Latin American Cities in the Fourth Industrial Revolution: The Potential and Social Risks of Smart-Cities Technologies

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ABSTRACT

In the wake of the implementation of smart-city technologies in Latin American cities, this article reviews both their potential for making municipal administration and local service delivery more efficient and the risk they pose, particularly to vulnerable communities. Based on the literature and the international experience on the social and policy effects of algorithmic decision-making, it proposes a few criteria that local and national governments in the region should keep in mind to prevent some of the undesired effects that the implementation of these tools may have, while harnessing their benefits.

1. INTRODUCTION

Digitalization is transforming cities all over the world, and Latin American large cities are not the exception. Perhaps the most intuitive example is how the Internet of Things (IoT) has transformed mobility.[1] As a user, think, for example, of ride-hailing apps like Uber, apps that let you know in advance when the next train or bus is coming, and traffic navigation apps like Waze. Municipal governments, however, use similar apps to gain real-time knowledge about traffic in cities, and to monitor and plan their transportation systems and policies more accurately and efficiently. These technologies have changed the way we move, live, think, and plan cities, and they all depend on the spread of smartphones, sensors, and internet connectivity. In Latin American cities, where 80 percent of the regional population lives in urban areas and around half of the total urban population of Latin America lives in relatively few large cities, these technologies promise to be potential solutions for the many challenges that the high rates of urbanization pose for local and national governments.[2]

This article reviews the potential and challenges that smart-city technologies pose for Latin American cities from a legal and social policy perspective. I refer to these technologies as smart-city technologies, as they are referred to in the technology market, but refrain from referring to Latin American cities as "smart," as we still have a way to go to get there.[3] As they are implemented in the region's cities—and especially so in fields that have considerable impact on people's lives, from healthcare to security and criminal justice systems—I propose a few criteria that local and national governments in the region should keep in mind to prevent some of the undesired effects that the implementation of these tools may have, while harnessing their benefits. These recommendations are based on the literature and the international experience on the social and policy effects of algorithmic decision-making.

2. "SMART-CITY" TECHNOLOGIES: WHAT THEY ARE AND THEIR POTENTIAL

Smart-city technologies are technologies specifically oriented to use data collection and analytics to make all sorts of service provision in cities more efficient. Cities are great sites for data collection. The agglomeration phenomenon that creates cities—in which people and businesses situate themselves geographically close to each other because of the information and knowledge spillovers that result from this—facilitate the harnessing of data that can be aggregated and read together.[4] Indeed, connected sensors, satellite images, and widespread smartphones produce massive amounts of data that facilitate better mapping by remote sensing, gathering environmental and other city-related data, and citizen behavior data.

Analyzed together, this information can be used to increase the efficiency of all sorts of local services, ranging from utility provision (like smart electricity and water grids), to planning and operating public transportation, managing traffic in real time, dealing with air pollution, monitoring a city's security, and even fostering local entrepreneurship and business, as this data is shared with private parties who might use it too, to start their own business and/or provide additional local services.[5] Consequently, the potential of smart-city technologies expands to all sorts of fields related to urban life, and connectivity allows for greater citizen engagement and use of information to engage more actively with the city and the city government. As a report by McKinsey Global Institute puts it,

> "Smart technologies can help cities meet these challenges [infrastructure, environmental and delivering a better quality of life], and they are already enabling the next wave of public investment. It all starts with data. Cities, in all their complexity and scope, generate oceans of it. Finding the insights in all that data helps municipal governments respond to fluid situations, allocate resources wisely, and plan for the future. Furthermore, putting real-time information into the hands of individuals and companies empowers them to make better decisions and play a more active role in shaping the city's overall performance. As cities get smarter, they become more livable and more responsive—and today we are seeing only a glimpse of what technology could eventually do in the urban environment."[6]

