Azadi Ka Amrit Mahotsav

सत्यमेव जयते
Ministry of Housing and Urban Affairs
Government of India

Smart City
MISSION TRANSFORM-NATION

NIUA
National Institute of Urban Affairs

सार
SAAR
Smart cities and Academia
towards Action and Research

75+ Case Studies of Innovative Projects of Smart Cities Mission

Part A

Urban Management

SPA *Vijayawada*
JMI *Delhi*
IIEST *Shibpur*
CEPT University *Ahmedabad*
RVCA *Bangalore*
MNIT *Jaipur*
COEP *Pune*
SPA *Bhopal*
IIT *Kharagpur*
IIT *Roorkee*
CET *Trivandrum*
MANIT *Bhopal*
ANNA University
KRVIA *Mumbai*
MANIPAL University

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Part A
Urban Management

Part B: **Climate Change and Resilient Cities**
Part C: **Urban Infrastructure**

Institutes:

KRVIA

College of Engineering Trivandrum

CEPT UNIVERSITY

MANIPAL SCHOOL OF ARCHITECTURE AND PLANNING

NATIONAL INSTITUTE OF URBAN AFFAIRS
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Part A: Urban Management
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STAY CONNECTED

Message from the Minister

Hardeep S Puri
Minister,
Ministry of Housing & Urban Affairs

हरदीप एस पुरी
HARDEEP S PURI

आवासन और शहरी कार्य मंत्री
पेट्रोलियम एवं प्राकृतिक गैस मंत्री
भारत सरकार
**Minister of
Housing and Urban Affairs; and
Petroleum and Natural Gas
Government of India**

Foreword

I am happy to note that the Ministry of Housing and Urban Affairs and the National Institute of Urban Affairs (NIUA) is releasing a set of best practices in the book 'SAAR: A compendium of 75 Smart Cities Projects'. It is pleasing to know that this compendium has been compiled by our partners in academia, with students and professors from 15 premier institutes contributing innovative studies on urban policies and reforms in 47 Indian cities.

Under the leadership of the Hon'ble Prime Minister Shri Narendra Modi ji, urban development has assumed central importance in India's growth story. It is seen as a means to accelerate economic growth even as it aims to provide urban dwellers with a better quality of life. Initiatives such as the Smart Cities Mission were launched with the purpose of unlocking the potential of urban areas through technology and citizen-friendly reforms.

R&D institutions, led by the enterprising zeal of their young researchers, are playing a crucial role in supporting urban development programmes. As India looks to become a developed nation by 2047, it is important to encourage research, and promote a scientific and technological bent-of-mind among the younger generations towards the field of urban development.

This compendium is a stellar example of the potential of the 'demographic dividend' that lies within India. More than 65% of the country's population is younger than 35 years of age today. It is imperative that we provide opportunities to our youth to engage with development processes and conceptualise solutions to India's emergent problems.

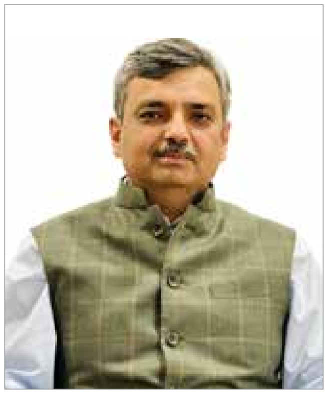
I congratulate the Smart Cities Mission, NIUA, and above all, the students and professors who prepared this compendium. It will surely be a useful addition to the growing discourse on urban development in India.

New Delhi
07 March 2023

(Hardeep S Puri)

Message from the Secretary

Manoj Joshi
Secretary,
Ministry of Housing & Urban Affairs



The partnership between Government, Industry and Academia is often referred as the triple helix. It is an important part of the national innovation system which supports achievement of national outcomes.

In this perspective, SAAR: Smart cities and Academia towards Action and Research is an important step undertaken by the Smart Cities Mission. The Mission's projects are lighthouses for other aspiring cities. Since the start of the Mission in 2015, the 100 Smart Cities have undertaken around 7,700 projects. Under the umbrella of SAAR, am proud to note that the Mission, NIUA, and 15 premier institutes of the country have created 75+ case studies which have been documented into this compendium.

This collaboration provided opportunities to students from these institutions to learn on the ground and enabled real-time information flow between urban practitioners and academia.

As we celebrate 75 years of India's Independence, I wish this compendium becomes the harbinger of a much bigger engagement between the triple helix thereby leading to development of cutting edge research, inflow of well-trained urban professionals, adoption of context-specific curricula in academia and much stronger flow of information between practitioners and academic institutions.

I want to commend the team of Smart Cities Mission, NIUA, and the 15 Premier institutes for their efforts and hard work in developing this compendium.

Message from the Joint Secretary

Kunal Kumar
Joint Secretary, Ministry of Housing and Urban Affairs
Mission Director, Smart Cities Mission
Vice President, National Institute of Urban Affairs

Perspectives, skills, and energy of the youth are essential ingredients for a prosperous city. The idea of a smart city has emerged at the confluence of increasing urbanization and the emergence of new technologies to address its consequences. Over 8000+ Smart City projects are either being developed or have got completed in the 100 Smart Cities.

In this background, we launched the Smart Cities and Academia Towards Action & Research (SAAR) program. It is a joint initiative of MoHUA, NIUA, and leading Indian academic institutions of the country, I am delighted to see the fruits of our combined labor. The hard work put in by partner institutions along with NIUA and the SCM team in MoHUA has been exemplary. Professors and students who documented the case studies on the ground, the cities which supported them need to be commended for forging such an enriching partnership and creating new pathways for holistic learning. The 75 case studies from 47 smart cities covered in the compendium will contribute to the discourse on urban development amongst all relevant stakeholders. My congratulations to the team and appeal to everyone in the urban sector to grab a copy as soon as possible!

Foreword by the Director - NIUA

Hitesh Vaidya
Director,
National Institute of Urban Affairs

Nearly four billion of the world's population under the age of 30 lives in urban areas. In less than a decade from today, 60% of the world's urban residents will be less than 18 years old. In India also, more than 50% of population is below 30 years. These numbers point to the fact that even though our cities are growing, they are also getting younger. Keeping this in consideration youth impact is a key factor in the discourse of our transforming agenda.
NIUA is dedicated to bridging the gap between policy and practice by creating and disseminating knowledge, building the long-term capacities of practitioners, and supporting ground-level work that contributes to national and global commitments. This compendium, created as part of the Smart Cities and Academia Towards Action & Research (SAAR) program, was an opportunity for us to engage young minds in this endeavour. The 75 case studies in this volume reflect the research and analytical skills of scholars from 15 academic institutions in India.
However, while I believe that the youth needs to be proactive and explore new solutions to the problems of a rapidly urbanising world, it is also our responsibility to nurture their ideas and guide them in making meaningful contributions to the urban discourse.

These case studies draw valuable lessons from projects under the Government of India's Smart Cities Mission. From the vertical gardens in Jammu to smart streetlights in Nashik, and from the use of bio-CNG to fuel Indore to improving pedestrian paths in Gangtok, these projects provide rich insights into how urban infrastructure and management can be innovative, effective and sustainable. I hope the learnings from these cases transcend the pages of this book and become a part of the curriculum in colleges and institutes across the country, inspiring the next generation of urban planners.

I am delighted that NIUA had the chance to not only evaluate and encourage their work, but also provide them with a platform to present it. I convey my thanks to the team from Ministry of Housing & Urban Affairs and my team Arvind Varshney, Purva Sharma, Himani Verma, Deep Pahwa, Bhavnesh Bhanot, Devender Rawat, Ambika Malhotra and Kapil Kumar– for putting together this compendium and supporting this effort.

Message from HOD

“We are very delighted to be the part of such thoughtful project of NIUA and congratulates the whole team including all institutes in making it a great success. The reviews of the studies are very insightful, and it has further given great scope of innovation in the current projects. Hope to see further continuations in such initiatives with impactful collaboration.”

Prof. Aarati Petkar
Coordinating Professor,
Town Planning Section, Department of Civil Engineering, College of Engineering, Pune

“A pragmatic initiative by MoHUA and NIUA which facilitated students to do in-depth investigation of the projects done by Smart City Mission. The whole process was an eye opener for students as it involved stakeholder meetings and public interactions to understand ground reality on how such development programmes influence and inspire daily lives of citizens.”

Dr. Bejene S Kothari
Professor and Head of the Department,
Department of Architecture College of Engineering Trivandrum

“The compendium projecting uniqueness of these projects, highlighting observed and targeted physical and socio-economic impact along with recommendations based on global benchmarks, will be an extremely relevant reading material for future professionals and students.”

Prof. (Dr.) Subrata Chattopadhyay
Coordinating Head from IIT Kharagpur

“The initiative like SAAR should be taken more often, which has excelled as a platform to learn, build connections, acquire skills and gain recognition for the participating academic institutions, students, scholars and researchers.”

Dr. Nand Kumar
Head of the Department, and Associate Professor. ,MNIT, Jaipur

“It has been an honour to participate in a remarkable partnership initiative involving students, practitioners and policy-makers. A compendium of case studies will immensely help us all, especially students, to understand the experience of project implementation, actor practices and institutional perspectives in the working of Smart City Mission.”

Dr. Nandineni Rama Devi
Director Professor, Manipal School of
Architecture and Planning, MAHE Manipal, Udupi, Karnataka.

“Bhopal Students have been benefitted immensely from the site visits, consultations, and documentation. The initiative we feel has met its objective of making YOUNG URBANISTs learn, share and shape India’s Urban Development Journey. Congratulations Team SAAR.”

Prof. (Dr.) Jagdish Singh
HOD, MANIT, Bhopal

“The assessment of the projects post implementation and completion was an important learning for the students. The critical thinking thus developed will bridge the gap between academia and urbanity to make cities resilient to address future challenges.”

Prof. Ainsley Lewis
Dean, Kamla Raheja Vidyanidhi
Institute of Architecture and Environmental Studies

“Experience of working with smart city project immensely benefited the team of faculty and students”

Dr. O P Bawane
Principal RV College of Architecture, Bangalore

“This project gave the students and faculty exhilarating learning experience on real world diversified projects of Smart city. We hope to continue our association with Ministry of Housing and Urban Affairs and National Institute of Urban Affairs in years to come.”

Dr. K. Pratheep Moses
Professor and Head, Department of Planning, SAP Campus, Anna University, Chennai

“SAAR gave the golden opportunity to our young minds to experience the on-ground challenges, successes, and pitfalls from ideation to implementation, role of leadership, feedback from users and way forward.”

Prof. Hina Zia
Dean of Faculty of Architecture and Ekistics, Jamia Millia Islamia

“I am sure that the compendium will be instrumental in learning from the on-ground experience and will lead the way forward in the successful development of infrastructure as per the aspiration of citizens.”

Prof. Chandra Charu Tripathi
Director, School of Planning and Architecture, Bhopal

“In the SAAR Compendium which has diverse urban infrastructure projects across the geography, the planning students got involved to develop case studies under the guidance of the Professors, which is great opportunity to create robust interface between the Academia and Industry interaction to gain the urban vision on real world.”

Dr. Ramesh Srikonda
Director and Professor, School of Planning and Architecture Vijayawada

“Exchanges with the stakeholders and beneficiaries at the grassroots level have elucidated momentous insights into the implementation of the flagship Smart City projects. This interface has immense potential for knowledge transfer to urban practitioners, planning professionals, and academia at large. We are delighted as our joint efforts come to fruition with this publication and look forward to more opportunities like this.”

Gaurav Raheja
Ph.D., DAAD Fellow Head, Department of Architecture & Planning Professor, Department of Architecture & Planning Joint Faculty, Department of Design, Indian Institute of Technology (IIT), Roorkee

“The SAAR compendium will have far reaching impact on the urban development sector in India and academia at large. CEPT University is happy to be a part of this initiative and we look forward to meaningful collaboration with MOHUA in near future.”

Tridip Suhrud
Professor and Provost, CEPT University

“The Department is proud of its active participation in five research projects of New Town (Kolkata) under the prestigious programme on “Smart cities and Academia towards Action & Research (SAAR)” conceptualized by Smart Cities Mission (SCM) and National Institute of Urban Affairs (NIUA), India. The faculty members (advisors and mentors) and the students (PhD and PG scholars) were deeply involved in providing critical appraisals on the functioning of the projects in line with the envisaged objectives of SCM. The exercise adds to the researchers’ knowledge on the processes, contents and outcomes of smart city applications in New Town (Kolkata). The Department wishes for long-term association in such research.”

Dr. Subrata Kr. Paul
Associate Professor & Head
Indian Institute of Engineering Science and Technology (IIEST), Shibpur

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This compendium would not have been possible without the shared effort, research and analysis by the students of planning. We thank all 15 institutions, their students and professors for contributing and cooperating in this project.

I would like to express my gratitude towards Shri Kunal Kumar, Joint Secretary, Ministry of Housing and Urban Affairs, for giving this opportunity to the young leaders of the country and for giving his guidance, constant supervision, and encouragement, which helped in completion of the project. I am also thankful to Mr. Vikas Chandra, programme team leader, management unit of SCM for all the kind support and conceptualizing the project. I would like to acknowledge and give my warmest thanks to Mr. Saswat Bandyopadhyay, Project Director, Centre of Urban Planning and Policy (CUPP), CEPT for ideating the project and to the whole working group for their continuous technical and coordination support.

Special thanks to Gargi Roy, Aman Singh Rajput, Saivarsha Akavarapu and Amit Kumar Sharma for their contribution and coordination with the universities for collating data for compiling this compendium.

I also want to express special gratitude to the team at NIUA for their complete support till the end, specifically Arvind Varshney and Purva Sharma, who helped take this project from conception to completion. I would also like to extend my gratitude to other institute members- Himani Verma, Ambika Malhotra, Anusha Sharma, Mehak Bakshi, Anirban Bera, Deep Pahwa, and the whole editorial and design team for lending their time and ideas. They helped by structuring the plan, developing the website and brochures supporting this voluminous compendium.

This handbook would not have been possible without the shared effort, research and analysis by the students of the 15 partner institutes documenting the projects-

1. Anna University, Chennai
2. Center for Environment Planning and Technology, Ahmedabad
3. College of Engineering, Pune
4. College of Engineering Trivandrum
5. Department of Architecture & Planning, Manipal University
6. Indian Institute of Engineering Science and Technology, Shibpur
7. Indian Institute of Technology, Kharagpur
8. Indian Institute of Technology, Roorkee
9. Faculty of Architecture and Ekistics, Jamia Millia Islamia, Delhi
10. Kamla Raheja Vidyanidhi Institute for Architecture and Environmental Studies, Mumbai
11. Malaviya National Institute of Technology Jaipur
12. Maulana Azad National Institute of Technology (MANIT), Bhopal
13. R V College of Architecture, Bangalore
14. School of Planning and Architecture, Bhopal
15. School of Planning and Architecture, Vijayawada

In the month of January to February 2022; the team of students, and mentors from these premier institutions visited the above-mentioned 47 smart cities to conduct a field investigation. This was followed by a series of data analysis & documentation, a national research methodology workshop for the participating students, a peer review of the first draft, a final submission made by research students to their respective institutions, and then the institutes submitted the final draft of the research paper to NIUA. All these efforts culminated in to develop a compendium of 75 urban projects that are impacting the lives of urban citizens.

Throughout the process, the Smart Cities Mission, MoHUA, and NIUA acted as the linkage between the Institutions and the Smart Cities to facilitate the documentation of specific landmark projects under the Mission.

I hope this compendium will serve as a valuable "lessons learned" document for architecture/ planning students and universities and a springboard for practical future courses and disciplines across India.

Executive Summary

'Smart cities and Academia Towards Action & Research (SAAR)' program, is a joint initiative by MoHUA, the National Institute of Urban Affairs (NIUA), and leading Indian academic institutions of the country. Under the program, 15 premier architecture and planning institutes of the country worked with Smart Cities to document the landmark projects undertaken under the Smart Cities Mission. This document captures the learnings from best practices, provides opportunities for engagement on urban development projects to students, and enables real-time information flow between urban practitioners and academia.

The Smart Cities Mission's urban projects are lighthouse projects for other aspiring cities. Since the start of the Mission in 2015, the 100 Smart Cities have been developing a total of 7,742 projects with an investment of Rs. 1,81,500 crore. Under the SAAR program, it is envisaged to prepare a compendium of 75 landmark urban projects of the Smart Cities Mission. These 75 urban projects are innovative, multi-sectoral, and have been implemented across different geographies across India.

This compendium will act as a first point of reference for future research in the field and will help to disseminate learnings from projects under the Mission, thus enhancing peer-to-peer learning.

The 75 urban projects covered in this SAAR compendium are distributed across 47 Smart Cities. The cities include: Agra, Ajmer, Chandigarh, Dehradun, Dharamshala, Faridabad, Jaipur, Jammu, Kanpur, Saharanpur, Shimla, Srinagar, Belgavi, Bengaluru, Chennai, Coimbatore, Erode, Kakinada, Kochi, Manguluru, Shivamogga, Thanjavur, Thiruchirapalli, Thiruvananthapuram, Tumakuru, Ahmedabad, Dahod, Nagpur, Nashik, Pune, Surat, Thane, Vadodara, Bhubaneswar, New Town Kolkata, Ranchi, Vishakhapatnam, Bhopal, Gwalior, Indore, Raipur, Sagar, Ujjain, Jabalpur, Agartala, Gangtok, and Namchi.

CONTENTS

Part A: Urban Management

A1

Escaping the City-Siege by Urban Floods: Case study of Davanagere Smart City, Karnataka

***Name of the project:** Escaping the City-Siege by Urban Floods*
***Location:** Davanagere*
***Year of Project Implementation:** In Progress March 2022*
***Sector:** Area Development*
***SDG:** No Poverty (SDG 1), Gender Equality (SDG 5), Decent work and Economic growth (SDG 8)*
***Project Cost:** Rs 9.9 Crores*
***SDGs:** SDG 11.4*

***Advisors:** Vikash Chandra*
***Students:** Abhisek Kumar, Aman Singh Rajput, Nishchay Kumar, Sai Varsha Akavarapu*

***Keywords:** Collectorate, Restoration, Conservation, Heritage, Culture*

Abstract:

"Water, Water, everywhere! but no water to drink", thought nine-year-old SriNandini, standing on the window of her one-room house at SPS Nagar, centrally located slum at Davanagere. Ever since it started raining, her house, the street in front, her school, the hospital in which her father worked and to the extent her eyes could see, was under knee-deep water. It was the month of July 2017. It had been raining for the last two days. But she was not surprised at all, as this had been a common sight for decades in the monsoon season. While she was happy that she won't have to go to her school, she was sad as her world had just become smaller and she had to stay confined on the 4'x6' bed of her house. No friends to play with, no ice-cream cart, no visits to her neighboring aunt.

But these seemed trivial issues to her, as she was thirsty. There has been no drinking water at home since last night. She was getting tempted to drink some drops of water, floating below her, except for a strict warning of her father. Her father's warning was not un-founded as he had seen a surge in the patients these days at the government hospital, due to water-borne diseases. She could see her dear friend Susheela, standing on the window just like her, across the lane. She wondered, if her city was under siege, and that too from water!

Case Study: **A1**

1. Introduction

Flooding truly disrupts the quotidian like no other crises and affects over 15 million people every year. Similar instances of water logging have brought several cities in the country to an abruptive halt. Several Indian metro cities such as Mumbai, Delhi, Chennai and Hyderabad are facing floods every single year, since the last two decades. An analysis conducted by the DTE-CSE Data Center of the Central Water Commission (CWC) reported that, since 1952, there has not been a single year where occurrences of floods haven't been reported. Unpredictable and increasing climate change, uncontrollable urbanization, and inadequate infrastructure are often cited as the major reasons behind urban flooding. A report furnished by SEEDS and CRED in 2018 observed that India has recorded a mean of 11 flood events per district over the last 18 years and suffered over INR 95,736 crores of economic loss in just 2019.

Urban flooding of such high magnitude and socio-economic and infrastructure losses cannot be contained by municipal authorities or the state governments alone. Floods cannot be averted without focused investments of energy and resources by the vested authorities, and can only be reduced when stakeholders at all levels including the civil society and their allied organizations are involved through the planning, problem solving, implementation and monitoring processes. In order to minimize the intensity of the impact of floods, today's cities need to focus on developing risk-reductive and resilience inducing mechanisms as opposed to following the traditional rehabilitation and response centric approach to managing urban floods.

To this extent, the launch of the Smart Cities Mission (SCM) heralded a new paradigm for urban development in India. Rigid, top-down, normative planning practices were discarded and 'people-centric sustainable and inclusive' urban development that provided a contextual potential for scalability and replicability across the country was envisaged and adopted. To enable this paradigm shift, the Ministry of Housing and Urban Affairs (MoHUA) through the mission, has sparked innovation, fostered partnerships across sectors and facilitated the development of novel solutions to curb the most pressing urban concerns of the country, all the while strengthening the core infrastructure of the cities. An embodiment of the above-said principles can be viewed in Davanagere Smart City, where the smart city officials, officials from various ULBs, urban practitioners and the civil society came together to combat the recurring issue of urban flooding in the city.

2. Core Enquiry:

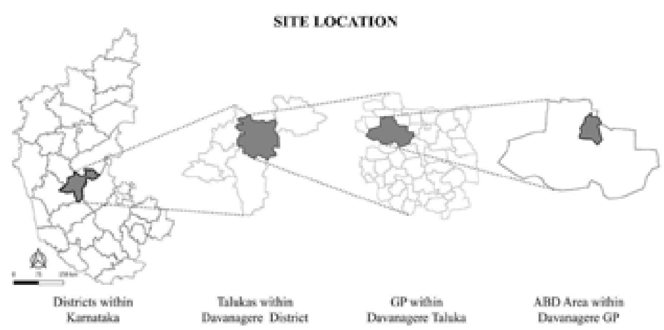
Davanagere, also known as the 'Manchester of Karnataka' is the seventh largest city in the state, currently serving as an administrative hub for Davanagere district. Accelerated urbanization (Map 2) coupled with inadequate and outdated infrastructure has put the city in a perilous position prone to sudden shocks and stresses such as torrential rains and flooding. However, the city of Davanagere, located in an upland region just east of the Tungabhadra river (Map 3), highlights the fact that the major reasons for recurring flooding since 2011, are due to human-made reasons as opposed to physical/ geographical reasons.

Noting the impact, the floods have had on connectivity, Mr. Siddeshwar Hebbal (Divisional Controller, KSRTC, Davanagere) reflected that "the KSRTC bus stand area was often fully flooded, affecting the movement of buses and any other vehicles." Similarly, Mr. Jai Kumar, residing at 11th cross from the last 10 years, shared that flooding in his locality was quite dreadful, clogging majority of the drains and routes even during shorter duration of rainfall.

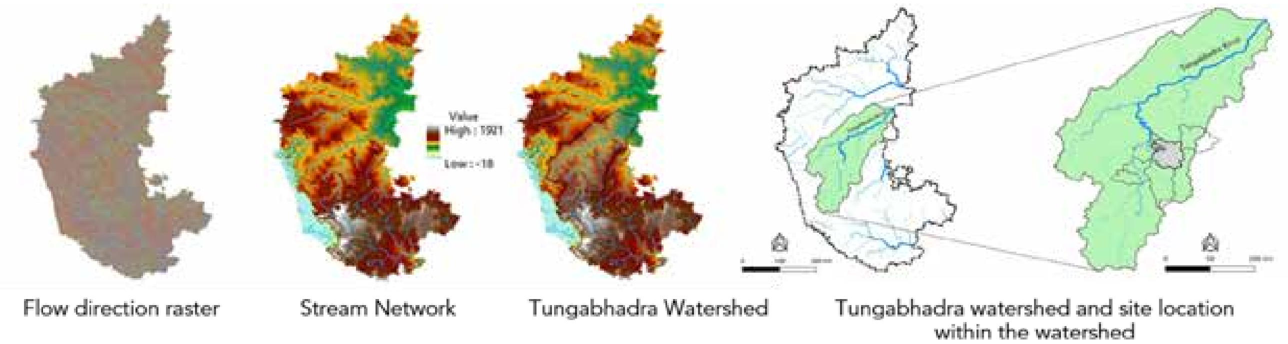
Outdated and inadequate physical infrastructure has thus resulted in reduction of infiltration land leading to low infiltration of rainwater (average of 647.54 mm a year) resulting in higher storm water runoff creating the issue of urban flooding. Additionally, due to discontinuity in the storm water drain network, rain water continually gets polluted when the storm water runoff meets the sewage water. Additionally, with the increase in infiltration land, irregular sections of drains, silt deposit along the drain tributaries, ill-maintained utility pipes across the drains, improper disposal of drainage lines and the reduction of urban water bodies owing to development, the issue of flooding intensifies with every passing year and so does its impact on the quotidian.

Mr. Irshid Shafi, identified that there was no pukka road due to which, during flooding, it became very difficult to commute to and from work. He shared that even after draining water, roads become slushy and difficult to be walk upon. Additionally, he also mentioned that people faced issues pertaining to drinking water, which was difficult to procure as roads were majorly blocked.

Map 2: Urban growth of Davanagere. (created from Google Earth Pro)



Map 1: Location of Davanagere in Karnataka.



Map 3: Tungabhadra watershed w.r.t. the location of Davanagere smart city. (Created using LANDSAT data)

Flash floods in the city have also washed away a police constable in 2017 and a farmer in 2018. Mr. Ravindra B Mallapur, the current Managing Director of Davanagere Smart City Limited (DSCL) elaborated on the previous interventions undertaken in the city to combat flooding by saying that, "the issue of floods was targeted by the municipal corporation in a smaller scale. Although the minor irrigation department attempted to channelize the water through a side bund construction on the main nalla located in the northern side of the city, urban flooding was not completely resolved." According to the Chief Engineer at DSCL, "From time to time, various small projects were taken up by the corporation related to de-silting, cleaning and construction of drains but no comprehensive approach was attempted to solve the issue at a larger scale before the Smart City Mission."

To combat the issue of urban flooding, under the Smart Cities Mission a detailed stakeholder engagement was conducted under which 10 storm water drainage projects of a total length of 37.18 km were identified. Furthermore, waste water management was given the highest priority with a cumulative score of 7 via citizen's assessment since it was in a very poor condition. Due to the problems of excessive flooding of the low-lying areas of the city between the bridge on NH 4 and the Harihareshwara temple on the eastern bank of the Tungabhadra River the Davanagere Smart City brainstormed and implemented a series of storm-water infrastructure projects coupled with ICT initiatives, which when contextualized to the cities across the country could minimize the risk of flooding and strengthen the physical infrastructure by at least 80%.

3. Why Storm Water Management?

Storm water management reduces or eliminates the negative impacts of storm water runoff. Storm water management includes controlling flooding, reducing erosion and improving water quality which can be achieved by following Best Management Practices (BMPs). BMPs are structural, vegetative or managerial practices used to treat, prevent or reduce water pollution. Suitable measures to assist in maintaining the pre-development storm water discharges include:

- Retention/detention basins as part of a storm water treatment, increase in pervious areas on the site,
- The use of porous materials in those areas normally surfaced (such as footpaths); and the inclusion of on-site detention storage tanks with the design of multi-unit/building developments.

The storm water during the rainy season results in severe drainage and road damage owing to the runoff rainwater. The water on roads during rains remains stagnant for hours together due to poor storm water management and results in erosion of roads. In our country, industries and cities are facing a water crisis due to over exploitation of underground water and no provision for recharge of aquifers. Declining water levels are also consuming more energy in lifting the water and reducing green coverage. Solution of managing storm water on roads in urban and industrial areas is channelizing the same to ground water systems in a hygienic manner. This method not only helps in controlling the devastating effects of storm water, but would improve ground water regime both in terms of rising water levels and increase in ground water availability. The techniques will also increase life of roads and reduce cost on maintenance and repairs. Besides, better plant growth is envisaged with less water requirement due to moist condition of surface soil through percolation structures.

Image 1: Discontinuity and utility pipe issues in storm water drains.

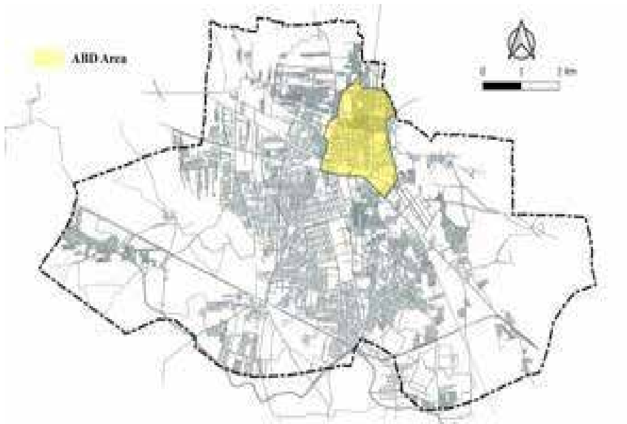
Image 2: Improper disposal point and irregular section of drain and silt deposition.

4. Implementation Methodology

Soon after problem identification, the Davanagere Smart discussed the importance of solving urban flooding in a board meeting and the following major steps were followed to identify the problems and areas of interventions. The exercise started with a topographical survey conducted for the entire storm water drain alignment till disposal point at Bethur nalla along with a cross section of each drain at frequent intervals. Topographic survey was conducted for about 20.19 km covering the primary drain within the ABD (Map 4) area of Davanagere city. Furthermore, Geotechnical investigation was done for salient locations to establish the nature of the soil below the existing ground level and to assess the soil conditions along the proposed alignment of the storm water drain. The ground levels vary from a maximum of 622.72 m at the TV station, to a low level of 561.40 m near the existing STP.

According to the Smart City Proposal, 5 primary storm water drains were identified within the ABD (Area Based Development) area to avoid flooding. However, the identified primary storm water drains encompass the commercial area of the core city / old city and the storm water drains are K.R. Road, Basha Nagar main Road, In front of Fish market, Razaul Mustafa Nagar Main Road and Kondajji Road to SSM Nagar along with SPS Nagar road side drain. Bethur Nalla, which runs from south to north on the periphery of the city, is the main collector of all drainage in the city.

All the above-mentioned drains were studied in terms of their physical conditions such as length, age, type of masonry used, single- or double-sided structure and major problems associated with them such as silting, choking due to waste.



Map 4: ABD area within the city

The Chief Engineer at DSCL stated that "From 2002, urban flooding had been occurring in the 15 low-lying areas of the city. Mr. Ashadh Sharif the then MD of DSCL, took up the issue of solving the urban flooding and suggested drafting a project report. Nearly 100 km of the drains are being constructed across the city under the project. It was found that the projected carrying capacity of the drains were higher than their existing ones and thus, apart from construction of new drainage lines. Additionally, revamping of the old dilapidated ones was also undertaken." The critical zones were identified in the municipal corporation limits, which were the areas present in the low-lying region and had an improper drain system. The local media reports during the monsoon were analyzed to identify the critical areas of flooding during heavy rains. Additionally, from the comparative analysis of the peak discharge runoff and carrying capacity of the drains it was found that some of the drains had sufficient carrying capacity for proper movement of the rainwater while some didn't. Many drains needed some repairs and renovation while others needed widening and deepening. Kutcha drains were causing a haphazard spread of rainwater and needed to be concretized. Cover slabs at some locations were missing.

The next step involved the preparation of the project proposal inclusive of extensive citizen engagement and stakeholder's consultation. The directly affected communities such as slum dwellers, street hawkers, shopkeepers and citizens residing across the 41 wards were involved. Further, being known as the 'Oxford of Karnataka', engagement with the teaching fraternity, the student community along with their family members was also conducted. The administrative stakeholders at city level via District Magistrate, Commissioner, Corporators, MLA of Davanagere and State Cabinet Minister were involved. The medium involved were face to face discussions, questionnaires, inviting suggestions through digital mediums like mygov, Facebook, twitter along with essay writing competitions.

5. Vision of the Davanagere SMART City

Located at the center of Karnataka with an area of 68.63 sq.km, the city is a residence of 4,34,971 people. The city is well connected via NH4 connecting to Hubli and Bangalore, SH 65 to Jagalur and SH 150 to Bellary. It is located on the Mumbai-Bangalore rail line with the nearest ports at Karwar and Mangalore, nearest airport at Hubli and nearest international airport at Bangalore. The Davanagere municipal corporation has been divided into 8 districts for proper planning and management. The city is divided into two parts by the railway line – the southern part (newer developed area) which is more developed than the northern part (old city area).

The ABD (Area based development) area selected under the Smart City mission for retrofitting development is 3.2 sq.km dominated largely by commercial land uses. The area supports a population of 115779 with an average density of 34052 persons per sq km. Out of the 35 slums located in the city, 27 slums are located in and around the demarcated ABD area. Situated in the

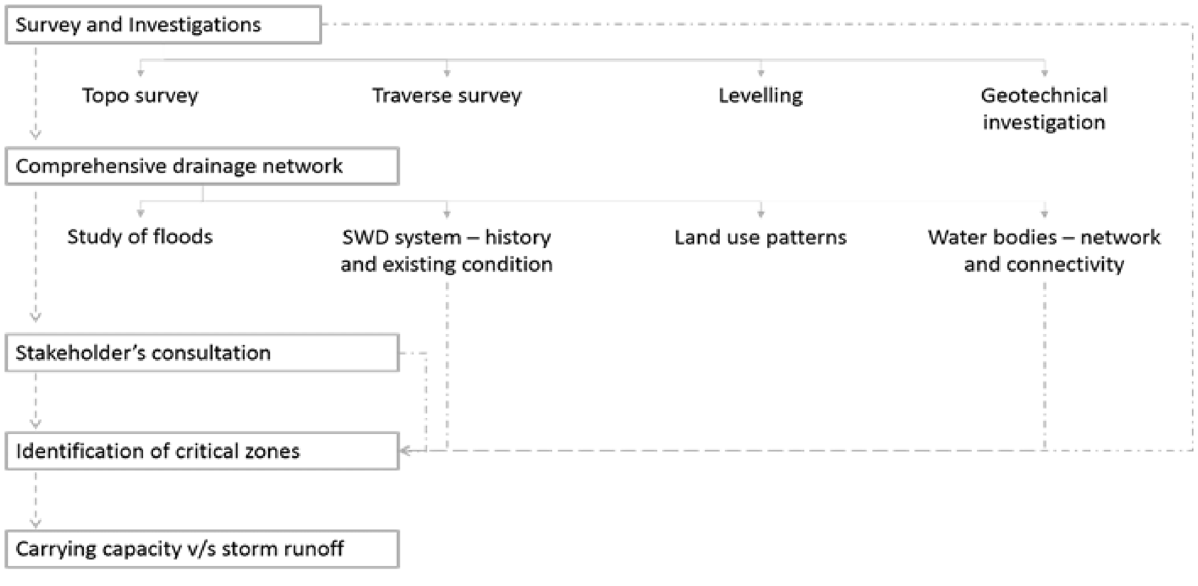
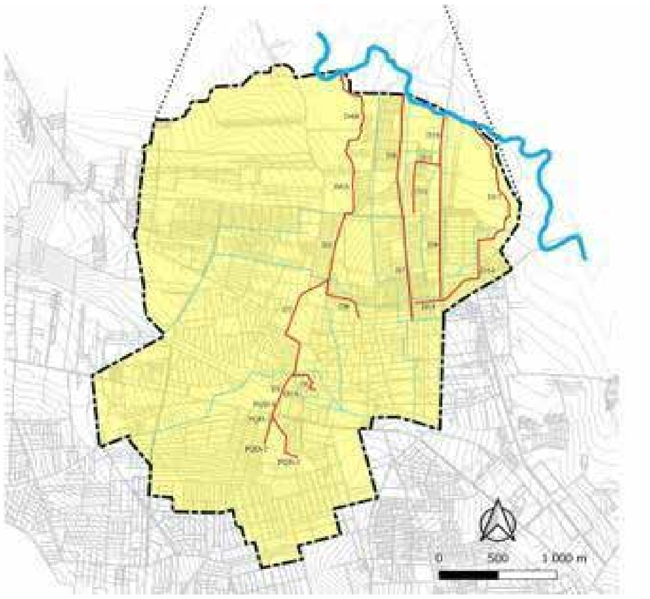


Image 3: Methodology for preparing the project proposal



Map 6: Main storm water drain within catchment area

Tungabhadra basin, the topography generally slopes towards north and west. The north-eastern and south-eastern part of the city drains towards north, through Bettur Nalla, whereas the western and southwestern part drains towards west, through Baathi Tanks.

Davanagere Smart City's vision is to be a city where L.I.F.E nestles. L stands for livable, convenient and safe; I stand for inclusive; F stands for financially vibrant and futuristic and E stands for edutainment, economic prosperity and environment friendly. It aims to transform the unplanned and congested inner core of the city, which is negatively impacting the quality of life of the citizens. In accordance with the vision, the area-based proposal of Mandakki Bhatti enterprises has been identified for a retrofit focusing on heritage and cultural precinct redevelopment and economic hub creation whereas Pan City proposals aims to upgrade the city's urban mobility, by strategic and targeted ICT based solutions.

Each of the issues that were observed in the storm water drains led to a phase-wise method of development adopted by the DSCL. The intensely flooded areas in the ABD area were targeted first and the pan-city areas next. Width and depth of the proposed drains were designed keeping in mind the peak discharge of respective drains and old/damaged drains were replaced with new RCC rectangular ones with cover slabs at suitable places. As MD of DSCL says, "due to the absence of required SWD oriented infrastructure, the project focused on developing new infrastructure through SCM instead of revamping existing infrastructure."

The interventions attempted are further divided into structural and non-structural.

6. Structural Interventions

In order to address the issues of the residents, problematic areas were identified, extensive discussions with stakeholders were held and projects were formulated under the Smart City Mission (SCM). These structural interventions included construction of major storm water drains and sub-drains across the city. These storm water gets mixed with the sewage and goes for treatment at sewage treatment plants situated outside the city. Further, after treatment at sewage treatment plants of 5 MLD and 20 MLD capacity, it meets Bethur Halla which ultimately discharges to the Tungabhadra River.

The total length of storm water drains proposed is 38.00 kms, out of these 38.00 kms, 27.38 kms of storm water drains are completed and the remaining is under construction. Defects of roads were rectified and new roads were laid under Smart City Mission (SCM) so that there should not be any potholes and no accumulation of water on roads. Slopes were made such that there should not be any stagnation of water on the pavement surface and pavement surface water can go to sub-drains along the road. These sub-drains are well connected to these storm water drains which go to Sewage treatment plants and after treatment finally discharge to Bethur Halla which ultimately meets Tungabhadra River. The groundwater recharge or storage aspect of the project was taken up in this city, since the domestic sewage from the entire city is flowing through the storm water drainage structure and this quality of water will contaminate the groundwater. However, under the smart road project in the Mandipet economic rejuvenation program, a storm water pipe network was provided with recharge arrangements in every collection chamber at frequent intervals.

7. Non-Structural interventions

Non-Structural interventions include spreading of awareness among people about throwing the garbage or solid waste in the drains. Residents were made to understand that utilities of chain-linked fencing, which is purposefully constructed with an aim to discourage people from throwing the garbage in storm water drains as garbage will obstruct the storm water leading to clogging of drains and flooding of the areas during rainy season.

8. Impact of Interventions

Urban storm water constitutes a non-point source of pollution, which contributes to the degradation of water bodies. With the specific structural and non-structural interventions undertaken by the Davanagere under the smart city mission, the issue of urban flooding has largely been solved. This was witnessed in the monsoon season of 2020 and 2021. The Mayor of Davanagere praised the works undertaken by the Smart City related to urban flooding and said "Presently, despite the heavy rainfall events, the water gets drained out easily. In the city area of Neelammathota, the storm water used to enter into the houses of the residents which had been solved through these interventions." Mr. Abdul Rahim, Corporator of Ward No. 3 which was adversely affected by the urban floods reflected how "the residents were facing problems related to urban floods from the past 20 years, but due to the efforts from the Smart City it has been resolved to a greater extent. The drains are constructed and linked from the Fish Market via Kochratti, Siddarameshwar Nagar, Ring road, Mandakki Bhatti, which finally gets discharged to Kalpanahalli Halla."

While the administrators and urban practitioners in Davanagere have vouched for the success of the project, the people living in the flood prone zones have agreed to the same. Mr. Ravi Rajappa, 34, a resident of Bhagat Singh Nagar residing in this locality for the last 30 years, has lived many a days shackled due to floods. He was quoted saying that "during floods, it generally took 2 to 3 days for water to drain out completely. I faced issues while going to his work and doing basic work. Flood water entered our house causing much difficulty. After the construction of drains, the problems have been resolved to a greater extent."

9. Conclusion

This effort of Davanagere Smart City is an example of how the Smart Cities Mission, has enabled the Indian cities to address the "urban problems of decades". The major takeaway from the case study analysis of Storm water drainage system development at Davanagere is the methodological approach of problem identification followed by a scientific and technical approach to solving the problem with people's participation at the center. It validates that the existing drainage system in our cities is unable to flush out water from heavy rains, and it requires a dedicated storm water drainage system.

This approach can be termed as best practice in terms of replicability and sustainability, as many cities across the Indian landscape can scale up the same process of implementation. While several cities have taken up projects related to development of storm water drains, the approach of Davanagere city has demonstrated a systematic approach and practical use of spaces available. To its credit, Davanagere Smart City extended the Storm water drainage network in three phases. Starting with the ABD area, the city has extended the network to PAN city, redesigning and developing the storm water drains, ending the city-siege of Davanagere from urban floods. This experimentation in ABD and further extension of learnings to the entire city, is in-line with the objectives of Smart Cities Mission.

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A2

Overview of Integrated Command and Control Centre Vadodara Smart City

Name of the project: *Integrated Command and Control Centre*
Location: *Vadodara, Gujarat*
Year of Project Implementation: *22nd October 2017*
Sector: *IT Solutions*
SDG: *SDG 3, SDG 6, SDG 11*

Project Cost: *Rs. 100 Crores*

Institute: *CEPT University*
Advisors: *Dr. Gayatri Doctor*
Students: *Meet Shah*

Keywords: *Integrated command and control centre, smart cities mission, city management, Operations centre*

Abstract

To meet the demands of an incessantly growing population, Indian cities are looking for ground-breaking technology solutions that will increase efficiency and optimise the delivery of a better living environment to its citizens. The Integrated Command and Control Centre (ICCC) will collect data from a variety of devices and sensors deployed across the city and provide it to decision makers in real time with suitable visualisation. The ICCC is designed to be the brain of municipal operations, dealing with exceptions and disaster management. Sensors and devices will gather data and create insights regarding water, waste management, energy, mobility, the built environment, education, healthcare and safety. If effectively operationalised and maintained, the ICCC may help a city become more responsible by ensuring efficient service delivery and quicker response to emergencies/crisis situations/hazards. Through primary research, secondary survey and stakeholder interviews, this study has explored the ICCC project for Vadodara Smart City.

Case Study: **A2**

1. Introduction

1.1 Topic and Context

The Integrated Command and Control Centres (ICCC) have been designed to be the brains of municipal operations, handling exceptions and disaster management. The sensors and edge devices will record and create data on water, waste management, energy, mobility, the built environment, education, healthcare and safety in real time. Through its different levels and components, the ICCC platform will function as a Decision Support System (DSS), allowing municipal management to respond to real-time events by collecting data feeds from multiple sources and processing information derived from the data-sets.

1.2 Significance of ICCC

Integrated Command and Control Centres or ICCCs, are an important element of the Smart Cities initiative which intends to create 100 citizen-friendly, self-sufficient urban communities. ICCC may be envisioned as a service that monitors Smart learning, Smart transport, Smart healthcare, 24-hour water, sewerage and sanitation, as well as any other service that influences a resident's life. The devices regarding Internet of Things (IoT) take real-time data from sensors and other sources which ICCC can gather or process to create information. The ICCC will also create warnings based on the data received and aggregated by its many components. It will be the nerve point for cities. (KPMG, June, 2020)

1.3 Scope of ICCC

ICCC will also take care and be involved in the following functions:

a. **Increasing situational awareness** by providing insights using data for civic officials across urban functions through deployment of sensors across the city.
b. Standardising **response protocol** at city level through institutionalisation of standard processes for recurring events, issues and exigency scenarios.
c. Enhancing **collaboration across multiple departments** within and outside urban local bodies and government bodies.
d. Institutionalising **data driven decision-**making for regular operations and during crisis across city level functionaries – from operators to city administrators.
e. Engaging with **on field support staff** to address civic issues and citizen grievances.

1.4 Aim and Objectives

To document the Smart Cities Mission's core project ICCC, its functionalities, risks and challenges for the city of Vadodara with the help of stakeholder interviews, field and primary visits and secondary data-sets.

Figure 1 represents Bhubaneswar's Smart City Visions.

2. Vadodara City

2.1 City Profile

Vadodara, Gujarat's third largest city, is one of the main centres of industrial expansion in Western India. The city, along with eleven other large cities around the country, became a metropolis in 1991. The Vadodara Urban Development Authority (VUDA) is incharge of all development initiatives in Vadodara District. VUDA has a 714.56 sq km border.

According to the UN World Urbanisation Prospects, the population of Vadodara in 2020 is estimated to be 21,89,973. Vadodara Municipal Corporation (VMC) has a population density of 551 people per square kilometre, while the total area is around 148.95 sq km. (Vadodara Municipal Corporation, 2019)

2.2 Vadodara Smart City

In the second round of selection for the Smart City Mission, among a total of 30 cities throughout the country, Vadodara was chosen to be developed into a Smart city. The Vadodara Smart City Project has 31 sub-projects, 9 of which are from the (Information and Communication Technology) ICT department and the rest are with the Infrastructure department, totalling Rs 2,400 crore. A separate Special Purpose Vehicle (SPV) has been created to manage the work and finances of Vadodara Smart City. (Vadodara Smart City Pvt Ltd, 2020)

Smart city initiatives are classified into two types:

- Area Based Development (ABD) Projects: Vadodara Smart City has 45 ABD Projects at a total cost of Rs 1806 crore.
- Pan-city Projects: Vadodara Smart City has 15 Pan-City Projects at a total expenditure of Rs 590 crore.

Vadodara has a Redevelopment and Retrofitting strategy. With the expansion of infrastructure facilities and the economy, it aspires to provide sustainable development to its population.

2.3 Goal of Vadodara Smart City

"Smart Utilisation of Vadodara City's potential for enhancing the quality of life of the citizens by providing equal access to best quality physical infrastructure, social infrastructure and mobility through leveraging state-of-the-art technology. Thus, making Vadodara a futuristic global city with focus on enhancing economy, protecting ecology and preserving the identity & culture of the city." (Vadodara Municipal Corporation, 2016)

2.4 ICCC Vadodara

On October 22, 2017, the Hon'ble Prime Minister of India, together with the state chief minister, inaugurated the multi-model ICCC - Integrated Command and Control Centre. Since then, more projects have been added to the list and are being tracked from the centre. (Smart City Mission, 2020)

The CCC operates on an integrated inclusive structure with inputs from many government/civic agencies such as fire, police, water/sanitation, transportation, health, weather and so on. Other initiatives of Vadodara Smart City Mission such as ERP, public Wi-Fi, GIS System, Smart Mobility, water SCADA, and so on, are directly connected with the CCC. The Smartphone app is beneficial to residents since it allows them to communicate with the government and stay up-to-date on any new developments. During the whole Covid-19 situation, the city's CCC worked tirelessly to ensure that citizens have access to medical services.

The CCC is operating on an integrated collaborative framework where inputs are received from different government/civic departments such as fire, police, water/sanitation, transport, health, meteorology, etc. All the ICCC data-sets are classified into two primary categories - Smart & IoT devices and Smart Solutions. Smart & IoT devices are distributed across the city to identify, access and get real-time data, information and statistics. These devices are designed to convey real-time live information through optical fibre which is distributed all over the city and connected directly to the command-and-control centre.

Smart Solution projects of the Vadodara Smart City Mission include ERP, which performs all activities through a single interface and public Wi-Fi. The GIS System has around 82 layers and has also mapped the subterranean utilities of many stakeholders' assets such as gas pipelines. Smart Mobility with ITMS operates with the assistance of specific dashboards for all mobility services in one place. The use of Smart water metering and water SCADA highlights each revenue and non-revenue based water and their flowing patterns with various analyses of their quality and volumes. Environmental sensors have supplied fast information on weather activity, air quality assessments and rainfall data. The Public Address System and Emergency Call Boxes are functioning in tandem to communicate directly from the CCC to the site and vice versa.

3. Smart IoT Devices

As technology progresses and more nations adopt next-generation connectivity, IoT technology will not only expand but will also have a greater impact on how we live. According to ITU (International Telecommunication Union), the phrase "Internet of Things" refers to anything that is connected to the internet. However, in recent years, the phrase "Internet of Things" has come to refer to items that can "speak" to one another. (Motorola, 2019)

It refers to a wide network of technological devices that connect and interact with one another, influencing our daily life. Smart sensors, monitoring devices, artificially intelligent programmes and actuators are among the equipment that can assess, monitor and regulate many elements of city life. For example, weather data may be collected by several sensors and utilised to adjust thermostats in public buildings, reducing emissions and saving money for the city.

3.1 CCTV Cameras

Vadodara city has identified many places to improve security and has mapped all operations and locations like traffic crossroads, sensitive zones and public venues. There are two sorts of cameras being used: static cameras and Pantilt-Zoom (PTZ) cameras. Both have FPS (Frames per second) values of 15 and 8, respectively and resolution of 1920*1080. All 409 CCTV cameras are scattered over 130 places and are equipped with an optical fibre network which strengthens the 24 core underground network.

3.2 Automatic Number Plate Recognition (ANPR)

The Automatic Number-Plate Recognition system in Vadodara city has numerous functions. The technology can trace up to four different photos of the same vehicle and can provide success rates of 80% or higher for standardised number plates. This also captures 75% of non-standard licence plates. It can recognise automobiles based on their colours and it will immediately generate an alert with the vehicle number plate screening. The -5 to +5 seconds for the occurrence and incident may be traced on the video clip.

3.3 Adaptive Traffic Control System (ATCS)

Vadodara's Adaptive Traffic Control System is powerful enough to provide vehicle detectors with real-time countdown clocks. The adaptive algorithm makes it more viable and saves a lot of time for passengers. These sensors can also map the volume of traffic, vehicle classifications and the directional distribution of vehicles in the locations. The same technology also controls lane marking and one-way traffic. Because this system is more beneficial at peak hours in saving fuel and time, it is now operational in the morning (9.30 am to 1 pm) and evening (5.30 pm to 9 pm).

3.4 Green Corridor

The Green Corridor in Vadodara is based on a sensor-based network that is linked to traffic lights. These traffic signals constantly respond to traffic conditions in real time and can be tweaked as needed, during peak time travelling. The duration of the traffic passage is currently plotted at a speed of 35 kmph. During office hours it controls as per the time pattern. However, during off-peak hours, this system maps the vehicle traffic pattern as well as the volumes and vehicle type to the command and control centre.

3.5 Public Address System (PAS)

The city of Vadodara has identified 33 areas where the PAS system has been deployed. The entire system is fully remote operated and linked to a speaker unit that is positioned in congested spots or iconic areas where the masses may be catered to using real-time communication. This aluminium body designed device can play both recorded and live audios to all locations or to a select number of places at the same time.

3.6 Environmental Sensors + Rain Monitoring

Vadodara city has established a network of eight places from which they may obtain data on temperature, humidity, pollution levels and air quality. These sensors are also used to monitor water levels near river regions to obtain real-time information regarding environmental activities. This sensor also collects data on rain and noise pollution. Authorities can read and report the following parameters with the aid of ICCC - temperature, humidity, ambient light, sound, CO, NO_2, NOX, CO_2 and SO_2.

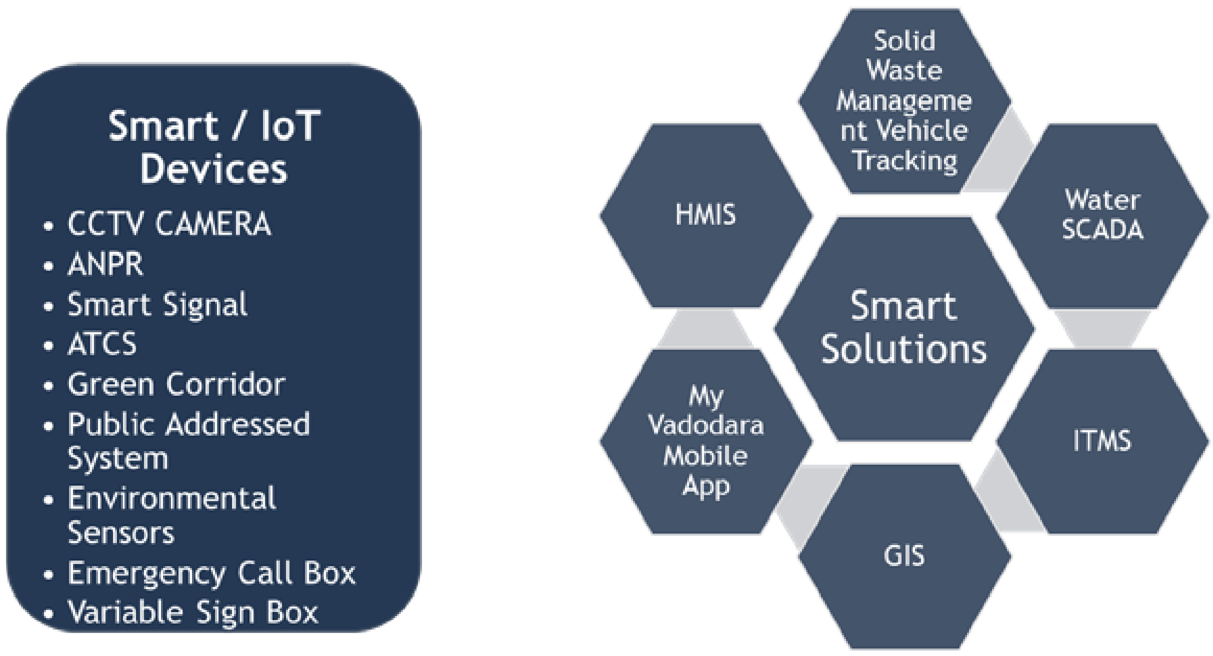

Figure-2: List of IoT devices and Smart Solutions

3.7 *Emergency Call Button*

The Emergency Box (or Panic Button) allows individuals to establish two-way audio communication (Microphone and speaker) with CCC by pressing a button. It also has a static camera for delivering still photographs of the caller to the CCC's incident collection. The photo and audio records for each event should be stored in the event library. A metal box contains push buttons and battery-operated gadgets are situated in 11 different locations. When a flood-like event occurred in Vadodara in 2018, this was widely used by the city's residents.

3.8 *Variable Sign Box*

Each location display is 3-m in length and 1.5-m in height. Every display is a LED with auto-diminishing brightness based on the amount of sunshine. It can display an image during a real-time communication through the CCC. This is the best-case scenario for generating income from displays while outsourcing it to advertising businesses for peak times into allotted time slots. Each of the 35 places is a sensor-based automated display that is now operational.

Establishing a Smart City using IoT and linked technologies improves the quality, performance and responsiveness of urban services, while also optimising resources and lowering costs.

4. Smart Solutions

The Internet of Things enables the development of Smart Solutions with new service offerings, increased productivity, less downtime and unparalleled levels of service. Devices and appliances in Smart Cities will be controlled by command-and-control centres. Smart solutions are essentially the collecting of multiple data-sets via IoT devices dispersed over the city's boundaries and connecting the dots of the data-sets to another set of information with ideas and values. This type of intellect strategy and ideas may be used to make real-time reflections. Smart solutions are an integral aspect of the centre since they are more organised, informative and collaborative of the centre's multi-mode classification. (Systems, i2V for ICCC)

4.1 *Water Supervisory Control And Data Acquisition (SCADA)*

The city's SCADA system was established with the goal of providing enough and high-quality water to its people. The overall goal of this project is to provide continuous water using cutting-edge automation technology such as instrumentation and SCADA systems for monitoring water supply flow and pressure in the main distribution line as well as automation of the pumping systems and booster pump house area.

The following are the SCADA System's characteristics that the city relies on the most:

- Water monitoring system that operates 24 hours a day, seven days a week.
- Improved efficiency, handling more infrastructure with less resources.
- Reduces break downs by overcoming human faults in operations.
- Direct monitoring from a centralised control centre.
- Automatic immediate reporting to all engineers involved.
- Monitoring is possible via a web-based application on a mobile device or any other device.
- People's safety and health are improved as a result of quality monitoring.

The ICCC's duty is to inspect online and insertion type flow metres that are based on sensors. Similarly, the water pressure level and the level transmitter are controlled from the centre. The pH Analyser along with the Chlorine Level Tester and Turbidity are also plotted for water quality. SCADA software is used from the centre to monitor butterfly valves with actuators.

Figure-3: Snapshot of all IoT Devices spread across the city

4.2 *Public Transport ITMS*

Vadodara Smart City has initiated an ITMS (Intelligent Transit Management System) to improve operational capabilities, citizen happiness, dependability and on-time availability of its services. It is devoted to providing city bus transit services for the citizens of Vadodara to deliver quicker, more dependable, environmentally friendly and innovative public transportation. The ITMS components utilised by the city and people are as follows:

- The Passenger Information System (PIS) is currently placed at 125 bus stops to monitor bus availability and scheduled arrival.
- Pole Mounted validators are handy for deducting to and from tickets for individuals who have daily passes.
- The Panic Alert Button communicates directly with the ITMS as well as the Driver Console for the same bus.
- Drivers may also report and update on-route challenges such as diversions and traffic jams using the feedback mechanism offered on their dashboard.
- More than 150 buses are tracked using Global Positioning Systems (GPS) and its exact location may be seen from the centre as well as from the mobile application.

This Smart ITMS is beneficial in the collection of transit data or information. It provides quick input to traffic management and passengers, ensuring a smooth travel for the citizens of the city. Real-time inputs are received for the fleet of public transportation buses which has been extended to the Vadodara district limit boundary. The transparency provided by the My Vadodara mobile application will improve commuter satisfaction, dependability and timeliness of bus operations.

4.3 *Enterprise Geographical Information System (GIS)*

Vadodara local body has established a Geographical Information System (GIS) to give VMC officials a comprehensive and dependable Decision Support System (DSS) that is integrated with other Information and Communication Technology (ICT). The National Remote Sensing Centre (NRSC) provides a Vadodara satellite picture (30-cm resolution) for mapping VMC's assets (on and below ground) utilising 82 Thematic Layers and 700+ Attributes. Sewerage, water network, storm water, SWM, public utilities, Town Planning (TP) Scheme, VMC road network, parks & gardens, Govt & VMC Hospitals, residential & commercial property layers and other levels which includes 23 departments of the VMC which have been mapped. Furthermore, approximately 6.6 lakh VMC properties have been surveyed and tagged as part of this initiative. (Vadodara Municipal Corporation, 2018)

A tool for Planning, Digging and Monitoring (PDM) is also being developed. Various VMC Departments as well as external utilities and network service providers will utilise this to request for digging authorisation using GIS (NOC). This will lessen the frequency and haphazardness with which roads are dug and avoid malpractices and wasteful expenditures on the part of VMC.

The process flow is depicted in the following points:

- Vendors or service providers must complete the online Permission Request form.
- The next step is to map their requirements on a GIS map and send this form to all relevant stakeholders.
- They can begin the planned digging as soon as they have authorisation and No-Objection Clearance (NOC).

The current Geospatial solution coverage is limited to the city. The current platform has the capacity to grow as the city's boundaries expand, adding more users, layers and department applications. The solution will be extended to external utilities such as telecom service providers, power service providers and the city's development authority for Spatial Database Infrastructure (SDI). The administration has been provided with precise location-based information in the form of an interactive map in order to detect COVID clusters and probable confinement zones.

4.4 Health Portal - Health Management Information System

Health Management Information System (HMIS) is a data collecting system created primarily to help in planning, management and decision-making in health institutions and organisations. The integrated HMIS being built for Vadodara Smart City Development Limited (VSCDL) is made up of three primary components:

- All residents of Vadodara will be able to use the web portal.
- Field health professionals (Asha Workers) will use the online software and a mobile application.
- HMIS application is for all facility users, whether they are from UPHC, private or government hospitals.

The web portal serves as the single point of access for all apps for all users. The complete system can be hosted in the cloud to provide 99.95 percent availability and scalability of the platform both vertically and horizontally, as well as cost-effective infrastructure management. The citizens' primary responsibilities via the web portal will be to see and update their Electronic Medical Records, update family information and obtain copies of birth and death certificates. Every citizen will be identifiable by a unique health ID which will be generated based on the individual's unique picture id evidence. The Government schemes can be monitored and controlled and the citizens requesting new registrations or data updates can be validated from the command-and-control centre. The live web portal is available both online on the website as well as on the mobile application to check the availability of beds, vaccination drives, oxygen monitoring and verify and trace medical records of citizens. This practice was used during the Covid-19 lockdown.

The health-related data captured by both the ANM application and HMIS will help the VMC internal users to get a summarised output for all citizens which will help in taking necessary preventive measures and effective decisions for the welfare of the society. This summary of the health records can be viewed through various reports and customised dashboards where all health-related performance monitoring Key Performance Indicators (KPI) will be highlighted area-wise across zones and Urban Public Health Centres.

4.5 Mobile Application

My Vadodara application is a one-of-a-kind mobile app that not only incorporates fundamental citizen-centric app functions (City information, complaint creation, property tax payment and so on), but also focuses on interactive and live services that make residents feel responsible and empowered. Unlike other cities that need residents and tourists to download a variety of Apps "My Vadodara" application functions as an all-in-

Figure-6: My Vadodara Mobile application screenshot

Figure-4: Snapshot of GIS Enterprise

Figure-5: Snapshot of HMIS Portal

Figure-7: Image of Smart Street Light

one solution to handle the demands of older people, students and tourists in a single app. The command-and-control centre monitors all the back-end processing of data.

- Citizens may use GIS technology to lodge complaints or issues on the My Vadodara app which allows them to take an image of the issue and post a complaint without providing any other data. The complaint is received by the appropriate official of the Municipal Corporation with a red tag which changes to a green tag only once the matter has been remedied.
- For the protection of women and older citizens, the app includes a Panic Button. In the event of an emergency, hitting this button will send a SMS to the person's relatives or friends, allowing aid to reach them as soon as possible.
- In addition to property tax different other taxes and services including fire, water and drainage have been incorporated as part of the e-Governance activity.
- Vadodara is home to a number of world-famous historical sites. The app utilises beacon technology to provide users with a real-time experience of these cultural sites including live messaging, photographs, music, videos, and so on.
- Sayaji Baug is Vadodara's oldest garden and home to a diverse range of trees, many of which are one-of-a-kind. These one-of-a-kind trees have been labelled with QR codes which when scanned reveal all the botanical information about them including images.

Citizens can download the 14 MB Mobile application directly from their Smartphones. Once logged in, people may follow public buses, door-to-door van collation vehicles, public spaces, washrooms and toilets and clinics near their homes. The bus routes to and from places, their schedules and the nearest bus stop can all be found on the app. This mobile application is being utilised by over 1500 households and the CCC can trace, input and access it as an admin console.

4.6 Solid Waste Management

Vadodara Municipal Solid Waste Management entails applying the Integrated Solid Waste Management (ISWM) concept to municipal waste. ISWM refers to the application for appropriate techniques, technologies and management plans for all forms of solid waste. The procedure remains the same for any city that is participating in these on-the ground activities. The vehicles gathering door-to-door waste have been mapped and over 20,000 points have been identified. The door-to-door pickup vehicle then transports all the segregated garbage that has been collected into the Transfer Station. This is followed by a series of steps after which the residual waste is deposited into the disposal area.

- The integration of SWM with other departments such as sewerage, water supply, health care and engineering has been done to reduce complaints and improve collective efficiency.
- The emphasis is on resolving issues that arise from the Complaint Redressal System via Global Positioning System (GPS) tracking and the Litter Prevention System via CCTV cameras.
- The company has made a financial commitment to supply necessities and a baseline set of tools. Each vehicle and piece of equipment is tech enabled and mapped using ICCC.
- Citizens are included through an effective campaign, digital social media outreach, audio video images and a public address system.

The My Vadodara Smartphone application tracks each door-to-door collection vehicle in real time. Garbage is collected from the door of the residential and commercial locations by specially designed closed-body vehicles. This system gathers more than half the city's waste. The door-to-door Garbage Collection Device vehicles are equipped with a GPS tracking device. Each vehicle is a closed vehicle due to the prevalent spoilage of waste on the road. As the transfer station is semi-closed, it has helped to eliminate foul odours. There will be no municipal solid waste storage, either permanent or temporary, at the transfer station because it will be delivered straight to containers without further treatment resulting in no flies' nuisance and animal access restrictions.

4.7 Smart Light Poles

The Public Wi-Fi and iPoles project aims to provide Wi-Fi Internet services across the city on a totally Public Private Partnership (PPP) basis for the first time in India under the Smart City Mission. The project is divided into two parts, namely the public Wi-Fi services to be used by citizens and the Intelligent Poles with Smart installations.

