SenseCityVity:
Mobile Crowdsourcing, Urban Awareness, and Collective Action in Mexico

The SenseCityVity project aims to engage youth in Guanajuato City, Mexico, helping them investigate, document, and reflect on urban problems though mobile crowdsourcing. The Urban Data Challenge encourages them to collect geolocalized images, audio, and video for further analysis.

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The future of cities in the Global South depends on the ability of their populations and governments to implement frameworks for sustainable development—that is, to implement processes "by which people individually and collectively enhance their capacities to improve their lives according to their values and interests."[1] Cities in Latin America face complex challenges, such as violence and economic inequality. In its most recent report on the state of the world's cities, focusing on trends in Latin America and the Caribbean, the United Nations Human Settlements Program (www.unhabitat.org) stated that cities are steadily expanding, sometimes outstripping the rise in population by two- to threefold due to urban sprawl, and that 90 percent of the Latin American population will live in towns and cities by 2050.[2]

Countries in this world region also have booming young populations, who are not only the inheritors of significant urban problems but also the most promising source of solutions. So how can we incentivize young people to become more aware of their urban environment? How can we help them gain a deeper understanding of their urban problems and design potential solutions?

SenseCityVity is a project we've developed to help young citizens in Guanajuato City, Mexico effectively define, document, and reflect on their city's problems (www.idiap.ch/project/sense-cityvity). Our approach integrates technologies such as mobile crowdsourcing and social media with community practices, putting youth in the "driver's seat" of urban engagement and perception (learn more at www.youtube.com/watch?v=sxUFcFCVyDA). SenseCityVity focused on three topics:

- developing a mobile crowdsourcing platform;
- deploying a mobile crowdsourcing experiment in the form of the Urban Data Challenge, codesigned by the research team and a community of young people, focused on collecting and mapping geolocalized images, audio, and video; and
- analyzing, appropriating, and creatively using the collected data for community reflection and artistic creation.

Here, we share our research experience in engaging a large population of young participants in the field and in the lab, summarizing our findings after analyzing the data in an attempt to

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understand the perception of youth with respect to their local urban problems.

Exploring Related Work

We wanted to use an integrative approach, combining multiple sources of information and a variety of analysis methods, to paint a more accurate picture of how youth perceive their own urban environment. To that end, we started by considering various related works, including civic reporting systems, youth and community engagement programs, open mapping initiatives, and social media.

Civic Reporting Systems

One of the earliest platforms to enable crowdsourced citizen reporting and mapping of local civic issues is FixMyStreet (www.fixmystreet.com). Reporting an issue via the FMS platform involves providing a description of the problem, locating the problem on the map, and optionally uploading a picture to illustrate the problem. SeeClickFix (en.seeclickfix.com) is another civic reporting system. These systems engage local public authorities to ensure that officials look into and subsequently address citizen reports in a timely manner.

A study analyzing 400,000 reports submitted to the FMS platform over a period of six years found that only 11 percent of reports contained images.[3] The average response time for fixing a reported issue was 66 days, and issues reported with a photo tended to get a quicker response from local authorities, implying that the photo-taking exercise itself is a strong indicator of future citizen participation. These findings supported our design choice of engaging participants with geolocalized media. Our work is community oriented, which contrasts with the individual participation promoted in these existing systems.

Youth and Community Engagement

Our work is related to numerous research efforts focused on designing community-based solutions with the youth population. In particular, we considered Stuart Poyntz's national research program to explore nonprofit youth media production and civic learning initiatives in Canada's three largest cities,[4] and Jaz Hee-jeong Choi's use of data to render the urban social networking of youth in Seoul.[5]

We also reviewed the design considerations of Marcus Foth, Victor Gonzalez, and Wallace Taylor for developing Web portals to facilitate the networking of urban residents in Mexico, South Africa, and Australia,[6] and we looked at the factors that Mara Balestrini and her colleagues found to be vital in developing community engagement and information and communications technology (ICT) interventions in Argentina (www.caminosdelavilla.org).[7] Finally, we considered Nancy Odendaal's examination of the local transformative qualities of mobile telephony in Durban.[8]

