

Smart Cities Mission: Promises & Performance: The Environmental Sustainability of Smart Cities in India

Aritro De, Aman Raj, Dakshil Rana, Pratyush Anand, Sumit Kumar Sharma, Vithika Seth

Abstract— Smart cities are becoming the ideal solution for urban settlements to address the issues and challenges of the future. India also adopted various missions and agendas to be a part of this sustainable journey. The Smart Cities Mission, adopted in light of this development, is one of the largest missions concerning urban development. The mission has been ongoing for the past six years in the country, but the citizens are likely unaware of its progress. The study examines the disparity between 'on-paper and 'on-ground reality' in four of the one hundred Smart Cities proposed by the mission. The mission aims to achieve the state of maturity under three pillars; Liveability, economic-ability, and sustainability. The government has provided different frameworks to assess these three pillars. The research examined the environmental component, which represents responses to the 2015 Paris Agreement and the UN Sustainable Development Goals (Goal 11-Sustainable Cities and Communities). The research examined the government initiatives and their progress by using the Climate Smart Cities Assessment Framework and respective government websites that track the success of this component for the government. These findings are then validated through citizen surveys to bridge the gap between the mission's promises and performance.

Index Terms— smart cities, citizen role, climate assessment, smart city proposals, performance, environmental sustainability, urbanization, city development

1 INTRODUCTION

CITY have long been hubs of business, culture, and invention, as well as the incubators of some of humanity's greatest ideas. Cities account for 80% of the country's GDP and influence long-term productivity and general stability. But at the same time, they use two-thirds of the world's energy and produce 70% of global greenhouse gas emissions [1]. Climate change is a worldwide phenomenon that has a significant impact on urban life.

Ending climate change begins in cities. They are a major source of Greenhouse Gas (GHG) emissions, making them a significant contributor to climate change. Cities around the world have begun taking steps to reduce them. They are formulating policies to encourage the use of alternative energy sources. India has its umbrella organization called National Action Plan on Climate Change (NAPCC) focusing on ecological sustainability and its closely related sectors. The Ministry of Housing and Urban Affairs (MoHUA) formulated the Smart Cities Mission India in 2015 under the National Mission on Sustainable Habitat, one of the 8 objectives of the NAPCC. The mission aims to develop the cities considering these three as the pillars; liveability, economic-ability, and environmental sustainability. The government has formed different frameworks to track and assess the progress of cities under these three pillars.

This research paper aims to find answers to the following

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questions.

- How aware are the citizens about the mission?
- Do citizens see any progress on a neighbourhood level?
- Is the government able to perform as per their promises in the proposals?
- What are the gaps between the proposal and the performance of the Smart City Mission of select cities?

A total of one hundred cities submitted proposals for the smart cities mission across the last five years to upgrade the cities to 'smart cities'. The paper tries to analyse four of the hundred smart cities (Bareilly, Bengaluru, Ranchi, and Vadodara) under the Mobility & Air Quality sector of the third pillar - Environmental sustainability. The policies of the Smart Cities Mission and the framework set up by the government-Climate Smart Cities Assessment were analysed to understand what the Government intended to achieve through this mission, performance of which was mapped with online surveys conducted for the citizens of the selected cities. The survey had questions in general and also specific to the cities to get to the bottom of the study. The results of this survey are matched with the proposals and the results according to the government.

The mission has been ambitious and could transform the way of lifestyle in these cities. However, the mission's primary goal is to make the city "smart," rather than "sustainable." It can be argued that that "smartness" cannot be viewed in isolation but requires several layers of sustainable development in each sector to achieve the larger goal of 'inclusive cities'. This study would help all the people concerned with this mission and its implementation.

2 BACKGROUND AND REVIEW

2.1 Concept of 'Sustainability'

The term Sustainability is not a new concept. This has been practiced unconsciously with the inception of human life through biological conservation, adopting local measures, various beliefs in religious culture, etc. The birth of Modern Sustainability dates back to the UN Monetary and Financial Conference of 1945 where International Trade was promoted globally, which led to large-scale industrial expansion.

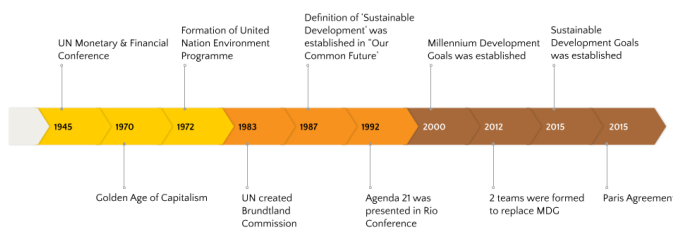


Fig. 1. History of Sustainability

In 1983 the UN created the Brundtland Commission and released a mandate for the world for attaining sustainability through the publication 'Our Common Future,' which coined and popularised the term Sustainable Development.

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Since the definition of Sustainable Development is open to interpretation by different people and organizations, the Sustainable Development Goals (SDG) only provide the guidelines under which each one of the stakeholders is free to formulate its plan of action at different levels.

In September 2015, a Blueprint was signed and adopted by 193 countries to achieve a better and sustainable future. It set 17 Goals and 169 targets covering all three aspects, Social, Economic, and Environment. This was called the "Sustainable Development Goal" and paved the way for further development and policy formation on sustainability on international fronts. There are 17 goals defined by the United Nations and each goal identifies specific targets, with indicators that are being used to measure progress toward each target. Sustainable Development Goal 11, is about "Sustainable Cities and Communities". It has ten targets to be achieved, and that is being measured with 15 indicators. As Joseph E. Stiglitz quotes "What you measure affects what you do. If you don't measure the right thing, you don't do the right thing". To measure sustainability, GDP does not provide the framework as it only measures the Economy of the country. It has no relation to the Social or Environmental Pillar. To cater to this several frameworks have been proposed and are implemented to measure sustainability, such as Genuine Progress Indicator (GPI) which was proposed by Daly and Cobb in 1989. This indicator includes 26 variables divided into the three pillars of sustainability. Other such indicators are the Happy Planet Index (HPI) and Human Development Index (HDI). Countries across the globe committed to creating a new international climate agreement by the conclusion of the U.N. Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) in Paris in December 2015.

India is one of the few countries to act on the Paris Agree-

ment and enact the various objectives of the agreement. NAPCC incorporates India's vision of ecological sustainability and the steps to implement it. It is based on the recognition that climate change actions must be carried out simultaneously in several closely related fields. Aligning to the National Mission on Sustainable Habitat, one of the 8 objectives of the National Action Plan on Climate Change, the Ministry of Housing and Urban Affairs (MoHUA) formulated the Smart Cities mission.

2.2 Smart City: A Global Initiative

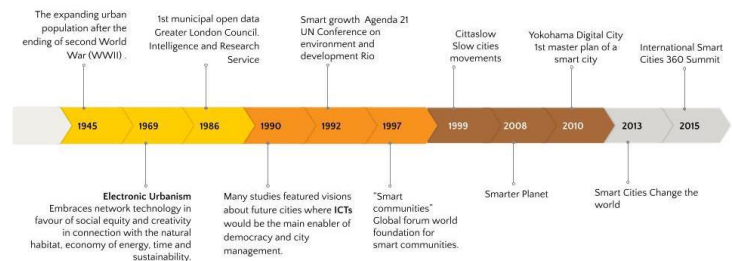


Fig. 2. Global Inception of Smart City

In the mid-1990s, many studies contained visions of future cities in which ICT would be the main facilitator of democracy and urban management [2]. Essentially, technology has been a major driver of visions for the urban future since the industrial age. These visions referred to cities that use technology to create modern and healthy living conditions, in which perfect democracy emerges from collective digital spaces, and people's needs are intuitively met. Some of today's smart city researchers acknowledge that the smart city movement is more of a strategic vision for the future than a reality [3], [4], [5], [6]. In general, the knowledge and innovation economy are one of the main drivers of the smart city discourse.

