ASSESSMENT OF SMART INDEX FOR ZONES OF SURAT CITY BY Z-SCORE METHOD

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Abstract : Smart cities encourage economic activities and change city infrastructure and services with the assistance of Data and Communication Technology. Cities are known as the engine of development. For cities to become effective engines of economic development, they have to move forward the well-being and quality of essential services. Rapid urbanization and development within the city require an expansive coordination effort to supply citizen services and oversee the city. Comprehensive development is critical for improving the quality of life and additionally fascinating individuals to the city. Subsequently, the evaluation of a smart city is required to measure the performance of the city. The Smart City Index is a valuable city assessment tool for measuring the performance of smart cities. It can be used as a support guideline for implementation and decision-making in urban development. The purpose of this paper is to the analysis the Composite smart index based on five dimensions of comprehensive development as Institutional, Social, Physical, Economical, and Environmental. Surat is listed as the fastest-growing city in India. This study reflects the identification of smart city indicators to measure the performance of all zones of Surat city. The Z-transformation method was adopted to measure the performance of CSI. The application of the Smart City Index is to measure the individual performance of indicators.

IndexTerms - **Sustainability, Smart city, Smart city indicators, Smart city index, Urbanization.**

I. INTRODUCTION

Cities are referred to as our "engines of economic growth" and ensuring that they work effectively is critical to our economic improvement and well-being. For cities to become effective engines of economic improvement, they need to move forward the quality of essential services. From this point of view the Government of India has decided to make 100 "Smart Cities" within the country in the midst of 2015-2019.[1]Sustainability and the productive utilization of assets such as energy will be central to a Smart City. As the smart cities and other urban enhancement activities roll out, it'll be essential to monitor progress, not only over time but also over cities to study comparative performance. So, this will require an Index that would enable cities to be compared against themselves over time to allow an evaluation of how well a city has advanced over a long time. A smart city index could be a measurement tool that aggregates the 'smartness' of a city into one number.[2]

II. LITERATURE REVIEW

2.1 Smart city concept

There's no single, all-around accepted definition for the smart city concept and interpretations may change depending on the context such as digital city, virtual city, ubiquitous city, intelligent city, creative city, knowledge city, hybrid city, information city, and wired city.[3] With the advancement of the smart city concept over the past decades, there has been a worldview move from an at first technology-driven Center (Information and communication technology) to adopting a more comprehensive approach, wherein the main role of people and the infrastructure such as institutions, citizen engagement, information, social advancement, information economy, equity, etc. is acknowledged. A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent, and aware citizens.[4] The key element which stands out in the literature on the smart city concept is the application of networked infrastructures to improve economic, social, cultural, and urban development. Smart city agendas are a concerned with social and economic sustainability.[5]

2.2 Smart city indicators

The indicators will empower cities to measure their performance over time. Since the performance indicators must be compelled to fulfil the Smart principle (Specific, Measurable, Achievable, Relevant, and Time-bound), the advancement of pointers for measuring and overseeing the shrewdness of a city is challenging. The smart city assessment tool utilizes different indicators.[6] There have been a few approaches to standardize the indicators from which the frameworks can give an evaluation for smart city execution.[2][7] In this research, all institutional, social, economic, physical, and environmental dimensions are considered for the

smart development of the city. Based on the literature study and based on prioritization with expert, appropriate indicators were identified on five dimensions in context to Surat city. For the expert opinion,20 experts of field from town planning, urban planning, and developers and also from institution were selected. The indicators are achieved to calculate the smart city index for all zones of the Surat city. The list of indicators selected for study are shown in table 1.

