

RESEARCH ARTICLE

Digitally Enhanced Violence Prevention in the Americas

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Latin America is one of the world's most digitally connected regions, and also its most violent. Some governments and civil societies are evolving innovative and dynamic approaches to address the challenges of violence by taking advantage of expanding connectivity. New information and communication technologies (ICTs) are being mobilized to strengthen the voice and capabilities of citizens and institutions to promote safety and security. Public and private actors are designing and applying innovative digital platforms and analytical tools to map insecurity online and off. This article reviews the emerging character and shape of *digitally enhanced violence prevention* in Latin America, drawing primarily on the cases of Brazil, Colombia, and Mexico. It presents insights on the wider outcomes and drawbacks of these activities, and sets out some lessons learned and recommendations for future action.

Introduction

Latin America is the developing world's most digitally connected region, but also the most violent. To be sure, Latin America is witnessing a digital revolution: almost half of its population is online, and the continent is fast becoming the planet's largest producer and consumer of social media (Diniz and Muggah 2012). Part of this surge is driven by sustained economic growth and the demographic and sociocultural constitution of societies in Central and South America. Yet Latin America also features the world's highest rates of organized and interpersonal violence, with most perpetrators and victims under the age of thirty. While not confronted with war in the conventional sense, many societies bare all the hallmarks of warfare (Tinderman 2013).

Some governments and civil societies are evolving innovative and dynamic approaches to address these challenges, in some cases

taking advantage of expanding connectivity. There is some evidence of the mobilization of information and communication technologies (ICTs)² to strengthen the voice and capabilities of citizens and institutions to prevent and reduce violence. Governments, private businesses, activist groups, and citizens are applying new digital platforms and tools to map insecurity. They are drawing on big and small data mining techniques, including from official sources and social media. Taken together, these initiatives are generating new avenues for understanding the transformation of violence while also creating opportunities for new forms of prevention and reduction.

This article reviews the emerging character and shape of ICTs for violence prevention in Latin America. In drawing primarily on the cases of Brazil, Colombia, and Mexico, it highlights the wider history and evolution of what we term *digitally enhanced violence prevention* across the region. It considers the density and diversity of ICTs for violence prevention since the 1990s; the factors shaping

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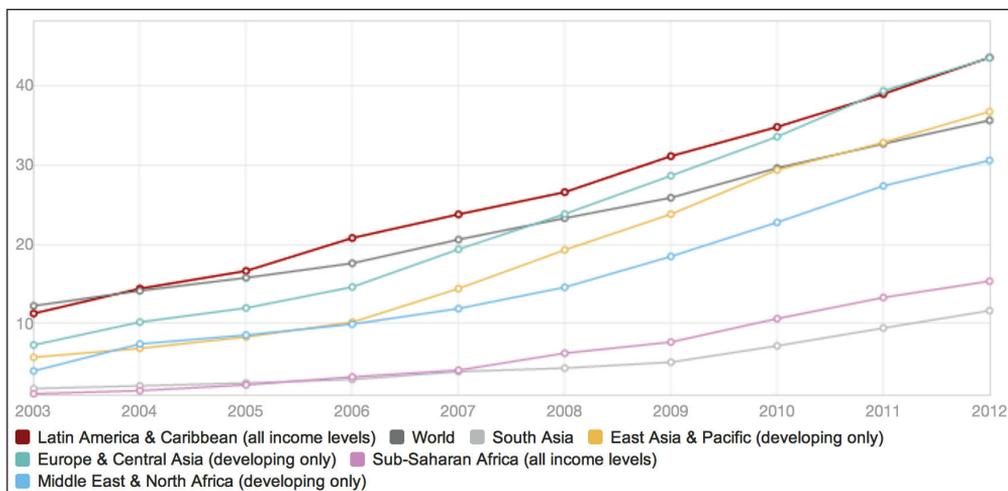


Figure 1: Internet penetration in the developing world by region (Internet users per 100 people) (Source – The World Bank – 2003–2012)

their onset and spread; the role of governments, international organizations, and citizen groups in fueling the information revolution; and wider outcomes and impact. The article also considers a number of drawbacks, such as the fear of retribution that can arise in environments where the simple act of citizen reporting is punishable by death.

This topic is comparatively new in Latin America and associated interventions are still nascent and untested. As such, this article constitutes a preliminary overview of ICTs' emergence and spread in the area of violence prevention. Thus, while issuing some recommendations on lessons learned, these are very tentative. Indeed, further research is urgently required to measure the intended and unintended outcomes of specific ICTs.

Spread and Impact of Latin America's ICT Networks

Latin America is undergoing a digital revolution having witnessed a massive regional expansion of Internet use, especially among younger population groups. Almost half of the population of Central and South America will soon be connected to the web - far ahead of counterparts in Asia, Africa, and elsewhere (see **figure 1**).³ Roughly two thirds of all users are under the age of thirty-five.

Online access has grown thirteen-fold over the past decade, with a tenfold increase in mobile subscriptions over the same period. Countries as diverse as Argentina, Brazil, Chile, El Salvador, Honduras, Panama, and Uruguay have an average of one cell phone per inhabitant, with smartphone ownership increasing rapidly (Diniz and Muggah 2012).⁴ What is more, Latin American Internet users are coming online using mobile devices, not laptops, thereby increasing the spread of certain features over others.⁵ It is worth emphasizing, however, that the regional and sub-regional distribution of users is still unequal: there are massive disparities in Internet penetration rates that also mirror the inequities between and within many Latin American societies. Indeed, there are strong correlations between Internet access and wider patterns of poverty, inequality, socioeconomic class, and urbanization (see **table 1**).⁶

Nevertheless, given the sheer scale and demographics of Latin America's digital natives, it is hardly surprising that they are amongst the world's most active users of social media. Indeed, five Latin American countries are included in the top ten most actively spending time in web-based social networks (comScore 2012).⁸ Both Facebook

Country	Internet Users	Penetration (% of population)	HDI ⁷ (global ranking 2013)
Argentina	28,000,000	66.4	45
Colombia	26,936,343	59.5	91
Chile	10,000,000	58.6	40
Uruguay	1,855,000	55.9	51
South America average	189,982,457	48.2	---
Brazil	88,494,756	45.6	85
Ecuador	6,663,558	43.8	89
Costa Rica	2,000,000	43.1	62
Panama	1,503,441	42.8	59
Venezuela	12,097,156	41.0	71
Mexico	42,000,000	36.5	61
Peru	9,973,244	36.5	77
Central America average	51,452,595	32.6	---
Suriname	179,250	32.0	105
Guyana	250,274	32.0	118
Bolivia	3,087,000	30.0	108
El Salvador	1,491,480	24.5	107
Paraguay	1,563,440	23.9	111
Belize	74,700	22.8	96
Guatemala	2,280,000	16.2	133
Honduras	1,319,174	15.9	120
Nicaragua	783,800	13.7%	129

