The need and rise of secondary smart cities: a case of Bhuj

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Abstract. With the Fourth Industrial Revolution, cities are being acknowledged by various city leaders, urbanists, and urban enthusiasts as the employing giants of the world. Urbanization has led to people migrating to urban nodes, not only from rural to urban but from urban to urban areas as well, thereby, leading to a significant influx of migrants. This is more evident in the fast-growing secondary cities that are becoming the new job centres. However, while incorporating a Master Planning and Development Planning approach, there is a consequential crisis of resource and infrastructure while accommodating the new residents. Coupled with the rise of health emergencies such as cholera and now, recently, COVID-19, the cities are calling for better management and administration of resources, especially water resources in the cities of the global south. As envisioned in various debates, 2/3rd of the world’s population shall reside in urban areas. Self-sufficiency and resource management are going to be prime concerns soon. In Bhuj, the district headquarters of Kutch in Gujarat, India, a water crisis is already evident, and the city will need to cope up with this increasing demand for the better. This provides a potential for the development of a framework that can lay out a more efficient system for resource provision and administration. The Smart Cities initiative can act as a tool for bridging the gaps between technology and sociology. This study, therefore, acknowledges the potential by understanding the concept of smart cities, the application, and nuances of the concept in India, where the concept has started to hold ground as a notion in the form of Government-led Smart City Competitions. This research aims to study the various frameworks and mechanisms related to smart cities and Smart Cities Mission, and how the different verticals of the framework, i.e. physical, social, economic, and governance points of view, are co-dependent on each other. The study also acknowledges the existing arguments surrounding the potential of secondary cities like Bhuj, and how the efficiency in terms of water sensitivity can be improved optimally by bringing all stakeholders to the table and trigger discussions to provide a better quality of life to the citizens. The paper aims at urban enthusiasts, academicians, citizen groups, and decision-makers to dive into the potentials of the water-sensitive aspects of the Smart Cities Mission and how secondary fast-growing cities can gain some headway with this.
1. Introduction

Megacities like New York, Tokyo, and many more had already developed the infrastructure and resources to ensure the needs of their citizens. Concepts showcased in texts like *Garden Cities of Tomorrow* by Ebenezer Howard, *The Cities of Tomorrow and Its Planning* by Le Corbusier, and *The City: Its Growth* by Gottlieb Eliel Saarinen showcase the modernist approach to cities, which laid the foundation of the demand for better infrastructure and quality of life for the citizens. However, most of these modern cities are currently located in developing countries, which are having an acute shortage of food, education, and health services, not to mention that the existing infrastructure is not able to sustain the current demands of the cities themselves, creating a chasm between the demand and supply of basic necessities in the cities [9]. This mismatch between the various verticals has led to the widespread demand for smarter cities. The necessity of Smart Cities came up in the 20th Century post-World War II (as shown in Figure 1) when Sustainable Cities became the name for the “Future Urban Cities”. Following the UN Brundtland Commission report, this notion has accelerated, bringing forth the need for Digital Cities at the beginning of the 21st Century. The Smart Cities Mission and the G20 Smart Alliance are some of the contemporary notions accepted as Smart Cities in India, which allow for incentivising the growth of new Smart Cities in India with Government support and an overhaul of efficient approach and growth.

![Figure 1. The Genesis of Smart Cities](image)

2. Methodology

With the rise of the number of fast-growing secondary cities in the country, the working population tends to move towards urban areas to look for new job opportunities. This is currently straining the existing infrastructure like water, sanitation, and healthcare. With COVID-19 hitting India, primarily in highly-populated cities such as Mumbai, Delhi, Bengaluru, Chennai, etc., secondary cities like Bhuj can, furthermore, be growth providers for the migrant population. However, these secondary cities still have the potential to grow more sustainably if resource inefficiencies are dealt with and the resource crisis is managed. A more inclusive approach might therefore be the more optimal solution. The Smart Cities Mission is a paradigm for these growing cities, which are now fighting for more jobs per square footage. These missions, therefore, also provide a stage for the cities to flourish.