Open Mapping Initiatives

Our work is also related to several citizen mapping efforts in developing regions, including Map Kibera (www.mapkibera.org) in Kenya and various community initiatives around the Ushahidi platform (www.ushahidi.com). Humara Bachpan (www.humarabachpan.org) is an organization in India that conducts civic campaigns, where groups of children create detailed "social maps" of their marginalized neighborhoods to voice their concerns about the public space in Indian slums. In the Latin American context, Google and Microsoft started an initiative to map the urban informal settlements in Rio de Janeiro, which don't currently exist on city maps.[9] Similar efforts have been undertaken in Argentina to improve the integration of urban spaces by mapping and monitoring Buenos Aires' marginal areas. In a study conducted in Brazil, Dietmar Offenhuber and David Lee mapped the spatial organization of waste collection though mobile technology.[10]

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Mobile Data in Everyday Life

Our work also has connections with studies on how people go about their daily routines and interact with the world through their mobile devices. Matthias Korn and Amy Voida discuss a theoretical framework that advocates for the design of civic engagement infrastructure supported by HCI tools. The goal is for such tools, embedded throughout the city, to provoke contestation in the everyday lives of citizens, prompting them to request needed improvements.[11]

In addition, Christopher Le Dantec and his colleagues have studied how data from a smartphone app can be incorporated into urban planning events.[12] Furthermore, Kathi Kitner and Thea de Wet describe an experience in Johannesburg, aimed at tracking and studying the everyday behaviors and practices of urban traders and a group of university students equipped with smartphones.[13]

Social Media

Finally, social media is increasingly used as a medium to voice urban concerns.

In the specific Mexican context, Twitter has been actively used as a channel to disseminate eyewitness reports of drug-related crimes in several cities.[14]

An Integrative Approach

Our work integrates community practices, mobile crowdsourcing for data collection, and mixed methods for analysis (both quantitative data analysis and interviews) to advance the understanding of how we can help working class youth populations in Mexico better document, characterize, and reflect on urban concerns. At the same time, we aim to generate previously unavailable data resources and create suitable conditions for transforming the collected data into insights about urban issues, so citizens can debate community-oriented solutions.

Beyond the creation of maps, our approach encourages the use of the collected data for artistic and educational endeavors by the youth communities. Our work helps demonstrate that integrating existing methods and best practices in ubiquitous computing and HCI with the understanding of a concrete social context can result in a participatory framework that exploits phone-based sensing to let everyday citizens survey and articulate urban challenges, enabling the participants to share their experiences and reflections in a variety of ways.

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Guanajuato City as an Urban Lab

Guanajuato City (with a population of 170,000) is the capital city of Guanajuato State in Central Mexico. Guanajuato started out as one of the most important mining towns in the 16th century, developing into a city of great historic significance. Over the years, rough geographical terrain led to an urban landscape that has many narrow and winding alleys and streets, originally constructed on the side of streams running downhill. Various streets, where rivers once flowed, run underground, and long tunnels carved in solid rock connect various zones of the city.

The traditional architecture and unique construction style characterizing the urban space, the large number of historic monuments and museums, and two of the most important international cultural festivals that occur yearly, make Guanajuato City attractive for tourism. The city is surrounded by small towns and communities and is an important connection to other cities in Guanajuato State. However, like numerous cities in the Global South, historical patterns of disordered urban growth, characterized by the fast expansion of city borders and the establishment of informal settlements, have resulted in a complex urban environment where large socioeconomic disparities pervade.

Platform Deployment and Data Collection

As part of the SenseCityVity project, we used a methodology to explore Guanajuato's intricate urban landscape through five main activities that enabled the integration of youth work supported by mobile and social technologies: develop and deploy a mobile crowdsourcing platform, recruit a population of student volunteers, codesign a mobile crowdsourcing experiment (that is, the Urban Data Challenge, or UDC), implement the UDC, and encourage participating volunteers to use the collected data in creative ways.

