s.m.a.r.t.

Paths to Sustainability

acciona

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It is possible to progress while preserving the planet

The notion of "sustainability" impregnates the agendas of public and private organizations, political parties, firms, NGOs, and social players of all kinds. From Mexico City to Sydney, Dubai to Madrid, there is a shared concern about the severe challenges we face as a consequence of climate change and other global phenomena that threaten the equilibrium of our planet. Our lands are rapidly turning into deserts. Our cities are increasingly overpopulated and polluted. Water is a natural resource that is growing scarcer over time. Throughout our history, economic growth has been irremediably linked to the deterioration of the planet's environmental conditions. Something must change.

Not without great effort, we have managed to generate an ample consensus in recent years that it is now "essential" for our societies to change direction toward a more sustainable world that will give rise to a new economic and social model.

However, the concept of "sustainability" in itself can prove ambiguous. It is continually used, and often imprecisely. We risk emptying it of content.

This is where the idea of **s.m.a.r.t.** comes in, a proposal that takes material form in the magnificent and highly informed contributions to this volume. It is an acronym that encompasses the elements of an integral vision of the future based not only on the notion of **s**ustainability itself, but also on **m**itigation, **a**daptation, **r**esilience and the **t**ransformation of societies.

For without **sustainability**, progress will be simply impossible. A collective effort is necessary for the **mitigation** of the harmful effects of our activity, by reducing greenhouse gas emissions through clean energies, for example, or by ensuring a more reasonable and efficient management of water. Initiatives are needed to encourage the **adaptation** of communities to the consequences of global warming by means of infrastructures capable of withstanding the greater frequency and intensity of extreme meteorological phenomena. In this way, we shall help equip the societies we live in and whose services we provide with the **resilience** necessary to confront these hurdles. Finally, our response to these challenges has a clear objective: the **transformation** of the world into a safer and more balanced planet.

Much can be done by firms both large and small in pursuing these ambitious goals. At ACCIONA, we are committed to this new **s.m.a.r.t.** model of development, which takes sustainability as the basis for specific actions aimed at mitigation, adaptation, resilience and transformation. It is a formula that can make economic growth compatible with the decarbonization of our economies, for our own benefit and, above all, that of future generations. That is our proposal, and that is what the book in your hands is about.

I have not only the hope but also the firm conviction that more and more players and organizations will embrace the **s.m.a.r.t.** criteria and join us in this new "sector", whose guiding principle is precisely to contribute to an increasingly sustainable society and world.

José Manuel Entrecanales,
Chairman of ACCIONA

Technology and the Democratic Management of Urban Complexity

Michael Batty

The computerization of society has now reached the stage where hardware and software are rapidly spreading out into the built environment and enabling ourselves as both users and designers of cities to automate many of our routine practices and functions. This automation has given rise to the notion of the "smart city:" cities in which digital media is heavily embedded in public and private places, enabling us to function better, to become smarter citizens, by producing much more secure, sustainable and livable environments. Once we build information infrastructure into cities—which is no more, or less, than what we have been doing for the past two hundred years with conventional transportation infrastructure—we are not only able to control the functions of the city in better ways but we are also able to enhance our understanding of cities and their planning thanks to the useful information generated by such infrastructure. Much of this data is streamed in real time and in this sense it is "big" in terms of its volume. Therefore, we need to employ new digital methods to explore and manage it. Such big data is essentially the "exhaust" or by-product of the smart city, and we are only just getting to grips with assessing how useful this is likely to be for managing the future city.

Cities, of course, tend to be sustainable under many varieties of technological disruption, such as the introduction of new forms of automation and changed behaviors associated with them, for they are highly adaptive, complex systems. But the real question is whether cities are becoming more sustainable in terms of their living environments with the kind of technological change that currently dominates their development. We are living in a time when our ability to communicate with one another is being dramatically enhanced by new information technologies (IT). The issue we need to consider is whether or not the gains in efficiency derived from these developments are leading to more livable and equitable urban environments. To this end, this chapter will explore the ways in which these developments are being implemented under the guise of the smart-city movement. Smart cities imply smarter responses to urban problems but at the same time these responses, like many developments in cities, can be divisive and confusing, and might go against the more general goals of sustainable urban development.