The current system calls for better management of resources and therefore, provision for a more sustainable lifestyle. While the master planning techniques are based on long-term future projections, a better monitoring and strategizing tool might be the Smart Cities, which are currently seen as the way to go with smart interventions for more sustainable cities. Smart Cities are generally seen as technologically-advanced cities of the future, which can resolve issues with digital platforms. Combined with a Master Plan or a Development Plan approach, this is generally considered to be a top-down approach. The ground-level issues, however, are not considered while making decisions to upgrade infrastructure. Bhuj is a brilliant example of the same, where the water supply network covers over 92% of the Kutch area, but more than 20% of the population still depend solely on tankers for water supply. A smarter approach is, therefore, the need of the hour.

This paper tries to showcase the prime objectives of smart cities and what a smart city is in an Indian context. It also shows the prevalent issues in the contemporary context, including COVID-19 and the water crisis. The paper examines the case of Bhuj with its various challenges and potentials, the alternative sources of water in Bhuj, the top-down and bottom-up approach of Bhuj, and the interdependence of the different pillars on each other. There is an eminent paradigm shift due to
COVID-19, for which the contemporary systems need to be more enhanced and adaptable to the evolving world scenario. Therefore, the pillars are in a stark need of reconsideration. The paper also brings forth the notions related to Smart Cities and their applicability, which can then be carried out as part of further research to undertake the cohesive preparation of Smartness ladders for various aspects.

3. Smart Cities: The What, the Why, and the How

The successful management of urban growth is the key to more sustainable development and economic growth. The cities today are facing crises on their inherent resources, like healthcare, transportation, energy, education, water, and natural disaster response. The master planning outlook to predict and provide each aspect of a society is one of the primary reasons for a more top-down and less inclusive approach. The available infrastructure in place is, by far, not just limited, but also inaccessible to a large segment of the society. This is less amenable and does not accommodate unforeseeable changes. An example is the spread of COVID-19 in urban growth centres that have brought the world into a hold, and now calls for better management at the city level.

The cities, therefore, need to have the right technology and the know-how to govern it to make the communities more inclusive, resilient, and sustainable [25]. As per [2] specialists from various domains have suggested definitions for smart cities, like:

- A “smart city” uses information and communications technology (ICT) to enhance its liveability, workability, and sustainability [Smart Cities Council 2014];
- A city that monitors and integrates conditions of all of its critical infrastructures – including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings – can better optimize its resources, plan its preventative maintenance activities, and monitor security aspects while maximizing services to its citizens [US Office Technical and Scientific Information];
- A smart city can be seen as a determined geographical space able to manage resources (natural, human equipment, buildings, and infrastructure), as well as wastes generated by lifestyle; it should be sustainable and must not be harmful to the environment.

![Figure 2. Characteristics of a Smart City (Source: Eremia, Toma, & Sanduleac, 2017)](image)

Smart cities and their development are hugely dependent on the level of intelligence of the supply network and infrastructure, along with integrated planning and a participatory approach, which can help improve the efficiency (as shown in Figure 2). However, achieving this smoothly would require easy coordination between the urban administration, the operators of the various infrastructures, and those responsible for the public health and safety – as a result, a more balanced top-down and bottom-up approach. This can enhance the response time of Smart Cities, which in turn can be monitored in real-time.
As per Raza [5], Central and State Governments are approaching data regarding the evolving needs of the communities in the country. Smart initiatives are current digital works that can record data using technological models like the Internet of Things (IoT) and Array of Things (AoT), which allow making estimated data for physical components like air quality, transport, pedestrian movement, and standing water, and could allow citizens’ groups to come up with the analyses to help city administrators make better decisions, boost transparency, and make officials more accountable. Furthermore, access to special funding can make it mandatory for services like Public Transport to provide real-time information in form of open data, an inexpensive global standard that raises both access and efficiency to the citizens.

