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Smart Cities for A Sustainable Future : Can Singapore be a Model for Delhi?

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ABSTRACT

Modern cities have been shaped by a host of factors, such as, resources, technology, communication, education, medical facilities and other developmental parameters. However, problems of degradation, pollution, diseases and an overall poor quality of life have resulted from rapid urbanization and population growth in many cities. Environmental degradation has caused threats to the living conditions of people and thus to their sustainable common future. The major challenges before the urban growth centers have necessitated the formation of smart cities. Sustainable future of a city lies in the development of transport, infrastructure, environment, energy, ICT and its citizens with a sustainability approach. The Government of India has launched the scheme to create hundred smart cities across the country, among which the national capital of Delhi is a frontrunner.

Singapore is a success story in the smart city initiative. It is among the top performers in digital governance, countrywide networking and an overall good quality of living. The country recognizes sustainable development as a long term and ongoing effort with clear goals to be achieved by 2030. It has adopted a four-pronged strategy: boosting resource efficiency, enhancing urban environment, building capabilities and fostering community action.

This paper tries to study the case of Singapore as a model for Delhi. Lessons from Singapore may be helpful to gauge the preparedness of Delhi to become a smart city, given the existing infrastructure and facilities in Delhi. It also attempts to analyze the citizens' perception about Delhi as a smart city through a primary survey. Despite its limitations in the current scenario of economic and environmental performances and people's perceptions, Delhi makes a strong case for becoming a smart city.

Keywords: Sustainability, Smart City, Transport, Energy, Water, Resources, Information and Communication Technology, Citizens, Perception

1. SUSTAINABILITY AND SMART CITIES

Cities are often equated with the idea of progress of mankind because they manifest technological innovations, socio-cultural interactions, economic structures and political systems. It is the city in which the concept of citizen was born. Almost half of the world's population today lives in urban areas. Factors like resources, technology, medical innovations and environmental developments have shaped modern cities. On the other hand, it is ironic that they have become symbols of fear, poverty, degradation and diseases. In view of the increasing risks, concerns and problems, it has become necessary to find 'smarter ways' to handle the upcoming challenges. The search is to find sustainable pathways backed by experience and knowledge. Sustainability of cities requires the creation of an urban future that uplifts quality of life. The concept of smart cities is essentially a manifestation of all such solutions towards urban problems based on sustainability of the society, economy and environment with the objectives of equity, viability and carrying capacity.

A Smart City delivers public and civic services to citizens in a resource efficient way to improve the quality of life. It integrates the physical, digital and human systems in the built environment to deliver sustainable, prosperous and inclusive future of its citizens. It is a process rather than a static outcome, in which increased citizen engagement, hard infrastructure, social capital and digital technologies make cities more livable, resilient and better able to respond to challenges. Smart city is a multidimensional concept that includes sustainable management and development of the following: Transport, Infrastructure, Environment, Energy, ICT, People and Sustainability approach.

The Government of India has announced the policy to create hundred smart cities across the country, one of which is the national capital of Delhi. In order to know the 'preparedness' of the city to become smart, the present scenario in Delhi may be examined in terms of the different parameters of smartness.

Singapore as a nation has succeeded well in implementing the project of Smart City. Its success story can provide the vital lessons for cities trying to find sustainable solutions in urban scenarios. The Singapore model can help evaluate the case for Delhi by identifying target areas that are required to be focused in a Smart city.

2. SINGAPORE: A SUCCESS STORY

Singapore has become a global leader in its smart city initiative and has been ranked one of the top countries in terms of usage of ICT, deliverance of public services, digital governance, countrywide networking, environmental quality, economic growth and quality of life.

Singapore, a city-state located at the southern tip of the Malay Peninsula, about 85 miles (137 km) north of the Equator. Its location on the geographical map is favorable in terms of intersection of international sea and air routes, except for which it has got no special gift from nature. It imports food and industrial inputs and also pipes drinking water from other nations. Moreover, being an island nation, it faces the threat of climate change.