Though Latin American cities still lag behind in some of the aspects that power smart-city technologies, particularly in installing a sensor layer, they have started implementing these technologies already, oftentimes with good results.[7] Initiatives like free WiFi, smart electric grids, smart water resources management, bike-sharing systems, and so on are spreading in the region.[8] Santiago, Chile leads most international rankings as the city that has made the most progress in this direction,[9] but other cities like São Paulo, Buenos Aires, Bogotá, Medellín, Río de Janeiro, and México City follow closely. They have all started developing a technological basis of sensors, communication infrastructure, and open data portals, and they are deploying smart-city applications in realms such as mobility, security, utilities, healthcare, and economic development.[10] Cities in the region have also created "smart" complexes, to promote urban renovation and local entrepreneurship, like Ciudad Creativa Digital in Guadalajara, Ruta N in Medellín, the Parque Tecnológico City Tech in Manizales, and the IBM Control Center in Rio de Janeiro.[11] Also, alongside national policies in over 20 Latin American countries, Medellin, Bogotá, São Paulo, Rio de Janeiro, Buenos Aires, and many other cities have open-data portals that promote citizen engagement, local entrepreneurship, and transparency.[12]

The private sector and public-private partnerships are key in these developments. As the local startup and innovation environment flourishes, local players like

Rappi, Easy Taxi, Jetty, and Supercívicos are offering urban services and changing the way people live in cities. Quipux, for example, is a Colombian company that provides technology solutions for over 50 cities, most in Colombia and Brazil, to improve public transportation by collecting data on private and public vehicles, drivers, and public transportation routes.[13] Supercívicos is a Mexican startup that won a prize as the best "urban government app" in the World Summit Awards in 2018. It allows citizens to report problems in infrastructure and utility provision.[14] Bogotá has begun contracting, and Medellín and São Paulo have started implementing, systems of "intelligent street-lights" that regulate lights according to the flux of traffic and the pace of pedestrians.[15] In the security realm, since 2016 Bogotá has implemented a security data-based strategy that allowed it to identify that 30 percent of crimes took place on 1 percent of the city streets, and then used that information to carry out police interventions on those sites, significantly reducing property crimes like robbery.[16] São Paulo, too, has a crime-monitoring system developed by Microsoft and New York City that improves crime investigation, prevention, and patrolling by indexing large amounts of police information.[17]

In the mobility sector, traffic navigation apps, ride-hailing services, taxi-calling apps, public transportation information apps, bike- and scooter-sharing platforms, and even applications that tell users where to park are all widespread in the region's main cities.[18] Mexico is Uber's second-largest market after the US, and Latin America is the largest, fastest-growing and most profitable region for the ride-sharing giant.[19]

Additionally, as connectivity and smart-phone use increases, the potential for these and future businesses and also government-led applications grow: Latin America is not only the most urbanized region in the world, but the world's second-fastest-growing mobile market in the world. It has around 200 million smartphone users (out of 640 million people), and it is the region with the second-largest social media presence after North America.[20] Predictions state that by 2020, 63 percent of the population in the region will have access to mobile internet.[21] National governments are making important efforts to increase internet connectivity in the region via broadband and cable.[22] Consequently, there is great potential in the region for using these technologies to tackle the many challenges that come with our urban present and future.

3. RISKS AND CHALLENGES THAT SMART-CITY TECHNOLOGIES POSE FOR LATIN AMERICAN CITIES

As previously mentioned, data-gathering and algorithmic analytics are at the core of all smart-city technologies. The literature and international experience suggest, however, that there are several important challenges with these data-driven solutions of which local and national governments should be aware. Here, I focus on the social impacts that the adoption of algorithmic decision-making can have, especially on some of the most vulnerable communities.[23] Particularly, I focus on the undesired harms that the implementation of algorithms may generate, which might be aggravated if they are seen as neutral tools that can solve problems, and on the privacy risks of citizens that the vast amounts of data collection entail.

The challenge of the unjustified harms created by algorithms has been widely documented in other contexts, and it refers to the fact that although these tools often improve the provision of services and officials' decision-making processes, they can also unjustifiably harm individuals when implemented. In the US, for example, the use of decision-support software in judicial decisions "uncovered evidence of racial bias, finding that when the effect of race, age and gender was isolated from criminal recidivism risk, 'black defendants were

77 percent more likely to be pegged as at higher risk of committing a future crime and 45 percent more likely to commit a future crime of any kind.'"[24] The same is true in other fields. In the banking sector, low-income students did not receive student loans because they were considered too risky based on the place they live, limiting their access to education and opportunity.[25] Some of these mistakes are based on the fact that a substantial portion of human-made decisions that the datasets used as input might have been biased and prejudiced, and consequently inaccurate in the best scenario. The algorithms' outcomes were similarly inaccurate (though sometimes to a lesser degree).