All in all, four verticals are covered in any smart city across the globe – physical, social, economic, and governance, as shown in Figure 3. The liveability standards are drawn on the backbone of these pillars. However, while making a city smarter, perhaps it is a better idea to visualize the four pillars as the foundation that support the development of the urban ecosystem cohesively as a combined system instead.
4. Smart Cities Mission India

4.1 Prime objectives

As per Smart Cities Mission, India [15], the smart cities are developing the urban ecosystem under the following 4 pillars – Physical, Social, Economic, and Institutional Infrastructure incrementally, while adding various layers of smartness to achieve the prime objectives of a smart city.

The Smart City Mission India aims at creating a replicable model that will act as a lighthouse to other aspiring cities. The Smart Cities Mission use ‘Area-Based Development’ and ‘Pan City Development’ to promote the cities that:

- Provide core infrastructure
- Gives a decent quality of life to the citizens
- Provide a clean and sustainable environment
- Applies “Smart” Solutions

These are being taken into consideration by Smart City measures from the Smart City Mission India (as shown in Figure 4). Thus, it might also be said that these smart cities tend to be more liveable with the incorporation of such tools.

The above tools are further evaluated with due diligence and data validation by Smart Cities Mission. The Smart City initiatives are implemented through either Area-Based Development (ABD) and/or Pan City Development [15].

4.1.1 Physical Infrastructure Enhancement

The mission focuses on improving liveability, sustainability, and economic development showcasing Key Performance Indices/Indicators (KPIs) that one can validate or are available in the public domain. The major topics covered under the same are related to the enhancement of transport conditions, provision of water by measures, and reduction of wastewater/Non-Revenue Water, solid waste management programs in the city, safety and security conditions in the city, energy availability and reduction of outages in the city, housing situation in the city, specifically related to the role of the municipality in expediting approvals, property tax collection, etc. to capture improvement of operational efficiency in the city. The area-based developments are further scrutinized by considering the efficiency of on-site infrastructure, smart solutions utilized to make services and infrastructure better in ABD and improving the potential of the existing infrastructure, and being resource-efficient. Real-time monitoring of public services is also considered as a part of the enhancement of Physical Infrastructure, which can further provide a system to deal with problems in real-time.

The infrastructure, however, is based on projections deduced by time-series analyses and providing infrastructure to the formally involved population. The informal population like slum dwellers are still at a loss as the measures are not all-inclusive yet since the administration does not have enough data on the same. Use of manual systems in parallel to the digital systems can help in an all-inclusive fail-safe mechanism [13].

4.1.2 Governance Measures

The Smart Cities Mission also encourages the use of Information and Communication Technology (ICT) as a part of Smart Governance. This includes two-way communication between the citizens and the administration, the use of e-Gov to enable hassle-free access to statutory documents, creation of dashboards to integrate analytics and visualization of data, and availability of basic information to citizens. The measures also take into consideration the implementation of convergence by evaluating the readiness for the implementation of convergence by various consistent and predictable mechanisms to achieve convergence (like issued Government orders, passed Council Resolutions, delegations made, etc.). As far as Area-Based Developments are considered, the scaling up and replication of the models are focused by the mission by taking note of governance impacts, spatial impacts, social impacts, economic impacts and environmental impacts. During city profiling, it is also considered if there is a closer link between identified issues/priorities from consultations/profiling and the solution selected; also the need for close correspondence between input/resources and intended results and established appropriateness in the selection of smart solutions.
Unfortunately, capacity building for the employees is still a primary concern for cities. Retention of a capable resource pool, especially in secondary fast-growing cities, is a must now [13].