2.3 Urbanisation in India

Nearly 31% of India's current population lives in urban areas and contributes 63% of India's GDP [7]. By 2030, urban areas are predicted to house 40% of India's population and contribute 75% of the country's GDP [8]. To meet this ever-increasing demand, extensive physical, institutional, social, and economic infrastructure development is required. All of these factors have a role in increasing the quality of life in the city and attracting people and investments, resulting in a virtuous cycle of growth and development. Smart City development is a step in that direction.

2.4 Smart City Mission in India

A Smart City has no universally accepted definition. The definitions differ for different places, depending on its level of development, and readiness to change and reform based on resources, and aspirations.

The image of a Smart City in the mind of any Indian city inhabitant has a wish list of infrastructure and services that reflects his or her level of aspiration. Urban planners would ideally aim to develop the entire urban ecosystem, which is represented by the four pillars of comprehensive development – institutional, physical, social, and economic infrastructure – to meet residents' goals and requirements. This can be a

long-term objective, and communities might strive toward it by gradually adding layers of "smartness" to their infrastructure. The objective is to promote cities that provide infrastructural facilities and provide a decent quality of life for their residents. It also aims to have a clean and sustainable environment including the use of "smart" solutions.

The Smart Cities Mission is an ambitious urban development program launched by the Government of India (GoI) in 2015. According to the GoI, people are at the core of the city. Therefore, cities should work for their people. A smart city hence can be defined as a city that works for its citizens. This means that the city creates opportunities that improve liveability, enable economic growth, and also works on the sustainability aspect. To define a Smart City, The GoI lays down 3 important pillars:

Liveability, Economic-ability, Environment Sustainability

Sustainability is affected by such human activities and the state of the urban environment becomes an indicator of what has gone right or wrong in the city. Sustainability is divided into social, economic, and environmental sectors. The Sustainability indicators under the Ease of Living Index (EoLI) and the Climate Smart Cities Assessment Framework (CSCAF) are tools formulated by the Government of India to understand a city's performance on different dimensions of sustainable development in the Indian context.

The emphasis is on sustainable and equitable development, intending to create a 'replicable model which will act as a lighthouse to other aspiring cities.' as stated in the Mission Guidelines.

The structure of the whole mission is divided into two broad categories of development:

1. Area Based Development: This would improve the overall liveability of the city by transforming existing areas (retrofit and redevelop), including slums, into better-designed regions.
2. Green Field Development: To accommodate the growing population in metropolitan areas, new developments will be built surrounding the cities.

All the development is based on the Smart Solutions that will allow communities to improve infrastructure and services by combining technology, information, and data leading to 'Inclusive Cities'.

2.5 Climate-Smart Cities Assessment Framework (CSCAF)

The Climate Smart Cities Assessment Framework (Ministry of Housing and Urban Affairs, Government of India, 2020) is a tool to assess the climate initiatives of smart cities. CSCAF seeks to address both the mitigation and adaptation sides of the equation and also to develop the emphasis of different sectors of the economy across both in the Indian urban setting. This also involves a grasp of the specific areas that the city authorities may assess and govern. It contained 30 indicators in the 5 most prominent sectors for Urban Climate Action.

1. Energy and Green Buildings
2. Urban Planning, Biodiversity and Green Cover
3. Mobility and Air Quality
4. Water Resource Management
5. Waste Management.

The Climate Smart Cities Assessment framework is a step to put together a methodology and develop an objective approach that is aspirational in its objectives and relies on both individual and collective effort, and consequent action. It is presently attempting to map the progress of the 100 smart cities based on existing reporting systems.

The CSCAF 2.0 (2020 edition) is designed to be specific, measurable, actionable, relevant, and time-bound. Moreover, each indicator includes progressive levels ranging from '1' to '5' to present each city with a roadmap to track their growth and enhance necessary solutions to solve the same. The CSCAF 2.0 reduced the indicators to 28 from 30 with a sector-wise weightage marking system introduced. ClimateSmart City's score is calculated based on each sector's weightage and score. The sector-wise score is calculated by summing the weighted scores against each indicator.

1. Energy and Green Buildings - 25%
2. Urban Planning, Biodiversity and Green Cover - 25%
3. Mobility and Air Quality - 15%
4. Water Resource Management - 15%
5. Waste Management - 20%

3 METHOD

The paper follows the flowchart in Figure 4 as the path to reach the conclusion. In order to carry out the research with time constraints, the study is limited to four of the hundred Smart Cities: Bareilly, Bengaluru, Ranchi, and Vadodara. These were selected on the basis of the following parameters.

1. The cities are accessible to researchers during pandemic times.
2. They are located in different geographical zones, hence diversifying the dataset.
3. These cities have easy access to previous years' data that is required for the study.

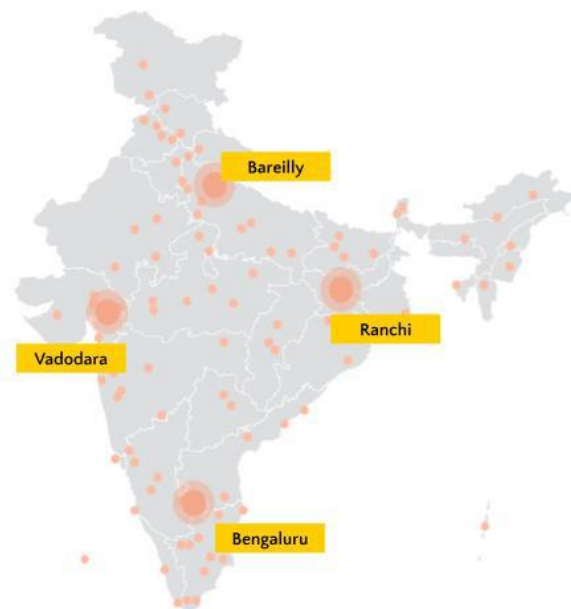


Fig. 3. Selected Cities for Study

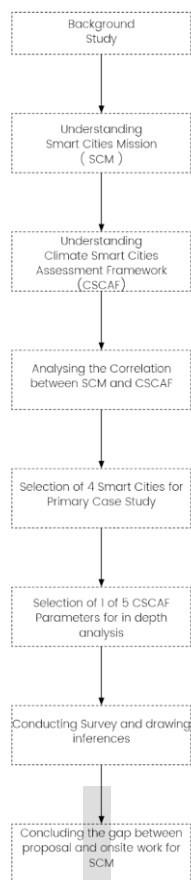


Fig. 4. Method of Research

The cohesive study of Climate Smart Cities Assessment Framework indicators and Smart city mission proposals lead to several connections between them. Eleven of total twenty-four Smart city mission features are correlated with the CSCAF sectors:



Fig. 5. Correlation between CSCAF and SCM Features

To have an in-depth and thorough study, the paper is restricted to the sector of Mobility and Air Quality. The reason for choosing the sub-topic are as follows:

1. It is one of the fastest-growing carbon emission sources.
2. It is responsible for 13.5% of the country’s energy-related CO2 emissions, with road transport accounting for 90% of the sector’s final energy consumption [10].
3. This sector is most closely related to Citizens.