Table 1: Internet penetration in Latin America (Caribbean not included) (Source – Internet World Stats - June 30, 2012 - and UNDP 2013)

and Twitter are spreading rapidly, reaching membership levels equivalent to upper-income settings (*Internet World Stats*).⁹ Moreover, given that populations across the region share language and cultural affinities, Latin America's cyberspace is one of the world's richest in terms of social media production and consumption. That said, Latin Americans have only started to take advantage of ICTs to express wider political and social grievances (Muggah and Diniz 2013). With the exception of the wave of massive protests that sparked in Brazil in June 2013,

Latin America has yet to witness events as intense as an Arab Spring or an Occupy movement.¹⁰ There are signs that this could change, however, as Chilean student protests and the Mexican pro-democracy movements - known as #YoSoy132 and #1DMx - attest.¹¹ As the 'protest meme' continues to spread, digital mobilization will also likely increase across Latin America in the years to come. At any rate, so far the expansion in Internet use and, by definition, ICTs, has generated a host of paradoxical outcomes across political, social, and economic arenas.

On the positive side of the ledger, there appears to be a marked surge in ICT use by governments to enhance citizen participation in elections, as well as in decision making and planning. After decades of dictatorships and repressive governance, some governments in Latin America are going online in a bid to modernize public institutions and service delivery functions through e-government platforms, and to publicize expenditures and activities through open-data initiatives. Likewise, small- and medium-sized businesses are investing heavily in e-commerce sites, while most large banks have made the shift to e-banking services. A growing number of public and private universities and schools are also investing in distance learning, while civil society groups are using the net to recruit members, raise funds through crowd-funding mechanisms, and increase public awareness (UNDP 2013: 47).¹² There are grounds for cautious optimism that such activities will grow in pace and scale. Even grassroots movements are pushing for more access to bridge the digital divide and strengthen their demands, such as the autochthon peoples of Bolivia, Brazil, and Peru.¹³

More troubling, cyberspace has become fertile territory for criminal activity. New and emergent forms of digital criminality are taking advantage of expanding (and poorly regulated) connectivity across Latin America. Much of this is economically driven and includes criminal hacking (cracking), data and identity theft, advanced credit card fraud, and phishing.¹⁴ What is more, 'old' crime is increasingly migrating online with a combination of narco-cartels and drug dealers, gang members, human traffickers, pedophiles, and others seeking recruits and also selling wares using platforms as diverse as Google, Facebook, Twitter, Tumblr, and YouTube (Cattan 2010; Womer and Bunker 2010). Latin America has seen a rise in the use of cyberspace for the open selling of illicit drugs - but also for money laundering, extortion, and other organized criminal activities - through Facebook, Orkut, and the so-called 'Deep Web'.¹⁵ In the most extreme cases, as with cartels

in Mexico, social media is effectively being 'hijacked' to send messages of intimidation and harassment to public officials, political and economic elites, journalists, activists, and others. There are widely publicized accounts of prominent social media users being targeted and killed in Latin America, and likely many more cases that go unreported (Ungerleider 2011; Blog Del Narco 2011).

There is also a 'gray zone' of social media activity that persists in Latin America, as in other parts of the world. Hacktivism in particular is growing, including with prominent engagement from major decentralized networks such as Anonymous. This and other groups have undertaken massive 'distributed denial of service' (DDoS) attacks against Latin American governments, banking establishments, and private businesses in retaliation for what they see as injustices (Kishetri 2013: 145). Often they threaten to release sensitive and confidential data to expose corrupt authorities, while in other cases they dump such information into the mainstream and independent media. While serving a 'watch dog' function on the overstretch of governments and corporations, they are also forcing a reflection on the appropriate balance between online freedom and security. Owing in large part to a relatively under-regulated cyberspace and an under-developed cyber-security infrastructure, hacktivists often cite Latin America as a safe haven for the privacy and protection of individual rights on the net.¹⁶

Governments and private sector actors are gradually responding to cybercrime and hacktivism, albeit in a piece-meal and fragmented manner. Specifically, cybersecurity interventions are expanding, targeting a whole spectrum of cybercrimes.¹⁷ Most states across the region are developing units under the framework of the Organization of American States' 'Inter-American Strategy to Combat Threats to Cybersecurity', established in 2004. The most common institutionalized responses are so-called *computer security incident response teams* (CSIRTs), the elaboration of criminal legislation for cybercrime

offenses, the formation of specialized cyber-crime units in law enforcement and justice departments, and the development within civil society of awareness-raising services and reporting on cases of digital and real violence, victimization, and human rights abuses (Diniz and Muggah 2012).

Dynamics of Violence in Latin America

While Latin America has witnessed a massive expansion and spread in connectivity and ICT use, it has also experienced an unprecedented surge in organized and interpersonal violence. And while all countries and societies around the world experience violence in distinct ways, the scope and scale of organized and interpersonal violence is markedly more virulent in Latin America. For example, Central America and the Caribbean register homicide rates of 29 and 22 per 100,000 residents respectively - three to four times the global average (UNODC 2011; Geneva Declaration Secretariat 2011). Just as alarming, it appears that homicide rates are increasing across these two regions. There are, of course, strong differences in the distribution and scale of violence and insecurity across Latin American states and cities (Muggah and Aguirre 2013).¹⁸ While a range of factors shape the high incidence of homicidal violence and victimization, there is some evidence that organized crime groups, drug trafficking organizations, and gangs (e.g. *maras*, *pandillas*) play a prominent role.

Globally, young males are four to five times more likely to be killed by violence than females.¹⁹ This is also true in Latin America, where the overwhelming majority of those perpetrating and being victimized by violence are fifteen to twenty-nine year-old males (UNODC 2011). The risk of becoming a victim is especially high within this age group: homicide rates of young people are over 35 per 10,000 in the region, more than in any other part of the world.²⁰ Given the demographic trends in Latin America - a particularly youthful region - there are concerns that the challenges of youth violence

will deepen before it improves. There are currently roughly 140 million young people in the region, and in some countries those under twenty-four years of age account for up to 60 per cent of the population (Diniz and Muggah 2012). And while countries have to some extent already reached the peak of their youth bulge, the proportion of young people in the population will remain at a high level in the coming years (Imbusch, Misse, and Carrión 2011).

No monolithic factor can explain why so many of Latin America's countries and cities present spiraling levels of violence. In Latin American societies, as elsewhere, collective and interpersonal violence remains an extremely complex phenomenon with roots that can be traced to the interaction of overlapping factors - some neurobiological, social, and cultural, with others more economic and political.²¹ Alongside structural factors are proximate 'drivers' such as arms, alcohol, and drugs, which are routinely singled out as vectors that tip social tensions into outright organized or interpersonal violence.²² Societies in Latin America and the Caribbean are in fact becoming more securitized²³, aided on by the expansion of private security companies, but less so than neighboring United States. And while these characteristics are complex and overlapping, understanding the multifaceted dynamics of criminal violence is essential for designing and implementing effective citizen security strategies that enhance state legitimacy, promote access to basic police and justice services, and ensure effective penal and prison systems.