Singapore has won over the problems of overcrowding, pollution due to congestion, poor living conditions, environmental problems and poor infrastructure that existed forty years ago. Singapore today produces enough water, energy, efficient public transport, lush greenery and clean air. These have come through a multi-pronged strategy with planning and implementation of agreed principles. The country recognizes sustainable development as a long term and ongoing effort with clear goals to be achieved by 2030. It has worked on three guiding principles and adopted a four-pronged strategy.

2.1. Guiding Principles and Strategy

Singapore follows a policy with twin objectives of economic growth and environmental sustainability. Singapore has the following three guiding principles:

- Long term integrated planning for energy, transport, urban planning;
- Pragmatic and cost effective implementation of policies with long term benefits despite short term costs;
- Flexibility in meeting the challenges to economy and environment, keeping pace with technology and the global scenario.

The strategy to achieve the above principles is four-pronged:

2.1.1. Boosting Resource Efficiency

Realizing its limited resource availability it has focused to increase resource efficiency by 35% by 2020. It includes the following steps:

- Pricing resources efficiently in order to encourage conservation;
- Providing information for better decisions to encourage re-use;
- Introducing energy labeling and benchmarks for industries;
- Boosting energy efficient designs, technology and processes to minimize emission;
- Building capabilities in renewable energy such as, solar energy;
- Promoting resource efficient buildings with an aim to achieve 80% of buildings having green mark certification by 2030;
- Promoting public transport by aiming 70:30 ratio between public and private sector usage with cleaner technology and improved vehicle ownership policies;
- Improving water efficiency by reducing domestic consumption, promoting water recycling, introducing water efficient buildings;
- Managing wastes by redesigning processes, packaging, recycling;
- Using potable water for drinking purposes;
- Land use planning to earmark potential areas of given space through a master plan.

2.1.2. Enhancing Urban Environment

This effort made Singapore a place with a good quality of life and an attractive tourist destination. Efforts to enhance cleanliness, greenery, waterways and pollution have ensured a sense of space and comfort for the people. The following measures have been adopted to improve environmental quality:

- Regular review of air quality standards;
- Adoption of new technologies like hybrid vehicles, particle filters in industrial equipment;

- Pricing pollution to discourage excessive use of vehicles;
- Improving water quality by controlling water pollution and repairing sewers, reducing leakages etc.;
- Enhancing greenery in the city by green spaces, parks, biodiversity;
- Improving transport links and modes.

2.1.3. Building Capabilities

Singapore is striving to make a new environmental and technological capability to be a global center for knowledge by

- Investing in R&D to test new technologies of environmental protection and adapt them to local needs;
- Facilitating international knowledge sharing.

2.1.4. Fostering Community Action

Singapore aims to build a sustainable space with community support by

- Promoting community action that engages NGOs, government sector, industrial sectors and individuals through constant dialogues and environmental awareness.

Some of the initiatives in various sectors that were highly successful are listed below:

- Master plan that envisaged broad long term strategies in detail with revisions in every 5 years involving all stakeholders;
- Decentralizing commercial hubs to reduce the need to travel, pollution and congestion;
- Maintaining heritage sites, natural areas by selecting and safeguarding sites with outstanding historical significance;
- Strict environmental regulations and city planning guidelines to manage pollution;
- Controlling source pollution, especially for water;
- Recycling and water purification by membrane-filtration techniques, desalination plants for sea water and rain water harvesting;
- 100% sewerage system;
- Integrated waste management plan with segregation of wastes, incinerators and waste-to-energy plants to meet 2-3% of the total electricity needs;
- National recycling program providing centralized recycling bins, collection of recyclables from houses every fortnight;
- Reducing packaging waste especially from the food & beverage industry;
- Removing subsidy on energy and promoting competition to encourage innovation of energy efficient devices;

- Robust public transport system and licensing scheme 1975 to reduce congestion;
- Electronic road pricing system for the motorist to pay every time of entry to congestion prone areas;
- Vehicle quota scheme 1990 to check the number of vehicles;
- Setting aside land for development of parks and gardens with community action including roadside greenery, roof top gardens, conserving wetlands and biodiversity;
- Excessive use of IT in health, education, government services, public delivery and transport;
- Creating cycling tracks, bus lanes, public transport and online information;
- Community involvement and education;
- Energy efficient buildings with better ventilation, natural sunlight, rooftop gardens, use of solar energy and LED lights;
- R&D units for constant evaluation of ongoing developments with knowledge sharing.