Developing the crowdsourcing application. To gather data during the project, we designed and developed an Android-based mobile application. The application recorded the location traces of students in the background and let them take pictures and videos while mapping Guanajuato. All the generated data was automatically synchronized with our backend server. The mobile application was active only during the UDC to prevent collection of participant's personal data. Data collection used best practices to satisfy the requirements of anonymized data management.[15]

Recruiting volunteers. We recruited volunteers (students 16–18 years of age) from the Centro de Estudios Científicos y Tecnológicos de Guanajuato (CECYTE-G; www.cecyteg.edu.mx/cecyteg), a high school that provides education in science, technology, and humanities to working class youth in Guanajuato City and surrounding suburbs. The recruitment process took four weeks of intensive work by our research team, who worked with school authorities, teachers, parents, and students. We presented our project goals to the community during a series of weekly workshops, emphasizing the importance of the collective participation of citizens to understand and address pressing urban issues. We also stressed how social and mobile technologies could be used to empower people to make improvements.

Our population of volunteers consisted of 10 teams of 10 members each. Teams were encouraged to actively seek support from their classmates for achieving their goals, so that a larger community could be involved in the project. At the end of the fourth week, participating teams and their work plans were presented during a plenary session to 600 students, teachers, and team leaders' parents. At the end of the session, the community was motivated and eager to support our research effort to better understand the urban environment in which they live and the urban problems they face on a daily basis, as well as to reflect on how to develop community-based solutions to address such problems. To incentivize student participation, registered volunteers were allowed to accumulate the time spent in SenseCityVity's activities toward their social service requirement.

Codesigning the experiment. Our research team and the participating volunteers designed the mobile crowdsourcing experiment. The codesign was conducted during a series of four weekly workshops and study groups that led to discussions about mobile and social media technologies for the common good, ethics, data privacy, personal safety, urbanism, and basic techniques in filmmaking and photography. The workshops aimed to spark the curiosity of the volunteers to address the challenges of our mobile crowdsourcing experience, keeping in mind that youth often use and transform technology in the most innovative ways.

During the last workshop, participating teams developed a chronogram of the activities that would be conducted during the UDC. Teams were instructed to focus on urban challenges negatively affecting the city landscape instead of focusing on both positive and negative aspects. Therefore, each team defined one or two urban problems they wanted to document and the specific approach to conduct their investigation. Some of the urban concerns highlighted during the codesign workshops ranged from garbage in the streets and alleys to crime and vandalism, worn public infrastructure, graffiti, and the prevalence of alcoholism and drugs.

The project also integrated the use of social media (Facebook and Twitter) to maintain communication with the student community while collecting additional images through a dedicated channel (www.facebook.com/SenseCityVity).

Implementing the Urban Data Challenge. The UDC (see Figure 1) lasted for eight weeks and consisted of two main activities: data collection in the field by student volunteers; and an online crowdsourcing experiment, where impressions about areas in Guanajuato City were collected using online questionnaires. Participating teams were encouraged to conduct data collection during the week (if they had a signed parental consent form).

Fieldwork was mainly conducted on weekends. On these weekend gatherings, members of our research team led a review session to reinforce the key ideas discussed during the workshops and to check each team's work plans for data collection. This check was necessary to ensure that student teams didn't visit unsafe parts of the city.