Currently the smart-city movement embraces a perspective that examines the city through its most routine functions. These tend to include the flow of information, materials, and people which takes place daily and which we record over a relatively brief period of time, be it minutes, hours or days. In fact, city planning in the past has been largely about how cities change and are

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planned on much larger time scales, over years and even decades, which reflect the time required for substantial spatial change to take place. But the fact that we now have the ability to capture data in real time using a variety of sensors is changing the way we look at cities, shifting the nature of our planning and design to the much shorter term. Data is being captured either through passive sensors embedded in the built environment or active ones which we control through our own actions, typically smartphones and portable computers of various kinds. Much of this data capture is made possible by the electronic skin that has been layered across the planet in the last thirty or forty years, with the Internet and its visual interface constituting one of the most dominant modes of communication. Many private networks at many spatial scales also exist and interact with the Internet in diverse ways—a fascinating glimpse into this world is contained in Andrew Blum's book *Tubes: A Journey to the Center of the Internet* (Ecco Books, 2013). But most of the time this world is hidden to us and we only see evidence of the smart city in the most superficial way—in the use of our own devices as smart sensors, in the data that is provided by them and packaged into information delivered to us to help our decision-making, particularly in terms of travel, retail purchasing, perhaps in how we might control energy use at home in basic ways involving heating, and in the delivery of online financial services, increasingly known as "fintech."

As a matter of fact, our image of the smart city is much more comprehensive than the reality of it. The big computer companies, such as IBM and CISCO among many others, portray an image of the smart city where everything is integrated in seamless fashion, where there is universal access for all, and where the prospect is one of continued sustainability. The reality, however, is very different. New information technologies do require integration—which ranges from interoperability over different platforms to different data being linked to each other—but this is extremely difficult to achieve, not least because software and indeed hardware is increasingly developed ad hoc.

It could not be otherwise, for developments in computation involve new discoveries and it is impossible to invent and develop a piece of hardware or software able to anticipate all future developments, no matter how flexible and open its design. Sustainability can thus be compromised by the fact that we can never know the future. In fact, all complex systems are like that—they evolve in an organic manner rather than being designed from the top down as rigid and fully functioning structures.

The other message that has been preached in the last thirty years in terms of cities is the idea that they are complex systems, more like organisms than machines, systems that grow from the bottom up, never designed in their entirety, and that, for the most part, undergo incremental development. Such development is not irrational: it may be very rational in function but the design of complete cities is a rarity, often conceived as an ideal type and predicated as a demonstration project. A number of smart cities have been designed this way, almost like company towns: the digital new towns of Masdar in the United Arab Emirates and Songdu in South Korea are examples of what might be produced in idealized, optimal conditions. But like conventional new towns before, they tend to force population behaviors into something of a straightjacket.

Smart cities, which as mentioned above are part of the current stage of the computerization of society, trace back their origin to the Industrial Revolution and the use of mechanical technologies in the late eighteenth century. Cities were then transformed by electricity in the late nineteenth and early twentieth centuries, and have been powered by digital computation since the mid twentieth century. This automation has permeated virtually every corner of our lives. Thus the smart city, which is the most recent stage of urban development, can be defined in multiple ways through multiple applications of digital media and IT. It is not possible here to define all of these, for they are everywhere, but some are more important and widespread than others, and in this brief outline we will focus on three of them: the first dealing with transport, the second with social media and social networks, and the third with citizen services and citizen science. Each of these examples has different implications for increasing the sustainability of our cities, and in each case there is evidence that these developments will both enhance and detract from the general goals of increased sustainability.

For over 50 years we have been collecting data on the supply (numbers, type, etc.) of vehicles through loop counters embedded in roads, though progress has been slow in terms of collating ticketing data into transit demand measures. Some of the first IT developments in transport involved automated ticketing, and in many large cities—cities with a population in excess of two to three million people and underground transport networks—such systems are now routine. In London, whose inner core is home to over eight million people, some 40 percent of the population travel by public transport, 85 percent of which use the standardized automated ticketing associated to the Oyster card. This is the smart card which records the details of every tap in and out of the system,

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the cost of each trip, and the stored credit available for travel which users load onto their card. There are approximately twelve to thirteen million such taps per day on tube, overground rail, and bus, and the data obtained in real time—according to location at the start and end of each trip, and time elapsed in seconds—provides a unique record of the behaviors of the travelers and the dynamics of the transit system.

This data can also be used to control such systems. It is possible to extract the functions of travel from where people enter and leave the system by comparing this with land uses and activities at different locations, and to explore the enormous heterogeneity of travel which is associated with these functions. The impact of disruptions on the system can be studied with respect to the cascading effects of stalled trains and signal failures on the paths and trips made by travelers and then used to suggest strategies of mitigation.