To map the performance, a primary citizen survey was

conducted through online mode. The objective of this survey was to get the citizens’ perspectives about their respective smart cities, in a way, defining the on-ground reality of smart cities.

The survey was conducted in two parts. The first part contains general questions, which were common to all the four smart cities. This included at least one question from each of 5 indicators in the sector. The list of common questions as per the indicators is provided in Table x. The second part of the survey contained city-specific questions, which were formulated based on the SCM Proposals. A set of around 100 citizens were surveyed from each city. The majority of the questions were based on a rating of a scale of (1-5), where 1 means poor performance and 5 means excellent performance.

To conclude the study, the results are divided into two parts. The first part has the results according to CSCAF, which is available under the NIUA program called Climate centre for Cities (C3) [11].

Table 1: Questions against Indicators

Criteria (CSCAF)	Smart City feature	Indicators as in CSCAF	Questions
Mobility & Air Quality	Transport	Indicator 1: Clean Technologies Shared Vehicles	Type of fuel in shared vehicles
		Indicator 2: Availability of Public Transport	Accessibility of public transport Affordability of public transport
Air Quality	Air Quality	Indicator 4: Level of Air Pollution	Air Quality
		Indicator 5: Clean Air Action Plan (Planning and Implementation)	Govt. efforts to reduce air pollution
	Walkability	Indicator 3: Percentage of coverage of Non-Motorized Transport network (pedestrian and bicycle) in the city	Availability of pedestrian facilities

As the CSCAF was not launched until 2018, the C3 score for the cities at the beginning of the mission, i.e., 2016, was calculated on the basis of previous years’ data. Comparing this 2016 score and the published C3 score of 2019, a qualitative conclusion was determined on whether there is any progress. The cities, in either case, are working on projects which are not related to the mission.

The next step is to check the response of the city’s proposals for the given indicators. To connect both of these separated results, a matrix was formed to distinguish the following four

possible cases.

Table 2: Result Matrix

A	SCM Proposal stated initiatives and an improved situation
B	SCM Proposal stated initiatives but no progress
C	SCM did not have any initiatives and no progress
D	No stated Initiative but has an improved situation

These results, when combined with the citizen responses gave either a positive or negative correlation between the 'promises and performance'. The conclusions for the specific cities contain the reasons for these correlations. The overall study is concluded on the basis of these results giving the recommendations that can be helpful to the stakeholders holding the responsibility of the mission.

4 RESULTS

4.1 Vadodara

Indicator 1: Clean Fuel Shared Vehicles

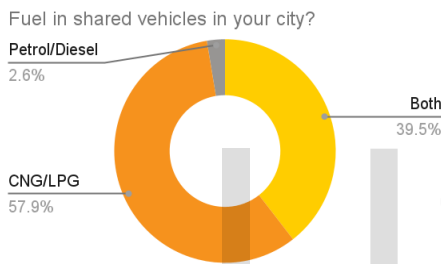


Chart 1: Clean Fuel Shared Vehicles

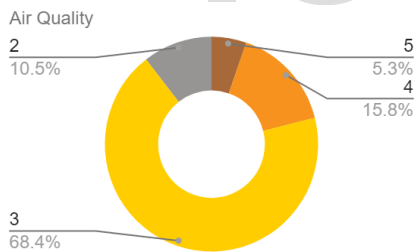


Chart 2: Air Quality

The air quality of the city is average according to 68% of citizens. For 15% of them, it is above average (chart 2). 57% are aware of the fuel used in the shared vehicles as green fuel (CNG/LPG) and 39.5% say the city uses both petrol/diesel and CNG/LPG. The city currently doesn't have any shared vehicles running on electricity as per their response.

Indicator 2: Availability of Public Transport

For 52.7% of surveyed people, public transport is accessible within 1 km of their place (Chart 3). And 86.9% of citizens say that it is affordable for the majority of the public (4 & 5 stars) (Chart 4). Although the public transport in the city is run by private companies, they have managed to make it affordable for the public.

The following results (Chart 6) show that the majority

(55%) of citizens say that the pedestrian facilities in the city are average. Also, 42.1% say it is below average or poor. And for 68% of surveyed people, the government efforts against air pollution are below average.

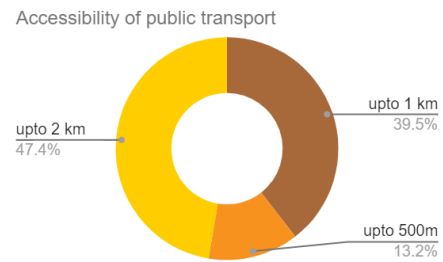


Chart 3: Availability of Public Transport

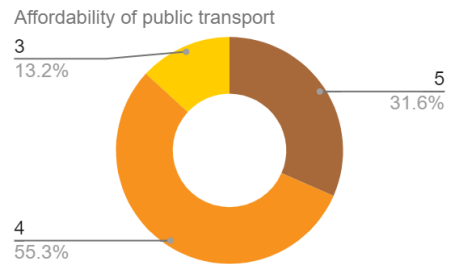


Chart 4: Affordability of Public Transport

Indicator 3: NMT coverage

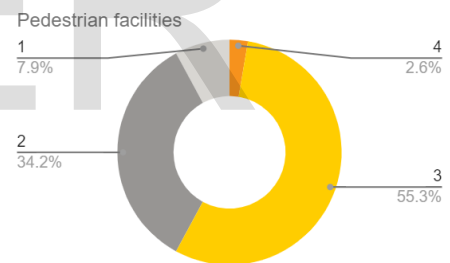


Chart 5: Pedestrian Facilities

Indicator 5: Clean Air Action Plan

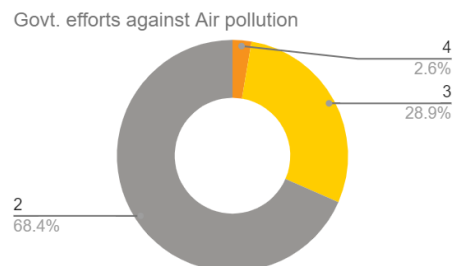


Chart 6: Govt Efforts against Air Pollution

Vadodara Smart city Proposals:

Vadodara has proposed some projects for the urban parks which would indirectly enhance the air quality and promote walkability. But these projects were unknown to many people. And the implementation of 2 of the 4 projects has not even

begun yet (Chart 7).