A growing movement is oriented toward the promotion of new and innovative strategies to prevent and reduce organized and interpersonal violence in Latin America. Over the past decade, so-called *mano dura* approaches that promote repression, penalties, and incarceration have unintentionally radicalized gangs, expanded violence, and filled the region's prisons to bursting point. Across the region prisons are known colloquially as 'universities of crime', deepening

networks of gang members rather than contributing to rehabilitation. Fortunately, some enlightened leaders in the region are calling for more investment in *citizen security*, an approach that advocates people-centered security aligned to principles of democracy and human rights.²⁴ With support from international agencies such as the Inter-American Development Bank (IADB) and the United Nations, many states and cities are making progress in reversing violence and promoting social cohesion.²⁵ Indeed, governments, civil society groups, and others beginning to engage with ICTs in order to expand safety and security are doing this within the broader framework of citizen security.

Using ICTs for Violence Reduction

The use of digital tools and ICTs has the potential to re-organize the way researchers understand patterns of violence. Indeed, big-data researchers associated with large firms such as Google and Microsoft, but also Harvard and smaller research think tanks, are exploring a combination of methods to understand inductively how violence shifts and transforms in Latin America. For example, Monroy-Hernández et al have assessed social media trends and in particular Twitter hashtags to examine the drug war in Mexico (Monroy-Hernández et al. 2012; Monroy-Hernández et al. 2013). In assessing literally millions of tweets and using specialized word searches they have detected tensions between activist Twitter users, traditional media, government actors, and cartels.²⁶ They have also followed the rise of so-called civic media curators, a small number of central individuals who are responsible for a disproportionate number of violence-related real-time tweets.²⁷ Likewise, Coscia and Rios have undertaken similar assessments using Google data to track Mexican drug trafficking organizations (Coscia and Rios 2012). They have elaborated low-cost methods of gathering intelligence on the mobility and *modus operandi* of criminal groups using Google's search engine and by generating visual plots

and maps charting the market strategies of criminal enterprises over the past decade. Finally, Osario has examined almost 10 million data points through a review of new and old media to disaggregate the micro-mechanisms of drug-related violence, testing models of agency and structure (Osario 2012).

Alongside this big and small data research, there is a range of recent innovations in the use of ICTs to prevent and reduce various types of violence in Latin America. Some tactics are pursued by governments and citizens and address organized criminal violence associated with cartels and gangs. Others are mobilized by international agencies and local nongovernmental organizations (NGOs) and intended to address more discreet forms of interpersonal, domestic, and child-related violence. Still others involve advocacy organizations and are focused on state-led violence and repression, or other structural forms of violence associated with injustice and privations of freedom of expression. The approaches being adopted are diverse. They include the use of mobile and fixed Internet-based platforms intended to collect and transfer information within government agencies and between them ('vertical' ICTs) and more decentralized and spontaneous modalities developed and shared within civil society and the private sector ('horizontal' ICTs). There are also interconnected mechanisms designed to transfer information from governments to civil society, and *vice versa*. An overview of all of these approaches is presented below, drawing primarily on the cases of Brazil, Colombia, and Mexico. **Table 2** below summarizes the typology developed by the authors and features a compilation of examples.

It is also worth noting the distinction between *data-generating* and *data-analyzing* ICTs. On the one hand, there are systems that seek to promote information harvesting through anonymous dial-in systems, crowdsourcing modalities, gaming approaches, and other means. On the other are platforms that seek to interpret and parse out data, as well as report it through big-data analytics,

Type	Approach	Functions	Examples
Vertical: government-government	ICTs developed by and for intra- and intergovernmental use	Real-time and social media surveillance and big-data analytics for hot-spot mapping and internal accountability (data gathering)	Infocrim, Igesp, Ter-racime (Brazil), Sala de Evaluación del Desempeño Policial (Mexico), CUIVD (Colombia)
Vertical: government-citizen	ICTs developed in cooperation with governments and citizens to enhance security delivery	Tailored data fusion systems to enhance mapping of incidents, bespoke applications for citizen reporting (data gathering/data analysis)	Procuraduría General de Justicia and Secretaría de Seguridad Pública of Coahuila (Mexico), IADB and UNICEF initiatives, and Igarapé Institute assistance (Brazil)
Horizontal: citizen-government	ICTs developed by private or nongovernmental groups with applications for governments and citizens	Tailored (open) data systems using a combination of ICTs that allow for anonymous reporting on actual or suspected crimes (data gathering/data analysis)	Disque-Denuncia, Unidos pela Segurança (Brazil), Citivox-Monterrey (Mexico), UN Women-assisted interventions
Horizontal: citizen-citizen	ICTs developed by private, nongovernmental, and activist groups for citizen safety and security	Social media and network systems using existing models (Google, Facebook, and Twitter) or bounded systems (data analysis)	Blog del Narco, NAR, Notinfomex, Tehuan platform, Narcowiki (Mexico), Hollaback! Say no to Violence, Bem Querer Mulher (Brazil)

Table 2: Vertical and horizontal applications of ICTs for violence prevention in Latin America²⁸

blogs, and other social media. For example, the emergency services telephone number (911) and the computerized statistics system used by the New York City Police Department (COMPSTAT) (analyzed in deeper below) are both data-generating tools, while blogs covering violence are data-analyzing ones. As more and more data exists online - referred to in some circles as 'digital exhaust' - there are emerging questions about what types of ICTs will prevail. Put another way, will horizontal approaches be in a position to analyze data at scale, or will only centralized organizations using vertical approaches and sitting on large regularized datasets be capable of meaningfully engaging with the data? While such questions are outside the scope of the present assessment, they are

nevertheless emerging in the Latin American context.

Vertical government-to-government ICT interventions

There is considerable evidence of vertical state-led applications of ICTs for violence prevention and reduction. It is worth noting that law-enforcement and public security experts across the region have long emphasized the importance of technology - and increasingly web-based innovations - in shaping effective preventive strategies, as well as the potential for transferring such innovations across hemispheres and between countries. Across Latin America, and particularly in Brazil, Colombia, and Mexico, there have been efforts to: enhance

the technological capacities of law-enforcement entities (both military and civil police) and courts; improve the use and connectivity of surveillance cameras; increase the quality of mobile communication systems; install GPS and tablets in patrolling vehicles; and, more recently, harvest and analyze large quantities of raw data. The most common platforms emerging across Latin America are COMPSTAT-style systems²⁹ combining traditional surveillance measures with geo-referenced data collection from conventional administrative data sources as well as citizen and police reporting.