After the review session was finished, each team moved independently to document the various parts of the city using mobile phones. Android-based smartphones were given to each team; however, students also used their own phones for data collection. Photo taking was considered a necessary practice to map Guanajuato City, given that other available imagery mediums (such as Google Street View, GSV) are often incomplete or erroneous. (In a preliminary study, we demonstrated that in some areas of Guanajuato, as much as half of the data from GSV have limitations.[16])

During the UDC, students explored various routes, which can be seen on an animated map at http://bit.ly/1ZS6yij. At the same time, we also conducted a crowdsourcing experiment in which 177 student volunteers (who didn't participate in the fieldwork) provided their impressions of different areas in Guanajuato along various physical and psychological dimensions using images as stimuli (see Figure 2). Details of this research have been described elsewhere.[16]

Getting creative with the data. The SenseCityVity project created a film festival with the slogan "Observe, feel, and share!" (www.idiap.ch/project/sensecityvity/film-festival) to provide the student community with the opportunity to make and show short (four- or five-minute) documentaries, created using the data collected during the UDC. The festival took place in February 2015. Documentary topics included poverty and safety, artistic graffiti, urban and social issues, graffiti in city alleys, and garbage on the streets of Guanajuato.

The film festival had three goals. The first one (at time of recruitment) was to funnel the festival as an incentive for students to participate in the project by giving them a motivation to use their own data for a common purpose. The second and third goals (during the festival itself) were to open a discussion within the broader community about the use of mobile technology to document pressing urban problems, and to reflect as a group about possible community-based solutions to some of these problems.

Results

The collected data, summarized here, is rich in content. It's enabling a number of qualitative and quantitative studies, also discussed here.

Collected Data

A total of 277 student volunteers registered for the UDC (100 of whom participated in the fieldwork, and 177 in the online crowdsourcing experiment). About 100 nonregistered volunteers (relatives, classmates, friends, and teachers) additionally participated during the UDC activities. Volunteer work during the UDC produced more than 7,000 geolocalized images and 380 videos captured from the perspective of a pedestrian exploring the city (see Figure 2). Data also includes 20 audio recordings of informal interviews, 5,300 GPS locations, 9,027 impressions of urban spaces (collected during the online crowdsourcing experiment), 14 short video documentaries, and 100 Facebook posts. During the UDC,

Figure 1. The Urban Data Challenge (UDC) implemented by students and the research team. The two main activities were having student volunteers collect data in the field and conducting an online crowdsourcing experiment, where impressions about areas in Guanajuato City were collected using online questionnaires.

approximately 19,000 generic geotagged tweets were also collected between 2014 using the Twitter API.

Video-Recorded Interviews

Of the 380 videos collected during UDC, 200 contained informal interviews with pedestrians on the streets of Guanajuato. Of the 200 interviews, 180 followed a structured interview format, where the interviewees (108 males, 72 females) were asked three questions:

- What are the urban problems that Guanajuato inhabitants face on a daily basis?
- What are the urban problems that affect you the most?
- What are possible solutions to these problems?

Structured interviews have an average duration of six minutes each. The remaining 20 interviews were audio only

Figure 2. Sample photos of Guanajuato City taken during the UDC. Photo taking was considered a necessary practice to map Guanajuato City, given that other available imagery mediums (such as Google Street View) are often incomplete or erroneous.

because the interviewees didn't want to be filmed. The 20 audio recordings also contained conversations addressing urban issues.

Video of Urban Scenes

Additionally, UDC participants recorded 180 videos to illustrate and capture urban issues (such as a large wall with painted graffiti on a bridge or tunnel) or to show relevant events (such as a bumpy ride in a city bus or a pedestrian crossing a dangerous street). Collected videos last between 20 seconds and 10 minutes. About one third of these videos include comments from the person recording it, which makes these videos valuable to understand how students feel about their city.

This kind of fieldwork, which requires direct interaction with people on the street, offered a unique opportunity for students to have a first-hand account of the dynamics of urban landscapes of Guanajuato. It also let them reconnect to the tangible reality of their city through the lens of their mobile device.