Table 2: Conclusion for Vadodara

Criteria (CSCAF)	Smart City feature	Indicators as In CSCAF	CSCAF 2016 Points (Out of 100)	CSCAF 2019 Points (Out of 100)	SCM Initiatives (Yes/No)	Progress as per CSCAF (Yes/No)	Inferences from SCM and CSCAF	Inferences of Survey (Vadodara)	Correlation
Mobility & Air Quality	Transport	Indicator 1: Clean Technologies Shared Vehicles	75	94	Yes	Yes	A	97.38% of citizens say that shared vehicles are running on green fuels	Positive
		Indicator 2: Availability of Public Transport	25	25	No	No	C	86.9% of Citizens say that Public transport is affordable and 52.7% say that it is accessible within 1km	-
	Air Quality	Indicator 4: Level of Air Pollution Indicator	50	77	No	Yes	D	68.4% of Citizens say that Vadodara has average air quality	Negative
		Indicator 5: Clean Air Action Plan (Planning and Implementation)	25	30	No	Yes	D	68.4% of Citizens say that the efforts of the Government to curb air pollution are below average	Positive
	Walkability	Indicator 3: Percentage of coverage of Non-Motorized Transport network (pedestrian and bicycle) in the city	-	50	Yes	No	B	94.7% of Citizens say that there have been NO significant changes in the conditions of pedestrian facilities	Negative

Which projects are you aware of?

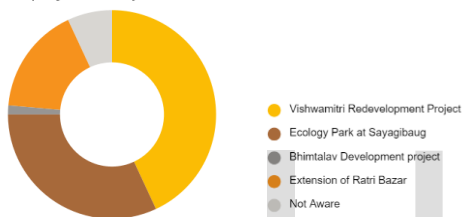


Chart 7: Projects and Awareness

Which projects have started its implementation?

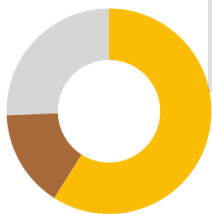
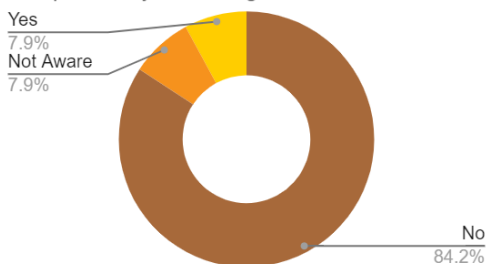


Chart 8: Setups for Bicycle Sharing

To promote walkability, the city proposed two main projects. One, to set up bicycle sharing and create a network for non-motorized transport in the city. But 87% of people don't see any kind of setups in the city (chart 8). The second was to improve the pedestrian facilities on the existing roads. But the citizens see little or no progress in this area (chart 9) too.

Setups for bicycle sharing



Improvement in pedestrian facilities

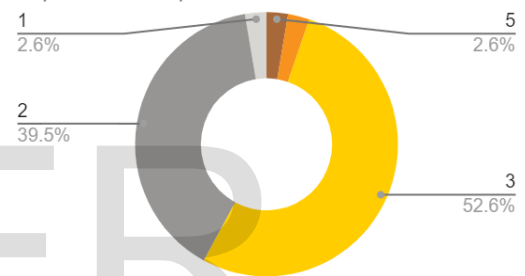


Chart 9: Improvement in Pedestrian Facilities

4.1.2 Conclusions for Vadodara

Table 2 concludes all the results for Vadodara. Many of the projects have not started and those started are progressing at a very slow rate. The indicators with positive correlation were achieved as the city was already working on those things for years. They started converting the autorickshaws to CNG in 2004 after the Gujarat Motor Vehicles (Use of Fuel) Regulation Bill, 2003. And the air quality of the city is not that bad to worry about. The implementation of the Clean Air Action Plan will supposedly catch up to its desired progress before it is much needed. The ones with the negative correlation show that the city was not focusing on these areas. Some of the reasons for the delay include time delay in the approvals, lack of qualified/experienced contractors, shortage of labour due to the pandemic, problems of re-tendering due to tight budgets, and inclusion of different ongoing projects in the mission. (Pete, 2021)

4.2 Bengaluru

Indicator 1: Clean Fuel Shared Vehicles

The air quality of the city is average according to 40% of citizens. For 32% of them, it is above average. 42.3% of people indicate that shared vehicles run on both petrol/diesel and LPG, with 7.7% indicating vehicles running on petrol/diesel and electricity.

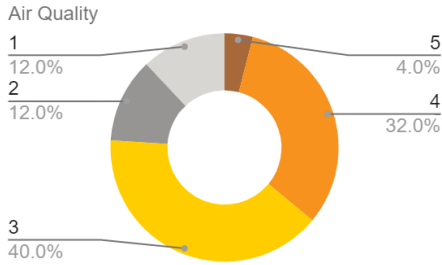


Chart 10: Air Quality

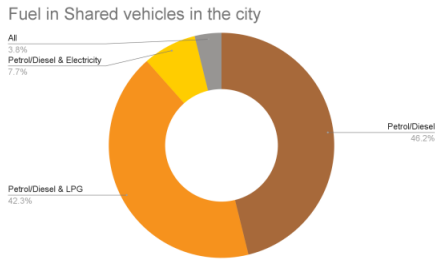


Chart 17: Clean Fuel Shared Vehicles

Indicator 2: Availability of Public Transport

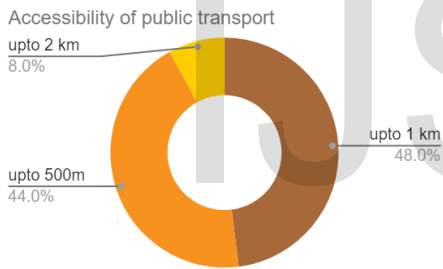


Chart 12: Affordability of Public Vehicles

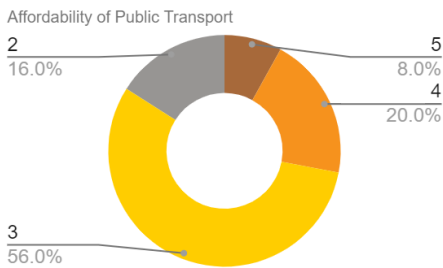


Chart 13: Accessibility of Public Transport

For 48% of surveyed people (Chart 12), public transport is accessible within 1 km of their place and 44% say it is accessible within 500 meters. 76% of citizens say that it is fairly affordable for the majority of the public (3 & 4 stars) (Chart 13). As the majority of public transport is run by the state government (Bangalore Metropolitan Transport Corporation, Bengaluru Metro Rail Corporation, and Karnataka State Road Transport Corporation), the rates are determined by the government.

Indicator 5: Clean Air Action Plan

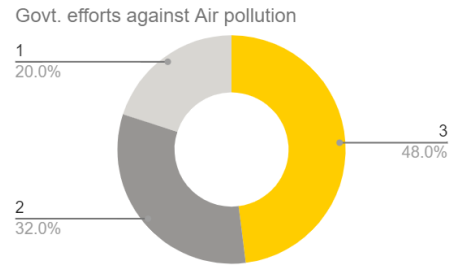


Chart 14: Govt. efforts against Air Pollution

Indicator 3: NMT coverage

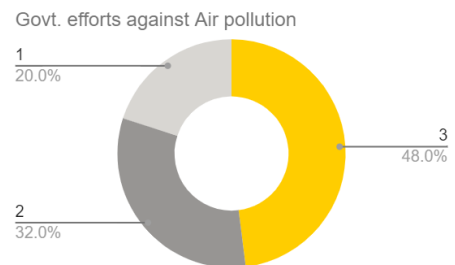
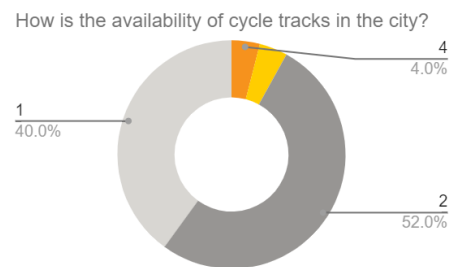


Chart 15: Pedestrian Facilities

For 88% of surveyed citizens, the pedestrian facilities in the city are below average. And according to 48% of surveyed people, the government efforts against air pollution are average, with 32% of people saying the efforts are below average.