In Brazil, São Paulo's Secretary for Public Security (SSP-SP) undertook a pioneering effort beginning in 1999 to modernize the state's information gathering capacity. In order to enhance policing capabilities in this city of some 20 million inhabitants, the office launched *Infocrim*. The system registers data from police reports in a central database that is then automatically updated every other hour. The system features information on the types of crimes committed, their location and the time they occurred, the nature of the incident, and other variables. The system is online and generates real-time interactive maps. It is credited with contributing to reducing annual homicide rates from 12,800 in 1999 to some 7,200 by 2005 (Lemie 2006a). Similar initiatives have been launched in neighboring Minas Gerais state, including the Public Security Integration and Management System (*Igesp*), which is based on New York's COMPSTAT system. Indeed, *Igesp* is credited with reducing homicides by more than 20 per cent in the state's capital, Belo Horizonte. Another initiative supported by the Brazilian federal government is *Terracrime*, a geoprocessing tool fielded by the National Secretariat of Public Security (SENASP) which operates in six Brazilian cities (Lemie 2006b).

Meanwhile, Mexico, Colombia, and some Central American countries are also developing similar types of digital platforms to enhance surveillance capacities but also promote accountability within police forces.

For example, the Federal Secretary of Public Security of Mexico City also drew on New York City's COMPSTAT process in 2008 to upgrade its capacities. The Police Performance Evaluation Room (*Sala de Evaluación del Desempeño Policial*) introduced a digitized system to evaluate the capital's tens of thousands of policemen (Compstat 2012). In Colombia, Bogota's police force also adopted a unified information system on violence and crime (CUIVD) in 1995, also drawing on COMPSTAT principles (Moncada 2009). Building on this program, Colombia's 150,000-strong national police force also upgraded their cell phone system in 2007 with support from Microsoft. As a result, the police are now better able to ensure integrated audio and video conferencing and more communication in real time, making them better equipped to fight crime.³⁰ Finally, in Central America, as part of the Central American Regional Security Initiative, a new regional police systems reform program is seeking to improve policing capabilities. The approach explicitly advocates COMPSTAT techniques and community policing (Brownfield 2012).

It is also worth noting that Colombia in particular has witnessed the vertical development of ICT tools in the context of the longstanding conflict against guerrilla groups, including the Revolutionary Armed Forces of Colombia (FARC). What is particularly intriguing is the way that early initiatives pursued by the Colombian army and its auxiliaries in cyberspace spurred on FARC applications and, later, activities by the political elite. Specifically, the Colombian armed forces and paramilitary groups often posted polemical blogs to communicate with the public and throw a veil of ideology over their actions. FARC guerrillas also used the Internet to run an 'international front', routinely posting statements and producing videos for their website. What is more, civil society groups then began organizing mass rallies online. Much later to catch-on were Colombian politicians, not least ex-president Uribe, who are now avid users of Twitter and conduct bitter debates on government policy online.³¹

At the regional level, there are nascent indications of governments seeking to share and even harmonize data on criminal violence. For example, within the Americas there is the Regional System of Standardized Indicators of Peaceful Coexistence and Citizen Security (RIC) supported by the IADB (RIC n/d). This effort is intended to enhance more than a dozen key indicators of violence and ensure sharing across countries. Likewise, the South American Common Market (Mercosur) has elaborated a *system for security exchange* (SISME) to share data digitally with members, including Bolivia, Chile, Colombia, Ecuador, Peru, and Venezuela (Mercosur n/d). It should be stressed that intergovernmental sharing of information on issues of organized violence continues to be uneven, in large part owing to concerns of sovereignty but also due to low levels of regional integration. Rather, information on specific dynamics of violence tends to be shared on a bilateral basis, between defense, intelligence, and police branches. Indeed, the old adage 'garbage in, garbage out' should be recalled, since poor and incorrect reporting can generate biases and false positives that result in structural irregularities and frustrate comparisons between cases.³²

Vertical government-to-citizen ICT interventions

Notwithstanding a rapid growth in 'citizen security' across Latin America, there are relatively few examples of ICT use connecting state entities and civilians to prevent and reduce violence. Indeed, a long legacy of repressive policing and state violence has limited the opportunities for such exchange, though there is some evidence that this may now be changing. For example, in cases where extreme forms of organized violence are occurring, as in northern Mexico, special efforts are being made to improve interactions with communities to gather information, including anonymously. Examples of this include efforts by the Mexican state of Coahuila to reach out to its citizens through the official Twitter accounts of its public secu-

city institutions: *Procuraduría General de Justicia del Estado* (@PGJCoahuila) and *Secretaría de Seguridad Pública* (@SSPCoahuila).³³ Likewise, in Brazil, as processes of pacification advance in Rio de Janeiro, the military police are exploring new ways of reaching out to affected communities before, during, and after territories are re-secured and permanent community police posts installed (Willis et al. 2013; Muggah and Mulli 2012).

There are also increasing examples of federal and, more commonly, municipal authorities working with major private firms and international agencies to enhance their ability to harvest and disseminate information on public security to citizens. Indeed, Google, IBM, and Microsoft have all started developing and selling products to enhance public safety in Latin America. Rio de Janeiro is one of two cities seeking to connect all disaster response capabilities to enhance police action in hot spots via the 'Smart City' initiative.³⁴ Also, organizations such as Igarapé Institute are working with private partners to develop applications with Rio de Janeiro's military police to enhance accountability and interactivity with citizens in pacified communities.³⁵ Likewise, organizations such as the IADB and the United Nations Children's Fund (UNICEF) are developing new ICT projects, albeit cautiously, to begin tracking violence and measuring the performance of interventions. A prominent example is UNICEF's development of participatory mapping tools in Brazil, which focused initially on environmental hazards and are now being extended to promoting safer communities (UNICEF, MIT, and Public Laboratory for Open Technology and Science n/d; UNICEF n/d). Finally, other international groups are also beginning to monitor various types of crime in Latin America, though still experimenting with 'big data' (UN Global Pulse n/d).

Horizontal citizen-to-government ICT interventions

There are also a number of ICT initiatives being developed from the 'bottom up' and in some cases working with government enti-



Figure 2: Mapping violent incidents using crowdsourcing in Brazil ³⁶

ties. In most cases, the originators of the data-management and -collection platforms are NGOs or small start-up companies. In some instances, they collaborate with local metropolitan authorities and law-enforcement agencies, either on the basis of a contract or in the spirit of partnership. What differentiates these activities from vertical interventions is their primary reliance on citizen participation and their multi-dimensional forms of information capture and dissemination. Such ICT activities tend to combine spatial and temporal analysis of violence trends while also seeking to use this data to improve the accountability and responsiveness of state institutions.

