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Smart Cities for Sustainable Development: *A Policy Framework for Developing Countries*

Hari Srinivas



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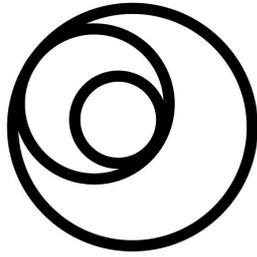
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Abstract

Two key processes have fundamentally changed the way human settlements have developed over the last two centuries – globalization and human migration. Globalization has enabled the separation of humans from the land that had defined an agrarian lifestyle. Migration also contributed to growth of cities, catering to the innate need of people for a “better” quality of life, better jobs, better homes, higher incomes, or access to education, health and other public services. Besides these two processes, “push” factors such as poverty, disasters and conflicts, lack of economic and social opportunities etc., have also triggered migration to cities.

As the number of people arriving and living in cities has increased over the years, this has led to a number of challenges faced by both urban authorities as well as its residents. The paper discusses these challenges and the need to intrapolate the global priorities of sustainable development (particularly in light of the recently promulgated Sustainable Development Goals) to the level of cities, where day-to-day lifestyle decisions are made.

This is where the concept of smart cities comes in. Smart cities, with its widely differing definitions, can make significant contributions to enable cities to be more efficient, accessible and sustainable.

Keywords: Sustainability, urbanization, governance, education, technology, smart cities

1. Importance of Sustainable Urban Areas

Global Urbanization Processes

Two key processes have fundamentally changed the way human settlements have developed over the last two centuries – globalization and human migration. Globalization – the free movement of resources, goods and money over national and regional borders – has enabled the separation of humans from the land that had defined an agrarian lifestyle. Migration – the movement of people from one place to another – also contributed to growth of cities, catering to the innate need of people for a “better” quality of life, better jobs, better homes, higher incomes, or access to education, health and other public services. Besides these two processes, “push” factors such as poverty, disasters and conflicts, lack of economic and social opportunities etc., have also triggered migration to cities.

The above processes have resulted in what the United Nations calls an “urban” century – a situation where a majority, more than 50 percent of the global population, live in cities. The UN estimates that cities are growing at the rate of 60 million people per year [UN HABITAT, 2016 a], and that by the year 2050, this proportion will increase to two-thirds of the global population.

Urbanization processes are characterized by both an increase in overall population of cities, as well as changes in lifestyles that require more resources and more water, energy and food etc. and generate more waste, emissions and pollution, compared to an equivalent rural lifestyle.

Challenges of Urban Areas

As the number of people arriving and living in cities has increased over the years, this has led to a number of challenges faced by both urban authorities as well as its residents. Some of these challenges include, for example:

- Urban growth and concentrations of population leading to greater poverty, with local governments unable to provide services for all of its residents.
- High fossil-fuel based energy use leading to greater air pollution with significant impact on human health. Urban-based CO₂ emissions have also accelerated as a result.
- Inefficient and poorly managed network infrastructure such as roads and bridges
- Insufficient capacity and quality of utility services, such as electricity, gas, water, etc. to cater to the full needs of the population.
- Large volumes of unmanaged waste¹ affecting people's health, as well as increasing environmental impacts such as methane and CO₂ emissions.

¹ The problems of urban waste generation are compounded by waste disposal practices such as landfills and uncontrolled garbage burning, which has increased its negative impacts on the environment.

- Increased risk of environmental hazards such as flash flooding, landslides etc. due to urban planning and development patterns.
- Waste, pollution and emissions drastically affecting the quality of water

The urban challenges of overcrowding and homelessness, poor living standards, water and sanitation, pressure on transportation, infrastructure and utilities has led to a global movement towards making our cities more livable resilient and sustainable.

A key milestone among these efforts was the recent unveiling of the “New Urban Agenda” by the United Nations in 2016. The New Urban Agenda represents a shared vision for a better and more sustainable future. It is built on the premise that, if well-planned and well-managed, urbanization can be a powerful tool for sustainable development for both developing and developed countries [UN HABITAT 2016 b].

SDGs for Cities

The challenges that cities face ,and its short and long term impacts on sustainable development, led to the issue being included in the recently promulgated Sustainable Development Goals (SDGs) as Goal 11 – “Make cities inclusive, safe, resilient and sustainable” [UN 2015].