Bengaluru Smart City Proposals

Walkability



How safe do you think is travelling as a pedestrian in Bangalore?

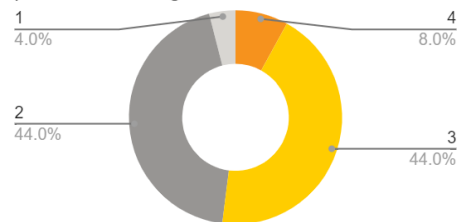


Chart 16: Walkability

Table 3: Conclusion for Bengaluru

Criteria (CSCAF)	Smart City feature	Indicators as In CSCAF	CSCAF 2016 Points (Out of 100)	CSCAF 2019 Points (Out of 100)	SCM Initiatives (Yes/No)	Progress as per CSCAF (Yes/No)	Inferences from SCM and CSCAF (A/B/C/D)*	Inferences of Survey (Bengaluru)	Correlation*
Mobility & Air Quality	Transport	Indicator 1: Clean Technologies Shared Vehicles	-	0	Yes	No	B	53.8% of citizens say that shared vehicles are running on green fuels	-
		Indicator 2: Availability of Public Transport	50	80	Yes	Yes	A	76% of Citizens say that Public transport is fairly affordable and 48% say that it is accessible within 1km	Positive
	Air Quality	Indicator 4: Level of Air Pollution Indicator	50	4	Yes	No	B	72% of Citizens say that the city has average & good air quality	Negative
		Indicator 5: Clean Air Action Plan (Planning and Implementation)	25	37	Yes	Yes	A	52% of Citizens say that the efforts of the Government to curb air pollution are below average	Negative
	Walkability	Indicator 3: Percentage of coverage of Non-Motorized Transport network (pedestrian and bicycle) in the city	50	66	Yes	Yes	A	88% of Citizens say that there have been NO significant changes in the conditions of pedestrian facilities	Negative

Is there any availability of Auto-stands and Bicycle share points in the city?

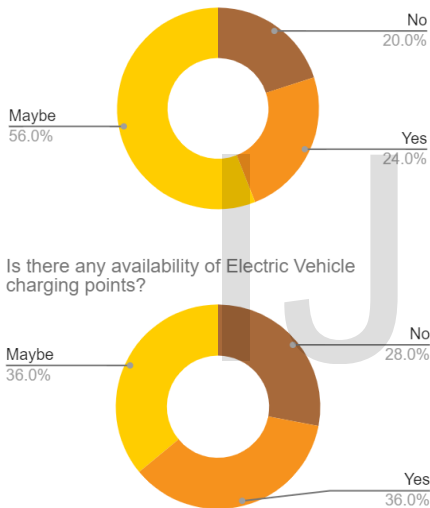


Chart 16: Walkability

How would you rate the traffic condition in the city?

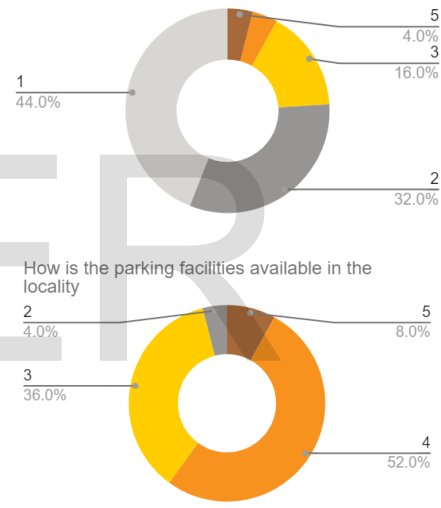
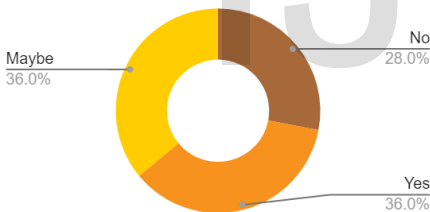
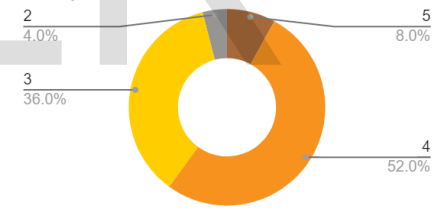


Chart 17: Traffic Congestion

Is there any availability of Electric Vehicle charging points?



How is the parking facilities available in the locality?



The government has proposed to build the infrastructure for the promotion of NMT and pedestrian-friendly streets, but, the survey shows that for 40% of people, there is poor/no availability of bicycle tracks, and 52% of them say it is below average (chart-top left). The survey (Chart 16) also conveys that 88% of people feel that the safety of pedestrians in the city is below average.

It is also conclusive that 56% of people are unaware (Chart 16) of the availability of auto-stands and bicycle share points in the city, and 36% of people agree that electric charge points are available with 36% unaware (Chart 16) of such activity.

Traffic Congestion

The survey puts out that 44% of people indicated that traffic congestion in the city is poor, with 32% saying below average/fair. The majority of people (88%) indicated that the availability of parking facilities is above average.

4.2.1 Conclusion for Bengaluru

Table 3 concludes all the results for Bengaluru. The focus, as per the SCM proposal, was to make the city connected and healthy, by improving pedestrian facilities, and promoting Non-Motorised Transport and cleaner vehicles. Bengaluru Smart City, proposed many projects, some being, increase in parking - on street and off street, along with auto and bicycle parking and extensive pedestrian network (Bangalore Annexure). But for the majority of citizens, the progress towards the work stated above is very minimal and slow. The reasons may be pertaining to the pandemic and lockdown, which have forced new projects to come to a halt.

4.3 Ranchi

Around 50% of the citizens of Ranchi feel the air quality is average and around 40% feel the air is better than average. Around 85% of citizens find that public transport vehicles are running on Petrol and Diesel, and only 12% find public transport running on CNG. The CNG stations have just started

in Ranchi and the up-gradation of shared auto-rickshaws to CNG has just begun.