These types of results are problematic and relevant in the city context too, and especially in fields that have significant social impact, such as urban security (e.g. where policemen are assigned, and who gets arrested). Research in Colombia has shown, for example, that police inspections are more common in low-income neighborhoods and among low-income persons and, unsurprisingly, arrests are more common in these populations.[26] However, statistics also show that domestic violence is equally common in rich and poor households, and that drugs are sold and consumed among youth from all social backgrounds.[27] Because algorithms that help policing activities often take information about former arrests and crimes to tell police officers where crimes are likely to occur in the future, the algorithms may end up reinforcing existing prejudices, such as that low-income people are more likely to be violent and consume or sell drugs. They could also maintain the individual and social harms that follow from putting youth from poorer backgrounds through the criminal justice system, in a disproportionate and unfair way.[28]

Policymakers and government officials adopting smart technologies should thus pay close attention to the potential social effects of the decisions made and recommended by these systems. Algorithms can be taught to correct biases, but for this to work they must be programmed to do so. Local governments and tech companies must thus be careful about the impacts of these technologies and evaluate them constantly.

Indeed, the implementation of these systems is not done in the abstract, but rather within the structure of local legal and social structures. Thus, they will not solve complex urban issues by themselves, and governments should be careful not to divert attention and resources away from important sectors and non-tech-driven policies to technological tools, with the hope that adopting technologies will be a quick fix for social issues. For example, focusing exclusively on crime detection and deterrence should not stop policymakers from implementing broader measures that prevent crime in the first place, which can be as far-reaching as providing education and spaces for extra-curricular activities for especially at-risk youth.[29] In a similar way, solutions that seek to improve mobility by coordinating traffic might mean little if the public is not educated to use more public transportation. The point is that technology alone does not provide neutral and optimal solutions to social problems, and that technology alone is not a primary mechanism of social change.[30]

Technologies are in fact shaped by the social and economic contexts in which they are developed, and then they become a way of settling an issue in a particular community, like the bias in policing example above shows.[31] Regarding the context in which the technologies are designed, the point is that the engineers and companies that design algorithms, though well-intended, may have different worldviews of what a particular community needs and values than the community itself. Additionally, the interests and incentives of these companies and designers matter too. These interests, worldviews, and incentives, however, influence the final technology, and they are increasingly relevant from a policy

and legal perspective when these technologies have important social consequences.

To counter-balance these risks, the implementation of these technologies should be accompanied by careful analysis of the type of data that is being used to "teach" the algorithms, and careful analysis of the results and decisions proposed by the algorithms, for which community engagement might be key. Making available clear explanations of what the algorithms do with this information might be key to ensure some democratic accountability[32] (to the extent that it is technically possible).[33] Some have suggested that the fairness and eventual usefulness of a given technology should be evaluated with counterfactual analysis of the effects that the design, implementation, and use has on the well-being of individuals.[34] The algorithm's decision-suggestion should also be controlled in several ways: for example, taking into account constitutional standards of non-discrimination and human rights, and encouraging community engagement to ensure that the implementation of these technologies responds to local issues, and in ways that are meaningful to the communities themselves. This might help guarantee that the implementation of those decisions don't harm already vulnerable communities in disproportionate and unfair ways.

Finally, the vast amounts of data collected by smart-city technologies suggest that there is risk to citizens' privacy, as both local governments and commercial actors may end up having access to vast amounts of citizens' personal data. Additionally, in the context of smart-city technologies that collect personal data in public spaces, the typical way to protect citizens' privacy—to ask for consent—is useless.

There are some strategies from the field of systems engineering that aim at tackling this problem, and that should be included in the contracts that local governments sign with smart-city technology providers. An example of a strategy to tackle this risk is that privacy be taken into account throughout the design process of these applications, so that the devices are designed to not collect, or collect less, sensitive and personal data—what has been called privacy by design. The new European regulation on data protection has incorporated privacy by design in its mandates.[35] However, it is unclear how useful these mechanisms are in big-data contexts, in which the size of the database may reflect personal information about a particular individual even when that particular information was not collected. Differential privacy is another strategy, in which random data is incorporated into the data sets used so that an observer (a government or company, for example) may not recognize particular individuals, without significantly damaging the value of the data to make policy decisions.[36] From a policy perspective, protocols and laws that protect citizens from the uses of this type of data in ways that might be harmful to them must be passed and strictly enforced.