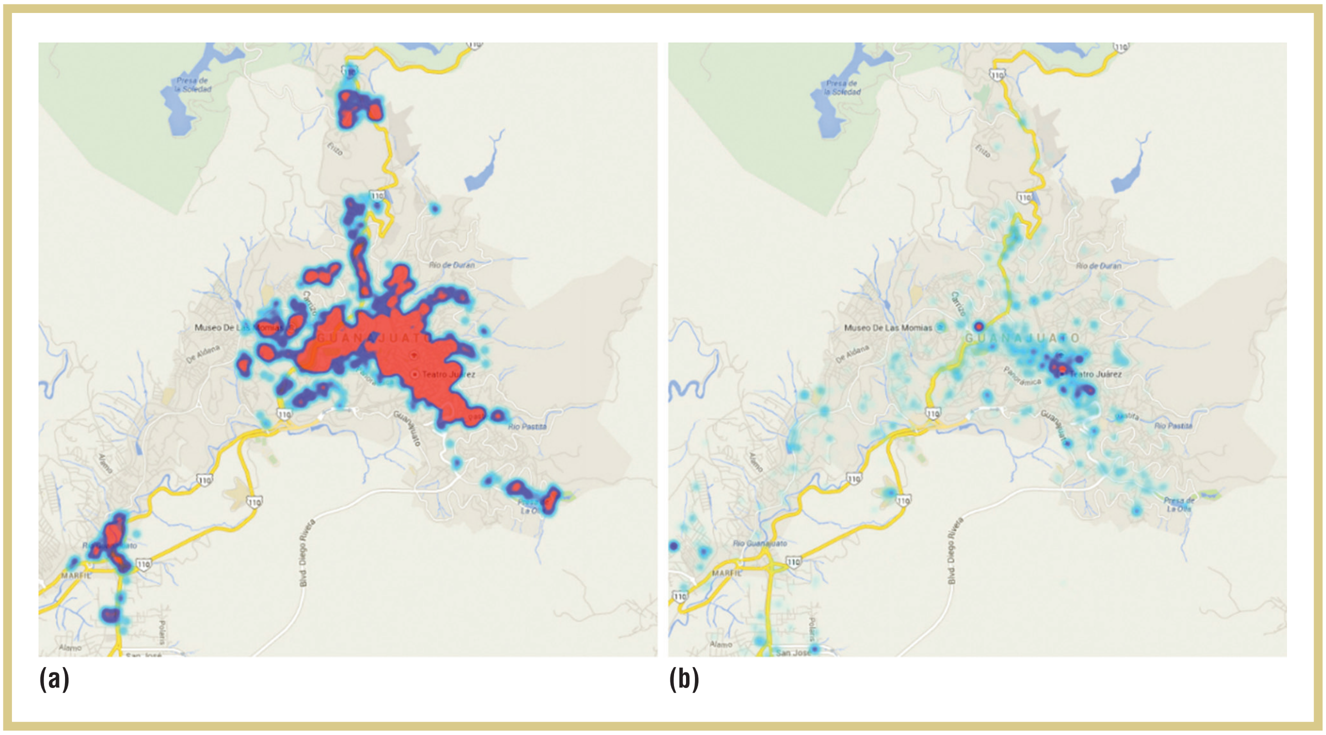

Figure 3. Heat maps helped identify areas where participants documented specific concerns: (a) heat map computed using geolocalized UDC images showing the areas marked as being of concern (in red) and (b) heat map computed using geolocalized tweets by general Twitter users in Guanajuato. Red indicates high density, while blue denotes low density.

Mapping Urban Concerns

From a quantitative viewpoint, one of the first tasks was to create heat maps to identify areas where participants documented their respective concerns about specific urban issues. We created these maps by applying density estimation techniques to GPS locations embedded in the geotagged images collected during the UDC (see www.idiap.ch/project/sensecityvity).

The main areas of concern were detected in traditional neighborhoods, plazas, historic alleys, and central avenues, as shown in red in Figure 3a. We also wondered how the UDC data compares to data from mobile social media such as Twitter, which is increasingly being used as a source to analyze cities.[17] The information provided by the UDC heat map describes patterns that differ from those obtained by aggregating geotagged tweets for the same geographical area (Figure 3b). Specifically, Twitter activity is low in several areas of Guanajuato, where the UDC teams detected urban concerns; yet, as expected, activity was high in both the touristic areas of the city and close to the main campus of the University of Guanajuato. Areas of urban concern might be digitally invisible in social media channels such as Twitter, showing the relevance of our approach as a complementary tool to map urban spaces in developing cities.