The secret of success lies in its understanding and handling of the constraints, threats and challenges that has been specified in the Sustainable Singapore Blueprint published by the government. It believes and encourages efforts from people to adopt an environmentally responsible lifestyle. It has involved every sector at all levels from schools to government. It has set for itself a master plan that sets the future goals and challenges along with strategies to be followed.

2.2. The future ahead

The country has identified the following goals for the future to be achieved by 2030:

- Reducing energy usage by 20%;
- Improving recycling rate to 70%;
- Reducing domestic water consumption;
- Improving air quality with standards for each pollutant;
- Improving 'blue' and 'green' environments;
- Building capacity and knowledge hubs;
- Making environmental responsibility a part of culture and life.

Going at the current pace of development, Singapore is expected to meet its targets by 2030 and set yet another model for upcoming smart cities in the developing world.

3. THE SMART PARAMETERS OF DELHI

Delhi was accorded the special status of the National Capital Territory by the 69th amendment of the Constitution of India. The city has a rich historical past, special geographical location. Due to the immense opportunities, avenues and resources, the capital city of Delhi attracts a large number of people in search of better options of education, employment, health and many more. This puts huge pressure on the city in many ways.

With a rising demand for resources like land, water and energy, the future quality of life needs to be designed properly in harmony with the ecology. Smart Cities are conceived as solutions to the urban crisis. Smart people need to live in a smart city with smart transport, resources, ICT and above all a clean environment.

3.1. Transport

Sustainable mobility is required in a smart city to provide safe, comfortable and economical modes of transport that can control pollution and congestion at the same time. Delhi has both public and private transport systems. Table 1 summarizes the alternative modes of transport and their comparative advantages.

Table 1
The Transport Scenario of Delhi

Mode	*Comparative Features*	*Actions Taken*
Bus	AC and non-AC buses with low floor; Lower fares	Converted to the clean fuel CNG in 2003; Plans to install passenger information system;
Metro Rail	Reduction in pollution levels by 6.3 lakh tons every year; Ridership of 2.4 million people per day; Cheap, safe, punctual, comfortable	Use of smart cards, online recharge systems; Interactive maps, travel information guides; Mobile apps;
Auto Rickshaws	Daily fleet of around two lakh	Run on CNG and electronic meters; Guidelines for mandatory uniform, badges and first aid box; Installation of GPS devices under consideration; Proposal of Pink Autos targeting exclusively women, equipped with panic buttons for women's safety;
Ring Rail	Cheap, affordable, safe, comfortable; Operational failures, unimportant routes;	Great potential to be revived;
Taxi/Cabs	Running on CNG	Use of GPS track mechanisms; Mandatory display of boards, electronic meters; GPRS devices and panic buttons; Verification of drivers, helpline numbers for safety purposes;
Others	Pulled rickshaws, sharing vans, and electronic-rickshaws; Private cars	Promotion of e-rickshaws with low fuel cost, low fares, less human effort, electric motors and eco-friendliness; Introduction of the odd-even car formula;

Source : Various Newspapers

The current transport scenario in Delhi is not at its best. However, there have been major drives towards an eco-friendly transport system, a significant part of which has already been achieved. With successful implementation of appropriate policies, Delhi can reach a state of smart transportation.

3.2. Energy and Water Resources

With the rising population, Delhi has an ever-increasing demand for energy in industrial clusters, residential areas, office spaces, educational zones, and transportation. Adequate and uninterrupted power supply is a basic requirement for Delhi to be a smart city. The energy scenario of Delhi is summarised in table 2.