4. CONCLUSION

Smart-city technologies are valuable tools to drive social change and development, and to address many of the social and policy challenges of providing local services in growing cities. Their implementation, however, is still associated with certain risks, and poses questions of equality and social justice. As they are implemented in Latin American cities, national and local governments, as well as the private sector, should be aware of them to be ready to address them. This paper has been a first attempt to map some of the main risks that they represent, so that they can be prevented when these technologies are implemented.

NOTES

[1]The Internet of Things, or IoT, refers to a system of devices, such as vehicles, home appliances, smart phones, and street sensors that contain

computational technology that allow them to interact, transfer, and exchange data over a network without the need of direct human intervention.

[2]BBVA Research, "Urbanization in Latin America," July 2017, accessed 9 December 2018, p. 3, https://www.bbvaresearch.com/wp-content/uploads/2017/07/Urbanization-in-Latin-America-BBVA-Research.pdf.

[3]According to Christos Cassandras, "The emerging prototype for a Smart City is one of an urban environment with a new generation of innovative services for transportation, energy distribution, healthcare, environmental monitoring, business, commerce, emergency response, and social activities ... the ultimate value of a Smart City's infrastructure lies in 'closing the loop' that consists of sensing, communicating, decision making, and actuating—rather than simply collecting and sharing data." Christos G. Cassandras, "Smart Cities as Cyber-Physical Social Systems," *Engineering* 2, no. 2 (June 2016): 156.

[4]Jane Jacobs, *The Economy of Cities* (New York: Random House, 1969); Edward Glaeser, "Introduction to Agglomeration Economics," in *Agglomeration Economics* ed. Edward Glaeser (Chicago: University of Chicago Press, 2010), 1-14.

[5]Federal Trade Commission, "The 'Sharing Economy': Issues Facing Platforms, Participants & Regulators," November 2016, accessed 31 January 2019, https://www.ftc.gov/system/files/documents/reports/sharing-economy-issues-facing-platforms-participants-regulators-federal-trade-commission-staff/p151200_ftc_staff_report_on_the_sharing_economy.pdf;

Nestor M. Davidson and John J. Infranca, "The Sharing Economy as an Urban Phenomenon," *Yale Law & Policy Review* 34, no. 2 (2016): 216-279.

[6]McKinsey Global Institute, "Smart Cities: Digital Solutions For a More Livable Future," June 2018, accessed 31 January 2019, ii, https://www.mckinsey.com/~/media/McKinsey/Industries/Capital%20Projects%20and%20Infrastructure/Our%20Insights/Smart%20cities%20Digital%20solutions%20for%20a%20more%20livable%20future/MGI-Smart-Cities-Full-Report.ashx.

[7]McKinsey Global Institute, "Smart Cities," 10.

[8]See, for example, the website of Smart City Expo Latam 2018, which took place in Puebla, México: https://smartcityexpolatam.com/.

[9]McKinsey Global Institute, "Smart Cities," 10.

[10]McKinsey Global Institute, "Smart Cities," 10.

[11]CCIT and Fedesarrollo, "¿Qué tan inteligentes son las ciudades colombianas?" Coyuntura TIC, April 2016, accessed 9 December 2018, http://www.ccit.org.co/wp-content/uploads/que-tan-inteligentes-son-las-ciudades-colombianas-abril-de-2016-fedesarrollo.pdf.

[12]Michael Steinberg and Daniel Castro, "The State of Open Data Portals in Latin America," Center for Data Innovation, 2 July 2017, accessed 4 December 2018, https://www.datainnovation.org/2017/07/the-state-of-open-data-portals-in-latin-america/.

[13]Quipux, "Soluciones para prestación de servicios de tránsito y transporte," n.d., accessed 29 November 2018, http://www.quipux.com/soluciones-transito-transporte.html.

[14]Supercivicos, "¡Los Supercívicos ganan mundial de innovación para México! Su app es reconocida como la mejor plataforma de gobierno y participación ciudadana," 27 November 2018, accessed 8 December 2018, https://www.supercivicos.com/los-supercivicos-ganan-mundial-de-innovacion-para-mexico-su-app-es-reconocida-como-la-mejor-plataforma-de-gobierno-y-participacion-ciudadana/.