Indicator 4: Air Quality

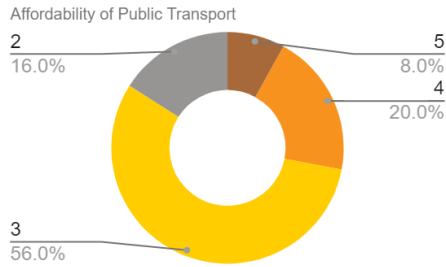


Chart 18: Accessibility of Public Transport

Indicator 1: Clean Fuel Shared Vehicles

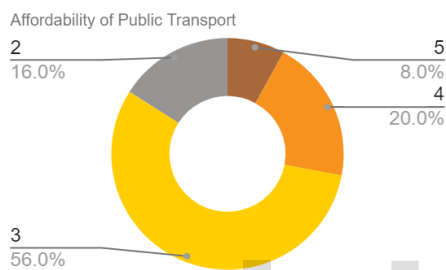


Chart 19: Accessibility of Public Transport

Indicator 2: Availability of Public Transport

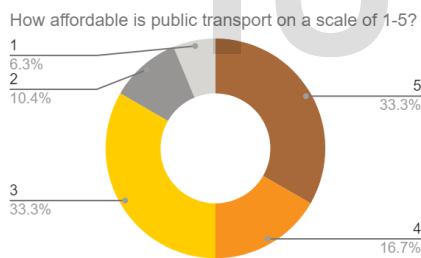


Chart 20: Affordability of Public Transport

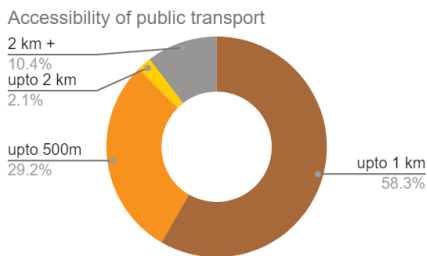


Chart 21: Availability of Public Transport

Nearly 30% of the citizens find access to public transport within a range of 500 m from their place. It is fairly accessible to the public as almost 90% of citizens can access it within 1 km. It is very affordable according to about 50% of the citizens (4&5 stars) and 33% of citizens find it moderately affordable.

Indicator 3: NMT coverage

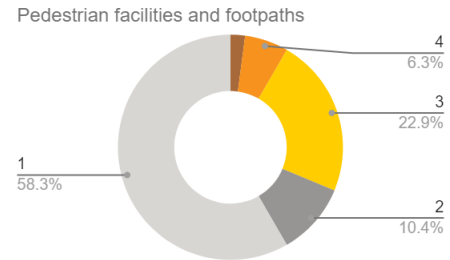


Chart 22: NMT coverage

Indicator 5: Clean Air Action Plan

How would you rate the government efforts to address air pollution?

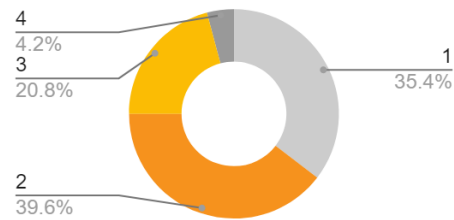


Chart 23: Clean Air Action Plan by Govt

60 % of surveyed citizens of the city rate the footpath availability as very poor. The city has almost non-existence of dedicated footpaths and pathways for non-motorized vehicles. This is forcing people to take vehicles and creating traffic issues in the city. Also, 75% feel that the government's efforts to curb air pollution are poor. (1 and 2 stars).

Ranchi Smart city Proposals

Ranchi Smart city proposal has development focused on the creation of an Area Based Smart city Project as well as a pan-city traffic and parking management system and integrated command centre for traffic violation and management.

Air Quality

Do you see any setup for E-Rickshaw in the city?

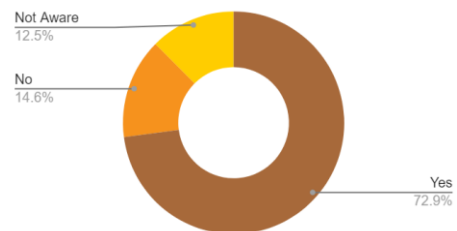


Chart 24: Setup for E-Rickshaw

87% of citizens have observed that there is infrastructure for cycle stands. There are cycle stands at almost 1-2 km in the city. Around 72% of citizens say that there are setups for E-Rickshaw in the city. These were the initiatives of the Government and these are well implemented on the site.

Table 4: Conclusion for Ranchi

Criteria (CSCAF)	Smart City feature	Indicators as In CSCAF	CSCAF 2016 Points (Out of 100)	CSCAF 2019 Points (Out of 100)	SCM Initiatives (Yes/No)	Progress as per CSCAF (Yes/No)	Inferences from SCM and CSCAF (A/B/C/D)*	Inferences of Survey (Ranchi)	Correlation*
Mobility & Air Quality	Transport	Indicator 1: Clean Technologies Shared Vehicles	0	100	Yes	Yes	A	16.3% of citizens say that shared vehicles are running on green fuels	Negative
		Indicator 2: Availability of Public Transport	25	25	Yes	No	B	50% of Citizens say that Public transport is affordable and 58.3% say that it is accessible within 500 m	-
	Air Quality	Indicator 4: Level of Air Pollution Indicator	50	60	Yes	Yes	A	77% of Citizens say that Ranchi has average air quality	Positive
		Indicator 5: Clean Air Action Plan (Planning and Implementation)	25	25	Yes	No	C	75% of Citizens say that the efforts of the Government to curb air pollution are below average	-
	Walkability	Indicator 3: Percentage of coverage of Non-Motorized Transport network (pedestrian and bicycle) in the city	0	100	Yes	Yes	A	70% of Citizens say that there have been NO significant improvements in the conditions of pedestrian facilities	Negative

4.3.1 Conclusion for Ranchi

Table 4 concludes all the results for Ranchi. The main focus of the government was to solve the issue of traffic congestion in the city and to create a smooth flow of traffic on major arterial roads. There were only 3% footpaths available for pedestrians in 2016 (The Smart City Challenge-Stage 2: Smart City Proposal-Ranchi | Smartnet, 2021). The government intended on improving the infrastructure for non-motorized vehicles as well as creating paths for pedestrians and cyclists.. The citizens feel that the pedestrian infrastructure is poor and even though the city rates itself well in coverage of non-motorized vehicular roads, the citizens do not feel it is being implemented. Some of the other projects under the smart city mission are still under tendering process and have not yet been fully implemented. The government rates air quality as 60 by the government and rated average by the majority of the citizens. Shared vehicles in Ranchi still run-on diesel and petrol as suggested by the survey. On the other hand, the government rates itself as 100 in the clean fuel category. There are a few disparities between the government data and what the citizens feel and it would take some time for the people to realise the effects of the government’s efforts.

4.4 Bareilly

Indicator 4: Air Quality

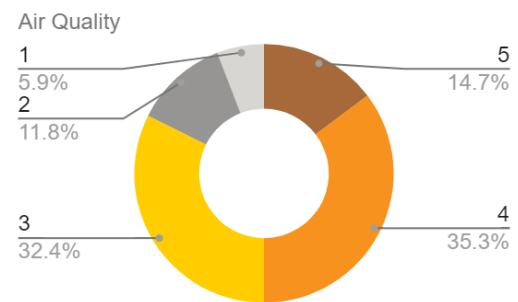


Chart 27: Air Quality

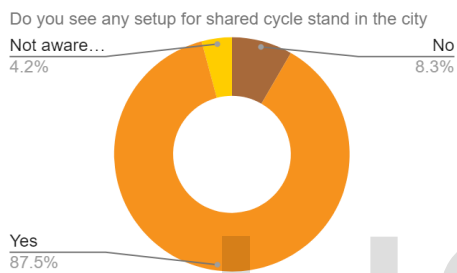


Chart 25: Air Quality

Traffic congestion

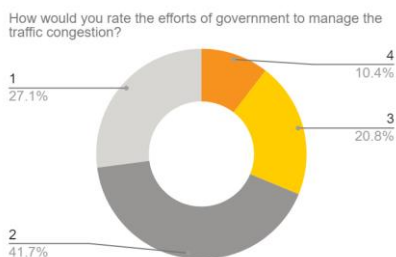
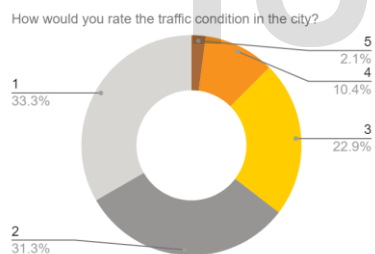


Chart 26: Traffic Congestion

Traffic congestion is a major issue in Ranchi city. Around 65% of citizens rate traffic conditions as poor. About 70% of citizens feel that the efforts of the government to reduce traffic congestion are poor or are not working. The citizens are still facing traffic issues even though traffic management was one of the proposals of the smart city mission.

