

Open Source Smart City Dashboard: Analysing the structure and Trends in Infrastructure Proposals under the Smart cities mission India

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Abstract

Burgeoning urbanisation worldwide has directed nations to rethink urban missions, national agendas and policies by governments. The notion of Smart Cities is one such route that many countries are aspiring to tackle the innumerable urbanisation related issues which cities are facing. India too has stepped onto a similar direction and it has almost been three years, since India has had a formal introduction to smart cities mission (SCM) which proposes to make 100 smart cities in the India by the year 2022. This empirical research is based on two openly available data sources, smart city proposal document and annexures of the smart city proposals for each selected smart city. The study analyses 88 smart city proposals out of the 100 smart cities chosen by the Government of India. The SCM is thought-out by set of goals, largely estimated investments, several private sector involvements, and a new governance framework for city development. The SCM's main ambition is economic growth and improved quality of life of people by permitting urban local bodies to apply for components : (a) Area-based development (ABD) that aims to transform smaller areas of the cities which will then act as lighthouse for other parts of the city (b) Pan-city development (PAN) that envisions the application of smart solutions covering the larger city wide area of the existing city. The results of this study show that on average cities are investing 80% of their total investment in ABD component and 20 % in PAN based initiative. This paper first analyses demographic and geographical variables which could have influenced planning approaches to create smart city proposals. The results have revealed that the evolution patterns of Indian smart city proposals do not depend on its local structural urban variables. The proposals have very little influence on variables like city's population density, per capita investments towards city's future digital pathways. The paper also provides a statistical analysis of demographic related trends and correlations of 99 selected smart cities proposals. This study then demonstrates by giving sectoral trends in the infrastructure proposals for lighthouse top 20 selected smart Cities in India. The paper provides commonalities in the Round 1 cities by critically analysing sectoral priorities and estimated investments segregated into eight sectors. It investigates both the sectoral priorities and its correlations to demographic variables in the open source software called Tableau. The results indicate that cities estimated investments are focusing on mobility, followed by Information Communication and Technology (ICT) related governance initiatives. As one of the objectives of the SCM is to deliver existing core infrastructure that leverages smart solutions It also analyses vital ICT component in each sector prioritised in cities proposals. In summary, it was seen that out of the top twenty selected cities more than 50% of total ICT related investment was proposed to be in transport and urban city management. This research provides policy-makers and city-managers with valuable strategies to define and initiate their Smart Cities proposals in India. This study also develops a dashboard Framework at all levels of governance. The primary objective of the dashboard is to create a Smart City Dashboard for the performance, visual sectoral analysis for the different categories of Stakeholders which enables decision making.

Keywords: Smart City, Smart Cities Mission, Structural Variables, Open - Source dashboard, Governance, Trends

1. Introduction

It has only been two years, which India has had a formal introduction to smart cities mission (SCM) which purposes to make 99 'smart cities' in the India by the year 2020, The SCM is one of the utmost known among the many other national

agendas of the BJP government. It is thought-out by set of goals, largely estimated investments, several private sector involvements, and a new governance framework for city development. As the Mission is about to be three-year-old in few months, now is an ideal time to study its implications on India's urban population.

This report would provide a trend in the infrastructure proposals for Smart Cities in India. A structured approach was taken for capturing the solutions-based project status for selected Smart Cities according to their category. The approach involved assessment of fundamental and critical data proposed within the Smart Cities Mission. The smart city proposals available on the MoHUA website for the selected cities were studied to understand and list the various projects aimed at both area-based development (ABD) and PAN-city area.

The trends will highlight investment challenges the cities have estimated, current infrastructure gaps, and fiscal tools that cities can essential consider reaching their local smart city objectives. Essential infrastructure—including transport has been given priority even after previous national missions already focused on the same, this research will focus on critically analysing sectoral priorities and estimated investments in these sectors

This research focuses on financial aspects of SCM proposals about the implementation challenges. This report has been prepared for providing a trend in the infrastructure proposals for Lighthouse Smart Cities in India. The document provides commonalities in the solutions-based update of twenty Lighthouse Smart Cities (Round 1 cities) under the following eight solutions. It will also look at India's top 20 selected cities and there funding structure, proposed convergence with other national initiatives.

A structured approach was taken for capturing the solutions-based project status for selected Lighthouse Smart Cities according to their category. The approach involved a detailed assessment of fundamental and critical data proposed within the Smart Cities Mission.

1.1 Understanding the concept of Smart city

Academicians and scholars internationally have reached some anomalies concerning the definitions of the conceptual cities and thus the research on this topic has reached foremost. The research paper was selected based on papers, which mainly looked at influences and actions of this conceptual cities. One of the significant focus was given to the concerns and the solutions identified in the article towards making an “ideal”

city which embraces the balance between smart and sustainability.

It is found that there are fifteen ideal cities as seeming from peer reviewed as shown in table below. It discusses the sectoral aspects of smart cities in the fundamental focus of support of each notional city. The detailed list of notional cities is in table 1 below.

Assigning classification to cities that suggest desirable outcomes has developed into a very complicated notion of the desired city. A literature review of the numerous opinions of imminent and required cities promoted under several tags recommends the future cities will have the prerequisite to be smart, sustainable, inclusive in every characteristic of economic, social and environmental well-being. This part of the study basically looks at scanning and analysing current literature of ideal cities and the smart component of these cities.

A detailed review of each notional city is not undertaken due to the scope of the paper. But it was found that a recent study by Shahid Khan, Atiq Uz Zaman, 2017, has taken a critical investigation of existing notions of cities with a strong focus on supporters of each concept with comparison along ten dimensions of sustainability. However, the thought of the city has been ever evolving with changing the importance on the principles, influences such as the economy, transport and eco-sensitive planning. Constructive notions have been promoted instead of prevalent and alleged implication, applicability with political influence.

As a result, it was seen that a major shift in the notions of Smart, Sustainable city took place in early 2000s. The exploration for the ultimate sustainable city form conceivably was the main agenda of most of the papers, while more recent papers focused reorienting the parameters of these city concepts and holistically merging them to form model cities like “Smart Sustainable city”. Many intellectuals tried the tactic of alteration by operationalizing the concepts of the city through setting down main indicators, under which the countenances of a city form could be categorized. Due to limited research on available on Inclusive, Eco-city and other few concepts, only three concepts “Smart, Sustainable, Smart Sustainable city” were used for finding essential limitations,

Table 1 Conceptual cities and its prevalent concept

Conceptual cities	No of papers based on the concept	Year of origin and subsequent published journal in order of published	Prevalent Concept
Compact city	3	1997,2006,2015	Sustainable city
Creative City	2	2009,2010	Smart City
Eco-city	4	2005,2006,2007,2010	Sustainable city
Global City	2	2000,2007	Smart city
Inclusive cities	2	2006.2008	New concept with special social notion
Livable City	2	1997,2000,2007	New concept with special Livability notion
Resilient City	3	2004,2013,2013	Sustainable city
Sustainable cities	6*	Prevalent concept across years	
Smart City	6*	Prevalent concept across years	
Smart Sustainable City	4	New concept of city	Smart and Sustainable
Zero Waste City	3	2013,2015,2016	New concept developed with self-sufficiency notion
Ambient City	-	-	Sustainable cities
Sentient city	-	-	Sustainable cities
Ubiquitous city	-	-	Sustainable cities
Green city			Eco-city

uncertainties, and fallacies about existing smart city proposals in India.

This section of the research inspects the several tags cast-off to categorize municipalities and similarities that each tag tends to highlight. In the summarized table below, it is seen that new concepts have emerged during a change in political agendas or change in government. Intense research needs to be done on this fact of how political agendas drive the concepts of cities to its implementation plans for the country. It also briefly classifies the familiar idea of the new tags city copes to be a label that to pursue swayed aspects of sustainability. It then scopes down the conceptual tags for the city to scrutinize few concepts prevalent concepts.

The concept of compact city recommended that compact cities are promising regarding using less energy and transportation for the highest level of leisure-time and least level of transit time. Whereas, authors of creative city concept suggested interrelation amongst creative industry policies and impact of affordable housing, public space, and social investments. It seemed more in connection to inclusive city principles and seemed

a modified city concept of the inclusive city with creative urban regeneration processes. Ecocity concept has also picked up recently as a buzz word for greenfield developed cities with prominence on the sustainable design in framework on eco-friendly astral project and green as main additions to the principles of sustainable city concept. Global, livable city concept was new models and depiction of distinct scale with specific attention to changing city policies with the changing political geography. Zero waste, Resilient city, and sentient city were prevalent concepts of the sustainable city with very little change in principles and had principles of interrelating between consumption and energy use in cities.

The definitions of smart, sustainable and smart sustainable city had the highest number of publications, and the contrast in the definitions was a possible further analysis to arrive at definitive definitions of these three concept cities. Hence, the paper analyses these three concepts into furthest, to arrive at better understanding of the most cited concepts. The table 2 below highlights the influential papers, which scrutinizes the conceptual understanding of these concepts and the analysis is based on these papers.

2. Method and Materials

As the world rapidly urbanises, it is imperative to move cities towards greater livelihood in the cities. Urban infrastructures: their design, planning, construction and maintenance are the key to achieving urban sustainability, and in India, these are fundamentally shaped by public programs. This current study seeks to analyse the trends of Smart Cities Mission, one of the most extensive flagship urban programs of Independent India.

2.1 Objectives

The study aims to undertake an empirical analysis of the trends in of Smart Cities Mission, the most significant chunk of public sector funding yet to be channeled into urban India. The focus of this study is on critically reviewing smart city proposals. The study sought to ask three critical questions of SCM:

- a. Critical Analysis of the Infrastructure investment proposals of SCM
- b. To question the “process of project prioritizing and convergence by each city” and funding allocated to them
- c. To what extent have smart city proposals have been influenced by demographic and geographical variables

The third question has two parts to it: an examination of all rounds of Smart City plans to assess whether and to what extent trends are visible with structural (City area, City population etc) factors and if there are any correlations existing within these parameters and SCP documents.

Second, this involved examining in a specific round 1 which are the twenty lighthouse cities, through a sectoral segregation study, whether the city sectors are in correlations previous national mission sectors city have focused on. Also, if these sectoral segregations have any implementation challenges related to them. As stated in the proposal, it is clear that it would be difficult to arrive at detailed findings unless an extensive review of what sectoral components actually form a smart city. Hence the first preliminary objective was to do a detailed review what constitutes a smart city in India and a pilot a methodology for the sectoral segregation is the outcome.

The results of the study based on the review of the programmes, the CDPs and fieldwork illustrate how issues of funding structure cities have adopted into Smart Cities Mission at different levels. Based on these findings, the study has put forward a set of draft recommendations that can ensure that investments in next phase of Smart Cities Mission can be directed towards financial sustainability. This study also creates a Smart City Dashboard framework for the performance, visual sectoral analysis for the different categories of Stakeholders which enables decision making. Developed dashboard have been attached in the Annexure 1.

2.2 Research Methodology

A detailed analytical framework and methodology was followed to fulfil the above objectives. Table 4 below reports on the extensive methodology adopted for each objective of the directed research proposal with key outcomes at all levels of the research. The table also highlights the key sub tasks and approaches taken at each stage of objective for making the rationale clear for the study. Due to variability in the details of the proposals across all the selected cities. The proposals documents were classified into both the details and the classified city size classes as shown in the tables below.