- To kick-start the project, VMC is providing two OFC pairs out of CCTV project to carry internet bandwidth required for the citizens.
- iPoles have the provision to install 2G/3G/4G (and upcoming technology) mobile antenna which can be given on rent.
- Smart billboards can show third party advertisements.
- Beyond 100 MB/30 minutes of free usage, premium Wi-Fi data packs can earn additional revenue.
- Additional fibre duct being installed by the concessioner along the route can also generate additional revenue.

The project is being constructed under PPP with a revenue promise of Rs 22.41 crore to VSCDL/VMC over a 15-year concession period (out of that Wi-Fi service would run for 7 years). M/s Indus will invest about Rs 200 crore in this project. As part of this project, 450 intelligent poles (with a height of 12-m and a height of 30-m) will be erected in key areas of Vadodara. Around 200 iPoles will be operational in the first few years. This project imposes no financial strain on VMC or VSCDL because the concessioner is making the total investment. (Vadodara Smart City Development Ltd., 2020)

4.8 Fire and Emergency Response

The Vadodara Fire and Emergency Services are being modernised with cutting-edge technology and control systems. The Vadodara Fire and Emergency Services have ICT upgradation of fire stations and ICT enabled fire services to provide speedier and efficient service to keep Vadodara safer under the Smart City Programme, which has cost Rs 7.95 crore. Artificial Intelligence, GPS, CCTV and a sonar system are among the modern technologies being used to track cars and expedite rescue efforts. ICT advancements enable the collection of real-time location data for fire vehicles. It gives the Fire department rapid feedback about on-the-ground initiatives. It provides facilities for real-time monitoring of fire engines and viewing the incident area.

- Each fire vehicle is fitted with an IoT device that can be monitored via the ICCC. Real-time call details, GPS tracking of the complainant and location auto identification of the caller can also be seen from the screen.
- The position is exchanged in real time with the respected nodal agent, fireman and driver console and can command via IoT devices.
- Water level sensors have been installed in the fire department's emergency truck. Due to the sonar system and the driver, a green corridor can be obtained as they move through traffic.
- The vehicle's front and back panel are fitted with CCTV cameras for real-time surveillance from ICCC.
- AVLS (Automatic Vehicle Locating System)

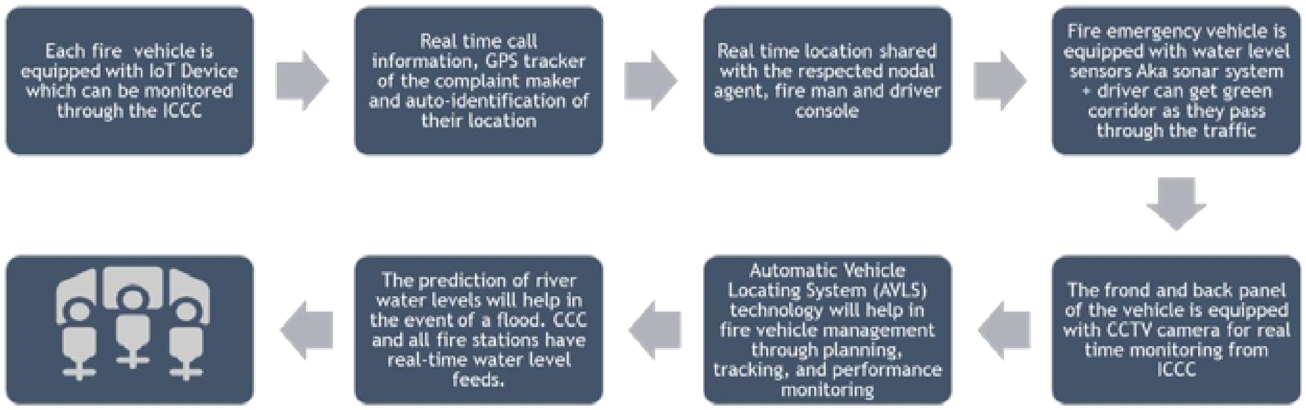

Figure-8: Work Process of Fire Department technology will aid in fire vehicle management by assisting with planning, tracking and performance monitoring.

- Forecasting river water levels will be useful in the case of floods. The CCC and all fire stations have real-time monitoring.

It is now easy to submit incidents in incident management. The time of incident reporting at the Central Fire Station, the time of dispatch from the Fire Station, the time and route travelled to reach the location and the time taken to finish the activity all can be recorded.

The navigation feature will have a significant influence since the driver will be able to view the traffic on the maps, avoid crowded routes and arrive at the place in the shortest time thanks to the Mobile Data Terminal and GPS installed in the Fire Tenders. The prediction of river water levels will be useful in the event of floods or flood-like circumstances. The Fire Department operation is now automated with real-time water level trace feeds accessible at CCC and all fire stations.

5. Stakeholders

For any project to be completed successfully, numerous parties must work together. As a result, it is critical to comprehend the many stakeholders that participate in a project and the roles they are expected to perform. The following are the essential stakeholders whose participation will propel the project and allow the formation of robust project governance. (Smart Cities Mission, 2016)

5.9 Vadodara Municipal Corporation

The project will be led by Vadodara Municipal Corporation (VMC) in collaboration with Vadodara SPV. The VMC will also oversee maximising the use and acceptance of ICT functions among city departments. VMC departments are crucial for encouraging adoption and will be the project's final customers. The project's immediate advantage will be felt in each department. There are total 28 departments which are already integrated to come up with the expected outcome.

5.10 Vadodara City Police

The main objective of the Vadodara City Police Force is to protect and secure the inhabitants of Vadodara, which has a population of about 22 lakh. The cameras installed at over 100 sites are continually watched collaboratively by the police force in order to control the ongoing situation and avoid any sensitive information from being revealed.

5.11 Vadodara Fire Department

The city's fire department will be prepared to respond to any emergency, whether it is medical, civic or fire related. Although the fire department has its own specialised video walls and operations and administration, the same situations are monitored by the ICCC and can aid the department with any mitigation or preparedness.

5.12 Central Ground Water Department

The water department not only works inside the municipal boundaries but also extends beyond the urban development limit to ensure that every property has a seamless water supply connection. The incoming water flow from the source to the tap is monitored using a SCADA system and departments are evaluated based on the data-sets generated by the system in accordance with the KPIs. (Key Performance Indicators)

5.13 Regional Transportation Office

The city of Vadodara in Gujarat has one Regional Transport Office (RTO) that is incharge of different activities including cars, drivers and enforcing traffic and transportation laws and regulations. A few functions of the Vadodara RTO from the command centre are to monitor transportation lines, public transportation, vehicle tax collections and executing vehicle checks through number plates.

5.14 Gujarat State Disaster Management Authority

The Gujarat State Disaster Management Authority's duty is to give assistance to individuals for losses caused by natural disasters as well as to conduct rehabilitation and rebuilding along with social and economic activities and restoration of the situation. They will also undertake efforts to reduce the effects of natural disasters through preventive programmes and schemes. During an emergency, all real-time data acquired by IoT devices is analysed and actions performed depending on the evidence.

5.15 Consultants

The Project Management Consultant will be incharge of the overall project design, RFP & bid and vendor on-boarding. PricewaterhouseCoopers (PwC) is the principal owner for comprehensive project design and project implementation on the ground. They are incharge of providing appropriate guidance and support during acceptance testing for the integration of the core system to each of the sub systems. Following that the implementation partner will serve as the principal owner for operations and maintenance (O&M).

5.16 Citizens

The elected candidates of the government are the citizens' representation and all activities, programmes and initiatives are their responsibility. Citizens' comments as stakeholders are critical for the development of the ICCC since they directly profit from the same. Whether it is to monitor property taxes, track solid waste vehicles or even during the Covid-19, the command centre has offered adequate support to the people by connecting with them via the numerous IoT devices.

6. Discussion and Areas of Improvement

6.1 Stakeholder Interview

Throughout the research, results, primary field visits and secondary recording of the project various stakeholders were identified whose engagement in the ICCC was important. During the interview process we came across several ideas, implementation challenges, and used case scenarios where stakeholders joined for the betterment of the citizens. Several stakeholders were met during the whole process of gathering data-sets, information, field trips and many other actions and their contribution was crucial in documenting this research. Among them were consultants, government officials, senior position holders, the ICCC's administration incharge and a GIS expert. All their responses were recognised and documented. (Vadodara Municipal Corporation, 2016)

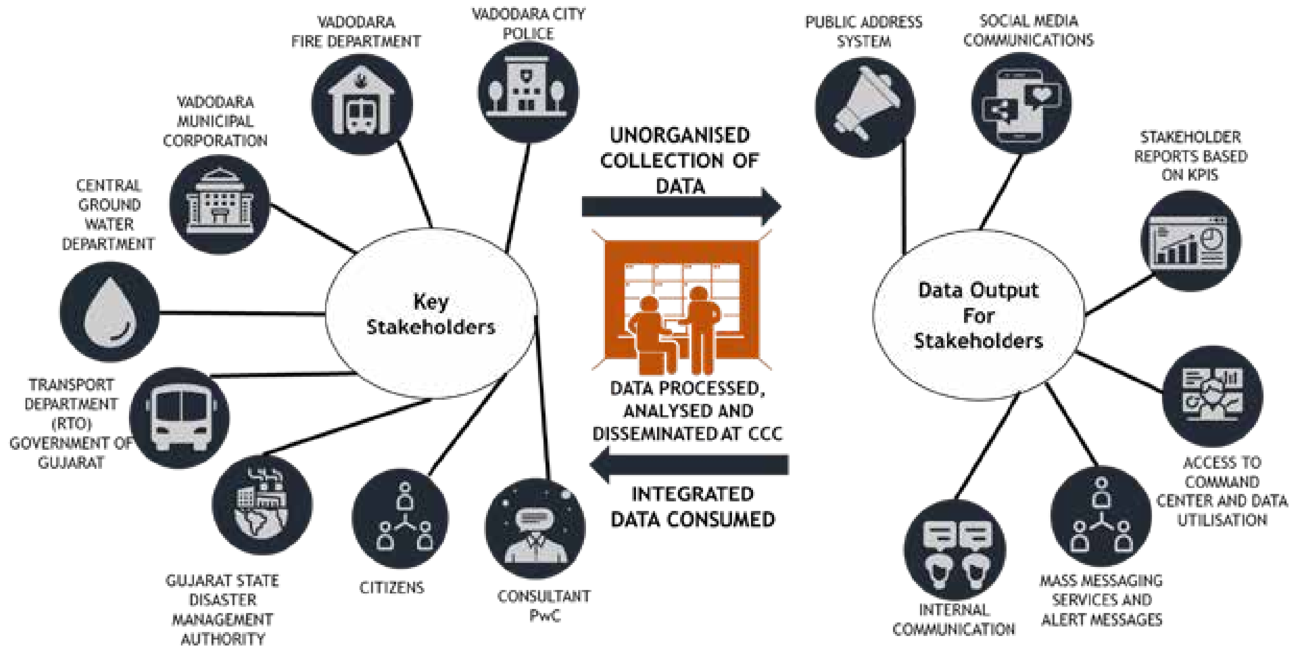

Figure-9: List of Key Stakeholders

6.2 *Risks Identification*

Several risk areas were identified to the ICCC during the stakeholder interviews and while determining the process. Some of the risks can be mapped and their impact on the entire process of the ICCC must be considered. The concerns may be reduced by consistency, standardisation of technology and skilled manpower.

When an Internet of Things device fails, it is vital to gather real-time information and data-sets from the places where the IoT devices fail. The initial difficulty may be seen from a device aspect, specifically the sensing gadgets because of their extremely restricted nature. These restrictions apply to the battery, memory and processing power of the IoTs. For IoT applications, battery life is a concern. Weather changes may also have an impact on their present position and performance.

The ICCC is a massive amalgamation of several departments, numerous stakeholders, governments and their policies. The stakeholders' coordination is at its optimum over the course of the working environment. A high level of communication is necessary as is the integration of intelligent insights from each stakeholder's point of view. When a high degree of information is communicated through individuals, a lack of coordination, communication or connection may result in undesirable effects.

The admin access and data entry personnel are also accountable for accurate information inputs, timely updates and constant refreshing of the insights into the dashboard. The back-end application user, Asha workers or GIS enterprise employees may enter data that is either outdated, erroneous or misinterpreted, posing a danger to citizens. The incorrectly entered data-sets may be traced in real time to each of the stakeholders and their prompt action may result in turmoil and unforeseen conflicts.

6.3 *Challenges for ICCC*

Following the identification of risks, the challenges of the operating level are also major critical components of ICCC. Challenges at the operational level are critical for the development of the control centre mechanism. The ICCC is a phased eco-system. It comes with several micro level operational challenges that however little, require attention from the authorities to alter their work patterns.

ICCC is a new idea as well as a technological operation that demands expertise to run. However, as all the manpower comes from diverse backgrounds it is necessary to have specific rounds of training and capacity building workshops. Only the GIS needs a highly skilled and knowledgeable workforce along with support from other departments to upgrade their work patterns as per the new Planning Digging Module. As a result, a capacity-building session for each stakeholder and employee is required to keep them up-to-date with technology and work patterns.

ICCC is an ecosystem and a collection of databases with a wide range of services and strategies. The IoT sensors are tracking every activity in the city and mapping all data-sets into the datacentre. The city has already developed infrastructure and obtained all the data, but if these data-sets are not used to analyse patterns or trends the ICCC's goal will not be met. To maximise the benefits of the ICCC and their data-sets, the acquired data can be used with a specific goal and result oriented output.

ICCC as a service is a very cash-savvy and expensive enterprise that comprises not only many displays but also city-wide infrastructure to track each corner of the city. This is already being implemented in the city of Vadodara. The idea may now be applied to other adjacent small towns, villages and industrial cities. The 100-km peripheral coverage may be expanded to prevent duplication infrastructure costs and save the government a lot of money. At the same time, the war room provides the authorities with the freedom to evaluate distance information which can be managed through the Vadodara ICCC.

6.4 *Areas of Improvement*

The study identified many important areas where this system may be enhanced in the best capacity after rigorous discussions and engagement with various stakeholders. The existing system is fully operational and all relevant departments are already operating to their maximum potential. Each department of the Vadodara Municipal Corporation, Smart City authorities and other state and national level administrative authorities are in the loop and have access to the system as needed.

The lack of red-light violation cameras leads citizens to disregard traffic rules and regulations, resulting in driver errors and accidents. As a result of deployment of red-light violation cameras, traffic offences tend to be reduced. This is a step in the right direction towards encouraging safe driving and enabling pedestrian access to the highway, particularly while crossing the street at zebra crossings. This policy is expected to expand the usage of zebra crossings and allow more commuters to use other modes of transportation than autos. This sort of a monitoring gadget is critical in areas around railway stations, bus stops and other important landmarks.

Vadodara is surrounded by commercial townships and industrial zones. However, this has resulted in the biggest mess when it comes to parking. Each car is parked on the ground, obstructing other vehicles and resulting in traffic mismanagement. Because the city has previously developed sufficient infrastructure to monitor these operations, parking monitoring is an area for improvement. Effective parking monitoring can eliminate on field congestion, particularly in residential areas, while also organising the parking system as a whole.

The infrastructure is already in place for the city to monitor, access and interact with people and departmental associations. The system will be most effective when each department uses it to its full potential. Capacity building for each department is essential for improvement. This will be done either by the ICCC's administrative department or through experts. Better capacity building will enable stakeholders to use the data-sets and information to develop evidence-based solutions with measurable outcomes.

7. Conclusion

The ICCC is a project of the Vadodara Municipal Corporation as part of the Government of India's Smart Cities Mission. The Vadodara Smart City Development Ltd (VSCDL), a Special Purpose Vehicle (SPV), is in charge of carrying out all Smart City Projects in the city. Inaugurated in 2017, the ICCC platform is connected with an 80+ layers of GIS platform for the project. This centre is attached to the CCTV project of the Vadodara City Police Department which includes 409 CCTV cameras at various locations.

This centre collects functional information from all departments and the public in real time. Automated sensors and systems provide numerous data-sets to the ICCC which are processed to provide critical information for decision-making. All VMC's internet and mobile apps for people-centric services will be monitored from a single location at the Smart City Centre. The birth and death records, pertinent information on development plans and basic services, such as water supply, are being integrated. During natural disasters such as floods, authorities from several agencies can communicate through the centre.

VSCDL is now able to monitor traffic flow, regulate the smart street lighting system and maintain a bird's eye view of the city from a single place thanks to the deployment of this pilot project. The centre collects functional information from all departments and the public in real time and assists them in meeting the daily civic service delivery criteria.

Emergency management in the city benefits from the combination of forward-thinking system design and end-to-end integration. The tools required cope not only with today's dangers but also with swiftly changing conditions and technology as they develop. Any sensor input, video, data or voice from any source can be easily included into the data stream and accessible by whoever requires it.

Not only does ICCC management comprehend the entire scenario but people on the ground are also kept up-to-date on the status of other teams and resources. This unified picture of status and events minimises misunderstandings and allows for much faster and more effective decision making. Departments are now better equipped to deploy proper assets, resulting in maximum reduction in response time. City authorities may now prioritise and deploy emergency resources based on their understanding of how complicated and/or how many disasters affect the whole region. Resources are managed in a fully coordinated and effective manner that considers all requirements of the community, not just those of a particular incident.

The integration of information, systems, data sources and people is critical to ICCC, but it proved challenging. Not only must the city combine all the technologies now utilised by the multiple stakeholders but it must also integrate other external organisations and show aggregate output to the residents of Vadodara.

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A3

Mobility as a Service – Surat

Name of the project: *Mobility as a Service, Surat Intelligent Transport Management System (ITMS), Automatic Fare Collection System (AFCS), Surat Money Card*
Location: *Surat, Gujarat*
Year of Project Implementation: *ITMS- 2016, AFCS – 2017, S Money Card - 2017*
Sector: *Transportation*
SDG: *SDG 11.2*
Project Cost: *ITMS – Rs 55 crore, AFCS - Rs 30 crore, S Money Card – Rs 44 crore*

Institute: *CEPT University*
Advisors: *Dr. Gayatri Doctor*
Students: *Swetha Chandran*

Keywords: *Surat Municipal Corporation, Mobility, Ridership, Revenue, Transportation, Smart city, citizens.*

Abstract

Mobility as a Service (MaaS) is often suggested as the tool for achieving sustainable mobility and especially in increasing the share of public transport in cities. MaaS is a paradigm shift in the transport space. Its benefits include easy route planning, simplified payments and fully personalised service that builds relationships between the users and the transport provider. The Surat Municipal Corporation (SMC) used various Smart tools such as Intelligent Transport Management System (ITMS), Automatic Fare Collection System (AFCS), Surat Money Card and Intelligent Traffic Control System (ITCS) to bring efficiency in public transport. Using these Smart tools, Surat Municipal Corporation integrated various forms of transport service and tried to bring them onto a single platform. This case study focuses on analysing the efficiency provided by ITMS, AFCS and Surat Money Card to public transportation.

Case Study: A3

1. Introduction

Intelligent Transport Management System (ITMS) is an application which includes the control and information systems that use integrated communication and data processing technologies for improving the mobility and efficiency and enrich users or commuters with prior information about real time running, tracking of buses, seating availability, traffic etc, enhancing their safety and comfort.

Automatic Fare Collection System (AFCS) is a ticketing system in public transport where the fare is no longer paid directly but paid via ticketing machines, online services or other methods. It is an automated version of the manual ticketing system and is based on integrated ticketing which refers to those tickets which are valid across different operators and modes.

In the cities of a growing country like India, cashless travel on public transportation systems has not gained foothold. The Ministry of Urban Development in India has launched the 'More Card,' with the goal of standardising the Smart card-based payment system across all public transportation systems in the country. Surat Municipal Corporation (SMC) together with ICICI bank introduced Surat Money Card, the Smart city card which is used in BRTS and City bus travel tickets and passes and SMC civic centres for tax and bill payments.

1.1 Aim and Objectives

The project's goal is to research and evaluate a pan–city initiative - Surat Smart City project. The Intelligent Transport Management System (ITMS), Automatic Fare Collection System (AFCS), and Surat Money Card projects must be researched and the project's existing situation must be analysed and documented as a case study.

2. Surat City Profile

Surat Municipal Corporation has a population of approximately 4.5 lakh people. Surat has attracted migrants from adjacent rural areas and cities due to its abundance of opportunities for labourers and investors.

As a result, the need for intra-city transportation has risen. SMC limits were raised from 112.28 sq km to 326.515 sq km in 2006. To offer transportation services and manage traffic, the city's expanding geography necessitates a high level of cooperation and consistency. Surat has a bus transportation system with 291 operational lines and a daily average travel of 0.22 lakh kilometres. The residents of Surat favour personal vehicles and auto-rickshaws to public transportation. This has resulted in a situation where 60 percent of private vehicles which lead to city roads have significant on-road parking issues, obstructing traffic flow.

Table 1: Demographics of Surat

AREA	1981	1991	2001	2011
Surat Municipal Corporation				
Area (sq km)	54.64	112.56	114.56	326.51
Population	776586	1498817	2433785	4462002
Growth rate in decade (%)	-	92%	62%	83%
Population density (per sq km)	13977	13483	21678	13665
Surat Urban Development				
Population	984677	1765466	3095676	4685367
Decadal Growth Rate (%)	-	80%	75%	65%

Source: (Surat Municipal Corporation, 2022)

2.2 Key challenges in public transportation:

Surat is a sprawling industrial and commercial centre in Gujarat. It is India's eighth largest city. Surat is one of the major thriving economies and is a popular location for job seekers around the country. This can be observed by the fact that the city has routinely experienced decadal growth rates in excess of 60% over the last five decades. If current growth trends continue, the city will face considerable mobility issues. The main difficulties are: (sustainable urban transport index, surat, 2018)

- By 2046, the population will have doubled from 60 lakh in 2016 to 125 lakh.
- From 18 lakh in 2016 to 72 lakh in 2046, there will be a 2.9-fold rise in the number of personal vehicles (2-wheelers and cars) on the roads.
- Number of passengers increased by 2.3 times from 53.42 lakh to 124 lakh.
- Congestion on the network increased from 14% to 57%.
- Speed of buses dropped from an average 28 km/h to less than 18 km/h.
- The average commuting time of residents increased by 2.6 times, from 13 minutes to around 34 minutes.
- Accidents have risen by 2.8 times
- GHG emissions have doubled.

3. Comprehensive Mobility Plan 2046

The Ministry of Urban Development, Government of India formulated the National Urban Transport Policy (NUTP) in April 2006 which envisaged the comprehensive mobility plan. The Comprehensive Mobility Plan is a strategic document which provides long-term vision for accessibility and mobility of people in the city to provide safe, secure, efficient, reliable and seamless connectivity. It covers all elements of urban transport under an integrated planning process.

Surat's Comprehensive Mobility Plan 2046 is a strategic transportation plan designed to meet the city's future mobility needs. It provides a long-term vision as well as a road map for achieving an integrated and sustainable transportation system by 2046. For this Surat Municipal Corporation worked with Surat Urban Development Area (SUDA) and other stakeholders. A series of stakeholder consultations were held to incorporate the people of Surat in the planning process. Aside from consultations with transportation stakeholders, the public was polled via an online forum, where they gave their opinions on the important issues facing Surat and their expectations from the plan. People highlighted traffic congestion, safety and insufficient public transportation as major difficulties, with safety, efficient mobility and seamless connectivity outlined as critical expectation areas. Priorities in the plan included reducing traffic and air pollution as well as managing parking lots and focusing on public transportation, safety and walkability.

3.1 SARAL – Safe Accessible Reliable Advance and Low Carbon Mobility

Keeping in mind the focus area and challenges, the Comprehensive Mobility Plan (CMP) 2046 was drafted. The plan's five strategic targets have been outlined in accordance with the vision of 'SARAL Mobility 2046':

- Providing a safe and sustainable transportation system to improve people's quality of life.

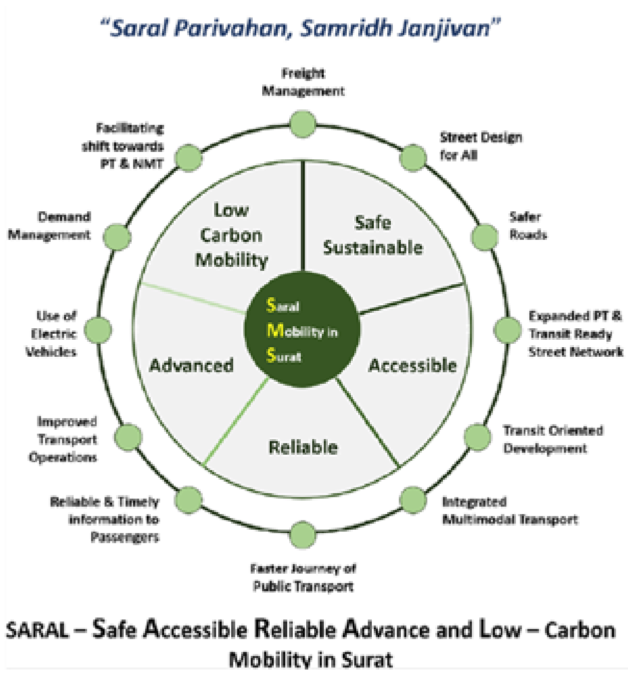

Figure 1: SARAL 2046
Source: (Comprehensive Mobility Plan 2046, 2018)

- Providing accessibility for people and products to improve the activity centres to support economic growth in the city.
- Providing dependable multi-modal travel options to ensure smooth connections.
- Using advanced technological applications in transportation, optimising operations of the transportation system and improving people's travel experiences.
- Promoting low-carbon mobility as a way to help the environment

The Special Purpose Vehicle (SPV) called Sitilink Limited was created which looks after the city-wide public transportation. The Surat Sitilink Ltd Company, incorporated on 07 August 2013 under the Companies Act 1956, is a fully owned subsidiary of the Surat Municipal Corporation. It is engaged in Mass Public Transportation – mainly the BRTS and city buses. At present, Surat Sitilink Ltd operates 157 buses and 575 city buses in Surat city.

Smart tools such as the Intelligent Transport Management System (ITMS), is subcontracted to the Technical Service Provider (ARS T & TT Technologies) by the SMC. The AFCS is managed by the sub-contractor NEC Corporation which provides hardware and software solutions. The banking service and support for the Surat Money Card is provided by ICICI Bank.

4. Existing Bus Service in Surat:

Under the new National Urban Transport Policy (NUTP – 2006) SMC plans to provide last–mile connectivity to a majority of the city's 50 lakh residents. Sitilink Ltd, an SPV under SMC, currently operates the City Bus Services (CBS), Bus Rapid Transit Services (BRTS) and High Mobility Corridor (HMC) on a gross cost basis.

4.1 City Bus Service:

Currently, there are 31 routes operating within the SMC region with 242 buses on the road. Daily the bus system transports around one lakh people (June 2018). All these are minibuses that are operated on a Gross Cost Contract (GCC) by three separate private operators. Currently, City Bus Service covers 73% of the Surat Municipal Corporation area.

4.2 Bus Rapid Transit Service (BRTS):

Sitilink launched BRTS Phase-I, a 30-km network in 2014 and today with a 102-km network in operation, it has the largest BRTS network in India. At present, the BRTS network carries around 80,500 passengers per day. Sitilink BRTS has connected the important transport points such as railway stations, GSRTC points, residential and commercial centres as well as recreational and public areas of the city. BRTS buses travel at an average speed of 24 mph which is quite fast when compared to the existing city bus services and auto rickshaws.

4.3 High Mobility Corridor (HMC):

Surat's Inner Ring Road is circled by the 12-km High Mobility Corridor. It is expected to meet the main city's high mobility needs. In its present condition, the HMC has just two primary operational routes.

5. Difficulties in conventional transport

Surat's two major bus services, Bus Rapid Transit (BRT) and Surat City Bus Service (CBS) transports 2.5 lakh passengers daily across the city. Despite affordable ticket prices the bus services were under-utilised due to customer concerns over quality.

The manually operated systems suffered from poor route planning, lack of advertised bus schedules, bus-bunching, excessive waiting time, rough driving, stop skipping and inconvenient or inconsistent cash collection.

A lack of transparency also resulted in higher operating costs and poor customer complaint handling. The city authorities were keen to upgrade to a cashless, software-based bus service system backed by advanced information and communication technology to help reduce expenses and problem-response time.

The lack of scheduling and planning led to improper drivers and conductors'allocation. The Logbook maintenance led to manipulation and losing of data. The number of kilometres travelled, speeding of vehicles, expected time of arrival kept changing due to the lack of travel monitoring.

5.1 Need for Smart tools:

Smart tools in the public transportation sector were essential to regularise the increase in ridership and provide quality service to citizens. The Smart introduction was very important in driving Surat towards a sustainable urban mobility city. By improving the quality of public transport through which the greenhouse gas emissions were reduced and utilisation of private vehicles could be reduced. The major points for which Smart tools were introduced are:

- To make the public transport system adequate
- To control the speed and movement of vehicles
- Reduction in stops and delay management
- Capacity and incident management
- Travel time management
- Increased transparency
- Enhanced data centres

5.2 Leverages in Surat transportation:

The Surat Municipal Corporation adopted Smart tools for public transportation system. The Smart tools adopted are :

- Intelligent Transport Management System (ITMS)
- Automatic Fare Collection System (AFCS)
- Surat Money Card
- Integrated Command and Control Centre (ICCC)

The various types of leverages in public transportation following the adoption of Smart tools include the integration of various bus services, an increase in city network from 10 km in 2014 to 430 km in 2019, information such as tariffs, maps and timetables identified, technical services such as GPS, Electronic Ticketing Machine (ETM), Point on Sale (POS) are in place and improved public transportation efficiency through ITMS, AFCS analysis.

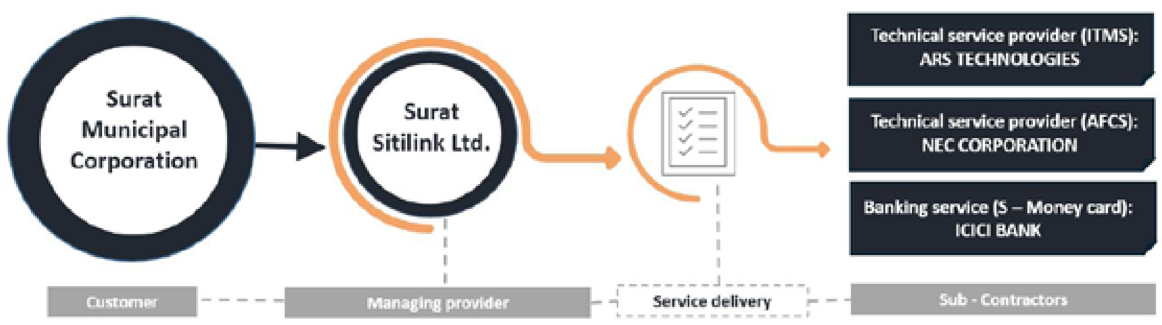

Figure 2: Stakeholders Involved
Source: Primary

Figure 3: Surat Mobility Map
Source: (Surat Municipal Corporation, 2022)

6. Intelligent Transport Management System – ITMS

Surat Municipal Corporation implemented a city-wide integration system, Intelligent Transit Management System to manage the diverse set of transportation needs of the city which includes public transport and vehicles related to civic services like solid waste management, drainage, heavy engineering and emergency services. The aim and objectives of implementing ITMS was to bring the best operational efficiency and operational capability to ensure that the services are delivered constantly and meets the service excellence. The ITMS in its current scenario is expected to bring about a paradigm shift in service quality, operations and integrate all transit systems.

The SMC awarded the contract to design, implement and operate the ITMS system, a city-wide integrated platform for various transportation needs to ARS Traffic and Transport Technology. The implementation included the BRTS, city buses and vehicles used for other civic services such as solid waste, engineering and emergency services.

The ARS Technologies secured the contract published by SMC in 2016. The capital amount invested in the project was Rs 48.99 crore in which Rs 33 crore went for implementation of the project and Rs 15.99 crore was utilised for the operational and maintenance phase. The ARS T&TT manages real time travel information, arrival/departure time and unplanned and scheduled changes etc. For ease of commuters over 150 passenger information displays were installed at BRTS stations and over 800 displays were installed at city bus stations in Surat which are monitored by the ARS T&TT. Commuters can also access this information through the SMC website and mobile application.

6.1 ITMS components and footprint

The ITMS system acts as a common city platform and allows individual services to maximise the utilisation of the common tracking and operations management platform. The ITMS acts as the Central Operational Management System which created the unique operational capability for individual stakeholders like fire, ambulance etc to meet their requirements which increased their capability to better respond to the service requests.

The ITMS is made up of many software and hardware components. The software components are:

- Vehicle Planning Scheduling and Dispatch (VPSD)
- Automatic Vehicle Location System (AVLS)
- Depot Management System (DMS)
- Enterprise Management System (EMS)
- Incident Management System (IMS)

The hardware components are:

- Bus Driver Console
- Passenger Information System – BRTS, City Bus Station and Inside Bus
- GPS – BRTS, City Buses, SMC Vehicles

6.2 Vehicle Planning Scheduling and Dispatch – VPSD

The VPSD is prepared by Surat Sitilink Ltd, a special purpose vehicle. The scheduling and dispatch software is used in designing and modifying the transit routes. The VPSD with combined technologies such as AVLS increases the transit operations, enhances safety and improves services. The VPSD is capable of dynamic planning and optimising the movement of 850 vehicles. This provides automatic dispatch distribution, dynamic vehicle rescheduling and real–time event assessment of drivers.

The VPSD system delivers schedule adherence reporting, route monitoring and conditioning, emergency interfaces and dynamic scheduling and dispatch services from designated operation sites inside the SMC operational framework. VPSD not only adds capability to transit vehicles but also to other municipal vehicles used for solid waste, engineering and emergency services.

6.3 Automatic Vehicle Location System – AVLS

The AVLS is web-based and uses a high-resolution digital map to show the real-time location of buses. The control centre operators use the software to track buses using maps and transit route lines. The AVLS is planned to offer corporate capabilities, allowing many user types to carry out various duties as standard functionalities such as Alarm Management, Vehicle Schedule Tracking, Speed Management, Stoppage Management, Route Replays, Bus Tracking Dashboard, and so on.

The software enables the personnel of the control centre to make timely decisions by offering graphical visualisation capabilities. SMC is able to examine and evaluate information and online data in several dimensions. The vehicle tracking in BRTS happens every 3 seconds and in city buses it happens every 6 seconds.

6.4 Depot Management System – DMS

Depot Management System plays an important role in the availability and safety of transit buses. Depot resources carry out day-to-day maintenance of vehicles and preventive and predictive maintenance of the schedules. The depot management is primarily responsible for the following functions:

- Crew restoring, vehicle maintenance and operational requirements like fuel.

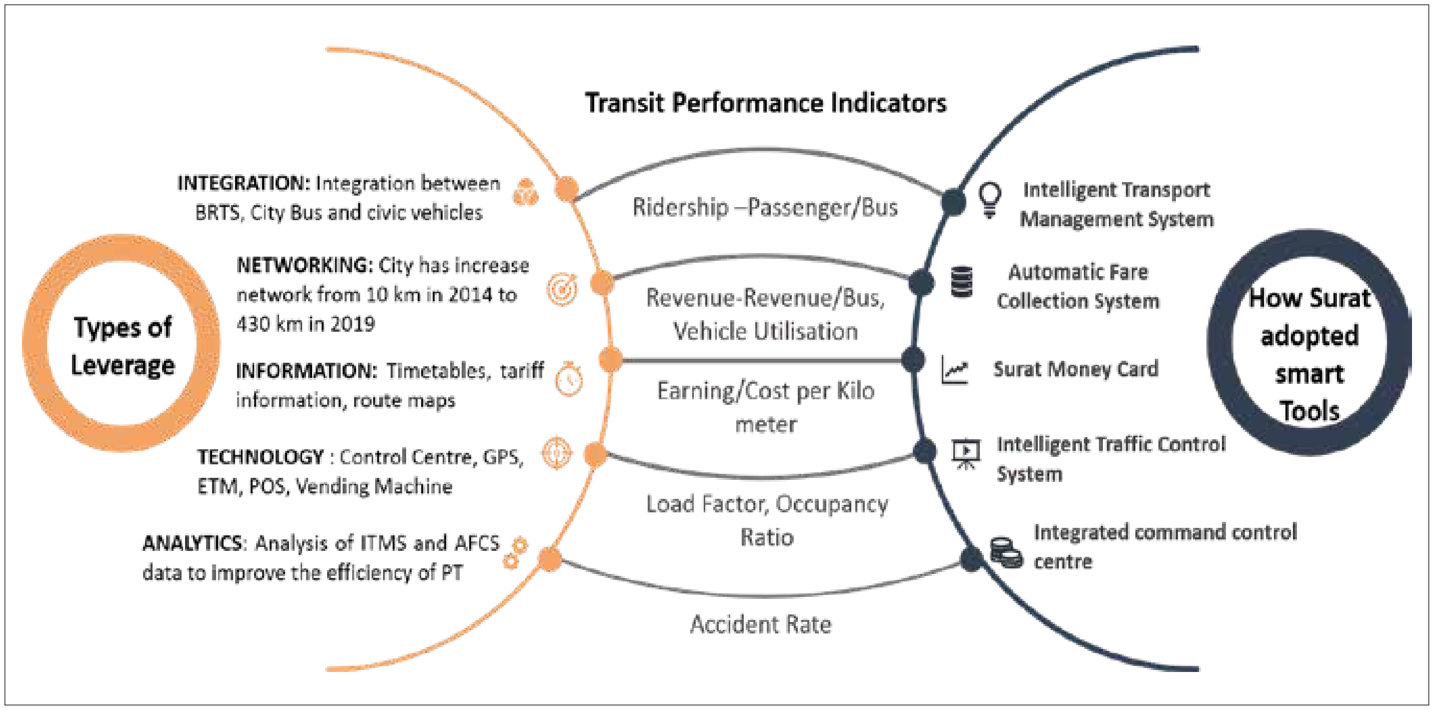

Figure 4: Transit Performance Indicators and Transport Leverages in Surat
Source: (Surat Municipal Corporation, 2022)

Figure 5: ITMS poster
Source: (Surat Smart City, 2016)

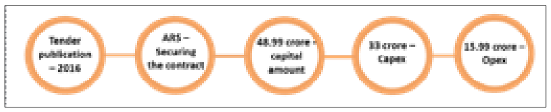

Figure 6: ARS T& TT Securing the Contract
Source: Primary Interview

- Vehicle scheduling and dispatch using scheduling system
- Maintenance expense of the buses

6.5 Incident Management System – IMS

The Incident Management System has an efficient and coordinated management of incidents to reduce the adverse impact on public safety and traffic conditions. The IMS helps in reducing vehicle delays and enhances safety. The IMS is a planned effort to reduce the impact of accidents and improve overall safety. The operational incidents such as traffic congestion, accidents, riots, vehicle breakdown, fire incident, etc are logged in the system and monitored.

6.6 Passenger Information System – PIS

The Passenger Information System is a critical component of an intelligent and integrated ITMS. Accurate and timely PIS delivery fosters consumer trust in public transportation and in the long run, supports modal shift as customers see the reliability and availability. The PIS has been fitted in 184 BRT stations, 998 city bus stations, 07 interchange stations and 26 terminals. It is also set in 160 BRT buses and 575 city buses.

6.7 Bus Driver Console and GPS – BRTS, City Buses, SMC Vehicles

The bus driver console is a multi–functional display unit, integrated with the AVLS system. The bus driver console has been fitted in 166 BRTS buses and 575 city buses. The GPS is fitted in all the SMC civic vehicles, BRTS and city buses. The vehicle tracking system like GPS is also fitted in 160 BRT buses, 575 city buses and 584 SMC civic vehicles. The SMC vehicles include emergency vehicles, solid management vehicles and engineering and administrative vehicles.

7. Surat Money Card

Surat Municipal Corporation's concept of payment digitisation is when the same payment instrument may be utilised in numerous locations by the residents. The system is intended to provide significant convenience to citizens by allowing them to pay for all city services electronically using a Smart card, including transportation, municipal services such as library, swimming pool, community hall, entertainment and amusement park, parking, bill payments, utility payments, and so on.

The City Payment Card's underlying concept is to employ a single payment instrument for all city-wide services. This made it easier to combine the city's transportation systems with other services. SMC introduced standard fare medium across the city. Surat Municipal Corporation and ICICI Bank Limited collaborated to launch the Surat Money Card. The bank acts as the Clearing House for other Municipal Services Applications, Card Management Services, initialisation, personalisation, and so on. The total capital cost incurred for Surat Money Card was Rs 44 crore.

The Surat Money Card is in two categories - personalised and non–personalised. The personalised card has the name and takes about 30 days to get the card after applying. The non-personalised card can be fetched immediately from the ICICI banks or from the SMC office. Because the cards are open standard-based they may be used across all transport and retail modes, as well as for other municipal services such as tax payments, library/swimming pool membership and one-time admission fees, and so on. These are systems in which cards are issued to card holders by numerous issuing corporations and accepted at multiple places that are not necessarily owned by SMC.

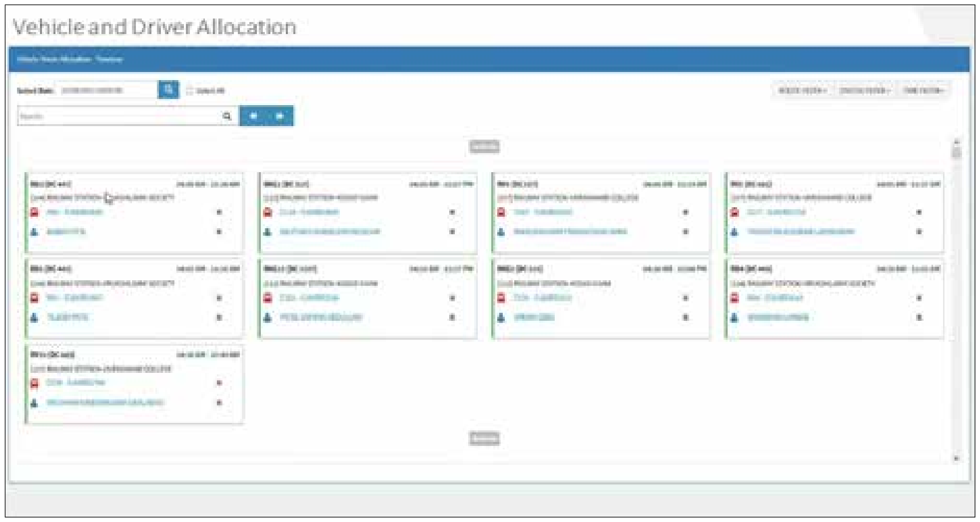

Figure 7: Example of the Real Time Dashboard of VPSD
Source: (Sitilink, 2017)

Figure 8: Example of Real Time Dashboard of AVLS
Source: (Sitilink, 2017)

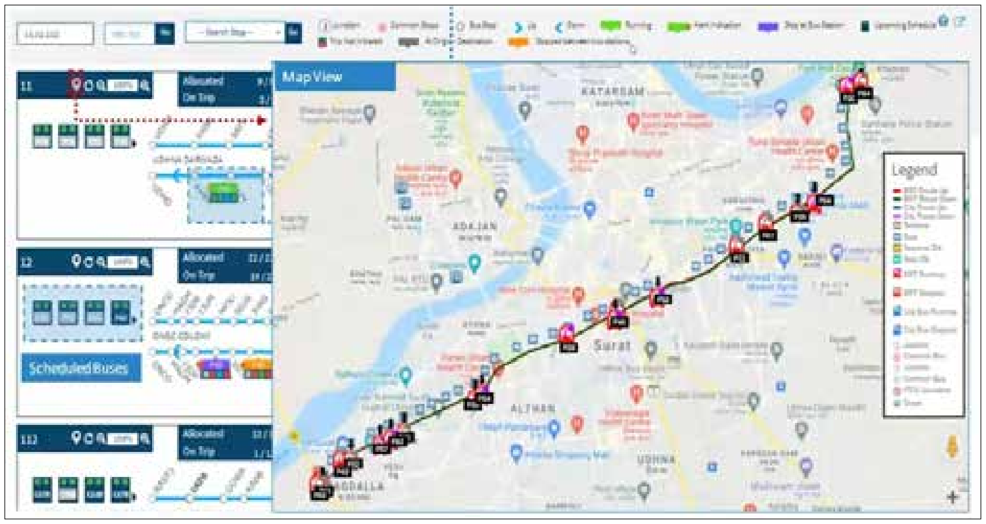

Figure 9: AVLS Real Time Tracking Dashboard
Source: (Sitilink, 2017)

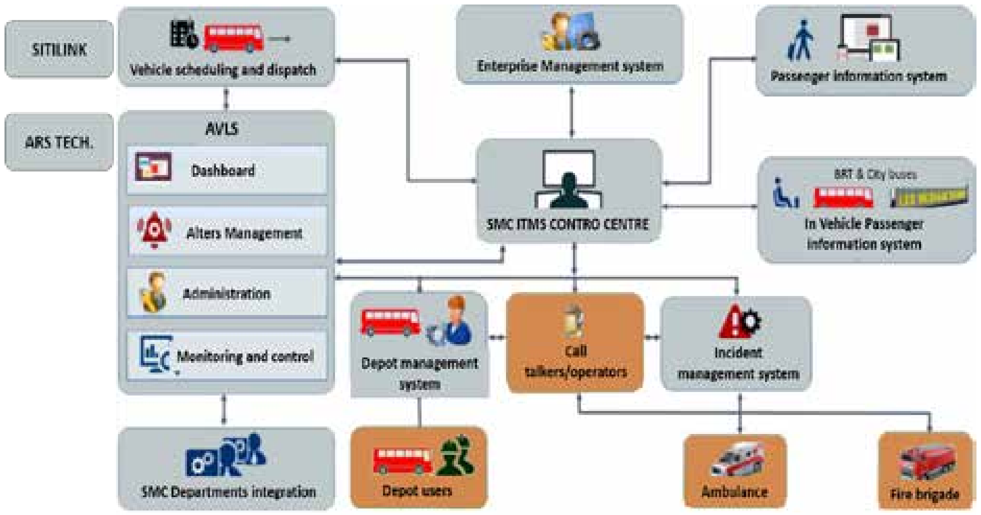

Figure 10: ITMS Workflow Chart
Source: (Surat Urban Transport Index, 2018)

There is also a Co-branded Card and an Open Loop Card. Surat Money Card, as an Open Loop card may be used outside the SMC merchant environment, i.e. in retail. There is no fees for issuance. Replacement fees for non-personalised cards is Rs 50 and Rs 75 for personalised cards. The first top-up must be at least Rs 100. Subsequent top-ups can be in multiples of 50 (Like 50, 100, 150 etc.) and Rs10,000 is the maximum balance.

There is no loss to customised card holders if the card is lost because the value is also saved on the server and if the customer notifies the loss to the financial institution in time for the card to be blocked. Customers receive the cards free of charge with no recurring monthly or yearly payments. The eco-system incorporates Prepaid Cards, co-branded debit/credit cards, mobile wallets and NFC enabled mobile payments thereby future proofing the solution. With RuPay as the preferred scheme, the solution will be interoperable with UPI, Aadhaar connected payments and National Mobility Card programmes. Higher transaction limitations are controlled by the regulations of the RBI or any other regulatory body dependent on the kind of transaction.

8. Automatic Fare Collection System – AFCS

The AFCS project intends to automate the fare collecting mechanism and technology inside Surat's transportation ecosystem (BRTS & City Bus Services) and improve operational capability, citizen happiness, dependability and convenience of operation for its services provided via various transits. SMC and NEC Corporation have a 7-year AFCS contract. The project is currently in the operations and maintenance phase. The integration of Smart cards is the responsibility of the AFCS provider (NEC) and the bank (ICICI) with SMC acting as the regulator.

The functional requirements section specifies the following AFCS key components:

- Devices with fare collection
- Incident management with integration
- Business intelligence with integration
- Integration with Enterprise Management System

These AFCS fare media were made available to users in a variety of sites including BRTS stations, service delivery points set-up across the city, designated branches, a web application, a mobile application, and so on. The AFCS supports M-ticketing and the Surat Money Card. By establishing an environment for the issuing and acceptance of fare media, the station ticketing facility would facilitate commuter travel. The ticketing facilities are available at BRTS ticketing stations and in bus ticketing facility through ETM is also available. The station ticketing facilities includes the Point of Sale (POS), automatic turnstile gates with ticket validators, handheld ticket terminal, ticketing mobile application and station server.

AFCS is located in 153 BRTS stations, 166 BRTS buses and 575 city buses. The number of POSs located are 206, Pole validators - 1300, turnstiles – 414, fare gate validator – 414, swing gate – 195, station server – 195, Mobile application – 1, AFCS software – 1. Transit assessment is done through the data collected from the AFCS. The key measurement indicators are daily ridership and revenue, weekday weekend schedule preparation, peak – off peak ridership and revenue, highest and lowest ridership revenue route-wise and stop-wise, passenger type-wise and transit analysis – high and low footfalls/revenue stations.

Figure 11: Surat Money Card (Personalised)
Source: (Surat Smart City, 2016)

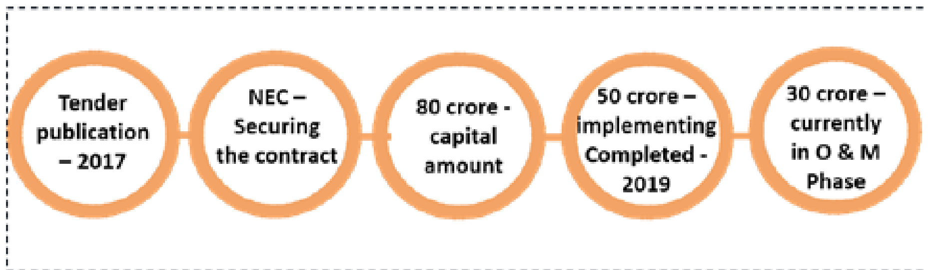

Figure 12: NEC Corporation Securing the Contract
Source: Primary Interview

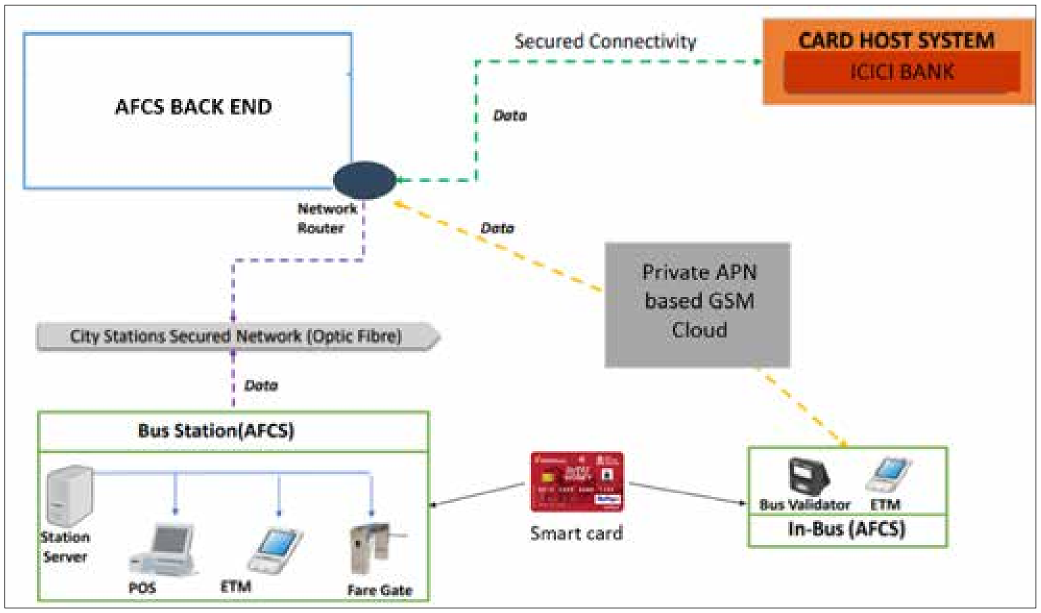

Figure 13: AFCS Workflow
Source: (Surat Urban Transport Index, 2018)

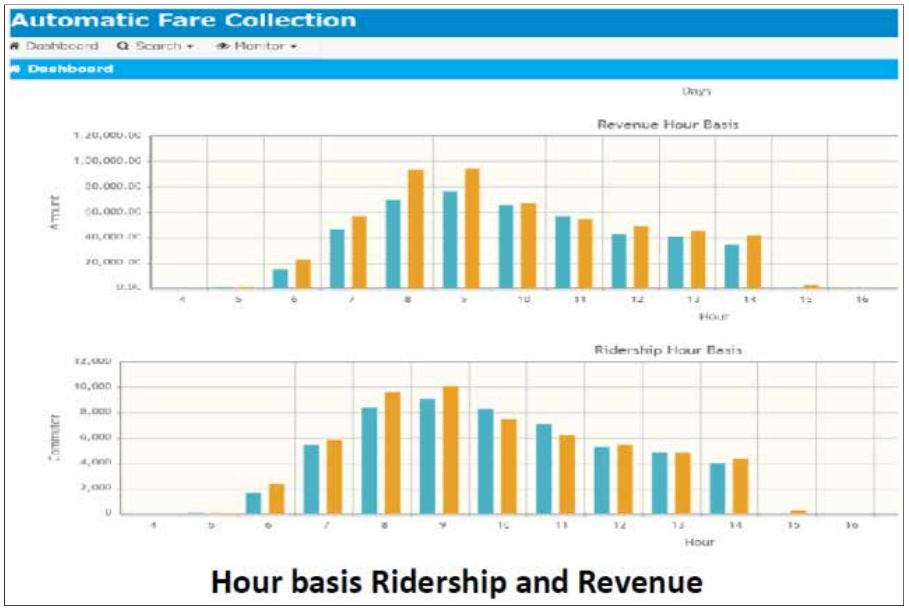

Figure 14: Real Time Dashboard of AFCS
Source: (Surat Urban Transport Index, 2018)

9. SITILINK Application – AFCS

The Sitilink Smartphone application allows citizens to arrange their travel more efficiently. Surat Sitilink application includes the following options: Travel Planners, M-ticketing, Information about the Routes and Stops.

SMC vehicle application has been built for real-time vehicle tracking and reporting. It is also used for AVLS data-based operator billing. The Sitilink Supervisor application was created to oversee Sitilink activities.

10. Main applications and uses of Smart tools (ITMS, AFCS, S Money Card)

The schedules of conductors and the income received in each bus and route are identified which prevents revenue leakage and increases collection. The driver analysis on each road is assured to preserve and increase the residents' dependability. Bus bunching, over speeding and failure to reach the specified ETA are all measured and fines are imposed on the driver for each characteristic. Incidents such as bus accidents and breakdowns are investigated by the operators. These technologies are useful in optimising the fleet's route and peak hour schedules when the ridership is high. The arrival and departure of buses are tracked both by the operator and by the bus. The route-based performance analysis is addressed and metrics such as ridership, revenue, vehicle utilisation, dead kilometres and revenue kilometres are tracked.

11. Analysis:

In order to complete the case study, the evaluation framework for assessing the ITMS, AFCS, and Surat Money Card was done. The possible parameters for assessments were identified through qualitative and

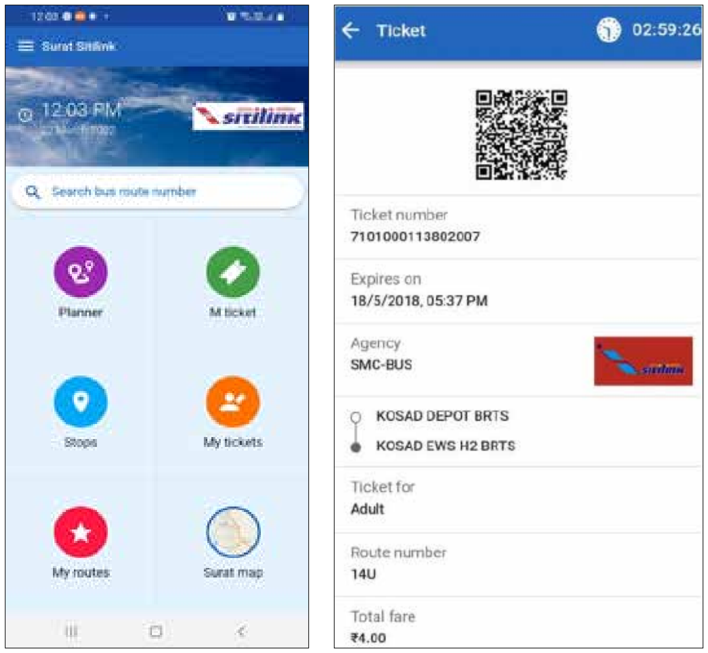

Figure 15: Sitilink App
Source: Sitilink Application

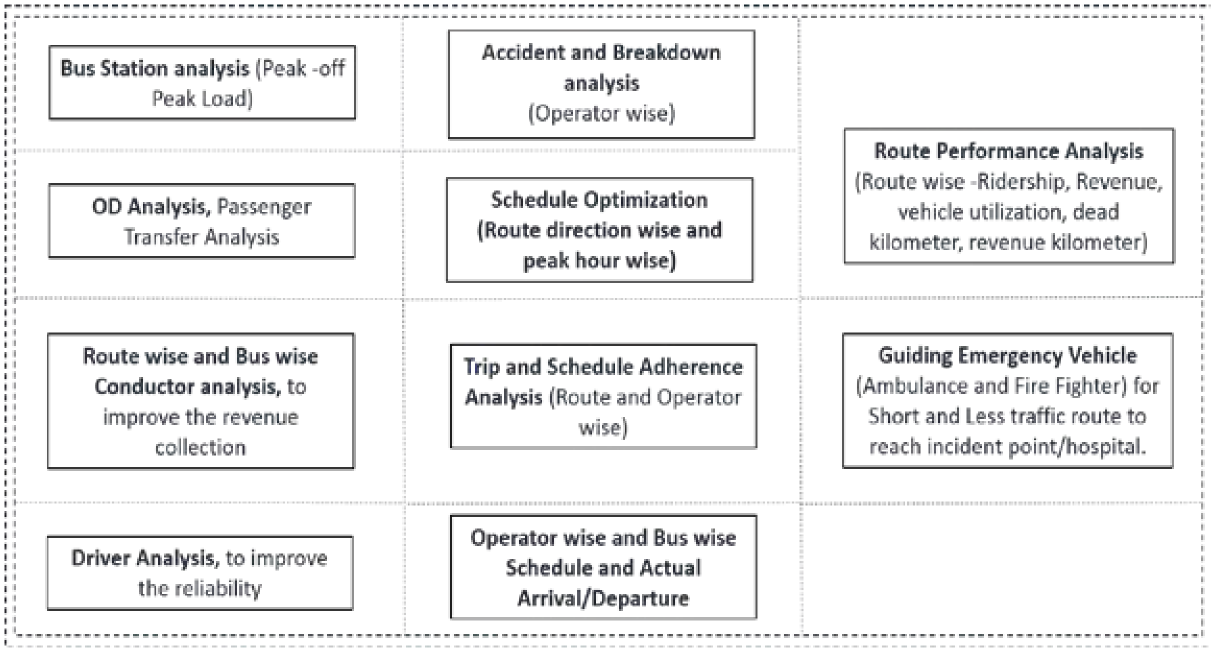

Figure 17: Applications of ITMS, AFCS and Surat Money card
Source: Primary Interview

Figure 16: Sitilink App Used by Employers
Source: Primary Interview

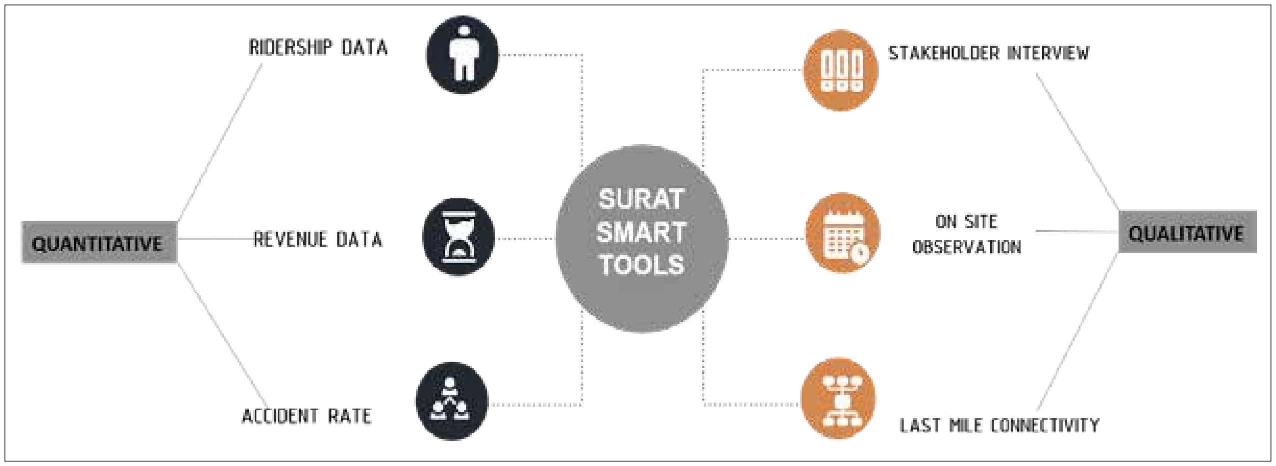

Figure 18: Analysis Method
Source: Primary

quantitative analysis. The qualitative analysis includes stakeholder interviews, on-site observation and last-mile connective. The quantitative analysis includes ridership data, revenue data and accident rate.

11.1 Quantitative Analysis – Ridership Data

Ridership increased from 70,000 in 2017 to 2,70,000 in 2022. According to the AFCS dashboard which provides ridership statistics to aid in the preparation and modification of the VPSD, new demand regions were discovered and city coverage was extended to 98 percent in 2021. The average ridership data per day in BRTS and City buses is 1,63,856 and 96,579 per day respectively.

11.1.1 Revenue Data

After the implementation of ITMS and AFCS, the revenue leakages have been reduced over time. The Vehicle Planning Scheduling and Dispatch (VPSD) and Depot Management System (DMS) have made a constant increase in revenue and decrease in non–revenue km. The non–revenue km is when the fleet runs without any ridership and on less ridership routes. Optimising the depot allocation for drivers is in place. Decrease in non–revenue km has resulted into a huge saving of Rs1.2 crore to Rs 1.5 crore within a year. Savings in non-revenue km led to savings of 28% GHG emissions.

11.1.2 Accident Rate

Through the Automatic Vehicle Location System (AVLS) and Incident Management System (IMS) accident fatalities which were occurring over a period of time reduced drastically. In 2017, before the ITMS was in place, the fatalities rate was 239 persons per one lakh population which reduced to 162 persons per one lakh population in 2022.

11.2 Qualitative Analysis

11.2.1 Stakeholder Interviews

To go deep and analyse the project, numerous stakeholders were interviewed to learn about the real-world problems and to examine the varied viewpoints provided by stakeholders at each level. We then conducted a study of the passengers on city buses and BRTS services. The interview was done with representatives from Surat Municipal Corporation who were instrumental in moving this project ahead. The vendor interviews from NEC Corporation and ARS T &TT were conducted to learn about their contractual conditions and service delivery to the SMC. People working at depots, BRTS bus stops and municipal buses were questioned to learn about their attitudes regarding these technological solutions.