1.Institutional Dimension:
It concerns with the activities that link with the governance, telecommunication, finance, and management of city. [8] It includes indicators like E-governance, wi-fi spots in public place, Household level internet connection, coverage of wireless connection. Tax collection as percentage of tax billed, Tax recovery from water supply services,

2.Physical Dimension:
It refers to the cost-effective physical infrastructure which has water supply, transportation and mobility, power supply, housing, and public open spaces factors. It includes indicators that related to these factors as Slum settlements, Basic services in slum areas, Homeless population, green cover, Public and recreational places, Electricity services, Energy consumption, Electricity system outage frequency, Intersection control, Coverage of footpaths, Road network with dedicated bicycle tracks, Basic Water Supply and Quality of water, Smart water meters, loss of water supply etc.,[9]

3.Social Dimension:
It concerns with the development of human and social capital. It includes factors like education, healthcare, social inclusion, and safety and security, culture, and identity. Related indicators are In-patient hospital beds, Physicians, Traffic fatalities, Crime Rate, population living in Disaster Prone Areas, Fire Service, Culture expenditure, cultural infrastructure, Poverty, Childcare availability, Voter Participation, Literacy, no. of physicians, no. of in-patient hospital beds, School with digital educational facilities etc.[10]

4.Economical Dimension:
It refers to the economic activities. The indicators are unemployment rate, percentage of women workforce and % of registration street vendors, GDP per capita, Youth unemployment rate etc.,

5.Environmental Dimension:
It refers to the environment of the city and quality of life of people. It includes factors like air quality, noise pollution, energy consumption from public building, solid waste management, energy, and wastewater management. The indicators are Coverage of toilets, Sanitation facilities, Collection efficiency, Efficiency of MSW collection, MSW treatment, Household coverage of MSW collection and Air quality index.

Table 1 List of indicators and variables

Components	Factors	Indicators	Variables
Institutional	Governance	E-Governance	Percentage of citizen service available online
		Public sector E – Procurement	% of public sector procurement activities conducted online
	Finance	Tax collection	Tax collected as percentage of tax billed
	Telecommunication	Availability of Wi-Fi in public Areas	Total no. of Wi-Fi spots provided by the ULB
Physical	Housing	Slum settlements	%of slum areas in city
		Basic services in slum areas	% of slum areas covered through basic services
		Homeless population	% of homeless population in the city
	Public open spaces	Green cover	Per capita availability of green spaces
		Public and recreational places	Per capita availability of public and recreational spaces
	Power Supply	Electricity services	% of city population with Authorized electrical services
		Energy consumption	Annual energy consumption per capita (Electricity in KWH)
		Electricity system outage frequency	Average number of electrical interruptions per customer per year
	Transportation	Intersection control	% of Intersection control
		Coverage of footpaths	% Coverage of footpaths
		Road network with dedicated bicycle tracks	% Road network with dedicated bicycle tracks
	Water Supply	Basic Water Supply	% of population Basic Water Supply
		Quality of water	quality of water supplied
		Water consumption	Water consumption
Economical	Economy and employment	Unemployment	Unemployment rate
		Street vendors registration	% of vendors registered and provided formal spaces
		Women in workforce	% of women in workforce

Social	Health	In-patient hospital beds	No. of in-patient hospital beds per 1 lakh population
		Physicians	No. of physicians per 1 lakh population
	Safety and Security	Traffic fatalities	Traffic fatalities per 1 lakh population
		Crime Rate	Crime rate 1 lakh population
		population living in Disaster Prone Areas	% of Population Living in Disaster Prone Areas
		Fire Service	No of firefighters per 1 lakh population
	Social Inclusion	Poverty	Percentage of population below poverty line
		Voter Participation	% of population that voted during last municipal election
	Education	Literacy	Literacy rate
Environmental	Wastewater management	Coverage of toilets	Coverage of public toilets
		Sanitation facilities	Basic sanitation facilities
		Collection efficiency	Wastewater collection
	Solid waste management	Efficiency of MSW collection	Efficiency of collection of MSW
		MSW treatment	Extent of MSW recycled
		Household coverage of MSW collection	Household coverage of MSW collection
	Pollution	Air quality	Air quality Index

All the indicators are selected for the study area.

III. STUDY AREA PROFILE

India. Surat is the most dynamic city of India with the fastest growth rate due to migration from several parts of Gujarat and other states of India. The whole Surat city is divided into different zones - Central zone, south zone, south-west zone, southeast zone, east zone A, east zone B, north zone, west zone, and all zone having different population density.