Table 2 Types of proposals

Types of proposals	No of cities
Detailed	20
Medium	52
Very low	15
Not provided/corrupt	11

Table 3 Classified Population

City Category	Classified Population classes
1	1,00,000-10,00,000
2	10,00,000-30,00,000
3	30,00,000-50,00,000
4	>50,00,000

Table 4 Extensive methodology adopted for each objective of the directed research proposal with key outcomes at all levels of the research

Objectives	Sub tasks	Approach	Outcomes
1. Critical Analysis of the Infrastructure investment proposals of SCM	Review of the smart cities mission statement Literature Review of the past missions	Remodified Class Ranges Create rationale for the study to find patterns in the Investments	Database for all selected available Cities from approved Smart city plans and Detailed project report
2. Review of available data for Smart Cities Proposals by Empirical database with trends in Population vs investment, Area vs Investment	Examination of a selected sets of trends like Linear, exponential or polynomial degree of relationships within the smart City plans to assess whether they are following an trend	Discussions with key stakeholders Develop and pilot a methodology for the analysis for further enhancing the analysis of large dataset with correlations	A dashboard which can help decision making in smart city proposals
3. To what extent different sectoral investments have been considered in the smart city proposals across the smart cities in round 1 and 2	To identify categorically which cities are trying to focus on which sectors Also, analysis of the funding structure cities has proposed in there smart city proposals	A set of process recommendations have been formulated in this report to increase the implementation rate of national programmes like Smart Cities mission.	A set of draft recommendations that can ensure that investments in next phase of Smart Cities Mission

2.3 Limitations

One crucial limitation of this academic work is that the Smart Cities mission is in a very nascent stage and has started only a two and a half year ago. There are various types of SCPs documents and all are not in the same format, table 4 above shows the various types of documents available on the ministry website (Ministry of Urban Development, 2015). The implementation of the proposed projects has not yet fully commenced and some of the cities are in the process of selecting the technical experts and other key personnel for implementing the projects. This means that there is limited knowledge or information on some of the projects in this study, such as –, financial supervision, percentage implementation of the projects and political representation. This study also does not consider the facets of urban local governance and institutional capacities in relation to the Smart Cities mission in India. Thus, this research would primarily look into the face values of the data provided in the SCP documents, which Government of India have used to select the cities. All the data used in this research is available in public domain. After scrutinizing all the proposals 88 out of 99 selected cities have been considered for this study. Eleven cities as shown in the table 4 could not be considered due to either corrupt data or the proposal documents of these cities has not been provided. The eleven cities which are not part of this study include New town kolkata, Naya Raipur, Moradabad, Chandigarh, Itanagar, Dahod, Aligarh, Agra, Namchi, Jalandhar and Diu.

2.4 Research structure

The data analysis had two objectives. First, when the descriptive statistics were analysed, the goal was dual: i) to identify Smart City initiatives all over the world; ii) to detect commonalities and differences in the patterns of Smart City trends across all the selected cities in India.

The second step of the empirical study involved a more wide-ranging analysis on how the structural factors such as city size and the predicted investments could influence the different dimensions of the smart city. This was done through various software and a regression analysis on these parameters were applied.

Thirdly, the research considered sectoral segregation and analysed the sectoral priorities

and its correlations to demographic variables. Lastly, it also analyses vital ICT component in each sector prioritised in cities proposals. As another deliverable, this study also develops a dashboard Framework at all levels of governance for enabling decision making.

3. Results and Findings

3.1 Smart cities mission India

Just like the previous national initiatives, India's "Smart Cities Mission" main aim is to accelerate the core infrastructure improvements in the cities by providing a decent quality of life to citizens, offer a clean and sustainable environment, and readily apply "smart" solutions. With an "area-based" growth tactic, this inventiveness varies markedly from preceding initiatives, which inclined to trail a project-based change method. The figure 1 below shows the components of smart city government of India envisions for smart city in India.

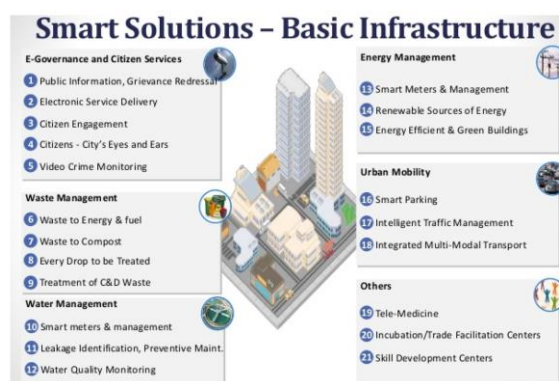


Figure 1 Components of Smart City Source: Government of India, 2015

Indeed, the scope of India's Smart Cities effort is quite striving. Its preliminary five-year plan from 2014-2015 to 2019-2020 with a total budget of INR 48,000 crore. The central administration plans to invest INR 500 crore per city during these five years, and state governments, ULBs, and private investors are expected to raise the other matching amount. The creativity of the method is to create new business incentives, pushing state and local governments to generate innovative funding resources and also entice additional private investment for long-term sustenance of these infrastructure projects.

3.2 Smart city proposal analysis

Three central areas of intervention for the cities under this mission are:

- Area-based development by retrofitting an existing area of 500 acres in the town or by redeveloping a field of 50 acres by improving the level of infrastructure and essential services.
- New city areas or Greenfield development of more than 250 acres using innovative planning, plan to finance and plan implementation tools (e.g. land pooling/ land reconstitution) with provision for affordable housing.

Table 5 SCP document parameters

- Pan-city development with application of selected smart solutions to the existing city-wide infrastructure, like traffic and transportation systems (Government of India, 2015b).

The table 7 below highlights the data available in the smart city proposal and annexure document with the sectoral segregation done via analyzing the smart city data and the variables used to make the Dashboard.

SCP data	Analyzed data from SCP	Comparators variables
Population Growth Rate	Beneficiary Population (Lakhs)	Access to banking facilities
Slum Population (%)	SCM Investment Water	Swatchh Bharat Ranking
Total Area (sq. km)	SCM Investment Waste Water	GOI Funding under SCM
Density of population (person per sq. km)*	SCM Investment Solid Waste	GOS Funding
Total investment for Pan city	SCM Investment Transportation	ULB Funding
Total Investment For ABD	SCM Investment power	PPP Mode
Total Estimated investment	SCM Investment ICT	AMRUT
% of investment in Area based	SCM Investment Heritage	PMAY
% of investment in Pan city	SCM Investment Affordable Housing	SBM
ABD Area (Sq. Km)	SCM Investment Future Proofing	SGMMSYY
ABD Area (acres)	SCM Investment others	Municipality Surplus
Area of ABD Proposal as % of Total Area	Per Capita Income Of ULBs	Total Payback and Revenue

3.3 Financing Smart cities

As per the guidelines, the objective of the mission “is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of ‘Smart’ Solutions....It is meant to set examples that can be replicated both within and outside the Smart City, catalysing the creation of similar Smart Cities in various regions and parts of the country” (Government of India, 2015: 5). Its preliminary five-year plan from 2014-2015 to 2019-2020 with a total budget of INR 48,000 crore. The central administration plans to invest INR 500 crore per city during these five years, and state governments, ULBs, and private investors are expected to raise the other matching amount. But then this investment from the national

government is just 20 percent of the total funding cities have predicted. The rest of 80 percent is foreseen to be subsidized by the private sector (Balachandran, 2016). The methodology involved looking at following national missions like--- JNNURM, SBM, HRIDAY and RAY. From the city perspective and analysing the amount funding convergent in each of these missions. A sample of how this segregation was done is shown in the table 8 below. The figure 2 - shows the predicted funding segregation for top twenty cities. It shows that cities are over reliant on private funding and on the also cities have predicted vast amount of resources will generated through their own resources. A detailed analysis according to the tier of the city and its funding structure is in the third chapter of this report.

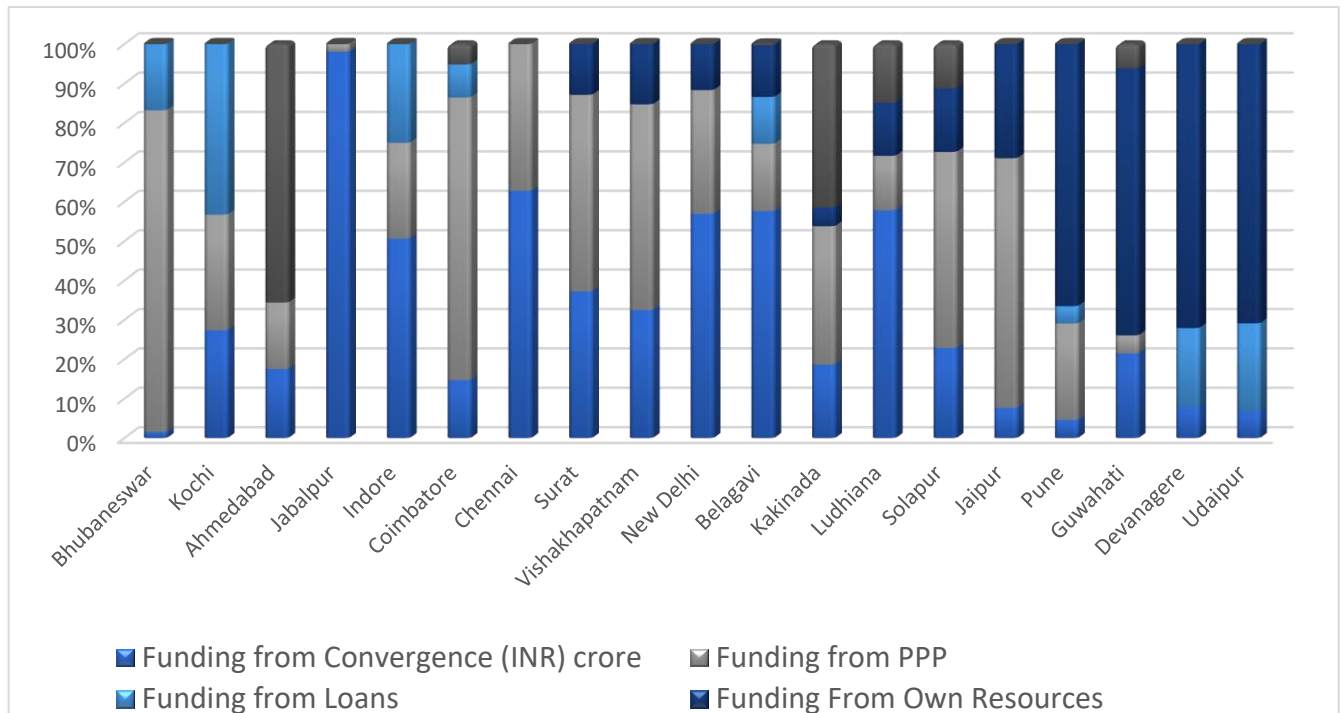


Figure 2 Funding from Convergence, PPP, Loans, Own resources, Other sources

3.4 Parameters for sectoral analysis of smart cities

This section describes the preliminary sectoral analysis according to the literature review described in the 1st chapter of this report. It develops a difference between smart and sustainable city parameters. As the last objective of this part of the paper was to understand the development of the smart cities and its agenda was closely interrelated to the global concept of the smart city.