Workers in depots:

Some major concerns include:

- ETM problems
- Efficiency of hardware equipment
- Absence of Pole validators
- Lack of access to servers at times.
- Lack of monitoring of PIS in bus depots
- People travel without paying for tickets, majorly students (25,867 memberships)
- Difficulty in checking M-ticketing through electronic machines

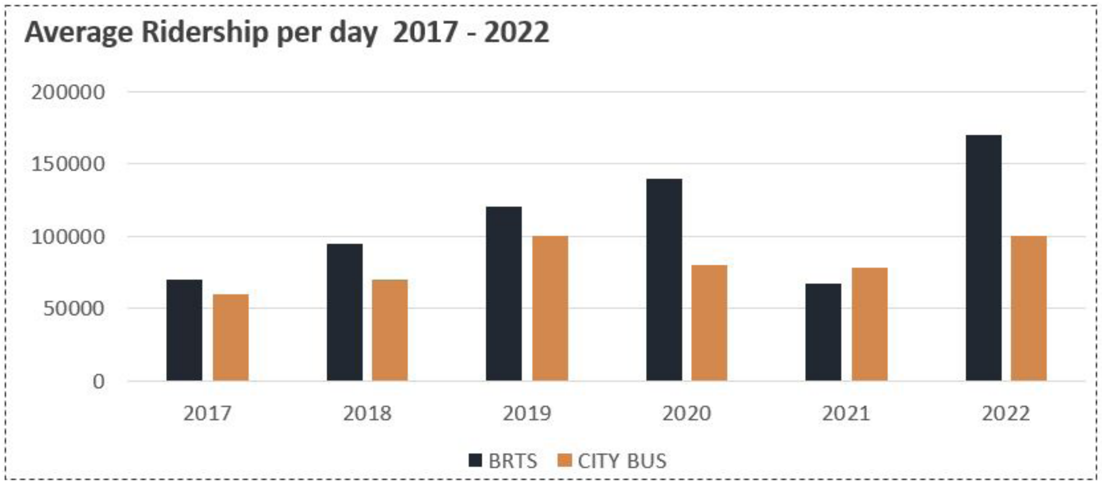

Figure 19: Ridership Analysis
Source: (Surat Urban Transport Index, 2018), Primary Interview

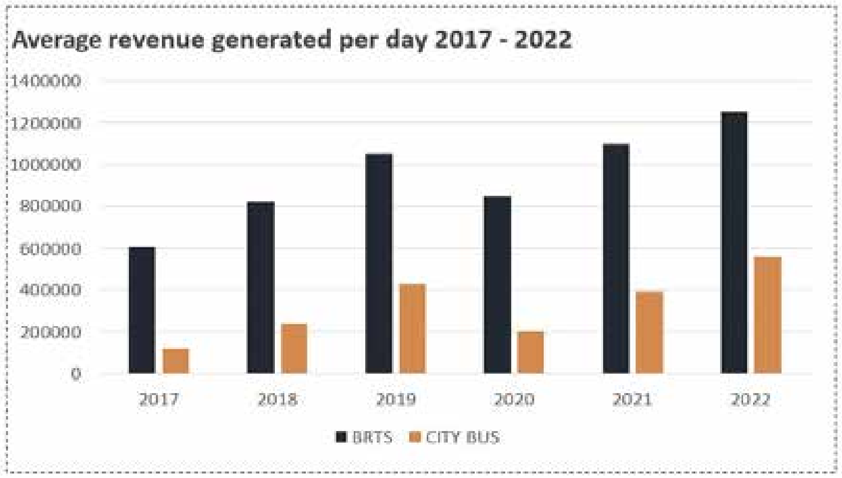

Figure 20: Revenue Analysis
Source: (Surat Urban Transport Index, 2018), Primary Interview

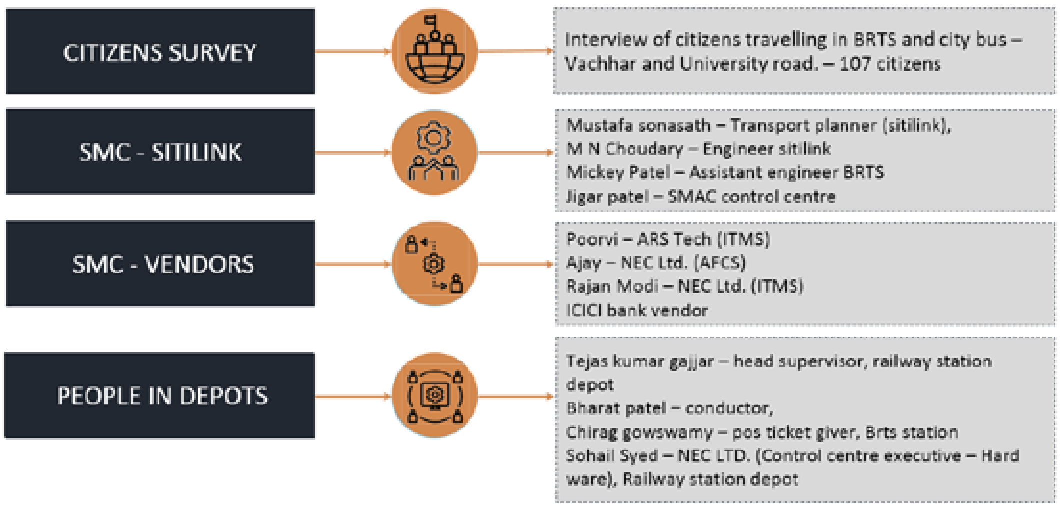

Figure 21: Interviewed Stakeholders
Source: Primary

USER INDICATORS	DISSATIAFIED	SATISFIED	PERCENTAGE OF SATISFIED
Frequency of the service	35	72	68.6%
Punctuality (delay*)	39	68	61.2%
Safety of the vehicles	21	86	84%
Convenience of stops and stations	20	87	91%
Expected time of arrival	36	71	65.7%
Cost of travel	15	92	95.4%
Easiness in using surat money card	23	84	78.4%
Point of sale ticketing	22	86	91.5%
Speed of the bus	31	76	84.3%
City bus service and BRTS service	28	79	86.5%
Passenger information system (helpful)	72	35	24%
Surat money card – awareness	63	44	37%
Availability of information	56	51	50.1%

69%

31%

Figure 22: Citizen Survey
Source: Primary

There is quick resolution if the problem occurs but skilled labour is required.

11.2.2 Citizen's survey:

A sample of 110 users was used to conduct the survey, of which 35.2% were women. All age groups were considered and samples were collected from bus terminals and from bus passengers. The survey was conducted in major bus stations also. The time of survey was peak hours of 8-11am and 5-8pm.

11.2.3 People Working in SMC:

Every day 20% to 25% people travel without tickets. Strict monitoring takes place in more ridership areas such as Vachhara, University Road, Kadodra, Kamrej and Kosad. There is no monitoring in areas with less ridership and people tend to forget their social responsibility.

11.2.4 On-site Observations:

People with Surat Money Card travel without paying tickets, majorly students (25,867 memberships) and there is difficulty in checking M ticketing through electronic machines. All this requires skilled labour. The Passenger Information Systems, Pole validators and Turnstiles are not well maintained and not in working conditions. The routes with more ridership follow strict rules and all hardware components are in place. But, places with less ridership are well maintained.

12. The Strengths, Challenges and Possible Outcomes

The well-integrated system between the BRTS and City Buses, low ticket prices and growth in fleet number and overall network area are among the primary strengths of the Bus services in Surat. The necessary Smart components are in place. The mentioned strengths are causing certain issues such as overlapping inside and across services, passengers travelling without tickets, a lack of monitoring of hardware components and the demand for skilled labour. Congestion has been caused by an increase in ridership during the last five years.

Possible recommendations include monitoring the services supplied by contractors and frequently analysing the routes and time-tables for remedial solutions. Employers must become acquainted with the technology and receive basic training. Leakages can be reduced by increasing the percentage share of income per kilometre.

Figure 23: PIS Systems not in place
Source: Primary

Figure 24: PIS - In Bus is not in Working Condition and Improper Functioning of Turnstile
Source: Primary

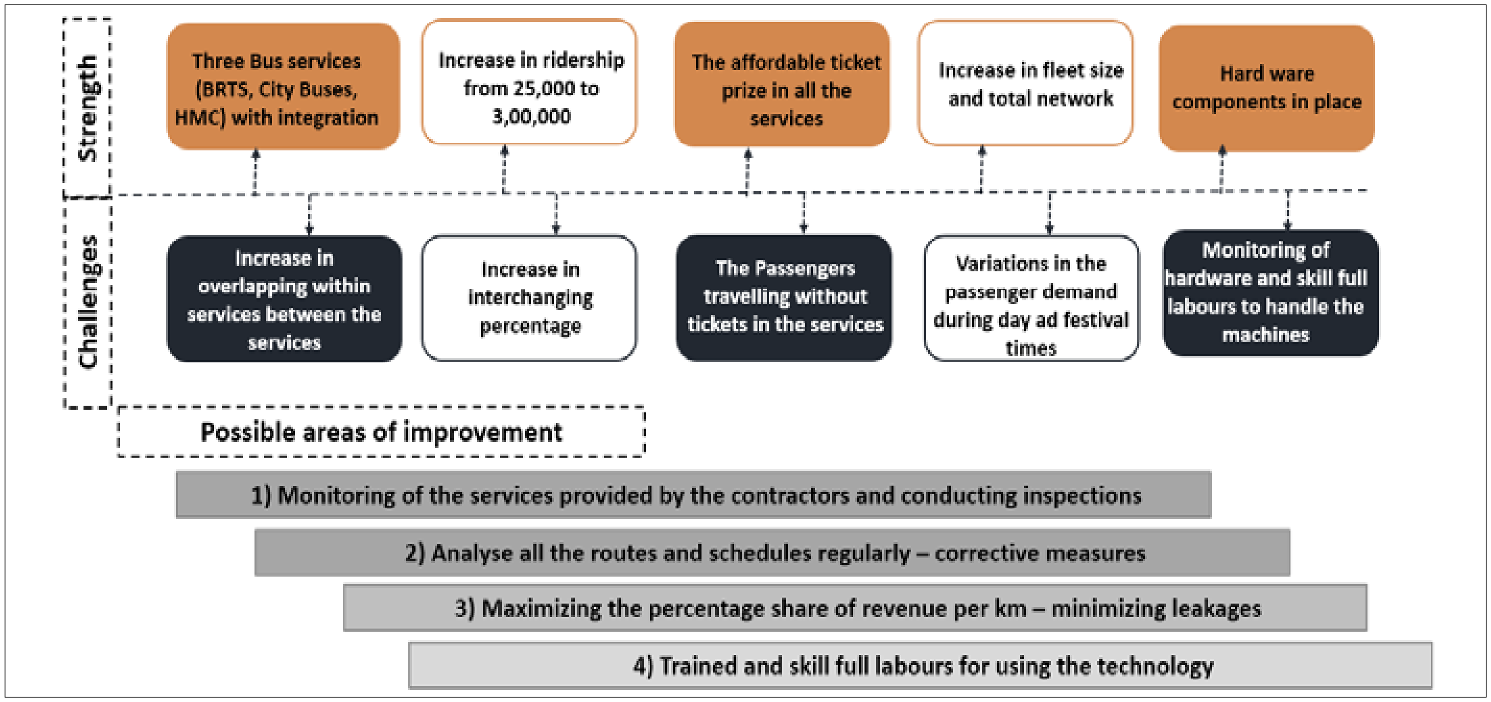

Figure 25: Strengths, Challenges and Recommendations
Source: Primary

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A4

AIC Surati iLab-Surat

Name of the project: *Critical review of AIC Surati iLab*
Location: *Surat, Gujarat*
Year of Project Implementation: *2019*
Sector: *Innovation, Incubation*
SDG: *SDG 8 - Decent Work and Economic Growth, SDG 9 – Industry, Innovation and Infrastructure*
Project Cost: *Rs. Rs 6.97 crore. (Sanctioned by NITI Aayog)*

Institute: *CEPT University*
Advisors: *Dr. Mercy S Samuel*
Students: *Jahnvi Pathak*

Keywords: *AIC Surati iLab, Surat Smart City, Smart City Mission, Incubation, Innovation Policy, Urban Innovations, Startups and Entrepreneurship*

Abstract:
This study is an on-ground understanding and assessment of Surati iLab which is one of the projects undertaken by Surat Smart City under the Smart City Mission to foster urban innovations in the city and nearby regions. Looking at the complexities of city management, innovations in urban services are the need of the hour arising as a consequence of urbanisation in India. Innovative solutions are required to meet our complex challenges of service delivery in sectors like water, waste, health, transport etc. An innovation ecosystem to support and boost entrepreneurs to test their ideas for urban problem solving is needed. This study has attempted to look at Surati iLab from the innovation ecosystem point of view considering different stakeholders and identifying the drivers and barriers towards institutionalising the concept of iLab within other Smart Cities of India. A primary research was conducted along with stakeholder consultations to understand the current level of outcome realisation and how it can be further evolved to attain the larger objectives of urban problem solving, start-ups and innovations along with creation of employment opportunities.

Case Study: **A4**

1. Introduction

Surat Smart City
Launched in 2015 with the objective of promoting cities that provide core infrastructure, a clean and sustainable environment and gives a decent quality of life to their citizens through the application of 'Smart Solutions'.

Under the Smart Cities Mission, SAAR initiative was introduced jointly by the Ministry of Housing and Urban Affairs (MoHUA), National Institute of Urban Affairs (NIUA) and academic institutes to give students a platform to engage in the here and now of the urban domain. The programme will facilitate greater engagement between educational institutes and urban flagship missions. The essential purpose of SAAR is to maximise learning for students, institutes and cities. Under the initiative, this study is based on Surati iLab as a Smart City project of Surat.

Incubation and Innovation
India is not at all a paragon of efficiency, but it has certainly learned how to manage with less and that is something the West can learn from. (Forbes, 2020)

Start-ups and innovation play a crucial role in the economic growth. Besides generating jobs, they focus on more innovative, gen-next solutions which bring economic dynamism through innovation and by spurring competition.

This part of the research introduces the Atal Innovation Mission and Atal Incubation Centres. It lays out the programs and services offered, the impact created on the society and a preliminary study of the related policies.

In 2014-15, the Government of India (GoI) allocated around USD 2 billion to start-up incubation and investment through different initiatives. As of 2019, thirteen ministries and agencies of the federal government were funding incubators. In India, 284 incubators were funded, including both government-supported and commercial. In the following sections, we will examine the key features of incubators as well as crucial government policies that support them.

Atal Innovation Mission (AIM)
Introduced and launched in 2016, this is a flagship programme set up by the Govt. of India under NITI Aayog. Towards this end, AIM has taken a holistic approach to ensure the creation of a problem-solving innovative mind-set in schools and is creating an ecosystem of entrepreneurship in universities, research institutions and in private and MSME sectors. All AIM initiatives are currently monitored and managed systematically using real-time MIS systems and dynamic dashboards. AIM is also currently having its programs reviewed by third-party agencies to ensure continuous improvements (Mission A. I., 2020).

In 2015, before the launch of AIM, India ranked 80th on the Global Innovation Index – The Global Innovation Index (GII) takes the pulse of the most recent global innovation trends. Every year it ranks the innovation ecosystem performance of economies around the globe while highlighting innovation strengths and weaknesses and particular gaps in the innovation metrics (World Intellectual Propoerty Organisation, 2020).

After the launch of AIM in 2016, India has managed to move up in the Top 50 worldwide at 46th position in 2021 and leads in the Central and Southern Asia region.

The objective of AIM is to promote an innovation ecosystem among students, MSME sector and industry. They work in five critical areas – Atal Tinkering Labs, Atal Incubation Centres, Established Incubation Centres, Atal New India Challenge, Atal Community Innovation Centre and Atal Research and Innovation for Small Enterprises (ARISE).

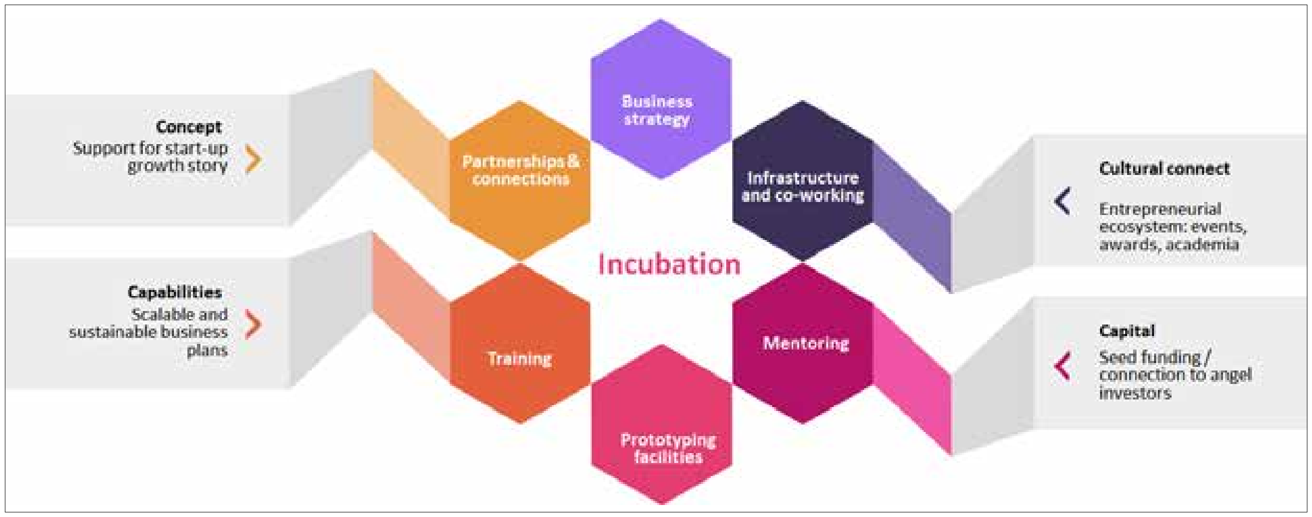

Figure-1: Incubation Support, Source: aim.gov.in

The innovation cycle starts from idea and research to problem identification and design thinking, solution tech development and POC, pilot implementation, production start-up and ultimately to large-scale deployment. According to set guidelines, each initiative falls under a particular part of the cycle. Atal Tinkering Labs focuses on encouraging innovation at the institute level; Atal Incubation Centres, Established Incubation Centres and Atal New India Challenge focuses on supporting tech development, deployment and commercialisation in essential sectors; Atal Community Innovation Centres focuses on building a robust innovation ecosystem in unserved/underserved regions of India; and, Atal Research and Innovation for small enterprises focuses on supporting research and innovation in the MSME sector.

AIM has managed to open over 9000 Tinkering Labs, 59 AICs, 9 EICs, overall supported more than 2200 start-ups, houses over 5100 mentors, has taken up 15 ARISE challenges, 19 Atal Community Innovation Centres, 24 New India Challenges and over 40 Domestic and International Partnerships. Surati iLab also comes under one of the AICs of the Atal Innovation Mission.

Incubation (AICs and EICs)
Business incubators are institutions that support entrepreneurs in developing their businesses, especially in the initial stages. These are organisations geared towards speeding up growth and success of start-ups and early-stage companies. Incubation is usually done by institutions that have experience in the business and technology world.

Incubation support includes providing technological facilities and advice, initial growth funds, network and linkages, co-working spaces, lab facilities, mentoring and advisory support. They are often a good path to capital from angel investors, government organisations, economic-development coalitions, venture capitalists and other investors. (Atal Innovation Mission, 2020)

1.1 Topic and Context
As part of the Smart Cities Mission, Surat Municipal Corporation (SMC) and Surat Smart City Development Limited (SSCDL) have set up Incubation Centres to promote the culture of Innovation, Start-up Incubation, Trade Facilitation and Skill Development. They aspire for an industrial bend to capitalise on the new types of jobs generated whilst maintaining Surat's dominance in the Textile and Diamond industries.

A Special Purpose Vehicle (SPV) was incorporated as a Section 8 company on 6th April 2018 under the

Companies Act, 2013 wherein the Surati iLab was inaugurated on 30th January 2019 with Diamond, Textile, Chemicals, Smart City/eGovernance, IT/IoT and Agriculture as the primary sectors in focus.

The vision is to act as a perpetual and sustainable growth engine for the South Gujarat region by creating an environment that fosters entrepreneurship by providing and arranging the required resources and mentorship to start-ups and businesses. 'Start-ups and Innovation play a crucial role in economic growth. Besides generating jobs, they focus more on innovative and gen-next solutions which bring economic dynamism by bringing in innovation and spurring competition.' (Startup Gujarat)

Aligning with the above, Surati iLab was conceptualised and built to foster urban innovations along with other sectors.

1.2 Significance of the project

As part of the background study conducted for Surati iLab, various reasons emerged that highlight the need for setting up this incubation centre. Surat is the trade centre in the entrepreneurial state of Gujarat. This indicated that the city has potential for new innovations but lacks handholding support for start-ups to reach the next level. There was need for a single platform providing infrastructure facilities, business assistance services, guidance and consulting services to start-ups. Local businesses require skill development and innovations in terms of products and technologies. It was also observed that there is a lack of ecosystem for advisory and knowledge to promote and further the progress of existing local businesses. There was also sub-optimal outreach related to government start-up policies.

1.3 Aim and Objectives

The aim of the study was:

- To understand the innovation policies currently operational in India
- To understand the functioning of Surati iLab
- To conduct stakeholder consultations
- To understand the impact of iLab
- To suggest measures to enhance the functioning of iLab to attain the next level of impact

To further analyse the operations of an incubator, a background study was conducted with various policies of the Government of India and Government of Gujarat related to start-ups, innovations and existing industries in Surat. A best practise study was conducted to benchmark and visit which included T-Hub of Hyderabad, SINE of IIT-Bombay, Startup Village in Kochi, Sandbox Startups in Hubli. A secondary research was conducted considering the international start-ups, Y-Combinator in the US, and Seedcamp in London. Consulting various other associations and institutions for the sectors in focus was also done.

Surati iLab alone has been able to integrate 19 partners, connected as facilitators and mentors. Till date, they have 20 registered start-ups, 22 registered mentors and organised 26 events.

2. Contextual Background

Surati iLab has successfully incubated the following start-ups since it was inaugurated in 2019: MieMaw Services (Waste Management Services), Yantrah (Technological Innovation), Biofics Pvt Ltd (Green Campus development), yogamilk (Unprocessed and Clean Foods) and BlinkLink Solutions (AR Solutions) are a few of the success stories who have been able to create successful and sustainable businesses. In-depth stakeholder consultation helped in understanding the nitty-gritty of iLab, its functioning, challenges, strengths, etc.

2.1 Conceptual Framework/Research Design

The research design involved documenting the existing practices at Surati iLab in consultation with different stakeholders like current incubates, graduated incubates, mentors, partners (educational institutions) and office administration of Surat Smart City. Case studies of leading practices of iLabs like iCreate, Ahmedabad; AIC MIT ADT, Pune; and CIIE, IIM Ahmedabad were done to understand the functioning of the peer iLabs. This helped in strategising recommendations to take the functioning of Surati iLab to the next level.

2.2 Key Features of the Project

The Surati iLab is headed by a CEO who reports to the MD and Chairman of Surat Municipal Corporation. The CEO is assisted by vice president - ecosystems and vice president – operations.

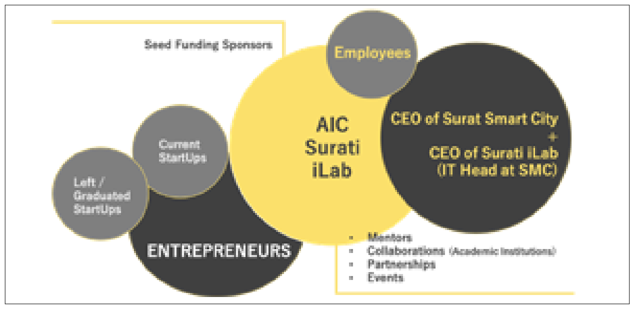

Figure- 4: AIC Surati iLab Stakeholders

Stakeholders of Surati iLab include the CEO of Surat Smart City along with the CEO of Surati iLab (Currently appointed IT Head at Surat Municipal Corporation). AIC Surati iLab also has a network of mentors who are appointed to coordinate with the incubated start-ups and collaborate with academic institutions which helps them receive better research material along with partnerships with various other national and international institutions. They also host events to give an opportunity and a platform to young entrepreneurs by inviting industries for peer learning and networking. The currently incubated start-ups, graduated start-ups and shortlisted entries of the events held at the site add to the stakeholders of AIC Surati iLab. Being provided with a co-working space for the incubatee entrepreneurs have the opportunity to connect and network with various stakeholders that help them magnify the potential of the

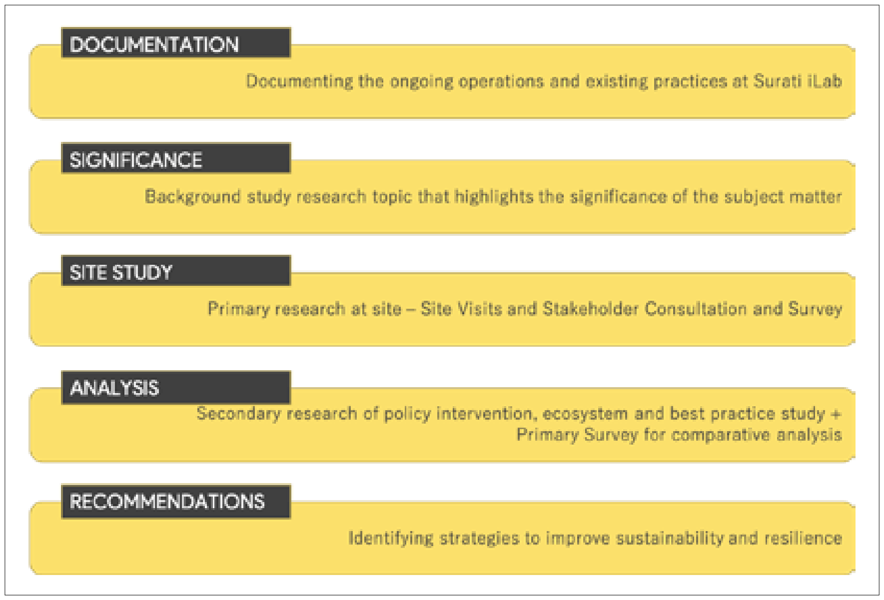

Figure- 2: Research Methodology

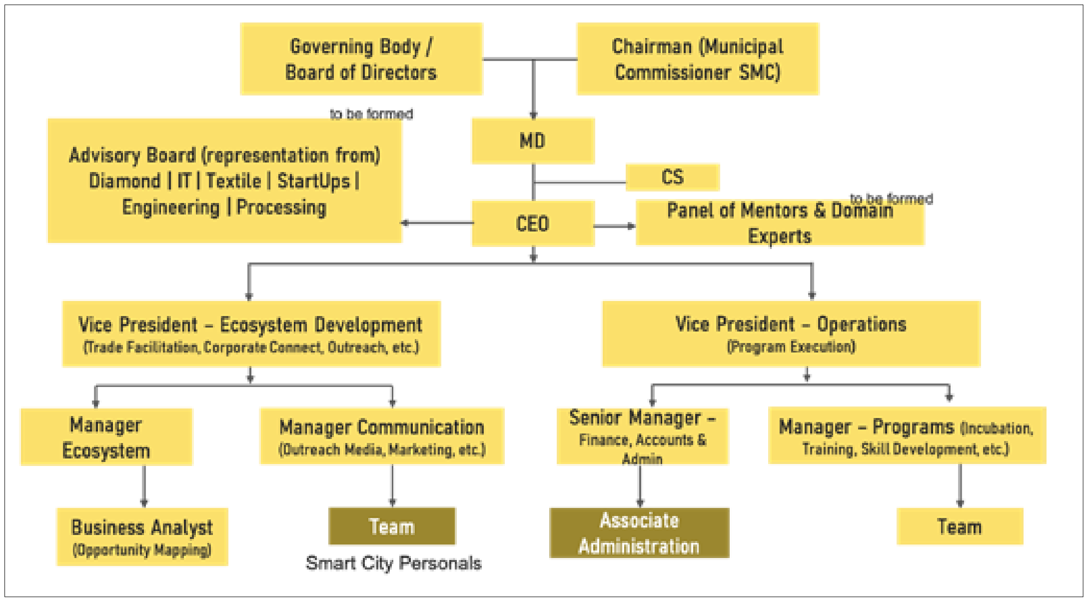

Figure- 3: AIC Surati iLab Organisational Structure project. A pool of crowd funding entities, seed funding supporters, angel investors and various other sources of funding networks become an important part of the incubation system.

The Start-up Cycle at Surati iLab

Starting at Ideation, the company then undergoes a process of formation with documents, following which they get officially registered as a start-up under Start-up India and receive a unique series number. A contract is then made that details the involvement of the incubation centre with the start-up and then the start-up is incubated.

2.2.1 Features and Benefits

a. Start-up Assistance Policy – AIC Surati iLab

Quantum of Assistance

Post clearing the eligibility criteria, AIC Surati iLab mentioned various ways to provide assistance to incubatees in the form of financing.

Sustenance Allowance:

As the name suggests, it is the funding provided to all incubated start-ups for a period of one year. A sum of Rs 20,000/month will be handed over to all the start-ups (Rs 25,000 will be provided for start-ups who have atleast one woman co-founder)

Seed Support:

Acting as fuel for start-ups Seed Support will be provided based on approval/sanction by SC for the cost of raw materials, market research, testing and trials and marketing assistance.

Assistance to enrol and participate for acceleration program:

Approved start-ups will be eligible to participate, without paying any fees, in the acceleration program run by AIC Surati iLab typically a 12-14 week program for start-ups at the early traction and scaling stage. It is a process of intense, rapid and immersive education aimed at accelerating growth.

Pre Series Funding:

In the life-cycle of a start-up there is a funding gap which is better identified as the valley of death. This is a phase post commercialisation where the start-up has just started generating revenue till the time period where its product/service gets market traction. Such start-ups will be assisted in getting venture capital.

Assistance to start-ups having a significant impact on society:

Upto Rs 3 lakh will be provided to start-ups in tune with various focussed missions of the Central and/or State Government's Swachch Bharat Mission, Smart City Mission, Amrut Mission, HRIDAY Scheme.

Assistance for Skill Development

Approved/sanctioned start-ups shall be provided skill development trainings specific to soft skills, managerial skills, marketing skills and financing skills customised for the start-up project. Upto Rs 50,000 will be provided on a reimbursement basis.

Procedure

Eligible Institutions/Start-up:

- Eligible innovator/start-up shall be registered on the online portal.
- Registered start-ups will apply with requisites in the prescribed format.
- AIC SURATi iLAB office shall evaluate, validate and after due diligence recommend the start-up project proposal to the Proposal Scrutiny Committee (PSC).
- The start-up's project p roposals will be scrutinised by the PSC and after due diligence the start-up project proposal will be placed before the SC for approval/sanction.

The detailed procedure for approval/sanctions of start-ups, terms, conditions and guidelines will be issued separately by the AIC SURATi iLAB Office.

Proposal Scrutiny Committee

A committee of the following members will be constituted for approval/sanction of assistance under the scheme:

- CEO, AIC Surati iLab, Chairman
- Incubation Manager, AIC Suarti iLab, Vice Chairman
- Business Analyst, AIC Surati iLab, Member
- Two representatives from the appropriate Advisory Committee (1 SMC + 1 Industry), Invitee Members
- Two Subject/Domain Experts, Invitee Members

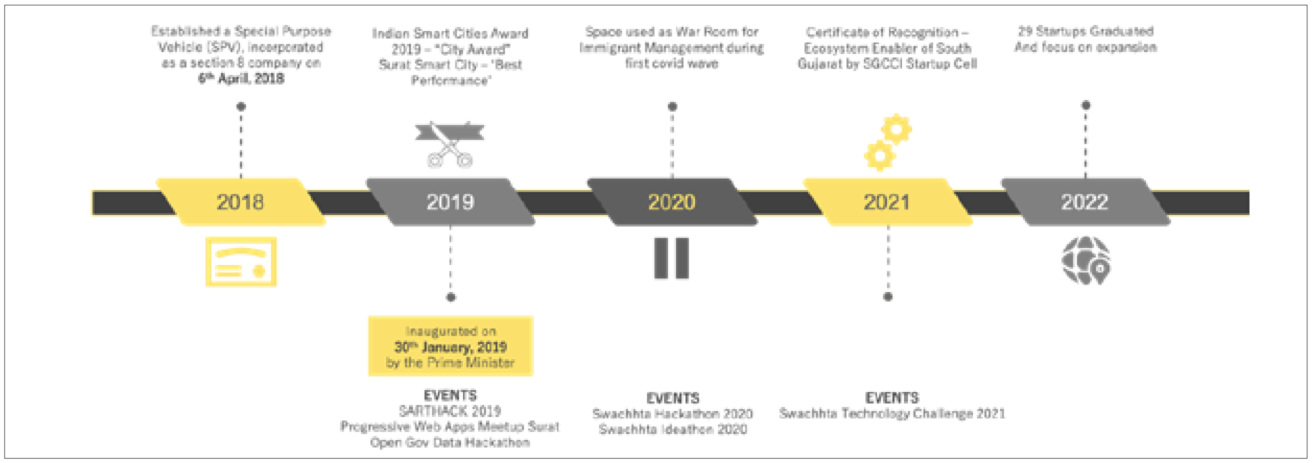

Figure 5: AIC Surati iLab Timeline

Selection Committee

A committee of the following members will be constituted for approval/sanction of assistance under the scheme:

- CEO, SSCDL and MD, AIC SURATi iLAB, Chairman
- CEO, AIC SURATi iLAB, Vice Chairman
- Company Secretary, SSCDL, Secretary
- Incubation Manager, AIC SURATi iLAB, Member
- Two representatives from appropriate Advisory Committee, Invitee Members

Equity Sharing

Currently no equity sharing is required by AIC SURATi iLAB Foundation for providing assistance under the scheme to the approved start-up.

b. Networking Events

Surati iLab has hosted three events to provide a platform for young entrepreneurs to showcase their research and study in the following sectors – Sanitation, Drainage, Environment and Public Health. These have three stages:

- **Ideation Stage:** This is the first stage where there are entries in both students as well as open category.

- **Proof of Concept:** This is the second stage at which point winners are shortlisted, announced and provided with facilities of the incubation centre like co-working space, mentors, business registration and patent registration which are shortlisted by a jury panel of 32 members.

- **Final Prototype:** This is the third and final stage where the selected urban innovations will be undertaken by the Surat Smart City and Municipal Corporation for trials and testing on field.

Events held till date are Swachhta Hackathon 2020, Swachhta Ideathon 2020 and Swachhta Technology Challenge 2021.

2.3 Key findings from interviews, surveys and primary/ secondary data collection

Gap Analysis

The gap analysis or identification of problem areas was done through three different methods of data collection – primary survey with stakeholders at site, policy level comparative study of objectives and expectations from incubators and assessing the critical success factors which will determine the efficiency to execute their vision. Certain common factors will also determine the efficiency of the incubators as mentioned in the Handbook for Incubator Managers.

Primary Survey

Involving all stakeholders, with a sample size of 30 respondents, a primary survey was conducted at the site with various questions, mainly under the broader topics of access and availability of physical infrastructure, advisory, mentoring support, network connections and linkages, recognising revenue streams, assistance in legal structure and overall work culture.

The graph shows the results of the survey:

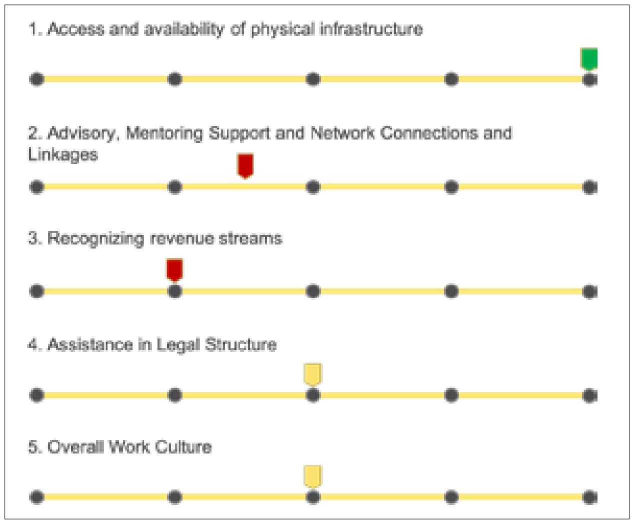

Figure 6: Stakeholder Survey Analysis, Source: Primary

Comparative Analysis

A comparative analysis of various agencies and the incubation policies of those agencies was undertaken to understand their primary objectives and expectations lodged under these agencies to get incubated. A comparison of objectives and expectations helped us to better understand what each agency and its incubation initiative aims to achieve.

Assessing Critical Success Factors

As addressed in the Handbook for Incubator Managers, a Kiviat chart or a radar chart helps highlight the areas that need to be improved on priority for Surati iLab.

As seen in the figure, AIC Surati iLab needs to work priority-wise on the following areas:

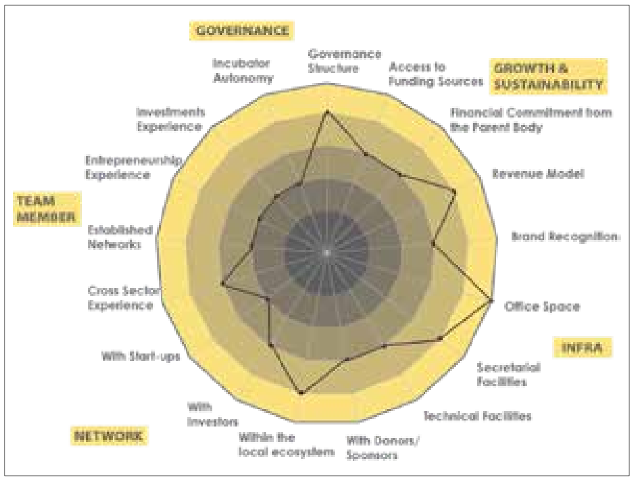

Figure 7: Assessing Critical Success Factors, Source: Handbook for Incubator Managers

High Priority

- A team member with experience in investments
- A team member with entrepreneurship experience
- A good network with start-ups at other AICs
- A team member with strong linkages within the ecosystem
- A team member who has worked in multiple sectors or who has sector-specific knowledge or technical expertise
- A good business relationship with donors and sponsors

Medium Priority

- Creating a brand recognition for the incubator's growth and sustainability
- Having a revenue model that motivates the incubation engagement with each venture

Benchmarking

iCreate

Started and established in 2012, iCreate has supported 472 start-ups till date, filed over 38 patents, created employment for over 800 people via start-ups and conducted around 1090 events that helped networking and exposure to the industry.

Key Takeaways

We recognise that vision, governance and execution all play an essential role in an institution's success. This is

Table 1 Comparison of Objectives and Expectations from Incubators

	AIM AIC – NITI AAYOG	MSME TBC	DST – NIDHI TBI	MEITY TIC
Primary Objective	Assist incubatees in creating sustainable, scalable and profitable business models	Promote speedy commercialisation of technology developed in the host institute	Provide a platform for speedy commercialisation of technologies developed by the host institution or by any academic/ technical/R&D institution or individual. Promote new technology/knowledge/ innovation based start-ups	Transparent selection process on the basis of detailed techno-commercial proposal. A committee to evaluate the proposal on its technical merits and commercial viability. The committee would also recommend the level/ duration/terms of support to the entrepreneur(s)
Building Networks	Create a strong network of mentors who would provide sector specific knowledge and practical guidance, Conduct inspirational programs, Forge partnerships and networks with academia, industry, investors, incubators and others.	Network between industry, academia and financial institutions	Build a start-up ecosystem, establish a network between academia, financial institutions, industries	
'Value Added Services'	Enable access to prototyping facilities, test beds, markets and pilot implementation. Provide training and mentorship	Support development of new enterprises	Provide cost effective services to start-ups like mentoring, legal, financial, technical, intellectual property related services	Mobilise technical/ mentoring/managerial/ financial /administrative/legal support
Physical Infrastructure	Physical infrastructure and support services		Earmarked funds for infrastructure development	Sufficient operating space – on rent for two years
Incubator's Team	Build a team with adequate knowledge and experience to guide start-ups on business plans, investments and networks			
Source	Guidelines for setting up of Incubators under the Atal Innovation Mission, 2017 www.niti.gov.in	Guidelines of ASPIRE, 2018 www.aspire.msme.gov.in	Guidelines and Proforma for submission of proposal, 2016 www.nstedb.com	Technology Incubation and Development of Entrepreneurs Scheme, 2018 www.meity.gov.in

Source: Incubation in India – A multi-level analysis, Supriya Sharma, Neharika Vohra, IIMA, March 2020 why we have put in place a robust, multi-tiered structure consisting of:

- An Advisory Board comprising eminent members of the industry, academia and other fields to provide the big picture and inspiration
- A Statutory Board comprising senior technocrats that ensure we have the right strategic direction and oversight
- A Team comprising of experts in various fields who are committed to excellence in execution

Support Provided
Each venture is provided support in terms of Funding, Mentorship, Market Opportunities, Global Networking and Physical Infrastructure.

AIC MIT-ADT
Incorporated in 2018 and inaugurated in 2019, it has supported 54 start-ups out of which 14 were student start-ups. Initial funding of Rs 2.5 crore was received in the first round and Rs 2.7 crore the second round.

Key Takeaways
- As per the contract and management at AIC MIT ADT, they hold a **2% equity** sharing with each incubated start-up that encourages involvement in the progress and success of the incubation centre.
- Focus on training workshops
- Funding used in providing infrastructure for prototypes
- Advisory and Mentoring support with a set discussion agenda

Support Provided
Administration and Mentoring support, Legal and CA Advisor support, Funding support, Networking connections and linkages, technical lab/facilities and Assistance to Start-up India Seed Fund Scheme

CIIA-IIMA
Established in 2008, situated in the lush IIM campus, Ahmedabad it has 31,000 sq ft of well-equipped innovation space. Inspirational, competent and perspective tools for solving big problems, hosting interactive sessions with success and failure stories of entrepreneurs and Fund support provided per venture at every stage by the host.

Key Takeaways:
- Work closely with government agencies and corporates to channel non-dilutive grants for aspiring entrepreneurs and idea-stage start-ups building product-based solutions.
- To bridge the valley of death, they invest a certain amount per venture and draw upon vast networks to syndicate capital from other co-investors
- Seed to growth stage is driven by multiple sources of investment with support provided
- A 3-6 month acceleration program with community-driven workshops, events, bespoke coaching for founders, platforms for start-ups to engage with relevant audiences, investors and partners has also been created.

3. Discussion and Conclusion

Discussions and Learnings
Immediately after independence, the concept of Incubation was encouraged in India, yet it is only in the last decade that we have seen a wave of small businesses, entrepreneurs and unicorns emerge. Many ministries support incubation and many state governments are launching updated versions of the current policies indicating a growing interest in promoting the culture of innovations in India.

Smart Cities and Incubation
Smart urbanisation promotes innovations! Atal Incubations Centres being a part of Atal Innovation Mission under NITI Aayog, has created a huge impact on the overall ranking of India in the Global Innovation Mission. Now at first position in Central and Southern Asia Region and at 46th position globally after the launch of AIM in 2016, (WIPO, 2021) it speaks volumes for itself. Although most of the Incubation Centres are under educational or private institutions, after examining the Surati iLab model and its impact, it becomes crucial to introduce such incubation centres in all other tier 2 Smart Cities. This would promote the idea of urban innovations, along with localised sectors for innovation which would make basic service delivery like water sanitation, healthcare and housing more accessible and affordable. Additionally, such small businesses would enhance livelihood opportunities, leading to reduction in poverty and inequality. Smart Cities give opportunities to private players to work for the municipal government in a PPP mode to enhance and smoothen their service delivery. In this context iLabs institutionalised under the Smart Cities Mission would help generate solutions to complex and wicked challenges of cities due to urbanisation.

Incubation more than Physical Infrastructure
At this point, it is also pertinent to mention that incubation is not about creating an iLab facility as a building, a co-working space or a lab it is much more than that. An incubator can help navigate the challenges that start-ups face owing to their size. Start-ups are prevented from failing by government regulations, availability of low-cost finance, qualified employees and market access. Surati iLab, although has substantial space and infrastructure provided for its incubatees, it still needs to provide a positive push to the start-up culture. As established in the gap analysis, a strong support network, mentorship, mutually supportive community, followed by various streams of funding and conducting numerous types of trainings and seminars are a few resources that create a successful incubator model. Simultaneously, while the Startup Assistance Policy has a solid structure, it can only be successful if implemented appropriately. The infrastructure at Surati iLab is adequate to implement and has a sizable portfolio that helps comprehensive economic development.

In conclusion, Incubators catalyse economic growth and sustain fragile businesses founded mostly by first-generation entrepreneurs. They enable the commercialisation of new technologies and research developed at universities and research labs therefore, unleashing economic and societal value. Collaboration between the government and academic institutions to nurture entrepreneurs through the incubator is mutually beneficial. Most significantly, hiring competent and motivated incubator workers and defining meaningful performance evaluation KPIs are critical for the incubation to remain effective and have a greater impact.

3.1 Limitations of the Research
Surati iLab is an innovative initiative of Surat Smart City, however immediately after being launched and inaugurated the Covid-19 crisis emerged in the country due to which many anticipated activities at the iLab took a backseat and it turned out to be more of a co-working space. However, all infrastructure and facilities are in place and it is just a matter of rejuvenating the iLab with the recommendations below to be able to create a larger impact in terms of problem solving, employment and livelihood creation. However, as a co-working space 29 start-ups have used the infrastructural facility of Surati iLab.

3.2 Key Lessons Learnt
- An incubation facility is more than an infrastructure set-up
- A strong support network is required to constantly support and facilitate incubates in terms of funding, market access, commercialisation and competition

3.3 Recommendations
Incubation should be viewed as a method of reducing the risk associated with an idea or a business while at the same time assisting them in increasing their chances of success. As a result, the incubation process can take many forms such as giving office space, a prototype lab, initial capital, market access or business coaching, among other things. Each of these tasks is essential for de-risking the endeavour in its early stages and should be considered part of the “incubation” process. There is no one-size-fits-all formula for starting a successful business and there is no one-size-fits-all strategy for putting up a successful incubator. Our research has indicated that the following aspects should be taken into consideration for the Surati iLab to be able to create better impacts and realise larger outcomes.

Support Network of Industry Experts
- Surati iLab essentially needs to have a robust support network that will help incubatees to accelerate their business to the next level
- Formation of experts with experience in investments, in entrepreneurship, start-up network experts and sector specific technical experts

These experts need to be consistently engaged with and be rewarded for their time and expertise so the formation of the support network would then be followed by introducing an engagement model or a reward system which can be in the form of variable pay, bonuses, profit sharing or stock options. To have a steady growth and expansion of the support network, various events and workshops can be hosted so as to attract incubatees with fertile ideas and also create a platform for all stakeholders to engage and interact with experts from various fields to enhance their market knowledge and give them realistic advices and suggestions for scaling and commercialising. This can be achieved by start-up fests, panel discussions, seminars, conferences, summits, investor meets, alumni interactions, hackathons, ideathons, bootcamps and business plan competitions. Such events should be organised on a regular basis.

Building Workplace Culture

There is also a requirement to create soft interventions like workplace culture that will help optimally utilise the infrastructure. Introducing unplugged engagement programs - Offline engagement programs to be held on site would help elevate the overall workplace culture:

- Sector focused 3-6 month long programs on acceleration
- Evangelisation, community-driven and training programs in group formats
- Hold events that create platforms for start-ups to engage with relevant audiences, investors and partners
- Bespoke coaching and joint problem solving with founders

Taking advantage and online presence, the networking can also be taken on an international scale by introducing virtual insights as Tools, Talks and Tutors and collaborations with international iLabs and accelerators.

What follows incubation is acceleration which can be achieved by various ways and means. One such scheme would be forming platforms with high impact interventions with other stakeholders. Acceleration is required to turn a viable business into a profitable model which is fuelled by high impact networks and these are created by collaborating with various stakeholders and creating other platforms/programs that will help the start-ups to accelerate. In this case collaborating with already existing successful incubation centres under education institutes will help to accelerate.

Developing Revenue Streams

Surati iLab now operates on a rent-to-own arrangement for the co-working space it provides to start-ups. This creates a barrier between the incubation centre and the incubatees, leaving little room for both sides to participate in building a sustainable firm out of a small business. While providing the mentioned linkages and support, Surati iLab can look towards developing revenue streams out of successful commercialised start-ups incubated at their iLabs.

Equity Participation - iLab can take minority ownership (2-6 percent) in incubated enterprises in exchange for free or reduced rent periods for the time duration of the contract. For extra duration spent in the incubation centres further equity (e.g., 1-2 percent) may be added. This not only decreases the entrepreneurs' immediate expenses but also stimulates and motivates iLab to get involved with each start-up on a micro level and assist them in creating a sustainable and lucrative firm.

Sponsorships - Several "sponsors" contribute to the incubator programmes. In exchange for sponsorship, a sponsor may desire logo visibility, access to potential clients, brand visibility or affiliation with "innovation," among other things. The incubator may also collaborate with long-term partners to co-create a brand and turn sponsorships into a longer-term brand relationship.

Program Funding

- Start-up support programmes, ecosystem development programmes or branding/marketing programmes are a few types of funding accounts that can create a majority of cash flow into the incubator.
- Programme funds received by the incubator are either restricted or unrestricted grants, i.e., the utilisation of such grants is mandated by the donor.
- An incubator that leverages donor funds to raise additional funding support for the programme is able to demonstrate a higher utilisation of the donor's funds and thereby, greater value for money and the subsequent impact.

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A5

Integrated Command and Control Centre Surat with focus on Solid Waste Management

Name of the project: *Surat ICCC with focus on Solid Waste Management.*
Location: *Surat, Gujarat.*
Year of project implementation: *2016*
Sector: *Integrated Command and Control Centre (ICCC)*
Project Cost: *Rs 4.14 crore*
SDGs: *SDG 11 – Sustainable Cities and Communities*

Institute: *CEPT University*
Advisors: *Dr. Mercy S Samuel*
Students: *Kavya Lalchandani*

Keywords: *Solid Waste Management, Integrated Command and Control Centre, Assessment, Smart City Mission, Surat Smart City.*

Abstract:

Urbanisation and densification have brought with it complex challenges for city management. Most of the challenges are regarding basic service delivery such as garbage, water, sanitation, mobility and healthcare. The government of India recognised these issues and commissioned the Smart City Mission in 2015. Under the Smart City Mission 100 Smart Cities were chosen to work on pan city and Area-Based Development (ABD) projects for improving service delivery by providing higher-quality services to citizens and running their communities more efficiently.

The Integrated Command and Control Centre is one such initiative for managing cities with expanding populations by generating, tracking and controlling real-time data of municipal services on a daily basis. Surat Smart City has a state-of-the-art Integrated Command Control Centre (ICCC) to manage its city functions. This connects all departments of the city to collaborate for better city functioning, as well as reducing the difficulty of dealing with multiple systems/applications having various technologies and platforms by integrating them onto a single platform to harness the intelligence for decision-making, ensuring that all decisions are well-informed.

This research attempts to study in detail the functioning of ICCC and its impact on the performance of municipal services. It also attempts to suggest measures to take it to the next level for empowering citizens and engaging them actively in the municipal service delivery.

Case Study: **A5**

1. Introduction

1.1 Topic and Context

Integrated Command Control of a city serves as the 'nerve centre' for the management of day-to-day operations, exception handling and disaster management. It gathers complex data sets and analyses them to provide insight for improved decision making. The ICCC is designed to collect data from a number of apps and sensors deployed across the city, and then convert this data into a set of meaningful information for different departments of the municipal corporation for timely action and strategic planning.

Surat Municipal Corporation developed ICCC Surat as a SMAC (Smart City) Centre to help manage the city more efficiently while offering high-quality services to the city's inhabitants. The goal was to create a command-and-control centre and consolidate the IT assets that were being used at multiple locations in Surat. This would help to monitor various SMC services from a single location, and provide a resilient and scalable infrastructure that could be used to add new services which could then be monitored as needed in the future. The project's main focus was on ICCC Surat's Solid Waste Management system along with other initiatives at Surat ICCC (Surat Smart City).

1.2 Significance of the project

The first phase of the Integrated Command and Control Centre was launched in June 2016. Initially, the project started at a small scale to monitor limited operations such as the Complaint Management System (CMS), CCTV Network and GIS. The ICCC has shown significant improvement in municipal service delivery. They have the capability to access real time data through sensors, cameras, apps and IOT devices installed at multiple strategic locations to monitor the different elements of service delivery. This kind of data generated digitally proves to have great significance in providing information to different departments of the municipal corporation to help them identify root causes of problems, recurring problems, monitoring the third-party delivering the services along with citizen behaviours and enforcing rules for better city management. This kind of information generated from the data which is integrated at the command control centre helps the Surat Municipal Corporation in both short and long term to take tactical and strategic decisions. The ICCC is an important tool for city management.

1.3 Aim and Objectives

The aim of the study is to analyse the functioning of ICCC in Surat with the focus on Solid Waste Management while briefly also covering other services under ICCC.

The objectives of the study are:

a. To identify and analyse the Solid Waste Management (SWM) System of Surat by observing its functioning.
b. To understand the impact on citizens by stakeholder consultations.
c. To suggest measures to take the ICCC functioning to the next level for higher impact and citizen empowerment.

2. Contextual Background

The Integrated Command and Control Centres are designed to be the brains behind municipal operations, exception handling and catastrophe response. The ICCC platform with its various layers and components operates as a Decision Support System (DSS) for city administration, allowing it to respond to real-time events by consuming data feeds from various data sources and processing the received information. (Ministry of Housing & Urban Affairs (MoHUA), 2018)

Through the placement of sensors, cameras, IOT devices around the city, data is generated and captured under ICCC which is used to enhance situational awareness while delivering insights by using data for civic officials throughout urban functions like solid waste management, transit management, health etc. This helps in creating a standardised response strategy at the city level by instituting standard processes for recurring events, issues and emergency situations. It also helps in improving coordination across and within departments. This further helps in evidence-based decision-making by institutionalising data-driven operations. Recently, ICCC has also been of immense support during the management of the crisis situation of Covid-19.

2.1 Conceptual Framework/Research Design

While a few cities have begun deploying ICCC under the Smart Cities Mission with the necessary applications, networks and sensors, they are at different degrees of maturity in terms of making informed decisions. As these ICCCs are implemented, it will be necessary to assess their success by using a consistent methodology across the country for cities' investments to generate equal benefits to the cities and its inhabitants. The objective of the Maturity Assessment Framework is to provide cities with a do-it-yourself toolkit to measure maturity and effectiveness of the Integrated Command and Control Centre in the management of civic operations, day-to-day exception handling, disaster management, planning and policy making.

There are three dimensions (Functional, Technological and Governance) on which ICCC Maturity Assessment Framework assesses the ICCC ecosystem, water, waste water, storm water, sanitation, waste management, roads, traffic and street lights. All these are examples of functional coverage as are social infrastructure such as education, healthcare, leisure and recreational facilities and services such as certificates, approvals and licence issuance. Then are its technological coverages which relates to aspects like technological capability, scalability and security. Governance fundamentally relates to the human side of the system, with a focus on the governance policies in place to effectively run the city ICCC.

The Maturity Framework measures the development of the above-mentioned components using a detailed questionnaire to determine how well the city has used the Integrated Command and Control Centre's capabilities to improve the day-to-day operations, policies and decision-making. Cities might use the Maturity Framework to identify implementation, technological and operational gaps in various smart solution initiatives, allowing the ICCC to reach its full potential. Integrated Command and Control Centre's Maturity Assessment Framework is conceptualised to achieve a few objectives which will leverage the true potential of the platform, for maturity assessment of its components, to create knowledge exchange for peer to peer learning to design innovative impactful use cases, for impact assessment on improving City livability indicators. (NIUA, pp. 7-23)

Likewise an Impact Assessment Framework was carried out for this research by analysing the technical capabilities and functional deployment of various services of ICCC. Solid Waste Management (SWM), Complaint Management System (CMS) and Intelligent Traffic Control System (ITCS) are the main services which have been taken to conduct this research. The study was done by going into each component of these services and further dividing the components into sub-components to have a more thorough review.

Surat ICCC

Surat is India's eighth largest city, having a population of approximately 4.6 million people according to the 2011 Census. The city is the world's fourth fastest expanding city. The population is currently projected to be above 5.5 million people. The city's jurisdiction covers 326 square kilometres. Surat Municipal Corporation established the SMAC Centre (Smart City Centre) to monitor and manage the city operations. The SMAC Centre is SMC's administrative control centre. Its goal is to improve service delivery, make the best use of municipal assets and create synergy between different departmental activities through effective monitoring of the city operations.

The SMAC Facility was set-up with the goal of establishing a centre that would aid inter-departmental cooperation and enable monitoring of major business domains and service indicators. (Surat Smart City) SMC's SMAC Centre was launched on June 25, 2016, and the systems covered in the first phase were Property Tax, VBD Health Survey Application and Complaint Management. This will also help in monitoring City Operations through CCTV Network, Water Treatment Plant (WTP) SCADA, Sewage Treatment Plant (STP) SCADA, Intelligent Transit Management System (ITMS), Swachh Bharat (Swachhata App) and Monitoring of D2D Garbage Collection using GPS. In future the SMAC Centre will be used to integrate and monitor numerous SMC operations such as Intelligent Traffic Control System (ITCS), D2D MSWM and Road Asset Management System.

Surat's SMAC Centre serves as an administrative control centre, assisting the city in improving coordination, administration/management and service delivery and creating synergy between multiple departmental tasks through excellent coordination and monitoring of municipal operations, and so on. (Surat Smart City Development Limited, 2020)

To maintain cleanliness SMC has invested in various equipment such as garbage collecting vehicles, transportation facilities, disposal mechanism, treatment of collected waste and 2100 cradle type dustbins. This equipment is linked with the waste management program at the ICCC to strengthen the implementation of smart solid waste management system.

Broadly, the ICCC monitors and controls two very important functions of the entire Solid Waste Management process:

i. Collection

Each vehicle is assigned different PoIs (Point of Interest) which they have to cover in certain a time. Vehicles go back to the transfer station to dump waste if the containers of these vehicles are filled. They dump the waste in a segregated manner at the transfer station of that particular ward and then again continue with their trip. In case the vehicle breaks down in the middle of a trip, immediately a spare vehicle is sent from the workshop of the organisations to replace the vehicle and continue with the trip. Finally, the vehicle goes back to the transfer station to dump the waste. The truck collects all the waste from the transfer station in a segregated manner and takes it to the final dumping site.

a. Point of Interests (POIs)

All the vehicles engaged in waste management are fitted with common vehicle tracking system. Each vehicle is assigned trips with fixed locations. Each trip covers designated locations known as PoI.

b. Route Monitoring

Mobile application has been provided to the field staff to monitor and manage the activity. The on-field application monitors the activity and sends data to the command and control centre which helps to track and monitor the entire field engaged in solid waste management process. It also helps to assign spare vehicles in case of breakdown. (Smart City Proposal (SCP))

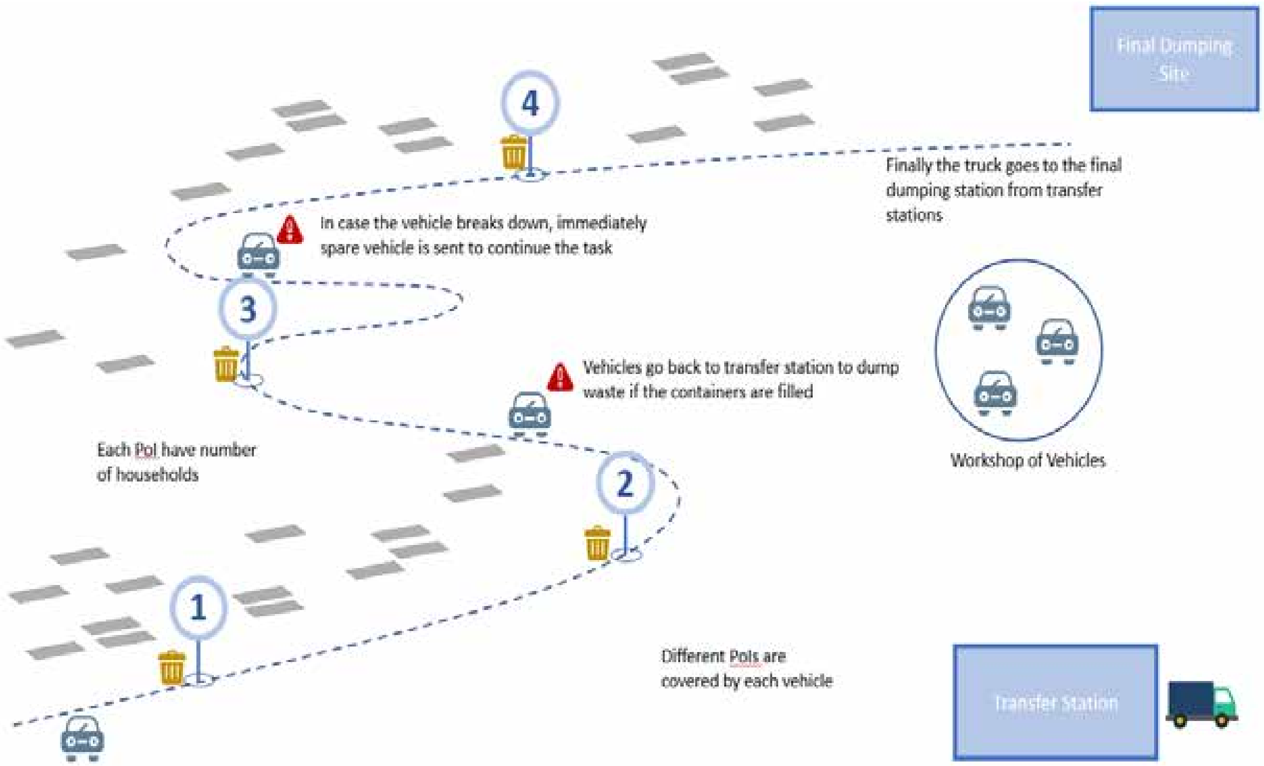
Figure 1: SMAC Centre, Source: Surat Smart City

Figure-4: Disposal Mechanism Source: (Surat Smart City Development Limited, 2020)

Figure- 5: Treatment of collected waste, Source: (Surat Smart City Development Limited, 2020)

Figure-6: Garbage Collecting Vehicle,
Source: (Surat Smart City Development Limited, 2020)

Figure 1: SMAC Centre, Source: Surat Smart City



c. Impact

With the entire process in place, the accuracy of the timings of vehicles has increased. It has become convenient to locate the vehicles and take action at the time of any sudden breakdowns or unavailability of vehicles to complete their trips and accordingly take action with the help of alerts for any such situation.

ii. Transfer Stations

When a vehicle enters the transfer station it waits on a weighbridge from where the weight of the vehicle is taken, a camera is installed at the point which captures the image of vehicles while the RFID Reader reads all the information from the RFID tags on each vehicle. The vehicle moves and dumps the dry waste first and then returns back to the weighbridge, again the weight of the vehicle is taken and the process repeats one more time with the empty vehicle. This process helps determine the weight of dry and wet waste separately and the total amount of weight collected every day. After this entire process the vehicle exits the transfer station and continues with its trip.

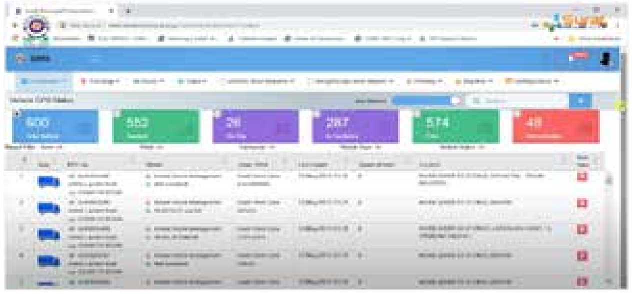


Figure-2: Vehicle Tracking,
Source: SMC Portal

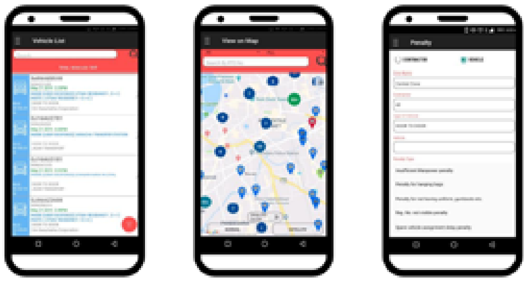


Figure-3: SWM Mobile App for Field Officers,
Source: Surat Smart City Development Ltd., 2019

Figure-4: Waste Collecting Vehicle at a transfer station,
Source: Surat Smart City Development Ltd. 2019

a. RFID tags and Readers

Each vehicle is fitted with the RFID tag mapped with the vehicle registration number. Each transfer station is fitted with a RFID reader.

b. CCTV Camera

CCTV Cameras have been integrated with solutions to capture the vehicle registration number at the time of measuring the gross weight.

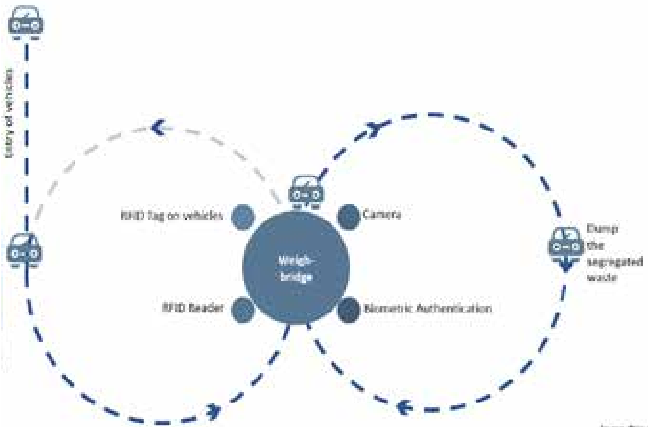
c. Weighbridge

d. Biometric Authentication

Biometric devices have been integrated with solutions to ensure the availability of the designated staff. (Surat Smart City Development Ltd., 2019)

Impact

The payment and penalties to contractors based on different SLAs and KPIs pertaining trips, missed PoIs is autogenerated through the system. Also, as seen the graphs of complaints regarding D2D has gone down over the past three years. There is reduction in missed locations (PoI) improving D2D coverage. (Surat Smart City Development Ltd., 2019)



2.2 Key features of the project

2.2.1 Challenges in the project

The challenges faced in the project were:

Surat is the second cleanest city in India and it was a challenge to find scope of improvement in the city that is already functioning so efficiently, especially in Solid Waste Management system. However, we had suggestions to take this to a more enhanced level.