In Brazil, there are several prominent and well-regarded examples of horizontal citizen-government ICT activities. The most widely known is *Disque Denúncia* ('Call to Denounce'), which was created in 1995 in Rio de Janeiro during a particularly violent episode. Indeed, a surge in homicidal violence, kidnapping and ransom, and other forms of violence precipitated a response from private entrepreneurs, NGOs and the local government. Inspired by the United States *Crime Stoppers* model, the system was designed to help community residents inform the police anonymously about actual or suspected crimes. A nongovernmental agency served as the intermediary and filtered, managed, and

mediated interactions between the community and the police. The intervention has now been scaled up across Brazil to all twenty-seven states and exported as a model to other countries across Latin America. A more modern and pilot-based approach is the *Unidos pela Segurança* ('United for Security') initiative developed by a private company called STAL IT. While still searching for a public partner, the initiative uses crowdsourcing methods from a bounded network of some 1,000 participants (with some curators more active than others) to track violent incidents in selected states of Brazil (UPSEG). It has a linked web-based platform that is filtered by the ICT manager and seeks to provide verified information to Disque Denúncia and the military police (see **figure 2**).

In Mexico groups such as Citivox have developed ICT tools to support hot-spot mapping (Citivox n/d). On the basis of a simple open-access system, Citivox has worked with private companies, nongovernmental groups, and the city authorities of Monterrey to track electoral violence. The tool is based on real-time reporting using crowdsourcing methods. First, citizens are expected to report and share information on what they identify as the principle problems affecting their communities. Second, decision makers are then in a position to use the platform to better understand and respond to

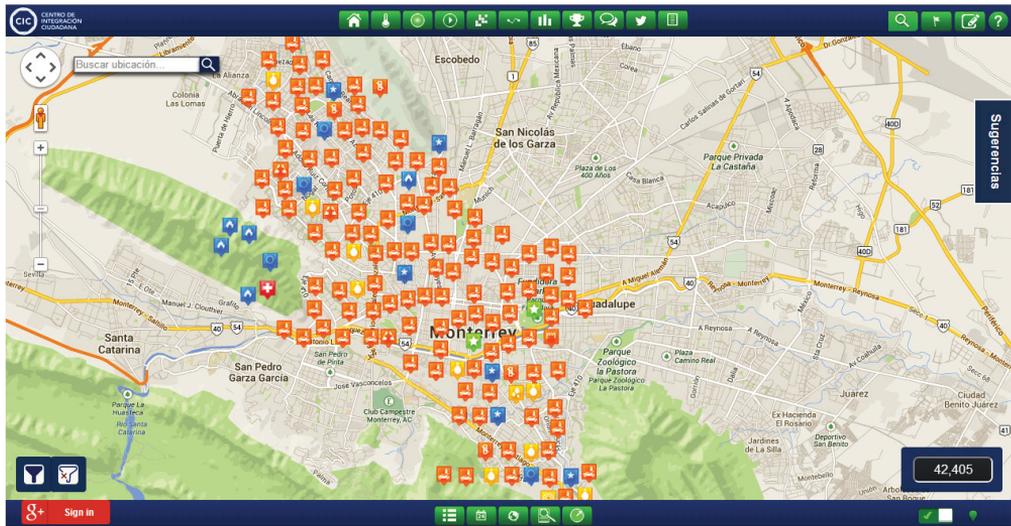


Figure 3: Platform developed by Citivox in Monterrey (Mexico)³⁷

citizen complaints. As **figure 3** shows, this is achieved by first converting reports into manageable and visual feeds showing trends in visual (heat maps), temporal (line charts), and other forms. Citivox has replicated these tools both in other Latin American settings as well as in Eastern Europe (Soto 2013).

Horizontal citizen-to-citizen ICT interventions

The most dynamic area of innovation for ICTs to promote violence prevention and reduction is occurring within civil society. Designed neither for public authorities nor police actors, such tools are emerging spontaneously from individuals, the private sector, academic and research institutions, and NGOs themselves. It should be noted, however, that while some of these ICTs may appear to be entirely locally based, they may also have outsiders supporting and funding them. The largest generators of such tools are in Mexico, largely as a result of the self-imposed censorship of mainstream conventional media outlets and public authorities. ICT growth is thus driven by residents' intense desire to protect themselves and to promote awareness of public security issues. A number of exceedingly high-profile

and brutal instances of violence committed against Internet activists and hacktivists has in turn unleashed a wave of measures from within civil society intended to reduce the strength of cartels (and their sympathizers), but also defend the public against them and other forms of violence.

Citizen reporting systems and blogs are two common horizontal citizen-to-citizen ICT tools for violence prevention, the most prominent examples of which are 'narco-blogs' and 'narco-tweets' in Mexico (Monroy-Hernández 2011). Indeed, the wildly popular *El Blog del Narco* (The Narco-Blog), posts graphic images, stories, and posts on the drug war not published elsewhere and was sustained anonymously for five years before being shifted to another less popular venue (*Blog del Narco* 2013). Related sites include *Notinfomex/Narcoviolencia* and *Nuestra Aparente Rendición* (NAR), which advocate more pro-peace messages and sustain communication networks among activists (*Notinfomex* n/d; *Nuestra Aparente Rendición* n/d). Other more proactive sites seeking to 'out' suspected cartel members and known criminals include the Tewan platform run by the Center for Citizen Integration (CIC), also developed by Citivox (*Milenio* 2011). The plat-

form seeks to incentivize citizen engagement while also using crowdsourcing methods. Another intriguing approach to tracking violence in the absence of 'administrative' data sources included Wiki_Narco, which used a mixed method of crowdsourcing, a wiki platform, and Google maps to visualize trends across Mexico. The tool allowed for a better understanding of incidents of violence, but also of fluctuations in the demarcation lines separating specific cartels. Wiki_Narco, however, was recently shutdown (Jardin 2012).³⁸

Across Latin America, various e-networks and specialized applications that report and share information on various types of violence are emerging more or less spontaneously. For example, in Brazil there are blogs that actively reflect on violence-prevention measures in the recently pacified slums (*favelas*) of Rio de Janeiro. Community residents, many of whom are now purchasing tablet computers and smartphones and actively using Facebook, are tracking trends (*Rio Real* 2012). Other ICT tools designed to prevent sexual violence and developed outside of Latin America, including Hollaback!, are establishing chapters in the region. Two other prominent examples are Say No to Violence, a social-mobilization platform established in 2009 and connected to UNiTE and *Bem Querer Mulher* ('Cherish Women'), supported by UN Women (*Say No - Unite* n/d; *Bem Querer Mulher* n/d). To be sure, new ICTs are routinely emerging to explore ways of enhancing the protection of women and girls from violence in Brazil, Colombia, and Mexico, but also elsewhere (Bavidziuk and Davidziuk 2009; Fascendini and Fialova 2011).