Most of the articles highlighted the uncertainty and contestation of urban development policy address the challenges of Indian cities. As it currently stands, the uncertain concept of the smart city's perception has allowed political and economic elites to skillfully sell the unworkable campaign promising of building 100 new cities, to a theoretically more valued (but still confronted) smart city mission (SCM) that could be far more actionable.

Though the mission envisions greater citizen participation in smart city concept, the SCM focuses too much attention too neoliberal philosophies risking Indian cities expansion on the corporate urbanism and overseeing the essential obligation to restructure its unsuccessfully decentralized system of governance. Moreover, the current selected smart city plans are not attending to both market and societies; it is unlikely smart cities will bring equitable growth and could additionally peril be expanding only the economic elite societies. Therefore, the problems of fairness, reasonableness, and sustainability are essential in taking the SCM forward. For example, the studied smart city plan of Bhuvneshwar has allocated 90% of total funds to 5.5% population of the city. And the rest 10% funding is for the pan-city allocation.

If these plans are then mapped with previously explained concerns for sustainability along dimensions, the findings of the study demonstrate that labels of desired city outcomes are without considering the sufficient breadth of the sustainability spectrum. Similarly, in cumulative terms for a smart city the various smart city plans of 24 x 7 electric supply and water supply, these points out the concerns of enabling levels of smart concepts in the plans. The pilot smart city and sustainability assessment frameworks also highlighted that Indian cities completely misses the smart governance and data analytics in comparison to most of the smart cities abroad, as smart data is a base towards opening up smart planning techniques (Ahvenniemi, Huovila, Pinto-Seppä, and Airaksinen, 2017).

The findings also point out that while Indian smart cities severely highlight social and economic aspects of cities more related to urban sustainable frameworks, they also tend to be missing in their focus on environmental indicators.

4 Discussion and Conclusion

A significant number of aspects can impact the estimated investments cities have made to being selected in smart cities mission of India. In this

section of the paper, we indicate and analyze estimated investments cities have made across the round and also if the estimated investments are correlated to parameters like its city size and population. It also discussed the correlations with aspects like investment per capita, with the focus on city size and demographic density. It also highlights the need and importance of considering these factors, for achieving the expected outcomes for the development of Smart Cities across India.

4.1 Smart Cities Trends across all the rounds

The 99 cities under the SCM have proposed a significant budget of Rs 2,01,979 crore, sourced through relatively outdated and relatively eccentric financial mechanisms (Taraporevala, 2017). This research has analyzed the finances of the top 99 cities and found that a little over 80% (over 1,63,199 crores) of the funding is directed towards 'area-based developments,' which focus on upgrading small part of the city (a little over 4%) of a total area of the cities. The remainder of the funds of 387,79 crores is directed towards 'pan-city' projects that impact a grander geographic scale of the city.

Table 6 Smart City analysis

Rounds	No of cities	Total Population to be Affected	Average Population to be impacted per 1 crore spent
All	99	99486840	493
Round1	20	37308257	776
Round2	27	25506844	473
Round3	30	23683030	413
Round4	9	3531794	275
Fast track	13	9456915	317

4.2 ABD vs PAN estimated investment across all the rounds

In the below figure 3 aggregate investments across the selected cities in the rounds. The percentage investment in area-based developments is increasing, where the opposite trend can be seen in the percentage pan city investment. There was a negative relationship in the average number of populations to be impacted with selected cities across the rounds. Figure 4 below shows the negative trendline for the impacted population across the rounds in smart cities mission.

A significant number of aspects can impact the estimated investments cities have made to being selected in smart cities mission of India. For the better analysis in the further sections' population were classified in to classes for indicating and analyzing if the estimated investments in these classes are co-related to parameters like its city size and population

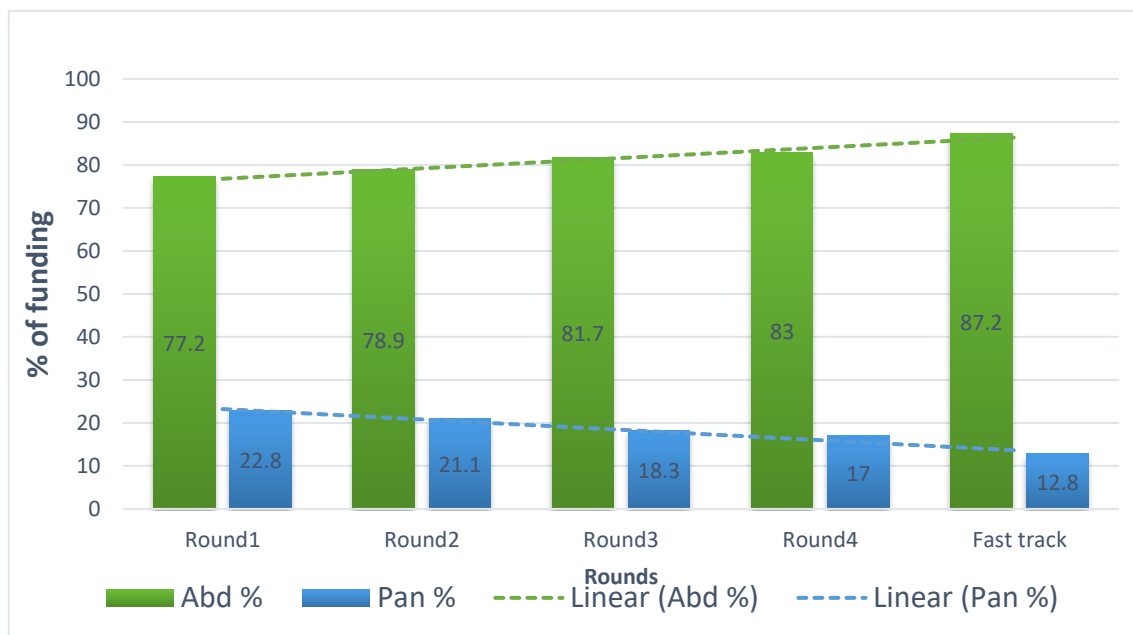


Figure 3 % Proposed Funding across the selected cities in the rounds

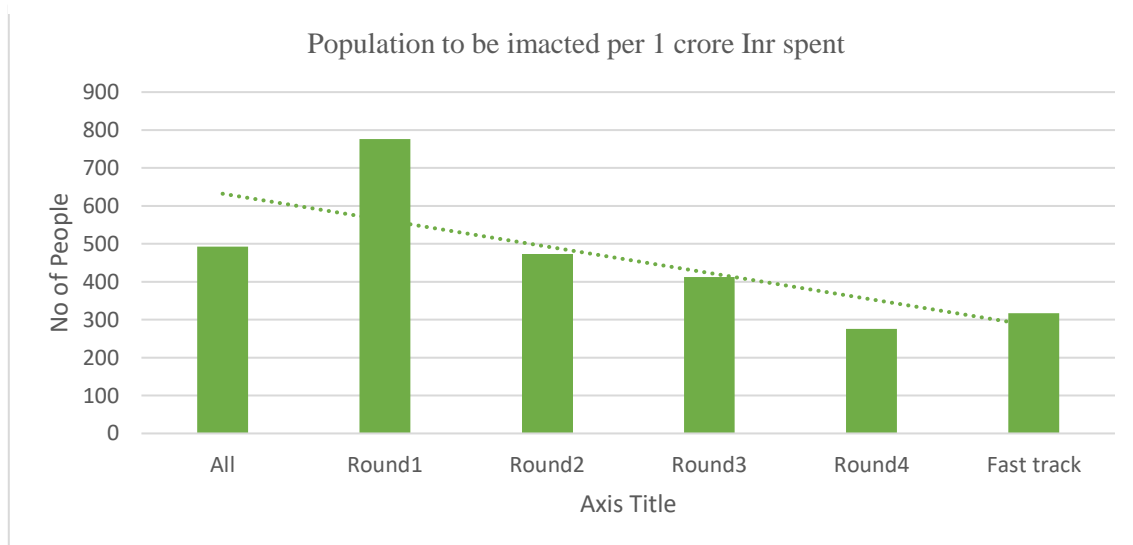


Figure 4 Planned population across the rounds in smart cities mission to be impacted by proposed investments

4.3 Structural factors: size and demographic density

4.3.1 City Size

Despite expectations, city area is not in correlation to the estimated investments. This can be because of the breadth of the diversity in terms of selected cities across all rounds. Cities have predicted an average investment of about 2078 crores. There is a 3rd degree power relationship for City size and Estimated investment

City Category	Avg Total Estimated (Cr / Km2)
1	38
2	14
3	7
4	4

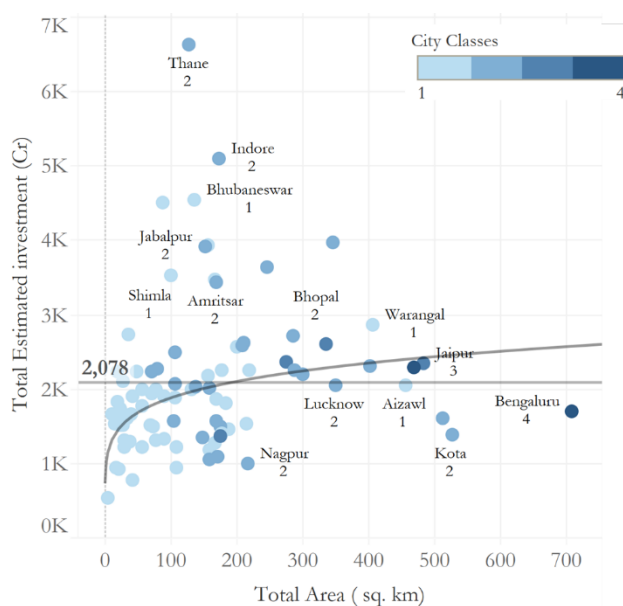


Figure 5 Total Estimated investment vs Total Area

City population with correlation to the estimated investments by the cities does not seem to be significant factor for the smart city investments by the selected cities in India. The below figure 6 suggest a possible positive polynomial relationship between population 1 to 2 million

category and then the relationship is negative in nature with the a very low p-value. On average cities are investing 2070 Cr Inr and the population class 2 seems to have the maximum number of standard deviations from these values. We will later look at the Urban demographic density instead showing a significantly positive effect on the estimated investments by the cities.

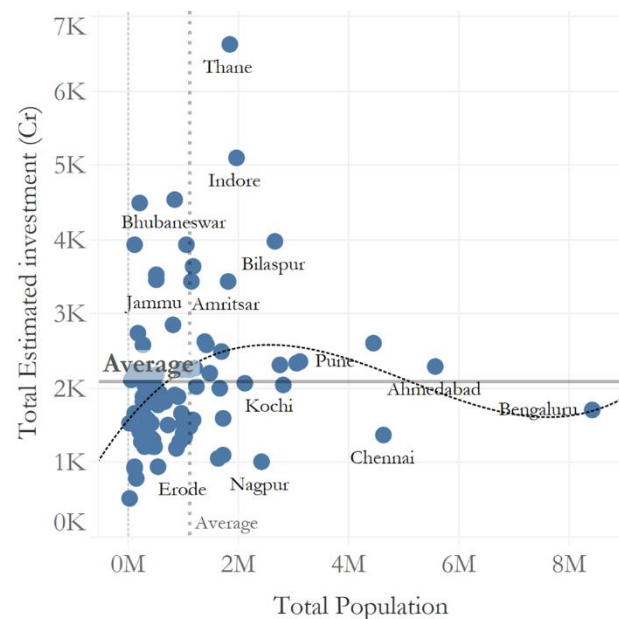


Figure 6 City population vs Total Estimated Investment

4.3.2 Total Investment per Capita vs Total Area

In the co-relation of total estimated investment per capita and total area, there was a vital difference between the highest investment per capita which is Pasighat and least which is Bengaluru. It had a significant power relationship with an high r-squared value. This can be because of the breadth of the diversity in terms of selected cities across all rounds. On average, cities are planning to invest 60,000 Cr Inr per capita.