The power situation in Delhi is less than optimal and calls for the development of alternate sources like solar power, bio-fuel, wind energy etc. The government has introduced promotion solar energy by providing subsidy, mandatory adoption of energy conservation measures in buildings like building codes, smart grids etc. Awareness campaigns have also been initiated.

Table 2
The Resource Scenario in Delhi

Energy Consumption (KWH)	*27234*
Peak Load (MW)	5653
Power Supply from Local Plants (MW)	1213
Power Supply from Central Plants (MW)	2873
Waste-to-Energy Installed Capacity (MW)	16
Plan Outlay for Energy Conservation in 2013-14 (Rs. Lakhs)	100
Demand for Water (MGD)	1380
Production of Water (MGD)	1290
Shortfall in Water (MGD)	90

Source: Socio-economic Profile of Delhi, 2013-14, Delhi Jal Board, 2014

With only one natural source of water, river Yamuna along which the city is situated, Delhi sources its water from neighboring states. There are five water treatment plants to distribute water across the city.

The issues with water in Delhi are two-fold: scarcity and quality. Table 3 shows the daily shortfall in water supply. The state of Yamuna is worrisome and has been declared almost 'ecologically dead'. The problems may be summarized as follows:

- Greater dependence on groundwater and supply from neighboring states;
- Low water table in almost every region except central and north districts;
- Presence of heavy metals, calcium, magnesium salts and untreated sewage;

Sustainable water management in Delhi requires the following:

- Optimized resource utilization;
- Ban on withdrawal of ground water;
- Storage of rainwater in Yamuna;
- Rainwater harvesting;

- Building additional capacity through reservoirs and water treatment plants;
- Dual pipe system for flushing purpose;
- Reducing wastages through repair of supply pipes;
- Using wastewater for purposes like construction;
- Reclamation of sewage water;

The North East Water system of Singapore using ultra-filtration, reverse osmosis and UV treatment processes may be models for smart water management in Delhi.

3.3. Environment

A Smart city must have a smart environment that includes the natural environment comprising of air, water, soil and forests as well as the built environment that includes buildings, parks and green spaces created and/or modified by people. It impacts the physical and social environments and subsequently the health and quality of life.

3.3.1. Green Spaces and Buildings

The Delhi ridge, often termed as the 'lungs of the city' acts as a pollution controller, climate moderator, preventer of soil erosion and a habitat for wildlife. The forest cover of Delhi is less than the prescribed 23% necessary for ecological sustainability. Delhi Parks and Garden Society, registered under Societies Registration Act, 1860 has the objective of greening environment by identifying vacant spaces in coordination with local bodies.

The Government of Delhi is committed to sustainable habitats. Councils for green rating and assessment of buildings along with energy conservation are part of the Action Plan for Implementing the Climate Change Agenda 2009-2012:

- Reduce the energy consumption in existing buildings by 30-40%;
- Make at least 250 green buildings by adopting the green building standards;
- Implementation of the Energy Conservation Building Code (ECBC) in all buildings;
- Eco-friendly measures in site selection, orientation of buildings, rainwater harvesting;
- Use of LED and solar powered lights;
- Water re-cycling and efficient waste disposal.

3.3.2. Pollution

Pollution is a major threat to life in Delhi. Along with the poor quality of water, the Air Quality Index also depicts a worrisome picture of Delhi. The high levels of PM 2.5 and 10, ground level ozone, carbon monoxide and SOx / NOx have made the city prone to health risks. The positive benefits of conversion to CNG are largely lost due to the ever-increasing number of vehicles in the city.

Delhi is also facing increased noise pollution levels beyond permissible limits as formulated by the Central Pollution Control Board. The industrial and commercial areas as well as the congested roads are the hubs of the highest pollution levels. Table 3 presents the poor noise quality standards and the alarming air quality indices.