2.3 Key findings from interviews, surveys and primary/ secondary data collection

The objective of conducting stakeholder consultations is to understand the impact of ICCC. The main stakeholders involved in the study were the citizens of Surat, SMC Employees and ICCC Employees with respect to Solid Waste Management (SWM), Complaint Management System (CMS) and Intelligent Traffic Control System (ITCS). The methods and tools adopted to conduct the consultation were interviews, meetings, desk studies and news articles.

Below is the Impact Assessment Framework for Solid Waste Management, Complaint Management System and ITCS.

Summary

In SWM, the cameras deployed at transfer stations and the final dumping site help take a picture of vehicles when they arrive. There are various issues identified on-field such as vehicle breakdown, uniforms, bags, etc. which are not detected by cameras but by on-field officers. This system can be improved if cameras are deployed on-field to identify the issues. All vehicles are installed with GPS and RFID tags. The speed of the vehicles is also monitored with the help of GPS. If the speed of any vehicle goes beyond 60 km/hour, speed alerts are generated. All errors regarding GPS are handled by field engineers. The errors usually have some connection with the SIM card of GPS. All RFID tags provide accurate information to the system about the vehicle (No., trips, driver, etc). Earlier sticker tags were used but now all RFID tags are metal mounted.

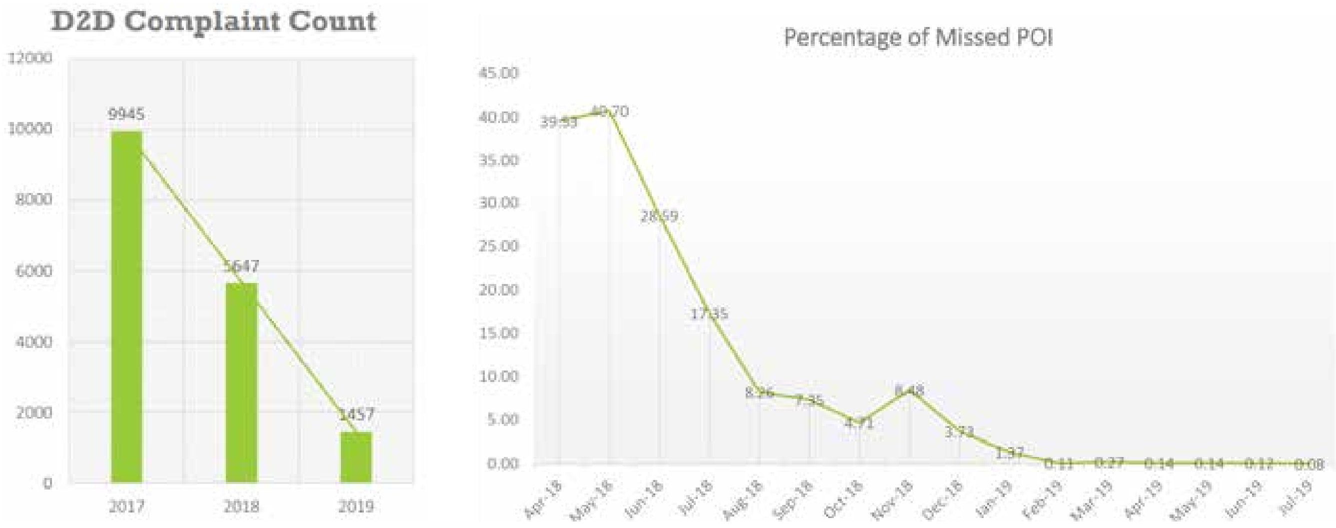


Figure-5: Reduction in Complaints and Percentage of missed POIs,
Source: Surat Smart City Development Ltd. 2019

There is a mobile app for supervisors and on-field officers to take action. Data available on the app includes movement of vehicles, spare vehicles, uniform of workers and bags hanging on vehicles. Waste collection is also done in a segregated manner. Waste is segregated into three types - Dry, Wet and Organic waste. During stakeholder consultation, there was an issue with the collection method of the waste. As per citizens, some field workers collected waste from the doors in some areas whereas in some areas they did not do so. While verifying the information from SMC officials it was projected that if collection was happening then it must be separately through the workers of that particular building and not by the corporation workers as it would add more time to the collection process and is also not feasible.

Table-1: Impact Assessment Framework for Solid Waste Management (SWM)

Components	Technical Capability	Weightage	Functional Deployment	Marking (In%)	Implications
Camera	Are CCTV cameras deployed on-field geo referenced?	20%	Yes	90%	If the cameras deployed across the city for different purposes are used for issue identification for solid waste also then it will act as a preventive measure rather than a complaint resolution measure.
	Are all the cameras installed on-field in working condition?	20%	Yes		
	How often do cameras cause technical errors and how quickly are they resolved?	10%	Cameras do not cause errors very often.		
	Are the issues identifiable in control and command centre through CCTV footage?	20%	For SWM, on-field identification is done for any issues caused.		
	Is the verification done after an issue is resolved using the CCTV Camera?	30%	Verification is done by on-field officers.		
GPS	Does the GPS trackers installed on every vehicle provide real time data for route monitoring?	40%	Yes	100%	
	Does the data get escalated through GPS monitoring in the form of messages or alerts?	30%	Yes		
	Is the speed of vehicles also monitored with the help of GPS?	30%	Yes, the speed limit being 60 km/hr.		
RFID Tag and Reader	Are the RFID tags always functional on transfer stations?	30%	Yes	100%	
	Is the data received from RFID tags accurate?	40%	Yes		
	Does the RFID reader cause any error while reading the information from it?	30%	No		
Mobile App	Does the android application allow the collection of a wide range of data from GPS and the camera?	50%	No	100%	
	Are there on-time notifications and alerts? (Without any time lag)	50%	Yes		

Table-2: Impact Assessment Framework for Complaint Management System (CMS)

Components	Technical Capability	Weightage	Functional Deployment	Marking (In%)	Implications
Application	How long does it take for any complaint to be resolved?	40%	There are different timings for resolution of each complaint.	80%	The complaint loop is currently closing at the corporation's end. However, if an opportunity is provided to the complainee to close the complaint within a given time frame of complaint resolution, it will give a sense of empowerment and satisfaction to the citizens. However, if the citizen fails to close the resolved complaint from their end within the given time frame then the corporation retains the right to close the complaint from its end after the lapse of such time given to the citizens.
	Are there any officer-wise complaint pendency for longer periods?	20%	No		
	Is proper compliance followed while monitoring complaints, considering the quantum of complaints?	20%	Yes		
	Are citizens made aware of what happens if the complaint is not resolved?	20%	No		
SMC Portal	Does the complaint management portal and app work as communication between government and citizens?	100%	Yes	100%	
Feedback from Citizens	How do the citizens give feedback in the Complaint Management System?	100%	Feedback from citizens is basically just how many complaints are being done and resolved.	100%	

Summary

For any complaint to resolve there are designated time periods in which they need to be resolved. Citizens can reopen their complaints only twice if the complaint is not resolved. For resolution of complaints, cameras are deployed which help in confirming the case. Complaint escalations are done from level 1, level 2 and then level 3 officers. If the complaint is not resolved even after level 3 escalation, citizens need to re-register the complaint. Feedback from citizens is taken only based on how many times citizens reopen complaints. The ratio of positive to negative feedback is more inclined towards positive.

Intelligent Traffic Control System (ITCS) system at ICCC:

It is commendable to see that Surat ICCC has started with yet another initiative at ICCC which is the Intelligent Traffic Control System (ITCS). This initiative has been started with the aim of managing and controlling traffic system in the city for smooth navigation within the city limits. The work is in progress and only 25% has been implemented. Since it is in the design phase there are a few suggestions which can be incorporated for the ease of citizens.

ANPR Cameras generate e-challans and Overview cameras take evidence photos on junctions for any violations that are taking place. Mostly red light violation and wrong side driving are the reasons for generating e-challans. Payment for e-challan is done through the police portal or by going to the RTO. Presence of vehicles is detected through sensor cameras to identify the density of vehicles. Currently, the reasons behind congestion in the city are metro construction, office hours and the construction of bridges or roads. At present, the green corridor system has been implemented only in six junctions as a pilot project while still 75% of the work needs to be completed for green corridors to function properly.

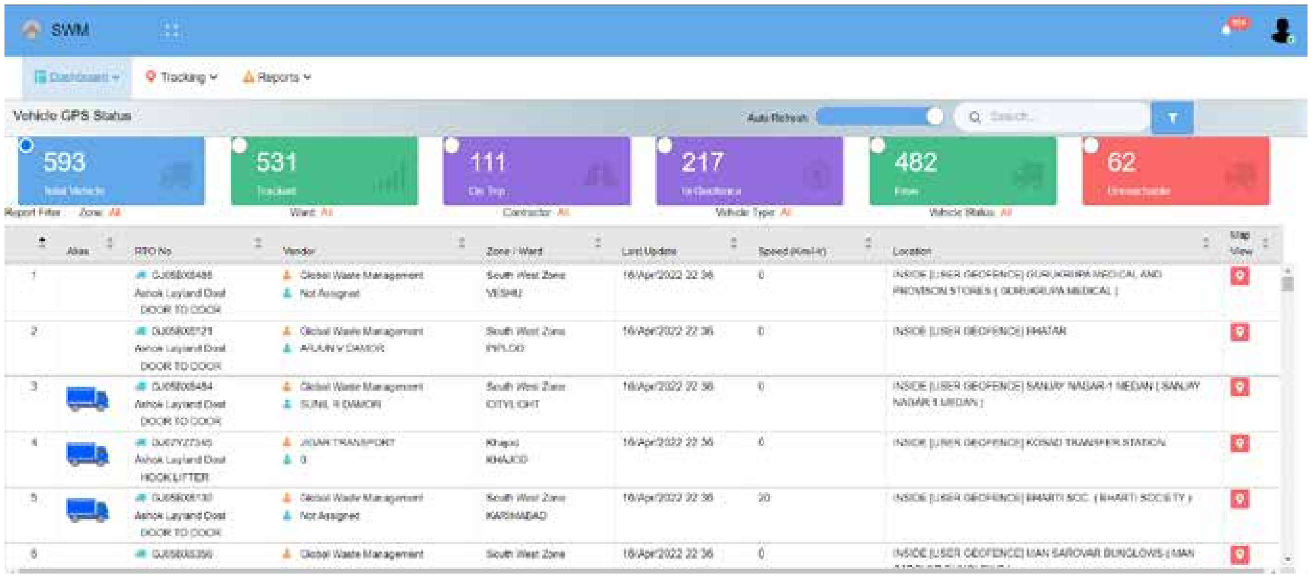


Figure-6: SMC Portal for SWM,
Source: SMC Portal

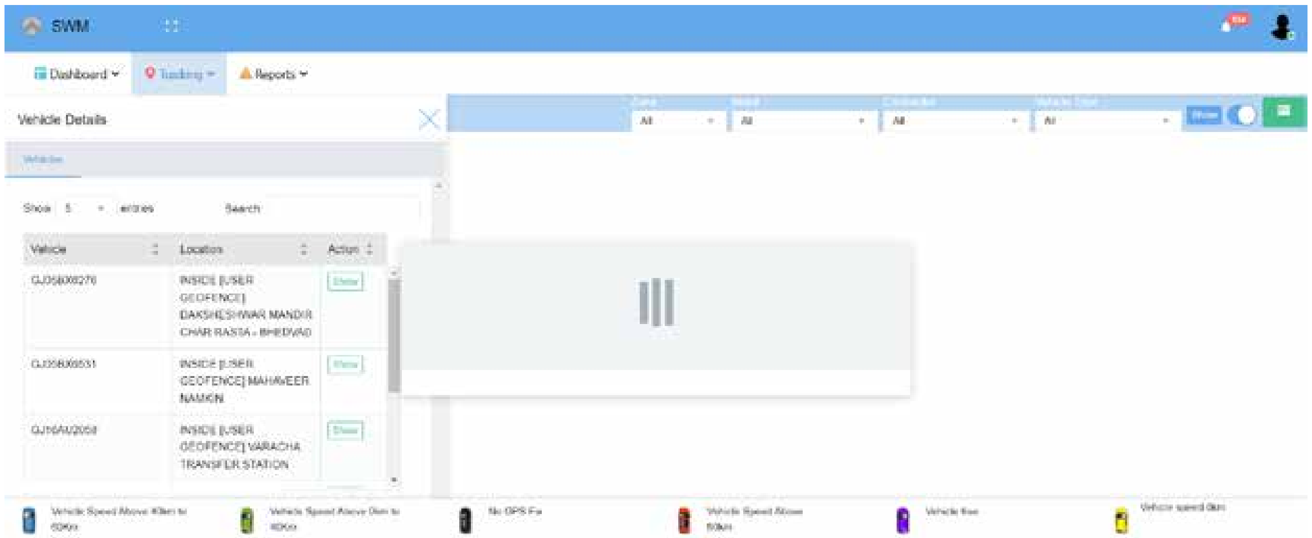


Figure 7: Loading of Tracking System,
Source: SMC Portal

3. Discussion and Conclusion

3.1 Recommendations

3.1.1 Solid Waste Management (SWM)

The citizen's expectations need to be met for the system to function smoothly. On the SMC website there is an option for public to view all the information of the vehicles including their timings and areas which they will be covering. The portal has three categories - Dashboard, Tracking and Reports. While choosing the tracking category, the page keeps on loading and there is no result . The system needs transparency to keep the citizens satisfied.

In the tracking section, the information about vehicles is visible but the on-map tracking keeps on loading with no result. Citizens can track the vehicles by searching them according to their zone, ward, contractor or vehicle type. In the report section, the activity of vehicles is visible to the citizens. The total number of trips a vehicle has made, the total number of PoIs allotted and attended. The data of vehicles' early or late visits is also recorded along with missed or pending PoIs.

In South Korea and Singapore, Smart bins have been introduced in the city which help in the scheduled collection of waste, eliminating the waste falling on roads due to spillage and also reducing the time taken by vehicles to make the trips every time for every bin.

3.1.2 Complaint Management System (CMS)

The loop of CMS is missing the part wherein the complaint is closed only by the admin, eliminating the role of the citizens from the final step. When this happens, citizens have to re-file their complaint or write mails regarding the issue. A few steps can be added in the loop which can be beneficial to both citizens and government. In case there are any recommendations or suggestions regarding the issue filed by the citizen, then that can also be provided for in the process.

Also, at the end of the cycle, the confirmation about the resolution of the issue should also be done by the citizen and in case the issue remains unresolved, then the citizen and admin both should take the next step. By doing so, citizens will not only be given authorisation but also the opportunity to close the complaint, making them feel empowered.

3.1.3 Intelligent Traffic Control System (ITCS)

Citizens are not aware about the penalties for various violations. In the existing app (Surat Traffic Force) this information can be added for the ease of citizens. Currently, the app shows only the violations and their fine and not other fines for other violations.

Currently, the green corridor system has only been implemented in six junctions as a pilot project and still 75% of the work needs to be completed for the green corridors to function properly. It doesn't benefit the citizens if the green corridors are not implemented in the entire city.

3.2 Conclusion

Overall, the system is working exceptionally well and has shown positive impact from both the citizen's perspective as well as from the system's point of view at the corporation. The citizens are satisfied because they know precisely when the vehicle will come for collection and they can plan their schedule well in advance. Moreover, there is no change in the timings which also leads to a lot of surety in the services, leading to massive reduction in complaints related to SWM. The city appears as neat, clean and un-littered due to 100% coverage of door-to-door collection.

For the benefit of the municipal staff also, the system helps as they can get reports in a more systematic manner, third parties involved can be easily evaluated and the penalties for any mis-happenings can be recorded and the entire system works efficiently by validating all the points that need to be covered. Contracts can be executed appropriately because real time data is captured by the system.

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A6

Integrated Command and Control Centre (ICCC)-Redressal System

Name of the project: *: Integrated Command and Control Centre*
Location: *Ahmedabad, Gujarat*
Year of Project Implementation: *23rd February 2018*
Sector: *Technology*
SDG: *SDG 3, SDG 6, SDG 9, SDG 11, SDG16*
Project Cost: *: Rs 310 crore*

Institute: *CEPT University*
Advisors: *Dr. Saswat Bandhopadhyay, Dr. Sejal Patel*
Students: *Meet Rakeshbhai Patel*

Keywords: *Smart cities, technology, Barriers*

Abstract

Population growth, sustainability and climate change are all current issues being faced by cities, so the idea of Smart Cities took birth. Technology is used to create a sustainable Smart City. Urbanisation has taken on new dimensions in the twenty-first century, requiring urgent upgrades to existing cities to meet the new worldwide "Sustainable Urban Development Goals." The concept of a Smart City is new. These Command-and-Control Centres (CCCs) show how Indian Smart Cities have advanced in acquiring and merging massive data using audio, video, sound, sensor and crowdsourcing devices. A lot of these concerns had to be resolved by the state. But the government's attempts failed in various ways. Given the poll's findings, the government has developed a "Citizen Complaint Redressal System" to address this issue. To gain public trust in the AMC's carrier management and service delivery skills, the AMC uses the CCRS. Everything from the first filing through the final conclusion is automated.

We need to learn more about the CCCs and analyse service delivery in Ahmedabad using the CCRS. In total, 216 citizens were surveyed and 25 were interviewed for the study. The system's functionality was better understood by using qualitative analysis to extrapolate several conclusions from stakeholder interviews. We encountered many technological and awareness barriers.

To improve the system's efficiency and usability researchers made certain recommendations. To get beyond the different hurdles discovered during inquiry, both long-term and short-term targets have been proposed

Case Study: **A6**

1. INTRODUCTION

1.1 Topic and Context

Cities are becoming more liveable and responsive as they become smarter and this is just the beginning of what technology can do in cities. The establishment of 100 Smart Cities in India is revolutionising urban planning and governance. Intelligent use of technology, information and data to improve infrastructure and services is what Smart Cities is all about (GoI, 2015). With the Smart Cities Mission, cities will be fitted with an extensive network of sensors, cameras and Smart metres to continually monitor, control and regulate city flows. This worldview will promote a 'Smart mentality.' Most of India's 100 Smart Cities want to construct a centre to collect data and integrate stakeholders for better urban management using modern technologies.

1.2 Scope of the Project

With the growing need for civic services, the rise of e-government could be one of the solutions. Local governments are aggressively utilising e-government to make life easier for citizens and for themselves, particularly the CCRS interventions. With the use of mobile applications, websites and email addresses, e-government has got a huge boost. However, for a variety of reasons, it is not reaping the intended benefits either because people are unaware of it or because it is not convenient for them.

As a result, the issue statement is to see if the Complaint Redressal System is effective in terms of service delivery and whether individuals are aware of and satisfied with it.

1.3 Aim and Objectives of the Study

The aim of the study is to critically review and analyse the operation of the Command-and-Control Centre (CCC) of Ahmedabad with respect to the Complaint Redressal System (CRS), its fundamental and technical process, financial sourcing and its implications and outcomes.

1.3.1. Objectives

The objectives of the study are:

a. To review the history, evolution and mandates of Command-and-Control Centre with respect to service delivery and Complaint Redressal.
b. To analyse the importance of the Complaint Redressal System at the back and the front ends.
c. cTo analyse the gap in the Complaint Redressal vis-à-vis the Citizen Charter through the Complaint Redressal System.
d. To know the future targets of government authorities and recommend ways to further improve the system.

1.4 Research Methodology

In the Qualitative and Quantitative Analysis, a list of possible parameters for analysing the usability of the CCRS in ICCC was identified. The research involved a quantitative survey of inhabitants in several zones of Ahmedabad to understand various aspects. A sample size of 20 people from each zone was taken as random sampling. The study is a qualitative survey of Ahmedabad's government officials.

2. CONTEXTUAL BACKGROUND

2.1 Need for Command Centres In India?

The following are the issues that prompted the development of Command-and-Control Centres:

1. Frequently, two distinct agencies do not share the same point of view. The creation of a Command-and-Control Centre (CCC) is primarily motivated by the desire to create a common platform for collaboration across various local and state entities that deliver urban services and infrastructure.
2. As internal government structures are integrated, Indian cities will need to collaborate and partner with external organisations and individuals to reap the benefits of the development of big Data Centres.
3. Currently, Indian cities lack methods for opening data and Smart City concepts place little emphasis on the creation of open data platforms. As a result, the data is collected using cutting-edge technologies that acquire, process and analyses large amounts of data from a variety of urban sub-systems.
4. Striking a careful balance between using new types of digital technology to monitor and measure cities while allowing the government to open available crucial data-sets to maintain transparency and stimulate creativity.
5. Command and Control Systems can concentrate authority and decision-making in a small number of offices equipped with huge displays and cutting-edge algorithms. (Praharaj, 2020)

2.2 Establishment of ICCC Ahmedabad

On February 23, 2018, the hon'ble Gujarat Chief Minister Shri Vijaybhai Rupani launched the Safe And Secure Amdavad (SASA) Project's Integrated Command and Control Centre (ICCC) at Paldi. The control room has cutting-edge technology. The structure has a total size of 2300 sq m and four storeys of 4.5-m each. It was designed to last 75 years. In total, the project is anticipated to cost roughly Rs 310 crore.

2.3 Objectives of ICCC Ahmedabad

Track vital data such as pollution levels, water levels and traffic

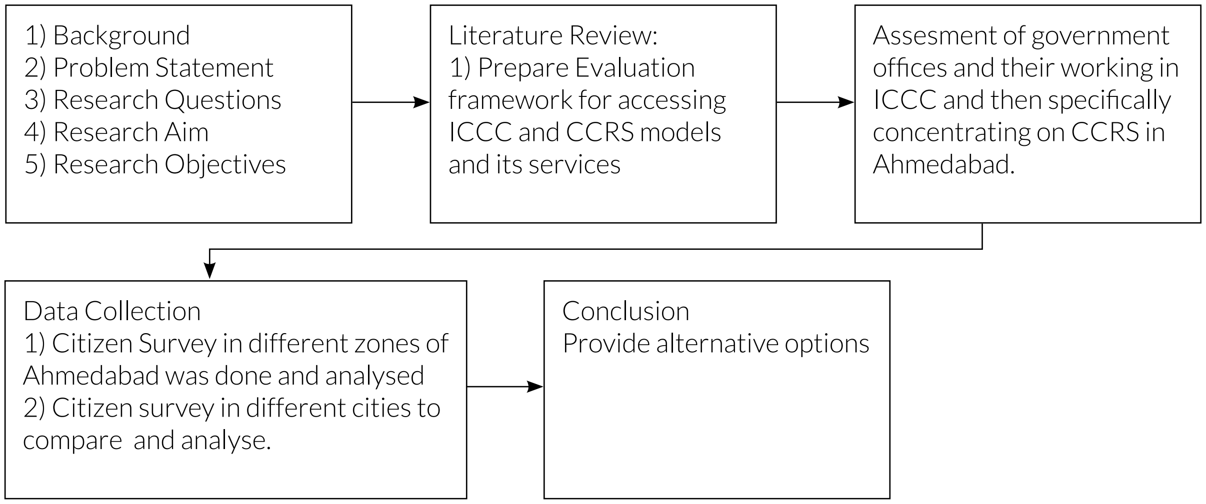


Figure-1: Depicting the Research Methodology
Source: Primary Source

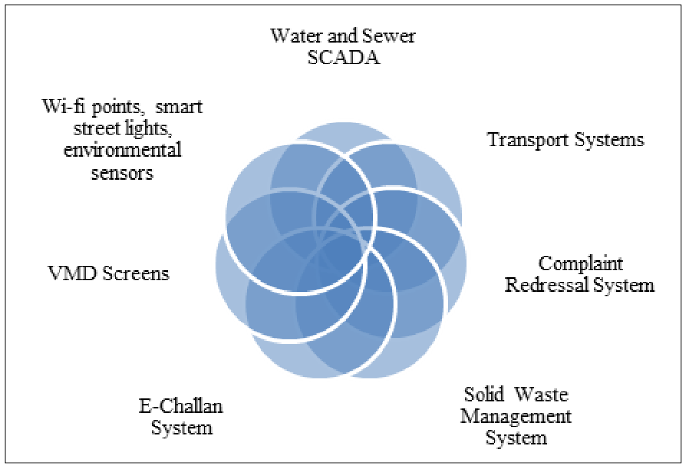


Figure-2: AMC departments to be monitored and controlled through ICCC
Source: Primary Source

1. Improve security in the city
2. Integrate emergency services such as fire, police, ambulance etc.
3. Be adept with intelligent solutions for disaster management and city operations.
4. Integrated Command and Control Centre is a hub for visualising, co-relating, monitoring and controlling the services from one location. Ahmedabad ICCC focuses on tackling the problems in the city and improving various functions and services. (cities, 2014)

2.4 Understanding the Complaint Redressal System Ahmedabad

To identify issue areas where regulations and policies will be altered and where the Complaint Redressal System will be used regularly to evaluate public grievances. Citizens can report on-the-ground issues to the municipal employer to enhance execution and the residents' quality of life and safety. Vision Comprehensive Complaint Redressal System (CCRS) is Ahmedabad Municipal Corporation's (AMC) trusted platform for people to file issues. Through total carrier control and effective service delivery, the CCRS enables the AMC to improve public pride. (Corporation AM, n.d.)

2.4.1 Various Modes to Register Complaints

There are various modes to register complaints. The different modes are:

- Call
- SMS
- Email
- Mobile Application
- Ward Office Desk
- IVR

2.4.2 Understanding the Citizen Charter

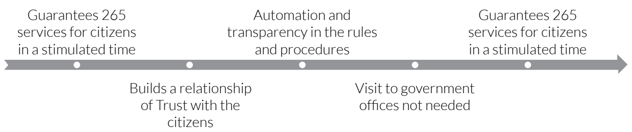


Figure-4: Reasons for implementing automatic technology for governance
Source: Citizen Charter Report, 2013

2.4.3 Timeline of Complaint Redressal System

In June 2013, the e-governance system was created as a complaint redressal method with the goal of utilising technology. E-governance has unquestionably proved to be a powerful instrument for any citizen-centric, transparent and effective governing system. With important infrastructure and rules in place, the GoG (Government of Gujarat) has actively promoted information sharing by displaying and disclosing information from a number of functional departments and their subordinate entities on their websites. The government recognises that information alone will not suffice to fulfil the ever-increasing demand for government services. As a result, various projects to provide citizens with faster government services have been undertaken in the past. CCRS was integrated into the Command-and-Control Centre in 2018 as part of a new intervention in the integration of several departments and services available to the citizens to file complaints.

2.4.4 Flow of E-Governance before ICCC

Ahead of the ICCC's implementation of the CCRS, three different types of complaints were brought into the system under the CCRS model which provided citizens with greater comfortability in dealing with the complaints. Initially 15 departments were combined into a well-channelised systematic structure with complaints being directly addressed to the ward department that they originated from.

2.4.5 Complaint Process in CCRS after Integrating in ICCC

Complaints can be filed both offline and online through the ward office's complaint redressal department as well as the CCRS portal. Complaints can also be made by phone, by calling 155303 from an individual's landline or mobile between 6:00 AM and 10:00 PM or by sending an SMS to 56079 with the text 'AMCCRS NEW'.. Under the supervision of the AMC and contract labourers, problems are rectified. Online complaints can also be submitted through mail (AMC, 2014)." A receipt is generated for each complaint registered on the desk or through the CCRS portal and a copy of the same is kept by the citizen. In the event of online complaints, each person is assigned a unique complaint number. The receipt is subsequently forwarded by a clerk at the ward office to the Technical Supervisor (TS), who informs the Assistant Engineer, who further assigns the job to some official.

2.4.6 Complaint Departments

There are 24 complaint departments for every service under which a person can file their complaints on different complaint subcategories. Some of the departments are Higher secondary school, ICDS, Kankariya Lakefront, Engineering, CNCD, Bal Bhavan, Estate, library, garden, gymnasium, health, heritage, lights, mid-day meals, museum, professional tax, Urban Health Centre, Town Planning, Swimming Pool, Slum Networking, Zoo, Kankariya, SWM, Property tax and others. Under each department there is a complaint category which is further divided into different sub-categories based on departments.

2.4.7 Case Studies of Pune Complaint Redressal System

Social media presence for PMC to foster a stronger connection with the public

a. Social media platforms such as Facebook and Twitter will be utilised to enhance the quality and effectiveness of PMC's engagement with all stakeholders.
b. Social media will be employed in novel ways to increase the participation of PMC taxpayers in the corporation's governance.
c. Total 18 means of complaints are available to residents with contact centre and WhatsApp being the most frequently utilised, while manual complaints are the least frequently used. (Corporation PM, Pune Smart City – Vision Document)

Departments involved in the Grievance Management System

a. There are several types of feedback provided by residents and the portal automatically gives out an average rating based on the reviews received from the citizens, which further assists the department in analysing and resolving barriers to the department's functionality. Garden and administrative departments earn the highest average rating while departments of security, encroachment and building permits receive the lowest average rating.
b. A total of 33 departments are involved in the system which provides a forum for residents to address concerns that arise daily. There are nine additional departments in Ahmedabad's CCRS. The addition of more departments has added value to the system and significantly increased its efficiency and accessibility.

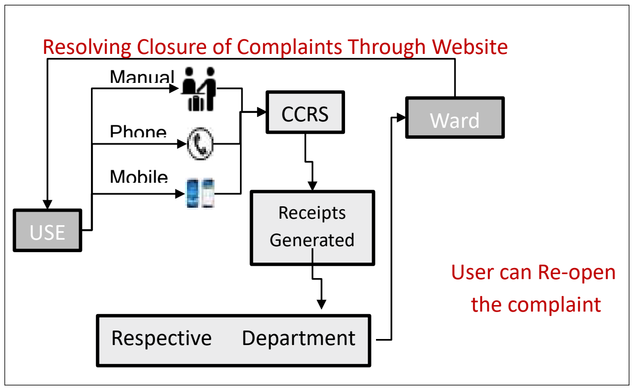


Figure-5: Work flow of CCRS before integration in ICCC
Source: Primary Source

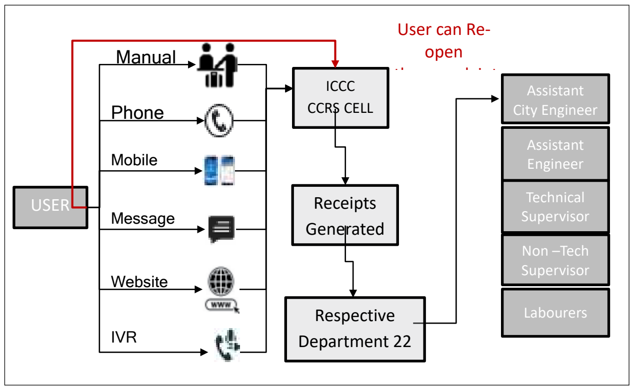


Figure-6: Work flow of CCRS after integration in ICCC
Source: Primary Source

Value Addition in the System

1. Inclusion of the building department makes the process of approving building plans more efficient and user-friendly for those interested in the real estate market. It established a transparent approval process, resolving time-consuming procedures that required innumerable visits to government agencies.
2. The grievance management system's objective is to establish a citizen-centric city by soliciting significant suggestions and reviews from residents to improve the city's Urban Management System. As a result, Smart City Pune and City Planning departments have been added where citizens can voice their concerns and suggestions to the governing authorities.
3. A transferable development rights department has also been added to the GMS, providing transparency to real estate developers and allowing them to conduct transactions in streamlined ways without hassles, avoiding TDR black marketing.
4. This has increased public knowledge, resulting in citizens adopting many modes of complaints incorporated within the system.
5. Because citizens are aware they also provide appropriate inputs which assists the governing body in identifying systemic flaws and improving the system's efficiency.
6. The GMS dashboard is updated with various analyses so that citizens and government agencies can make the best use of it. Every detail is shared and can be accessed after sensitive data screening.

2.5 Conceptual Framework/Research Design

To achieve the research goal of creating a framework for evaluating the usability of the CCRS, a list of potential assessment parameters were identified in Qualitative and Quantitative Analysis.

2.5.1 Quantitative Analysis

Quantitative analysis uses mathematical or statistical methods to examine a situation and better understand group behaviour. This strategy is used by researchers who need hard facts on a subject. Thus, quantitative data is used to support or deny a study issue or theory. The research involves a quantitative survey of citizens in several zones of Ahmedabad to understand key aspects of the CCRS model. Thus, a random sample of 20 people from each zone was used.

2.5.2 Qualitative Analysis

Qualitative analysis aids data analysts in interpreting a group's thoughts and subjective feelings in each setting. As a result, qualitative analysis frequently employs more textual descriptions than numerical data. If analysts have access to statistical data, such as the respondents' age, gender or geographic region, they can utilise it to learn more about the responses. A qualitative survey of various government officials in Ahmedabad is part of the research.

Users - Citizens	CCRS Department
• Survey of 210 citizens • Interview of Mr Jain • Interview of Mr Patel • Interview of Mrs Thakkor	• Adil Infosys, Team Head • Adil Infosys, Developer • Adil Infosys, Operator • Ad Director, CCRS
ICCC Officials	**AMC Ward officials**
• SCADAL Officer • PWC Head • PWC Core Team	• Ass City Engineer • Ass Engineer, Sabarmati Ward • PHSS, SWM Department • HMSI, Health Department • West Zone, City Engineer

3. KEY FINDINGS

3.1 Analysis of Interviews, Surveys and Primary/ Secondary Data Collection

3.1.1 Analysis of Statistical Data of CCRS

Between 2018 and 2021, the overall number of complaints climbed from 3,78,608 to 5,77,182, indicating that public knowledge of CCRS has improved. However, in 2021, 8.08 percent of the anticipated population will have some complaint or the other.

3.1.2 Analysis of the Citizen Survey

The random sample poll included 218 citizens of Ahmedabad from various zones and found that 67% were unaware of the Complaint Redressal System, while 33% had filed a complaint. Of the 33% who had filed a complaint, 64% chose to phone the call centre. Analysing the age group the evaluation revealed that 36% of respondents were under 26 years of age and were aware of the CCRS. Majority of those who complained were in the 36-45 age bracket.

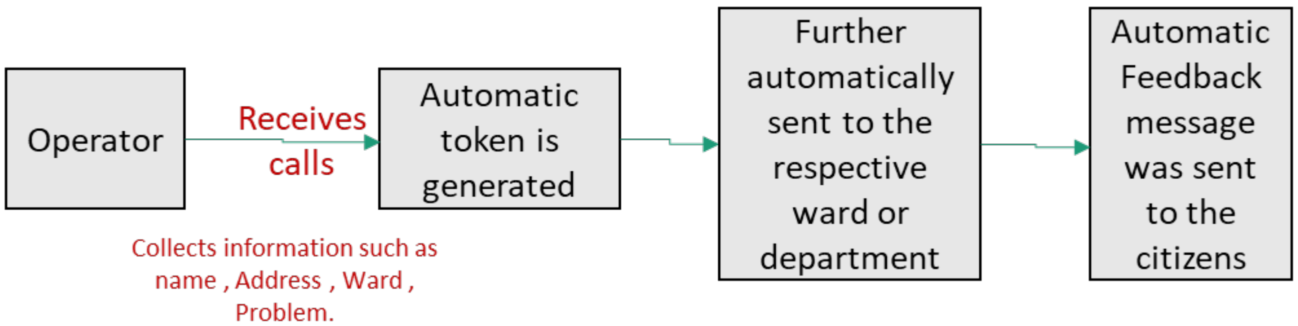


Figure-7: The process of Operators in CCRS
Source: Primary Source

3.1.3 Inferences from People Working in CCRS Department in ICCC

Since the inception of the CCRS in E-Government, the private firm Adil Infosys has been responsible for its operation. They were instrumental in setting up their complete APIs and systems in the ICCC building in Paldi. There are a total of 40 employees divided into three shifts: 6 am to 2 pm, 2 pm to 10 pm, and 10 pm to 6 am. At any given time, 15 to 20 people are present.

The work pattern is that the phone operator takes the information and details of the complaint from the citizen, feeds it into the system and then the system functions automatically.

During interaction with officials, it was indicated that the daily average complaint volume is between 1700 and 2000, with 90 percent of complaints being telephonic. Eighty percent of all complaints are from the Engineering and SWM departments. Additionally, 50% complaints in Engineering are directed at the drainage department. Approximately, 60% of the total complaints are received during the monsoon season, which runs from July through September.

Complaints of the Estate Department are frequently unanswered due to land-related legal concerns. During Covid-19, they also served as the phone centre for detecting sick individuals and organised tiffin services which provided people with food packets.

3.1.4 Inferences from Interviews of Citizens

Interviews were conducted with residents who had filed complaints in order to better understand their experiences and the numerous challenges encountered by them during the process.

i. Mr Jain
   A resident of Sterling Flat in Sabarmati Ward he wanted to complain about drainage. He tried to complain twice via the mobile app but there was a login problem. Registration of the complaint through phone was simple and user-friendly and the personal and societal details were requested and the call token number was sent via text message. When they began correcting the difficulties, the government employee kept the public informed. The complaint was resolved in two days (which exceeded the time according to the citizen charter).

ii. Mr Patel
   Another interview was with Mr Patel who is a resident of Antillia flat in Ambawadi ward who had an issue of water leakage and asked the government workers who were working in the neighbourhood to solve the issue. They guided him to either call or lodge a complaint via the application. He tried calling but the server was busy so he used the AMC CCRS application. After registering the complaint, the receipt was generated and then he again conveyed to the worker who resolved the issue. The complaint was closed in a day. It was a wonderful experience.

iii. Mrs Thakor
(Acher Jupadpati) (Personal Interview)

The medium of complaint was offline in the civic centre ward office. Her complaint was that there is only one water supply tap between five houses which has been provided by the government. The supply of water is only two hours a day. We all united and went to the ward office to complain about the issue where we registered the complaint and the concerned officer gave us the receipt and told us that these issues can't be solved as we don't have the legal documents.

3.2 Technological Barrier

3.2.1 Digital divide among unprivileged people

Ahmedabad is one of the fastest growing cities in the world with a strong socio-economic culture. Almost 710 slums were identified in the city with a total population of 1.76 million people and 1,76,754 families residing in sub-human (slum) conditions over 710 acre. According to the Town Planning Department of the AMC, it is possible to give services to only 417 slum pockets.

3.2.2 Technological issues of the CCRS

There is a technological barrier in the system that prevents a complaint from being routed to the appropriate ward and department, resulting in the matter remaining unresolved. The lack of technology understanding among government personnel about the many alternatives available in the systems to transfer a complaint or link a complaint to another department within the same agency is another issue to be addressed.

3.2.3 Knowledge Barrier among Officials

The whole CCRS is automated except for one way of complaint registration - telephonic complaint registration where the operators at the ICCC and the CCRS take note of the problems that citizens are experiencing and file the complaint. Many times, the operators are unable to identify the problem that has been communicated by the client, resulting in the citizen being automatically redirected to the incorrect ward and department.

3.2.4 Awareness Barrier among Citizens

Complaints are an important way for the management of an organisation to be accountable to the public, along with providing valuable prompts to review the organisational performance and the conduct of people that work within. A complaint is an "expression of dissatisfaction made to or about an organisation related to its products, services, staff or the handling of a complaint, where a response or resolution is explicitly or implicitly expected or legally required.

3.2.5 The Perspective of the Citizens

- There is a lack of awareness among the general public (Awareness Issues)
- People are unable to complain because of technological obstacles and glitches. (Technological Barrier)
- There have been numerous reports of login troubles with the mobile application, as well as complaints about calls not coming through. (System Technological Issues)
- There are a variety of complaints, but because of a lack of confidence in the governing body, many are reluctant to file them. (Reliability Issues)

3.2.6 CCRS System at ICCC

The technology must be updated because it has been in operation for the past nine years with the same system.

• A larger crew is necessary during the monsoon season when the number of complaints doubles.

3.2.7 AMC Official's Issues

• A technological barrier that prevents complaints from being sent to the appropriate ward and department, resulting in the concerns remaining unresolved. It is not possible to transfer complaints within a ward. There is a scarcity of workers to deal with overcrowding that occurs during the monsoon season.

4. Discussion and Conclusion

4.1 Limitations

To conduct a critical review of the project, a thorough investigation and precise approach was used. However, the study encountered several drawbacks:

i. The municipal corporation withheld data from the CCRS for the last three years due to security concerns.
ii. The CCRS supports 24 departments. The investigation examined all the departments but concentrated on the top three which received nearly 90% of all complaints, namely the Engineering Department, the SWM Department and the Health Department.
iii. Throughout the study's duration, twenty citizen samples were taken from each zone to critically examine the situation and its implications on the ground.

4.2 Key Lessons Learnt

4.2.1 Value Addition in CCRS after Integration in ICCC

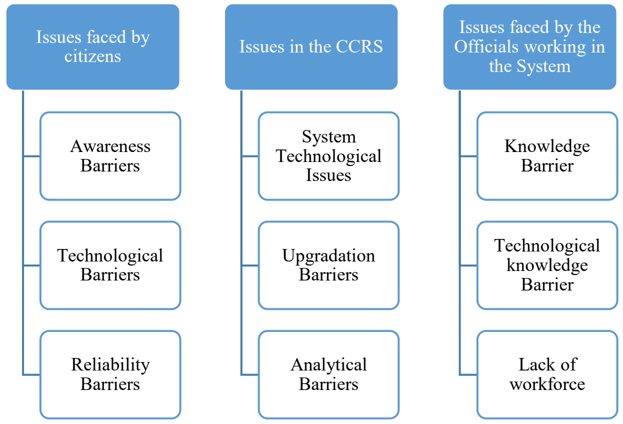
Due to CCRS's brain integration, the system has become more accessible. With eight new departments, it has modernised and streamlined the city's progress. With no ability to express issues or protest about the settlement, the government and residents had only one-way communication before the ICCC. But this has made the citizens feel more at ease and approachable. The technique is inclusive because it uses 5 media. Consumer/citizen feedback helps municipal organisations assess the service quality and discover (and subsequently correct) structural or other flaws. It enhances municipal efficiency, accountability, responsiveness and transparency. Overall, it gives a fantastic service.

4.2 Recommendations

4.3.1 Recommendations for Technological Issues Faced by Citizens

Numerous challenges were encountered at both the front end and back end of the CCRS, which were analysed and identified as mentioned in the preceding chapter of the research.

Table-3: Barriers faced in the System



4.3.2 Recommendations for Awareness Issues Faced by Citizens

Various long term and short term initiatives should be taken by the government to create awareness among the people of the city.

Awareness among the citizens

Awareness through VMD Screens

Citizens can be made aware of the CCRS and the various means of registering complaints by generating advertisements about the CCRS and the various methods of complaints available to citizens by utilising the 126 VMD (91 installed, 31 ongoing) Screens placed on several main crossroads in Ahmedabad. This may be a long-term goal with ongoing cost, but it will be crucial in educating the people about the CCRS, resulting in increased citizen engagement and efficiency.

Awareness through Navigation Hoardings

There are various signages installed on every node across the city to navigate citizens to various residential societies and other buildings. Therefore, these information boards should be used to create awareness by mentioning the call centre number for the convenience of citizens to educate them about the services which are provided to them to complain about the various issues faced in their daily routine. This will be a short-term plan that can be quickly implemented at a low cost and will have a greater impact on raising public awareness.

4.3.3 Recommendations For technological Barriers Conducting Seminars in the City

There should be an initiative to hold seminars on various events organised by the government such as the Kite Festival, Political Rallies and so on. These platforms raise awareness among the people about the process of complaining through various modes available to citizens which has a larger impact.

4.3.4 Recommendations to Create Trust between Citizens and Government

Automatic Reopening of the Complaint
The system is made for the people so the workflow should be changed to ease repetition for citizens to reopen the complaint and for better efficiency. The complaint must automatically reopen and be forwarded to the zonal officer and if it still doesn't get resolved it should be automatically forwarded to the head office. This automatic reopening system can ease the usability for the citizens and they don't need to reopen the same complaint again and again.

Mentioning Charter time and Assigned Person
When a citizen lodges a complaint using the CCRS a token number is created and the complaint is routed to the appropriate ward office with a time frame for when the issue should be resolved. Despite this, most citizens are unaware of the intended time frame in which their complaint should be resolved. The procedure and the assigned government officer who is responsible for resolving the complaint should be communicated to the citizen and photographs of the process should be posted onto the application which will make the entire system more open and accessible to the public.

Feedback calls to Citizens
Feedback call should be taken after the complaint is resolved to evaluate the satisfaction rate of the citizens and to identify the on-ground issues faced by the residents. This plays a vital role in building a level of trust between citizens and the government.

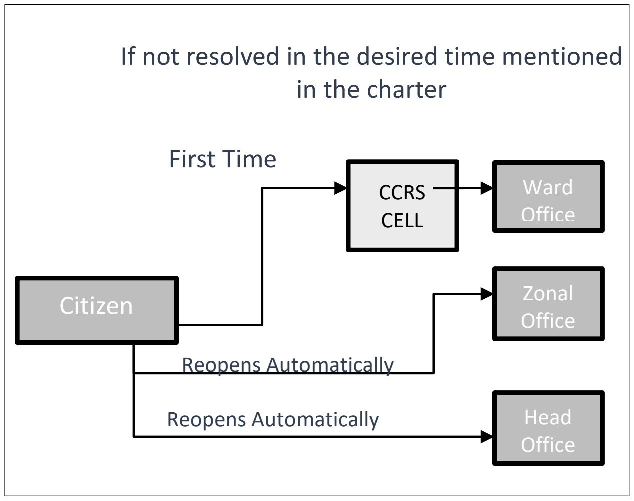


Figure-8: Recommended Automatic System for CCRS Ahmedabad. Source: Primary Source

4.5 Recommendation for Improvement in CCRS

4.4.1 Resolving the Glitches Faced by Citizens in the System

Login Errors in the Applications
There are various issues faced by the citizens during the complaint process. At times, the application gets stuck during the process and various people have also faced login errors which makes the whole process tedious for the citizens resulting in neglect of the system. Hence, the server issues faced by the citizens during registration need to be updated. Problems should be identified and resolved for better working which will save time and energy of the users.

Complaints gets redirected to zonal office
Many times the complaints are received by the zonal officer instead of the ward officer. Hence, simulation and regular checks should be done to solve the errors that occur in the system.

Upgradation of the System
The CCRS has been the same since it started nine years ago. There have been no major changes in the system except the addition of various modes for complaining which were added after integration with ICCC. The system needs a regular check and upgradation would keep it much more advanced and efficient.

Updating Dashboard and opening up data for Citizens
The dashboard of the CCRS should be updated which can be a platform to open up data for citizens and which can also be a platform for automatic generation of the statistical report which can be useful for government officials and also for the users. The dashboard should be user friendly for easy accessibility by the citizens.

4.4.2 Analysing Data for Better Decision-Making

A weekly report should be submitted to the zonal office and an analysis must be done on a case-to-case basis. Warning must be given to officers when more than 5% of complaints go beyond the stipulated time frame. Only 3 to 4 warnings in a year should be allowed to the ward officials. During monsoon season the complaints increase and due to lack of sufficient work force they are not resolved. Hence, assessment of the report will also help to identify the problem and provide proper workforce.

4.3 Recommendation for Officials Working in the System

Recruiting Well-educated Phone Operators
The CCRS has given the tender for maintenance of the system to a private firm. Hence, the government should structure guidelines to the private firm to recruit well-educated people for the post of phone operators. This is needed so that they can understand the various issues conveyed by the citizens and enter efficiently into the system so the system may automatically channelise it to the dedicated ward office for resolving the complaint. Proper training must be given to the people working in the system.

Government employees should be adequately trained to make efficient use of the technologies at their disposal. Complaints from citizens should be supported by a time-table for resolving the concerns.

Conducting workshops for Ward Officers
Efforts should be carried out for ward officials so that they are provided with the knowledge and have a proper understanding of the technology. For example, after a new update to the system a workshop should be held to ensure that the system functions well.

Recruiting a technical person in every zone
A technical support team is required in each of the seven zones to address any technical challenges encountered by the zone's ward officials. This will expedite aid and may also result in increased efficiency as officials will be able to overcome technological impediments.

Recruiting additional workforce in every zonal office
Additional staff should be deployed in each zonal office who can be redirected to the wards in the event of a sudden increase in the number of complaints. This additional staff can be utilised to ensure that complaints are resolved within the time specified in the charter. This additional staff can also play a significant role during the monsoon season when complaints to the engineering department, SWM department and health department spikes. Through this integration no complaint will expire or stay unresolved, increasing the citizen's trust in the government's efficiency.

4.4 Recommendations from Learnings from the Case Study of GMS, Pune

Taking note of the various observations from the case study of the Grievance Management System of Pune, which can be the recommendation for CCRS for better usability and functionality.

Integration of New Departments
As the real estate market in Ahmedabad is booming and the most time-consuming process is getting approvals, the building approval department must be integrated with CCRS. This will make the approval process of building plans extremely user-friendly for citizens, as all documents will be uploaded electronically. This may effect the new entrants into the real estate market, while also benefiting the government by reducing maintenance cost through integration under one roof.

Aiming for a Citizen-Centric System
Creating a platform where citizens can voice their concerns and suggestions to the governing authorities on City Development Plans and TP Plans. Thus, departments such as Urban Development and Town Planning must be added and should be opened for public review through the CCRS model.

Updating the Dashboard

The CCRS dashboard should be updated to enable citizens and government entities to make the best use of it. Every detail should be shared and viewed following the screening of sensitive data.

5. CONCLUSION

The CCRS is aimed to engage citizens in governance by allowing them to raise their voice and enhance their standard of living which also aids in the system's urban management. Several suggestions have been provided to improve the system and utilise the developed facilities. It should focus on creating a citizen-centric system that addresses many concerns and realities. As a result, this system creates a lot of data which, if correctly examined, can assist in discovering problems early on and help the city to enhance the functionality and prevent future concerns. A self-sustaining, scalable, efficient and effective ICCC system requires multiple upgrades, moderation and analytical approaches.

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1. Questionnaire for the Citizen Survey

Awareness
1. Are people aware of the CRS?
2. How many methods are available to register complaints?
3. How would the system be used to assess the various parameters?
4. Are there categories for users to choose from so complaints are more specific?
5. Are the categories mentioned cover most complaints that could be registered?
6. Are these categories clear?
7. Does the user know in how much time the complaint would be resolved?

Accessibility
1. Is the mention of the app at a convenient place in the municipal websites for the user to find?
2. Is the application easy to find in the app store (first five positions)?
3. Is the app available on all platforms?
4. Is there a clear description of what the app has to offer in the app store?
5. Is the app title complete and self-explanatory?
6. Are there categories for the user to choose from, so complaints are more specific?
7. Are the categories mentioned cover most complaints that could be registered?
8. Are these categories clear?
9. Can the user register complaints for any topic other than those mentioned in the categories?

Ease of Use
1. Is all information of direct importance to citizens accessible from the home screen?
2. Can the user zoom in/out?
3. Does the app have the option of regional language?

Privacy and Security
1. Is there a privacy policy to protect the user's personal information?
2. Do they have to give their personal information again for registering a complaint?
3. Does the app ask for user permission before accessing information such as GPS location, calendar, contacts or financial transactions?
4. Can anyone fudge a complaint?

Reliability
1. Is there fast navigation through the application without jam?
2. Is all useful information about the department present in the app in 'About us'/ similar section?
3. Is up-to-date information provided (old tender, news, content etc)?
4. Does the app have clear description of its uses?
5. Does the user know in how much time the complaint would be resolved?

Feedback and Citizen Satisfaction
1. Whether feedback is taken from the citizens on their overall experience?
2. Are the citizens satisfied with the services?
3. Do they have the option to complain if the officer doesn't treat them well during the process of resolving the complaint?
4. Can the user check the status of his complaint?
5. Does the user have the option of putting more than one photo while addressing the complaint?
6. Do they have to give personal information again for registering a complaint?
7. Can they reopen their complaint through the app?
8. Do you receive a message after registering a complaint?

2. Questionnaire for Stakeholder's interview

Efficiency
1. From which day did the CRS start functioning?
2. Which are the maximum complaints received?
3. Which zones receive the maximum complaints?
4. What percentage of cases have resolved?
5. Which medium of CCRS is used the most?
6. Which age group registers the maximum number of complaints?
7. What measures and initiatives are taken to create awareness?

Finance and Maintenance
1. How many people are working in ICCC under the CRS?
2. What was the initial investment to set-up the CRS?
3. What is the maintenance cost for different model systems in CRS?
4. What measures and initiatives are taken to create awareness among the people?

Performance over the period
1. How was the participation of citizens over the past three years?
2. What was the more user-friendly mode in the CRS?
3. What are the parameters of improvement in the system?
4. What has been the zone-wise performance history over the last three years?
5. How efficiently are the complaints resolved and how does it benefit the citizens and the government?

Stakeholder's Role and Involvement
1. Who are the stakeholders?
2. How is the system channelised and how are the stakeholder's responsibilities assigned?

A7

Smart Clinics, Pune Smart City

Name of the project: *Smart Cities*
Location: *Pune Smart City*
Year of Project Implementation: *2017*
Sector: *Retrofitting and Redevlopment under ABD*
SDG: *SDG 11.2*
Project Cost: *46,409,070 INR*

Institute: *College of Engineering Pune*
Advisors: *Dr. Arati S. Petkar, Ms. Lisha. C. Bendre*
Students: *Harshvardhan Patil*

Keywords: *Urbanization, Conservancy Lanes, neighborhood, framework, social fabric*

Abstract:

The city of Pune is the second largest city in Maharashtra with a population of about 7.4 million as of 2020. With such a large population, a proper planning for the city is important. It is also the responsibility of the city to provide basic facilities like housing, drinking water, health facilities, etc. to its citizens. Health is an important aspect when talking about basic facilities. The structure of health facilities of a city defines how healthy its citizens are and how efficiently the ULB is able to fulfill the needs of the citizens. One of the goals of the Smart Cities Mission is to improve people's quality of life, particularly in low-income areas, in order to make Smart Cities more inclusive. In India, private out-of-pocket health costs (OOPE) account for 64 percent of overall health spending. Medicines, diagnostics, and consultations are the most common health-related expenses. An urban household spends 5 times more on diagnostics, 2.6 times more on drugs, and 2.4 times more on doctor's fees than a rural home. As a result, lowering the high OOPE experienced by urban people, particularly slum dwellers, contributes to cities that are more inclusive. Thus, the project of smart clinic is initiated. Two smart clinic have been setup in Baner and Balewadi area and land for third clinic is referred so as to setup a clinic in future. These smart clinics provide basic health care facilities free of cost to the people belonging to economically weaker section of the society. The clinic uses modern technology like mobile application and modern structural designs to produce best outcome with minimum expenditure. This ensures that the all the basic healthcare facilities are provided to each and every citizen irrespective of their financial background. One of the PSCDCL's key priorities is the smart clinic project, and in order to comprehend the extent of these initiatives across India, they must be examined through the eyes of city planners. The public's perspective of the projects will aid in the advancement of technology, and private sector collaboration with the public sector will be a significant step forward in the advancement of technology. The current study's findings reveal an intriguing reality and pique interest in further investigation of comparable corporate initiatives.

Case Study: **A7**

1. Introduction

Pune is the seventh-most populous city in India and the second largest in the state of Maharashtra. The city is known for manufacturing and automobiles, as well as government and private sector research institutes for information technology (IT) education, management and training that attract migrants, students, and professionals from India, South East Asia. Pune is one of the most populous districts in Maharashtra and ranks third in the state in terms of population. Pune has a population of more than 9.4 million people, with a population density of 603 persons per square kilometer, according to the 2011 census. From 2001 to 2011, the decadal population growth rate was 30.34 percent. The statistics show that Pune has a long way to go in building a robust healthcare infrastructure.

About Pune Smart City Development Corporation Limited (PSCDCL)

By solving its core infrastructure issues in a "Future-proof" manner, Pune aims to become the livable city in India by capitalizing on its rich cultural and natural heritage, strong human capital, and robust business environment. To achieve this goal, a special purpose vehicle company called the Pune Smart City Development Corporation Limited was setup by PMC solely for the purpose of implementing the Smart City Projects.

PSCDCL aims to achieve the above-mentioned goals by identifying the true needs and views of the citizens; by focusing on creating more with less investment; by focusing on creating self- sustainable infrastructure; by focusing on low-cost information-communication & technology-based solutions; by making implementation strategies which will insure every project can be implemented in real life.

1.1 Smart Clinics

In order to make Smart Cities inclusive, the Smart Cities Mission aims to improve quality of life, especially for the poor. The Smart Clinics project will be the tool, which will insure better and affordable health facilities for all sections of the society. The Smart Clinics project falls under health sector of Smart City Mission. At present Pune has about 2.5 hospital beds per 1,000 population, compared to 4 for urban India. There are also approximately 70% of these beds in the private sector. As for primary healthcare centres, while there are 60 lakhs of people in Pune, dispensaries and maternity hospitals provides a coverage of only 1 PHC per 1 lakh population against the standard of 1 PHC per 20,0000.

1.2 Objectives of the project

World Health Organization defines primary healthcare as reducing exclusion and social disparities in health and organizing health services around people's needs and expectations. The idea of government run clinics with small staff, diagnostic facilities and pharma facilities is quite popular and Pune has its own version of this in the form of Vasti clinics. The smart clinic project is aimed at creating an overall complete health system at Pune. The objective of this project is to design and operate Smart Clinics at 100 locations to provide primary healthcare to citizens of Pune. Smart Clinics will provide various services to citizens like free primary health check-up and diagnosis free sample collection and lab services & free medicines for common ailments. To initiate the setting up of these clinics, a pilot is envisaged in 3 strategic locations within the Smart City. These locations have been identified with parameters such as the population served, accessibility etc. Details of the three smart clinics currently operating within the city can be seen from the table.

Survey Number	Location	Area (in Sq. m.)
112	Baner	539.14
17	Balewadi	61.31
-	ITI Road, Aundh	61.31

The project is initiated with an aim to provide health facilities to lower income groups at affordable cost. The strategy of Smart Health is based on providing cheaper medical consultation, reasonably priced medicines and affordable diagnostics.

1.3 Significance of the project

The health facilities at Pune are quite expensive for everyone to afford. In addition, purchasing of medicines is not affordable by all. In many areas, there is lack of primary health facilities so people need to travel long distances to get certain health related facilities.

Smart clinic project overcomes this issue by providing basic health related facilities at affordable cost, certain free medicines and other facilities at subsidized rate. Various health related government schemes are used for funding like Free Diagnostic Service Initiative, Pradhan Mantri Jan Aushadhi Yojana (PMJAY), etc. Also, the location of these clinics plays a significant role as it provides basic health facilities at a minimum distance, hence covering a vast population's health related needs. Qualified doctors from Government hospitals are appointed at smart clinics for consulting. The infrastructure of these clinics is quite modern which will serve patients across the socio-economic spectrum.

The project holds great significance as health is an important aspect and not everyone has equal access to it. Smart clinics will reduce the burden of government hospitals by providing basic health care facilities at walkable distances. Consequences of not having smart clinics can be dramatic as it will increase the burden on the existing government healthcare facilities and people will need to travel a lot even for basic needs.

1.4 Aim and Objectives

The aim of this study is to examine the impact of Smart clinics on health sector of the city.

The objective of this project is to design and operate Smart Clinics at 100 locations to provide primary healthcare to citizens of Pune. Smart Clinics will provide following services to citizens:

- Free primary health check-up and diagnosis with free sample collection and lab services
- Free medicines for common ailments.

The objective of the study is to examine how effective has the project been implemented and what impact it has on the existing healthcare facilities.

2. Contextual Background

2.1 Conceptual framework

The limited health facilities in many regions of Pune have worse off the lives of people specially the ones who belong to the lower income group of the society. Smart clinics initiative will improve the current scenario of health sector by providing many facilities through various government schemes. The aim to setup many such smart clinics around the city will drastically improve the scenario of the city, as most targeted people will be able to consume certain health facilities free of cost. All smart clinics keep track of various data regarding their patients through Health Management Information System (HMIS), which provide various facilities like online consulting, a database for all records through an online platform.

2.2 Key feature of the project:

2.2.1 Pune Smart City Development Corporation had following challenges:

- Limited clinics in Baner and Balewadi area resulting in serious predicament with respect to health in the areas.
- Identifying ideal location to setup smart clinics.
- Availability of area for the creation of porta cabins, which are at walkable distance from key areas.
- Absence of a digital platform, which can collect and store all the data related to health of the people.

2.2.2 Risks involved in Smart clinics:

Inadequate funds as they are distributed between PSCDCL & PMC.

- Low patient response as only 11,610 patients have visited the clinics.

- Clinics are operational either only in the morning or only in the evening, which is not always convenient for patients.
- The doctors for the smart clinic are appointed from the government hospitals who may not always be available, as they need to attend other hospitals.
- Existing staff had to be deployed since no additional budget or resources could be procured for Smart clinic project, but there are already 514 posts vacant in the health department, out of which 22 are vacant for medical officers.
- Shortage of staff is leading to unavailability of staff at the clinics on several days. At many times patients have to keep waiting for the doctor and go back without any diagnosis.
- Transfer of attendants and nurses between Vasti clinics and other PMC dispensaries/hospitals does not allow them to settle down or build rapport with patients.
- Patients want multiple investigation services under one roof, including diagnostics services, which is not feasible.

2.2.3 Features and Benefits

The rising population's health and safety expectations are posing a problem for most communities, which are striving to keep up. Digital Cities make use of big data technologies to track the community's overall health and respond to disease outbreaks before they become epidemics. Furthermore, these technologies assist cities in better managing and planning resources so that they can fulfil demand more efficiently. Mobile and social solutions assist in connecting and engaging citizens in order to educate and give remote health services. Smart clinics act as catalysts towards achieving the goal of a healthy society.

The smart clinics setup across Baner and Balewadi provide a range of facilities to the citizens living in those areas. The smart clinics provide free primary health checkups. Essential medicines are provided to the patients under the scheme of Pradhan Mantri Jan Aushadhi Yojana (PMJAY). Many diagnostic test facilities are provided at subsidized rate. Two smart clinics are setup in Baner, there is a proposal for one at Balewadi.

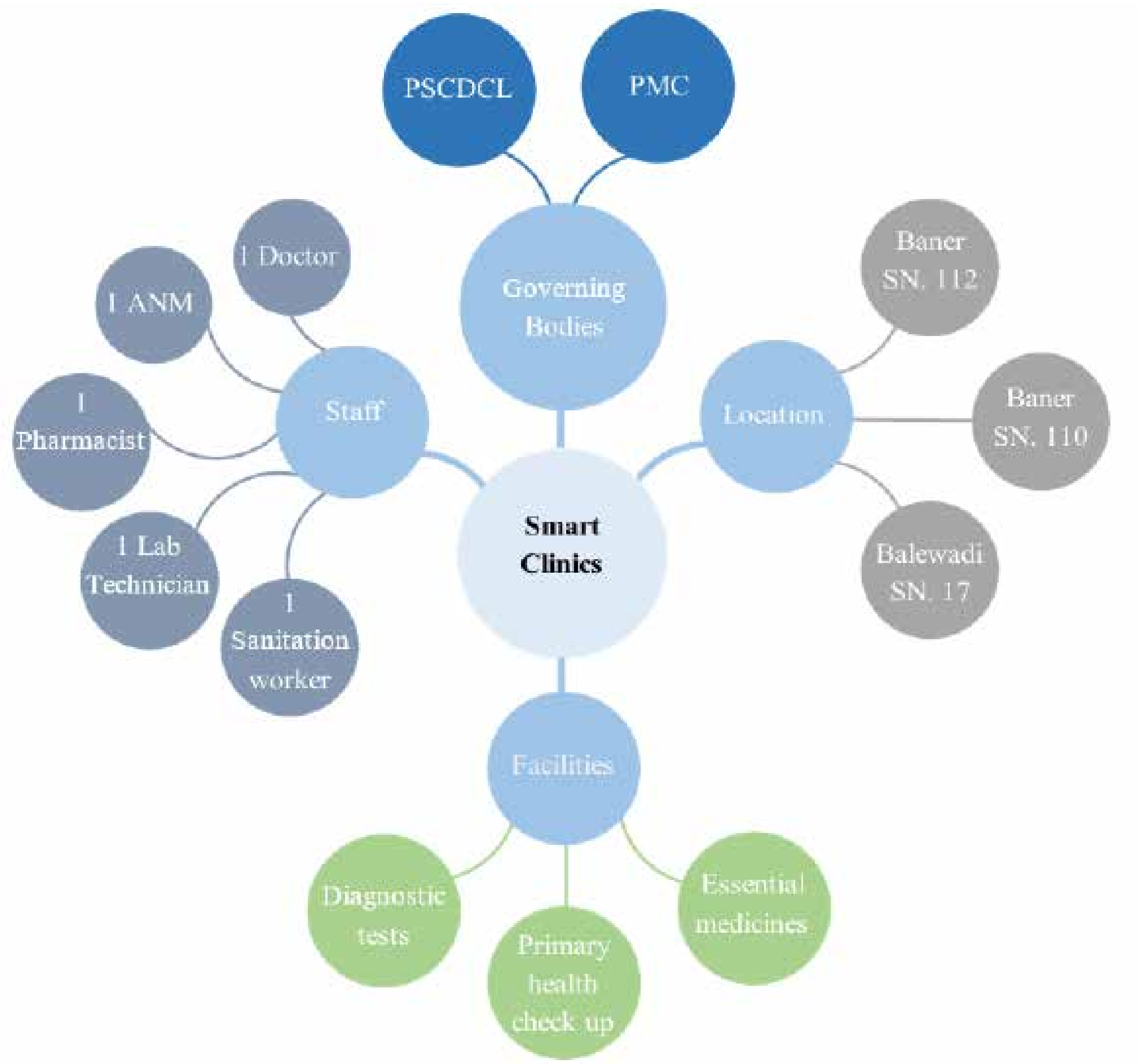

Figure 2.1: Flow chart of various components of the smart clinic

Two of the smart clinics are setup in porta cabins. The sites of these smart clinics are chosen keeping in mind that they are easily accessible by major roads, they are surrounded by a mix of residential-commercial urban fabric and the land parcels are available to launch on a priority basis. The first site is at Baner opposite to D-mart. It is a porta cabin type with reserved area about 539.14 sq.m. The second site is also a porta-cabin type at Balewadi and the third site at Baner is a building with 741 sq.m area. The porta cabins for smart clinics are designed to be future oriented. The cabins have modular design and are featured with universally accessible design layout. All spaces within the cabin are well lit and ventilated. The waiting area, which is provided alongside the reception, is designed to withstand 15 patients at a time. There is separate toilet facility provided for the doctor's cabin. Lab are located at one side of the cabin. However only one smart clinic, which is located opposite to D-mart, is working, while the one near NICMAR is been setup but not yet functional. The third site at Balewadi is in the government multi-purpose hall within the Central pollution control board office but the clinic has not been setup.