Emerging Themes

To study the state of Guanajuato City and explore the various themes captured by UDC participants, we conducted a qualitative study by manually coding the set of interviews and urban videos into three main categories:

- *city image*—showing littered garbage, graffiti, street dogs, and so on;
- *infrastructure*—showing infrastructural problems, ranging from insufficient street lights and garbage containers to inadequate street access; and
- *quality of life*—showing everything from vandalism, alcoholism, and drugs to insufficient public transportation.

In Figure 4, we plot the number of participants who described a specific problem according to these three categories.

From Figure 4, it's clear that trash accumulation and mismanagement has been identified as a serious concern that produces odors and pests, severely deteriorates the city appearance, and blocks drainage and sewer pipes, especially during the rainy season. Although some inhabitants think that "the people in charge of collecting the garbage in the city are not able to do it on time, and the garbage containers often overflow, polluting the environment," others believe that "the garbage problem in the city is a people's problem. We are responsible as a community to address it." People were also concerned about the worn infrastructure pervasive in the city. It's not uncommon to find high-powered

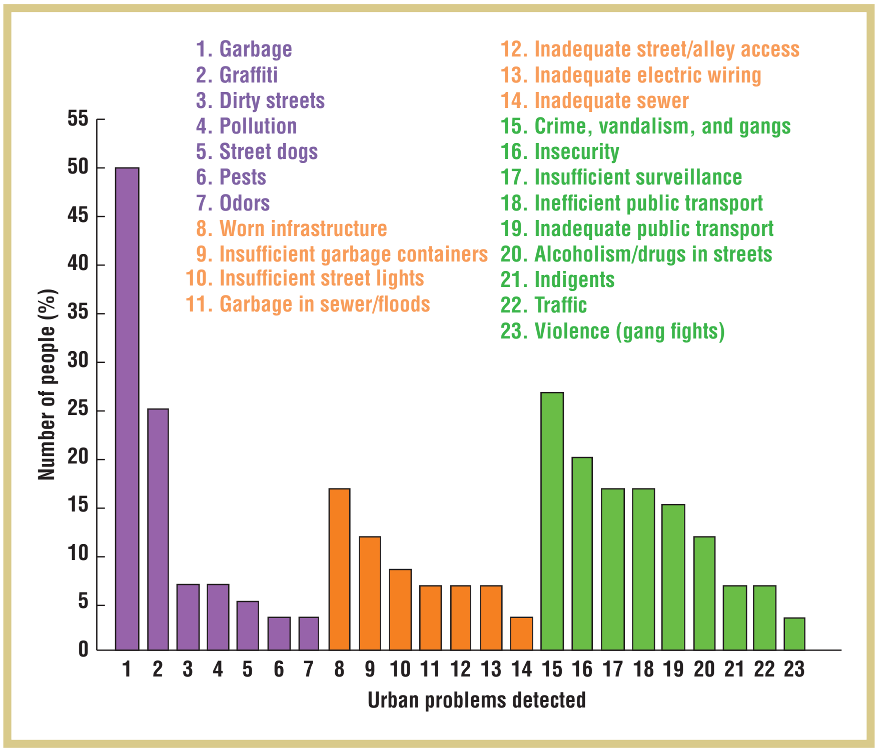

Figure 4. Urban problems detected by UDC participants, which are further divided in three categories: the city image (purple), infrastructure issues (orange), and quality of city life (green).

electric wires installed too close to rooftops, leading to serious hazards.

Participants also perceived an increased sense of insecurity in many city neighborhoods and suggested increased police surveillance of streets and alleys. One participant noted, "The problem here is that there is a lot of insecurity, in the alleys, outside the downtown area. At night, there are people drinking and smoking marijuana in the street alleys. We used to play by the Hidalgo market every day. But now we are limited because of insecurity; things can be complicated, and we are limited to go outside."