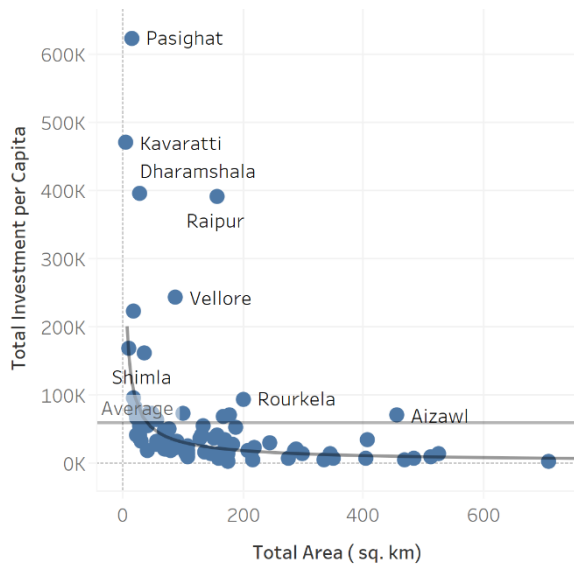


Figure 7 Total Investment per Capita vs Total Area

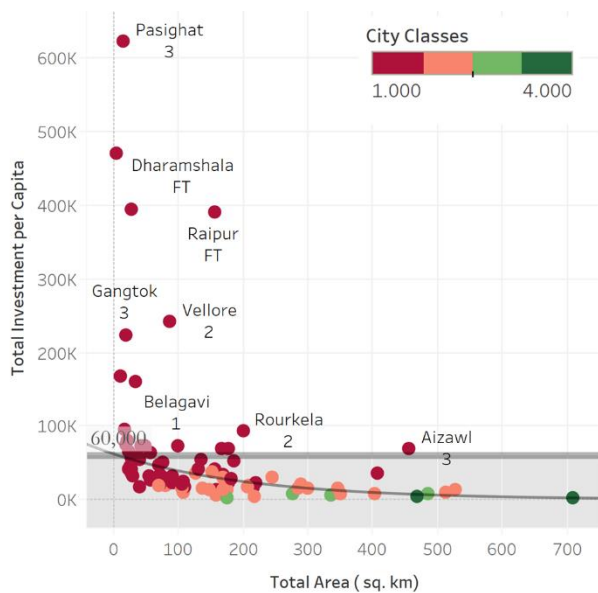


Figure 8 Total Investment per Capita vs Total Area for classified classes

Table 7 Average Total Estimated Investment per capita in classified classes

City	Classified classes	Investment per capita (Cr) - Average
1	1,00,000-10,00,000	88,028
2	10,00,000-30,00,000	16,768
3	30,00,000-50,00,000	6,000
4	>50,00,000	3,050

4.3.3 ABD Area vs Total City Area

This section looks at correlations of total estimated ABD area development and total city area. On average cities are looking at an area of 4.91 Km².

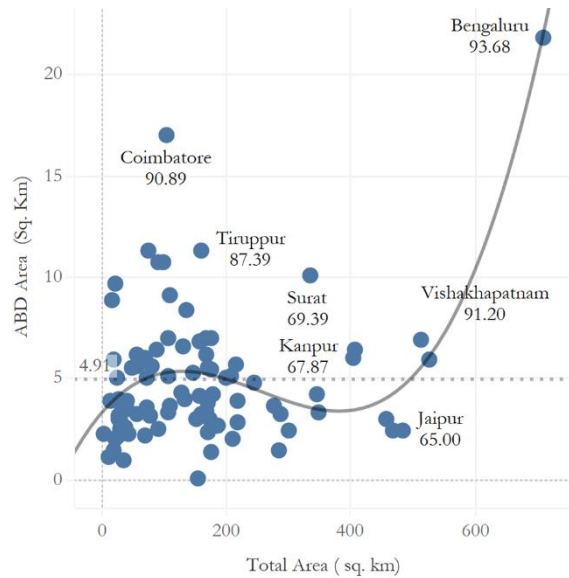


Figure 10 Total Estimated investment vs Total Area

Table 8 Average Total Estimated Investment in Cr/Km²

Category	City Area Categories	No	% Average Investment in ABD
Very small	Under 50	22	80
Small	50 - 99	14	77.808
Medium	100 - 199	30	81.9
Large	200 - 299	10	79.804
Very Large	300 Above	12	75

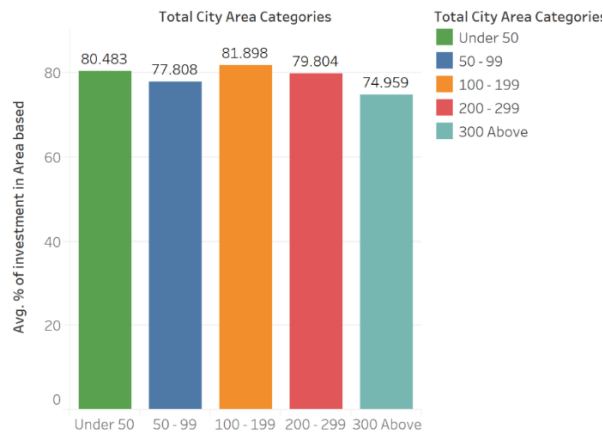


Figure 9 Average % investment in Area based vs City Category

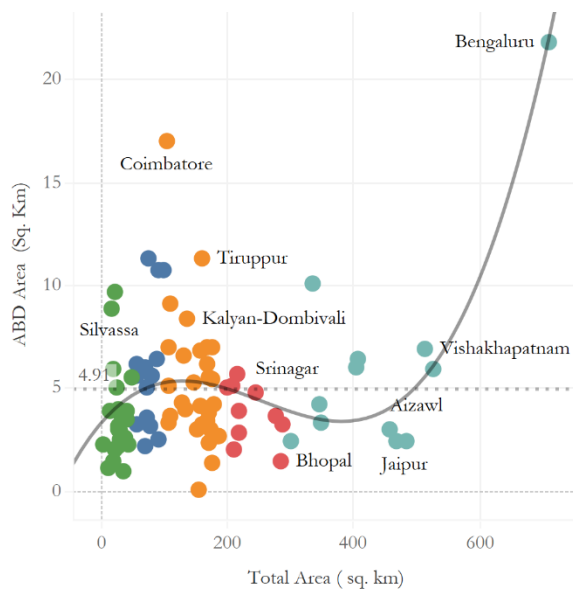


Figure 10 Correlation of Total Area vs ABD area according to classified classes

4.3.4 ABD area vs Density of population

In the co-relation of density of population and ABD area, there was a positive but not significant relationship. The city of Bengaluru is having the highest ABD area and city of Raipur having the least. Average density of population to be affected is 7600 per/km². It has a very low r-squared value.

On average cities are looking at investing 80% of their funding in ABD. While, its comparison to ABD area cities have proposed to develop, cities are on average investing this 80 % of their funding in 4.9km² of an area. If we take a total of area all the 99 smart cities ABD area, it is going to affect 431km² of area.

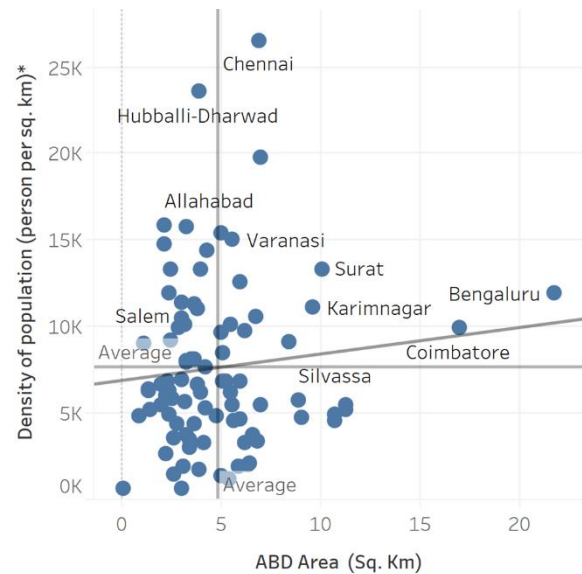


Figure 11 Total Investment per Capita vs Total Area

4.3.5 ABD Area vs Total Estimated Investment for ABD

In the co-relation of total estimated investment and ABD area, there was a negative but not significant relationship. The city of Thane is having the highest ABD investment going in just 22km² of an area and city of Panji having the least. Average investment in ABD area is found to be 1662 crore INR. In the parameters of % of estimated investment in Area based Development, there is a very diverse result. There are smaller cities like Port Blair, which are investing 99% of their funding in ABD and larger Municipalities like New Delhi which are investing only 35% in ABD.

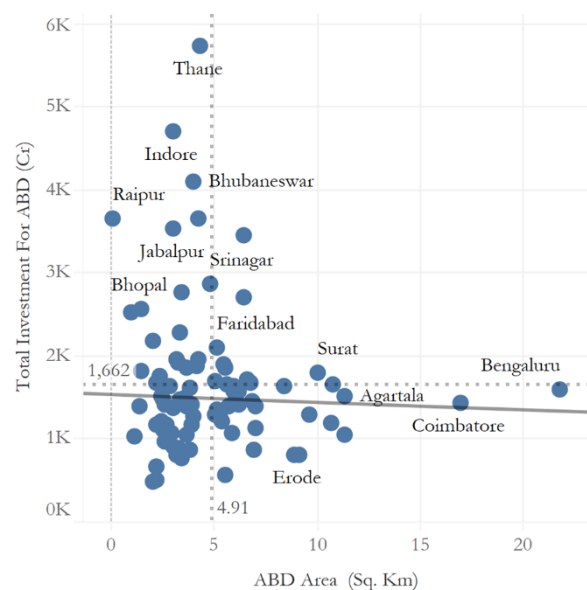


Figure 12 Total Investment per Capita vs Total Area

4.4 Sectoral Analysis

This section of the report looked at sectoral analysis for top twenty selected cities by segregating the investments in the following sectors. It was seen that the maximum amount investment was estimated to be in the transport sector. ICT and power were given second and third priority, roughly 20 percent of total funding was going in these two sectors. The next priority was water and future proofing sector. The sector

given the least priority was solid waste. The figure 13 below shows the % of total investment. It was also seen that when cities have predicted to invest in sectors like Affordable housing, most of this funding is going in one sector and thus the other sectors are almost of least priority. The figure below also shows that the sectors like future proofing, Affordable housing, Solid waste and Waste water have the least percentage investment of the total investment.