In this study, the author considers zones as study area. Table 2 shows the demographic profile of Surat city.
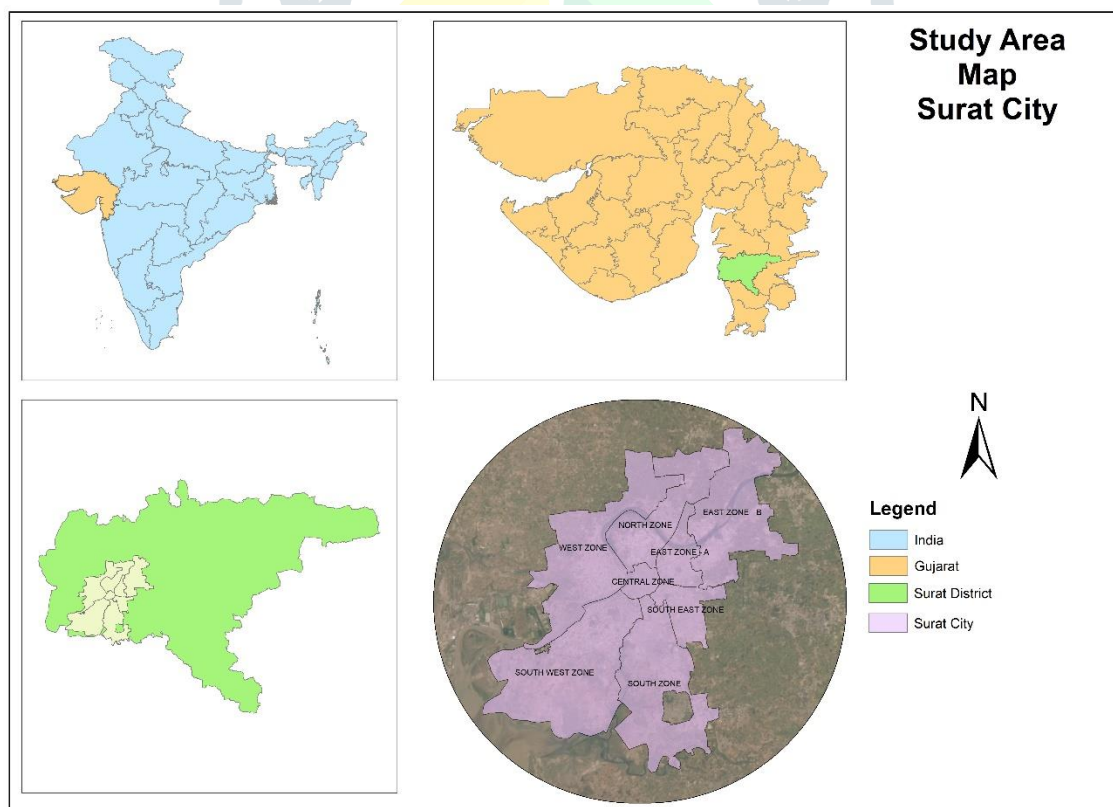

Figure 1 Location of study area

Table 2 Demographic details of Surat city

Sr.no	Zone	Area Sq. Km	Population (Census 2011)	*Population 2021 (Average)
1	Central	8.18	408760	403879
2	West	86.639	449943	612742
3.	North	51.263	716110	1015850
4.	East A	14.84	798005	1314305
5.	East B	78.929	388945	606802
6.	Southwest	112.122	348423	454380
7.	Southeast	22.342	754128	1110999
8.	South	87.83	781070	1154160

(*Forecasted population for each zone using two methods. Average value of arithmetic increase method and incremental increase method.)

From the above table 1, the East A zone has lowest area with highest population.

IV.METHODOLOGY TO DEVELOP COMPOSITE SMART INDEX

Step – 1: Normalization

The smart index and components score were calculated by aggregation and therefore the aggregation process requires that all indicators follow a same normal distribution. The Z-score method is used for normalization.