4.1.3 Social Inclusion and Participation
Social inclusion is the need of the hour. The Smart City mission takes into deep consideration the involvement of citizens. The extent of citizens in shaping the vision and goals, engagement strategies to get best results from the citizens, different means of citizen engagement adopted, the extent of coverage of citizen engagement in different media and channels, and incorporating the citizens’ inputs in the overall visions. The quality of KPI is connected to the aspiration of the citizens themselves, which can further define the self-assessment criteria more exhaustively. The citizen responses need to be incorporated into area-based development and pan-city development. Also, the consultation should include the viewpoints of women, weaker sections, differently-abled, youth, children, etc. The approach and methodology for selecting and identifying the area-based development and pan-city proposal need to have citizen opinions and engagement, along with the opinions of elected representatives, urban planners, sector experts and suppliers/partners; thus providing a combination of the bottom-up and top-down approach.

As per the essential practices of the Smart Cities, the social inclusion principles are not included; even though they have been calculated as a part of the scoring parameters [15].

4.1.4 Funding Mechanism
The funding mechanism of the cities needs to look at resource efficiency, building upon existing infrastructural assets and doing more with less. There needs to be a combination of government orders, rules, laws, etc. to support each financing detail.

The city proposals, as per Smart City Mission [15] are to dovetail different sources of funding (Central Government, ULB/State, other complementary Central and State funds), leading to the development of the four verticals to make a city smarter. The involvement of the State Government and different decision-making councils by contributing their buy-in can provide higher accountability while making the projects more doable. The convergence needs to be aligned to the priorities set in the national agenda (eg. SBM, Make in India, Skill India, etc.) for better fund sourcing. Creative management of different sources of funding and financing to ensure debt settlement needs to be kept in mind while the loans are funded via SCM.

The funding and timelines need to be set for a comprehensive doability proposal. A better financial risk management standpoint may include the identification of each risk between all inputs/activity and activity/output, their likelihood, the likely impact, and mitigation strategies. The measures will need to be financially sustainable, and the proposals need to demonstrate the revenue-generating potential of the proposal to pay the capital cost and provide for O&M expenses. The O&M costs need to be validated with revenue generation and financial backup. The respective timelines need to be well-prepared and the proposals should indicate the extent to which the results are achievable within set timelines, keeping in consideration cash flows, etc. The catalysis methods of additional revenue generation need to sustain the city’s long term agenda to become fully ‘smart’; the further fall back options will need to be reliable considering the do-ability of the project and all the risks involved.

However, Foreign Capital involvement targets a higher rate of returns, whereas smaller ULBs may not be equipped with such financial prerequisites, thus creating biases.

4.1.5 Issues in the contemporary context
COVID-19: Various studies have produced evidence that the spread of COVID-19 cases has been in major urban settlements with thousands of cases increasing daily. The mass exodus of migrants between states and mass hotspots of people had been identified as some of the major cause of the surge in the number of cases [8]. This leads to a few key requirements of the hour:

● The formal health infrastructure is poor and is very limited for slum communities. The amount of information regarding the spectrum, burden, and determinants of illness in such communities, that give rise to preventable but chronic diseases, which are not appropriately treated. Neglecting the ever-expanding urban slum populations in the world can further be the
cause of greater expenditure and diversion of health care resources to the management of end-stage complications of diseases that are preventable [4].

- The Global South already struggles with access to basic needs such as water, toilets, sewers, drainage, waste collection, and secure and adequate housing. Further space constraints, violence, and overcrowding in slums make physical distancing more difficult and self-quarantining impractical, thereby making the spread of infection more likely to be rapid. Any responses to COVID-19 that do not recognize these realities will further jeopardize the survival of large segments of the urban population globally [10].

**Capacity Building:** With the Fourth Industrial Revolution on the rise, technological advancements are shaping the world [3]. The Smart City mission pushes for a smarter governance mechanism by incorporating AoT, IoT and smart technologies, which is one of the prime focus of the Smart City Mission. However, the officials and employees of many such organizations are not accustomed to the digital platform to work. The documentation of many institutions is still not digitized completely, which creates problems for fast-changing scenarios such as COVID-19. The current modelling scenario is limited with an accuracy of only 60% [8] which leaves the system vulnerable. The lack of capacity building also can create biases towards bigger ULBs than small/medium towns, due to more data comprehensibility ([13].