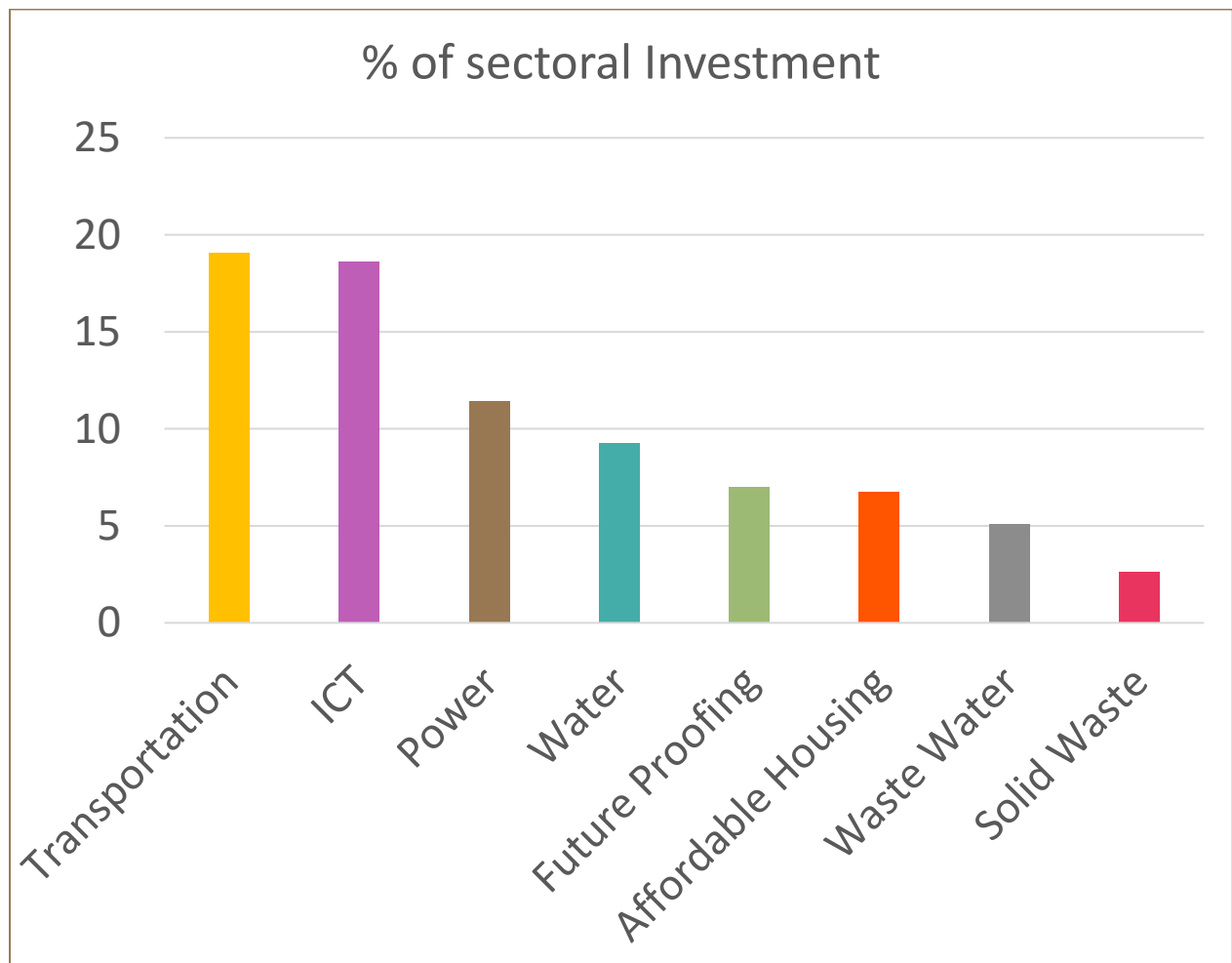


Figure 13 % of sectoral investment

5 Conclusion

This working paper can be well-thought-out a primary influence on the progress of empirical research for 99 Indian Smart Cities in a direction to attain an improved understanding of the current singularities of smart city investment trends in India. To this end, eight main sectors associated with Smart Cities in India have been deployed for

a better classification. An empirical data of structural and sectoral variables has been collected and analyzed to comprehend the relationships amid physical, municipal, demographical, sectoral and ICT sector. The same study can be done for environmental and agro-climatic related variables, and its relations and

trends on smart city proposals can be identified as a way forward.

One of the first results of this research has revealed that there are no dominant trends between the 99 selected smart cities in India. Neither, the global definition of Smart city is applicable in India, nor the current inclinations and progress patterns of any individual Smart City estimated investment be contingent to any extent of structural or sectoral classification. City policy-makers are consequently advised to attempt to realize these trends and use some analytical tool to inspect the appropriate plans for smart cities in India.

This study also develops a dashboard Framework at all levels of governance and has been attached in Annexure 2 and 3. The primary objective of the dashboard is to create a Smart City Dashboard for the performance, visual sectoral analysis for the different categories of Stakeholders which enables decision making. It also relates to the implementation and service data and presents it in a consistent and structured format with parameters like % investment in Pan city vs Implementation ranking. This research provides policy-makers and city-managers with valuable strategies to define and initiate their Smart Cities proposals in India.

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Annexure 1

Transportation Investment (Crores)

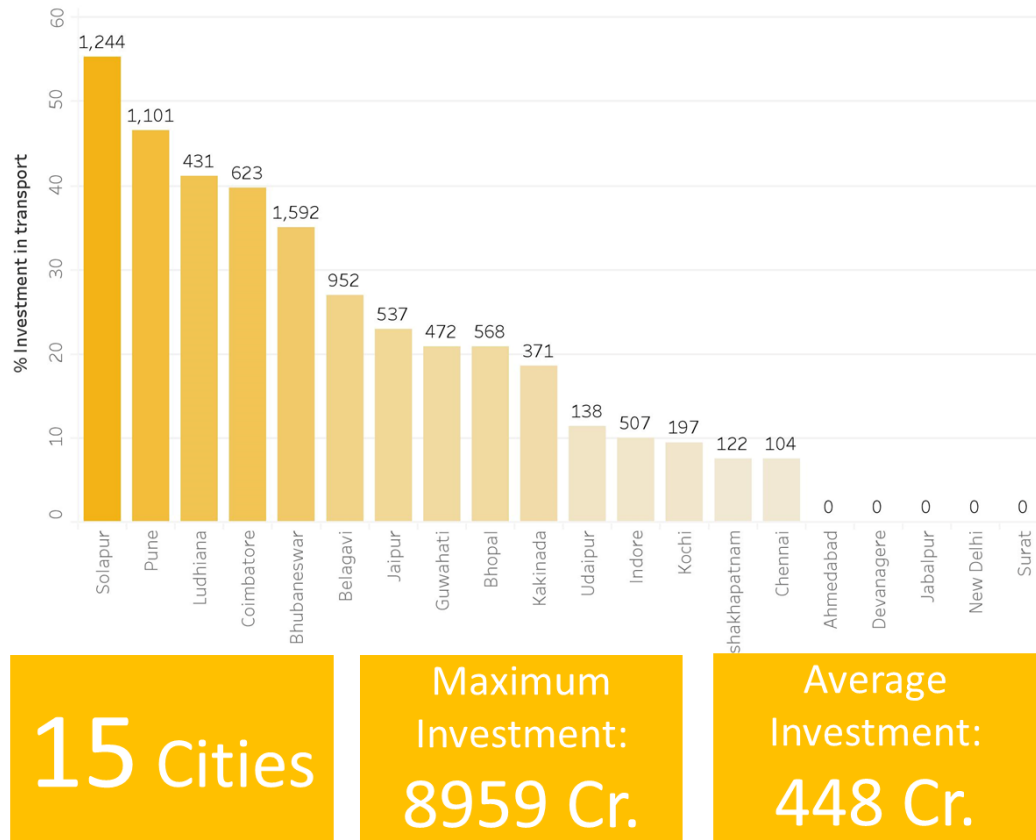


Figure 14 % Transportation Investment



Figure 15 % ICT investment

Power sector(Crores)