[15]Alcaldía Mayor de Bogotá, "Así funcionarán los semáforos inteligentes en Bogotá," 29 December 2017, accessed 9 December 2018, http://www.bogota.gov.co/temas-de-ciudad/movilidad/asi-funcionaran-los-semaforos-inteligentes-en-bogota.

[16]W Radio, "Bogotá aumentará tecnología de punta para fortalecer la seguridad," 19 October 2016, accessed 5 December 2018, http://www.wradio.com.co/noticias/bogota/bogota-aumentara-tecnologia-de-punta-para-fortalecer-la-seguridad/20161019/nota/3278223.aspx

[17]Athima Chansanchai, "Microsoft and São Paulo Government Partner to Release Crime Monitoring System," *Official Microsoft Blog*, 16 April 2014, accessed 4 December 2018, https://blogs.microsoft.com/blog/2014/04/16/microsoft-and-so-paulo-government-partner-to-release-crime-monitoring-system/.

[18]See, for example, Waze, Uber, Cabify, Easy-Taxi, Tapsi, Moovit, and Grin Scooters.

[19]Nathan Lustig, "Latin America is the Next Stage in the Race for Dominance in the Ride E-Hailing Market," *Techcrunch*, 7 September 2018, accessed 31 January 2019, https://techcrunch.com/2018/09/07/latin-america-is-the-next-stage-in-the-race-for-dominance-in-the-ride-hailing-market/.

[20]GSMA, "Mobile Internet Users in Latin America to Grow by 50 Percent by 2020, Finds New GSMA Study," 20 September 2016, accessed 27 November 2018, https://www.gsma.com/newsroom/press-release/mobile-internet-users-in-latin-america-to-grow-by-50-per-cent-by-2020-finds-new-gsma-study/.

[21]GSMA, "The Mobile Economy: Latin America

and the Caribbean 2017," 2017, accessed 27 November 2018, https://www.gsmaintelligence.com/research/?file=e14ff2512ee244415366a89471bcd3e1&download.

[22]A good example is the program "Colombia Vive Digital." See http://www.vivedigital.gov.co/.

[23]These are, however, definitely not the only challenges. Other key challenges are related to whether some of the data collected by private actors should be made available to the cities, and what data should be made available to the public. Another one is whether these apps and technologies really relieve congestion and make cities more sustainable or not. These challenges, however, go beyond the scope of this paper.

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[25]Cathy O'Neill, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* (New York: Crown Publishers, 2016).

[26]Sebastián Lalinde, "Los positivos no tan positivos de la Policía," Semana, 15 September 2015, accessed 9 December 2018, https://www.semana.com/opinion/articulo/sebastian-lalinde-las-metas-que-los-policias-deben-cumplir-hace-que-cometan-arbitrariedades/442609-3.

[27]Jimena Patiño Bonza, "Golpes que no se ven," El Tiempo, 5 July 2018, https://www.eltiempo.com/carrusel/violencias-invisibles-contra-la-mujer-en-colombia-239724;

Laura Galindo, "Así está Colombia cuando hablamos de consumo de drogas," Pacifista, 8 May 2018, accessed 6 December 2018, http://pacifista.co/colombia-consumo-drogas/.

[28]Ben Green, *The Smart Enough City: Putting Technology in its Place to Reclaim our Urban Future* (Cambridge: The MIT Press, forthcoming 2019).

[29]Interestingly, this was General Naranjo's comment to the security system in Bogotá, referred to above.

[30]Green, *The Smart Enough City*, 4.

[31]Langdon Winner, "Do Artifacts Have Politics?" Daedalus 109, no. 1 (1980): 121-136.

[32]The concept of algorithmic transparency is controversial, however.

[33]Robert Brauneis and Ellen Goodman, "Algorithmic Transparency for the Smart City," *Yale Journal of Law and Technology* 20, no. 103 (2018): 103-176.

[34]Micah Altman et al., "A Harm-Reduction Framework for Algorithmic Fairness," Berkman Klein Center for Internet and Society, Research Publication 2018-3, 3 August 2018.

[35]European Parliament and European Council, *Article 25 Regulation (EU) 2016/679 on the Protection of Natural Persons With Regard to the Processing of Personal Data and on the Free Movement of Such Data (General Data Protection Regulation)*, 27 April 2016.

[36]Cynthia Dwork, "A Firm Foundation for Private Data Analysis," *Communications of the ACM* 54, no. 1 (2011): 86-95.