5. **Evolution of Smart City in Contemporary Context**

With all the observations above, there is a clear need for enhancing the criteria of evaluation for Smart City. The contemporary context involves a drastic need for social inclusion and capacity building, and not just the involvement of technology, especially in secondary fast-growing cities that are seeing the rise of migrant job sectors. There is a lack of importance for Social Inclusion that is evident in the essential features of Smart City proposals ([15]. Bridging the gap between the top-down and bottom-up approach can help to come up with sustainable solutions and lesser conflicts. There is a need to acknowledge the need for a paradigm shift in the Indian context for secondary cities, which has further been discussed in detail in the case of Bhuj.

6. **The Case of Bhuj**

Bhuj is the Headquarter of the district of Kutch. The city has an average precipitation of 350-360 mm, however, in the last few years, there has been considerably low rainfall. The season is also very hard to predict, as per various reports and expert studies. The studies also point out to the 1819 earthquake in the Rann of Kutch that made the Indus River change its course [26].

**Table 1. Water Sources for Bhuj (Source: Rethinking Urban Water Management, Lessons from Bhuj, Final Report, October 2017)**

| Sources                                | Quantity (MLD) |
|----------------------------------------|----------------|
| Narmada Main Line                      | 14.0           |
| Narmada Air valves                     | 4.0            |
| Kukma Borewells * (outside Bhuj Municipal Boundary) | 2.5          |
| Madhapur Borewells (outside Bhuj Municipal Boundary) | 8.0         |
| Bharapar Tubewells (outside Bhuj Municipal Boundary) | 1.0          |
| Patwadi and Valdasnagar (local borewells) | 3.0           |
| **Total**                              | **32.5**       |

Bhuj has been principally provided with enough water supply (as shown in Table 1) and the largest piped water supply network in Gujarat that covers about 92% of villages in Kutch. However, more than 20% of villages remain under tanker supply, the cost of which exceeds ₹20 million besides large capital and operational expenses of the public water supply schemes. Rainfall is highly localised and comes in heavy spates. Generally, in every 10 years, three years are near dry, three are normal years and there is one year with above-average rains. Kutch also has large parts formed in a marine environment, which is the main reason for the inherently saline groundwater, leading to only 15% available, known as tube-
well zones, as the available source of usable water [14]. The provisional approach based on population projections may not have been the most optimal solution to resolve the water crisis in Bhuj. The city also is currently at a 2-lakh population mark, rising almost 100% during the last 20 years with the sprawled settlements covering about 31% of the total area. The city is facing excessive untreated waste generation, water scarcity and contamination, and resultant health hazards. [7] This is also a major concern with health emergencies such as COVID-19, which can tip the scales completely towards a more devastating option if it hits the city in its current condition. The city is a drought-prone region and is facing rural and urban water scarcity while the quality of groundwater is deteriorating.

6.1 **Strengths and Weaknesses in Bhuj**

The hydrological conditions in Kutch can be attributed to low rains, high evaporation rate and no perennial rivers, which contribute to poor surface water resources. Large parts of Kutch had formed under the sea which is the primary reason for high salinity and TDS in water. The region is a self-contained geo-hydrological unit with no potential recharge from neighbourhood areas. The city of Bhuj currently has a supply of 32.5 MLD from various sources. More than 20% of villages in and around Bhuj are currently tanker-supplied, while even less than 15% of mainland Kutch is under tube-well zones [14]. More than 90% of the city and surrounding villages are provided with piped supply network [21]. The city of Bhuj and surrounding villages thus need revitalization in terms of water provision, use and management.