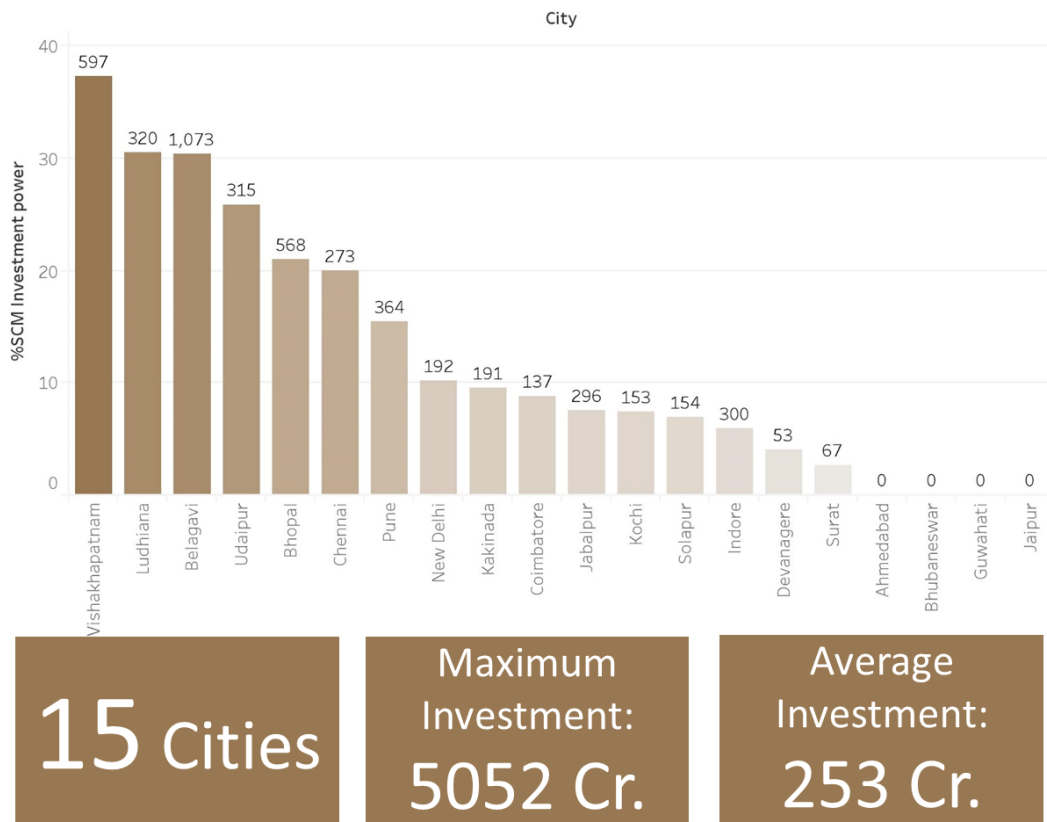


Figure 16 Investment in Power

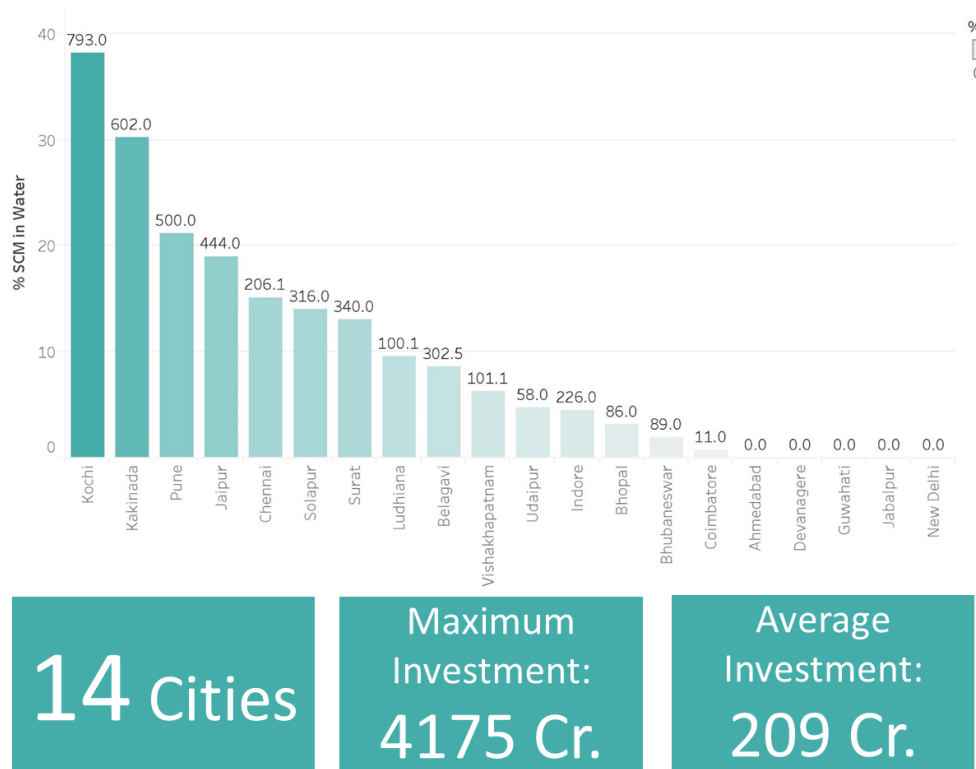
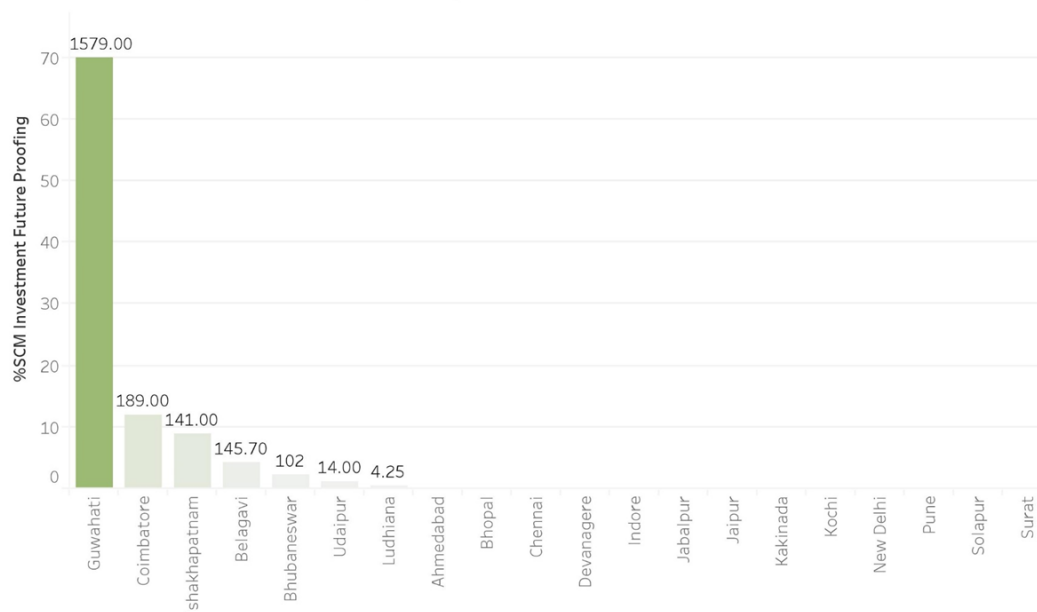


Figure 17 % investment in Water sector

Future Proofing Investment(Crores)

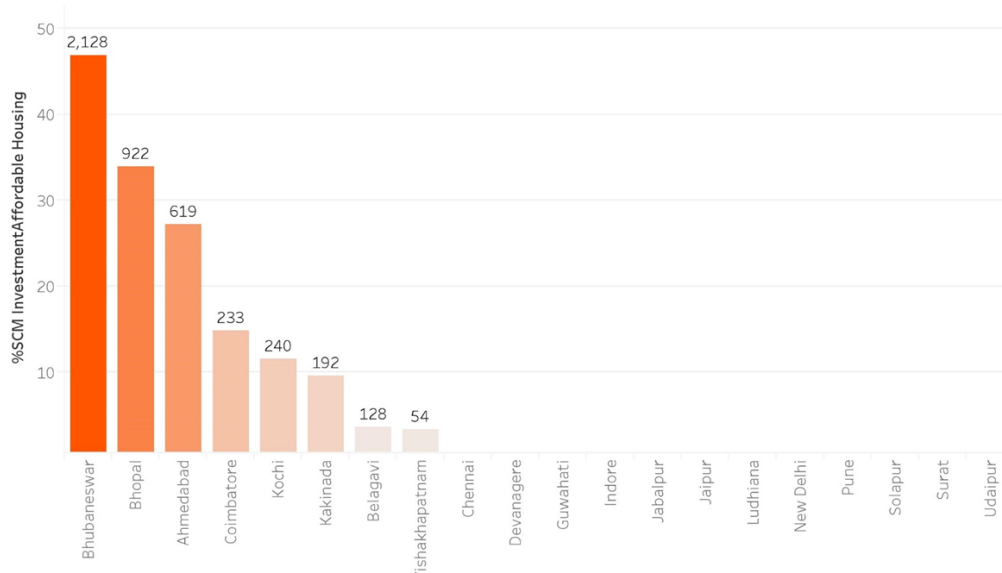


7 Cities

Maximum
Investment:
98 Cr.

Average
Investment:
5 Cr.

Figure 18 - % investment in Future proofing sector



8 Cities

Maximum
Investment:
4156 Cr.

Average
Investment:
226 Cr.

Figure 19 - % investment in Affordable housing sector

% Waste water investment(crores)

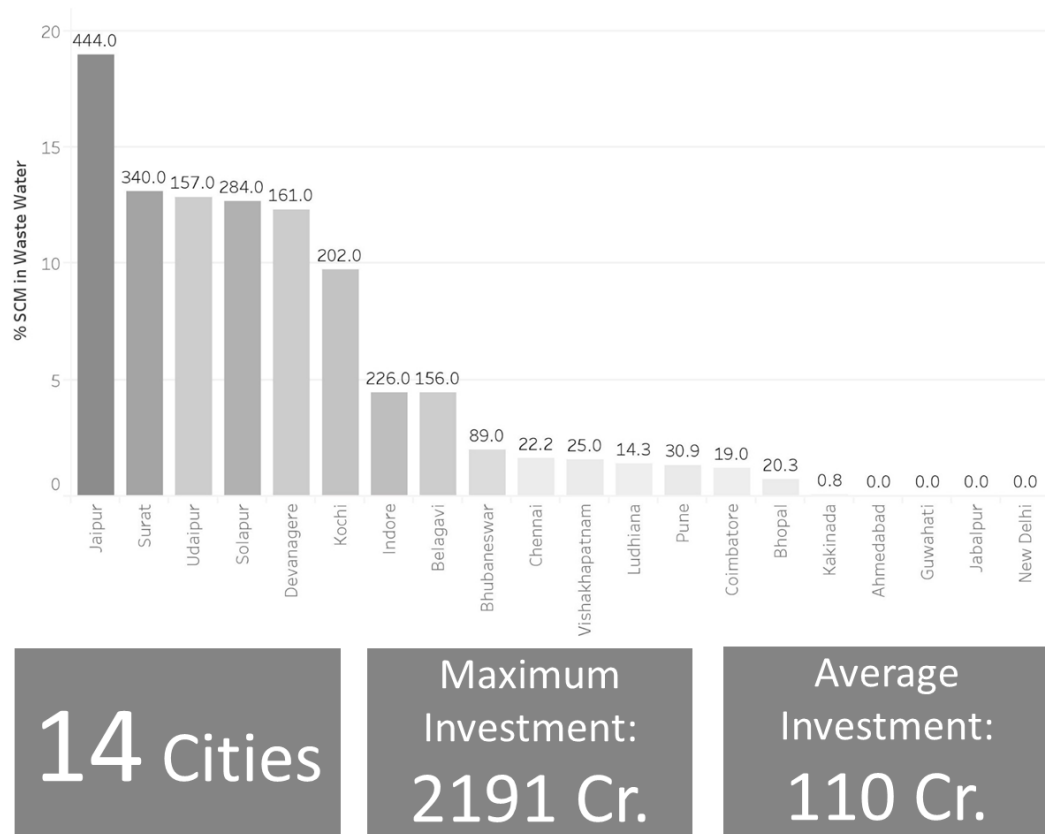


Figure 20 % investment in Waste Water sector

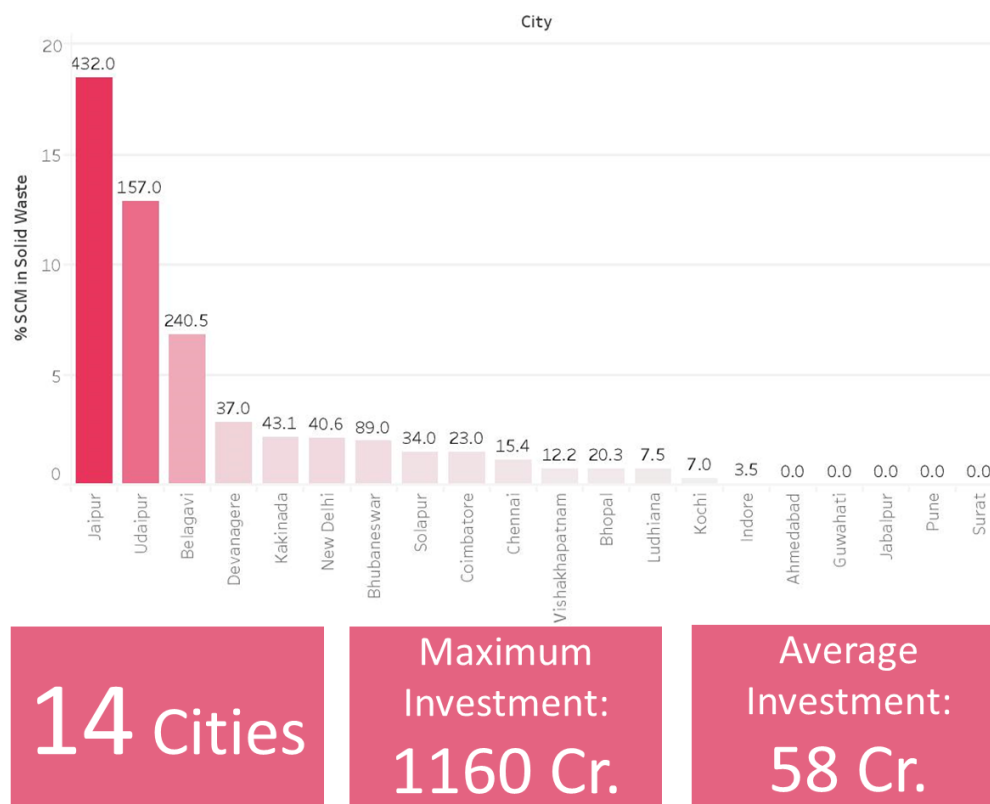
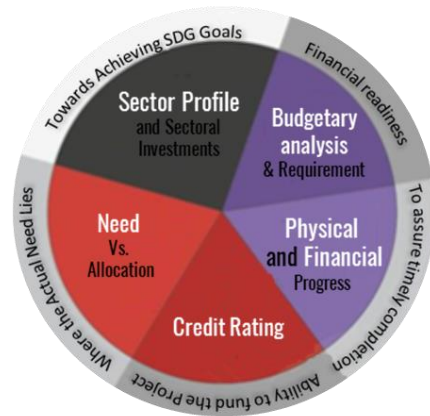


