithms that require [them] to understand these things." Doctors should instead use these systems to "help [them] learn about things [they] don't understand" (Ward, 2019).

Conclusion

Smart cities are a complex sociotechnical phenomenon. Both high-tech and low-tech innovations are necessary. Engineers and technology companies tend to favor high-tech, but low-tech offers advantages in terms of simplicity and cost, and may be an essential complement to high tech. Discarding current systems for high-tech replacements will create new problems that might be more costly to fix. Past innovations and designs are essential to future success and

should not be discarded. Instead, they should be used in part with technology to bring the future that humanity desires. Innovation is a process of taking what exists and improving to create something new.

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