The idea of smart cities puts forth a picture of a place where all activities takes place in a well-planned manner with use of proper technology to achieve the desired goal while reducing the cost & efforts by the people involved. Such measures have been taken by PSCDCL, which are reflected in various projects that they have undertaken. Smart clinics are setup, keeping in mind the ideology of a smart ideal city. Such elements are incorporated while setting up the pilot project of smart clinic which will be a blend of new technology and conventional planning to provide basic health facilities to the target group. The 2 smart clinics are setup within walkable distance of Baner & Balewadi area.

The clinic offers a blend of traditional diagnosis approach with modern technology, which makes the process of acquiring health facilities easy for all. A mobile app has been setup by the health department which keeps track of all the data related to the patient's history thus, eliminating enormous paperwork. It can also be used to book appointment for diagnosis at the clinic. At present, the app is not in use as there is significantly less patients visiting the clinic than expected but there is a potential

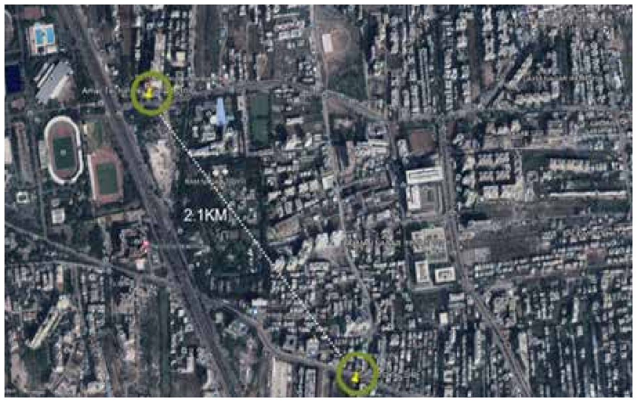

Figure 2.2: Location of the two-setup pilot projects of Smart clinic

to incorporate the app in the system to make things easy for all.

The one clinic, which is functioning in Baner area currently, operates between 9am to 5pm. The clinic provides services for 6 days a week. The timing during the period of Covid was 3pm to 9 pm. After survey, it is observed that the timing of 3pm to 9pm was preferred by many patients as most of the patients visiting the smart clinic belonged to the lower income group and they need to work during the day time which makes it difficult for them to visit the clinic for checkup. The timing for clinic plays a significant role in order to provide health facilities to maximum number of people. Now as majority of patients, especially women who work during day time are not able to manage work and visits clinic at the same time, they often need to take a leave off work or manage their health issues at their own level which is not the best desired case.

Pune Smart City took home the India Smart Cities Award 2019 for the Baner Smart City Clinic initiative. The Ministry of Housing and Urban Affairs (MoHUA) recently presented the award. The clinic in Baner is not only equipped with basic health-care services, but it also provides free over-the-counter (OTC) drugs and subsidized specialized examinations.

Various health implementations like joint inflammation, diabetes, cold and cough, gynecological issues, fungal infections, sugar and blood pressure, etc. are treated at smart clinics. Family planning safeguards women from any wellbeing gambles that might happen previously, during or after labor. These incorporate hypertension, gestational diabetes, contaminations, unsuccessful labor and stillbirth. As indicated by studies, women who bear multiple kids are at expanded risk for maternal mortality, so they need to in like manner plan. Women who get pregnant after the age of 35 are helpless against wellbeing gambles, so they ought to be safeguarded through cautious preparation too. Likewise, by decreasing accidental pregnancies, family arranging additionally eliminates the choice for perilous early termination. Hence advise related to family planning is also provided to the poor people who are unenlightened about the importance of family planning. Also, smart clinic has provision to support pregnant or lactating women who belong to economically weaker section of the society. This is achieved through various government schemes like Pradhan Mantri Matri Vandana Yojana (PMMVY) & Janani Suraksha Yojana (JSY).

Furthermore, smart clinic has been a major provider of Covid vaccines to the nearby areas including Pashan, Aundh, Baner, etc.

The city administration plays an important role in proper functioning of the health system. In case of Pune, PMC's health department is responsible to look after the maintenance and functioning of various health facilities. In case of Smart clinics, PSCDCL is the authority who will look after setting and financing capex for the pilot of Smart Clinics in ABB area.

The body will support the rent for 5 years of setting up of smart clinics. It also has the responsibility to coordinate with various stakeholders and to implement the planned strategy for achieving the desired goals. PSCDCL is the body responsible for the paying incentives to the staff. On the other hand, Pune Municipal Corporation (PMC) will support PSCDCL for setting up of the pilot project. It will be the opex for smart clinics and support findings like salaries to the staff, medicines, diagnostics tests expenses, water, electricity, sanitation, etc. PMC is responsible for coordination between various departments like road, etc. for easy implementation of desired goals. In addition, PMC concentrate their efforts towards integrating the existing healthcare infrastructure with the ones developed under smart city initiative. Thus, these two bodies govern the administrative structure for proper working and maintenances of the smart clinics. Currently, in case of the one working smart clinic, PMC is looking after the functioning and maintenance of the same. All the staff for the clinic is appointed by the central authority. The staff members are the workers of various government healthcare system. Their salaries are paid by PMC. There is a yearly survey conducted by central authority to keep a check on the working of the clinic. Thus, proper functioning of the clinic is ensured.

Smart clinics have proven to have a positive impact on the environment. Health sector has affected the environment in many ways. The medical waste, if not properly disposed may have adverse effects on the health of the local people. In addition, the amount of paper work generated from the data entry of various aspects produces a lot of waste, which needs to be disposed properly. Smart clinics offer solutions to the above-mentioned problems by either eliminating the problem or by reducing it to an extent where it does not have a significant impact in order to consider it for corrective actions. All the data regarding the details of the patient, are now stored in the HMIS system, which serves as a centralized digital platform for storing the data. This eliminates the tedious paperwork and thus, the waste generated due to use of paper at the clinics is significantly reduced. Proper dustbins are provided for disposal of medical waste at porta cabins, which are periodically emptied by the municipal waste collectors.

Smart clinics have affected the life of people belonging to the economically weaker section of the society. Free medical diagnosis and free basic medicines are provided to the people, hence supporting the economy of the society. In cities like Pune, where medical facilities are quite expensive and not everyone can manage to even afford basic health facilities, smart clinic will act as a medium to support the economically weaker section. On the other hand, the income generated by these smart clinics is not sufficient even for its own maintenance and

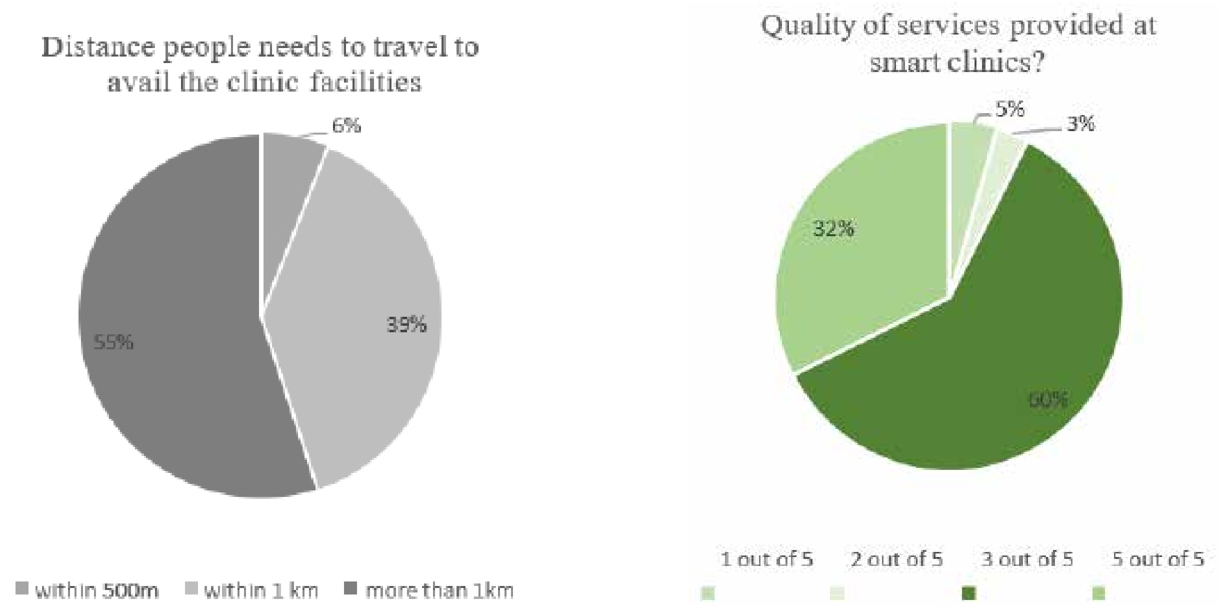

Figure 2.3 Pie chart representing various analysis

Figure 2.4: Smart clinic (Suvey No.112)

hence, there is a serious threat for future working and maintenance of the clinics. The funds for free services are provided through various government schemes but still there is a lack of proper source of funding and this may have cynical effect in the future.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

The project of smart clinics has influenced the public in numerous ways. Data from various surveys and interviews was analyzed to draw certain conclusions, which highlight both positive and negative aspects of the smart clinic. These conclusions are based on the information received during survey of staff at smart clinic and patients who visited the clinic for treatment.

Questionnaires for patients were circulated to gather data about their opinion on the clinic. This was a vital step for analysis as it provided direct and precise information about the actual on ground situation.

The analysis of two such parameters is provided below.

Questions regarding the distance that the patients need to travel, issues that they face, their experience, etc. were asked and the corresponding responses were analyzed. Some of the questions are mentioned below.

1. How much distance do you need to travel to consume the health facilities provided by the smart clinic?
2. How do you find the services provided at smart clinics?

The very first observation from the field survey is the location of the smart clinic. Though the clinics are located on the main road and are easily accessible, still the location is not best suitable to setup smart clinic. The reason for this is that smart clinics are setup with an aim to provide health facilities to poor and economically weaker section of the society but the localities at which the two clinics are setup are rich areas with high-class apartments, restaurants, etc. One can hardly find any area with people belonging to lower income group. Setting up the clinics at slum or gaothan area would have provided easy access to the people who actually require the services provided by the smart clinic.

Also, there is no proper direction or sign board provided which makes it hard to locate the clinics for anyone new to the area. People who visit the clinic from different areas like Pashan, Aundh, etc. find it difficult to locate the clinic.

Many people who visit the clinic are not literate and hence cannot recognize the clinic by reading. The name board is written in English language, which makes it difficult for the local people to read. Therefore, a proper name board with Hindi instructions should be provided at the clinic so that all people can refer to it.

The smart clinic setup at Baner, opposite to D-mart is the only clinic currently working. The clinic has two nurses, one person responsible for maintenance and one doctor (MBBS). Before Covid, the clinic had its own lab with provision to perform various blood related tests, all under the supervision of one lab technician. But due to excessive demand for lab testing during Covid, the lab was shifted to the government hospital. As a result, any test samples, which needs to be examined at the smart clinic, are outsourced to the pathology labs at Pashan.

The clinic was setup, considering an average daily patient count of fifty. But currently, the clinic has witnessed about ten to twelve patients per day which is far less than anticipated. There are several factors responsible for such a low patient count. The first reason, as previously highlighted, is the location of the clinic. Also, there is a concerning lack of advertisement about the smart clinic. People from slum areas or people belonging to lower income group are not aware of the fact that there are smart clinics, which provide health related services free of cost. There is a need to spread awareness about the services provided at the smart clinic along with its location so as to attract more number of people to take advantage of the facilities available. The concerned authorities can take various steps to promote smart clinics and to make people aware of the facilities it provides. This can be achieved by campaigns, door-to-door promotions, advertising banners/ hoardings, etc.

Another key issue observed at smart clinic is that it lacks space for various operational functions. There is only one compact cabin available to examine the patients, which includes a doctor's desk and a stretcher bed. Smart clinic has witnessed a significant number of patients who come for consultation regarding pregnancy. To examine such patients, there is no bed available at smart clinic. Additionally, there is not enough space available to perform ANC for pregnant women. Thus, patients who comes with pregnancy related queries are referred to other hospitals at Pashan & Aundh. Also, for pregnancy related patients, the number of staff is not sufficient, as more experts are required to examine and treat any health issues in pregnant women. Thus, smart clinics are not able to treat such patients and thus people often need to travel to other areas to get health facilities related to pregnancy.

From the survey; it was observed that the clinic lacks basic facilities like drinking water, washroom, etc. The staff needs to arrange water for drinking purpose at their end, which is not always sufficient to last throughout the day. The facilities provided for the purpose W.C. are of poor quality and not sufficient. Thus, making the environment of smart clinic less appealing.

The porta cabins are quite compact and there is no provision for shaded area outside the cabin where people can sit and wait in case of rush. The waiting room inside the cabin can withstand about 10 patients but in case of more number of patients, the patients will be required to stand outside in the open which is not desirable as it may negatively affect the health of the patient.

Smart clinic is situated on the NH4, because of which, it often encounters with accidental cases. Cases which require basic first aid are treated in the clinic and any cases which may be severe, are transferred to nearby hospitals.

Figure 2.4: Smart clinic (Suvey No.112)

Figure 2.5: Smart clinic

3. Discussion and Conclusion

Health facilities are one of the basic facilities that a city needs to provide to its citizens. With increasing urbanization and technology, more & more terminal diseases can be treated and thus, life expecptancy of the people is also increasing. On the other hand, these health facilities are not accessible to all. There is a large group of society, which is often neglected by others who are in greater need of such facilities. The economically weaker section of the society cannot cope up with the pace of growing society, technology, expenses, etc. and hence need a support to back them and to make their life easier. Thus, comes in picture, the idea of smart clinics which is blend of modern technology in the existing health care system to provide free of cost facilities. Smart clinics will not only provide health care facilities to the economically weaker section but also give a moral support to the people and hence, improve their mental health.

3.1 Implications

Through this study, conclusions can be drawn with reference to impact that smart clinic has on the society, especially on people belonging to lower income group. Smart clinics stand different from other health care facilities as it incorporates the use of technology (in form of modern infrastructure, use of software, etc.) and as a result, makes the experience of health treatment smooth and efficient. Although smart clinic provides free healthcare services, it lacks in providing services to all. People are not aware about smart clinics and thus, unable to take advantage of the facilities provided here.

The idea of a compact health care facility may sound contemporary but on ground, reality is quite different. In case of smart clinic present at Baner, many patients visit the clinic with pregnancy related queries which often require larger area for examining with respect to area currently present in the clinic.

There is no proper response by the authority towards the complaints and suggestion made by the clinic staff for various facilities like drinking water, maintenance of W.C., etc.

There is a provision for mobile application, which will provide a digital platform for all the records related to patients, but it is still not in use. This is because the number of patients visiting the clinic daily is not sufficient to support this facility. Thus, all these issues are inter-related.

The impact of smart clinic is not adequate, as it was desired to be. Hence, reforms in the structure are needed so as to overcome these drawbacks.

3.2 Limitations of the research

- Among the 3 pilot sites, only one is functional hence the impact assessment cannot be made as accurately as was desired.
- Collection of data regarding the patients view is difficult to gather.
- The research lacks in accurately reflecting the opinion of the target groups as significantly few number of patients are able to utilize the facilities at smart clinic.

3.3 Key lessons learnt

Planning a city to be sustainable and self-sufficient is crucial in today's context. In addition, it is important that all the basic facilities right from housing, drinking water to health facilities are provided by a city to its citizens. Smart clinics will be the future of health facilities as it requires less expenditure to setup and most important is the fact that it aims to target the economically weaker section of the society.

At present, only one smart clinic is operational at Baner and lack of funds has been a major hindrance in the expansion of the project.

Lack of proper IEC activities has resulted in less awareness among the target group of the society, which is a serious issue.

During the difficult periods of COVID-19, Smart Clinic was a major aid to the government in terms of vaccine distribution, corona patient care, and so on. This assistance during times of hazard can be very important.

Planning a city to be sustainable and self-sufficient is crucial in today's context. In addition, it is important that all the basic facilities right from housing, drinking water to health facilities are provided by a city to its citizens. Smart clinics will be the future of health facilities as it requires less expenditure to setup and most important is the fact that it aims to target the economically weaker section of the society.

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3.4 Recommendation:

The smart clinic will have more impact on the society if it is setup in the locations where the target group that is the economically weaker section of the society resides. As a result, people who actually require the services of the clinic will be able to easily access the clinic. The current location of the clinic is in area where people belonging to middle class or elite class reside, and as they are not the one who requires or uses the services provided by the smart clinic, the clinics are not able to record the required patient count as desired.

When asked about the future plan during the interview with the officials, it was observed that there is lack of funds for any expansion. Even the basic demands of the clinic like drinking water, W.C. , etc. have not been provided. Therefore, a proper funding pattern needs to be implemented. Another approach to this is that the smart clinics be operated by PPP (Public Private Partnership) model. This will give opportunity to the citizens for employment and also reduce the financial burden off the PMC. Also, under private parties, the actions against the complaints and suggestion would be overcome as quickly as possible.

It is strongly advised that all the healthcare facilities at Pune city be linked via an online application which will insure that all the data records are easily accessible anywhere. Thus, the use of technology will simplify the process to access healthcare facilities. Currently, smart clinics are not able to use the mobile applications in its operational activity as it does not encounter sufficient patients count to support the application. Thus, increasing the number of patients visiting the clinic by creating more awareness is the first step to be achieved.

PMC can launch various campaigns under IEC activities to create awareness among the people who belong to slum or gaothan areas. Many people who come from such areas lack education and hence they need to be educated for the same. This can be achieved through education provided at schools where children can be made aware about various government healthcare facilities and schemes. Also, door to door campaign will have an effective outcome as people can directly approach the authorities in case of any queries.

A yearly impact analysis should be conducted by either the government or outsourced to any private companies. This will help in analyzing the actual impact that the smart clinics has on the society and also will be helpful in identifying any reforms that need to be made.

Survey form for smart clinics:

1. Name:

2. Age:

3. Purpose for visit:

4. Occupation:

5. How often do you visit the clinic?
   - Daily
   - Weekly
   - Monthly
   - Never

6. How much distance do you need to travel to consume the health facilities provided by the smart clinic?
   - Walking distance
   - Within 500m
   - Within 1 km
   - More than 1km

7. How do you find the services provided at smart clinics?
   - 1
   - 2
   - 3
   - 4
   - 5

8. Are doctors always available for diagnosis?
   - Yes
   - No

9. Is the staff supportive?

10. Are all the services required by the patients available at the clinic?
    - Yes
    - No

11. How much do you need to spend to obtain basic health care facilities at the clinic?
    ....
    ....
    ....
    ....

12. What changes do you think are required in the clinic?
    ....
    ....
    ....
    ....

13. From a scale of one to ten, how much useful has the smart clinic been in your case.
    ....
    ....
    ....
    ....

14. How did you find out about smart clinics?
    ....
    ....
    ....
    ....

15. Are you aware of various government schemes related to health?
    - Yes
    - No

16. How often do you need to go to other healthcare facilities?
    - Weekly
    - Monthly
    - Never

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A8

Urban Mobility Infrastructure (Bus service, Smart Parking, Public Bike Sharing)

Name of the project: *Urban Mobility Infrastructure (Bus service, Smart Parking, Public Bike Sharing)*
Location: *Nashik*
Sector: *Mobility , Urban Management.*
SDG: *SDG 7, SDG 8, SDG 9, SDG 11.*

Institute: *College of Engineering, Pune*
Advisors: *Dr. Arati S. Petkar, Ms. Lisha. C. Bendre*
Students: *Chidambari Kulkarni, Aryan Mande, Rutvik Belsari*

Keywords: *Transporation, Smart Parking*

Abstract:

Nashik is Maharashtra's third-largest city and is an important religious center that attracts thousands of pilgrims annually because of the sanctity of the Godavari River. Nashik Municipal Smart City Development Corporation Limited (NMSCDCL) has developed an innovative approach that could be used throughout the city to enhance the quality of life of all people. Various urban mobility infrastructure projects are amongst Nashik Smart City Projects in order to satisfy the city's transportation demands and discourage the use of personal automobiles along with the need for a Smart Parking System with high efficiency, low cost, and high security.

Nashik Municipal Corporation (NMC) with Nashik Smart City wants to provide the city with high-quality public transportation infrastructure. The purpose of this research is to assess three types of urban mobility infrastructure projects: intercity bus services, smart parking, and a public bike-sharing system (PBS). The focus of this study is to provide recommendations to help Nashik Smart City build efficient and sustainable public transportation systems that meet the city's current and long-term mobility needs. Taking into account how people feel about the projects will help to improve mobility services and allow for the inclusion of future initiatives. The findings reflect an intriguing reality and encourage interest in further research.

Case Study: **A8**

1. Introduction

1.1 Topic and context:

In India, the urban regions are expected to add 404 million people to the population expansion. Cities in India have evolved into hubs for thriving enterprises, livelihood, comfort, and a higher quality of life. As a result, the metropolitan population has grown, necessitating infrastructure rehabilitation. The Smart City concept is a type of structure that has been designed for the execution of a vision, which is a route that has been defined to attain the desired advantages and level of urbanization. The Smart City concept is vitally needed to address the difficulties that traditional cities bring in a systematic manner. Today, it is essential for cities to establish sustainable policies for city growth that take into account all stakeholders, including residents and businesses and the government

Nashik is the third most populous city in Maharashtra. The corporation's jurisdiction is over an area of 267.48 square kilometres. According to the census of India, Nashik had a population of 14,86,053 in 2011 and is predicted to rise to 21,23,000 by 2021. Nashik's transformation from a pilgrimage city to a planned Smart City is both remarkable and quick. Nashik's rapid urbanization in recent years is due in large part to its thriving skill-based manufacturing industries. Capital and consumer products, textiles, engineering, automotive, biotechnology, IT, and ITeS are among these industries.

Nashik is around 200 kilometers from Mumbai and Pune and is connected by major national roads NH160 (Mumbai) and NH60 (Pune). The 'Golden Triangle' is formed by India's fast-growing commerce corridor. The pleasant weather throughout the year encourages trade inside the city. Nashik also has a well-developed social infrastructure. This makes the city the epicenter of outstanding facilities and a Smart City in every sense.

Nashik is one of the cities on the Government of India's list of smart cities. Nashik has been selected for the "Smart City Challenge" by the Ministry of Housing and Urban Affairs (MoHUA) (then, the Ministry of Urban Development). The Smart City Mission serves as a catalyst as the city adapts to urbanization and industrialization. It is committed to preserving the cultural legacy. The city's concept of 'Smart City' purpose is subjective and relies on how it is viewed. Nashik aspires to be India's most livable city by leveraging on its rich religious culture and becoming a center of developing businesses by addressing significant transportation issues. The Nashik Municipal Corporation (NMC) founded the Nashik Smart City Development Corporation Limited (NMSCDCL) to achieve this. The goals of NMSCDCL are to identify citizens' true needs and priorities, focus on creating more with less investment, create self-sustaining infrastructure and technology-based solutions, and develop implementation strategies. The use of technology to improve the lives of people is at the core of this purpose. To make the city more reliable, sustainable, and hospitable, Nashik Smart City (NSC) submitted proposals in the areas of sewage, transportation, water, and associated sectors, as well as better livability and governance. Nashik was ranked 11th in the Smart City Challenge's Round 2 competition, which required cities to present a strategy for city development that comprised two parts: area-based development (developing a specific region within the city) and a pan-city programme.

1.2 Significance of the project

NMC has partnered with NMSCDCL to create a high-quality public transportation system. The purpose of this research is to make suggestions to assist NMC in developing an efficient and sustainable urban mobility infrastructure that fits the city's immediate and long-term transportation demands.

The public transportation development plans in NSC are divided into many categories mainly intercity bus services, smart parking, and a public bike-sharing system (PBS). Nashik's public mobility system should be convenient, efficient, inexpensive, dependable, and integrated. Infrastructure upgrades, such as reserving lanes and tracks, and operational improvements, such as refining routes and timetables, are all part of improving current urban mobility. Improvements in mobility infrastructure are expected to retain public transportation's current modal share while also causing a shift from other modes of public transportation to private transportation mode.

When building an urban mobility infrastructure system, it is important to examine whether it will be accessible to all possible passengers. Accessibility for walkers and cyclists, the differently abled and aged, as well as private car users after they have parked their vehicles, should be included in the system's planning.

1.3 Vision for area-based development projects

The rise in population has a direct impact on the city's increasing motorization and pollution. To meet the city's mobility infrastructure needs and discourage personal vehicle use, the city urgently requires a robust public transit system to encourage a modal shift from personal transportation to public transportation. NMSCDCL aspires to operate a high-quality public urban mobility system in the city. The purpose of this research is to make recommendations to assist NMSCDCL in developing an efficient and sustainable urban mobility infrastructure that fits the city's short- and long-term transportation needs

NMSCDCL envisages the creation of state-of-the-art public infrastructure facilities with a principal view to establish Nashik as a user-friendly Smart city. Effective parking management is an essential tool to facilitate the efficient use of road space to ensure free passage for pedestrians, cyclists, public transport and general users. Bicycle sharing is a key element in a city's strategy to expand the use of sustainable transport modes. Bicycle sharing is expected to boost the use of public transport by providing crucial last-mile connectivity to the system. The provision of bus routes and the upgradation of buses along with bus depots, bus terminals, and bus shelters will encourage the use of public transport. The vision of the above mentioned project is to promote public transport to score higher, however, some road infrastructure projects and traffic management projects too can promote public transport, focusing on reducing traffic congestion by providing smart solutions to vehicle parking and provision of pedestrian facilities.

Aim
To assess and evaluate NMSCDCL's urban mobility infrastructure proposals and implementation.

Objective

a. To realize the true potential of the Urban Mobility Infrastructure projects implemented in Nashik city.
b. To provide a low-cost, environmentally friendly, non – motorized and sustainable mobility option to the residents of Nashik.
c. To reduce dependency on automobiles, reduce traffic congestion, vehicle emissions and demand for motor vehicle smart parking.
d. To connect the citizens to the opportunities created by the smart city implementation in Nashik.
e. To study the level of satisfaction that the citizens feel about the initiatives in these areas.

2. Conceptual Background/ Framework

Projects for urban mobility infrastructure are categorised into three sections in the research study we did.

6. Bus services
7. Smart parking
8. Public Bike Sharing (PBS)

2.1 Bus services

Nashik has a very low density of buses per route. The service operated one bus on two routes as compared to other cities which operate multiple buses on a single route. The situation leads to low frequency of buses on an individual route. The public transportation facility for city bus service in Nashik is currently provided by MSRTC which also provides the state transport facility. Although MSRTC operated 243 buses on 508 routes in the year 2016, they subsequently reduced the fleet size in the year 2017 to 176 buses on 385 routes to mitigate its operational losses. Based on the estimated Year 2016 population of Nashik, UMTC's CTTP report recommended a bus fleet size of 698 buses to achieve an indicative LOS of 1 which was computed on the lines of MoUD guidelines of 0.4 buses per thousand population.

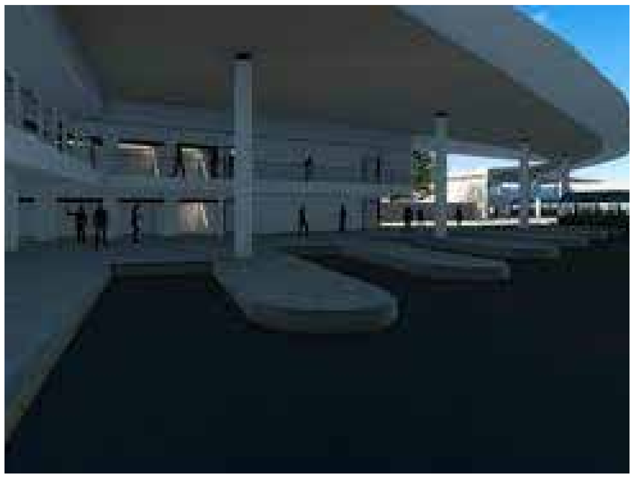
There is an immediate need to provide a robust public transportation infrastructure to the city to bring about a modal shift from the use of personal transport to public transport. This increase in population accounts for the increased motorization and pollution in the city. A more extensive choice of primary corridors as well as a more detailed identification of public transport routes ensured an improved service towards meeting ridership demand. Although most of the route selection was carried out based on the peak hour ridership estimates, a few distant routes to villages outside NMC boundary as well as a few localized routes based on inputs provided by NMC staff were identified, to ensure that the proposed bus transport continues to offer a public service to the City. Based on the revised bus routes, updated operation parameters and identification of feasible terminal and depot facilities, an immediate fleet size requirement of 400 buses to meet the public transportation needs for NMC was identified. Moreover, a detailed scheduling exercise for the proposed 146 public transport routes was carried out to design the bus operations plan in compliance with the objective of the project. Adding 50 new buses every year to the existing fleet size would help expand the public transport operations by not only increasing the number of routes being operated citywide but also provide an opportunity to improve the frequency of bus operations along the identified transit corridors.

Key features of bus service:

1. otal number of buses immediately required: 400 buses (135 standard size electrical buses (Non-AC), 15 standard size electrical buses (AC), 180 standard size CNG buses (Non-AC) 20 standard size CNG buses (AC), 45 medium size diesel buses(non-AC) and 5 Medium size diesel bus (AC))
2. Additional buses to be added every year for 9 years: 50 standard size electrical buses/year
3. 50 standard size electrical buses/year. New bus stops have been provided to facilitate mid-route boarding and alighting of passengers.
4. Bus stops in Nashik have been placed at a 500 m spacing in the core area, whereas in the less dense areas, bus stops could be placed over larger distances.
5. A 300 m to 600 m spacing is an appropriate spacing for city bus operations as per World Bank's Urban Bus Toolkit. Based on these assumptions 709 bus stops were identified within in NMC area.

2.2 Smart Parking System

With the growth of the economy, vehicles have become a necessity in our daily life making the vehicle quantity increase dramatically. Vehicles bring convenience to people, yet parking causes serious problems because of poor management. For drivers, traditional parking management has not met their needs in efficiency and security performance. Therefore, the need for a Smart Parking System with high efficiency, low cost, high security is indispensable for people in the modern-day society.



NMSCDCL will assign specific areas for development, implementation, operation & maintenance of Smart Parking Solution for on-street, off-street areas within Nashik city. The concessionaire will be responsible for managing parking areas through clear signage road markings. As part of the hassle-free payment system, payments are linked to a vehicle's licence plate number, which is then utilised in the enforcement process to determine whether the car has paid the fee or not. This information will also be displayed on the signage. A regular user will have the option of signing up for a user account connected to a registered vehicle mobile number(s) that can be used for parking fee payment anywhere in the city

The Smart Parking System will provide information to users through various media including the internet, smartphone applications, and web portal on-street signage. Users will be able to view real-time on-street, off street occupancies, applicable parking fees, enabling them to identify streets or lots with open spaces and applicable rates before planning their trips. The system will make use of social media to keep city residents apprised of new regulations and smart parking system features.

A total of seven parking locations are presently operational in Nashik as follows:

1. Ahilyabai Holkar, Ramkund
2. Gauri Patangan, Mhasoba Patangan
3. Gangapur Waterfall
4. Somani Garden, Muktidham
5. Basement of Annashastri Hospital
6. Govt. Girls High school, CBS
7. B. D. Bhalekar High school Ground

Key features of Smart Parking System:

1. Users will be able to see real-time on-street and off-street occupancies, as well as related parking fees, allowing them to locate streets or parking lots with available spaces.
2. The Smart Parking System will make it possible to pay parking costs quickly and easily.
3. To facilitate greater transparency and efficiency

in the collection of parking fees enforcement operations, the Parking System will use an Information Technology (IT) backbone.

4. Implement a Smart Parking System to improve parking operations, maximize the use of available parking, and improve the overall performance of municipal roadways.

2.3 *Public Bike Sharing (PBS)*

Public Bike Sharing (PBS) systems have evolved with time, from free bicycles for the community to technologically driven systems available on rent. However, the core objective of the system has remained the same, i.e. picking bicycle at one point, using it and returning it at another place. The bike sharing systems serve as a point to point mode of transport. Bicycle sharing is a cost-effective, sustainable, environment-friendly mode of transport in which modern bicycles are available to commuters. Generally, PBS docking stations are located in close proximity to existing bus stations/ Intermediate public transport (IPT) stands to integrate both modes and facilitate the last-mile connectivity

Bicycle sharing is an important part of a city's plan to increase the usage of sustainable means of transportation. Bicycle sharing is projected to increase public transportation utilisation by providing critical last-mile connectivity. The system will be linked to the ITS system through the location of its stations. The Bicycle sharing system will reduce reliance on autos, traffic congestion, vehicle emissions, and demand for motor vehicle parking by encouraging a shift to sustainable alternatives. In addition, the system will introduce new users to the health and well-being benefits of bicycling. Finally, the technology will aid in the transformation of streets into surroundings that are safe and comfortable for walkers and bicycles. The location of stations near major landmarks will be prioritised as commercial, cultural, educational, administrative, residential and tourist attraction points in the City.

Elements –

The PBS system in all has certain components that need to be integrated for the successful performance of PBS. Some of the key components of PBS are as follows:

- Bicycles
- Bicycle docking station
- Redistribution vehicles
- Maintenance depot

Key features of PBS:

1. The proposed bike-sharing programme would have 1000 bicycles distributed among at least 100 stations around the city.
2. PBS is a non-polluting and healthy mode of transport.
3. It offers a solution to last-mile connectivity issues.
4. The system has specially designed bicycles & stations. The system components i.e. bicycle and stations are planned in a way to discourage thefts.
5. The PBS stations can have automated locking arrangements at the docking stations.
6. Real-time monitoring is done for bicycles and stations to keep a track of bicycle
7. Movement and availability of bicycles and bays at docking stations.

Key findings from the interviews, surveys, and primary/ secondary data collection

The goal of this study is to look at residents' perceptions of Smart city projects in the Nashik city region. The information is gathered via a structured questionnaire as well as unstructured interviews and discussions with residents in various parts of the city. Following are the key findings of each urban mobility infrastructure

1. Bus services

- Since the launch of the bus service within the city, it has gotten a positive reaction, with over 20 lakh passengers using the buses.
- Commuters have been particularly supportive of the addition of new routes.
- It is made user-friendly by the construction and provision of infrastructure facilities to the operator on the bus depots, terminals, and bus shelters.
- For a smooth flow of buses, route design and operations are constantly modified depending on ridership statistics.
- Constantly check the bus operator's level of service to the citizens.

2. Smart Parking

- Disgruntled motorists in Nashik city have questioned the alleged 'inordinate' delay on the part of the NMSCDCL in starting operations of on-road and off-road pay and park zones, although the infrastructure was created two years back in different parts of the city.
- Because of parking concerns, many car owners indicated they hesitate to take their families to market locations
- Four-wheeler and two-wheeler owners have been facing problems by such parking and penalty concerns.
- Commuters have noticed that there is limited space to park automobiles in the city centre because there aren't many smart parking zones there, which leads to a lot of illegal parking and traffic bottlenecks, especially during late hours.
- Residents have insisted that NMSCDCL must resolve their issues and make parking lots operational.
- In the city, motorists face a major problem with parking. Getting a car to the city's central market areas is extremely tough

3. Public Bike Sharing

- There are no substantial provisions for designated bicycle lanes for the safety of bicycle riders, making the PBSS the locals' least favoured means of transportation.
- The lack of utilisation of PBS channels is mostly due to their ineffective location.
- People are less likely to use PBS bicycles since they are in poor condition owing to lack of maintenance.
- The PBS registration and operation method is complicated, strict, and non-streamlined, which is not user pleasant and makes the PBS difficult to use for the majority of the population

3. Limitations of the Research

1. Data collection is one of the most important concerns.
2. A lack of evaluation and impact analysis.
3. In the remaining locations, there is a lot of potential to integrate smart parking and PDS systems.

4. Discussion and Conclusion

Nashik is the third largest urban area in the state of Maharashtra. The Nashik Municipal Corporation (NMC) plans to operate its own city bus service to meet the short term and long-term transport needs of the City. The public transportation facility for city bus service in Nahik is currently provided by MSRTC which also provides the state transport facility. Based on the updated operation parameters resulting from the revised bus routes and identification of feasible terminal and depot facilities, an immediate fleet size requirement of 400 buses to meet the public transportation needs for NMC was identified. Moreover, a detailed scheduling exercise for the proposed 146 public transport routewas also carried out as a part of this study. Adding 50 new standard electrical buses every year to the existing fleet size wouldhelp expand the public transport operations

by not only increasing the number of routes being operated citywide but alsoprovide an opportunity to improve the frequency of bus operations along the identified transit corridors. A summary of the proposed recommendations is summarized below:

Buses:

- Total number of buses immediately required: 400 buses (135 standard size electrical buses (NonAC), 15 standard size electrical buses (AC), 180 standard size CNG buses (Non-AC) 20 standard size CNG buses (AC), 45 medium size diesel buses(non-AC) and 5 Medium size diesel bus (AC)) Additional buses to be added every year for 9 years: 50 standard electrical buses/year To support the proposed bus operations the following land parcels may be further explored for creation of the depot and terminal facilities:

Depots:

- Anandnagar Depot
- Pathardi Phata Depot
- Sadhugram Depot (Survey No. 288 Nashik)
- Adgaon Depot

Off-road Terminal Stations:

- Chehedi Terminal
- Mumbai Naka Terminal
- Sadhugram Terminal
- Pathardi Terminal
- Nimani Terminal
- Adgaon Terminal
- Nandur Village Terminal
- Anandnagar Terminal
- Makhamalabad Terminal

On-road Terminal Stations:

- Dindori Road Terminal.
- Peth Road Terminal.
- Gangapur Road Terminal
- Pimpalgaon Bahula Terminal.
- XLO Terminal.
- Uttam Nagar Terminal.
- Balaji Nagar Terminal.
- Shramik Nagar Terminal

The proposed city bus service covers maximum area of city. The no. of buses are calculated on the basis of maximum area coverage and to meet desired frequency of service. The major routes were finalized by Top 100 earning MSRTC routes while other routes were identified with the discussion with NMC staff. The current proposal of 400 bus is enough to meet demand of the city.

The concessionaire will establish, operate, maintain the Smart Parking System. The concessionaire carries out parking operations, including fee collection enforcement on designated streets. The concessionaire will create data links to (Smart City Operation Centre) so that NMSCDCL can monitor the status of the parking system.

Bicycle sharing is a flexible system of personalized public transport. Bicycles are available in a closely spaced network of semi-automated stations. Users can check out Bicycles at one station and return them to any other station in the network. Bicycle sharing is a key element in a city's strategy to expand the use of sustainable transport modes. The system will support the transformation of streets to become environments where pedestrians and bicyclists feel safe and comfortable.

A hybrid system is proposed for Public Bike Sharing. The stations will be manned by station attendants; however, the operations of each station are communicated to the Smart City Operation Centre. The number of Bicycles or/and stations can be increased/decreased with mutual consent of NMSCDCL and service provider but the cost of the same shall be borne by the service provider.

5. Recommendations

- The potential benefits of ITS in urban mobility infrastructure system applications are briefly stated herein. ITS urban mobility infrastructure system is conducive to improve
- Ridership and mode transfer: A passenger travelling can be estimated through the use of ITMS. Passenger data can be estimated by using electronic ticket data.
- System control : Through ITMS we can monitor routes taken by bus.The movement of bus can be monitored and a warning to the driver can be given if he misses a bus stop or deviates from the route. This can be achieved by installing a GPS system in bus.
- Quality of service : People will get improved service through ITMS. ITMS will provide information regarding the arrival of bus, total trip length and time required for trip at their fingertips. Also, it will be used to keep a check on the contractor to fulfil conditions in the agreement.
- Operations scheduling, bus and crew scheduling, : Based on data received from ITMS, we can plan new routes, or we can increase bus frequency at high-demand routes.
- For successful implementation of ITMS system a command and control center need to be established by NMC. The equipment required for the command and control center are as follows

1. Dedicated office space for employees.
2. Work stations for employees to monitor bus activities
3. Projector/ LCD screen to monitor the whole activity.

Future Expansion Strategy

Following the deployment of the initial batch of 400 buses, additional buses will need to be introduced every year to raise the modal share of public transportation in Nashik. Adding 50 additional electric buses to the existing fleet each year will assist extend public transportation operations by boosting not just the number of routes operated citywide, but also the frequency of bus operations along transit corridors. The data acquired from the Electronic Ticketing Machines (ETM) at the point of origin and destination would aid in fine-tuning the route optimization operations. An evaluation of bus service might potentially be conducted using the World Bank's Urban Bus Tool Kit based on data collecting.

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A9

Common Mobility Card, Smart City Kochi.

Name of the project: *Common Mobility card, Smart City Kochi.*
Location: *Kochi, Kerala*
Year of Project Implementation: *2018*
Sector: *Urban Mobility / NMT*
SDG: *SDG 9, SDG 11*

Institute: *College of Engineering Trivandrum*
Advisors: *Dr. Bejene S Kothari, Ar. Biley E Menon, Ar. Alok Dinesh, Ar. Ribi Rachel Mathew*
Students: *Nilofer J, Kalindi P S, Lalithambika NS, Rakhi Dev, Deepak S, Joe Augustine T, Vibin Vcitor*

Keywords: *National common mobility card, Smart card, AFP*

Abstract:

The number of Indians living in cities is expected to touch 843 million by 2050. To keep up with this pace of urbanization, the government of India kicked off the Smart Cities Mission in 2015 which focuses on incorporating smart features across 100 cities. Under the Ministry of (then called) Urban Development, the National Urban Transport Policy envisioned a single fare media for all public transport and seamless shopping, which is one of the key levers for smart urbanization. This vision led to the launch of the Smart National Common Mobility Card. This single fare card allows payments on various participating public transportation systems and can also be extended to retail payments, parking payments, etc.

This research paper explores various aspects and dimensions of EMV (Europay, Mastercard, and Visa) based Smart Card initiative for cashless payment solutions. It also attempts to understand its popularity, impact and scalability. The study approach was largely exploratory in nature, mostly based on a literature review of secondary data drawn from journals, books, websites, reports, etc.

Based on stakeholder surveys, we have analyzed the impact of the project on various user groups. The paper throws light upon the factors that made this smart city initiative a successful project.

Case Study: **A9**

1. Introduction

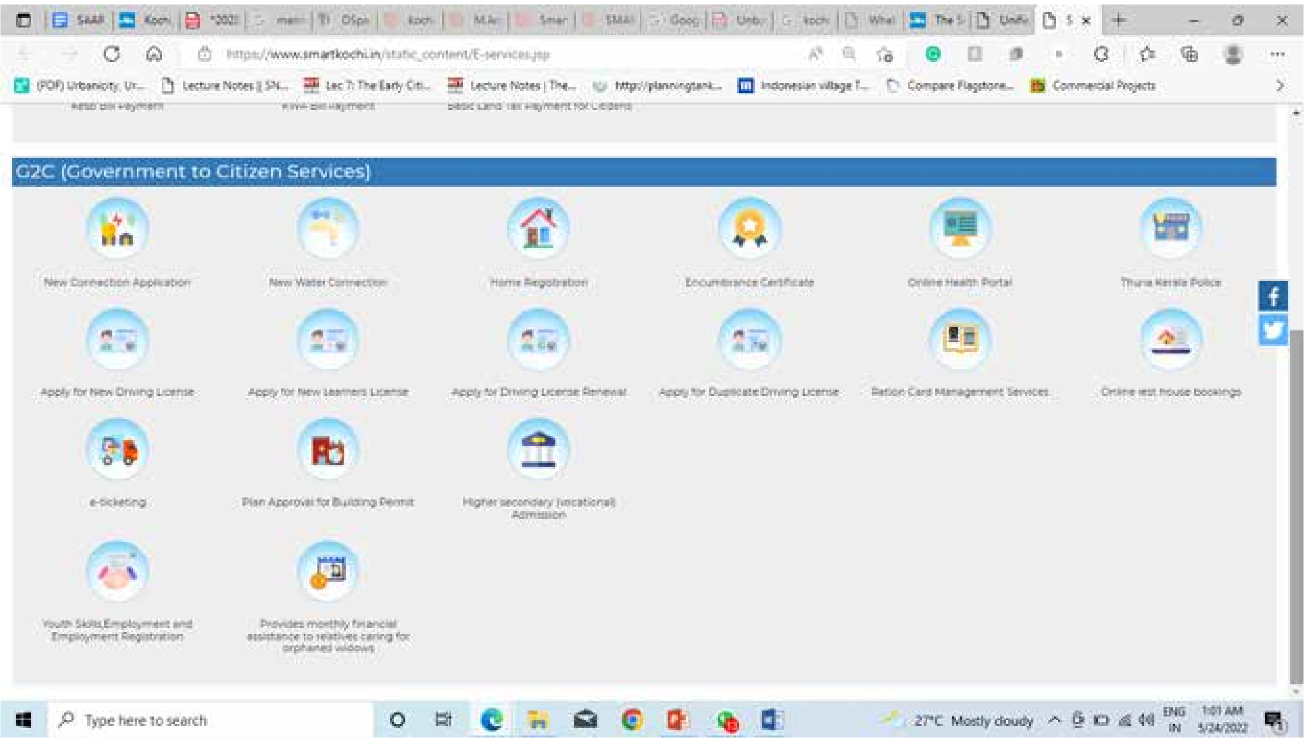
The role of technology in smart cities is mainly to deliver citizens' services and manage their infrastructure and core civic operations. From existing studies on the Smart City Mission, we can safely say that one of the major aspects of the Smart City Mission is to deliver effective smart mobility solutions while facilitating a collaborative ecosystem and meeting sustainable development goals. How each cities strategies to overcome city mobility challenges and solve urban mobility problems is what makes them unique. As a strategy, smartcards represent a key instrument to link citizens to public administration and local infrastructure to advance smart city plans further.

From the recent case studies, as of now, Singapore is the only nation with a nation-wide common transit system card. However, they have some shortcomings. In India, Smart National Common Mobility Card was launched to address the deficiencies seen in the Singaporean approach and provide an improved version of the one available in Singapore.

Common mobility card was implemented while keeping the following aspects in mind:

1. It should allow easy integration and adoption by all stakeholders.
2. It should allow ease in scaling and replicability.
3. It should be as safe and secure to use as a debit/credit card.
4. It should be made user-friendly by allowing offline recharge.
5. It should not hinder the purchase of regular token/ticket

Map 1: Geographical area of the project. Source: Author



Source: Screenshot from Smart City Kochi website: G2C services offered

This study, specifically looks at how common mobility smart cards were implemented in Kochi and their impact on the stakeholders.

1.1 Topic and Context

Kochi, geographically situated between Northern Latitude 90 47'and 100 17' and eastern longitude 760 9' and 760 47', is one among the first 20 cities selected under the Government of India's smart cities mission. Cochin Smart Mission Limited (CSML) is the Special Purpose Vehicle (SPV) formed to plan, design, implement, coordinate and monitor the Smart City projects in Kochi in coordination with the Kochi Municipal Corporation (KMC).

Smart City projects are classified under two categories, Area Based Development (ABD) projects and PAN City projects. The vision of CSML is "to transform Kochi into an inclusive, vibrant city of opportunities with efficient urban services, sustainable growth and ease of living". The key sectors identified in Kochi were urban transportation and mobility, solid waste and sewerage management, rejuvenation of water bodies (canals), public spaces/open spaces, economic opportunity and intelligent government services.

ABD projects are planned for an area of 1024 acres, spread across 8 wards of KMC (5 wards in West Kochi and 3 wards in Central city). Map 1 shows the extent of the KMC boundary within which the smart city projects are executed. PAN city projects include Kochi One Smart Card, 24/7 water supply management system, traffic management system, safety and security surveillance system and Integrated Command, Control & Communication Center (IC4).

To address the issues of scattered citizen-government services and to transform the quality of life of citizens a unique model of smart card was planned in Kochi. Smart card payment solutions can also be extended to other city services in a phased manner.

Two levels of convergence can be observed, first being at the national/central level for back bone and possible funding. Second, the government of Kerala that plans to support Kochi under a digital scheme to create network backbone and OFC (Optical fiber cable) connectivity of all government offices.

1.2 *Significance of the project*

Implementation of smart card infrastructure in Kochi is facilitated by KMRL as nodal agency and was planned to be implemented in 3 phases:

1. Implemented for ticketing and access to public transport starting with Kochi metro.
2. Subsequently extended to other public/paratransit forms.
3. Extended to G2C service.

1.3 *Aim and Objectives*

The aim of the study is to understand the role of information and technology in urban management in Kochi, through the case of the Common Mobility Card within the city.

The objectives of the study are:

1. To understand the components and services of the Common mobility card in Kochi.
2. To understand the positive and negative impacts of the project on various stakeholders through site study and surveys.
3. To identify the potentials, challenges and issues of the project that needs to be addressed.
4. To arrive at findings, recommendations and suggestions to improve the project.

2. Contextual Background

2.1 *Conceptual framework / Research design*

The research methodology was formulated in two phases for the collection of data, Pre-site and On-site. During the pre-site phase, literature review from secondary sources like handouts, official documents and case studies of best practices of NCMC were carried out. Based on the case studies for NCMC, parameters like public awareness, traffic management efficiency, social security and inclusivity were set. On-site phase consisted of on-ground data collection and stakeholder's consultation. Samples collected in the form of google survey forms were prepared and circulated to the general public to obtain the details of the project and tools that were adopted were semi structured interviews, both face to face and telephonic. Collected data was then analyzed and the impact of the project was assessed from which we were able to derive key findings and recommendations.

2.2 *Key features of the project*

Kochi-1 card is an EMV based Smart Card initiative for cashless payment solutions in the transportation sector implemented in the city. This card can be used for traveling in metro rail, water metro, buses, cabs and other modes of transportation in the city. From studies we understand that the uncontrolled growth in the private vehicular population leads to traffic congestion across the city. The Smart Card initiative would improve citizen convenience and improve public transport efficiency to a large extent.

From secondary studies one can understand that the implementation of Smart Card Infrastructure was led by KMRL as the nodal agency. The cards are launched in association with Axis bank. Ticketing and access to public transport modes started with the Kochi Metro and subsequently extended to other public/paratransit forms. The card would be priced at Rs.150 and can be purchased from metro stations by providing details like phone number and date of birth. Passengers can make transactions upto Rs.10000 every month for every card. The transactions can be raised to Rs.100000 per month after submission of necessary ID proof. Subsequent recharges can be done from Rs.100 onwards. The metro agency is also planning to set up kiosks to popularize this card. Subsequently the service is said to be extended to other G2C services. Two levels of convergence that are envisaged are:

- National level – This is for possible funding: The Government of Kerala plans to support Kochi under the Digital India scheme for creation of network backbone and OFC (Optical fiber cable) connectivity of all Government offices. KMRL will through KMC/SPV explore if there is potential to leverage this infrastructure as the network backbone for delivery of services under the Smart Card/Mobile App initiative.
- State level – This is for coordination across different agencies: The State is said to create an IT cell under KMRL which will be responsible for implementing the Smart Card infrastructure for ticketing & transport solutions. The IT cell will be working with KMC/CSML to prepare a roadmap.

Factors that determine the success of smart card implementation are:

- It is important that the existing platforms are integrated into the common platform which will bring in efficiency and transparency. If, however, all departments do not come together as envisaged, the Smart Card solution will still be implemented to address mobility and ticketing.
- Technical Integration: Building a roadmap for technical integration and interoperability early on is critical. To address these concerns, clear specifications need to be drawn on the capacity and components of the proposed systems in alignment with the baseline review of systems of line departments/agencies along with a roadmap for integration / interoperability.
- Contracting for performance: Procurement of IT services of this nature will require sophistication and capacity to deal with infinite possibilities. Key staff from KMRL's IT Cell and KMC/SPV will go through technical orientation early on and will learn from experiences of other cities that have implemented such systems.

2.2.1 *Challenges in the project*

a. Kochi would require collaboration and partnership with external organizations and citizens for integration of government services. At the moment, Kochi, like any other Indian cities, lacks mechanisms for data sharing
b. The concept of a smart card does not cater to all socio-economic groups
c. The Smart Card infrastructure will enable ease of ticketing and payment across all modes of travel, enable seamless integration of the various public modes of transport and significantly reduce usage of private vehicles thereby reducing the city's carbon footprint
d. Validity of the card is limited for 3 years.

2.2.2 *Risks involved in the project*

a. Proper functioning of smart cards and its

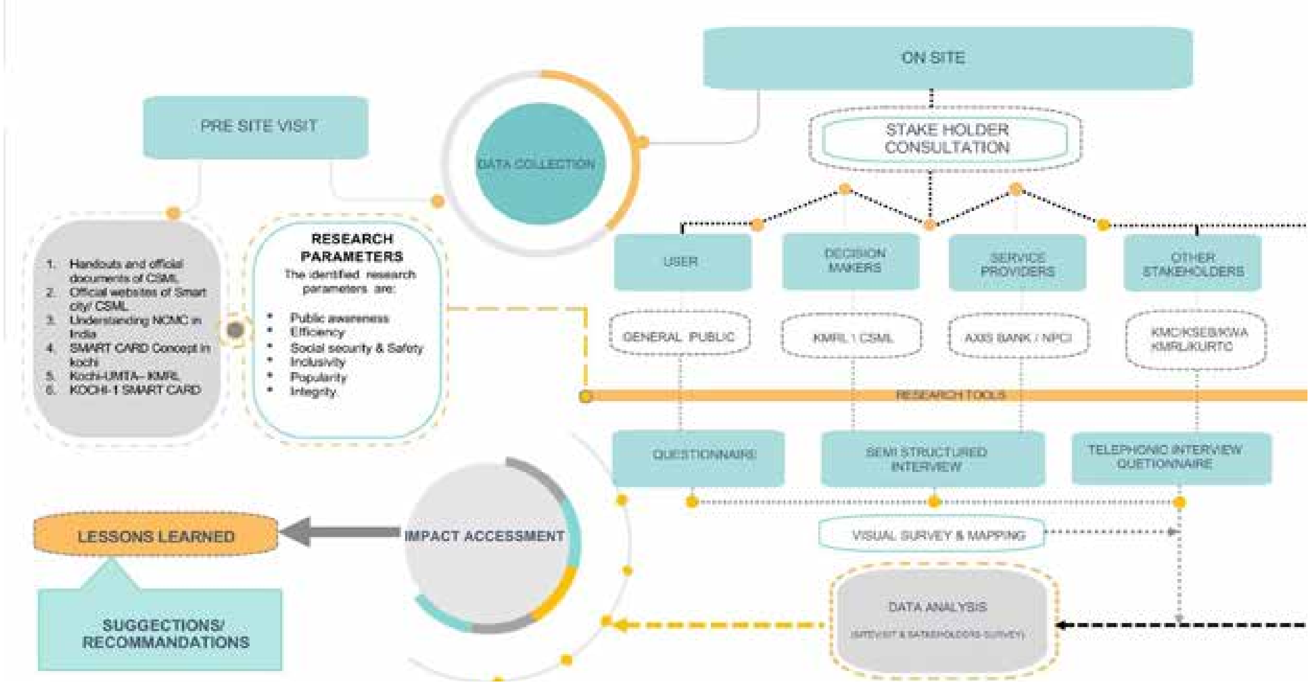


Fig:1 Research Framework
Source: Author

efficiency is highly dependent on the complete integration of ICCC

b. The Project has the risk to remain accessible only to a small portion of the population.

c. Applications like Google Pay, PayTm, etc. already provide facilities to pay water, electricity bills, etc.. Popularity of smart cards among the users would play a key role in it's success.

2.2.3 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)

a. It creates a common platform for all quintessential transactions that a citizen might need

b. Kochi 1 smart card can be used for transit and non-transit transactions

c. Attractive offers for card holders. For example, Axis bank has signed deals with thousands of restaurants and offers 15% or more discount on selected restaurants when you use the Kochi 1 smart card.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

The on-ground survey shows that about 80% of respondents use Kochi 1 smart card out of the 56% respondents that were aware. 50% of respondents who weren't aware of the smart card showed interest in using the same in future.

Advantages of Kochi 1 smart card:

- Making travel within city seamless and more efficient
- Improving access to public transit system
- Improved and scientific decision system
- Aids multimodal integration
- Aids policy decision by availability of analytics platform
- Makes transit cheaper by utilizing the advantages of economy of scale
- Dashboard driven operation and revenue data for the top management
- Reduction in personal vehicles with better utilization of public transport infrastructure.

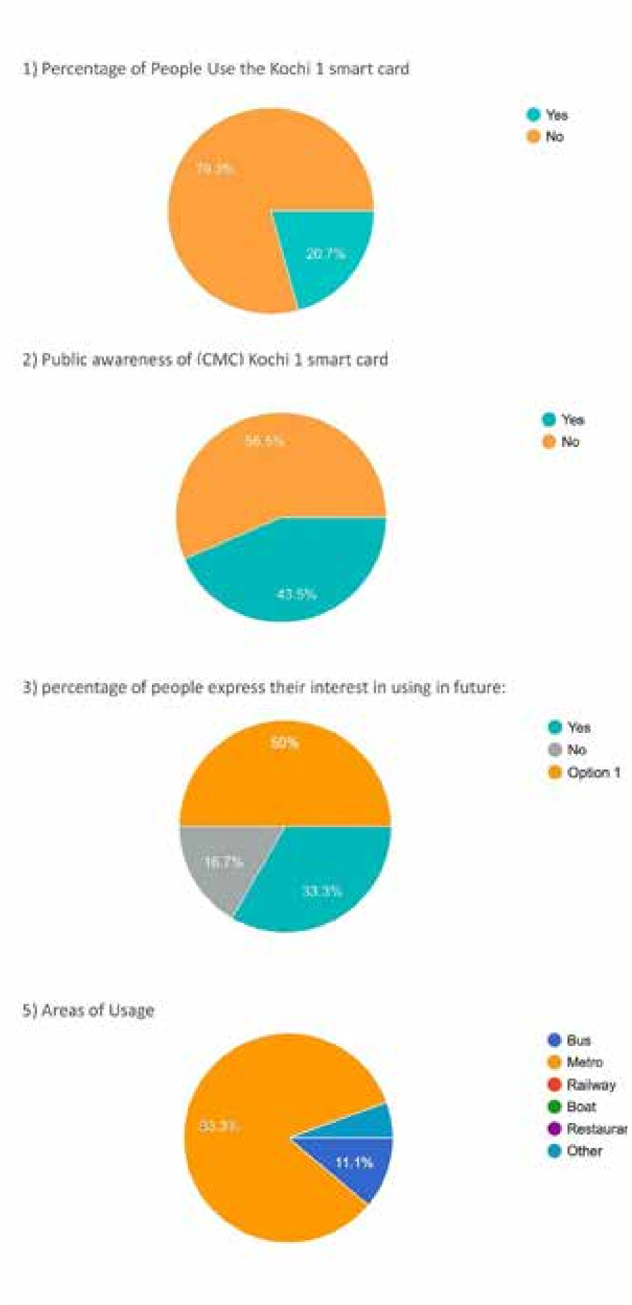


Fig:4 Analysis
Source: Author

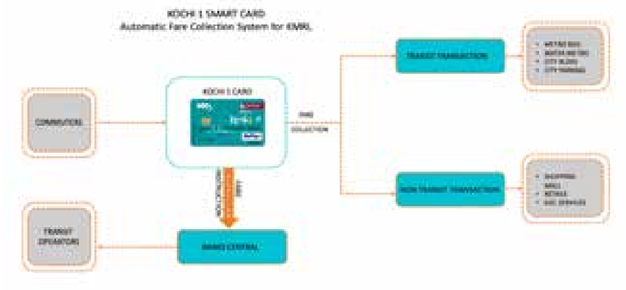


Fig 2: Automatic Fare Collection System framework
Source: Author

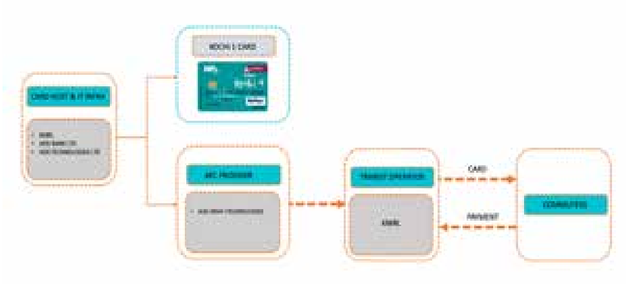


Fig 3: Kochi 1 card Operational framework
Source: Author

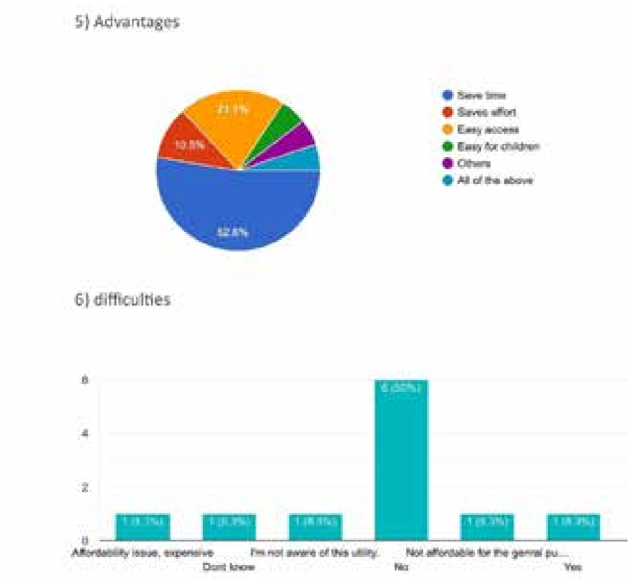


Fig:5 Analysis
Source: Author

3. Discussion and Conclusion

3.1 Discussion and Conclusion

Integrated ticketing for public transport through automated fare collection systems is the need of the hour and will go a long way in facilitating commuters. However, in implementing AFC systems, it is seen that while technically, the integration is feasible, there are substantial challenges in coordination and liasoning with the various agencies.

3.2 Limitations of the research

The sample size mostly included users in the Kochi Corporation area. Hence all the beneficiaries of Kochi 1 smart card are not covered.

3.3 Key lessons learnt

1. It intends to deliver effective smart mobility solutions while facilitating a collaborative ecosystem, and meeting sustainability goals
2. It should be as safe and secure to use as a debit/credit card
3. Smart one card in the current scenario does not cater to users from all socio-economic backgrounds
4. Encourages faster boarding
5. It saves manhandling hours
6. Increases the accountability and transparency of the transactions
7. The study informs us that mobile apps are preferred over cards due to ease of using, chances of misplacing are low, can purchase tickets in advance and remotely.

3.4 Recommendation

1. Incorporating offers and other benefits for the customers can increase user demand and willingness to use the card
2. Credit schemes in the scenarios of low balance in card will reduce the hassle of recharging
3. Introducing more kiosks and outlets for obtaining the card.