Indicator 1: Clean Fuel Shared Vehicles

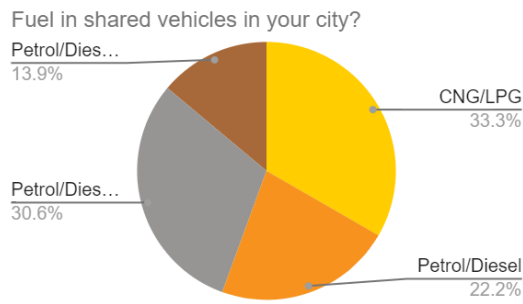


Chart 28: Clean Fuel Shared Vehicles

The air quality of the city is above average according to 50% of citizens. For 32.4% of them, it is average. 33% of them are aware of the fuel used in the shared vehicles as green fuel (CNG/LPG) and 30.6% say the city uses both petrol/diesel and CNG/LPG. 13.9% of people acknowledge that there are shared vehicles running on electricity as well.

Indicator 2: Availability of Public Transport

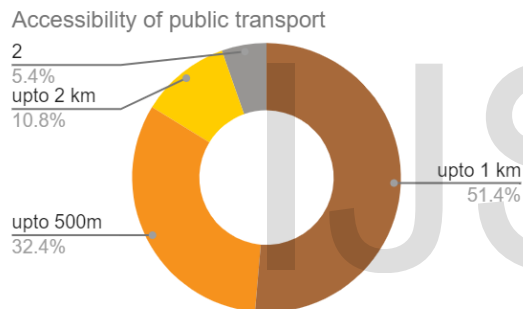


Chart 29: Accessibility of Public Transport

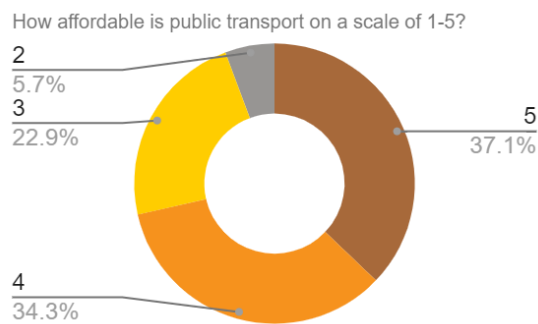


Chart 30: Affordability of Public Transport

For 51.4% of surveyed people (Chart 29), it is accessible within 1 km of their place. In Bareilly, autorickshaws, E-Rickshaw, and shared vehicles are considered as public transport. There is no intra-city bus service. 71.7% of citizens say that public transport in the city is affordable for the majority of the public (4 & 5 stars). Although the public transport in the city is run privately, they have managed to make it affordable for the majority of the public.

Indicator 3: NMT coverage

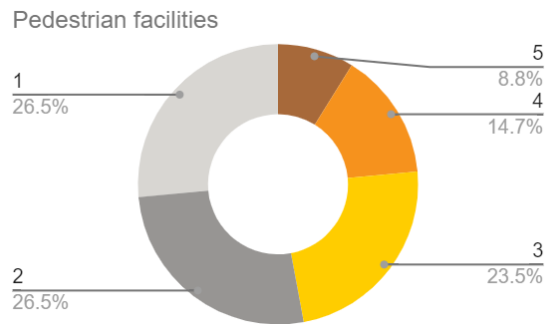


Chart 31: NMT coverage

Indicator 5: Clean Air Action Plan

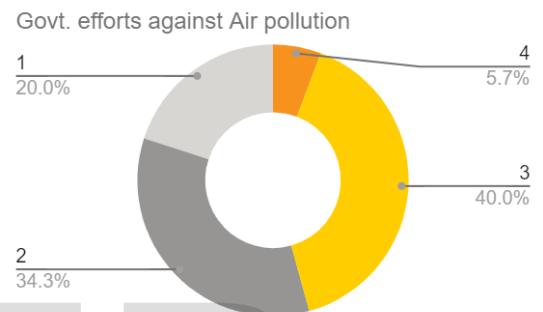


Chart 32: Clean Air Action Plan

These results show that the majority (47%) of citizens feel that the **pedestrian facilities** in the city **are above average**. Also, 53% say it is below average or poor. For 54.3% of surveyed people, the gov't. efforts against air pollution are below average.

Smart city Proposals:

Transportation and Mobility

Bareilly smart city proposal focuses on the introduction of public transport as a major mode of transport. Development of junction geometries for the safety of pedestrians and bicyclists, intelligent transportation systems for city-level traffic management, enforcement, and emergency vehicle response. But as per the surveyed public, 73.6% has an opinion that the parking facility in the city is above average to good, whereas in terms of safety of major chaurahas, 40% states as average (3 Star), with 37% saying it below average (2 stars).

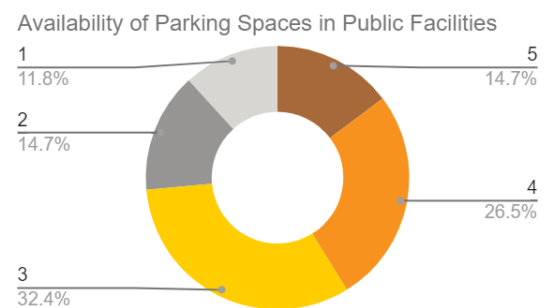


Chart 33: Availability of Parking Spaces

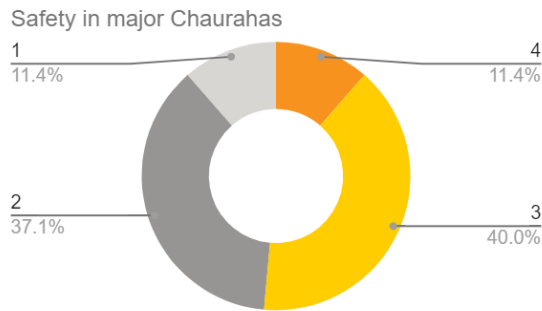


Chart 34: Safety in Major Chaurahas

Walkability

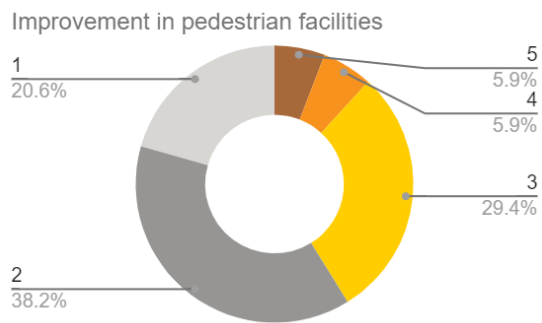


Chart 35: Installation of Traffic Management System

To promote walkability, the city proposes to create 15 km of footpath and 12 Km of cycle track under the ABD area and use advanced traffic enforcement techniques such as red-light violation detection to safeguard NMT modes from motorized components of the traffic. The proposal also includes the improvement of a 130 Km road of the ABD area with NMT infrastructure. But 58.8% of people feel that the improvement in pedestrian facilities is poor and 74.3% of people state that the traffic management system is poor (1 & 2 Star).