Step – 2: Calculation of Indicators

To compare the various indicators, standardization is required. Z-transformation method is used for standardizing indicators into one standardized value with mean 0 and standard deviation.[11]

This method is evaluated by following formula:

$$z = (x-\mu)/\sigma$$

where,

x = score,

μ = Mean,

σ = standard deviation

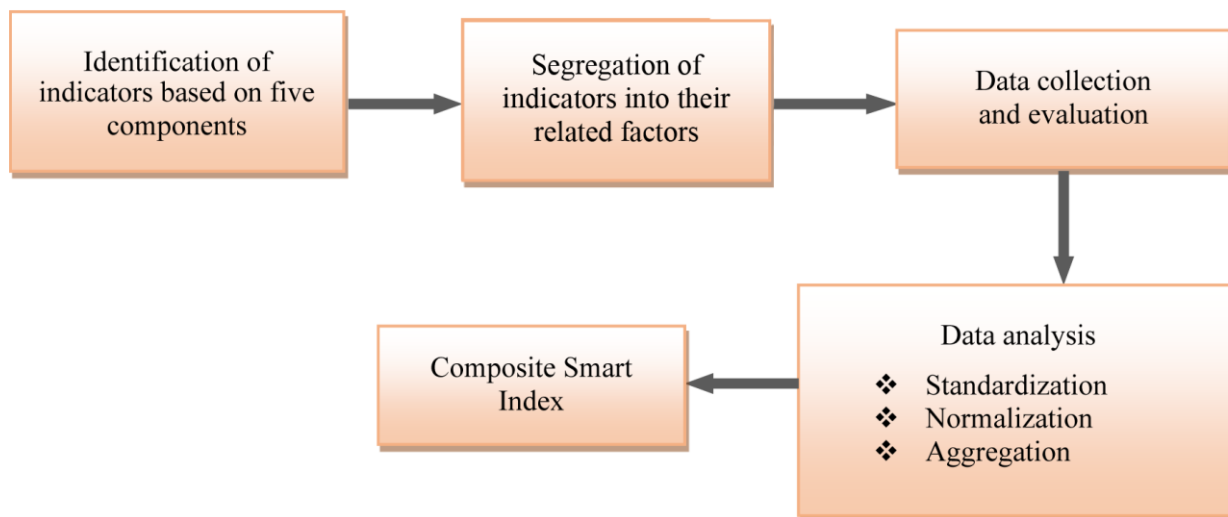The Index is prepared in following steps shown in figure 2

Figure 2 Analysis Methodology

As the Z-score represents the number of standard deviations from x(value) to the mean, it gives a relative score for all variables.[11].Most of zone's scores are in the range of 2 to +2.Positive Z- score indicates the better performance as above than average. While negative sign of Z-score indicate lower performance.

However, the composite smart Index results reveal that each zone has both positive and negative scores, which signify that even zone with overall less smart index have outperformed the higher smart index in certain sub-index and each zone has something to learn from other zones. Higher composite smart index means higher initial endowments or a higher responsive society.

That reflects that it shows the contribution to better potential to prevent and maintain environment. Less smart index means fewer initial endowments and poor management. That contributes to greater challenges towards the environment.

V. RESULT

Surat is India's 9th (Census of India 2011) and Gujarat's second most populous city. For the zone data is collected for the base year 2021 related to institutional, social, physical, economic, and environmental dimensions. Thus, from the data base the Composite smart indicators were found out for the 8 zones of Surat city. Following table-3 show the results of Five Indexes of 8 zones.

The CSI score was made comparable by rescaling the scores from a low of 0 to a high of10(Table-4). The zones were ranked according to their CSI score. The higher the CSI score the better the performance and the higher its ranking. Table -3 shows the five indexes based on comprehensive development.

Table 3 Zone-wise performance by Z-score

Zone	Institutional Smart Index	Social Smart Index	Physical Smart Index	Environmental Smart Index	Economical Smart Index
Central	-0.8763	0.2791	0.2682	0.9644	0.883
West	0.4411	0.2915	0.2799	0.4385	0.6130
North	-0.2767	0.1217	-0.0135	-0.0175	-0.4374
East B	-0.1985	-0.1394	-0.1643	-0.6021	-0.2315
East A	0.5789	0.0052	-0.0932	-0.2626	-0.1863
Southwest	1.2790	0.8959	0.1327	0.6283	0.2873
Southeast	-0.2160	-0.7515	-0.1408	-0.6263	-0.6706
South	-0.7314	-0.7025	-0.2934	-1.0627	-0.2573

The composite smart index is equally weighted average of all sub-indexes. Figure 3 indicate the map showing the ranking of composite smart city index for all 8 zone of Surat city.