It must be stressed that the use of ICTs is not the preserve of activists and proponents of violence prevention. At one extreme are citizens who are using ICTs to circumvent initiatives intended to reduce violence. For example, in Brazil and Mexico citizens are using Twitter to avoid anti-drunk driving campaigns (e.g., *Lei Seca* in Brazil), much to the consternation of public authorities

(*Jornal da Globo* 2012; *BBC Mundo* 2010). Citizens are also known to have abused ICTs, falsely reporting information and generating panic.³⁹ There is also a surge in ICT use by civilians for meting out vigilante justice against alleged criminals, often resulting in ugly retributive violence⁴⁰ (Dudley 2011). More ominously, and at the other extreme, is the parallel growth in ICT use (and monitoring of ICTs) by criminal groups, organized gangs, and drug cartels. For example, there are a number of cases of drug cartels infiltrating activist networks, identifying personal information, and ultimately killing the activists (Blog Del Narco 2011). This has in some cases led to the emergence of new forms of online engagements, including the expansion of activities against the Zetas cartel by the online activist collective Anonymous, and *vice versa* (Stewart 2011). What is more, citizens also frequently fear retaliation from the police, who themselves may be compromised by citizen reporting. For example, interviews conducted by the authors in poorer areas of Brazil, Colombia, and Mexico confirm that citizens are fearful of using ICTs to report denunciations for fear of being tracked down and punished.⁴¹

Conclusions and Emerging Lessons

This paper has introduced a framework to assess the form and function of ICTs designed to prevent and reduce violence in Latin America. While there appears to be terrific growth in such ICTs across the region, it is still too early to assess their broad impacts in the aggregate. Indeed, there is anecdotal evidence of some vertical ICT interventions generating important reductions in homicidal violence and improved intelligence and rationalization of police forces (Meurn 2011). There is considerably less information on the outcomes of horizontal measures. The 'field' is itself rapidly evolving and highly decentralized, not easily amenable to controlled scientific measurement on the ground. This makes the determination of definitive lessons learned difficult at this stage. Never-

theless, there is an apparent rapid growth in ICT use for violence prevention which is, in turn, suggestive of a wider appetite. An increasing number of public entities - police and metropolitan authorities are the tip of the iceberg - are actively enhancing their capabilities. While in some cases proceeding cautiously owing to structural concerns with transparency, it is now accepted wisdom that (especially mobile) ICTs - including the use of crowdsourcing, geospatial and geothermal mapping, and other data fusion techniques - are essential to mapping hot spots, prioritizing resources, planning interventions, and assessing outcomes. Likewise, citizen groups are experimenting with frontline data harvesting techniques and paving the way for a new generation of big-data research.

Notwithstanding the enthusiasm for technology-driven approaches to security promotion, Latin America is still a long way off from a genuinely democratic public-security project. Indeed, many government institutions have yet to fully embrace new technologies on 'sensitive' issues of organized and interpersonal violence, sometimes with good reason. New technologies can often dilute and diffuse information, an anathema to the older establishment that favors centralized forms of data management (such as some of the hotline systems documented above). As for citizens, many have engaged actively in innovative approaches to promoting safety, albeit sometimes at considerable risk and personal cost.

Yet, a similar number have yet to engage in the digital revolution, either because they are systemically excluded or because of fears of retribution. This speaks as much to the failures of the social contract as to the spectacularly brutal forms of violence meted out by cartels, such as the Zetas, on those who seek to denounce them. Nevertheless, there appear to be more and more examples of social media bringing previously 'untold' stories to light, including those that demonstrate how underserved and vulnerable populations are affected by violence. New

media transmits information faster than conventional media, often visually and in real time, and it is transforming the ways in which information is produced, consumed, and disseminated.

This final section sets out a number of tentative entry points and recommendations for stakeholders involved with violence prevention in Latin America. The focus is on international organizations, national and municipal governments, and civil society entities. It is, of course, challenging to issue standardized guidance given the extraordinary heterogeneity of Latin American states and societies. Indeed, a critical finding of this paper is the highly uneven penetration of Internet and mobile technology not just between regions, but also within them. Indeed, the variegated access to ICTs also extends to states, cities, and neighborhoods. This variation must be accounted for in the design of any strategies to mobilize ICTs for violence prevention and reduction.

International Actors

Acknowledge that there is already massive engagement with ICTs in Latin America and that this is likely to expand in the foreseeable future. The basic demographic calculus of the region suggests that ICT use will grow even as it 'matures' across the population. Moreover, there is evidence that social media, new forms of data-fusion technology, and digital activism are creating a new arena for monitoring and responding to violence in the region.

Seek to encourage the mainstreaming of ICTs in regional and national public-security plans, but also recognize that ICTs alone will not resolve the challenges of organized and interpersonal violence. There are many factors shaping violence intensity and organization, and ICTs are one important factor that can shape this violence positively and negatively. That said, national and metropolitan authorities, including public security personnel, are increasingly composed of digital natives and are open to innovation in many settings.

There is a need to support exposure and training in ICTs for violence reduction as well as to caution against their limitations.

Encourage South-South sharing within Latin America and beyond. The fact is that Latin America's experimentation in ICTs for violence prevention is comparatively advanced. While there was evidence of vertical and horizontal engagement with ICTs as early as the 1990s, it should be noted that these systems were not established in a vacuum. Indeed, many of the contemporary applications using new technologies were built on, and intended to enhance, existing or older systems. In other words, 'new' digital technologies may increase the pace and scale of communication, but they are not necessarily new in form or content. Identifying and analyzing these earlier systems may provide some possible innovations for other countries in the region and internationally.

National Actors

Capitalize on the growing acceptance and interest in ICTs for violence prevention among the young generation of Latin Americans. Police forces, municipal planners, and citizens are all more digitally aware than in generations past. They are more inclined to experiment with and adopt new technologies. There are remarkable examples of police and citizens developing tailor-made solutions using crowdsourcing, geo-visualization, gaming methods, and other media-monitoring tools, all of which reflect a curiosity and willingness to explore new approaches to tackle old problems.⁴² That said, there is a need to make investments in improving digital literacy. Indeed, there continues to be a significant digital divide that mirrors broader social and economic inequalities. Support for ICTs must be accompanied with investments in education and in strengthening technical capacities from below.