6.2 **Bhuj city-wide water management**

The city-wide water management in Bhuj needs to cater to building up usable resource potential in the city of Bhuj. However, supply inefficiencies are a major concern in the city. The current water supply provision is based on efficient supply and sources functioning at optimal conditions. Even with a piped water supply system set up during 1968-69, and significant addition of sources, the water delivery remains poor until to date, and the dependency on tanker water supply remains the only viable option [21]. The city of Bhuj needs smart and optimal solutions to sustain itself in situations of crises soon.

6.2.1 **Infrastructure efficiency enhancement**

Before laying a new pipeline, the existing pipeline infrastructure needs to be reinforced by identifying pain points based on historical complaints at the sites. This can also help identify the water requirement hotspots, which can also be used to manage health issues with proper public health infrastructure. Adding more resources might prove counterproductive if the existing supply does not function optimally. Reduction of non-revenue water (NRW), proper metering of water supply, along with
involving ICT to monitor the supply and demand chain can help in providing a better supply. Surat has been a wonderful example in that front, where the existing infrastructure has been optimized while achieving equity in water distribution. This was achieved by conducting periodic water audit and recognizing leakage hotspots by identifying regular complaint areas and non-metered water supply [1].

6.2.2 Revitalizing alternative sources of water supply and storage
Water supply and storage can be revived and revitalized using alternative resources, as shown in Figure 5. This may need to involve people from the ground up, by creating awareness for reviving traditional storage techniques, groundwater recharge and rainwater harvesting. Decentralizing drinking water in slums with better management can be done by proper monitoring by the ULB, providing infrastructure for recharging surface water by channelling surface runoff, along with city-wide sanitation repairs.

The digitization of water and sanitation infrastructure, along with manual documentation is the need of the hour. Also, digital platform creation for citizens for any qualms and complaints can help to identify issue hotspots and provide quicker solutions. This allows for a better fail-safe mechanism and quicker response time by the authorities as well as the citizens.

6.2.3 Accountability of people and administration
Along with awareness creation and capacity building, there may be a need for a stronger financial mechanism, where the citizens are accountable for the supply, and the administration is answerable to the citizens in case of any viability mismatch.

Regular audits can be conducted for identifying leakages and theft of water at ground level, providing the authorities real-time monitoring and allowing better provisioning of water services to the citizens. The financial measures can be implemented by enforcing a proper pricing mechanism. With ICT and regular audits and the data henceforth collected, an overall financial deficit may be calculated. On the citizen’s side, the user charges are at least catering to the marginal cost of water supply. Furthermore, revising the tariff charges can be a further way to go.

An overall cohesion of smarter technology while improving current potentials are therefore necessary for a net positive outcome. A top-down approach lacks on-ground scenarios which are crucial in making any planning decisions. Instead, a socially inclusive and bottom-up approach can not only provide a better audit capacity, but also allows to study the demand chain, and therefore, provision for the supplies soon.

7. Conclusion
Cities are growing in concurrence to the paradigm shifts in economies. The urban areas are the stronghold of development, and the secondary fast-growing cities like Bhuj are the upcoming opportunities if treated well. The master planning approach may provide for a longer duration, but is ill-equipped to handle the unforeseeable changes and sudden game-changers like disasters and pandemics. The issues need to be dealt with in real-time, which is possible with measures like Smart Cities Mission and smart technologies along with people’s participation, thus bridging the gap between governance and participation. The efficiency of the current system needs a more intricate review and audit system, which can be combined with better database management for quicker response time and feasibility study for newer projects while bridging the viability gap. A comprehensive bottom-up approach combined with necessary real-time action is, therefore, the need of the hour.
As shown in Figure 6, the pillars of the Smart Cities Mission may need to be reconsidered, especially to deliver a sustainable coherence to the urban ecosystem. The four pillars can be recognized as a common foundation for enhancing and providing for the cities soon. With the rise of the secondary cities, it becomes even more important to recognize their existing potentials and integrate a more comprehensive approach along with the citizens, and not just for them. The future cities are not just about incorporating technology to the equation, but also to use them smartly for creating better, liveable cities for the citizens.

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Figure 6. Smart Cities elements as foundation, not pillars
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