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A10

Integrated Command, Control & Communication Centre with ITMS, Smart City Kochi

Name of the project: *Integrated Command, Control & Communication Centre with ITMS*
Location: *Kochi, Kerala*
Year of Project Implementation: *2020*
Sector: *Information and Technology in Urban Management*
SDG: *SDGs: SDG03, SDG 07, SDG 11, SDG 12 and SDG 13*
Project Cost: *ICCC (Rs 64.50 crore), ITMS (Rs 26.9 crore)*

Institute: *College of Engineering Trivandrum*
Advisors: *Dr. Bejene S Kothari, Ar. Biley E Menon, Ar. Alok Dinesh, Ar. Ribi Rachel Mathew*
Students: *Nilofer J, Kalindi P S, Lalithambika NS, Rakhi Dev, Deepak S, Joe Augustine T, Vibin Vcitor*

Keywords: *Technology, Traffic Management*

Abstract

The Smart City Mission was launched in India by Prime Minister Narendra Modi on June 25, 2015. Kochi is at an early stage of building their unique version of smart city. Kochi has disparate service levels across the city and lacks a unified approach to basic services. The city roads are overstressed due to increasing traffic volume and unscientifically designed road networks. To manage the disparity in resources and to bring efficiency to the living environment, an Integrated Control, Command and Communication Centre was introduced at a pan-city level.

So far, the most developed smart service of the Integrated Control Command and Communication Centre or IC4 Kochi, is the Integrated Traffic Management System (ITMS). ICCC attempts to increase transparency and accountability for the citizens and the government through the concept of inclusive city, citizen driven planning and seamless governance.

This research paper explores the various aspects and dimensions of ICCC with ITMS and focuses on the role of information and technology in urban management. It also attempts to answer questions on its implementation, impact and scalability. The study approach was largely exploratory in nature, mostly based on a literature review of secondary data drawn from journals, books, websites, reports, etc.

On the basis of stakeholder surveys, the impact of the project on various user groups was analysed. The paper throws light upon the factors that can make this smart city initiative a successful project.

Case Study: **A10**

1. Introduction

The concept of smart city has been set up in India to adopt and adapt technology to reimagine the way cities function. The role of technology in smart cities is mainly to deliver citizen services and manage their infrastructure and core civic operations. Information and technology in urban management in smart cities has manifested mainly through the Integrated Control and Command Centre, also known as ICCC. This is the brain of the city that performs various functions such as operations, exception handling and disaster management. ICCC behaves like a decision support system. It receives real time data from sensors and edge devices placed all over the city from various utilities like water, waste management, mobility, etc. and responds to the real time event by processing information. In this study we are specifically looking at the ICCC located in Kochi, Kerala's first smart city.

1.1 Topic and Context

Kochi, geographically situated between Northern Latitude 90 47'and 100 17' and eastern longitude 760 9' and 760 47', is one of the first 20 cities selected under the Government of India's smart cities mission. Cochin Smart Mission Limited (CSML) is the Special Purpose Vehicle (SPV) formed to plan, design, implement, coordinate and monitor the smart city projects in Kochi in coordination with Kochi Municipal Corporation (KMC).

The smart city projects are classified under two categories - Area Based Development (ABD) and PAN City. The vision of CSML is "to transform Kochi into an inclusive, vibrant city of opportunities with efficient urban services, sustainable growth and ease of living". The key sectors identified in Kochi are urban transportation and mobility, solid waste and sewerage management, rejuvenation of water bodies (canals), public spaces/open spaces, economic opportunity and intelligent government services.

ABD projects are planned for an area of 1024 acres, spread across 8 KMC wards (5 wards in West Kochi and 3 wards in Central city). Map 1 shows the extent of the KMC boundary within which the smart city projects are executed. PAN city projects include Kochi One Smart Card, 24/7 Water Supply Management System, Traffic Management System, Safety and Security Surveillance System and Integrated Command, Control & Communication Centre (IC4).

1.2 Scope of the project

Kochi faces insufficient carrying capacity of the intra-urban and suburban routes, hindered development of vast areas as extensions due to urbanisation and unscientific planning of urban infrastructure development, absence of proper linkage of various forms of transportation etc, which have resulted in an inadequate mobility system in the city. Kochi faces a high level of traffic congestion, which shows that the road networks are not equipped to carry the traffic.

Introduced on 8th June 2020, the IC4 Kochi envisages the integration of various city services and to bring all civic bodies under one roof to achieve efficiency and effectiveness through standardisation. The urban traffic and mobility being one of the key issues faced by Kochi city, an Integrated Traffic Management System (ITMS) was introduced on 19th October, 2020. ITMS is currently being executed within the KMC region and is one of the functional components under IC4. Since all other major IC4 components are under progress, this study will focus on ITMS and its impact on stakeholders.

1.3 Significance of the project

The functions of any city can be categorised under urban governance, urban finance, urban infrastructure service and urban planning. ICCC has the potential to act as a binding agency of all these city components to achieve efficiency in city administration, city budget planning, basic service delivery to citizens and in-city planning processes. It also aims at achieving better situational awareness for bringing optimisation by reducing human touch points.

The ICCC will be used for:

- Providing insights to civic officials by using data across urban functions through deployment of sensors all over the city.
- Response protocol at city level through institutionalisation of standard processes for recurring events, issues and exigency scenarios.
- Enhancing collaboration across multiple departments within and outside Urban Local Bodies (ULBs) and government bodies.
- Institutionalising data driven decision-making for regular operations and during crisis situations across levels of city functionaries (from operators to city administrators).

Map 1: Geographical area of the project. Source: Author

- Engaging with on-field support staff to address civic issues and citizen grievances.

Efficiency in Operations:

- Understand efficiency in the way resources are used and consumed over a period of time
- Understand efficiency of municipal/contractual employees deployed for managing city operations
- Understand financial efficiency of other urban interventions through measurement of improvement across urban domains facilitated through availability of data and video evidence pre and post implementation

Improvement in Quality of Life

- Improvement in service delivery of municipal services (certificate issuance, licenses) and grievance redressal
- Improvement in urban utilities & services such as water, waste water treatment, storm water management, waste management and street lighting, etc
- Improvement in civic infrastructure such as housing, roads, bridges, parks, gardens, swimming pools and libraries, etc
- Improvement in urban transportation across different modes and traffic conditions in the city
- Improvement in safety, health and education indices in the city
- Improvement in city environment in terms of quality of breathing air, quality of water for civic consumption and pollution-free lakes, rivers and civic open areas

The Integrated Command and Control Centre, if operationalised and managed successfully, can play a pivotal role in improving the liveability of the city by ensuring efficient service delivery and quicker response to emergencies/crisis situations/hazards. ICCC is used for viewing, correlating, commanding and controlling city operations – including day-to-day scenarios and using case and exception management.

The Integrated Traffic Management System (ITMS) will collaborate with the ICCC for its efficient functioning. ITMS broadly consists of two elements - Enforcement and Traffic Management. Enforcement deals with violation detection and fining whereas traffic management deals with flow detection and optimisation of signal controls. Other benefits include incident management and better information dissemination.

ITMS aims to upgrade the entire system to automated technology, interlinking of all signals, effective traffic management and reducing the number of traffic violations. In Kochi, the ITMS helped Kochi Police by utilising technology for improving the city's traffic movement by measuring the traffic flow in real time and optimising data to avoid traffic congestion. ITMS is envisaged to encourage seamless mobility in the city that has diverse transport components such as metro rail, water metro, private buses and others.

1.4 *Aims and Objectives of the research*

The aim of the research is to study the role of information and technology in urban management in Kochi through the case example of Integrated Command, Control & Communication Centre with ITMS.

The objectives of the study are:

a. To understand the components and services of Integrated Command, Control & Communication Centre with ITMS in Kochi.
b. To understand the positive and negative impacts of the project on various stakeholders through site study and surveys.
c. To identify the potentials, challenges and issues of the project that needs to be addressed.
d. To arrive at findings, recommendations and suggestions to improve the project.

2. Contextual Background

2.1 *Conceptual Framework/Research Design*

The research methodology was formulated in two phases for the collection of data - Pre-site and On-site. During the pre-site phase, literature review from secondary sources like handouts, official documents and case studies of best practices for ICCC and ITMS were carried out. Based on the case studies for ITMS, parameters like public awareness, traffic management efficiency, social security and inclusivity were set. The on-site phase consisted of on-ground data collection and consultations with stakeholders. Main stakeholders identified were beneficiaries/general public, decision makers (CSML, KMC), service providers (Consultants and service providers) and city officials (SEB/BSNL MVD/RTO/Traffic police). Samples from the site were collected in the form of maps, photographs etc and tools adopted were semi-structured interviews, both face-to-face and telephonic. Questionnaires in the form of Google survey forms were prepared and circulated to the general public to obtain the details of the project. Collected data was then analysed and the impact of the project was assessed from which the key findings and recommendations were derived.

2.2 *Key features of the project*

IC4 Kochi envisages the integration of various smart elements and services which include solar rooftop, public bike sharing, adaptive traffic control system, traffic enforcement, Pelican signals, GIS, grievance application, solid waste management, electricity and water SCADA, smart metering, public health, e-governance, city surveillance, public address system, emergency call box, traffic management system, smart parking, smart LED street lights, variable message displays, monsoon relief camps, emergency services and environment sensors.

The key outcomes of the IC4 Kochi are real time situational monitoring, 24X7 engagement, rapid response to emergencies, KPI monitoring, identifying anomalies and inefficiencies, fostering transparency and accountability, monitoring of city functions, foundations for further innovation, controlling & monitoring city field assets and enhanced citizen and government engagement. One of the remarkable and successful initiatives of IC4 Kochi was its functioning as a Covid war room to fight against the disease for various tasks that included telemedicine counselling to the public, monitoring of quarantined people, coordination among various agencies involved in containment measures, etc.

ITMS deals with violation detection and fining, flow detection and optimisation of signal controls. The components of ITMS devised for Kochi City are:

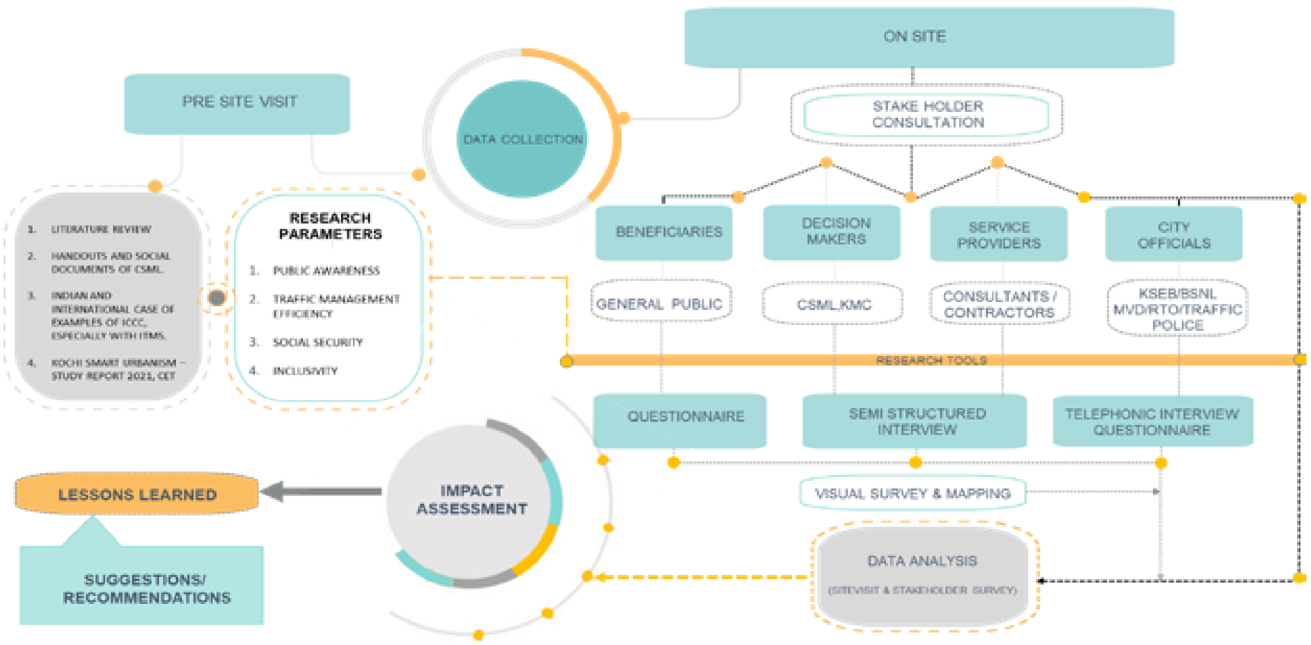


Figure 1: Research methodology framework. Source: Author

- *Vehicle Actuated Signals:* These can detect traffic and automatically adjust and optimise traffic at signals.
- *Pelican Signals:* Pedestrian signal is a definitive light controlled crossing signal which features a set of traffic lights with a push button that is operated by pedestrians for crossing the roads. Crossing layout needs to be designed specifically for Pelican signals as it may be subjected to heavy use.
- *Corridor Management and Area Traffic Control System:* Operated by the traffic signal controller in either fixed time mode, demand actuated mode or forced flash mode, etc. Vehicle detector through a video recorder is recommended for Kochi.
- *Traffic Surveillance Cameras through PTZ cameras for Violation detection and Incident management:* These are installed at strategic intersections to obtain live feeds; it also provides a bird's eye view of the traffic. Accidents and traffic disruptions are captured and traffic police is immediately alerted for appropriate actions.
- *Red Light Violation Detection System (RLVD):* The digital technology captures two key violations namely, over speeding and red signal jumping.
- *Automated Challan System*
- *Variable Message Signages (VMS):* These programmable traffic control devices display real time messages. The operator can choose from a wide range of pre-set messages on the server.

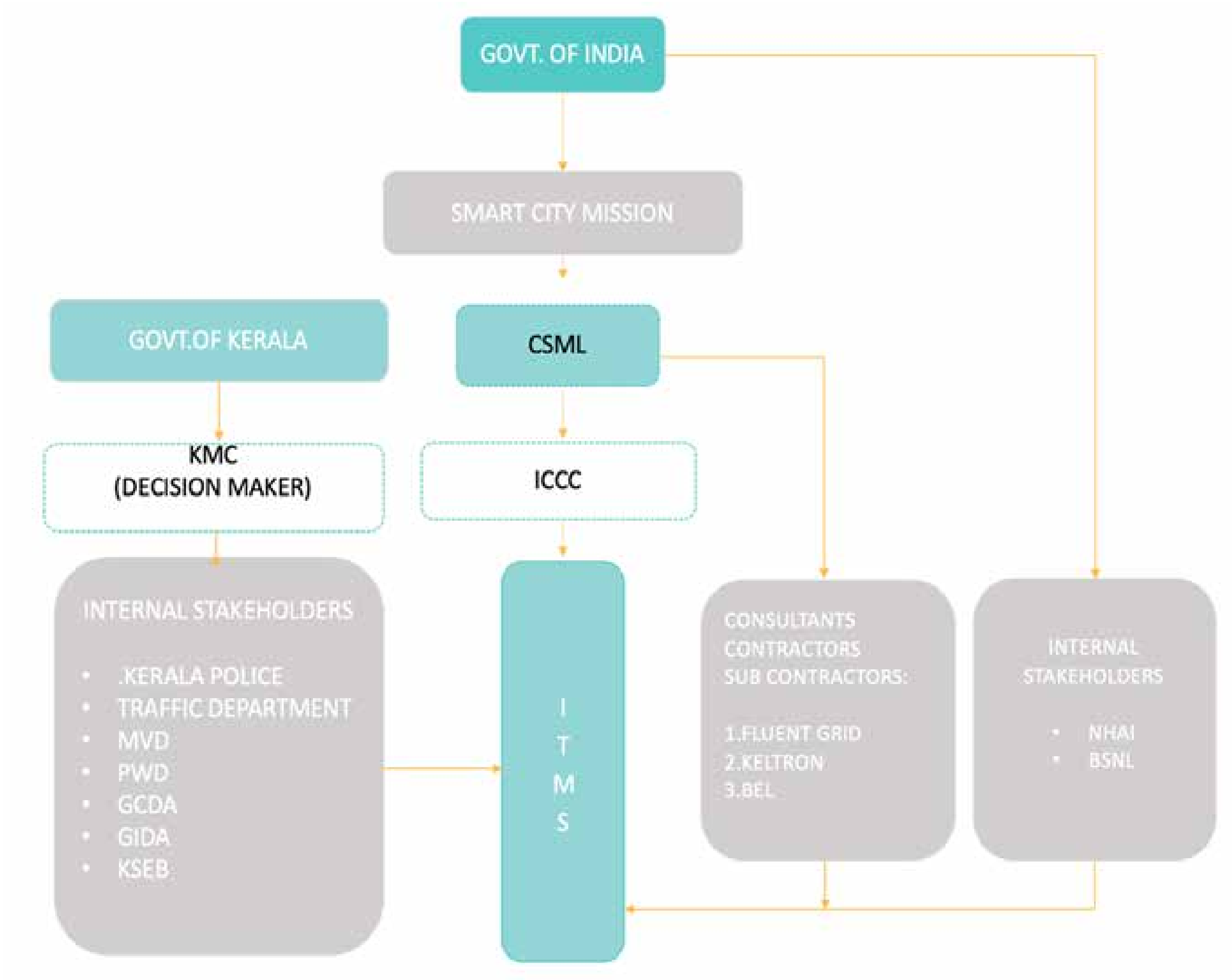


Figure 2: Organisational structure of IC4 and ITMS in Kochi. Source: Author

- *Control Centre or City Traffic Management Centre (CTMC):* It is the hub where information related to transportation is collected and combined to produce traveller information. It integrates traffic signals, traffic surveillance cameras and RLVD cameras.

2.2.1 *Challenges in the project*

a. Kochi requires collaboration and partnership with external organisations and citizens for integration of government services. At the moment, Kochi, like any other Indian city, lacks mechanisms for data sharing.
b. Ensuring transparency and maintaining a balance between executing new technologies to monitor cities and to obtain critical dataset from the government.
c. Requirement of experts and traffic staff to man the CTMC. Personnel need to undergo week long intensive trainings as poorly trained staff reduces efficiency.

2.2.2 *Risks involved in the project:*

a. Smart technologies have a risk of security compromise. Devices and technologies connected to ICCC have an increased risk for hacking and security attacks.
b. Hackers and cyber criminals can have access to sensitive information via ICCC.
c. Increased CCTV surveillance can hinder the personal space of an individual.

2.2.3 *Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)*

a. Real time monitoring
b. Improvement in urban transportation across different modes in the city.
c. Improving liveability of the city by ensuring efficient service delivery and quicker response to emergencies/crisis situations/hazards.

2.3 *Key findings from interviews, surveys and primary/secondary data collection*

The organisational structure of IC4 and ITMS in Kochi depicted in Figure 2 was derived from interviews with the city officials. The internal stakeholders identified include Kochi Municipal Corporation (KMC), Greater Cochin Development Authority (GCDA), Kerala Police, Kerala State Electricity Board Ltd (KSEB), Kerala Fire & Rescue Department, Kerala Water Authority, Motor Vehicle Department (MVD), District Disaster Management Authority, Kerala State Pollution Control Board, Kerala Public Works Department, BSNL, National Highways Authority of India (NHAI), etc. The consultants of IC4 and ITMS are Keltron, Fluentgrid and Bharat Electronics Limited (BEL).

Hence, in the case of Kochi there are multiple stakeholders acting at different levels. IC4 being an initiative of CSML and KMC, faces several challenges and hurdles regarding integration of data that is spread across various government agencies and departments. Various national agencies, state agencies and local government agencies function independently in the Corporation region. For the intended functioning of IC4, data sharing among these agencies is the first step, which is still not fully executed.

Based on the reconnaissance surveys, traffic data and discussions with traffic police, ITMS has identified 35 locations to install the project components. At present, the requirements have been fulfilled in 32 locations, which indicate that 91% of the projects are completed. The mapping of proposed and implemented project locations is shown in Maps 2 and 3.

Pelican crossings are proposed at four locations, out of which two have been implemented. But the implemented locations have changed from the proposed ones, due to technical difficulties during installation. All the four proposed RLVDs (Red Light Violation Detection Systems) have been successfully implemented in the city. Out of the ten proposed locations for VMS (Variable Message Signs), five have been installed. Mapping of the proposed and implemented Pelican crossings, RLVD and VMS are shown in Maps 4 and 5.

Map 2: Proposed project locations of ITMS. Source: Author

Map 3: Implemented project locations of ITMS. Source: Author

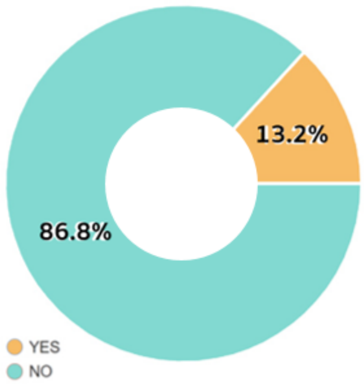
Map 5: Implemented locations of Pelican crossings, RLVD and VMS under ITMS. Source: Author

Map 4: Proposed locations for Pelican crossings, RLVD and VMS under ITMS. Source: Author

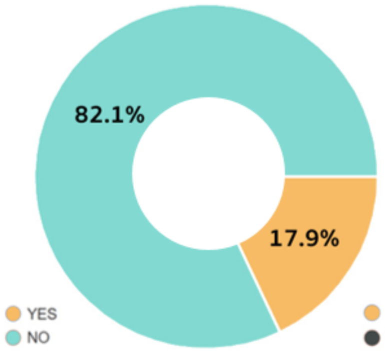
Site Photographs. Source: Author

PARAMETER 1: PUBLIC AWARENESS

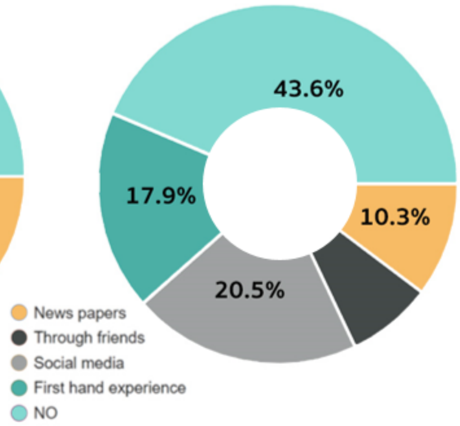
1.Awareness about Kochi as a Smart City



2. Awareness about ICCC or ITMS in Kochi



3. Awareness about Pelican crossing and Source of awareness



Data collection for the impact assessment of ITMS project was carried out with the help of questionnaires based on four parameters. The parameters formulated were public awareness, traffic management, social security and inclusivity. A sample size of 50 citizens was surveyed through an online survey.

- **86%** - Awareness about smart city
- **82%** - Unaware about ICCC
- **43%** - Unaware about the Pelican crossing

From the survey, social media has proven to be an effective mode for spreading awareness.

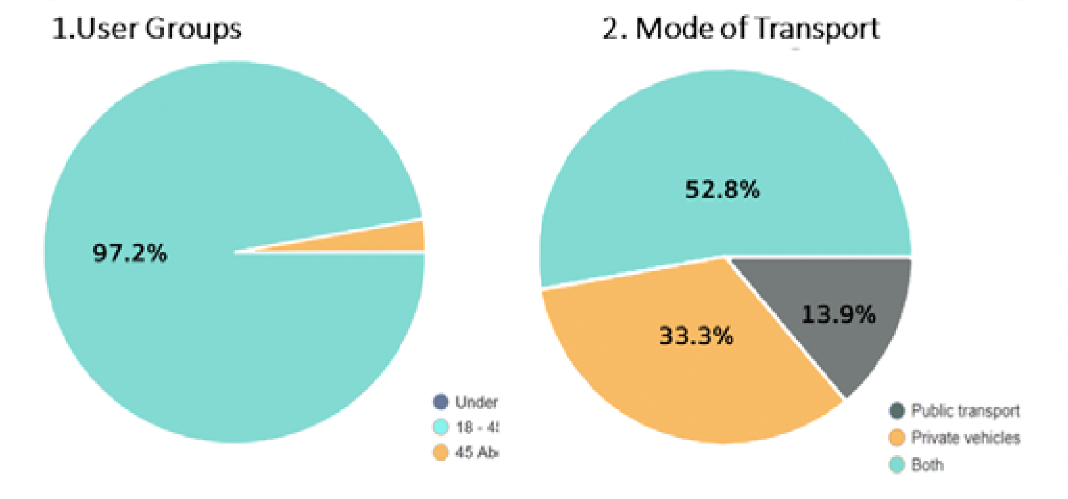
- **97%** - 18-45 age group
- **53%** - Use both public and private transportation
- **14%** - Use public transportation

Parts of Kochi that experience the most traffic congestion are Edappally, Vytilla and Kaloor. Areas that require maximum improvement are quality of roads and traffic management.

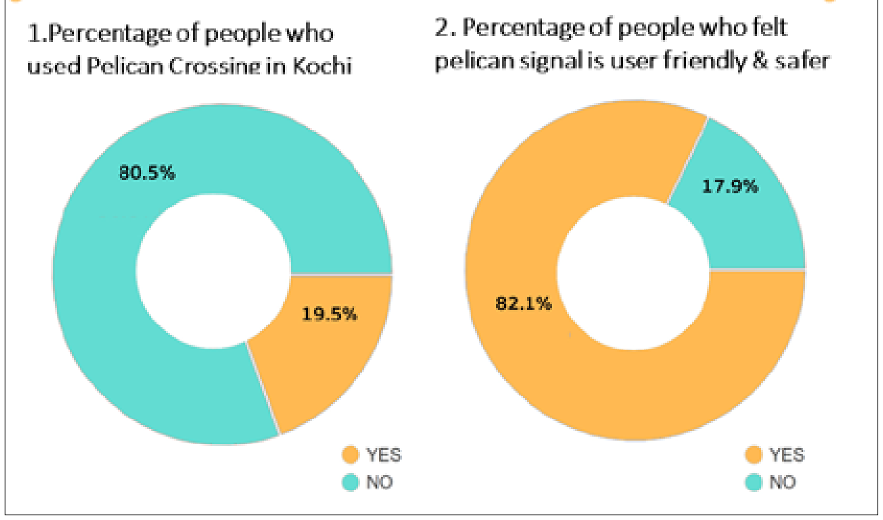
20% of the sample size has used Pelican crossings in the past, and 82% found the same user friendly.

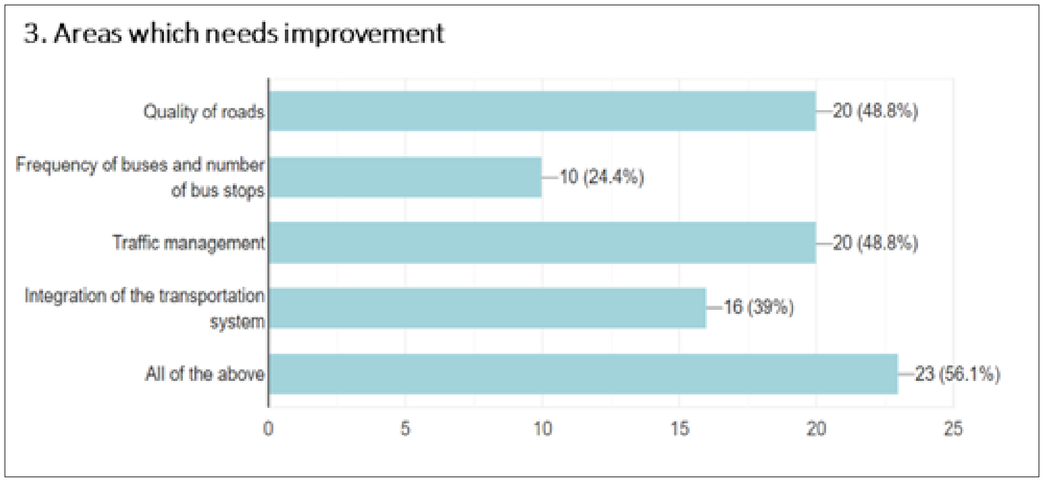
Not located in points that caters to all groups, for eg: Lack of ramps and unsuitable height, Refine physically disabled groups for accessing.

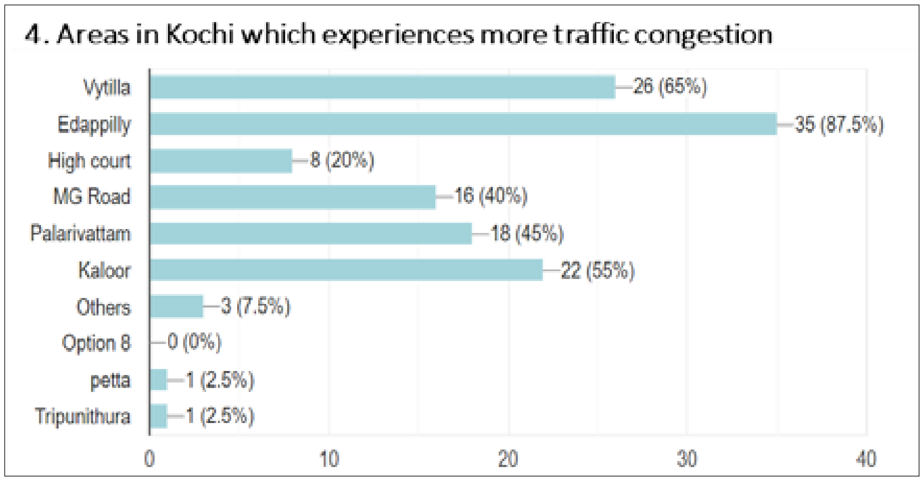
PARAMETER 2: TRAFFIC MANAGEMENT EFFICIENCY



PARAMETER 3: SOCIAL SECURITY







PARAMETER 4: INCLUSIVITY

3. Discussion and Conclusion

From literature reviews and case studies of best practices, parameters like public awareness, traffic management efficiency, social security and inclusivity were chosen for the impact assessment of IC4 and ITMS in Kochi. Questionnaires were framed accordingly and an online survey was carried out to understand the impact of the project on the citizens. Our inferences were that, around 86 percent of the sample size was aware about Kochi being a smart city, while only 43 percent of the sample size was unaware of Pelican crossing. The survey also showed that 20 percent of the sample size had used Pelican crossings and 82 percent of them felt it was user friendly. Majority of the population used both public and private vehicles for daily commute. It was also noted that major areas for improvement were quality of roads and traffic management with Edappally and Vyttila facing most congestions. Interactive components like Pelican crossing were not physically-challenged friendly.

3.1 Implications

Physical impact of the project is that it has improved the road experience by reducing traffic. This has been achieved through real time monitoring of vehicle movement. Use of smart components of surveillance has improved safety. There are also some not so positive impacts like structures requiring frequent maintenance. Some of the social impacts are that it creates a sense of safety. The economic impact is that digitisation leaves less room for mistakes and speeds up the administrative process.

Physical Impact

- Improved user experience of roads by reducing traffic
- Real-time monitoring of movement and congestion of vehicles
- Overall performance of traffic movement for greater safety
- Reducing the hassle of fine collection
- Frequent maintenance of the components

Social Impact

- 24/7 surveillance for safety
- Reduced crime rate
- Reduced accident based mortality
- Induces a sense of responsibility among people

Economic Impact

- Digitisation leaves less room for mistakes
- Timely decision-making and manpower optimisation
- Expensive infrastructure

3.2 Limitations of the research

- Incompleteness of the project can result in inconsistent findings
- Limitation in availability of real time data
- Corporative working and inter departmental data sharing

3.3 Key lessons learnt

- An integrated real time monitoring creates an efficient traffic management system
- Increasing situational awareness within the city.
- Aids faster response to incidents, crisis situations on the roads; enhancing public safety.
- Continuous analysis of data, preparation of dashboards for effective decision making by other departments.
- Creating a platform for collaboration of multiple stakeholders and various departments. But faulty coordination and integration affects the intended outcome
- Poor accessibility, visibility and inclusivity of various components of ITMS fail the intended services.
- All these components and services stated in ICCC and ITMS are explicitly dependent on a robust internet infrastructure which is still under developed in India

4. Recommendations

- Placement of ITMS components to be ensured on the basis of standard practices
- From the survey it is understood that awareness about various components of ICCC and ITMS can be created with the help of social media
- Setting up of a robust internet infrastructure to withstand the change in needs
- Setting up an efficient urban infrastructure to cater to the technological advancement in the systems

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A11

Integrated Command and Control Center, Chennai

***Name of the project:* Command & control centre (CCC) for Chennai smart city**
Location: *Chennai, Tamil Nadu*
Year of Project Implementation: *2018*
Sector: *Innovation and Infrastructure*
SDG: *SDGs: SDG06, SDG 08, SDG 09, SDG 11*
Project Cost: *Rs. 877.93 crore*

Institute: *Dept. of Planning, Anna University*
Advisors: *Dr. K.Pratheep Moses, Mr.P.Sudharsanamurthy, Ms.K.Madhivadhani*
Students: *Ashmi A,Manoj G R*

Keywords: *Command and Control Centre, initiatives, use-cases" matrix, integrating, Management System, smart city*

Abstract

Command and Control Centre (CCC) aims to have a nation-wide view of the ICT infrastructure, to effectively monitor the performances of all critical Government Services. Command centres conduct real-time monitoring of multiple locations from one central hub. The operators can watch and control several business functions in real-time, in various locations. Upon meticulous review towards implementation of these initiatives a lot of synergies were identified among these initiatives. These synergies, if optimally integrated through the Centralized Command & Control Centre, can reap exponential benefits.

In this regard, “use-cases” matrix was prepared with an aim to effectively integrate the existing Government services, which can facilitate in enhancing quality of life in the city of Chennai. Chennai Smart City has envisaged the following aspects as the smart components as part of integrated Command Control Centre such as Disaster Management System, City Surveillance System, Solid Waste Management System, Digital Signage Parking Management System, Smart Street Light Monitoring, Smart Pole Environmental Sensors, Data Centre & Disaster Recovery, Mobile Command & Control Centre, Smart city-Governance portal, Integrated Command and Control Centre (CCC). Integrating all these factors is the main challenge of the project. The existing departmental activities/ initiatives /infrastructure/ funds/ schemes and the applied technology by the command-and-control centre Chennai city which can be reworked and leveraged are reviewed in this report. The explored innovative smart solutions for addressing departmental challenges using CCC too are discussed.

Case Study: **A11**

1. Introduction

The "Smart City" is one of four important flagship missions established by the Ministry of Housing and Urban Affairs (MoHUA) of the Government of India (GoI) in June 2015 with the goal of improving people's quality of life in India's cities. The Chennai Smart City Proposal was named one of the top 20 smart city plans under the same.

Greater Chennai Corporation, which has a population of more than 70.8 lakh people and is still increasing, is one of the first municipal bodies to bring citizen services online. With growing industrialization and economic expansion, the Corporation has been forced to take on a slew of projects in order to capitalise on the city's role as a growth engine. One of them has been providing people and businesses with IT-enabled services. With the potential to become one of India's top 20 Smart City Missions, there is a pressing need to establish an IT backbone for administrative functions as well. With this motive of integrating the various functionalities of the Greater Chennai Corporation, it has been envisaged to set up a Command & Control Centre under the Smart Chennai Proposal.

Secondary research was carried out where-in the learning from other cities was carried out which also re-iterated the need for integrated Command & Control Centre (CCC) approach for similar initiatives undertaken by the other smart cities in the country. A "use-case" matrix was developed to ascertain that the establishment of CCC would enhance the quality of life in the city immensely.

1.1 Topic and Context

Command & Control Centre : The vision of the Command-and-Control Centre (CCC) is to have an integrated view of all the smart initiatives undertaken by the Authority with the focus to serve as a decision support engine for city administrators in day-to-day operations or during exigency situations. This dynamic response to situations, both proactive and re-active will truly make the city operations "SMART". Managing the complete incident life cycle is a critical element in CCC solutions. It requires the ability to detect performance anomalies i.e., KPIs, current status, leading indicators etc. that often serve as a precursor to an incident and continues with Situational Awareness, Situation Management and investigation/ learning. The investigation/ learning phase facilitates continuous improvement that improves all aspects of the incident handling process

Various smart elements are able to use the data and intelligence gathered from operations of other elements so that civic services are delivered a lot more efficiently and in an informed way. Command & Control Centre should be able to integrate with the various Utility systems such as Water/ SCADA, Power, Gas, ITMS, Sewerage/ Drainage system, Disaster Management System etc.

1.2 Significance of the project.

a. The Command and Communications Centres will be the nodal point of availability of all online data and information related to various current and future smart elements and will be connected to other network of services in Chennai through an integration layer.
b. The CCC will be established with all the hardware, software and network infrastructure including switches and routers and will be maintained throughout the mentioned period.
c. All the required Servers, Storage, Software, Firewall, Network Switches for the entire project shall be installed in an integrated manner.
d. The controls and displays should be mounted in ergonomically designed consoles to keep the operator's fatigue to a minimum and console's efficiency high.
e. Integration with Telecom / Internet service providers would aid in automatically capturing the CDR database for the person of interest.
f. Security: Under no circumstances the data accumulated and processed by Command and Control would be compromised. Hence, provisions will be made to keep all the data stored in the platform that is highly secured with required security framework implementation. The platform will be hosted in Data centre at a location decided by Authority to be provided by successful bidder. Further, the platform will provide an open standards-based Integration Bus with API Management, providing full API lifecycle management with governance and security.

1.3 Aim and Objectives

The aim of the study is to analyse the impact of implemented command control centre and the smart solutions and the dynamic response to situations truly making the city SMART.

The objectives of the study are:

1. To seek if there are any additional requirements that can be taken up as part of the envisaged CCC solution.
2. To highlight any existing departmental initiatives/ funds/ infrastructure/ schemes which can be reused/ leveraged.
3. To explore innovative smart solutions for addressing departmental challenges using CCC.

2. Contextual Background

The "Chennai Smart City Proposal" (SCP) had envisaged 48 smart initiatives to the tune of INR 1,366 crores. Chennai Smart City Limited Company was incorporated on 15.07.2016 having 50:50 shareholding pattern of Government of India and Govt. of Tamil Nadu.

The Smart City solutions will be carried out during a 5 year period (2015-2020) with the contribution of Rs.500 crore of State & Central Government each. In Chennai Smart City Proposal, Thiagarajan Nagar has been selected for Area Based Proposal in which 40 components were proposed at a cost of Rs 877.93 crore and under Pan City, 8 components were proposed at a cost of Rs 488.31 Crore. The tentative total cost of Chennai Smart City Proposal is Rs.1366.24 crore.

Upon meticulous review towards implementation of these initiatives a lot of synergies were identified among these initiatives. These synergies, if optimally integrated through Centralized Command & Control Centre can reap exponential benefits.

Chennai Smart City has envisaged the following list of smart components as part of integrated Command Control Centre.

1. Disaster Management System
2. City Surveillance System
3. Solid Waste Management System
4. Digital Signage
5. Parking Management System
6. Smart Street Light Monitoring
7. Smart Pole
8. Environmental Sensors
9. Data Center & Disaster Recovery
10. Mobile Command & Control Center
11. Smart city-Governance portal
12. Integrated Command and Control Center (CCC)

2.1 Conceptual framework / Research design

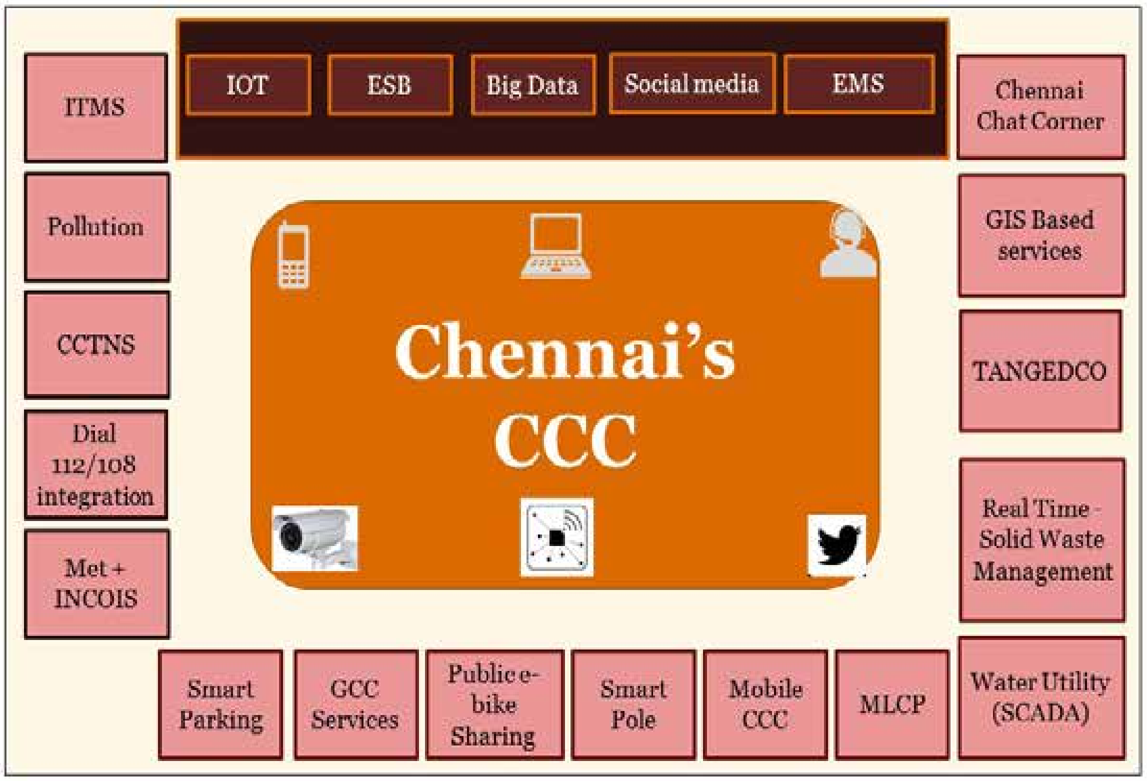

Figure – 1 Functions of the Integrated CCC
Source: Detailed Project Report

2.2 Key features of the project

a. This project enables dynamic response to situations truly making the city SMART.
b. It drastically cuts down on wastage of time, by coordinating between various departments in real-time.
c. The ease of accessibility and advanced technology will make it the epicentre of the executive body in the city.
d. Integrating all the services within one CCC and management and to monitor all the functions and projects under Chennai Smart City Mission.

2.2.1 Challenges in the project

The challenges of command-and-control centre is to comprehensively look into all the functional activities of the city. Their role is to constantly monitor the city in different aspects such transport, crime, health, solid waste management, surveillance and public mobility. Each sector has their own challenge to complete their given task.

Disaster Management

1. Damage assessment by photos sourced from public.
2. Integration with IIT, TNUFISIL, SDRF and on the GIS Platform.
3. A Person in-charge should be appointed at CCC for information gathering from social media.
4. Lead time – time to process the received information and responding to it accordingly.

Surveillance

1. Alternate easy means to communicate in case of any issue such as voice service which can operate without any mobile connectivity.
2. There would be certain trains in which it's very difficult to navigate or to have surveillance, so we should use drones in such cases

Public Mobility

1. Road crash reporting via app, integration of emergency lines, single window reporting.
2. Integration of parking spaces between agencies such as (CMRL, Southern Railways, MTC etc.)
3. On-board Wi-Fi facility for CMRL, suburban rail and MTC.

Environment and Pollution

1. Location of sensors based on area coverage.
2. Online metering of information.
3. Qualitative measurement of water (Lakes and Ground water) and domestic waste water.

Governance

1. SOP for interdepartmental work flow.
2. Existing E-Governance solutions of the dept. need to be taken care and integrated to CCC.
3. Responsibility of interdepartmental data analysis to be defined clearly in the RFP.

Connectivity

1. Smart Poles – MPLS Transport, 4G / LTE Micro BTS or Femto Cell Technology & Wi-Fi poles.
2. Mobile Command Control Vans should be there.
3. Environmental Sensors – IOT – Connectivity.
4. LBS (Location Based Service) – Network Failure Chain (Disaster) and device to device communication using towers.
5. Lifecycle Design & Maintenance to be done.
6. Smart Meter – Uday Scheme to be announced, funds to be acquired from there (AMI).
7. Open Ecosystem, an open platform where public can access data and use it to develop 3rd party applications.

Health

1. Monitoring of Bins – RFID tags
2. Monitoring of Secondary Collection – Weight

GIS

1. GCC and CMDA to capture latitude/longitude for all future approvals – EE (Town Planning) GCC / Chief Planner (Master Plan Unit) CMDA
2. Scheduled or planned power shutdowns can be shared to public. In case of power failure or any query, provide details of contact person etc. Sharing of real time data on power availability – EE (GIS) TANGEDCO.
3. Use common base map with periodic updating - by all departments – along with TNeGA.
4. Common mobile app for accessing all departments.
5. Disaster Management to look at integrating HAM radio signals in the CCC

2.2.2 Risks involved in the project

1. Infrastructure is a combination of multiple aspects. Each aspect introduces new technology/ platform. Multiple technologies with own management platforms has to be interlinked. Handling such multiple platforms for substantial results, is a major hurdle and a daunting challenge.
2. It is difficult to find an all-inclusive Command & Control platform. One should have the ability to communicate with all different platforms. Inclusion of Integration ability of system CCC.
3. High risk involved as these approaches entail the infusion of large amounts of funds.
4. Integration of existing legacy investments with modern CCC platform.

2.2.3 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city

Disaster Management

1. TNUIFSL has real time decision support system for 4 river basins in Chennai (flood related), urban street flooding, and river flooding for an area of approximately 4000 sq. km.
2. Based on this study the flood prone area is noted and flood sensors are installed, such that at times of flood these areas are given priority for implementation

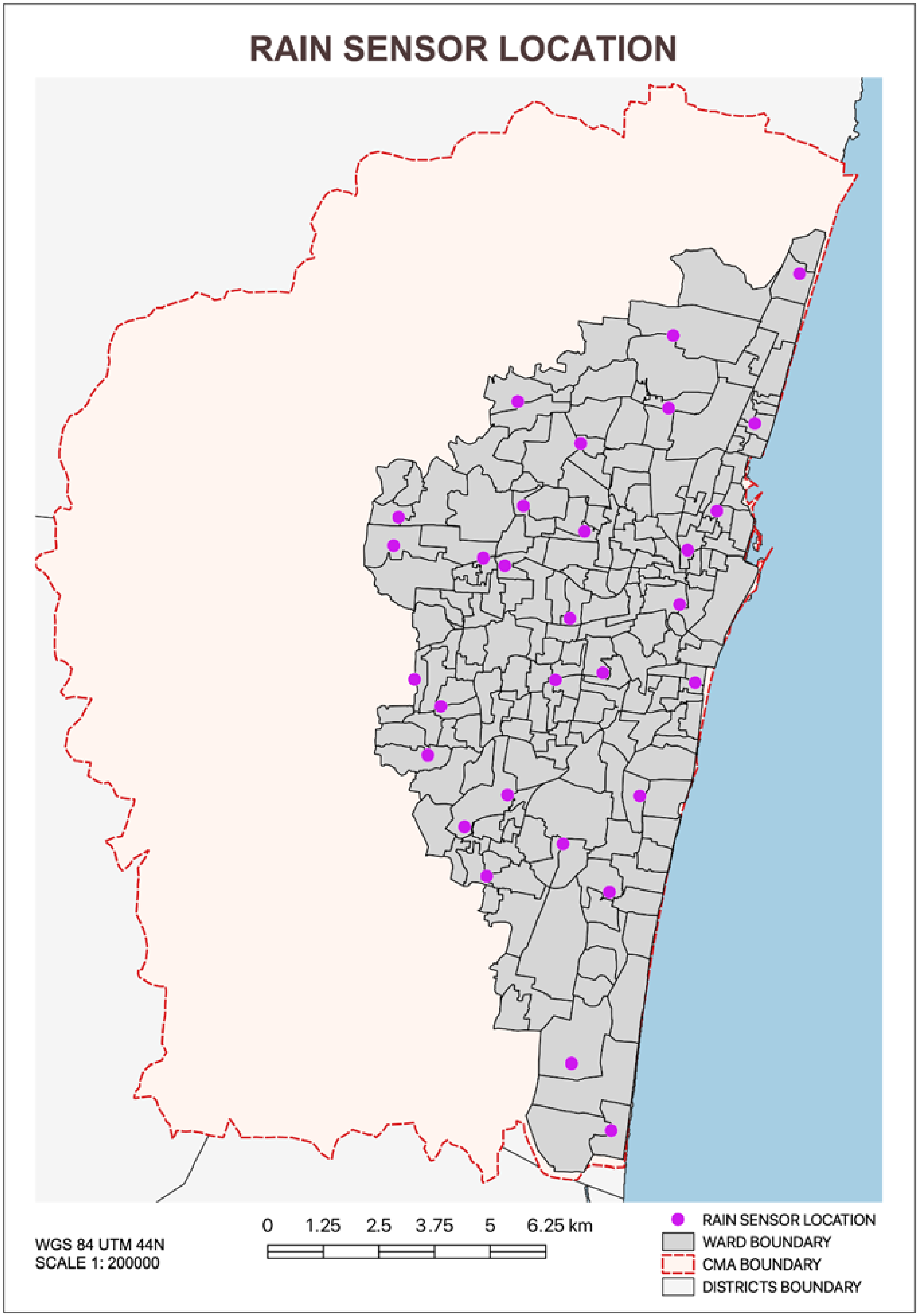

Figure – 3 Location of Rainfall sensors
Source: Author

of mitigation measures. Figure 3 and 4 shows the location of flood sensors and rain gauges.

3. Hazard analysis of Metro water i.e., a system to identify dangerous locations & data to protect machineries such as pumping stations which also involves risk analysis for the various structures.
4. State Disaster Management Agency – CRA has state emergency operations and district emergency operations.
5. PWD gives intermediate warnings to respective departments.
6. IMD has large volumes of information available and they are conducting a study with IIT on flooding areas.

Surveillance

1. Traffic police has already installed 9000 cameras for monitoring the city. All violations are captured and used as an evidence for further action.
2. Emergency call centre integration with Dial100 centre, which would help reduce the crime rate and providing a safe living space.
3. All calls related to health, disaster, etc. to be handled on 112.
4. Calls related to health (dial 108) can be done to facilitate a friendly interaction with the larger public.

Public Mobility

1. MTC, CMRL are in negotiations with vendors regarding common clearing house and common Smart card for ease of ticketing.
2. Synchronization of services between MTC & CMRL.
3. CMRL's mobile application development shall help reduce the queuing time for the commuters.
4. Level of data sharing between agencies to be detailed.
5. 5. New traffic signals (standalone) are being installed by traffic police at various locations.

Environment and Pollution

1. CAAQM at 4 locations provide the environmental status at the locations. This was implemented along the industrial estates to keep monitoring the level of pollutants.
2. CARE Air is another application to note the air pollutants.
3. Online noise monitoring at 10 locations is installed to monitor the noise levels, where alarms go off and warnings are sounded.
4. CRZ – High tide and low tide – Based on surveys conducted the details are noted, and any and every activity is regulated and controlled in this zone.

Connectivity

1. TACTV is working on providing WIFI Hotspots, Tamil net (they are going to become an ISP provider for government agencies), Common Service Centres, Cable TV Infrastructure (Approximately 5 lakh connections) & Alert Management (using the Cable TV)

2. CMWSSB provides Network, Bandwidth Sharing & Data Sharing for fluent network.
3. ELCOT has started a second Data Centre & TNSWAN Bandwidth sharing, which exists at all of their offices.
4. Highways have application sharing and road management systems, such that all the vehicle and passenger details are monitored.
5. Tourism App – Pinakin provides effective means to manage tourism.

Solid waste management

1. Integration of CDAC Dashboard- SWM, Revenue, CMWSSB
2. Geo-fencing & Mapping of Bins
3. Monitoring of Kodungaiyur and Perungudi garbage dumping grounds.
4. Establishment of Waste to Energy plants.
5. Secondary collection is monitored.
6. Grievance Redressal – SWM

GIS

1. Base map (1:1000 scale) for road network that is already available with TANGEDCO. GCC study on property survey and utility mapping using GIS is being done – EE (GIS) TANGEDCO /EE (GIS) GCC.
2. All assets of TNEB (underground/ over ground/ consumers) are already available in GIS format - EE (GIS) TANGEDCO.
3. AutoCAD drawings of CMWSSB for all water/ sewer lines in core/ added city areas available. This is to be upgraded to GIS layer - EE (GIS) CMWSSB.
4. Disaster relief points with GPS co-ordinates available with GCC - EE (GIS) GCC
5. All GCC assets with GPS co-ordinates available - EE (GIS) GCC.

Energy

1. TANGEDCO has SCADA data but no sub-SCADA data, at best they have sub-station data.
2. GCC stated that out of 6000 LED street lights scheme, about 4228 were already in place and only 1772 were remaining to be installed.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

From the site visit to command-and-control centre on 27th April 2022, one learnt the purpose of the control centre in Chennai city and how it plays a vital role in functioning of the city. They look into the various aspects, sectors and monitor them 24 x 7. The entire team stationed there is at the helm of CCC and the outcome is the accountable data which is most required for the city.

Environment

The dashboard of CCC assists in monitoring the environment. Through the installed IOT device, the temperature, humidity, windspeed and noise levels are recorded. This recorded data is then categorized as

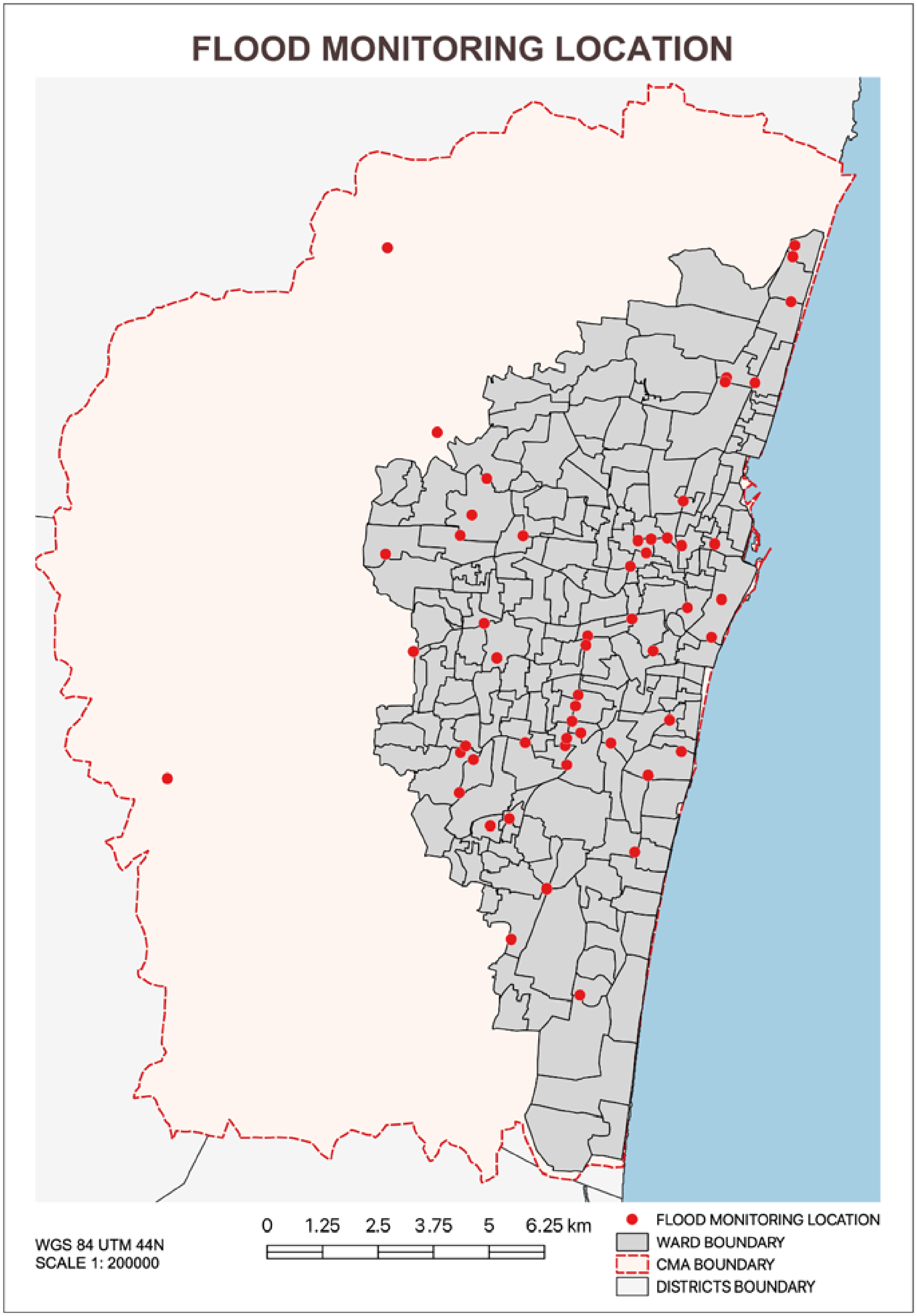

Figure – 4 Flood monitoring locations
Source: Author

good, satisfactory moderate, poor as per the AQI. Smart environment sensors will enable the citizens to keep a check on their endeavours which impact environment and enable the city to take remedial action if required.

These environmental sensors can also be connected via 3G or 4G wireless networks. This is monitored 24x7, and the recorded readings are reviewed frequently. Any malfunctions in the device or readings are sorted immediately. This greatly helps to recording the changes in different environmental factors. The readings are very peculiar that it provides the type of pollutant and their range. In terms of raise in pollution levels, actions are taken in that particular location. Thus, environmental stability is maintained.

Rainfall

The rainfall sensors provide the rainfall in millimetres (mm). The locations of installed rain gauges mapped is shown in the figure – 3. The information is shared with IMD, especially at times of flood, this sensor is helpful in taking effective mitigation measures throughout the city.

Flood

The flood sensors are implemented at various locations (refer figure – 4) along with a rain gauge. These flood sensors give an alert to the CCC when the water level rises. The CCC can monitor the level of water and accordingly precautions could be taken in that particular area. The device is located along the subways, canal, and lakes. Any increase in water level is measured and following actions are made based on the intensity of the rise in water level. The CCC keeps record of the weather changes and provides warnings to the disaster-prone areas to evacuate people. The figure – 3 shows the locations of installed flood sensors. Apart from Chennai CMA area, two sensors are located along the Chembarambakam and Poondi lake.

Figure Dashboard of CCC shows the flood sensors at different locations and its risk level. The alarms at emergency call are recorded and immediate actions are taken at times of flooding. They also keep a record of previous flood emergency calls and solved tasks.

Storm Water Drain

The 210 water bodies in Chennai are monitored and their status is checked periodically. Based on the schemes, the construction process (scheme wise) progress is monitored. Zone wise ponds and lakes, total number of temple lakes are noted and maintained without polluting them. The area around the water bodies and the activities are regulated and monitored.

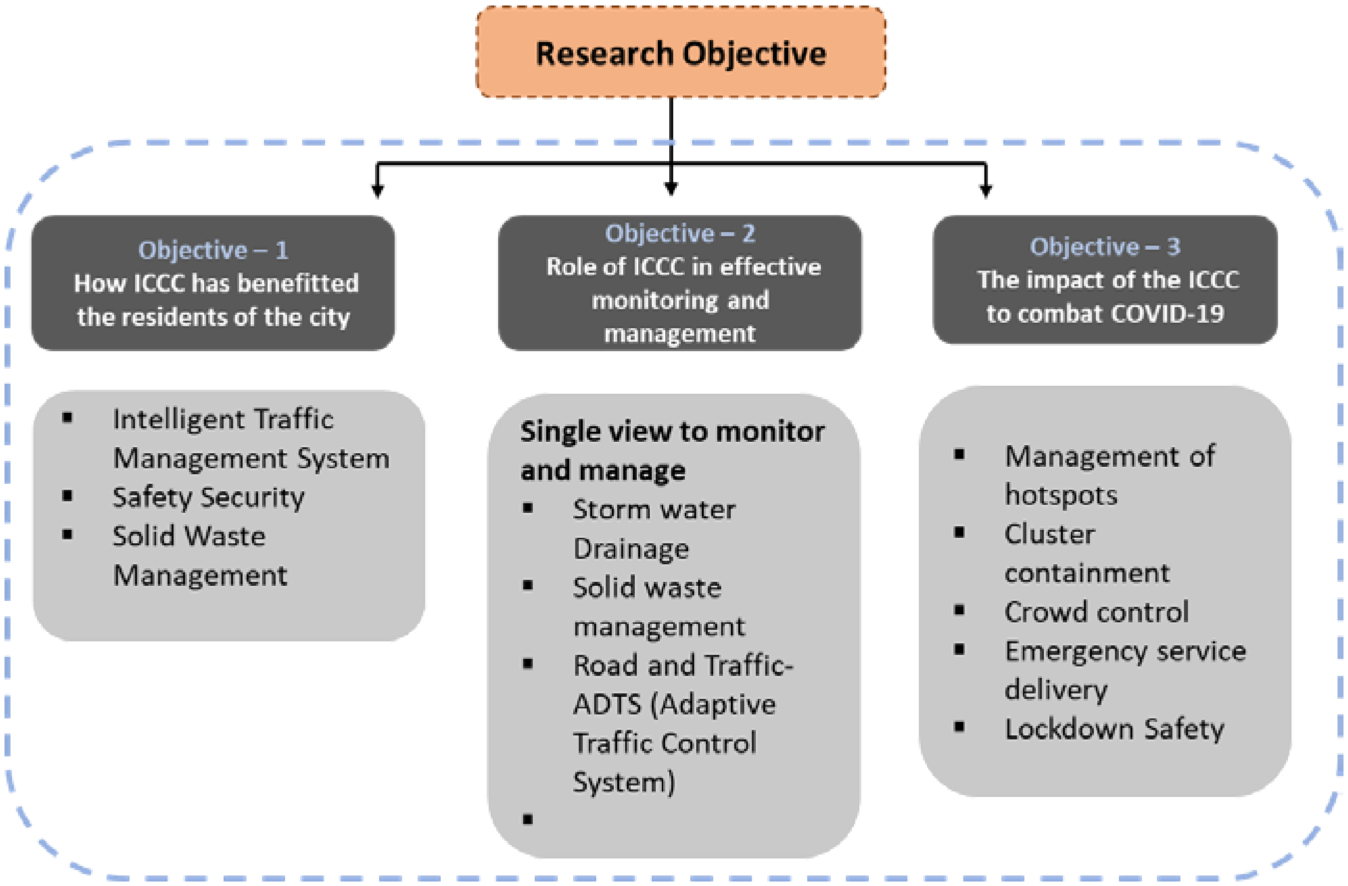

Figure – 5 SWM locations
Source: Author

Surveillance

Ease of access to all locations, especially remote and unmonitored by city surveillance systems. Identification & Integrating with Existing infrastructure such as, Malls, Hospitals, Schools College, Bus Terminus, Traffic Junction police, temples. Surveillance integration can be explored existing public transportation systems such as Metro rail, southern railway, etc..

Police requires surveillance feeds from at least 50-75 metres radius from every police station. Toll Plaza vehicle monitoring is already operational; feeds from the Highways may also be routed to the central place which would aid in tracking of theft vehicles / crime investigations etc..

WIFI

RFP has already floated for a City-Wide WiFi to commission at up to 300 hot-spots locations across the city.

TACTV has already chosen the vendor through an Open bid system and have agreed to setup up to 100 WiFi hot spots. The funding for this is to be done via CSCL to TACTV who in turn would get this commissioned through their vendor

Solid Waste Management

The ICT based SWM system will involve setting up of garbage bins along with RFID tags and RFID reader (vehicle), GPS device to track vehicle location in real time and automate the waste pickup process based on the sensor inputs which would help in reducing operation and maintenance costs besides managing routes and vehicles dynamically through an automated system. Figure – 5 shows the locations of SWM cameras installed to monitor the SWM activity throughout the city.

Real time monitoring of garbage collection points, efficient management of waste collection bins and route optimization shall help in reduction of trip time, fuel saving and serving more locations by effectively reducing human intervention in the monitoring process. It maintains history of vehicle routes, attended sites and other details. Integration of the dumping ground and transfer station facilities with the centralized locations, reporting of vehicles, garbage collected and other SWM details to higher authorities from any location at any time is also carried out. Daily monitoring and tracking of the activities of field staff force is also ensured.

Dump yard

Integrate the dumping ground and transfer station facilities with the centralized locations was the primary challenge for CCC monitoring. This entire process is seen on the Dashboard of CCC. For the dump yard at kodugaiyur and perugudi where the total collection at the land fill is measured zone wise. The debris collection and the segregated waste are also measured and recorded.