Develop and build on North-South and South-South transfers of ICTs for violence prevention. While there are examples of ICT technologies that are directly transferable from upper-income to lower-income

settings, there is also ample room for adaptation, experimentation, and replication among southern contexts. Indeed, particularly with respect to horizontal ICT transfers, there is already a strong tradition of learning about and sharing technologies for violence prevention. There are some examples where public-private partnerships have incentivized replication, and these offer some interesting cases for further study.⁴³

Civil Society

Acknowledge that while some ICTs for violence prevention emerged in a top-down manner, many also emerged spontaneously owing to failures in conventional media. In countries such as Colombia and Mexico, but also throughout Central America, the mainstream press and public authorities have self-censored reporting on violence either due to direct intimidation from organized armed groups or owing to a general secrecy around reporting. This has in turn triggered new forms of citizen reporting within social media and the blogosphere, and the development of more proactive reporting systems. This may have longer-term implications for the public legitimacy of traditional media outlets and also for the wider debate on freedom and justice in these countries. There are important opportunities to engage with citizen reporters and promote quality and ethical standards in reporting.

Tools that guarantee anonymity are critical for shaping citizen use of ICTs for violence prevention in Latin America. Throughout the region, violence rates are high, but actual reporting on conventional crime is comparatively low. This reflects a long-standing mistrust of law-enforcement entities and court systems that were seen to favor an unequal *status quo* and that have ingrained impunity. As a result, citizens seldom personally report crimes and in some cases actively avoid reporting for fear of retribution. The introduction of anonymity into ICTs, including in relation to direct dial-in, SMS, email, and other systems, has transformed reporting rates. What is more, the use of avatars, such

as a Twitter handle, still enables reporters to receive 'credit' for their participation.

Identify and reward valuable human resources among the population. There is a noticeable shift in the approach citizens are taking to reporting on violence. Due in part to the factors identified above, some advocates of ICTs - especially civic media curators in horizontal networks - are adopting ever more proactive approaches to preventing violence. Far from being mere passive citizen tweeters, they are in some cases actively denouncing violence. Likewise, some hacktivist groups are countering cyber-extortion methods adopted by crime groups (using denial of service attacks against those who will not pay up) with the very same methods, even outing collaborators, often with lethal consequences. Identifying and rewarding skilled individuals to promote a culture of legality might be a promising strategy so long as the threat of retaliation from criminal actors is prevented.

This article issued an initial overview of how social and political actors are appropriating ICTs in Latin America in order to understand, cope with, and fight back against organized and interpersonal violence. The fact that Latin America is simultaneously the developing world's most connected region but also its most violent ensures that it presents a vivid, real-life laboratory for the new field of ICTs for violence prevention. Indeed, the article shows that there is considerable room for more investment and engagement in Latin America. What is clear is that cyberspace provides avenues for the development of smart solutions for both structural challenges and proximate threats. A key challenge will be to find ways to incentivize institutions and individuals to embrace a meaningful and accountable digital revolution, one that promotes safety and security on- and offline.

Notes

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IRI-PUC in Rio de Janeiro, Brazil. Gustavo Diniz is a research associate at the Igarapé Institute. The article was prepared as part of a project led by the International Peace Institute and USAID. It is also informed by the openempowerment.org initiative, a project of the Igarapé Institute and the SecDev Group and supported by the International Development Research Centre (IDRC). Robert Muggah is also grateful to the Joan B. Kroc School of Peace Studies, University of San Diego, for supporting his peace scholar fellowship which enabled this research.

² Information and communication technologies include fixed and mobile platforms and tools used for information collection, sharing, and analysis, via the Internet or other communication channels. This article is more narrowly focused on ICTs using new visualization and analysis techniques and thus not comprehensive.

³ Roughly 43 per cent of Latin American residents (or 255 million people) were online as of June 2012, and this figure is likely to dramatically increase in the coming years. This compares to 27.5 per cent of Asians and 15.6 per cent of Africans (*Internet World Stats*).

⁴ Although 3G technology allowing remote access to Internet is still incipient in the region, telecoms are investing heavily in this domain and an increase in this market is expected for the coming years. Industry analysts predict that by 2016 smartphones capable of accessing high-speed Internet will account for over 50 per cent of all cell phone sales in the region.

⁵ In other words, GPS, microphones, cameras, and other devices are becoming common elements of the online experience. (Google Ideas 2013).

⁶ In Brazil, for instance, while 50 per cent of households in São Paulo, Rio de Janeiro, Minas Gerais, and Espírito Santo have Internet access, this number is of only 22 per cent in the Northern region. What is more, on average the country's richest

people spend much more time on the Internet than the poor. The proportion of those who go online at least one time per week is about 80% for upper-class users, 65 per cent for the middle classes, and less than 50 per cent for the lower classes (CETIC.br 2011).

⁷ Human Development Index.

⁸ These are Argentina, Brazil, Chile, Mexico, and Peru.

⁹ As of March 2012, the average Facebook penetration in South America was 28.1 per cent and in Central America 26.5 per cent. By way of comparison, Facebook penetration worldwide is as follows: North America (49.9 per cent), Oceania/Australia (38.4 per cent), Europe (28.5 per cent), Middle East (9.4 per cent), Asia (5.0 per cent), and Africa (3.9 per cent) (*Internet World Stats*). For a review of Twitter trends in selected countries and cities, see *SemioCast* (2012).

¹⁰ For an account in English of the Brazilian protests, see Muggah (2013).

¹¹ For an account of the Mexican protests, see Cave (2012) and *LatinoRebels* (2012). For an overview of the Chilean students' movement, see Fornoni (2011) and Barahona et al. (2012). Another wave of protests hit Latin America in September-October 2013. Cases included clashes with the police in Mexico and Colombia during protests related to a wide variety of grievances. See <http://www.bbc.co.uk/news/world-latin-america-24089051> and <http://www.reuters.com/article/2013/09/07/us-colombia-protests-idUSBRE9860HW20130907>

¹² Indeed, according to a recent study, some 59 per cent of social movements involved in social and political struggles in Latin America have an online presence.

¹³ In Brazil, for example, after a collective suicide letter from the tribe Guarani-Kaiowa came to the attention of the public, people started mobilizing on the web (e.g. by adding the ethnic group's denomination to their family names in social

network platforms) to push the authorities to stand up for indigenous rights. They were partially successful as Brazilian justice granted temporary permission to the tribe to remain on their ancestral land, which they had tried to wrest back from ranchers in a series of bloody confrontations (*The Huffington Post* 2012).

¹⁴ For wider assessments on cybercrime in Latin America, refer to Prandini and Maggiore (2011), Diniz and Muggah (2012) and Trend Micro (2013).

¹⁵ The Deep Web is made up of a vast assortment of encrypted websites and communication that are accessible only via proxy (so the IP address is harder to detect). It is allegedly 500 times the size of the 'visible' or surface net, the one that can be searched using conventional tools. Although it has been used to enhance personal privacy, it is also the case that criminal illicit activities are also common. A prominent example is the virtual black market called the SilkRoad which has been used by Latin American drug cartels. For more information, consult the entry for Deep Web on Wikipedia: http://en.wikipedia.org/wiki/Deep_Web.