Table 4. Composite smart city ranking

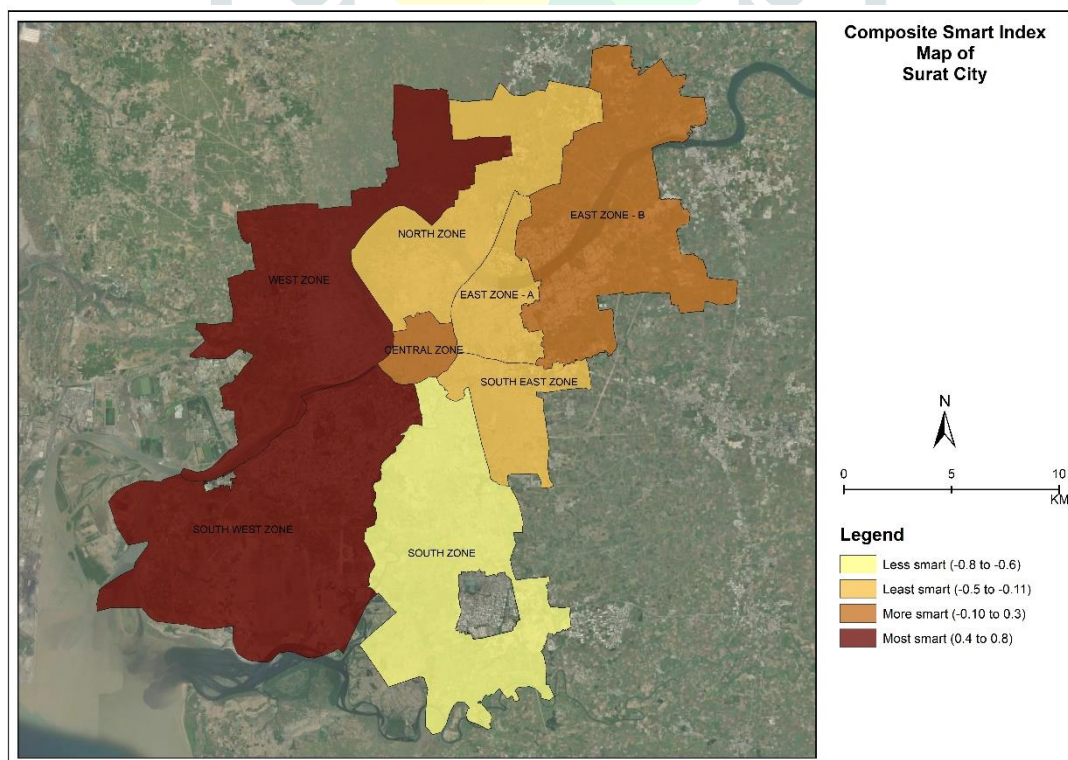| Zone	Composite smart Index	Ranking
Southwest	0.6555	10
West	0.4705	8
Central	0.2942	7
East B	0.0260	5
North	-0.1160	4
East A	-0.1536	3
Southeast	-0.5015	2
South	-0.6162	0

Figure 6. Map of Composite Smart Index.

VI. DISCUSSION

The following conclusions are drawn from the data analysis:

- Southwest zone stands first in the Institutional smart index it shoes that all the institutional factors like Telecommunication, Finance and E-governance are very strong.

- The results highlight that Central Zone stands first in economical smart Index. The results shows that Central zone stands first in environmental smart Index it shows its pollution free environment, better performance in waste collection system and solid waste management. However, the institutional smart index is much lower than the average.
- Southwest zone stands first in Social Smart Index as it shows that all the social factors like Health, Education, Social Inclusion, Safety index are very strong.
- From data analysis and study conclusion is made that overall performance wise Southwest zone of Surat city has higher smart index while South zone stands last position.

VII. CONCLUSION

To enhance the urban development and achieve a good position, the city needs to measure its smartness level. The indicators will empower cities to measure their performance. The smart city index is an aggregate of numerous key performance indicators. The ranking reflect that the south zone showed a considerable weak performance compared to other zones of Surat city. To improve the smart index, the city government shall be focused on physical, social, economic, and environmental components. The composite smart index shows how better way the available sources are utilized for smart sustainable development.

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