Street light

Integrated energy efficient Smart LED based street light system already exists under the Smart City mission. It is envisaged to have features such as automatic On and Off for controlling the LED luminaries. The same is proposed to be integrated with the CCC. Enhanced power savings due to efficient light technology, adds to the carbon credit of the city. It reduces the inefficiencies that exist in regular street-lights, such as staying off during night time or vice versa. They allow for centralised coordination of street lights system, wherein the luminosity can be reset.

The smart lighting system should be such that it is able to communicate the system issue or failure to the centralised Lighting Operations Management software.

Parks and open spaces

The parks are classified as neighbourhood, community and city. Apart from parks, play fields are also monitored. The pollution levels in the parks and playfields are also recorded and maintained.

Street parking

The Parking Guidance System shall comprise of components such as magnetic cum optical/magnetic cum Infrared, magnetic loop sensors for vehicle detection, level/zone display, bay finders, light indicators, electronic directional displays, map-based guidance system, etc.. The system caters to all types of parking lots envisaged such as on street and Off-street parking along with temporary parking and limited hour parking.

Live parking status for both two-wheeler and four-wheeler are tracked. The occupied spaces are monitored and priced on hourly basis and the rest of the slots are available zone wise.

Smart pole

The Smart Pole is a project to enable greater connectivity between the citizen and the government via provision of telecommunication services in a public arena. The primary function of the smart poles, which as shown in Figure 6, will be to provide street lighting, mobile broadband infrastructure, Wi-Fi hotspot services, Active Geo location transponder for location-based services and surveillance cameras. These facilities will be connected to the central command and control centre, from where it will be constantly monitored and managed

Digital signage

It allows the user to publish specific messages for managing traffic and disseminating general informative messages. DSB will enable the authority to communicate effectively with citizens and also improve response while dealing with exigency situations. These will also be used to regulate the traffic situations across the city by communicating the right messages, to the right people at the right time.

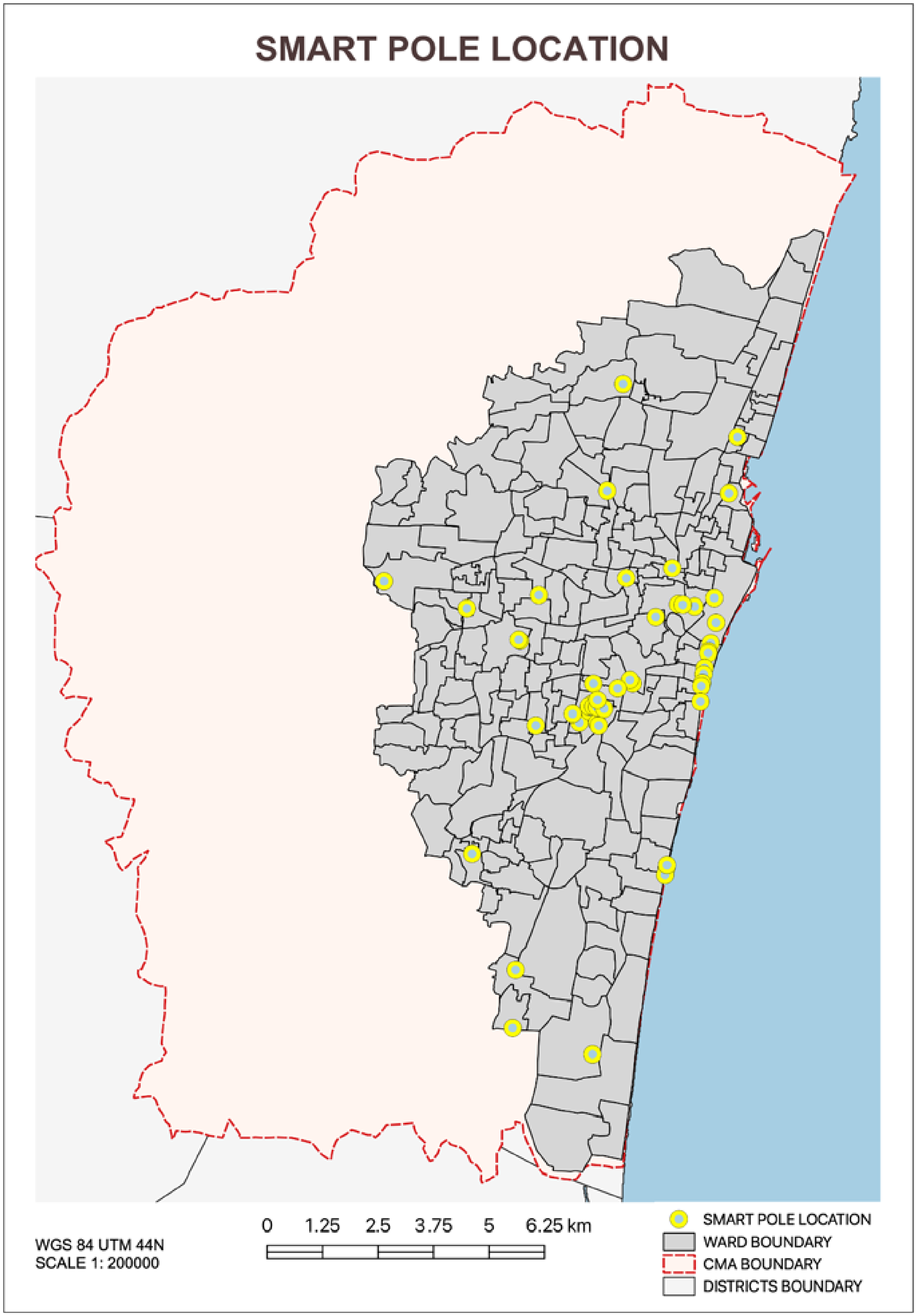

Figure – 6 Map Showing Smart Pole Locations
Source: Author

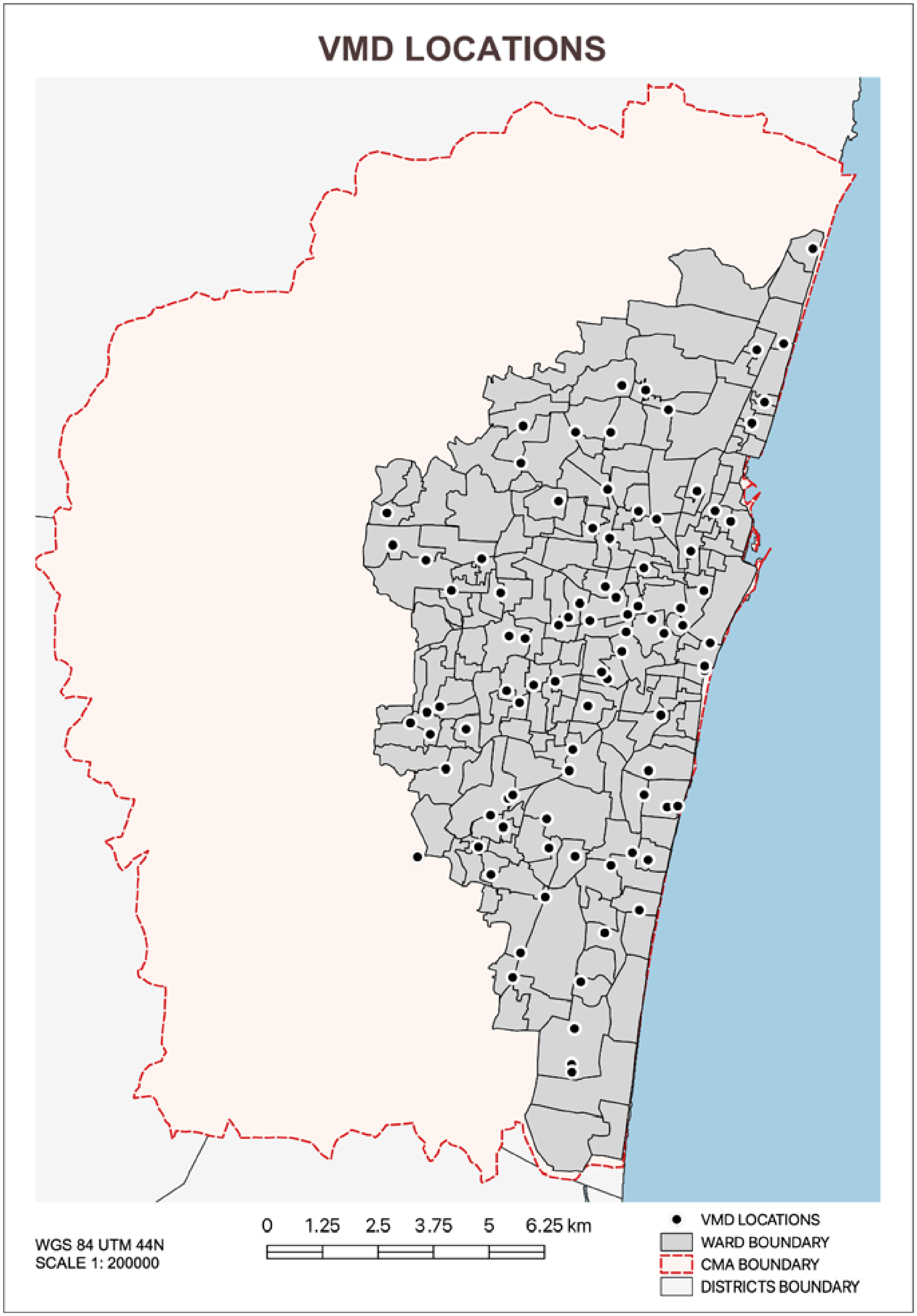

Figure – 7 Map showing VMD locations
Source: Author

Property Tax
The CCC also monitors the taxes such as property tax, land tax. Based on the assets type, the zonal, ward, village and taluk wise total extent of the tax ambit is monitored.

Health And Education
Integration service is envisaged in the proposed CCC so that the Hospital DB would be available on request through the web interface. Enhanced preparedness for any sort of possible medical emergency can be done. The Dashboard of CCC for health facilities, education facilities, the student teacher ratio, schemes beneficiaries are been monitored.

3. DISCUSSION AND CONCLUSION

The ICCC interconnects various departments with each other and the exclusive command centre monitors them at all time, it is a place that would show the entire functioning of Chennai city. Figure – 8 shows the stakeholders involved in ICCC.

3.1 Implications

The very use of such hi-tech equipment to understand public welfare shows how revolutionary this innovation is for Chennai. The routine usage of this technology will help understand the needs of the citizens better thus increasing efficiency. As with any other technology, this Command & Control Centre shall extensively save human efforts of the GCC officials.

3.2 Limitations of the research

The study depicted is solely based on the different modules implemented in various parts of the city and its functioning and how the integrated command center serves the city.

3.3 Key lessons learnt

The Integrated Command and Control Centre (ICCC) acts as the central node for operations management, day-to-day handling and processing the various functions of the city.

It also provides insights by processing complex data sets at an aggregated level to derive intelligence and solutions for improved planning and policy making.

The ICCC is envisaged to aggregate information from across multiple applications and sensors deployed across the city, and then provide actionable solutions with appropriate visualization for decision makers.

3.4 Recommendations

a. The command-and-control centre is considered to be the core for managing disasters, respond to inconsistent conditions and manage various operations in a city. Though Supervisory Control and Data Acquisition system could be more beneficial.

Supervisory control and data acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes, which can be incorporated with different sectors. This technology could be more useful for a city like Chennai. It makes it easier to find the hurdles within the city and in any body. For example, this would be a relief in times of flood in monitoring the storm water drain. Such that the malfunctions could be identified and rectified immediately.

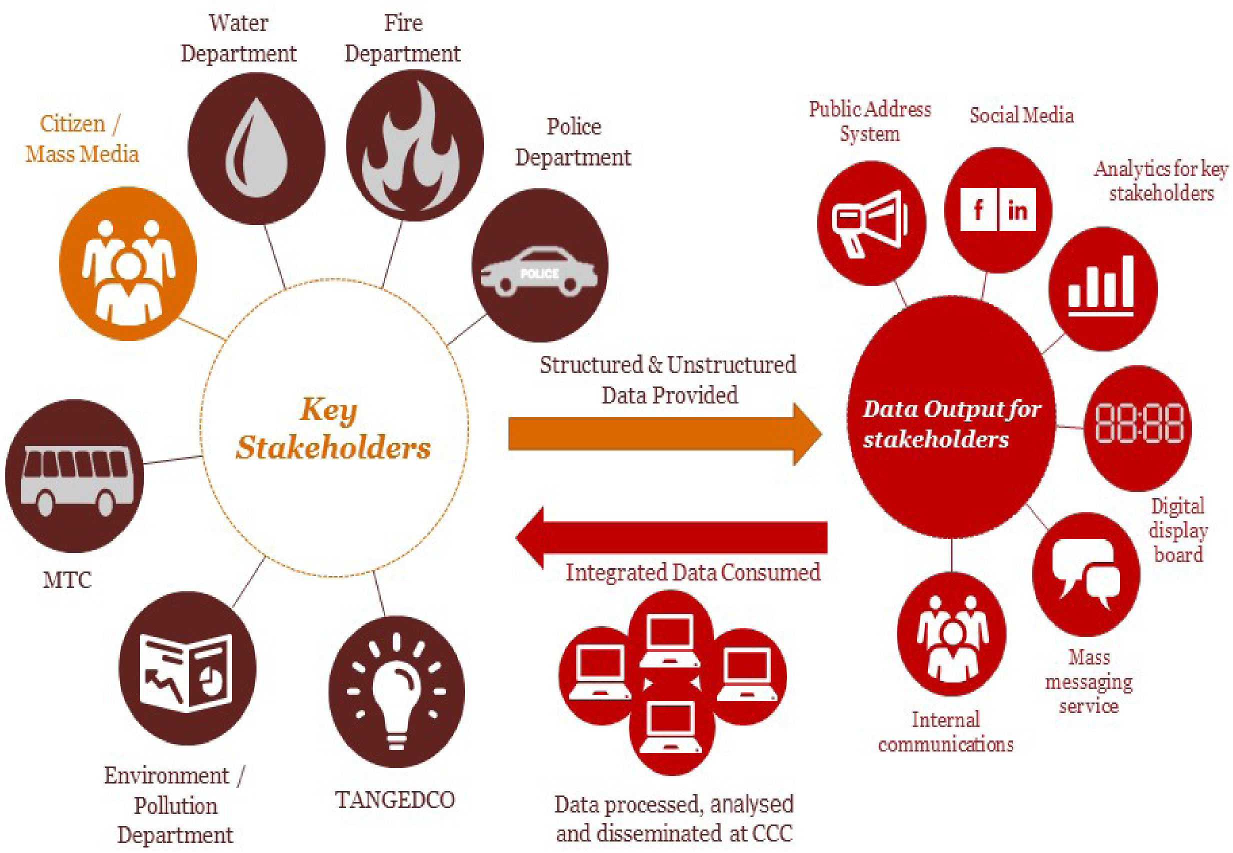

Figure – 8 Stakeholders involved in ICCC

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A12

Urban Street Scaping Of Main Road From Sarpavaram Junction To Balayogi Statue Junction As Smart Street Under Smart City Mission

Name of the project: *Urban Street Scaping of Main Road from Sarpavaram Junction to Balayogi Statue Junction as Smart Street Under Smart City Mission*
Location: *Kakinada, Andhra Pradesh*
Year of Project Implementation: *2019*
Sector: *Urban Mobility / NMT*
SDG: *. SDG 3, SDG 8, SDG 11, SDG 15, SDG 17*

Project Cost: *Rs 98.70 crores*

Institute: *Dept. of Planning, Anna University*
Advisors: *Dr.K.Pratheep Moses , Mr.P.Sudharsanamurthy, Ms.K.Madhivadhani*
Students: *Abiraami V, Swetha P*

Keywords: *Smart Roads, Urban Mobility, Urban Streetscape, Non-Motorized transport, Pedestrian*

Abstract:

Urban streetscaping project undertaken by the Kakinada smart city corporation limited (KSCCL) under the sector of Urban Mobility and Non-Motorized transport aims to improve the quality of life of the users and to improve infrastructure facilities on a long-term basis. Non-motorised transport (NMT) is often a key element of successfully encouraging clean urban transport. It can be a very attractive mode of transport for relatively short distances, which makes up the largest share of trips in the city. The key is to reverse the trend from increased private vehicle use to making walking and cycling attractive, besides improving public transport. This can be done by a range of activities including construction of sidewalks and bike lanes, bike sharing programmes, urban planning and pedestrian-oriented development. Smart roads if properly established would help a city thrive physically, socially and economically.

Smart road project undertaken by the KSCCL pursues to satisfy people from every strata, no matter the age or gender. The project solves both technical as well as social issues faced by the community. In the city of Kakinada, Smart Road acts as a link in connecting all varieties of spaces, like Public & Semi-public spaces, Recreational spaces etc., together. The paper specifies the advantages, issues, risks and challenges faced by all the stakeholders during various phases of the project and also anticipates the key highlights and innovative design strategies of the project. Topographic, Traffic and Inventory surveys were carried out to understand the existing scenario and various alternatives have been evaluated to arrive at the finest design strategy suitable for the city. The strategies include all kinds of modern technologies that are relevant to the current situation such as CCTV surveillance, Free Wi-fi etc..

Case Study: A12

1. Introduction

Kakinada is a port-based city in North Eastern part of Andhra Pradesh. The city is fourth largest by area (31.69 sq. Km) and fifth largest by population (3.12 lakh) in the state of Andhra Pradesh. It was also the origin point of Buckingham Canal where goods used to be transported by boats during the British era. It was once a home for Asia's largest sea port. The city lies along the sea with the Bay of Bengal and the Hope Island on the east. This island naturally acts as a barrier and protects the city from cyclones and tsunami effects which also serves as a tourist spot.

Kakinada is a town with a municipal corporation status and is also the headquarters of East Godavari district. The town has a potential to provide opportunities in the field of educational, health and other sectors of economy (like port-based, Industries etc.,) which has attracted people from various parts of the state.

The road network of the city is homogeneous in nature i.e. they have dedicated roads for specific uses. It used to have more than 15 Cinema theatres along a road, for which it has a dedicated road named Cinema Road. It also has a dedicated road for temples known as Temple Street. Kakinada was one of the 109 cities selected for the Smart City Mission introduced by the Ministry of Urban Development in 2015. In 2016, the city was selected as the 14th city in the top 20 smart cities from all over India.

Figure – 1 Phase of Smart Street Project

1.1 Topic and Context

Kakinada city is well-known for its well-established connectivity. Road network is very vital for a port-based city, as these cities plays a major role in connecting other towns and cities of the state. This is one of the main reasons for the Kakinada's Smart City Corporation to consider Urban Streetscaping, a component under Urban Mobility and Walkability. The Smart Road project has been successfully executed on one of the city's main Arterial roads of the city i.e. from Sarpavaram junction to Balayogi statue junction.

The Smart Road project is taken up in two phases, as elaborates in Figure 1 below. Phase I has two components i.e., the road from Sarpavaram junction to masjid junction and the road from MSN Charities to Balayogi Statue junction. Phase I, as a whole, cover about 5.9 kms. Phase II includes the road from masjid junction to MSN Charities, which covers a length of about 2.1 kms.

Phase – I : Road from Sarpavaram junction. to Masjid Junction. (5.10 kms): Msn charities to Balayogi statue junction (0.8 kms)

Phase –II: Road from Masjid junction. to MSN charities (2.1 kms)

The two stretches, that are to be taken up in phase I, are required to have a road width ranging from 19 meter to 26 meter. This enables comprehensive upgrading of the right of way (ROW) of the stretches, totalling to a length of 5.9 Kms. The entire stretch consists of 12 road junctions. The 8.0 km stretch has been chosen based on the importance of the road in the entire city. This stretch not just acts as a main arterial road, but as one the important links, that connects various activities of the city together. This connection includes Vivekananda Park, Eat Street, Cinema Road, Temple Street, Market Road etc..

1.2 Significance of the project

It is evident from numerous studies on pattern of human settlements, that roads are the backbone of any development. People tend to settle along the road network or water bodies as these two form an integral part of any human settlement. Looking at Kakinada's Road network, it is proven that this 8 km stretch, that connects the Sarpavaram junction to Balayogi statue junction is one such important road that further connects various other significant roads like, Cinema Road, Eat Street, Temple Street, Market Road etc.. Upgradation of this road not just improves the connectivity, but also decreases the traffic congestion and accidents. The project also includes non-motorized transportation by providing walkways and cycle tracks. Smart Roads focuses on prioritizing the public transport, improving traffic flow at highly congestion intersections, reducing accidents, supporting recreational activities and efficiently managing parking.

Before the implementation of the project, Kakinada city is characterized for its inadequate transport infrastructure for pedestrians and non-motorized transport users. Only 10% of the citizens of the city use Non-Motorized Vehicle. This is because, the majority of the roads doesn't have footpaths. This project not just focusses on visual changes, but also on the utilitarian changes like, free wi-fi, CCTV surveillance, underground electrification, etc..

1.3 Aim and Objectives

The aim of the study is to understand and analyze the impact incurred from the implementation of the smart street project.

The objectives of the study are:

a. To understand the outcomes of the project
b. To study the impact of project implementation.
c. To obtain knowledge about the issues faced and study the tactical strategies adopted to overcome them.
d. To check the replicability of the project in other cities

2. Contextual Background

Kakinada town has four arterial roads as shown in Figure 1, namely Main Road i.e., Smart Street -1 (Sarpavaram junction to Balayogi statue) cinema Road, Temple Street, Wharf Road, Nukalamma Temple Road, Rajahmundry Road, R&B Guest House Road, Town Station Road, Gandhi Nagar Road. The Area-Based Development area has three major arterial roads passing through, which are the Main Road (i.e.., Smart Street -1 (Sarpavaram junction to Balayogi statue)), Cinema Road, Temple Street Road.

These arterial roads are presently the most important roads connecting the project area to all other parts of the city. The main road is purely commercial in nature, the cinema road is so named as all cinema halls are located on this road, Temple Street has temples & Jewellery shops. These 3 roads are parallel to each other and are interconnected by a number of cross roads. There are various Collector Roads emerging from the Arterial and Sub-Arterial Roads which serve the Project Area. The city is well connected with rail and road networks. The city has long distance bus services, but lacks in intra-city transport systems. The city at present does not have any organised public transport system. Most of the citizens use private vehicles (mostly cars and motor bikes) or auto rickshaws to commute. As the city (with low density) expands laterally, commuting distances increases and citizens become more dependent on private vehicles for their mobility needs.

The city is desirous of developing a public transport system in the long term and while that intention is welcome, the private vehicles already owned by the citizens will remain in use till their operating lifespan and adequate provisions will need to be made for them. To tackle the growing congestion leading to unorganised and unregulated encroachment cause by parking on the road space, Kakinada proposed Smart Street which would promote non-motorized transport system.

2.1 Existing Situational Analysis

Existing situational analysis is important as it helps in detailed understanding of the environment in which the plan is to be delivered. Feasible solution should rely on better understanding of the context.

2.1.1 Climatic Condition

Kakinada is a coastal town, having an elevation of 2 meters and many parts of the city are below sea level. The city is prone to cyclones and has problems with its natural drains. Due to the inevitable occurrences of natural disasters, the overhead electric cables get severely damaged and the cost of restoring them is each time is a big financial burden. People inadvertently suffer from power interruptions during every monsoon.

2.1.2 Street Network Pattern

Kakinada is a small town having a linear street network, with all the activities concentrated on either side of the road and the new development takes place in the lateral direction having the main road as its spine. Similar types of activities are concentrated on particular stretches of roads, thereby the roads in Kakinada get their names from the activity that is being carried out there. The core of the city lies around the main road from two town junction till Jaganathapuram Bridge.

The most populous streets are Temple Street (from Mahindra Complex to Sivalayam Junction), Market Street, Cinema Road (from Pantam Circle to Jaganathapuram Flyover Approach Road) and Main Road (from Town Police Station II to Jaganathapuram Flyover). Review of city-level documented data and conducting interviews of Municipal officials and traffic police officials, it was understood that the CBD area consists of the cinema road, main road and the Temple Street. ICLEI conducted a survey of approximately 400 users, to understand the travel patterns and attraction spots to figure out the parking management requirements and strategies.

From this data it is evident that the CBD attracts lots of trips and this results in heavy traffic congestion, accidents, increased requirement of parking spaces. A smart street would be beneficial in mitigating these issues.

2.1.3 Pressure for Parking Spaces

On street parking pressure, has become compelling in the CBD area. About 2600 vehicles are daily parked in this area during the peak evening hours on the main road. The type of vehicle that is parked depends on land utilization. Studies show that two wheelers are parked on all three roads, whereas four wheelers are mostly confined to the main road and cinema road, due to the width of the roads. During the evening peak hours, on-street parking stretches throughout the main road's commercial area from the town police station-II to the Jaganathapuram flyover. About 40-50 percent of the road stretch is covered with parking during evening peak hour.

2.1.4 Absence of Public Transportation System

Kakinada is devoid of public transportation system, and has inadequate transport infrastructure for pedestrians and non-motorized transport users. Kakinada has a planned grid road system with an average traffic speed on major corridors recorded as 12-20 kmph. 10% of the citizens use non-motorised vehicles (NMV) but more than 90% of the roads don't have footpaths. Absence of a comprehensive public transportation system has resulted in making citizens depend on 8000 auto-rickshaws or other private means of transport. It has been observed that auto-rickshaws hold a greater share in modal split, next to two wheelers.

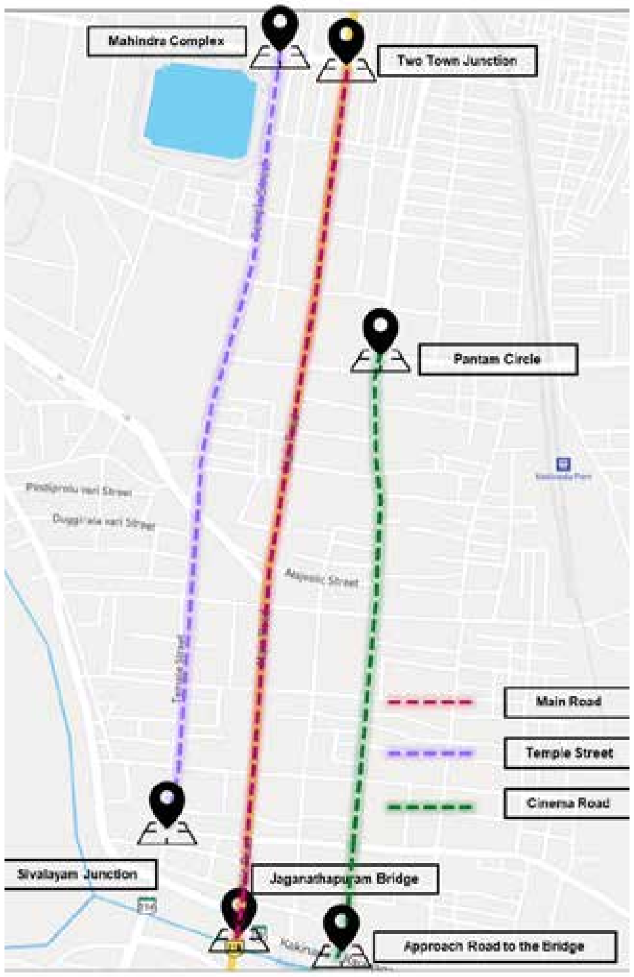

Figure – 2 Main roads comprising the CBD Area

2.1.5 Uncovered Drains

The drainage system is damaged in many places, during monsoon season the drains overflow and become a hub for mosquito breeding. Cover slabs alone are not efficient nor sufficient. Figure 3 shows the current state of the dilapidated condition of these uncovered drains and the danger that they pose.

2.1.6 Lack of Pedestrian Network

Roads are the arteries of our city; without quick and mass transportation of people to and fro, the places fail to perform their function.

The average length of the trip generated within the city is 3.4kms. Promoting non-motorized transport is feasible as the city is compact and all basic necessities are available within walkable distance. Devoid of pedestrian provisions, the citizens have to rely on other means of transport such as auto rickshaws or private vehicles. The absence of a pedestrian zone forces pedestrians to walk in the carriageway. The utility boxes which interrupt the pedestrian pathway and ever-changing levels as shown above in Figure 4, discourages pedestrians from using it.

Figure – 3 Uncovered Drains

Figure – 4 Uneven Pedestrian Surface with Obstructions

Behavioural models suggest that walking and cycling trips are influenced by attributes of the activity's origin (eg. Home, Work); the destination (eg. Park, Store); the area around the origin, and the route between these two points (eg. Roads, Sidewalks). Thereby, focus has been made to improve the condition along the ABD area.

2.2 Conceptual framework / Research design

The research framework includes the study of the project's background, context and need of the project for this particular city. This data can be obtained through secondary sources like, the detailed project report. It is important to critically analyse the implemented project. This analysis will help in identifying the risks and challenges faced during the planning, designing and execution of the project. Stakeholders meeting is needed to understand the needs and suggestions of the implementing agencies and the users. Finally, recommendations should be given, to formulate policies which can be implemented and which can support similar future developments. The research framework is shown in the figure 2.

2.3 Key features of the project

a. Providing uniform lane widths and geometric designs for roads and junctions as per street design standards.
b. Development of pedestrian walkways and cycle lanes wherever feasible - with uniform footpath widths, pedestrian friendly ways and barrier-free designs as elaborated in figure 6 and figure 7.
c. Construction of utility ducts for water, sewerage, drainage, power, gas and optical fibre cables (OFC), wherever essential – with suitable provision for O & M.
d. Provision of bus bays, auto bays and on-street parking wherever essential.
e. e.Beautification and landscaping including greenery
f. Provision of smart street furniture and public utilities such as installing communicative signages, lane marking, passenger shelters, bus stops, parking, green toilets, first aid care centres, traffic police booths, public leisure spaces etc.
g. Smart street-poles with LED lights, Wi-Fi, CCTV and various sensors as per city requirement.
h. Universal accessibility standards as prescribed by the MoUD, etc.
i. Particular focus on safety of women, children, elderly, etc.

2.3.1 Challenges in the project

a. Removing all over head cables laid by various telecommunication service providers along the 8 kms stretch.
b. Existing road from Two town Police Station to Jaganathapuram Bridge which has varying width from 56 feet to 60 feet was widened to 80 feet by acquiring private commercial properties.
c. Acquisition of 303 commercial properties by providing TDR to the tune of Rs. 212 crores.
d. Convincing people to accept TDR and hand over the property for development.
e. Resolving over 60 court litigations.

2.3.2 Risks involved in the project

a. Though non-motorized transport is ideal solution to mitigate traffic congestion and pollution, high outdoor temperature and less humidity makes people uncomfortable to use cycling and walking as a means of transport.

2.3.3 Features and Benefits

a. Underground electrification is a one-time investment which has reduced the cost of repairing the poles and wires which got destroyed during rainy season and cyclones.
b. Kakinada city has ensured uninterrupted power supply
c. The trees along the smart street provides shade and acts as an attraction.
d. Provision of free Wi-Fi poles have attracted the youth.
e. Crime rate reduction as there are more eyes on the street.
f. Government benefits economically from the advertisements.
g. Smart poles with 450 CCTVs have ensured safety for women and children.
h. h.No trees were removed during project execution
i. Dedicated and earmarked parking zones have

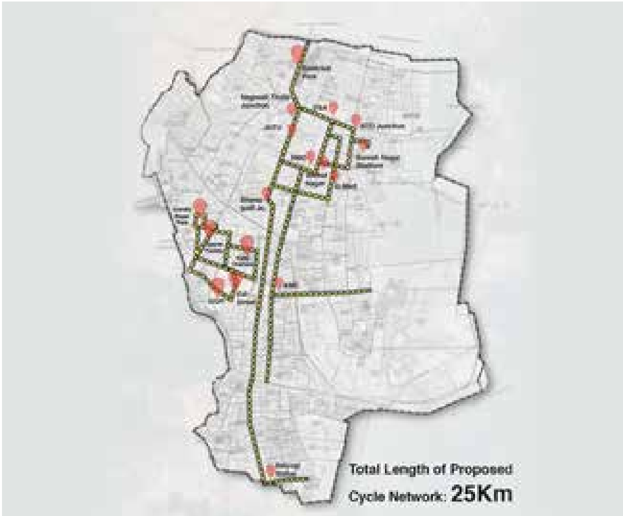

Figure – 7 Proposed Cycle Network

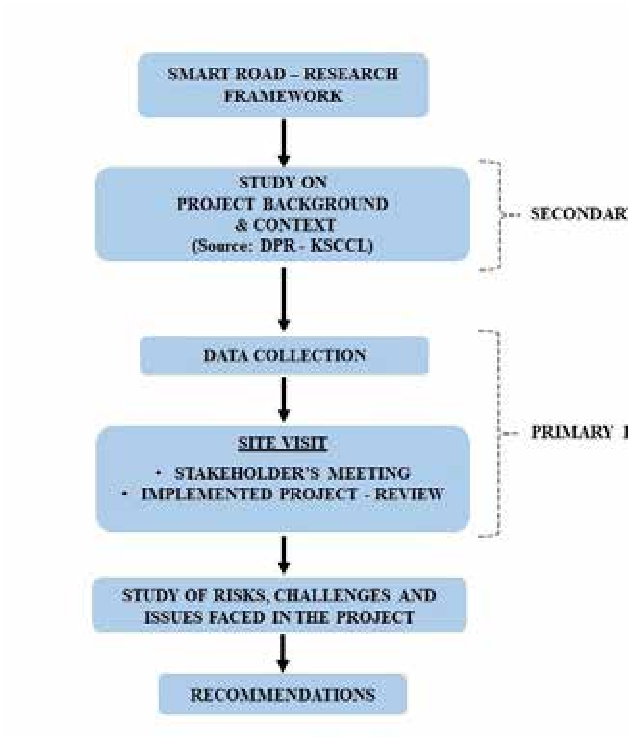

Figure - 5 Research framework

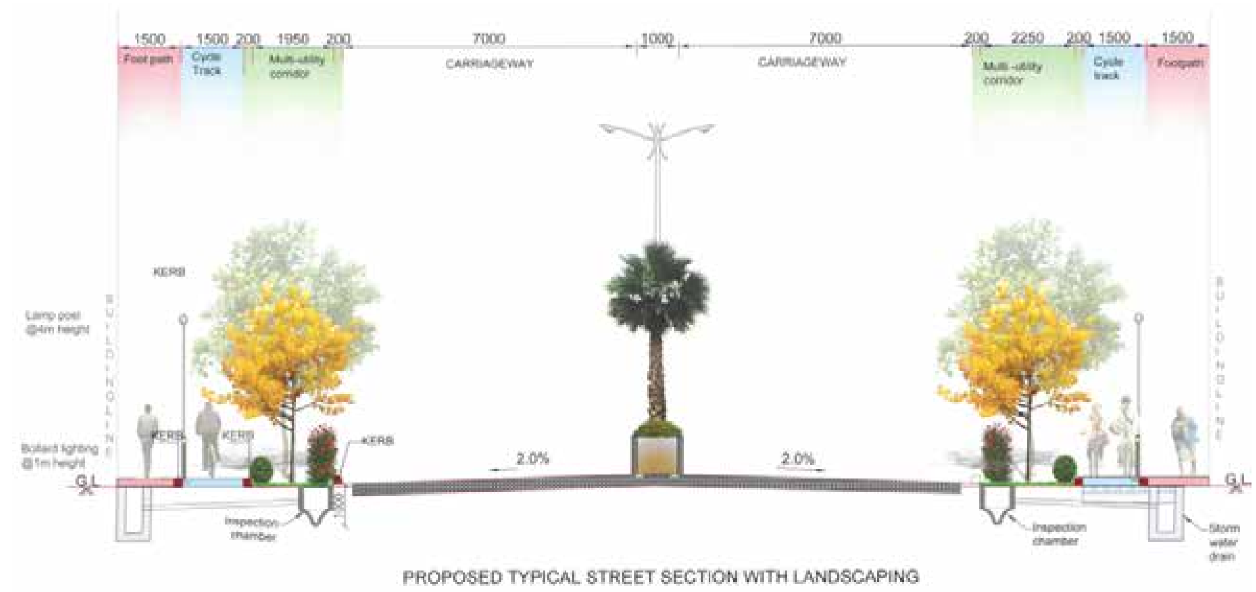

Figure – 6 Cross Section of the Proposed Smart Street reduced improper on street parking.

j. Improved aesthetics of the streets and its surroundings.
k. These attractive streets have improved the viability of the commercial component along them.

2.4 Key findings from the interviews, surveys, and primary/secondary data collection

Surveys and stakeholders' consultation were done on site and the outcomes are as follows:-

a. As the main road is entirely occupied by commercial properties, the smart street has significantly increased the customer footfall.
b. The vehicles are parked in the demarcated zone and people are satisfied with the smart street which can be assessed from their willingness to pay the parking fees.
a. Stakeholders are satisfied with the underground electrification system as it has provided uninterrupted power supply ever since the execution of the project.
b. People are slowly leaning towards non-motorized transport system options for transportation; this is evident from the involvement shown by the people on the Worlds Bicycle Day.
c. Dedicated cycle track has made the track free from hawkers.
d. Demarcated hawking zone along the east street project has attracted people to a greater extent.
e. Uniformly levelled, obstacle free footpaths are encouraging people to walk more.
f. Parking survey was carried out for a stretch of 100 metres. Figure 8 shows the findings of this survey, such as that bikes consist of a majority in the share that is competing for parking space. Provision of demarcated on-street parking has made the streets traffic free. This in turn has ensured increased footfall on this road stretch.

2.5 Before and After Execution of the intervention

Following Figures 9,10,11 are the before-after pictures of Sarpavaram Junction, Bhangudi Junction, Boat club showing the transformation that these road stretches underwent.

3. DISCUSSION AND CONCLUSION

3.1 Implications

With advancement in technology, the roads and transportation systems too have to take on a new form in order to exist in the long run. This has resulted in rapid transportation system, private vehicles, traffic congestion, air and noise pollution. In order to counteract all these effects, short trips should be made non-motorized so as to reduce the impact. Smart street is one such project that has so several ecological, social and environmental benefits.

3.2 Limitations of the research

The study focuses on the aftermath effects of the implemented project, it scrutinizes the economic, social and environmental and ecological benefits of the project. The study is limited to impact study rather than evaluating the design proposals.

3.3 Key lessons learnt

a. Smart Street project is ideal for cities having linear road network patterns and all such activities are concentrated within the CBD area.
b. Underground electrification is an effective proposal that can be used for coastal cities that are prone to cyclones and flooding as it has considerably reduced maintenance cost of electrification.
c. In many places NMT has been introduced with high success rate. Here too, as the pedestrian network is connected all the trip generating places, the success rate has been high.
d. Despite providing pedestrian facilities, outdoor thermal climate acts a driving factor for the usage of non-motorized transport.
e. Proper provision of parking spaces makes people willing to pay.
f. In order to remove hawkers permanently from occupying the pedestrian area, a proper hawking zone has to be carved out, which was successfully demonstrated in Kakinada.
g. Cycling track have to be demarcated clearly in order to be used for its allotted purpose.

Figure – 8 Analysis of Parking Survey along the Main Road

Figure – 10 Before and After Execution Pictures at Bhangudi Junction

Figure – 9 Before and After Execution Pictures at Sarpavaram Junction

Figure – 11 Before and After Execution Pictures at Boat Club

h. TDR is one such effective tool that eased land acquisition.

3.4 Recommendations

The government can effectively monetise the parking in

Figure – 13 Willingness of people to pay parking fee

order to break even the construction and maintenance cost. People's willingness to pay the parking fee was surveyed and the results turned out to be surprising. Being the commercial hub in the city, this place attracts many privately owned vehicles from the surrounding suburbs. The major concern shown by the vehicle owners was the need for assured space and security. With proper parking arrangements, CCTV camera, distinguished spaces the owners agreed to pay more for supervision of the vehicle.

Even though cinema road attracts comparatively lesser parking demand, the respondents showed willingness to pay between Rs. 10-20 per hour due to the nature of land uses along the road stretch. Temple Street being religious hub and centre for jewellery shops in the city, attracts all type of vehicle users. Survey results show that parking demand in this stretch is as equal to that of main road. Currently most car users tend to park in the adjacent sub-arterial roads and over sixty per cent are willing to pay over Rs. 20 per hour for safe and organised parking. Overall majority of the two-wheeler commuters agreed to pay between Rs. 5- 10 per hour and car users agreed to pay over Rs. 10. The common concern observed across all respondents was security.

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A13

Socially Smart Bhubaneswar

Name of the project: *Socially Smart*
Location: *Bhubaneswar, Odisha*
Year of Project Implementation: *2017*
Sector: *Smart City Mission*
SDG: *SDG 1, SDG 3, SDG 4, SDG 5, SDG 6, SDG 11*

Project Cost: *Rs. 4.76 Crores*

Institute: *IIT-Kharagpur*
Advisors: *Prof. Subrata Chattopadhyay, Prof. Haimanti Banerji, Asst. Prof. Arjun Mukerji*
Students: *Piyush Chandrashekhar Gharat*

Keywords: *Quality of life in slums, slum infrastructure, youth engagement, community-driven mapping, women and child health, training and capacity building, self-reliance, empowerment*

Abstract:

The Socially Smart Bhubaneswar programme, initiated in 2017 under the Smart City Mission, intends to bring people, especially vulnerable population groups, and their needs to the centre of urban development. This initiative promotes people-centric interventions focuses on the most marginalised through the engagement of youth, especially women and girls. Some of its engagement strategies included - 'youth engagement in educational institutes', 'youth engagement in urban slums,' and 'convergence and collective action'. The focus is on (i) Promoting volunteerism, (ii) Maintaining linkages with government programmes & schemes, (iii) Empowering girls/women, (iv) Linking youths with skill development, (v) Emphasis on gender issues, (vi) Imparting self-defence training to adolescents girls, (vii) Suggesting themes for the interventions in educational institutes, (viii) Promoting gender equality, (ix) Empowering youth to end violence against women, (x) Promoting healthy life.

This programme launched in partnership between Bhubaneswar Smart City Limited (BSCL), Bhubaneswar Municipal Corporation (BMC) and the United Nations Population Fund (UNFPA) is implemented at the ground level through the NGO 'Humara Bachpan Trust'. The project that was piloted in 8 slums increased to 24 and then 100. The residents are given education and training as well as material assistance to resolve the issues mainly aligning with the core elements of the Smart Cities Mission of Government (BSCL, 2022). The Socially Smart Bhubaneswar Programme has been linked with other initiatives under Smart City Mission and BMC like 'Citizen Connect Initiative' and affordable housing projects which have helped the programme gain momentum through synergy. This research studies and documents various aspects of the programme through field visits and interviews, while relating it to similar national case studies. The key findings are expected to help in bettering the programme, as well as in planning and implementing similar kinds of initiatives for other cities.

Case Study: **A13**

1. Introduction

The Smart City Mission is an initiative of the Government of India to drive economic growth and improve the quality of life in urban areas by enabling local development and harnessing technology to create smart outcomes for people (UNPFA, 2019). Bhubaneswar bagged the record of becoming the first 'Smart City' in India under this mission. Along with technological aspects of smartness, social aspects were also considered for Bhubaneswar's development through which the city became the first child-friendly smart city. The Socially Smart Bhubaneswar programme, a partnership between Bhubaneswar Smart City Limited (BSCL), Bhubaneswar Municipal Corporation (BMC) and the United Nations Population Fund (UNFPA), specifically addresses the vulnerable population groups, and their needs and integrating them into the mainstream urban development process.

1.1 Topic and context

With 365 million young people (10-24 years), India has the world's largest young population and has a huge demographic advantage in harnessing their energy and creative potential. As urbanisation is emerging as a global platform for accelerated development, states need to recognise girls and boys as critical agents of change. Young people needs to be involved in policy-defining processes affecting urban infrastructure, social protection, and opportunities to ensure cities become places of safety and opportunity. People-centric programme for making a city 'socially smart city' is an initiative which takes cognizance of the needs of the young people and other focused groups in the context of prosperity, safety, equity and sustenance by transforming the cities through improved infrastructure, technology, economic drive and quality of life for people (OMMCOM News, 2021). The 'Citizen Connect Initiative' launched by the Bhubaneswar Municipal Corporation (BMC) provides an opportunity for the residents of the city to participate in shaping the city's features by co-creating solutions for the Smart City Proposals (myGOV, 2015). The role played by 'socially smart' individuals is important considering their work on improvising the quality of life of the residents of vibrant and challenging neighbourhoods. These individuals work on the ground with the communities to devise 'win-win strategies' to address the issues that the public authorities find difficult to address (Gilchrist, 2019). The *Figure 1 represents Bhubaneswar's Smart City Visions*

The Smart City Vision of Bhubaneswar has the components like (i) transit oriented city, (ii) livable city, (iii) child friendly city, (iv) eco-city and, (iv) regional economic centre as mentioned in Fig.1. The 'Socially Smart' programme works in the domain of 'livable city' and 'child friendly city'.

1.2 Scope of project

This Socially Smart Bhubaneswar programme promotes people-centric interventions through engagement of youth, especially women and girls, with a focus on the most marginalised, through 'youth engagement in educational institutes', 'youth engagement in urban slums,' and 'convergence and collective action'. Objectives of the Socially Smart Bhubaneswar programme are:

a. To develop a youth-centric and youth-led integrated social intervention model to support 'Citizens Connect' initiative.
b. To promote safety and security of girls and women in Bhubaneswar with specific focus on urban slums through community partnerships.
c. To increase availability and accessibility of social, health and other development programmes for the vulnerable and marginalised population subgroups.

1.3 Significance of the project

The Socially Smart programme provides a platform for slums and selected communities to upgrade themselves by giving them social, educational and financial opportunities. The focus is on (i) Promoting volunteerism, (ii) Maintaining linkages with government programmes & schemes, (iii) Empowering girls/women, (iv) Linking youths with skill development, (v) Emphasis on gender issues, (vi) Imparting self-defense training

Figure 1 Smart City Vision, Bhubaneswar (BSCL, 2017)

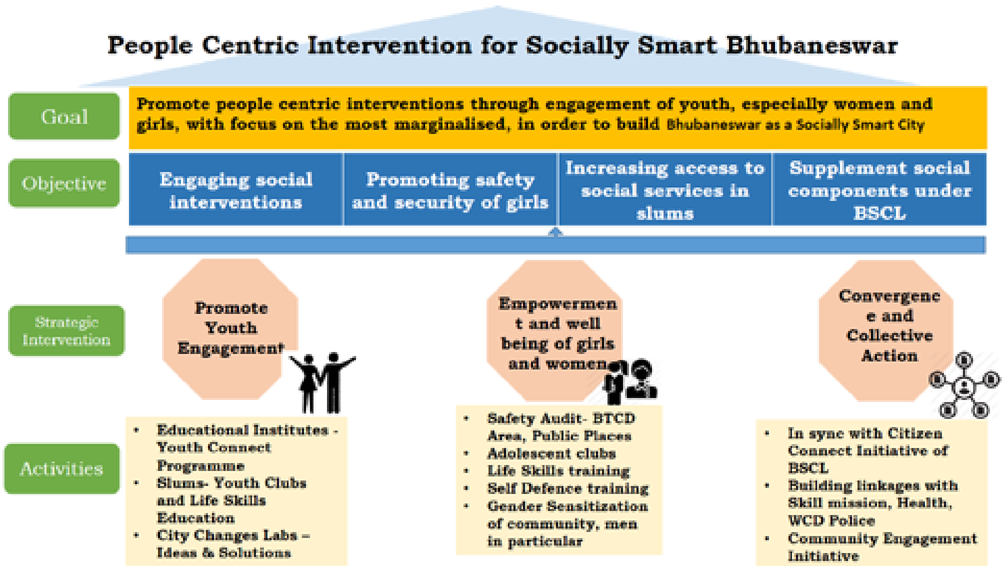

Figure 2: People Centric Interventions for Socially Smart Bhubaneswar programme (UNPFA, 2019)

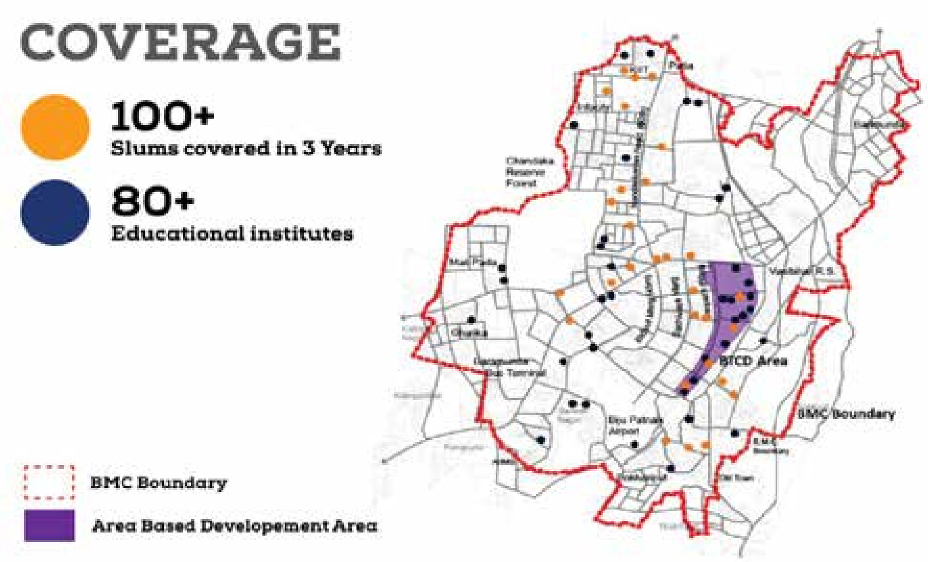

Figure 3: Coverage of the Socially Smart Bhubaneswar programme (UNPFA, 2019)

to adolescents girls, (vii) Suggesting themes for the interventions in educational institutes, (viii) Promoting gender equality, (ix) Empowering youth to end violence against women, (x) Promoting healthy life.

It enables the citizens to present their issues at ward and city level. Through the stories of young people who have initiated change in their communities, the programme exemplifies how the youth can play a crucial role in shaping urban development that is inclusive and responsive to the needs of the urban poor, young people, women and the aged.

Members of the benefitted communities are also empowered to participate in national as well as internationaleminars and conferences, presenting how India has beensuccessfully breaking social myths, empowering women and other marginalised communities. The project acts as one of the key components in realizing the true potential of the Smart Cities Mission by bringing even the most marginalized citizens under its purview.

This project has received 2nd rank in India Smart City Award Contest 2020.

1.4 Aim and objectives of the research

The aim of the research is ***to analyze the impact of Socially Smart Bhubaneswar in promoting people centric interventions through engagement of youth, especially women and girls with focus on the most marginalized, to build Bhubaneswar as a Socially Smart City.***

The objectives of the research are:

a. To study the functioning of this programme in respect to the various stakeholders involved to enhance and upgrade the communities targeted.
b. To compare the Socially Smart Bhubaneswar programme with the similar kind of initiatives taken in other cities and use the earlier made research for upgradation of the existing programme.
c. To explore the interfaces of interaction with the slum residents of Bhubaneswar and the process of how it was done.

This research will help in assessing the capability of the Socially Smart Bhubaneswar in contributing to the betterment of slums and communities with the involvement of youths.

2. Contextual Background

The Smart City Mission in India offers a comprehensive platform to harness the potential of India's young people to shape social and economic development, contribute to progress in social and civic norms. In Bhubaneswar, every fourth citizen is a young person. Recognising the stake and role of the young population in shaping the future of the city, the citizen-centric, youth-led intervention is strengthening the social and people-centric facets of the cityscapes, especially in the poor habitations (UNPFA, 2019).

2.1 Conceptual framework / Research design

The research methodology can be articulated through four major stages: (i) Literature review, (ii) Data collection, (iii) Analyses and inferences, and (iv) Conclusion. The various components of each stage are presented in Figure 4.

Literature review

Salaam Bombay, an NGO with office located in Mumbai, works for betterment of youth by engaging 'at risk' adolescents through in-school leadership programmes and after-school sports, arts media and vocational training academics. In the light of COVID-19 pandemic, the organization collaborated with Municipal Corporation of Mumbai to offer critical food and pandemic relief across the city. The organization have initiated programmes like (i) Super Army: Tobacco control and leadership programme, (ii) Knowledge on health and nutrition for adolescents (KANHA), and (iii) Happy Minds: The programme that helps the students to manage the stress, and build their mental resilience to resist the temptation of substance abuse (Salaam Bombay, 2021).

Asha, a New Delhi based NGO, motivates and empowers slum dwellers, giving them the confidence and ability to work together and influence their fellow slum residents, council officials, police, school authorities and others. They work to provide holistic community-based healthcare, empowerment, financial inclusion, education and environmental improvements by training, resourcing and encouraging slum communities to receive and enjoy their basic human rights (Asha, 2022).

Brief overview of the programme

Socially Smart Bhubaneswar is a people centric programme to make Bhubaneswar a 'socially smart' city with Humara Bachpan Trust (HBT) as an implementing partner. HBT is an NGO which was established in 2014. Since its inception, HBT started working in the domain of health, gender, education, housing and child and youth development. It was closely associated with the slums in Bhubaneswar, so when the 'Socially Smart Bhubaneswar programme was initiated in 2017, this NGO was selected as a partner to implement this programme. The existing organizational structure, consisting of field coordinators and peer leaders, was retained. The project was initiated with the selection of 8 slums. Later, t it expanded to 24 and as of now 100 slums are covered under this programme. Currently, community level mapping has been completed for 24 slums and line listing of youth has been done in 84 slums. The structure of the programme is presented in Figure 5.

The residents are given education and training as well as material assistance to resolve the issues mainly aligning with the following core elements of the Smart Cities Mission of Government (BSCL, 2022):

i. Adequate water supply
ii. Assured electricity suppe
iii. Sanitation, including solid waste management
iv. Affordable housing, especially for the poor
v. Good governance, especially e-Governance and citizen participation
vi. Safety and security of citizens, particularly women, children and the elderly
vii. Health and education.

Structure of the operation

The structure of the operation with all the stakeholders is systematically explained in Figure 6

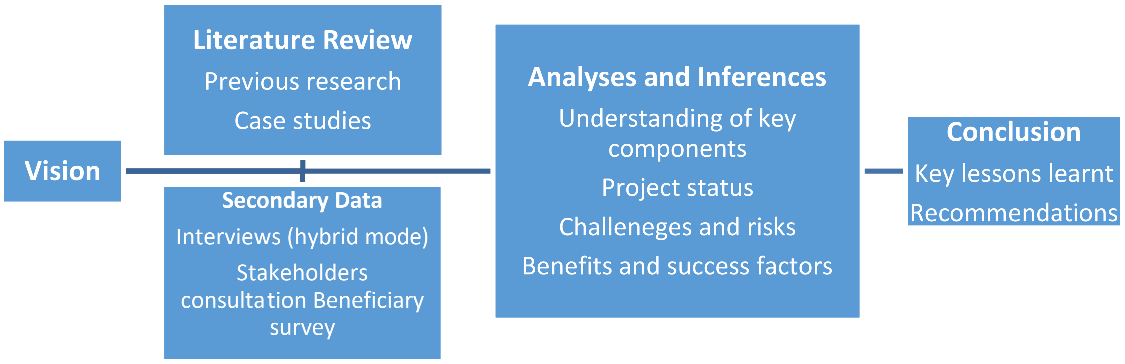

Figure 4: Research methodology (Source: Author)

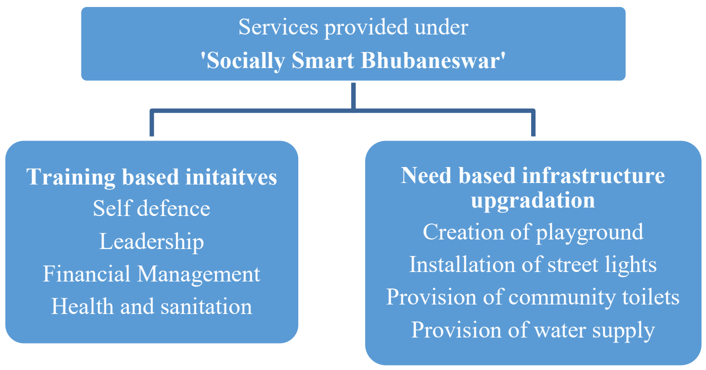

Figure 5: Services provided under the Socially Smart Bhubaneswar programme (Source: Author)

a. One project manager handles 25 slums on a rotational basis. Their role is to facilitate between BSCL authorities and field coordinator for efficient running of the programme.
b. 25 field coordinators to assist project managers each looking after four slums.
c. Peer leaders are young boys and girls mostly in the age of 11-21. Two peer leaders from each slum attend a 10 days training programme. They then conduct a fortnightly meeting with children, youth and women to discuss various issues and also to provide knowledge to these people.

Categorization of slums

The members of the programme conducts an exclusive social mapping process as a tool to assess the issues and challenges related to physical infrastructure of the community along with the social issues prevalent among youth and adolescents of the community. This gives a better understanding of the issues in each slum and to establish a way to deal with it. The slums are divided into three categories as follows:

a. 'A' Category: The slums belonging to this category are in good condition and fewer efforts are required to make them fully 'Socially Smart'.
b. 'B' Category: The slums belonging to this category are medium developedand considerable efforts are required to make them fully 'Socially Smart'.
c. 'C' Category: The slums belonging to this category are lagging behind in the terms of development and a lot of dedicated efforts are required to make them 'Socially Smart'.

2.2 Key features of the project

This section discusses the features of the Socially Smart Bhubaneswar programme in the form of challenges, risks involved in the project, benefits to the city and key findings from primary and secondary data collection.

2.2.1 Challenges in the project

a. It has been a challenge to sustain the networking and coordination with all the peer leaders. However, the efforts taken by HBT in integrating the network and establishing a connection with peer leaders from different slums helped in bringing synergies..
b. Mainstreaming and integration with other government and private agencies has been a challenge in the initial phase of the programme. However, the training sessions, focused on 'confidence boosting' and 'rights of citizens', helped the youth to approach the BMC corporators and other elected representatives in a confident way.
c. Mainstreaming the integration of the programmein all the targeted areas is quite impossible if there is shortage of funds at any given time. However, the programme has been receiving funds from BSCL as well as UNPFA every year since its inception.
d. Bringing all the slums and their periphery areas under this programme is a difficult task. However, the manner in which the programme hasexpanded from 8 slums to 100 slums in a period of 5 years is quite promising, and many other slums can be brought under the programme's purview.

2.2.2 Risk involved in the project

Reliance on only one NGO for implementation has concentrated all capacity enhancements on a single organization; there is no backuporganization who can step in to implement the programme without starting from scratch.

2.2.3 Features and Benefits to the city

Following benefits have been achieved by the city against the specific project components (Table 1).

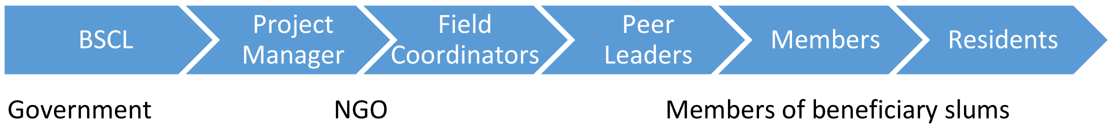

Figure 6: Hierarchy of the organizational structure of Socially Smart Bhubaneswar

Figure 7: The girl from slum displaying her self-defense skill to the IIT Kharagpur research team. (Source: Author)

Figure 8: Ma Mangla Basti transformed through 'Place making marathon in 72 hours', an initiative by BSCL. (Source: Author)

Figure 9: Meeting between Shri. Sanjay Kumar Singh, IAS (CEO, BSCL) and IIT Kharagpur research team. (Source: Author)

Figure 10: Meeting between BSCL authorities and IIT Kharagpur research team. (Source: Author)

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

The research primarily referred to the following as secondary sources of information:

a. Making Bhubaneswar Socially Smart by United Nations Population Fund- India
b. 'People Centric Programme to make Bhubaneswar a Socially Smart City' by BSCL
c. Humara Bachpan Trust's Annual Report 2020-21
d. Community planning reports by Pragati Saathi (adolescent boys and girls Sambhavi Women's Group, youth group)

Primary data collection involved interviewing officials from BSCL, project manager, field coordinator, peer leaders and residents of Santipalli slum and Kedarpalli slum, and key findings from these interactions are outlined as below:

Component	Activity	Outcome
Involvement of Youth and Community	Community Mapping in 24 slums	Identified the social and economic issues of the community and the prioritization by the community.
	Line listing of Youths in 84 slums	Assessed the training needs, aspiration of youth's trade preferences and gaps
	Peer Leaders (Pragati Sathis)	More than 500 young adolescent boys and girls are in the programs.
Empowerment of Girls /Youths	Modular Training	172 adolescent boys and girls were trained in life skill education and as per the module 'Mora Swapna Akasaku Chhunibaa'. Review and reorientation of these youth are being undertaken regularly.
	Capacity Building	350 peer members were oriented on the modules, new schemes and COVID19 from 80 slums through reviews, meetings ,exposure visits. Interface with Health Service Providers at facilities(UPHCs) 120 ASHA, Auxiliary Nurse Midwife (ANMs), Anganwadi Workers (AWWs) and Mahila Arogya Samiti (MAS) members participated and received orientation in the programs involving ICDS and health functionaries.
	Self-defense Training	More than 500 girls trained in 10 days self-defense training
	Experience Sharing Workshop	Peer leaders organized the events
	Fortnight Meetings	54 Peer Groups organized 14 fortnightly meeting and discuss on the issues faced by them and community
Emergency	Support during FANI, COVID-19 Pandemic (both the waves)	Relief, rescue FANI , Trauma Counselling COVID Sachetak Committee Members, Surveillance, Coordination and Support Counselling at neighborhood places for adherence to COVID appropriate behavior(SMS) More than 11000 houses visited, Thermal Scanning and Oxy. Level measurement More than 4000 persons got vaccinated (Registration, Slot booking, transport)
Recognition	Appreciation / Awards/	Provided with Safety Kits(T Shirt, Cap, sanitizers, Pulse Oximeter, Thermal Scanner) 64 Bicycles as to Peer Leaders promote fitness, on-motorable transport, environmental protection (reduce pollution) .Appreciation of their work
Promoting Gender Equality	Observation of International Events and days, Interface with Legal Practioners, Police Safety audit Theme based programmes in Educational Institutes Sensitization of 270 Auto drivers on safety of women passengers	Peer Leaders are actively participating in the community programmes . Representation at various levels, selected as Special Police Officers Safety audit of campus and steps to address the issue by authority.
Reaching Out to Senior Citizens	Senior citizen Recreation center at IPSC Saeed Nagar and Physiotherapy and health camps.	Senior Citizen Recreation Centre in IPSC Saheed Nagar
Coordination and Convergence	Linkages with Skill Development Institutes	More than 300 youths enrolled in to different vocational trades
Orientation of Safai karmacahris	Orientation of Safai Karmacharis on RCH & Health Issues	220 BMC Safai Kramacharis members were oriented about health and SRH issues covered with 8 BMC wards (30,34,41,53,48,50,51,17)

Table 1:

i. Shri. Sanjay Kumar Singh, IAS (Chief Executive Officer BSCL, Commissioner of BMC, Vice Chairman, Bhubaneswar Development Authority):

a. 'Placemaking marathon in 72 hours', an initiative by BSCL under Jaga Mission in which a challenge was given to transform the slum in 72 hours, was implemented at ***Ma Mangala Basti***. The dilapidated pond area, with garbage piles stacked all around, was worked upon by the community to transform it in 72 hours as shown in Figure 8.
b. BSCL is in process of denotifying all the slums in the city under 'Jaga Mission' with provision of water connection, access to ***pucca*** road, electricity connection, and individual toilets for each household as well as creating community spaces such as open playgrounds and ***anganwadis.***

ii Smt. Diptirani Sahoo, OAS (GM, Social Projects, BSCL):

a. The programme has resulted in holistic development of slums by providing 24X7 water supply, sewerage network etc.
b. Youth, especially from the slums, are made eligible for jobs through skill developments programmes by providing vocational training at ITI.
c. By realizing their potential, youths are motivated to participate in emergency response programmes.

iii. Peer leaders and resident's perception feedback: Santipalli and Kedarpalli slums were selected for field visits by the IIT Kharagpur research team as per consultation with HBT. The field visits were facilitated by HBT team, peer leaders, Sambhavi leaders and youth leaders.

Santipalli, spread over an area of 10 acres of land, is located near Maharshi Nagar, Shaheed Nagar area. There are a total of 1122 households with a population of 6165. Residentse are engaged in various types of business for their livelihood such as daily labor, painter, jobs in private companies, tailoring, petty shop etc.

Kedarpalli is one ofoldest informal settlements of Bhubaneswar City and is spread over an area of 42,907 sqm. This locality has 641 households with a total population of 2399. Majority of the working-age residents work as ***Safai Karmacharis*** (cleaners/

Figure 11: Location of Santipalli (Source: Google Maps)

sweepers) either engaged by Bhubaneswar Municipal Corporation (BMC) or work independently.