The overall SDGs are a blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. The 17 Goals that constitute the SDGshave been designed to be achieved by 2030.

Goal 11 of the SDGs aims to make cities more inclusive, safe resilient, and sustainable. It calls for action targeting housing and slums, transportation, urban planning and management, heritage, disaster management, air pollution, waste management, green spaces, etc. in our cities and urban areas.

The SDG Goal 11 is ambitious in its vision and targets, particularly in achieving them by 2030. This would require a drastic rethink of the strategies and tools that we use to plan and manage our cities. The goal of creating cities and communities that are sustainable, and of overcoming the urban challenges listed above, requires new concepts and approaches that strengthen urban governance and management processes, clearly delineating roles for local authorities, business and industry groups, and actors in the civil society. Besides the efficient urban governance systems, better education and awareness raising, and particularly appropriate technology solutions, remain key ingredients that will help achieve the urban goals of the SDGs.

2. The Smart City and Sustainability

The urban challenges outlined above – of creating cities and communities that are more sustainable – requires a number of key management tools and strategies that can make the

administration of cities more efficient and equitable. Of critical importance are the following interrelated and interlinked issues to make urban areas more sustainable:

- **Comprehensive Scenario Development:**
Unplanned development of cities is, in many cases, the key reason that they are facing the problems outlined above. This includes unanticipated patterns of development brought about by migration, lack of finances, or inefficient local authorities. Understanding the outcomes and realities of different solutions and presenting the information are important elements to develop future scenarios and overcome these problems.
- **In-depth Policy Planning:**
The challenges that cities face require innovative policies that take advantage of skills and resources from different stakeholders. Identifying and defining the urban problems, setting of development objectives, allocation of financial resources, planning of activities, evaluation of results, etc. are typically undertaken in a policy planning process. But many local authorities do not have the necessary information or capacities to undertake these tasks. The use of appropriate data analysis is key here to ensure that proper policy planning can be undertaken.
- **Efficient Decision-making:**
Action to make cities and communities more sustainable starts with a decision. But with scattered and disconnected decision making processes resting with different entities (both within and outside the local authorities), the coordinated approach needed for sustainability become more difficult. Many in fact function with opposing aims and objectives, increasing the uncertainty and conflicts in decision making. It is clear that good, efficient decision making needs well-organized collection/mining of data and information from multiple sources that can support and inform good decisions.
- **Broad Stakeholder Participation:**
Complex problems being faced by cities and urban areas need the active participation of different stakeholders with different resources and skills, enabling the different kinds of actions to be taken². The key to ensuring this division of responsibilities among different stakeholders is access to appropriate and applicable data and information.

Smart Cities

The four issues outlined above highlight the need for comprehensive/inclusive data mining, data analysis, data presentation, and data access to solve challenges faced by

² For example, while local authorities can be responsible for laws and regulations, civil society entities such as non-governmental organizations (NGOs) can be responsible for education and awareness raising, while private sector companies can be responsible for developing technology solutions.

cities today. This is where smart city concepts come into the picture, in providing the necessary technology ecosystems that can assist and support the four issues.

What are smart cities? Simply put, a “smart city” is a designation given to a city that incorporates information and communication technologies (ICTs)³ to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs. This helps cities to be more sustainable, as illustrated in Figure 1.