Figure 21 % investment in Solid Waste sector

Annexure 2 :- Dashboard Framework at different level of governance

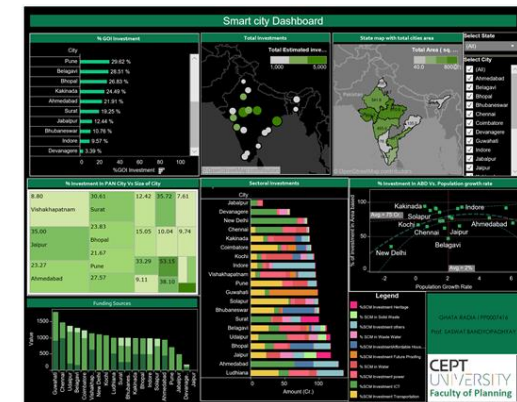


Central level Monitoring Framework

“Creating a Smart City Dashboard for the performance, visual sectoral analysis for the different categories of Stakeholders”



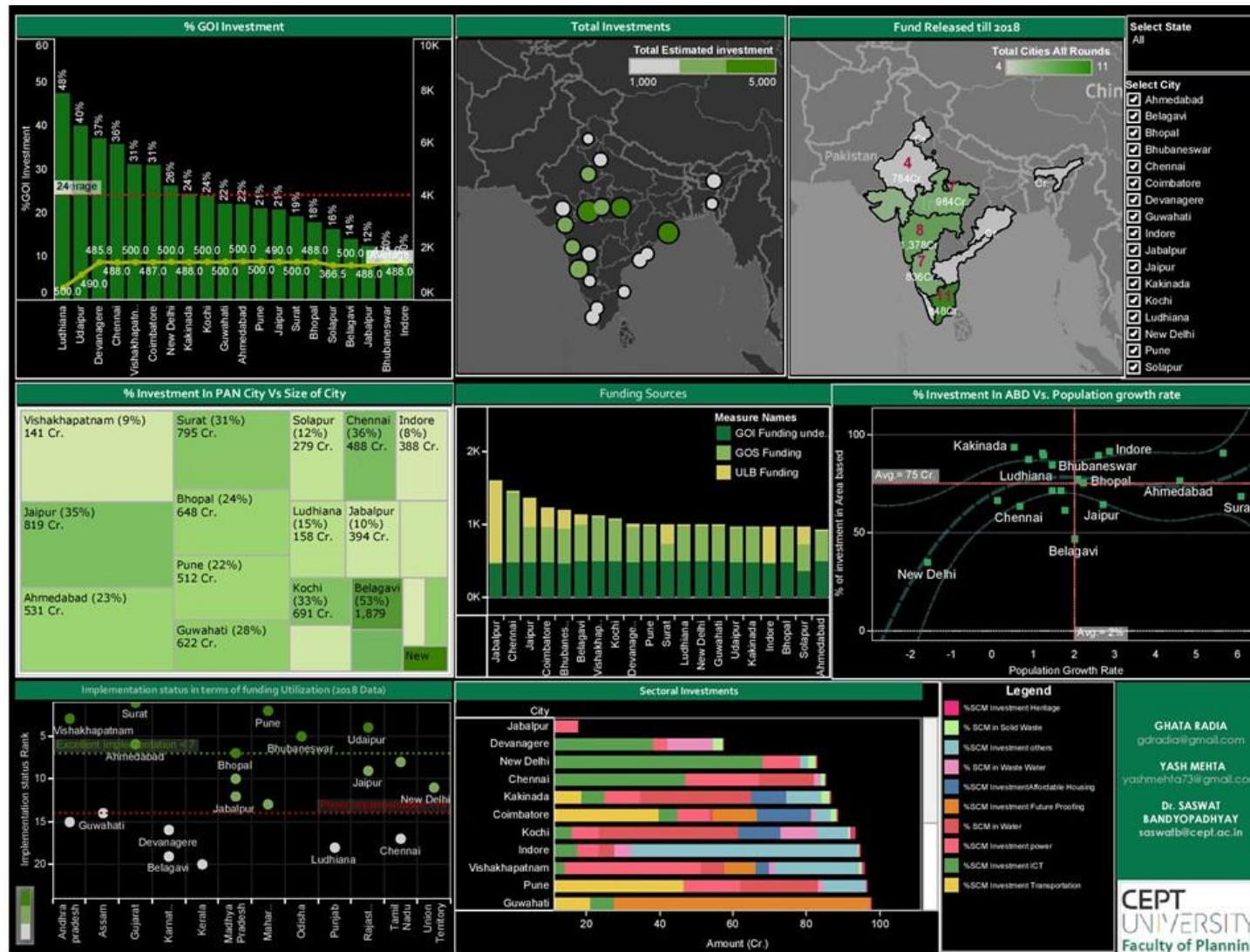
State level Monitoring Framework

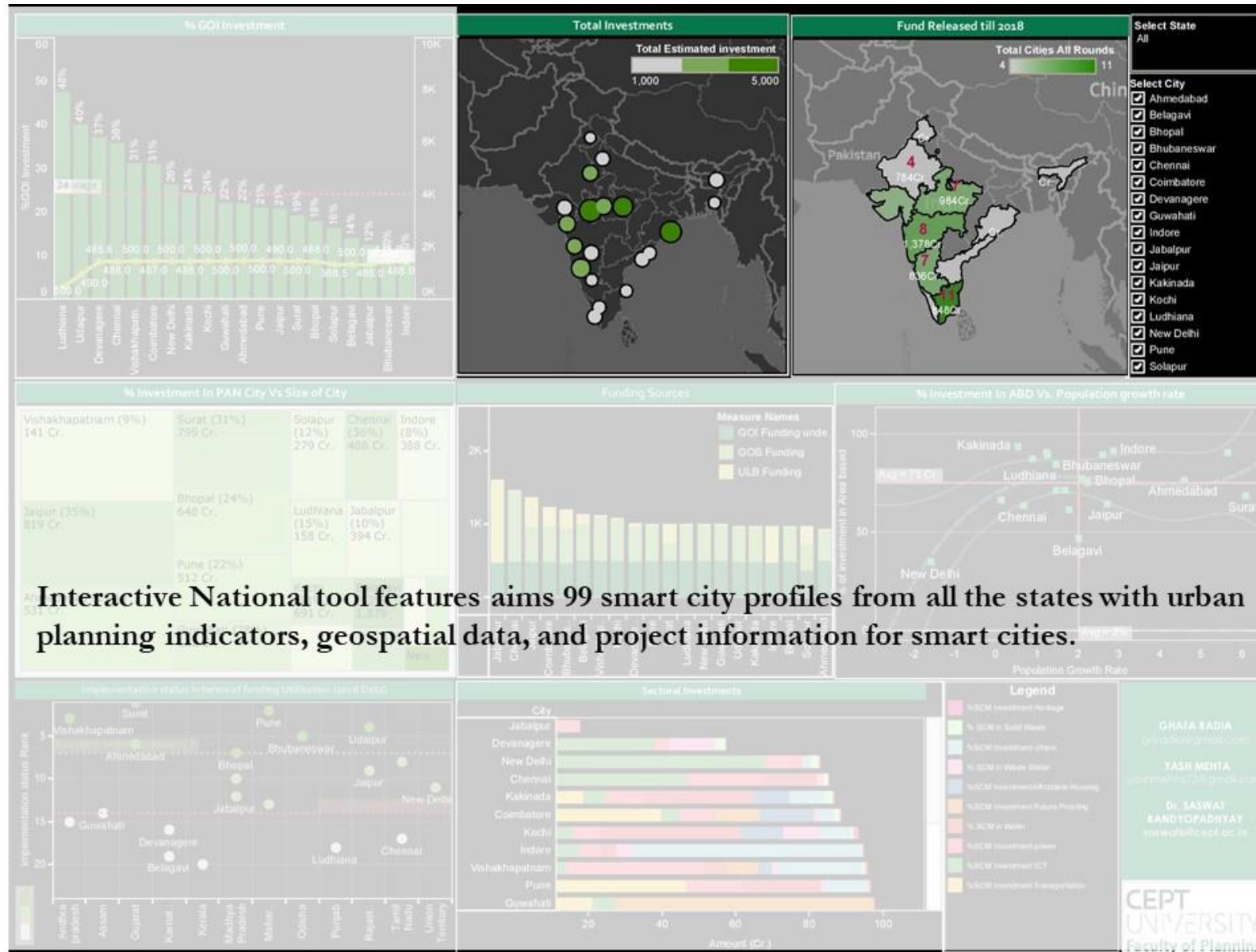


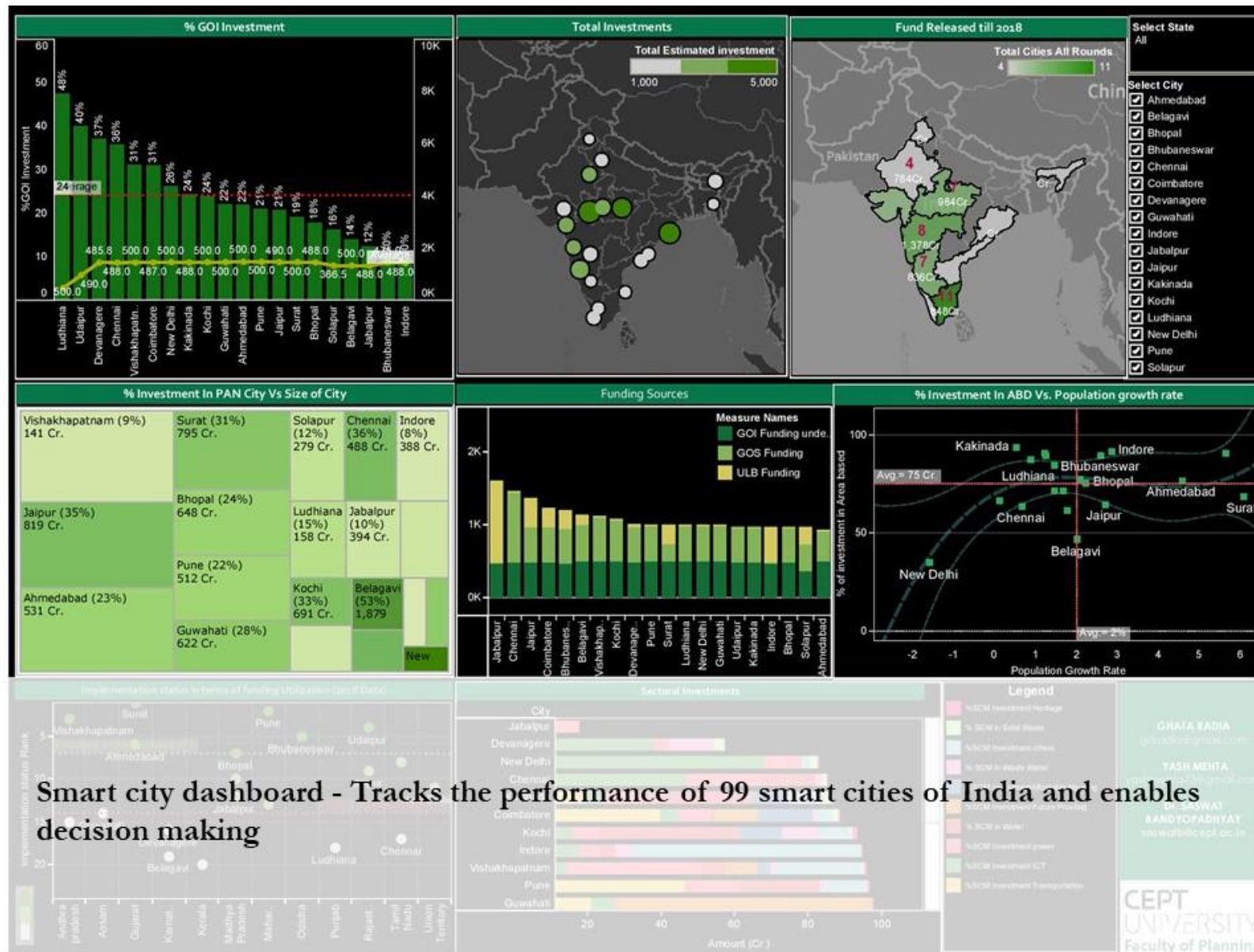
National level Monitoring Agency

“Service data in a consistent and structured format with parameters like % investment in Pan city vs Size of the city”

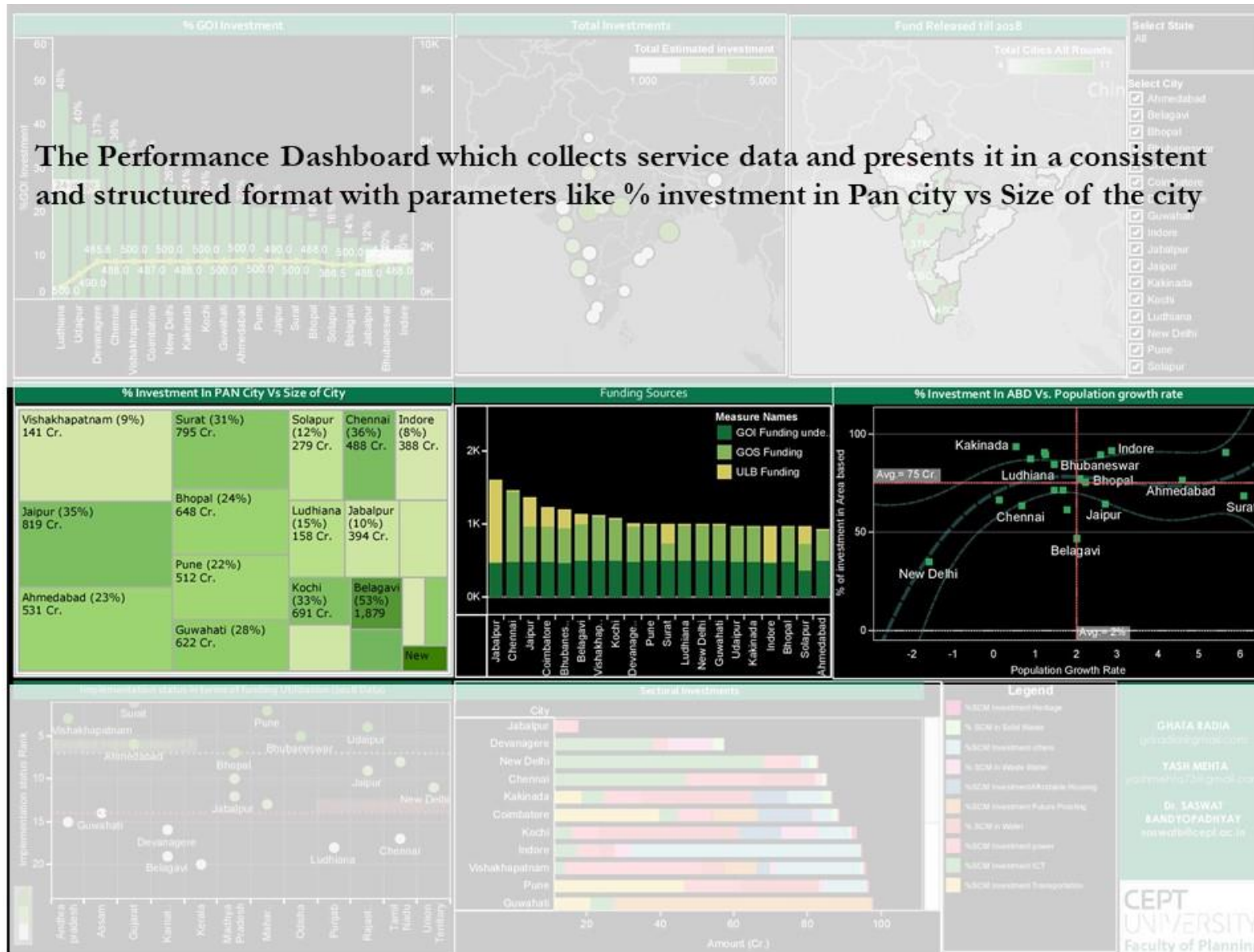
Annexure 2.1 :- Dashboard Framework at different level of governance

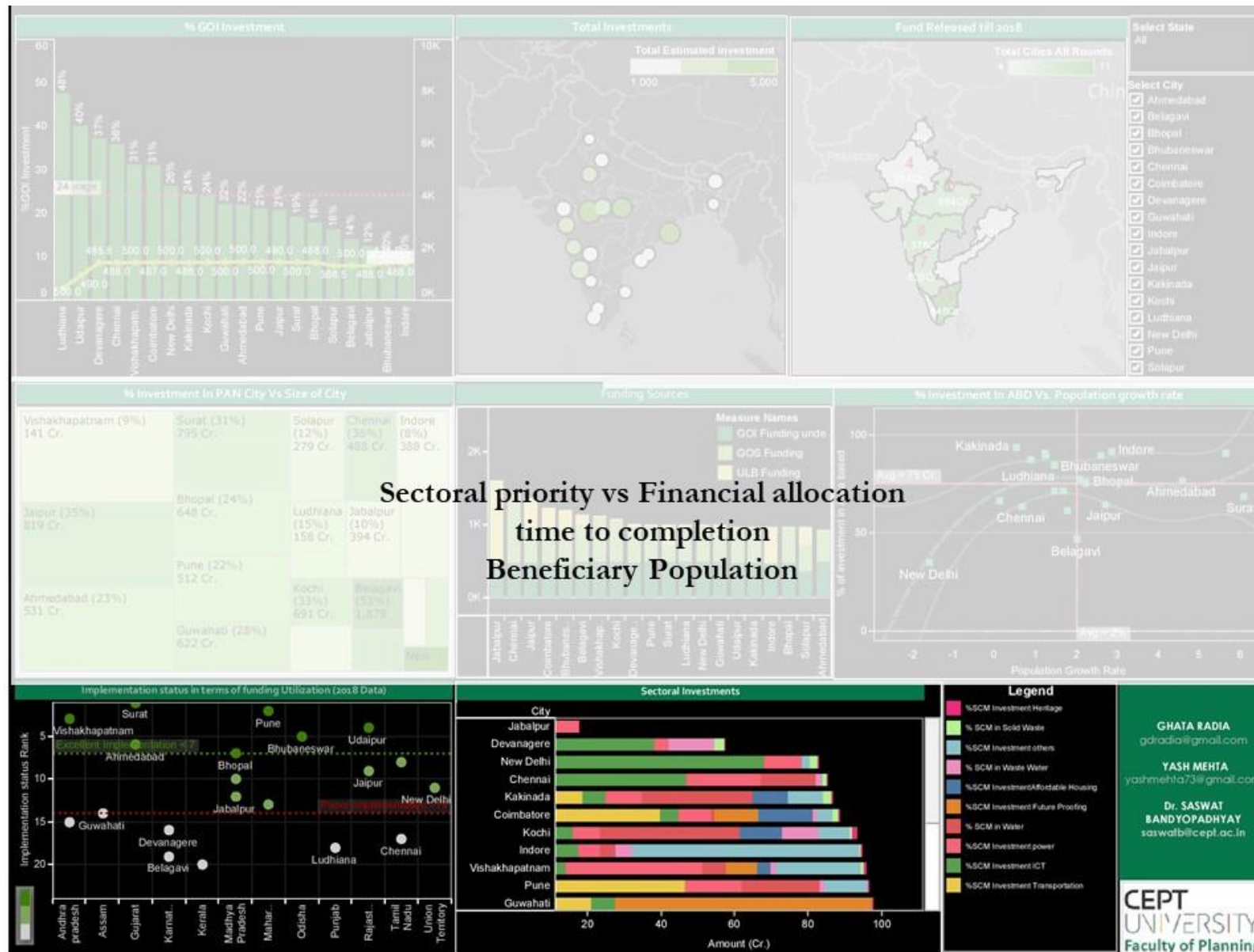






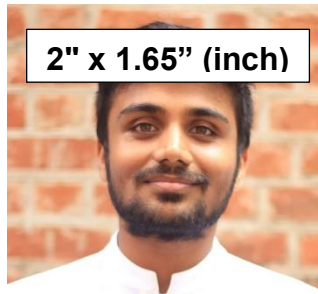
Smart city dashboard - Tracks the performance of 99 smart cities of India and enables decision making





3. Author/s Biography

Short Author/s Biography (150-200 words)



Yash is a Civil Engineer and Urban Planner in the fields of Advance GIS, Smart cities and Sustainable tourism. He has completed his master's in urban and regional planning with specialization in Infrastructure planning from Centre for Environmental Planning and Technology, Ahmedabad and Bachelor of Civil Engineering from University of Newcastle upon Tyne, Newcastle, United Kingdom. His research in the field of Smart Cities have won accolades by many CEOs of Smart Cities, Directors, Consultant and Academicians from various institutes and organizations. The research aimed to provide policy-makers and city-managers with valuable strategies to define and initiate their Smart Cities proposals in India. He has also been selected to work on the three-tier District Development Plan for a Ganjam district, Odisha in collaboration with GIZ - German development agency. He is also one of few students who attained an Extraordinary affiliation for my summer fellow program in Tsinghua University, china for impressive critical mind, thoughtful scientific thinking and strong team work spirit.