These are all features at the cutting edge of what the smart city might deliver in terms of transit, so that the quality of the travel experience can be improved and made more sustainable; but the clearest benefits to date involve the delivery of information online through apps on smartphones or digitally within stations, where displays and dashboards inform travelers about the state of the system. There are now at least two dozen systems around the world with comprehensive automation and an increasing number of smaller systems with part automation, and it is very likely that most transit systems in the wealthier G20 countries will be automated in this way by 2025. In fact, purpose-made smart cards are likely to disappear as such automation is ported to contactless payment cards (credit, debit and the like, as in London now)—a development that mirrors the massive proliferation of purchases now made electronically either directly in stores or on the web, which is part of the growing electronic skin of the planet we noted above. Add to this mix the commercialization of autonomous vehicles, which are self-driving and self-maintaining to different degrees, and the prospect of widespread automation in travel will soon lay before us, making this aspect of the smart city a reality. These are important elements of increasing sustainability with respect to congestion, accessibility and mobility in cities.

One of the most pervasive and fastest growing features of the smart city involves social media. Since the use of smartphones became widespread, as the cost of telecoms and phones fell and messaging apps became available, there has been enormous growth in individual access and messaging to websites that enable people to

communicate virtually anything they care to think about. Some half a billion tweets (short text messages) are posted to Twitter each day; the number of registered users in Foursquare, a similar but more niche social media site, is much smaller at 60 million; but both of these pale in comparison with the over 1.7 billion users of Facebook; and the list goes on: photo sharing sites such as Flickr now have 112 million users, while Instagram has more than 500 million. In China, similar but separate systems are fast emerging; these include Weibo, a social messaging site like Twitter, and Baidu, the search engine equivalent to Google. When we consider web search and email traffic, the size of the digital world positively explodes, and many of these statistics now correspond to significant fractions of the world population. Much of this is taking place in cities, possibly and hopefully making us all better informed and smarter while at the same time raising problems about personal privacy, confidentiality, ownership of intellectual property, and so on. The extent to which all these new media which have come upon us in the last decade are changing our behavior poses an enormous challenge to the way we understand the world, particularly the world of cities, the role of location, and the impact of globalization.

To some extent there is skepticism as to whether or not these new media are actually changing the traditional functions of the city. They may simply be reinforcing traditional modes of behavior, but as the data streamed by the sensors built into the various devices and applications is so unstructured, it is extremely difficult to search for patterns that might be different from those that we are aware of traditionally.

The other domain of data which is genuinely a product of the smart city is the much more interactive basis of Internet use known as crowdsourcing—where "crowds" or individuals forming a population create their own data from their own responses, which are recorded through the medium of the web. Despite the notion that the power of the crowd might come to a somewhat different or more intelligent conclusion than unstructured responses of many individuals, crowdsourcing data collection is now possible if enough people have access to a web-based media and are motivated to respond to a particular set of questions, issues, or challenges. This general area involves not only the creation of data but furthermore concerns data used for purposes which often work towards the empowerment of those involved in collecting it. Citizen science is the term often used to suggest that this activity is one in which citizens themselves can become smart, in that they are part of the process of collecting data that might make the city smart.

A rather basic and perhaps mundane but immensely successful effort is the crowdsourced mapping technology Open Street Map – OSM (www.openstreetmap.org) which involves relatively informed but amateur attempts to generate as detailed a map of an area as is possible at the level of streets and land parcels, including the activities or land uses that pertain to these. OSM is producing maps that are as good, if not better, than those produced professionally by national mapping agencies, with the added proviso that these maps get better and better as informed volunteers correct errors and add to their content. It is also part of the wider movement to make data "open," with crowdsourced data of this kind being open to others almost by definition. This is giving added impetus to government and other sectors to open and share their data more freely than has been the case in the past. In this sense, smart cities are cities where open data is the modus operandi of making citizens smart and giving them power over their future with this new technology. This, we believe, enhances their sustainability.

All of these technologies and the efforts to implement them have the potential to make the city smart. It is worth noting that the term smart is peculiarly American in its usage, but the downside is that it has become such a buzzword that it is being applied to every aspect of the city at the present time. Perhaps this is no bad thing because it does draw attention to the difficulties of widespread automation, the disruptions that are taking place, and the notion that traditional ideas about place-based activities need to be extended to movement and communications. New information technologies are providing an entirely different basis for communicating with one another than was possible in the past, and this is changing the nature of place. The terminology of the smart city will not last, as there will come a point in time when the focus of new IT will move from this public domain to other cutting edges—probably medicine, possibly the alleviation of poverty, perhaps the restructuring of government. And it may take some time before the promise of integrated IT systems—platforms, as they are increasingly being called—become a reality. But what is clear is that the industrial revolutions, of which the smart city is but the latest, are changing the concept of the city from a place-based set of activities to a set of activities that exist in a different kind of reality where information will be the new energy, the new fuel that will power the way we work and function in cities. In fact, when we move beyond the smart city, we may no longer talk of cities in a world where we are all in constant communication with one another, no matter where we are. In this sense, we consider that what is now happening with new technologies does herald an era when cities are likely to become ever more sustainable.

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