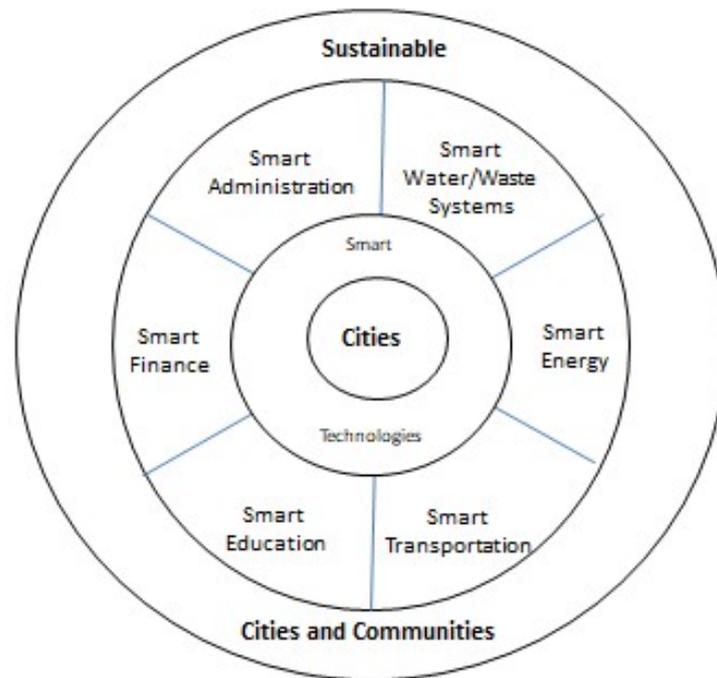


Figure 1: Conceptual Layout of Smart Cities and Sustainability

This includes monitoring and managing of public assets, transportation systems, citizens, power plants, water supplies, information systems, civil bodies, and other community services.

- For a local authority, a smart city uses ICTs to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare. It also helps in making public administration processes more efficient and targeted.

³ Smart City ICTs include, for example Internet of Things (IoT), data sensors, virtual reality, artificial intelligence (AI), Big/Open Data, mobile networks including high-speed 5G network, and cloud storage systems

- For a business, a smart city provides opportunities to not only implement its strategies and goals in an efficient manner using ICTs, but to also broadly engage with its customers and local communities as a part of its Corporate Social Responsibility (CSR) policies. A smart city also provides businesses with opportunities to develop new technologies needed for efficient urban management.
- For civil society entities, including non-governmental organizations (NGOs) and universities/research institutions, a smart city provides more tools and technologies to target local communities and groups with education and awareness raising programmes and capacity building opportunities.

Ultimately, a smart city is more than just technologies. While at its core, smart cities do connote the innovative and timely use of sensors, IoT, virtual reality, artificial intelligence, open/big data et al., the specific opportunities that smart cities offer are broad, and include - smart infrastructure (street lighting, traffic management, river management, etc.); smart buildings (energy efficiency, heating and ventilation etc.) ; smart utilities (water and sanitation, electricity, gas etc.); and smart governance (regulations, finance, participatory democracy, administrative services, elections etc.)

The success of smart city policies lie in the collection and use of comprehensive, appropriate and timely data and information in three spheres of urban management – governance, education/awareness, and technology.

- **Smart Cities – GOVERNANCE:**
Smart city policies and technologies help in better governance of cities. The provision of data and information in order to develop and especially implement applicable laws, regulations and rules are critical for long term sustainability. Besides, it also increases the efficiency of administrative and public services provided by local authorities to its citizens.
- **Smart Cities – EDUCATION:**
This is an important, but often overlooked aspect of smart city technologies – the improved opportunities that technology provides for education and awareness raising of a city’s residents. Such educational programmes include not only awareness raising campaigns, but also seminars and capacity building/training exercises that aim to make lifestyles more sustainable, particularly an environmentally friendly one.
- **Smart Cities – TECHNOLOGY:**
The technology sphere of smart cities not only includes the actual technologies that makes a city “smart”, but the facilitation of overall technology development itself that contributes to sustainability – technologies, for example, that help in

reducing waste during manufacturing, reduce amount of wastewater generated, use of energy efficiently, recycling technologies etc.⁴

It is these concepts of smart cities that hold the most promise for cities and communities to be more sustainable. In the following sections, the chapter looks at urban areas and how smart city concepts can help such cities to be more efficient and sustainable.

5. Contribution of Smart City concepts to Urban Development

Environmentally friendly cities are an innovative approach to incorporating and encouraging businesses (and their customers as well) to become more sustainable, while at the same time contributing to economic growth.⁵ This, along with lifestyle and behavioural changes among the city's residents, form the corner of a green or circular economy.

The technology systems embedded within a smart city (data collection and mining, Data presentation, data analysis and data access) have also obvious implications in making cities more efficient and sustainable.

Key Needs for “upgrading” to smart cities

The intersection of urban needs [Srinivas 2006] and the opportunities provided by smart cities provides an interesting matrix of actions and activities, illustrated in Table 2.