Over the past 20 years, the population growth in Guanajuato City and towns nearby has resulted in complex urban mobility patterns and insufficient and inadequate transportation. This issue affects the daily routines of participants, as one of them commented: "Transport does not come in time or is very scarce, or things like that, which affect us [in getting] to school; this problem affects … the majority of us." Visual inspection of the geolocalized images suggests similar themes to those obtained via coding interviews and videos (Figure 4), although detailed image coding and further analysis will be carried as part of future work.

It's worth mentioning that the SenseCityVity team working in the field also observed problems that were not reported by the UDC participants. For instance, the downtown area consists mainly of long winding alleys running hundreds of meters up hill. Because the city lacks infrastructure for the disabled and elders, a significant portion of these populations spend a fair amount of time walking the alleys for daily chores. However, UDC participants found that most of the interviewed elders didn't complain about accessibility problems. Rather, they expressed their dissatisfaction with vandalism, unsafe streets, or garbage in the streets. Our team also found increased noise levels and air pollution in Guanajuato's street tunnels, which have a considerable amount of pedestrian traffic, in addition to vehicular traffic.

Overall, our qualitative study suggests that participants are aware of both the beauty of their city and the key role that citizens should play in addressing urban issues. However, there is a general concern regarding the urban issues that are causing a gradual deterioration of the urban landscape, as well as regarding the need for more citizen and governmental involvement to revert this trend.

Potential Implications

A general consensus among participants with regard to possible solutions to the urban issues is that citizens and government need to work together. A historic trend in Mexico, in which citizens avoid their civic responsibilities and government institutions are oblivious to the needs of people, needs to be replaced by one in which government and citizen initiatives are put together through effective communication channels. Several of the observed problems can be directly addressed by citizen engagement and don't require a significant amount of external funding.

However, it was clear that many other problems will require direct government intervention. More than half of the people who were interviewed during the UDC still believe that government should be responsible for social transformation. For this reason, one of the main conclusions of SenseCityVity is that it's important for citizens to create effective ways to inform, communicate, and discuss urban problems with the other inhabitants to emphasize that, through citizen awareness and engagement, people can collectively enhance their capacities to improve their lives.

The complex patterns of urban growth in developing cities hinder the ability of their inhabitants to achieve suitable conditions for holistic development.

In this regard, SenseCityVity has demonstrated that in a specific local context in Mexico, it's possible to codevelop and apply technologies based on mobile crowdsourcing to support youth, so they can effectively define, document, and reflect on their own urban problems. This was achieved with the combination of citizen-contributed data and quantitative and qualitative approaches, which reveal which existing problems are perceived as more prevalent, and which go unnoticed. They also showed how these problems are geographically stratified, as well as the population's general impressions of the urban space.

However, a valid and relevant question regarding our proposed approach relates to the implications of deploying similar campaigns (with limited and incomplete data) to understand Latin American cities, and ultimately how this kind of work can be used to support city inhabitants' effective solution proposals. We suggest that, to be useful for studying cities in Latin America, future approaches must be based on a methodology that exhibits the following five requirements:

- deploys easily in the field,
- facilitates data collection to complement traditional data sources,
- engages local population from different segments and demographics of society,
- applies to a variety of urban landscapes (that is, to cities with distinct features), and
- is sustainable.

After completing the first phase of the project, our research has moved forward in two different directions. First, we have taken our approach to multiple cities in the state of Guanajuato. Second, we have engaged people from diverse segments of society, including young adults and elderly people. In addition, our methodology was recently adopted by other academics in different cities of Mexico, includ-

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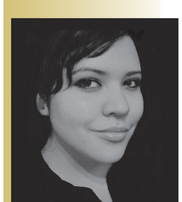

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ing in Leon and Merida (in southeast Mexico). These new partnerships will allow us to test our work in other conditions.

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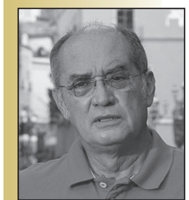

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