4.4.1 Conclusion for Bareilly

Table 4 concludes all the results for Bareilly. Many of the projects have not started and those started are progressing at a very slow rate. The indicators with positive correlation were achieved as the city was already working on those things for years. The ones with the negative correlation show that the city was not focused on these areas. The ones with a negative correlation indicate that the city was not paying attention to these issues. Some of the smart city mission's other projects are still in the tendering process and have not yet been fully implemented. The slow pace of new project development has also been hampered by the Pandemic and lockdown, which have forced new projects to come to a halt.

5 CONCLUSION AND RECOMMENDATIONS

India knows its future trajectory in different sectors to attain environmental sustainability. The government has formed different organizations and launched missions. But the survey results indicate the other side of the story. The studied cities were not able to focus on all the sectors at the same time, even with all the right institutions already formed. The citizens don't see much progress in terms of its implementation. The pace of the progress is very slow. Many of the projects are in the tender stage, even after six years since the project was initiated. Hence people are not even aware of such initiatives.

Table 5: Conclusion for Bareilly

Criteria (CSCAF)	Smart City feature	Indicators as in CSCAF	CSCAF 2016 Points (Out of 100)	CSCAF 2019 Points (Out of 100)	SCM Initiatives (Yes/No)	Progress as per CSCAF (Yes/No)	Inferences from SCM and CSCAF (A/B/C/D)*	Inferences of Survey (Ranchi)	Correlation*
Mobility & Air Quality	Transport	Indicator 1: Clean Technologies Shared Vehicles	0	0	Yes	-	-	76% of citizens say that shared vehicles are running on green fuels	-
		Indicator 2: Availability of Public Transport	-	0	Yes	*	-	71.7% of Citizens say that Public transport is affordable and 83.8% say that it is accessible within 1km	-
	Air Quality	Indicator 4: Level of Air Pollution Indicator	25	37	Yes	Yes	A	50% of Citizens say that Bareilly has air quality above average and 32.4% rates as average.	Positive
		Indicator 5: Clean Air Action Plan (Planning and Implementation)	25	35	No	Yes	D	54.3% of Citizens say that the efforts of Government to curb air pollution is below average	Negative
	Walkability	Indicator 3: Percentage of coverage of Non-Motorized Transport network (pedestrian and bicycle) in the city	0	0	Yes	*	B	81.1% of Citizens say that there has been NO significant changes in the conditions of pedestrian facilities	-

Some of the reasons for the delay as per the smart city mission website are as follows;

- Lots of time was taken and wasted in approvals.
- A limited number of qualified/experienced contractors to carry out the proposed projects.
- The shortage of labour is due to the pandemic.
- The problems of re-tendering due to tight budgets created a large time lag.
- The municipality added different ongoing projects in the mission to show positive results.

These situations can be easily tackled with timely regulation of citizen participation. It would help get a reality check and ease the documentation process systematically. They can run awareness programs to improve citizen participation. The problems for tendering can be tackled by privatizing various projects. It would also improve the quality and accountability of projects. Organizing the competitions and learning from the successful projects, both on a national and international level, can help get new and innovative ideas. Time management still remains a big hurdle in India's path to sustainability, and measures should be taken to escalate the progress.

6 LIMITATIONS AND SCOPE

1. Due to time constraints, only 4 cities namely Ranchi, Bareilly, Vadodara, and Bengaluru were taken for the case study out of 100 cities included in the smart city mission.
2. The study was limited to only 1 of the five Climate-Smart Cities Assessment Framework Parameters.
3. Due to COVID-19, fetching ground data for case studies imposed difficulties and hence the survey was conducted online.
4. Limited to study 4 cities

6. AKNOWLEDGEMENT

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REFERENCES

- [1] C40.org. 2018. C40 - Why Cities?. [online] Available at: <https://www.c40.org/why_cities> [Accessed 26 October 2021].
- [2] Climateactiontracker.org. 2020. Decarbonising the Indian transport sector: pathways and policies. [online] Available at: <<https://climateactiontracker.org/publications/decarbonising-indian-transport-sector-pathways-and-policies/>> [Accessed 26 October 2021].
- [3] ClimateSmart Cities. (2020). Retrieved 26 October 2021, from <https://www.niua.org/csc/assessment-overview.html>
- [4] Energy Efficiency-World Bank. (2017). Retrieved 26 October 2021, from <https://www.worldbank.org/en/results/2017/12/01/energy-efficiency>
- [5] Environmental and Social Sustainability Policy. (2012). Retrieved 26 October 2021, from https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_extenal_corporate_site/sustainability-at-ifc/policies-standards/sustainability-policy

- [6] <https://www.unep.org/>. 2018. Sustainable Cities. [online] Available at: <<https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/sustainable-cities>> [Accessed 26 October 2021].
- [7] International Finance Corporation. (2018). Climate Investment Opportunities in Cities, An IFC Analysis [Ebook] (pp. 48-50). 2121 Pennsylvania Avenue, N.W. Washington, D.C. 20433. Retrieved from <https://www.ifc.org/wps/wcm/connect/875afb8f-de49-460e-a66a-dd2664452840/201811-CIOC-IFC-Analysis.pdf?MOD=AJPERES&CVID=mthPzYg>
- [8] Ministry of Housing and Urban Affairs, Government of India. (2020). CLIMATESMART CITIES Assessment Framework 2.0. New Delhi: Ministry of Housing and Urban Affairs, Government of India.
- [9] Pete, K., 2021. Mahamari nu grahan. Divya Bhaskar, [online] pp.4-5. Available at: <<https://www.google.com/url?q=https://epaper.divyabhaskar.co.in/vadodara/32/16102021/0/-4/&sa=D&source=docs&ust=1635924997973000&usg=AOvVaw237RVvh0LLd3UjxI4hQ4dT>> [Accessed 3 November 2021]
- [10] Smart Cities: Mission Statement & Guidelines - Platform Cooperativism Resource Library. (2021). Retrieved 26 October 2021, from <https://resources.platform.coop/resources/smart-cities-mission-statement-guidelines/>
- [11] Smartnet.niua.org. 2021. The Smart City Challenge-Stage 2: Smart City Proposal-Ranchi | Smartnet. [online] Available at: <<https://smartnet.niua.org/content/cec45f61-c356-4ec1-8faa-fd25eaa566c7>> [Accessed 3 November 2021].
- [12] Un.org. 2018. 68% of the world population projected to live in urban areas by 2050, says UN. [online] Available at: <<https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>> [Accessed 26 October 2021].
- [13] United Nations Sustainable Development. 2016. Cities - Sustainable Development Goals. [online] Available at: <<https://www.un.org/sustainabledevelopment/cities/>> [Accessed 26 October 2021].