Table 2: Urban Needs and Smart City Data Technologies

Urban needs	Smart city data technologies			
	Data Mining	Data Analysis	Data Presentation	Data Access
Assessment of total and segmented waste water, materials and energy volumes and flow patterns from all industry sources at city, metropolitan and regional scale.	<i>Waste tracking</i>	<i>Waste volume by type</i>	<i>Waste generation trends</i>	<i>Web access of reports; Open data/big data</i>
Identification of actual and potential commercial waste volumes by industry segmentation and waste sinks (waste without use, sent to land fill or incineration).	<i>Waste generation reporting</i>	<i>Projection of waste volumes</i>	<i>Waste generation trends</i>	<i>Web access of reports; Open data/big data</i>

⁴ An “environmentally sound technology” for example, uses less virgin natural resources, produces less waste/emissions/pollution, recycles its waste, uses energy efficiently and is easily dismantled for disposal.

⁵ This, in fact, makes sustainable cities a very representative example of a “green economy” or “circular economy”

Economic, environmental and physical risk assessment of wastewater, waste and energy by-product utilization.	<i>Reporting by each industry</i>	<i>Data analysis of utilization rates</i>	<i>Trends in future generation of by-products</i>	<i>Open data/big data</i>
Spatial concentrations and transportation of flows of resources and products by types.	<i>Industry reporting; tracking codes and tools</i>	<i>Mapping of resource use and transport routes</i>	<i>Geospatial maps; data trends over time</i>	<i>Web access of reports; Open data/big data</i>
Environmental sensitivities of locations for waste materials, water and energy processing and reprocessing.	<i>Data on waste, water and energy use; reporting by industries and utilities</i>	<i>Projections in industry use of water and energy, and generation of waste</i>	<i>Environmental assessment of resource use by industry</i>	<i>Web access of reports; Open data/big data</i>
Implications of regional growth management strategy and planning schemes on sustainable industry development - especially future industry location.	<i>Data on market trends; urban planning schemes and maps</i>	<i>Market analysis on size of the market, buying patterns, competitiveness, barriers to entry and regulation etc.</i>	<i>Reports on industry outlooks, business risk reports (including environmental), global market trends,</i>	<i>Web access of reports; Open data/big data</i>
Regulative frameworks of environmental storage and handling of wastewater and waste material.	<i>Wastewater and waste tracking data, industry reporting</i>	<i>Projections on future generation trends</i>	<i>Scenarios on eco-impacts;</i>	<i>Web access of reports; Open data/big data</i>
Assessment of local government efforts on the application of environmental policies, standards and performance criteria affecting industries across the region.	<i>Information on government policies and reports on its implementation</i>	<i>Policy impact analysis and assessments; public opinion surveys; multi-stakeholder participation</i>	<i>Analysis and policy impact reports;</i>	<i>Web access of reports; Open data/big data</i>
Assessment of societal attitudes towards supporting industries in inner urban areas and other industrial sites, as well as attitudes towards integrated industrial development planning involving mixed industry development.	<i>Public opinion surveys; media reports; market growth data; social research studies</i>	<i>Growth trends, market analysis; Analysis on opinion mining and sentiment analysis</i>	<i>Reports on attitudes analysis; future market growth strategies</i>	<i>Web access of reports; Open data/big data</i>

Smart city technologies therefore help in collecting, analyzing, presenting and accessing data by concerned stakeholders in the public, private and civil sectors (with responsibilities in both collecting data, and in using it).

Smart City Features that Contribute to Urban Development

The success in development and operation of urban areas are dependent on four issues, illustrated in Table 3. These include (a) efficient decision-making, (b) comprehensive scenario development, (c) in-depth policy planning, and (d) broad stakeholder participation. It is particularly important to contextualize the last one, of broad stakeholder participation, within the involvement of not only local authorities, but also private businesses, universities and research institutions, industry groups, NGOs, and citizens groups,

Table 3: Intersection of urban areas and Smart Cities

Urban needs	Data needs	Smart city technologies
Efficient decision making	Data mining and collection	Sensors, Internet-of-Things (IoT), Open/Big Data
Comprehensive scenario development	Data presentation	Virtual reality technologies
In-depth policy planning	Data analysis	Artificial intelligence
Broad stakeholder participation	Data access	Mobile networks and cloud storage

The matrix of ecotown data needs and smart city technologies illustrate the policies and strategies that will make cities more efficient and sustainable, and achieve its main aims and objectives.