Table 3
Air and Noise Pollution Indices for Delhi

Ambient Noise Quality: Industrial (Decibels)	*70-75*
Ambient Noise Quality: Commercial (Decibels)	55-65
Ambient Noise Quality: Residential (Decibels)	45-55
Ambient Noise Quality: Silence zone (Decibels)	40-50
Air Quality Index: PM 2.5	245
Air Quality Index: PM 10	235
Air Quality Index: O3	3
Air Quality Index: NO2	49

Source: cpcb.nic.in, aqicn.org

Serious actions need to be taken in order to curb pollution. The model of Singapore may be used as guiding principles and strategies to be formulated.

3.3.3. Waste Management

A Sustainable Environment should also smartly handle its wastes generated from different activities. Approximately 9000 million tons of municipal solid waste is generated daily in Delhi. Disposal of solid wastes has become a major issue with huge sanitation landfills causing air and groundwater pollution. Three of the four existing landfill sites have become over-full and fresh sites are not available with states forming boundaries around Delhi.

Sustainable waste management strategies require the following measures:

- Segregation, pre-treatment, followed by incineration/autoclaving/irradiation as per the waste and transportation to the landfill sites;
- Waste management practices and rules according to the type of waste like biomedical, e-waste etc.;
- Optimum resource utilization through 'reduce, reuse and recycle'.

The draft concept note of the Government of India on smart cities has highlighted the importance of clean cities with appropriate waste management policies.

3.4. Information & Communication Technology

The development of a 'digital city' within the 'smart city' ensures online presence of government through websites, facilitating government-to-citizen interaction in terms of citizen charters, providing facilities like social networking, e-commerce, e-banking with emphasis on sectors like intelligent transport systems,

education, health, administration, healthcare etc. These are the areas that Delhi needs to emphasize in order to improve the quality of life through smart ICT. The Department of Information Technology was set up in year 2000. Realizing the huge potential for application of IT in Delhi, the government has identified the following thrust areas:

- Technology at its highest and best use through the government;
- Citizens' Charter with an aim to provide an efficient delivery of services;
- Transparency and accountability by building trust and confidence;
- IT policy of 6 E's: e-governance, equality, education, employment, entrepreneurship and economy;
- Free public Wi-Fi access zones, compulsory computer labs;
- Online management systems for students and libraries;
- Use of ICT in upcoming areas of health, transport, tourism etc.

3.5. Smart people

All efforts are eventually meant for the best utilization of the human potential and facilitating a better life for the citizens. Smart dwelling requires optimal housing, education and health services along with optimal resource utilization, better communication and technological advances. While these are the necessary conditions for better living, the sufficiency condition is the attitude towards environmental protection, conservation of resources and preservation of heritage monuments. This stewardship can lead to intergenerational transfer of good living.

3.5.1. Housing

The mega city Delhi has highly developed posh residential facilities that coexist with urban slum clusters devoid of basic facilities. A smart city cannot be visualized in this scenario. The growth of slums has resulted in environmental degradation as well as social tension and other problems. If a clean city is to be made, then clearing the slums is a challenge.

The Rural Development Board for Delhi ensures integrated rural development through priority projects and schemes to implement the Rural Area Plan. It aims at optimizing the use of energy, water, space and environment in the villages, while restricting their growth in future.

3.5.2. Education

Delhi records good educational achievements at all levels. The literacy rate in Delhi is higher than the national average. Delhi also has the best institutions of higher learning in the country. However, there is a need for improvement in the universal literacy and its quality. The higher education sector needs to be coupled with technology to make education more effective that provides future opportunities for employment in different sectors. Therefore, applying the IT in these sectors can yield better results for smart development.

3.5.3 Health

With congestion, changed lifestyles, and problems of pollution, citizens in the mega city are facing severe health problems that inhibit them from realizing their full potential. These coexist with chronic problems of malnutrition and communicable diseases.