¹⁶ An exception to the rule is Cuba where the national authorities undertake routine surveillance and filtering (OpenNet Initiative). However, concerns with surveillance schemes were recently raised after the Guardian and Washington Post released stories on the global surveillance system(s) established by the US National Security Agency (NSA), including Prism. Indeed, Brazil and other countries in Latin America were considered primary targets of the US (*O Globo* n/d). Likewise, the Brazilian Center of Cyber-Defense (CDCiber) and the government's intelligence agency (ABIN) have also launched a surveillance system to track down key protestors, including those associated with the infamous Black Bloc group, during the protests of June and July 2013 (*O Globo* 2013).

- ¹⁷ The International Telecommunications Union (ITU) sets out five types of cyber-crime: 1) offences against the confidentiality, integrity, and availability of computer data and systems; 2) content-related offences; 3) computer-related offences; 4) copyright- and Trademark-related offences; and 5) complex offenses (cyber-terrorism, -warfare, -espionage, hacktivism) (ITU 2009).
- ¹⁸ Homicide rates are concentrated in countries of Central America, with El Salvador and Honduras amongst the most violent. By contrast, countries in the southern cone (Argentina, Chile, Uruguay, and Paraguay) report the lowest youth homicide rates of the continent.
- ¹⁹ According to the United Nations Office on Drugs and Crime, 'the risk of becoming a victim of homicide is highest for young men in the 15–29 age group and declines steeply with age thereafter' (UNODC 2011: 64).
- ²⁰ Latin America also exhibits comparatively high rates of violence against women, particularly in urban areas. The difficulties of assembling and analyzing data related to gender-based, domestic, and intimate partner violence are arguably more challenging than is the case for homicide and other violent crime. Absolute levels of such violence are hidden owing to low reporting rates and weak sentinel surveillance systems (Aguirre and Muggah 2013).
- ²¹ The circumstances in which violence occurs, its nature, and society's attitude towards it varies greatly from one setting to another (WHO 2002). A number of studies in Latin America and the Caribbean reveal that while the sub-regions feature a history of armed conflict (especially in Central and South America), specific structural and proximate risk factors offer a more convincing explanation for the growth in inter-personal violence in recent years. These include growing up in a violent or broken home, a history of victimization, substance abuse, social isolation, and rigidly proscribed gender roles, as well as personal characteristics such as poor behavioral control and low self-esteem.
- ²² UNODC has noted that in 46 counties across the Americas and Caribbean, a 15–34 year old male is six times more likely to be killed with a firearm than a bladed weapon (UNODC 2011).
- ²³ The theoretical foundations underlying 'securitization' can be traced to Buzan *et al.* (1998). Here we use the term in a broader sense, in relation to the wider tendency of resorting to law and order measures across Latin America to confront what are ostensibly socio-economic and rights-based issues.
- ²⁴ See Muggah and Aguirre (2013) for a review of citizen security practices in Latin America.
- ²⁵ See, for example, the IADB and Washington Office on Latin America (WOLA) map of citizen security activities in Central America at <http://seguridadciudadana-centroamerica.org/>.
- ²⁶ See, for example, Oh, Agrawal, and Rao (2011) and Monroy-Hernández (2011) for a review of how these tensions are playing out in settings as diverse as India and Mexico.
- ²⁷ For more information on the role of civic curators, see Mustafaraj *et al.* (2012).
- ²⁸ This typology has been elaborated by the authors based on the findings and examples that have emerged during the research phase.
- ²⁹ COMPSTAT (short for computer statistics or comparative statistics) is a system of management for police departments equivalent to Six Sigma or TQM, though was not actually a computer system in its original formulation. It now refers to a multi-tier crime reduction and quality of life improvement process which combines GIS (geographic information systems) to map the incidence of crime. On the basis of these maps, weekly meetings

are undertaken with local level officers to review challenges, discuss tactics, and improve the standard of living in selected areas. The system was pioneered in NYC, but is now in action in Austin, Baltimore, San Juan, Los Angeles, and elsewhere. (Kelly 2012).

³⁰ More recently, Colombian National Police established a network of Voice over Internet Protocol (VOIP), to replace their antiquated Internet Protocol telephony system. This not only saved on cost, but allows for more effective internal communication, and therefore, in theory, more effective crime-fighting (Microsoft 2009).

³¹ A full account of the Colombian experience is being produced by the Igarapé Institute and SecDev Group as part of the Open Empowerment Initiative, to be published later in 2013. See the website openempowerment.org for more information.

³² For example, the authors visited a special hotline service - 190 - in Rio de Janeiro in December 2012. The service received some 650,000 calls a month. One of the primary calls received is related to 'bank robbery', suggesting a very serious epidemic of crime. It turns out, however, that most reports were triggered by bank system misfires registering frequent false positives. Yet these same false positives are recorded in the 190 logs dataset.

³³ These accounts have substituted an unofficial account of the Fiscalía del Estado (@FiscaliaCoah), which had more than 75,000 followers (*El Diario de Coahuila* 2012). However, it seems that the second account has been deleted. The first one has nowadays some 20,000 followers.

³⁴ For more on Smart Cities, consult its website at: www.ibm.com/smarterplanet/us/en/smarter_cities/overview/.

³⁵ Op Cit. Another example of this kind of tool, while not based on designing an app for a mobile phone but still focused on real time visual and audio feed, is an initiative launched in Brasilia in 2012. This tool draws from technology piloted dur-

ing the US Salt Lake City Olympics and is now in service in 200 US cities (*Fantástico* 2012).

³⁶ Screenshot taken from UPSEG web platform the March 23, 2013.

³⁷ Screenshots obtained directly from Jorge Soto in May 2013.

³⁸ The URL (http://es.elnarco-trafico.wikia.com/wiki/Wiki_Narco) has also been terminated.

³⁹ In Mexico, the false reporting of a kidnapping and shooting led to panic and chaos in a particular neighborhood. The person who created the false tweet and others who re-tweeted it were arrested on the charge of terrorism. Twitter users who use hashtags to report violence ironically henceforth started calling themselves 'twitterrorists' (Monroy-Hernández 2011).

⁴⁰ For an example, see *Justicia Final*, available at <http://justiciafinal.blogspot.com.br/>.

⁴¹ Interviews were conducted by the Igarapé Institute with residents in favelas such as Maré, Rocinha, and Complexo do Alemão between November and December 2012 and January and March 2013. Likewise, communications with colleagues working with *InSight Crime* in Colombia and *Centro de Investigación y Docencia Económica* (CIDE) in Mexico in January and February 2013 also suggested the pervasive fear among residents in poorer areas to report crime, either formally to police or online.

⁴² See Bott and Young (2012) for a review of crowd sourcing methods.

⁴³ For example, the New York City Police Department created COMPSTAT with Microsoft. The NYPD now makes a minimum of a 20 per cent royalty on all new sales of COMPSTAT (Kelly 2012).

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