Towards “Smart” Cities

The relative benefits of cities in contributing the reduction of negative urban environmental impacts and overall sustainable development is clear from the above discussions. But recent additional challenges of global environmental problems, particularly climate change, have added to the urgency to upgrade the functions and achievements of cities, as illustrated in Figure 3.

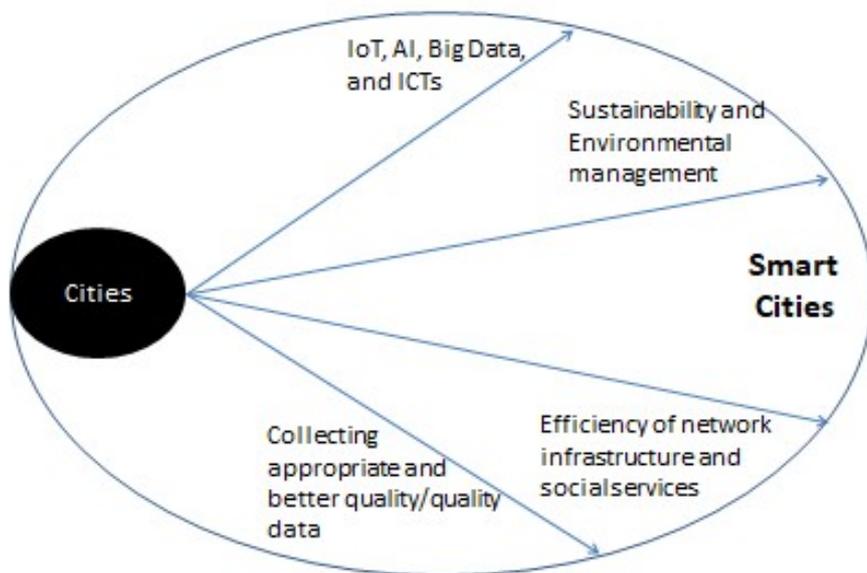


Figure 3: From Cities to “Smart” Cities

Taking advantage of the technologies and strategies of a smart city, cities need to be upgraded to “smart” cities by:

- Intensive use of ICTs – IoT, AI Big Data and other information and communication technologies
- Collecting appropriate and better quality/quantity data in real time
- Increased efficiency of network infrastructure and social services
- Use of innovative and sustainable environmental management practices and technologies

The promise of smart cities, and the opportunities that they enable, as explored in the above sections, clearly enable and provide better opportunities for cities to be efficient, resilient and sustainable. Smart cities bring together data sensors/detectors, communication infrastructure, Big Data, and artificial intelligence, in order to solve challenges of urban planning, development and management.

Our urban goals haven’t in fact changed. We still need livable, efficient, sustainable and resilient cities, as targeted by Goal 11 of the Sustainable Development Goals (SDGs). It is just that the way we approach these goals are changing with the opportunities provided by smart cities. As the management of cities become more complex, we are using more data (qualitative and quantitative), more analytics, and more technologies to achieve our old desire of a better quality of life.

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The Global Development Research Center (GDRC) is a virtual organization that carries out initiatives in education, research and practice, in the spheres of environment, urban, community, economy and information, and at scales that are effective.

The GDRC is an attempt to consolidate disparate issues, themes and topics into one umbrella to highlight their interconnectedness and interdisciplinary nature. With the focus being more on knowledge transfer and information dissemination, GDRC focuses on the micro scale - at the level of the man-on-the-street, where most of the everyday decisions are taken.

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- Policy and programme development at the local level

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Global Development Research Center (GDRC)

1-2-16-1 Mori Kita Machi

Higashi Nada-ku,

KOBE 658-0001

Japan

Tel: +81-50-5534-5535

Fax: +81-78-452-8414

Email: [gdrc@gdrc.org](mailto:gdr@gdrc.org)

Web: <http://www.gdrc.org/>