The city has major hospitals under public and private ownership. Health care facilities at affordable government hospitals need to improve in terms of overcrowding, cleanliness and people's confidence. People from neighboring states add to the city's pressure in availing better treatments. Use of ICT, improvement in medical facilities for all and healthier lifestyle may improve the health status of the people. This requires commitment by people to make efforts to have smart health.

3.5.4. Heritage Sites

Delhi is a city of historical monuments. It may be developed as a 'heritage city' within the broader concept of a smart city. The government, with adequate participation and support of citizens can maintain and preserve the present state of our heritage.

3.6. Citizens' Perception: The Survey

'Smart people' is a two-fold concept. Along with government initiatives, it needs a citizen-centric view to make people feel a sense of ownership that will make their participation voluntary and broad-based. A smart city cannot only be a public policy, it should also be in people's perception.

A random sample of about 50 people from different groups of income, age and professions were chosen for a survey. The findings are furnished in table 4.

Table 4
People's Perception of Smart Delhi

	Yes (%)	*No (%)*
Knowledge about Smart City	60	40
Use of Eco-friendly Mode of Transport	46	54
Ownership of Motorized Vehicles	68	32
Use of cleaner fuel (LPG, PNG)	96	4
Municipal Supply of Water	83	17
Awareness about Pollution	87	13
Ready to take up Environment as People's Responsibility	89	11
Segregation of Waste from different sources	4	96
Willingness to accept responsibilities of a Heritage City	92	8
Use of Internet Facilities	84	16
Desire to see Delhi as a Smart City	37	–

Source: Primary Survey

The citizens of Delhi have revealed reasonably moderate awareness about the concept of smart cities and the daily practices in life are aligned towards smart living for the majority.

4. CONCLUDING REMARKS

A critical analysis of Delhi in terms of the smart parameters reveals that Delhi is moderately prepared to be a smart city. The current scenario of water and energy resources and waste management are not at the desirable levels. The transport sector has problems of availability, safety, economy and pollution too. However, the people of Delhi have clean habits regarding the choice of fuel. They are exposed to the use of smart ICT and e-services. There is a definite need for improvement in the social sectors. Although the role of the government is felt, people are ready to participate in this new venture that the government has already initiated. With steps already initiated and further developments, Delhi can surely be visualized as a future smart city.

4.1. Recent developments

With "the mission to recast the urban landscape of countries by making cities more livable and inclusive besides driving economic growth", the Government of Delhi has announced to develop certain areas as sectors of the smart city with improvements in water, electricity and Wi-Fi connectivity. Following are the measures taken so far:

- Draft Concept Note prepared to discuss the key strategies of the project encompassing planning and implementation of smart cities;
- Operational and business models of public bicycle sharing scheme;
- Pollution to be reduced by 25% by repair of roads and broken footpaths;
- Grass to be planted on dusty patches with a plan to evolve a unified air quality monitoring system;
- The plasma gasification system and the water recycling model of Singapore under study for possible implementation;
- The National Green Tribunal (NGT) to ban all diesel vehicles that are older than 10 years;
- Ban on construction activities on road and open burning of crop remnants in neighboring states of Delhi;
- The odd-even car formula to curb vehicular pollution tried for limited periods;
- Companies invited to devise best practices of a smart city;
- Installation of rooftop solar panels being promoted on a priority basis;
- Future smart city projects to be invited through 'smart city challenge'.

4.2. A Strong Case for Delhi

The smart city model has been successful in some major cities of world. With the proposal of the same in India, a city like Delhi represents a Strong case. The guiding principles and strategies adopted in Singapore may be followed in spirit after adjusting with the local conditions in order to achieve the desired goals. It has the crucial presence of infrastructure that has the potential to transform the scenario. From deficient to effective resources, from restricted to open access, from a degraded to an improved state of environment, from worse to better quality of life, Delhi can move towards smart living. This needs effective planning, finances, vision and implementation along with a constant support from the citizens. With the Government of Delhi taking a great initiative, a bright future lies for Delhi to be a smart city with smart people living a smart life.

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