The perception about the programme and the feedback received from the peer leaders, field coordinators and residents during these field visits is as follows:

a. Residents are satisfied with the assistance they receive from the peer leader. Peer leaders, being directly selected from their own slum are able toconnect to the issues of the people. Weekly training is given to 100+ peer leaders regarding self-development, self-reliance, self-confidence, vocational training, rights and responsibilities, menstruation and hygiene, social taboo, myth, barriers etc. As a consequence of this, a sanitary napkin vending machine has beeninstalled and Menstrual Hygiene Day is celebrated to abolish the evils related to natural biological processes.
b. Since the implementation of the programme, the youths have been confident of bringing their issue to the notice of the local representatives of BMC. As a result, various problems related to drainage were resolved.
c. Confidence in the girls and women has been boosted with the help of programmes related to women empowerment such aslive training, and slum labor training. Also, the literacy rate of females has increased due to these initiatives.
d. Citizens are also enthusiastic about participating in the designing process of the residential buildings where they are to be rehabilitated. Case studies of other housing projects were conducted by the youths and design proposals along with 3D model as per their demand has beenpresented for upcoming 4 storey residential buildings.
e. Other services like sustainable kitchen waste composting, Aadhar card linking, PAN Card linking has helped in serving the slum residents.
f. Girls and women from these slums are statisfied as they get new oppprtunities to pursue their dreams. Also, direct contact established with the police under this initiative helped them to register the cases of domestic violence. As a result of this, the number of these cases has been significantly reduced.
g. Children of Santipalli are happy as a defecation ground was transformed into an open play space under this initiative.

Following are the experience shared by the peer leaders and beneficiaries as a part of perception feedback:

Sangita Pradhan

Sangita, a peer leader from Sciencepark Basti, failed in her higher secondary examination and faced challenges in continuing her studies. She has joined the peer leader group of her community and underwent the three-phase leadership building training process. Sangita gradually started advocating ending violence against women and girls by helping them to avail legal help.

Jasmine Nissa

The life skill training has helped Jasmine to explore available vocational skill training opportunities of counseling with the police. With support from the HBT team incommunicating with Police Authorities of Bhubaneswar, shehas been appointed as 'Special Police Officer' for three months.

Ananda Pradhan

Ananda, a peer leader from OUAT Farm Gatehe remembers that there were issues regarding inefficient electricity, lack of toilets, no space to play for children, lack of toilets in anganwadi, open drains, etc in his slum. They brought this issues to the notice of SSB authorities bacause of which the SSB team verified and acted upon these issues. This also led to Ananda's confidence being boosted and he has taken a community oath to serve his people through this programme and to become a peer leader to help other localities and youths in resolving their issues.

Figure 12: Location of Kedarpalli locality (Source: Google Map)

Figure 13: IIT Kharagpur research team with HBT team and children at Santipalli. (Source: Author)

Figure 16: The students of various institutes of Bhubaneswar presenting their projects in City Changer Labs. Source: (Orissa Diary, 2019)

Figure 14: Field Coordinator explaining about the implementation strategies of the programme to IIT Kharagpur research team. (Source: Author)

Figure 15: Meeting between IIT Kharagpur research team and peer leaders of different slums. (Source: Author)

Figure 17: Youth Conclave, 2018, Source: (BSCL, 2022)

Dipanjali Swain
Dipanjali is a peer leader who has represented Bhubaneswar Smart City and ultimately the country in different foreign countries through this programme. In 2019, she participated in the International Conference on Population and Development held at Nairobi, Kenya.

3. Discussion and Conclusion

This section of the report deals with the conclusion in the form of key lessons learnt and recommendations based on the inferences drawn through understanding the key components, analyzing project status, challenges and risks.

There are many youth-led and youth-centric approach of the programme that have been executed through the following initiatives:

i. Youth engagement in educational institutes
   a. Youth Connect: Designed to improve awareness and engagement of young people on social issues, Youth Connect programmes are organised for students from universities and colleges in Bhubaneswar. The initiative aims at promoting active citizenship, leadership and volunteerism among young people.
   b. City Changer Labs: It is a platform for young people to participate and present innovative ideas that can address some of the social and development concerns of the city. A city-level competition has been conducted where young people are provided with an opportunity to demonstrate technology based solutions for a better urban living.
   c. Youth Conclave: Conceived as an annual event, this mega event bring together hundreds of youth and students from across college and universities in Bhubaneswar to share experiences, achievements and challenges in the 'smart city' journey and present stories of young people as change makers.

The Progress so far (2016-2021) in connection with Youth Connect Program at the level of Educational Institutions:

Component	Activity
To create awareness on • Gender Equality • Youth to end violence Against Women • Promoting Healthy Life	• More than 80 educational Institutions onboarded through the youth connect program. • These included Government and private colleges, Govt ITI, Govt Polytechnic, Engineering, Medical and Management Institutes of Bhubaneswar. • It is being implemented through Nodal officers who mostly are NSS officers.
Creating a platform for youths to share their ideas/ innovations and proposals to improve urban living	• City-changer labs are organised annually for students to share their ideas • A total of 74 ideas/ proposals have been received in the last 3 years. • 12 proposals have been shared with Institute of Entrepreneur development (IED), MSME department in 2019 for further handholding support to the youth.
Bringing youths from various institutions together to share their views and suggest way forward for the program	• 2 Youth Conclaves have been organised wherein approx. 500 youths from various institutions of Bhubaneswar participated in the program. (February 2018 & December 2019)

ii. Youth engagement in urban slums
   a. Community mapping: This is a process led by trained volunteers where the community comes together todevelop a map of the slum by identifying issues, needs and resources that they can tap into.
   b. Community dialogue: Women's groups, men folk, community-based organizations and frontline functionaries are brought to a common platform to seek solutions and improve basic services in slums.
   c. Youth clubs: It consists of about 15 to 20 young girls and boys from the locality who meet on a fortnightly basis. These sessions are based on an assets building framework developed by UNPFA covering social, health and economic assets.
   d. Engaging men and boys: Men and boys are motivated through discussions to take on leadership roles, change gender norms and prevent gender based violence in their homes as well as in the community.
   e. Creating safe spaces for girls and women: Community advocacy programs are initiated based on the challenges faced by girls such as violence, stalking, teasing etc.

iii. Convergence and collective action
   a. Safety of girls and women: A ten-day intensive training on self-defense technique for girls in slums helps in boosting their confidence to deal with challenging situations in day to day life.
   b. Employability and skill development: eetings with skill development agencies and exposure visits are organised to motivate youth, especially women to enroll in such programs.

Figure 18: The drive was arranged to raise awareness on 'safe spaces for youth', especially girls and women, under the Socially Smart Bhubaneswar programme. Source: (Orissa Diary, 2018)

Figure 19: Girls receiving self-defense training under the Socially Smart Bhubaneswar programme. Source: (BSCL, 2022)

3.1 Implications

The Socially Smart Bhubaneswar programme can be aligned with five of United Nation's Sustainable Development Goals as illustrated in Figure 20.

a. SDG 1: No Poverty
The vocational training and skill development programme implemented under the Socially Smart Bhubaneswar projects help in strengthening the livelihood of the poor families by making them eligible to earn money and make themselves financially stable. This adheres to the target outcome 1.4 of this SDG which deals with the Equal rights to ownership, basic services, technology, and economic resources

b. SDG 3: Good Health and Well-Being
The provision of medical assistance towards the citizens, especiallythe slum dwellers, during COVID-19, by distributing medical kits, sanitizers, masks etc. helps in achieving the target 3.3 of fighting communicable diseases.

c. SDG 4: Quality Education
qual access to affordable and quality technical, vocational and tertiary education, including universities has been ensured for all women and men. Further, gender disparities in education has been eliminated to ensure equal access of education for the vulnerable, including persons

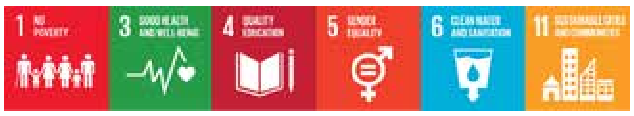

Figure 20: Project alignment with UN's Sustainable Development Goals

with disabilities, indigenous peoples and children in vulnerable situations

d. SDG 5: Gender Equality
The programme strengthens the decision making power of girls and women regarding their education and marriage. In addition, girls are encouraged to become peer leaders in order to lead and represent their community thus ensuring their full participation in decision making.

e. SDG 6: Clean water and Sanitation
Initiatives like provisioning of toilets and drains, helps in achieving access to adequate and equitable sanitation and hygiene for all and ending open defecation..

f. SDG 11: Sustainable Cities and Communities
The provision of adequate, safe, and affordable housing and basic services in order to upgrade slums is in process which will help in achieving the target 11.1 of the SDG.

The roleplayed by the Socially Smart Bhubaneswar programme has had positive impacts on the communities at present. Based on the inferences, following implications have been identified:

a. Mapping community level resources helps in identifying the social and economic issues of the community. Sequences of addressing these identified issues can be prioritised to help in efficient planning of the future schemes and initiatives that are customised for each slum.
b. The line listing of youths in slums will help in identifying the gap in aspiration of youth and the reality. Based on preference of sector given by these youths, training programmes aligning to their interest can be implemented.
c. Training of young girls and boys helps them to actively play leadership roles in the community. This will help in further bridging the gap between community and other government programmes. Thus, the community will be able to better avail public services and resources . Also, the trained youth can act as part of the response team during emergency and critical times.
d. Capacity building of ground level functionaries contributes in strengthening the coordination and cooperation among community and service providers. This will result in enhancing the negotiating and counseling ability of peer leaders.
e. Community advocacy meetings conducted will pave the way for the slum residents to explore out of the 'dimension' of the slum and to act on city level.
f. The self-defense training provided to the girls and women will act as catalyst in reducing the crime and violence against women.
g. Community leaders, peer leaders, field functionaries (ward officers, ANMs, AWWs, MAS members, sanitary inspectors, Integrated Child Development Service (ICDS) supervisors, and junior engineers) help in the betterment of the communities.
h. Capacity building of the youth and adolescents is achieved through modular training, exposure visits, and linkages with skill development institutes. Skill linkages for livelihood opportunities will enable the youth to become an earning member of the family and empower them to negotiate and take decisions on their own and to overcome family pressure.
i. The experience gained by the peer leaders while working during cyclone Fani and COVID 19, will help them in utilising their management experience to act promptly during disaster or any such pandemic in future.

3.2 Limitations of the research
The research is restricted only to studythe social aspects of the slums. The involvement of the educational institutes as a part of 'Youth Connect', 'City Changer Labs' and 'Youth Conclave' have not been assessed. The framework of these individual initiatives could not be studied due to the time limit.

3.3 Key lessons learnt
The key takeaways from the Socially Smart Bhubaneswar Programme are as follows:

a. Involvement of an NGO like HBT has made it possible to execute the programme more efficiently as they are part of the local community in terms of their structure. Contrary to the functioning of the private entities, the ultimate goal of an NGO is to serve the public interest with non-profit purpose. This helps the decision makers in making the choices in collective interest rather than personal interest. The members of any community have the maximum understanding of the issues faced by that particular community. Instead of assigning trained peer leaders from outside the communities, HBT selected the youth from the community itself, and then trained them as per the requirement. This has made it easy for residents to approach the peer leaders who from their own community. The additional guidance, if required, are provided by the qualified coordinators and managers of the HBT team.
b. Under Smart City Mission and BMC, various initiatives have been taken like 'Citizen Connect Initiative' and affordable housing projects. Linking the Socially Smart Bhubaneswar Programme with these initiatives has helped the programme to gain momentum through synergy.
c. The knowledge of the bright young minds has been utilized to strengthen the project. Involvement of the educational institutes adds an additional dimension to the programme.
d. To harness the potential of the youth in order to accelerate economic growth, it is important to invest in the programmes which result in making the youth self-reliant through the Smart City Projects.

3.4 Recommendations
Based on reserach and analysis conducted of the project the following are the key recommendations suggested:

a. There is a need to involve additional NGOs in the programme. This will lead to a healthy competition and better outcomes can be achieved. Also, this will reduce the reliance on a single NGO.
b. The initiatives taken under the programme canto be analysed through real time monitoring andintegrated into the Integrated Command and Control Centre (ICCC) for better administering of the programme.
c. Initiatives related to the technology, taken by the BSCL, such as Wi-Fi, digital kiosks, surveillance through CCTV cameras can to be installed in slums too. This will help in achieving the objectives of this programme in an efficient manner. The residents of the slums also need to be oriented on the usage and benefits of online portals like Bhubaneswar ME and Bhubaneswar One in order to connect them with digital initiatives by the BSCL.
d. Apart from the self-defense training and other training sessions, both girls and boys can to be provided with physical training. This will help in improving their health and well-being.
e. Assure job opportunities can be provided to the youth after completion of skill development training. The assurance of jobs after the completion of training, will increase the participation rate of the youth in the programme.
f. Soft skill, entrepreneurship, career counseling could be merged into future programmes.

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A14

Integrated Command and Control Centre (ICCC), Bhubaneswar

Name of the project: *Integrated Command and Control Centre*
Location: *Bhubaneswar, Odisha*
Year of Project Implementation: *2018*
Sector: *Smart cities mission*
SDG: *SDG 3, SDG 6, SDG 9, SDG 11, SDG 16*

Project Cost: *: Rs 51.54 crore*

Institute: *IIT-Kharagpur*
Advisors: *Prof. Subrata Chattopadhyay, Prof. Haimanti Banerji, Asst. Prof. Arjun Mukerji*
Students: *Piyush Chandrashekhar Gharat*

Keywords: *Command and control centre, operations, smart monitoring, grievance redressal, smart cities*

Abstract:

Integrated Command and Control Centre (ICCC), Bhubaneswar, which was implemented in 2018 under the Smart City Mission, is a state-of-the-art facility for centralised, smart monitoring of the functioning of city systems like traffic management, utilities, safety and security, App-based citizen services, grievance redressal, etc., as well as aspects like environmental quality. ICCC enables cross-system and cross-agency information sharing, coordination to monitor, operate, deliver and manage services in an integrated and efficient manner. The ICCC helps authorities to operate and the citizens to avail the facilities more efficiently. This research studies and documents various aspects of ICCC Bhubaneswar with reference to similar national and global systems, as well as findings from field visits, interviews and surveys. Supporting high quality communication networks for reducing the digital divide and enhancing everyone's quality of life; ushering the era of cashless society through city-wide common payment system; implementing open data policies and procedures for empowering citizens; changing the way Bhubaneswar city government works; creating an innovation culture in the city; and improving the delivery of public services are some of the benefits of the project. The key findings are expected to help in bettering Bhubaneswar's system, as well as in designing and implementing future ICCCs for other cities.

Case Study: A14

1. Introduction

Smart Cities Mission is a major step taken by the Government of India with a vision to improve the quality of life of people by enabling local area development and harnessing technology, especially that which leads to 'smart outcomes' (Smart Cities, 2021). There have been three distinct phases of how cities have embraced technology and development, progressing in the following manner:

i. Tech company-driven city
ii. City government-driven city
iii. Citizen-driven city (Cohen, 2015).

Bhubaneswar bagged the record of becoming the first 'Smart City' of India under this mission. The Integrated Command and Control Centre (ICCC) acts as a catalyst and helps in shifting this momentum from the traditional way of managing city operations to the citizen-driven approach. The current research will help in understanding the level of involvement and efficiency of the technology used in taking Bhubaneswar close to its goal of achieving smartness.

1.1 Topic and Context

ICCC is a 'nerve centre' of any city which assists in enhancing efficiencies of city operations and management. It provides a holistic view of all city operations allowing monitoring, control and automation of various functionalities at an individual system level along with enabling cross-system analytics. ICCC has been planned to leverage information provided by multiple city systems to support an integrated, seamless, proactive and comprehensive response mechanism for the day-to-day city operations and challenges. Figure-1 represents Bhubaneswar's Smart City Visions.

1.2 Scope of Project

The Pan-City projects in Bhubaneswar are technological interventions for city management of traffic system, transit system, parking system, emergency response & incidence management system, digital payment ecosystem for the city through introduction of Common Payment Card System, Enterprise Resource Planning and e-Governance for the four city level organisations i.e. Bhubaneswar Development Authority (BDA), Bhubaneswar Municipal Corporation (BMC), Bhubaneswar-Puri Transport Services and Bhubaneswar Smart City Limited (BSCL). It also includes setting up of an Intelligent City Operations and Management Centre (ICOMC) for managing these services on a common platform involving participation of different stakeholder organisations.

Objectives of the ICCC are:

i. Cross-system and cross-agency coordination to monitor, operate and manage the city in an integrated manner.
ii. Enable different agencies and departments to monitor and utilise information from other departments for delivering services in an integrated and more efficient manner.
iii. Normalise the data coming from different devices of various Original Equipment Manufacturers (OEMs), to support integration with multiple vendors.
iv. Leverage information provided by multiple city systems to support an integrated, seamless, proactive and comprehensive response mechanism for day-to-day city operations and challenges.
v. Evidence-based decision-making and responsive operational control for real-time incident management, inter-agency and inter-sector collaboration and service delivery improvements.
vi. Help in enhancing safe mobility, responsive city operations and management along with optimisation of capital expenditures by providing real-time data support.

1.3 Significance of the project

The ICCC gives real-time data analysis, enables integrated operations and informed decision-making. By providing a holistic view of the key functions for managing the city, the command centre enables civic officials to optimise allocation of resources, adopt preventive maintenance measures and proactively manage operational issues. Road safety and traffic management are the key features of the system. The ICCC also ensures that citizens avail efficient urban services, access information and grievance redressal thereby, improving the overall quality of life. The project acts as one of the milestones in realising and executing the potential of the Smart City Mission.

1.4 Aim and Objectives of the Research

The aim of the study is to analyse the impact of the Integrated Command and Control Centre (ICCC) on the basis of its efficiency in monitoring, operating and managing the city in an integrated manner.

The objectives of the research are:

i. To study the operational methodology of ICCC Bhubaneswar, to understand the monitoring and utilisation of information from other departments and to deliver services in an integrated manner.
ii. To study how ICCC is helping in manifesting the smart city concept.
iii. To compare ICCC Bhubaneswar with the efficient control centre of other identified cities through literature review.
iv. To explore the interfaces of interaction with the people of Bhubaneswar and the process of how it

Figure-1: Smart City Vision, Bhubaneshwar (BSCL, 2017)

Figure-2: Rio Operations Centre, Rio de Janerio
Source: (MoHUA, 2018)

was done.

v. To study the perception of various stakeholders involved in this project at different levels - the authorities, representatives of the implementing agency and the residents.

This research will help in assessing the capability of the ICCC Bhubaneswar in operating and managing the city in an efficient manner through comparison with other command centres, globally and nationally.

2. Contextual Background

Smart cities are defined by the Government of India as those creating 'smart solutions' by use of efficient technology, information and thus, data to improve the efficiency of the infrastructure and services delivered to citizens (Smart Cities, 2015). The Integrated Command and Control Centres (ICCCs) are established as projects of a city's development model, other being Area-Based Development (ABD). ICCCs have a city-wide impact. These projects are based on the data-driven model of networked urbanism embracing the process of using large quantities of data for capturing, modeling and predicting the urban process (Batty, 2012).

In India, so far, around six cities have established ICCC as a way towards data-driven governance. These centres are being used to monitor traffic, environment, law-and–order situations, water logging etc. which help in the smooth running of daily operations. In June 2020, projects that would build resilience against COVID-19 were asked to be implemented by MoUHA (Aijaz, 2021). ICCCs in cities inter alia Agra, Banglore, Pune and Vadodara were transformed into war-room for real-time monitoring and management to build resilience against COVID-19 (MoUHA, 2021). The ICCC Maturity Assessment Framework (IMAF), a self-assessment tool kit developed to assess the maturity of the Integrated Command and Control Centres (ICCC) across key aspects of functionality, technology, governance and citizen/stakeholders engagement, introduced by MoHUA, assessed the ICCC in categories like visualisation, analytics, communication and command and control where the facility should be working on 70% of the deployed infrastructure for each domain (MoHUA, 2020).

The two major drawbacks found in the current functioning of the ICCCs in India are:

i. Implementation of private agencies for operating and managing the functions of ICCCs as it poses a threat to data which could be used by these private entities for profit-driven motives (Hollands, 2008), and

ii. The command centres began to function merely for surveillance as the required output through the assessed data was not seen (Praharaj, 2020).

It is felt that the scope and role of ICCCs in the cities should be expanded. Cities such as Moscow are using these centres for effectively providing a variety of services like health, traffic management and security. So it is required to openly display or report the degree of benefits from the command centres mentioning the exact areas and stakeholders benefitted (Wigg, 2015). Figure-3 and Figure-4 represent the operations of the ICCC.

2.1 *Conceptual Framework/Research Design*

The research methodology can be articulated through four major stages:

i. Literature review
ii. Data collection
iii. Analyses and Inferences
iv. Conclusion

Figure 3: Indicative Functional Modules of an ICCC Platform.
Source: (MoHUA, 2020)

The various components of each stage are presented in

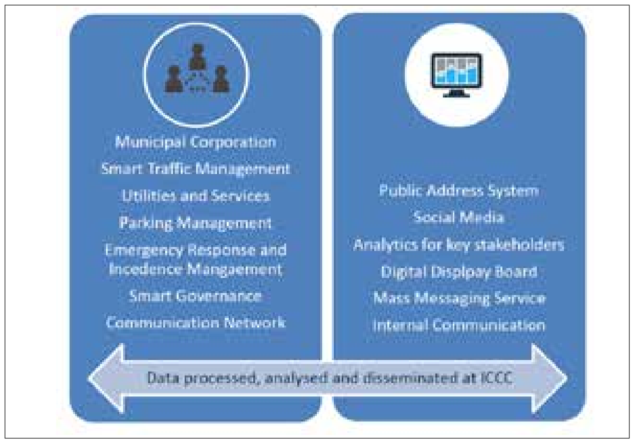

Figure 4: Operational Diagram and key stakeholders in ICCC, Bhubaneswar.
Source: Adopted from (Praharaj, 2020)

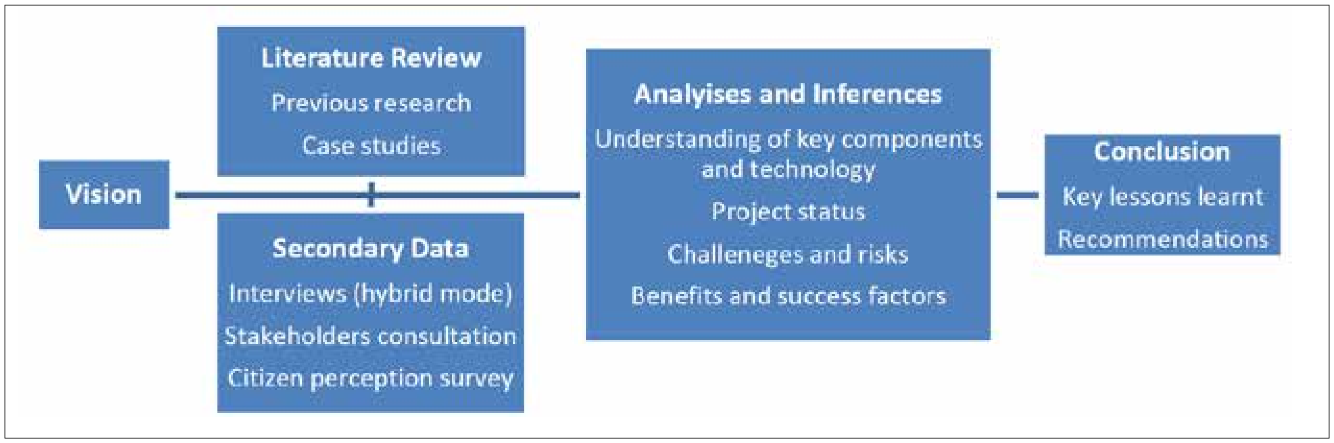

Figure 5: Research methodology
Source: Author

Literature Review (Case Studies)

Table 1: Profile of the cities with ICCCs

Sr. No	City	Bhubaneswar	Surat	Bhopal	Rio de Janeiro	Madrid
1	Area (in sq km.)	186	462	285	1,221	604
2	Population (in 000,000s)	1.22	7.2	2.5	13.63	6.71
3	Cost (Rs crore)	51.54	4.14	Not available	67.8	168.12
4	Implementation year	2018	2016	2018	2010	2007
5	System Partner	M/s Honeywell Automation India Limited	Not available	Not available	IBM, Bilfinger, Cisco	IBM

Source: (Author)

Table 2: The domains and application areas of the ICCC projects in selected citiesSource: Author with reference to Praharaj S, 2020

Sr. No.	Domain	Applications	Bhubaneswar	Surat	Bhopal	Rio de Janeiro	Madrid
1	Mobility	Public Transport	■	■	■	■	
		Smart Traffic	■		■	■	
		Parking Management	■		■		
2	Utilities	SWM		■	■		
		Water Supply	■		■		
		Street Lighting			■		
3	Environment	Environmental Monitoring	■	■	■		
		Disaster Management			■	■	
4	Safety and Security	Video Surveillance	■	■	■	■	■
		Wi-Fi Operation	■		■	■	■
5	Citizen Services	Public Announcement System	■			■	■
		Grievance Redressal	■	■	■		
		Tax Collection	■	■			
		Emergency Panic Button	■				
6	Commercial	App Services	■		■		
		Digital Signages	■		■		
7	Health	Health Surveillance		■			

Source: Author with reference to Praharaj S, 2020

Figure-5.

2.2 Key features of the project

The following features of the project were identified through field work by the IIT Kharagpur research team at Bhubaneswar during 23rd to 27th February 2022:

a. Intelligent Traffic Management: Installation of Red Light Violation Detection (RLVD), Speed Violation Detection (SVD) and pelican signals etc. to make the traffic flow more efficient.
b. Transit Operations: Mo BUS Service for intra-city transit with live location available on the Mo BUS mobile application.
c. Parking Management: Real-time monitoring of parking of vehicles involving sensor-based on-street and multi-level car parking with the help of digital interface to book the parking slot in advance.
d. Emergency Response and Incident Management: The city is under surveillance of CCTV cameras and panic buttons are provided to cater to emergencies or incidences.

The ICCC facility consists of the following features as shown in Figure-7:

a. Content input into the ICCC applications and web browsers – Software applications of various modules
b. Audio system and speakers – A system of audio components to provide sound in the operations and boardroom spaces.
c. Large format LCD/LED to provide display in the boardrooms.
d. A scalable 24 x 7 call center to support city operations.
e. Cable TV to provide information such as weather, news, etc. other than in-house systems.
f. Primary video inputs into the video systems through the city surveillance system.
g. Data centre and disaster recovery site in different seismic zones.
h. A video display wall as primary visual display for operators at the ICCC.

Figure-6: Pelican signals installed at the junctions (BSCL, 2022)

Figure 7: Bhubaneswar Operations Centre (ICCC, Bhubaneswar)
Source: Author

i. A video management system to manage CCTV streaming video, PTZ control and video archiving.

2.2.1 Challenges in the project

a. Cross-system and cross-agency coordination to monitor all systems under one roof was a challenge with the current area of 8,000 sq ft assigned in the existing facility. However, by mid-2022, the facility will be shifted to New BMC Building, as shown in Figure-8, where an area of 32,000 sq ft has been allotted for ICCC.
b. There was insufficient data during the initial stages to perform predictive analysis. However, since its implementation in 2017, a lot of data has been gathered which can be used for studying trends in data and obtaining various analyses.
c. Future integrations with any IoT/SCADA systems could not be determined in the initial stage. Nevertheless, the current operating system run by Honeywell Automation India Limited (HAIL) is suitable for integration of other domains with ICCC in future. Systems like water supply and SWM are in the process of integration with the ICCC. Integrating other systems like power supply and street lighting needs to be planned in a phased manner.
d. Preparation of data visualisation/dashboard for all systems in the platform was a challenge.

2.2.2 Risks involved in the project

a. Digital technologies are susceptible to system errors and bugs.
b. Digital data is associated with the risk of data loss.
c. Being an electrically powered system, the ICCC ceases to function during power outages.
d. Digital networks are susceptible to hacking, leading to data manipulation and corruption and failure in dependent physical systems.

2.2.3 Features and benefits to the city

Smart traffic management system has enhanced travel time reliability, reduction in congestion, distribution of green phase time equitably, faster response to traffic conditions, providing timely emergencies and support, predicting traffic volumes including adjustment to signal timings.

'Bhubaneswar One' is a Smart City initiative which integrates geo-spatial data from all the government and private organisations for providing easy and hassle-free information for the residents and the tourists, while 'Bhubaneswar Me' is a portal for citizen services.

The ICCC executes the concept of integrated transportation management by delivering a high quality, sustainable and integrated transportation system.

The project helps provide quick access to information for travellers, operators and decision makers to identify alternatives and deal with accidents and emergencies.

The ICCC helps in achieving transit as an alternative to ownership model through tracking, schedule adherence, traveller information, maintenance management and common payment systems and data analytics.

The ICCC Bhubaneswar has enhanced transparency, accessibility and efficiency of municipal functions through e-governance, ERP and other smart solutions providing integrated operations and operator management. It also has effective solutions for city's operational problems and provides a means of delivering opportunity to all through smart use of technology across the city.

Supporting high quality communication networks for reducing the digital divide and enhancing everyone's quality of life; ushering the era of cashless society through city-wide common payment system; implementing open data policies and procedures for empowering citizens; changing the way Bhubaneswar city government works; creating an innovation culture in the city; and improving the delivery of public services are some of the benefits of the project (Figure 9)

Figure 8: New Bhubaneswar Municipal Corporation (BMC) building where ICCC will be shifted
Source: Author

Figure-9: Features of the components of ICCC, Bhubaneswar
Source: IBI Group

2.3 Key findings from interviews, surveys and primary/secondary data collection

The research primarily referred to the following as secondary sources of information:

i. 'Smart Solution Project' by Bhubaneswar Smart City Limited (BSCL)
ii. ICCC Maturity Assessment Framework (IMAF) by the Smart Cities Mission

Primary data collection involved interviewing officials from BSCL and HAIL. The key findings from these interactions are outlined below:

1. Sanjay Kumar Singh, IAS (Chief Executive Officer, BSCL, Commissioner of BMC, Vice Chairman, Bhubaneswar Development Authority) and Shri Kamaljit Das, OAS (GM, Administration and Technology):
   a. BSCL is in the process of integrating SWM with ICCC. Door-to-door collection of the segregated waste and e-waste separately are some of the proposed features to be integrated with ICCC.
   b. BSCL is in the process of implementing an organised mechanism for collecting biomedical waste. E-waste collected is auctioned on a monthly basis, to promote recycling. Wet waste is converted into compost by the municipality.
   c. The entire operation and management during COVID-19 pandemic was done from ICCC. Real-time monitoring of doctors was done with the help of smart scheduling.
   d. Overall, 25 smart kiosks powered by solar energy have been installed in the city for e-governance applications and tax payment.
   e. The online service like kalyan mandapa booking and payment of property tax has been provided to the citizens. BSCL has partnered with ICICI

Figure-10: Meeting between Shri Sanjay Kumar Singh, IAS (CEO, BSCL) and IIT Kharagpur research team bank to introduce the Common Payment Card System (CPCS).

2. Ashit Kumar Rajhans (Bhubaneswar Smart City Limited):
    a. Traffic violations have been reduced after installation of ICCC technology enabler. Data regarding traffic rule violations, provided by Red Light Violation Detections (RLVD) and Speed Violation Detection (SVD) system, helps the police to take necessary action wherever required.
    b. The Automatic Traffic Counter and Classifier (ATCC) system has been incorporated, making BSCL a technology enabler.
    c. The LED message display boards have been installed at main junctions and also on the divider of main roads.
    d. The Optical Fibre Cable (OFC) network has been laid in the entire city. Almost 144 cores is the capacity of the installed network out of which only 10 cores have been used as of now. The manholes are installed at every 3-km and hand holes at every 1.5-km for servicing.
    e. Sensors on SWM collection vehicles have been installed and these vehicles can be monitored using real-time data.
    f. The concept of micro composting is in the pipeline and will be implemented soon. The idea is not just to use smart technology for waste collection but to use smart ideas to minimise the load as well as reduce reliance on smart technology. Each housing colony will have their own compost pit, which the residents of that respective colony will be responsible for managing with assistance from BSCL. It is a two way approach in which BSCL as well as citizens should actively participate in making the city smarter.

3. Santosh Kumar (HAIL employee):
    a. In the case of system error, the elements of the system may be turned off for maintenance. However, turning off the ICCC as a whole even for a limited period requires approval from the concerned government.
    b. Data back-up is stored on a daily basis at the Data Replication System (DRS) authorised by the government. The location of the DRS is undisclosed.
    c. Power back-up is provided through DG sets which can run the system for one week at a stretch.
    d. The system adopts an end-to-end security model that protects data and infrastructure from malicious attacks, thefts, natural disasters, etc, and as of now, no case of hacking has been identified. Nevertheless, there exists a 4-member cyber security team (1 from HAIL and 3 from cyber security consultants) for eventualities.
    e. The system is well-equipped with the required necessary infrastructure. Although the elements of smart traffic and other sensors are weather–proof, in case of any failure of the element, the implementing agency's team is always on-board to repair the failed elements in the stipulated time period as mentioned in the contract.

The IIT Kharagpur research team surveyed 44 citizens at various locations during field visits (February 22-27, 2022), as well as online surveys. The questionnaire collected information on respondent profiles and usage pattern of public interfaces of the ICCC. The major finding from this survey was that only 43.18% use Apps and portals like Bhubaneswar Me and Bhubaneswar One and/or the BMC helpdesk number. However, the digital interface is still favoured over helpdesk (13.63% compared to 4.5%). The popularity of the MO BUS App (43.2% users) indicates that users are comfortable with digital interfaces as seen in Figure-12. Therefore, there is a need to spread awareness to increase the usage of ICCCs' digital services for citizens.

Figure-11: Meeting between technical team of ICCC, Bhubaneswar and IIT Kharagpur research team

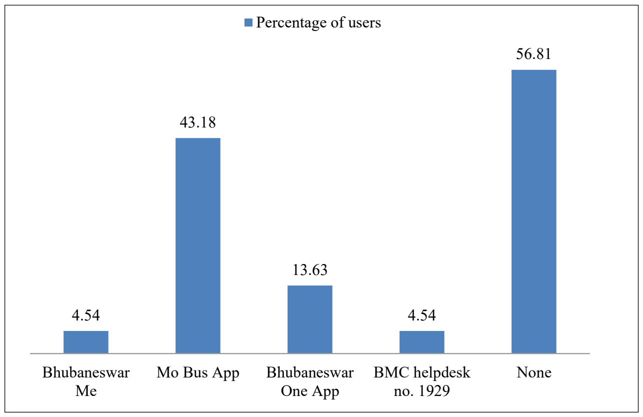

Figure-12: Citizen Response on the usage of apps, online portals and help desk (in percentage)
Source: Author

Figure-13: Project alignment with UN's Sustainable Development Goals

3. Discussion and Conclusion

This section of the report deals with the conclusion in the form of key lessons learnt and recommendations based on inferences drawn through understanding the key components, analysing project status and understanding the challenges and risks.

3.1 Implications

The Integrated Command and Control Centre, Bhubaneswar can be aligned with five of United Nation's Sustainable Development Goals (SDGs) as illustrated in Figure-13.

a. SDG 3: Good Health & Well-being
   The targeted outcome of SDG 3 is to reduce road injuries and deaths. Implementing pelican crossings, TVDS, Response and Incident Management System as part of this project has resulted in lowering the number of casualties by road accidents.

b. SDG 6: Water and Sanitation
   ICCC ensures adequate water supply along with monitoring water quality. The ICCC team has aligned with the Water Corporation of Odisha (WATCO) to maintain the water supply in the city.

c. SDG 9: Industry, Innovation and Infrastructure
   ICCC involves various technical components for conducting operations of different city departments. Embedding these different departments together helps in achieving the target of 9.1 that is to develop sustainable, resilient and inclusive infrastructure.

d. SDG 11: Sustainable Cities and Communities
   Provision of MO BUS Service, an affordable and reliable intra-city bus service, has made it possible to achieve the outcome target of a safe, affordable, accessible and sustainable transport system. In addition to this, water and air quality monitoring is done adhering to the outcome target of 11.6 which is to reduce the adverse per capita environmental impact of cities, including paying special attention to air quality and municipal and other waste management.

e. SDG 16: Peace, Justice and Strong Institutions
   The online services provided by BSCL and BDA help in developing effective, accountable and transparent institutions with a proportion of the population being satisfied with their experience of public services.

Following are the implications of the ICCC on different sectors:

i. Smart Traffic Management System
   a. The installation of a traffic violation detection system (consisting of Red Light Violation Detection (RVLD) and Speed Violation Detection (SVD)), as shown in Figure 14 (left), helped in reducing violation of traffic rules.
   b. Introducing E-challan as a traffic enforcement solution helped in reducing the load on traffic guards regarding penalty collection as traffic guards can focus more on managing the vehicular movements thereby, contributing to smooth traffic flow.
   c. The Automatic Traffic Counter and Classifier (ATCC) System, as shown in Figure-14 (right) helps in collecting real-time, reliable and precise vehicle flow information that is crucial for instant management of traffic on roads.
   d. Public address system and dynamic message sign boards help vehicle users and commuters in receiving updates from the BSCL or BMC as shown in Figure-15.
   e. Recording of traffic accidents through CCTV cameras assist the police department to investigate road accident cases as shown in Figure-16.

ii. Smart Tracking System
   a. The CAD/AVL system (Computer-Aided Dispatch/ Automatic Vehicle Location) helps in connecting the public transit (MO BUS) seamlessly with the back office scheduling and dispatching software. It collects important data used by the dispatchers such as bus GPS locations, schedule adherence status, breakdowns and emergencies.
   b. The citizens can make payments related to municipal services, utilities, parking, etc using the Odyssey City Card as shown in Figure-17. This helps to upgrade fare collection through digital initiatives.
   c. Bus and crew scheduling can be customised based on data analysis and Real-Time Data Monitoring (RTDM). In addition, RTDM of public buses help in resource tracking. Citizens can check the status of the bus through MO BUS tracking application as shown in Figure-18.

iii. Smart Parking Management System
The sensors-equipped on-street parking and multi-level car parking has been integrated with the ICCC. This helps the users to digitally book parking slots at the desired locations. The sensors installed in the parking spaces give real-time information regarding the status of parking to the parking operators, which helps in

Figure-14: Traffic Violation Detection System (left) and ATCC (right) (BSCL, 2022)t

Figure-15: Public Address System (left) and Dynamic Message Sign Boards (right) (BSCL, 2022)

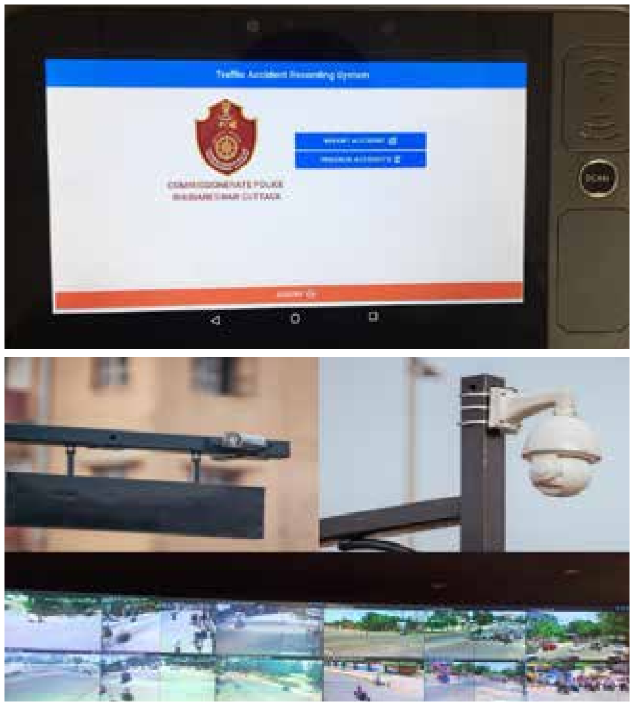

Figure-16: Traffic Accident Recording System (left) and Smart Response and Incident Management System (right) (BSCL, 2022).

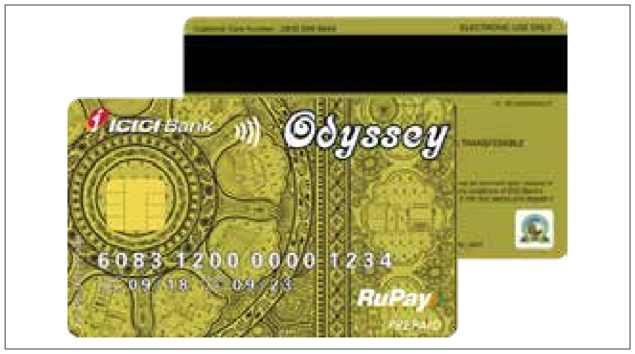

Figure-17: Odyssey Multipurpose Card (BSCL, 2022).

Figure-18: MO BUS Tracking App (BSCL, 2022).

Figure-19: Smart Parking Management System (BSCL, 2022).

increasing the efficiency of parking management as shown in Figure-19.

iv. Smart Response and Incident Management System
Access to live footage through a surveillance system equipped with 450 fixed CCTV cameras and 150 PTZ CCTV cameras, helps in decreasing the response time in case of any incident. Also, 75 digital kiosks placed at strategic locations have been equipped with an 'emergency button', which helps the users to connect directly to the ICCC.

v. Smart Governance and Smart connect.
Bhubaneswar Me and Bhubaneswar One help citizens to digitally avail facilities such as payment of taxes, registration of complaints, availing building approval plans and trade licenses, etc. Citizens can even track their complaints once registered as shown in Figure-20.

vi. Communication Network:
   a. Incorporating optical fibre cable networks throughout the city will help in increasing the efficiency of the digital interfaces through faster speed as shown in Figure-21 (left). The total network coverage is 680 km.
   b. Environmental monitoring systems installed at ten strategic locations, as shown in Figure-21 (right), help in getting real-time data regarding Air Quality Index (AQI) and noise level. If these parameters exceed beyond desired limits, it informs the authorities, after which necessary action can be taken.

3.2 Limitations of the research
The research conducted is limited only to the departments and systems which are closely related to the functioning of ICCC, Bhubaneswar. Further, field visits to departments like police, water supply, fire-fighting, etc, to get their additional inputs in improving the facility and the operations was not done and may be conducted in future.

3.3 Key lessons learnt
The key takeaways from the ICCC, Bhubaneswar, which can be incorporated in other similar kind of programs are as follows:

a. Adaptation of an end-to-end security model that protects data and infrastructure from malicious attacks, thefts, natural disasters, etc.
b. Hybrid architecture that includes on-premises and Data Centres
c. Creating a one-stop information hub through smart city platforms.

3.4 Recommendations
Based on the literature review on global best practices and the data collected by the IIT Kharagpur research team in Bhubaneswar, the key recommendations are:

a. Various sub-systems in the city should mandatorily be connected to ICCC in order to provide a common operating picture on city operations. This can be supervised by the officials of both, ICCC and Smart City, in normal circumstances as well as during emergencies.
b. ICCC is the brain and nervous system for city operations with access to a lot of valuable data and systems and also access to other data sets such as videos, audio & text data, both through field level systems like CCTV cameras or through social media or grievances received. It is thus recommended to have a robust IT Security system to be designed & implemented to safeguard the data & systems from internal/external threats.
c. There is a need to create awareness regarding digital services provided by the ICCC. As of now there is not much awareness. When citizens connect with the command centre through this digital interface, the goal of data utilisation by citizens will be achieved.
d. The health sector of the city needs to be brought under the purview of ICCC, Bhubaneswar. The geographical analysis of cases will identify the neighbourhoods with the highest infection rates and help in devising an appropriate action plan.

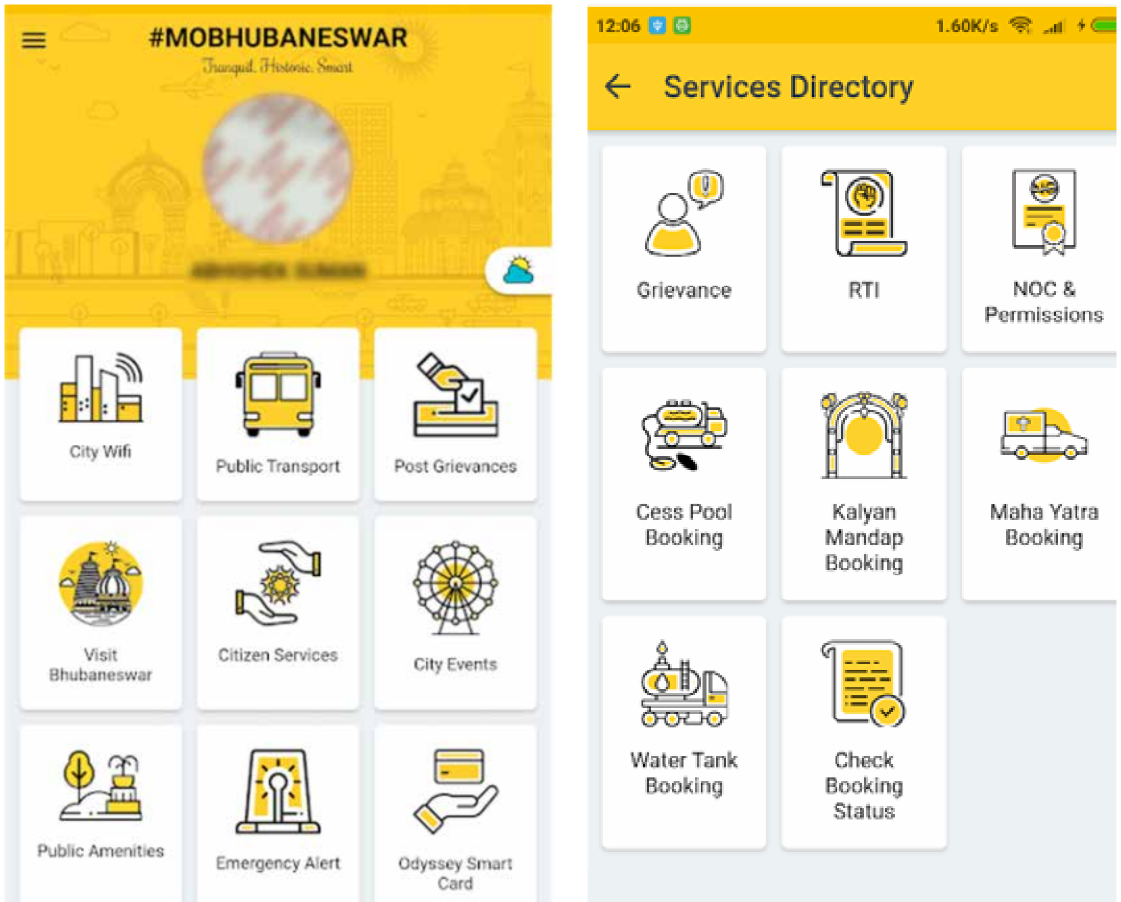

Figure 20: Bhubaneswar Me application interface (BSCL, 2022).

Figure- 21: Laying of Fibre Optics Network (above) and Environmental Monitoring Systems (below) (BSCL, 2022).

e. At present, the streetlight network of the city is operated manually. This needs to be upgraded by integrating it with ICCC, which will not only enable the switch off/switch on of street lights but also control the intensity of the light as per necessity. This will result in saving energy.
f. The various initiatives taken by BSCL and BMC such as the Socially Smart Bhubaneswar program and 'Citizen Connect' initiatives need to be integrated with ICCC. This will help in assessment of these programs with the help of real-time data.
g. Although BMC help desk numbers and other digital applications and web portals are provided to connect with the ICCC, other components like digital kiosks and panic buttons are not functional at some locations. Timely assessment and evaluation of these smart facilities is required to enhance its user efficiency. Also a few digital kiosks, which directly connect citizens with ICCC, were not properly located considering the surrounding barrier. These kiosks need to be placed where they can be easily approached by the people. In addition, pan-city implementation of components like digital kiosks and other smart traffic systems need to be done.

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A15

Smart Classes Project, Agra

Name of the project: *Nagar Nigam Inter College School and Girls High School*
Location: *Tajganj, Agra, Uttar Pradesh*
Year of Project Implementation: *2019*
Sector: *Smart classes*
SDG: *SDG 4 - Quality Education*
Project Cost: *Rs 0.61 crore (Rs 3 crore - entire upgradation and civil work)*

Institute: *IIT-Roorkee*
Advisors: *Faculty Coordinator: Dr. Arindam Biswas, Mentor: Ms. Nikita Ranjan*
Students: *Ms. Shipra Verma and Ms. Kritika Sharma*

Keywords: *Smart Education, Smart Schools, Technology Enabled Learning*

Abstract:

The Smart City Mission in Agra is based on the renewal, retrofitting and extension of the city. There are several flagship programs under the mission and one of them is the 'Smart Classes'. Agra Smart City Ltd (ASCL) is trying to improve 'how education is delivered in the municipal schools. It has implemented smart classes in two municipal schools in the ABD area (Area Based Development). The idea was to implement smart classes in all the classrooms which led to significant improvement in the quality of education. The project was completed in February 2019, and it is being used extensively by students and teachers. The research evaluated the condition, work and improvements in the system with the help of secondary and primary studies.

The primary study was done for both the schools. Students, teachers as well as officials were asked questions. This helped to know the ground reality and how the project was working. Since the project started in 2019, and the pandemic hit immediately after, it was hard to evaluate the work. It started working properly only by the end of 2020, so evaluations are based on this short experience. Indeed, it is a great initiative, as the number of admissions has increased drastically and student engagement has also improved.

Case Study: 15

1. Introduction

Agra Smart City:
Agra is located in Uttar Pradesh, a Northern state of India. Agra city is administered by the Agra Municipal Corporation. According to provisional reports of Census of India, the population of Agra in 2011 was 1,585,704, with 845,902 males and 739,802 females. The population of Agra Metropolitan Region which includes the Municipal Corporation is 1,760,285 of which 939,875 are males and 820,410 are females (Census of India, 2011).

In September 2016, during the third round of the Smart Cities challenge, Agra was selected to be developed as a Smart City. Agra Smart City Limited (ASCL), a Special Purpose Vehicle (SPV), was established to spearhead the Smart City project. The Companies Act is used to establish the SPV that carries out development projects at the municipal level. The Divisional Commissioner led the team to plan, approve, implement, manage, monitor and evaluate the Smart City related projects. Agra's Smart City projects comprise core redevelopment initiatives for Rs 2,133 crore. The proposed ABD is spread across 2,250 acres. The project will include areas around the Taj Mahal, Agra Fort and other important corridors of heritage and tourism in the city.

The area based development is an urban renovation, retrofitting and extension program started under the Smart City initiative by the Government of India in 2015. The goal was to enhance city infrastructure and improve the quality of life of the citizens. Each Smart City is expected to establish an ABD plan to revitalise an existing location through retrofitting, redevelopment and reconstruction. The pan-city plan would use smart city-wide infrastructure technologies to improve the infrastructure and services for all inhabitants.

The vision for Agra Smart City has been founded on the goals of its citizens as well as on an analysis of the city's strengths, weaknesses, opportunities and threats. Tourist-friendly, "memorable," "liveable," "culturally vibrant," "economically dynamic," "preserve and cherish history," "urban mobility," and "sustainable" were among the topics suggested by the citizens.

The vision statement for Agra Smart City is, "The City of Taj – where history is preserved, the environment is pristine, infrastructure is world-class and opportunities are plenty – a safe place to live, a great place to tour". The following flagship projects have been proposed under the Smart City initiative, which need to be implemented in the city.

- Integrated Command & Control Centre
- Micro-Skill Development Centre
- Automated Self-Cleaning Toilets
- Smart Health Centre
- Smart Classes

This research paper focuses on the study of **Smart Classes**.

1.1 Topic and Context

What is a Smart Class?
Smart classes are a way to teach students by using upcoming technology. This will enhance the teaching and learning experience for both teachers and students. Since it is a new skill-set, teachers need to learn it before teaching the students. It has been proved that visuals, videos and audios increase the memory of our brain, as we tend to remember the things we see and experience rather than just reading and writing. Smart classes are a way forward to enhance learning and creative skills, especially in children. The pandemic has also forced colleges and schools to adopt smart classes.

As technology and smartphones reach all household levels, it is observed that even children are getting used to operating smartphones. They spend more time on devices and are able to get a firm grasp on them. Smart classes are a way to teach them in a more creative and fun way. Smart classes are transforming their way of learning, making it easy and fun rather than it being a cumbersome task. According to the Indian education sector, only 10 per cent out of 1.3 million private schools have adopted the multimedia classroom teaching (Anu, 2021). This method engages students with the help of videos and animations. It also helps teachers to quickly evaluate the students' work and performance by making use of innovative technical instruments.

Traditional Classes vs Smart Classes
For traditional classes, teachers prepared lectures using textbooks and a chalkboard, while the students scribbled notes and essential points on paper. Students were occasionally brought outdoors for hands-on demonstrations and a better understanding of the subject. Students had to wait until the following day to raise questions in class if they had any uncertainties. Additionally, students used their textbooks and reference books from the school library to create notes. Furthermore, all examinations and evaluations were carried out manually.

Smart classrooms, like other types of classes, strive for high-quality learning, but the methods are different. Smart classrooms are equipped with computers, laptops, high-speed internet, LEDs, projectors, eBooks,

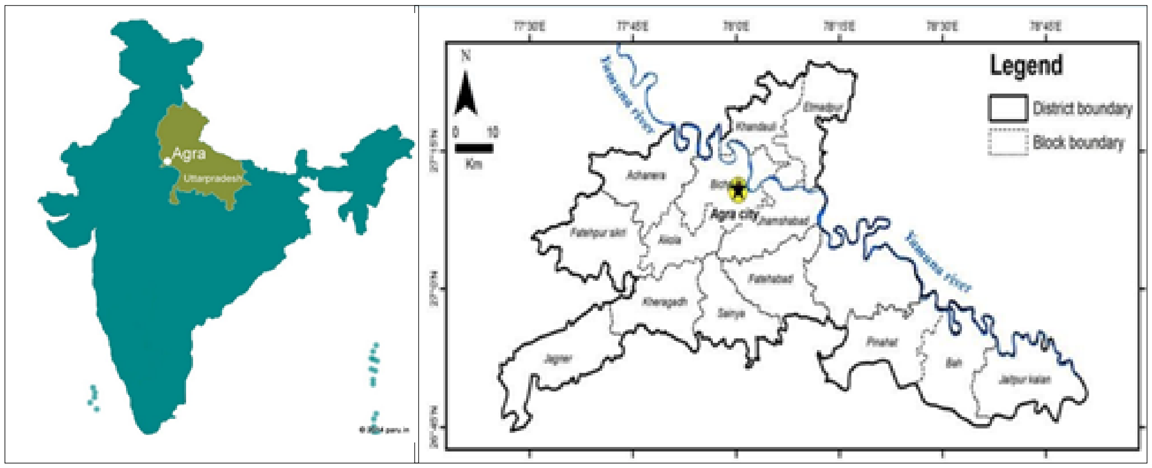

Figure 1.Location of Agra in India
Source: (Singh et al., 2020)

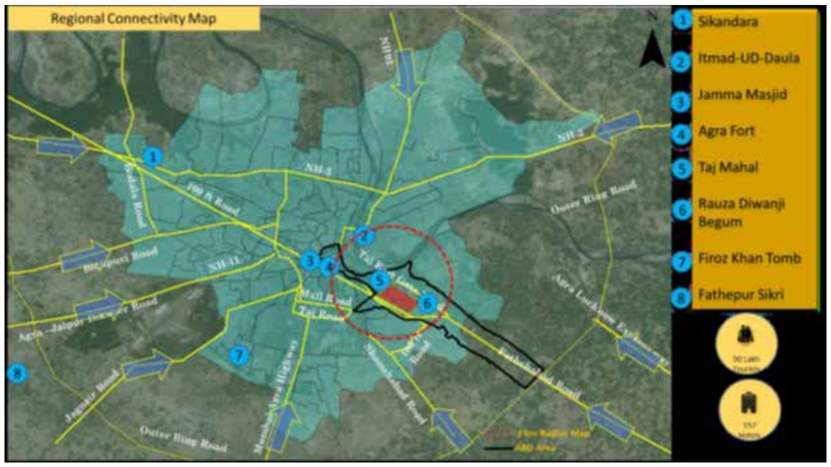

Figure 2. ABD Area and Regional connectivity map,
Source: Agra Revised Detail Project Report Estimated 2019

and other ready-to-use technology. Students participate actively in the classes, thanks to the audio and video lectures from their teachers and from professionals around the world. Teachers have direct access to their doubts, if they have any. Students can also communicate with their professors after the lectures and vice versa.

- Access to Online Information:
  Students and teachers have access to an online resource database and a variety of tools to help them study and teach more effectively. They gain access to online study materials such as movies, lectures, documentaries, PDF files and photographs, among other things.

- Accessibility:
  In smart classrooms, a high-speed internet connection allows students and teachers to rapidly access information from numerous educational sources, as needed.

- Connectivity:
  Smart classes are generally available in all locations for cooperation and motivation of distance learning. The goal of using technological tools to improve regional connectivity is to promote total engagement by students in learning from diverse places.

- Easy Access to Online Resources:
  It is simple for teachers to use computers to demonstrate concepts to pupils because smart courses are linked to internet and computers. One can extract and download study material using the internet. eBooks and other online learning resources are also readily available to students. In addition, the online mode of teaching makes exchanging of material easier for both teachers and students.

- Increased Productivity:
  In lesson plans with smart courses, students become more engaged and develop a higher level of interest. They have access to a variety of learning and practice resources to help them achieve improved results. It also promotes effective student-teacher interaction, allowing them to work together to achieve even better academic results.

- Interactive Learning Experiences:
  Teachers use projectors, presentations, movies and graphics to provide interactive sessions. This leads to growth of the student-teacher relationship, as the visualisation of lesson plans increases the students' curiosity and engagement, resulting in more inquiries and interactions between the two parties.

1.2 Scope of Research

a. The study is based on one of the flagship programs of Agra Smart City i.e., Smart Classes.
b. The first section of the study is based on secondary data and literature review and the second section is based on primary surveys.

1.3 Significance of the project

The project aims to provide quality education and change the way education is delivered in schools. Before this project was implemented, municipal schools were looked down upon because of poor infrastructure and unavailability of proper resources for education. This project not only provided better education opportunities to students but also changed the way municipal schools were looked upon.

The arrival of modern equipment for teaching and the infrastructure development attracted many parents and students to the municipal schools, rather than going to private schools, which were unaffordable for the lower-income groups. Now, people from the lower and middle-income groups are encouraged to send their kids to the municipal schools, since these schools match their level of performance with the private schools.

1.4 Aim and Objectives

The aim of the research was to analyse the quality of education provided in municipal schools by implementing smart classes (Nagar Nigam Boys Inter College and Nagar Nigam Girls School in Tajganj (ABD area).

The objectives of the project were:

a. To evaluate how quality of education has improved by smart classes.
b. To evaluate the problems faced in implementing the smart classes.
c. To evaluate how Covid-19 has changed the way in which smart classes work and the difficulties faced during the pandemic .

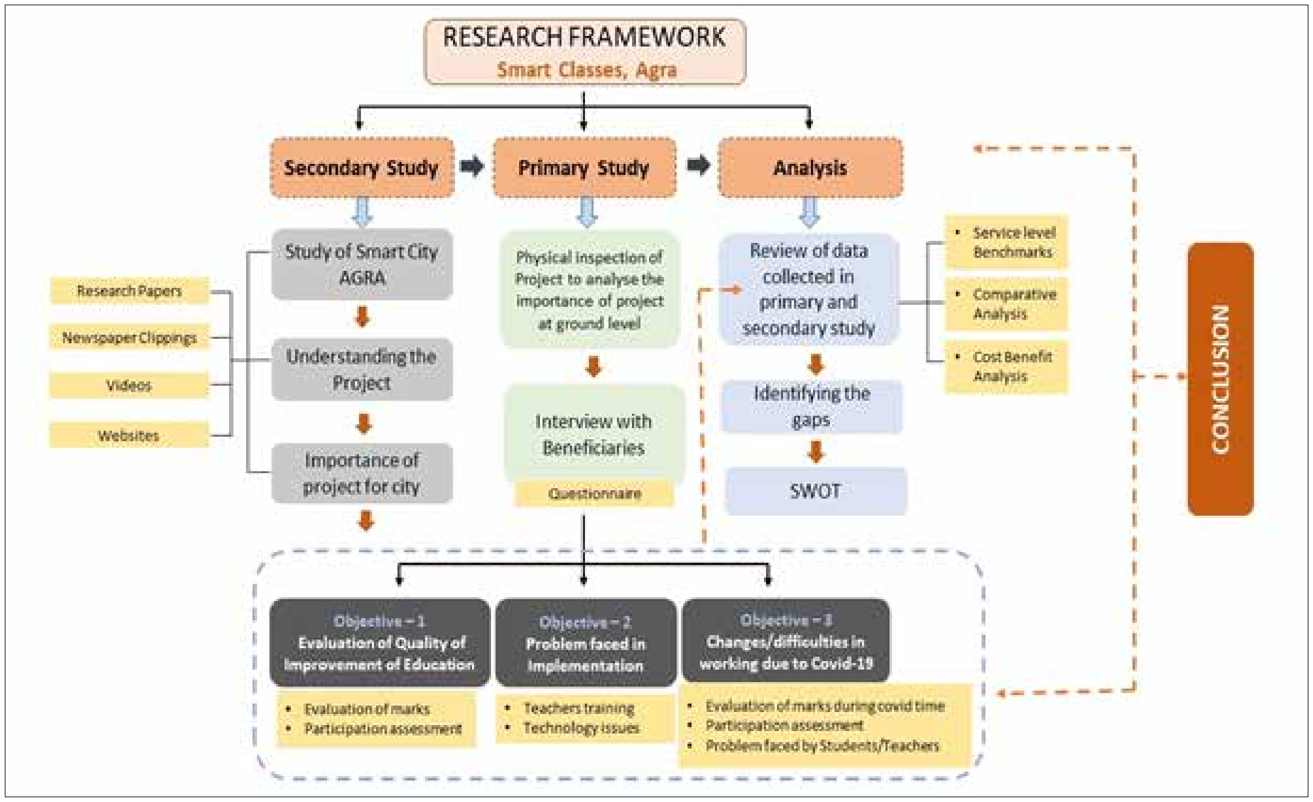

Figure 3: Research Framework, Source: Authors

2. Contextual Background

- Secondary study
- Design and proposal analysis
- Primary study and users' reviews
- Difficulties faced during Covid-19

2.1 Conceptual Framework:

Table 1 shows the detailed research framework. The research was designed in a categorised manner since every objective of the research required a different set of data and analysis. Accordingly, for each objective relevant methodology was devised to achieve the objectives in a systematic and concise manner. The methodology can be observed in the below table:

Table-1 Evolution Framework
Source: Authors

Sl. No.	Objectives	Evolution Framework
1.	To evaluate how the quality of education has improved by this initiative of Smart Classes.	a) Assessment of grades
		b) Performance assessment before and after the smart classes, involvement of students in class
		c) Change in the way students work (Classwork, homework, assignments)
		d) Increase in the number of admissions after implementation of smart classes

Sl. No.	Objectives	Evolution Framework
2.	To evaluate the problems faced in implementing the Smart Classes.	a) Teacher's training: To be equipped with tools on how the smart classes work
		b) Assessment of the gadgets and equipment used to conduct smart classes
		c) Internet and technical issues
		d) Issues related to the availability of study material for smart classes e) Inquire about maintenance problems, annual repair/service data regarding infrastructure
3.	To evaluate how Covid-19 changed the scenario of how Smart Classes work and the difficulties faced during Covid-19.	a) Number of admissions after Covid-19
		b) Assessment of grades
		c) Involvements of students in class. Is there an internet issue, class timings and any adverse effect on the children's health?

2.2 *Key features of the project*

Up-gradation of two municipal schools was implemented under the Smart City Project - Agra Nagar Nigam Inter College & Girls High School, in Tajganj.

Smart components

a. Interactive multimedia content
b. Projection equipment
c. Online support for students and teachers
d. Capacity building of teachers

The features of smart classrooms include the following:

a. Interactive Multimedia Content: The NCERT aligned interactive multimedia content for classes I to X which includes English, Mathematics, Science and Social Science. This comprised a variety of animation and video-based modules as well as simulation-based interactive virtual experiments which help students to grasp concepts by bringing real-world examples into the classroom.

b. Projection Equipment: With a compact, simple, yet powerful gadget like a projector, classrooms are dedicated to simplifying the way technology is used. It can be fully embraced by teachers when attached to any projection system. Teachers who were hesitant of using technology in the classroom will also quickly adapt to the digital teaching and learning environment.

c. Online support for students and teachers: This creates a shared learning ecosystem for students and teachers on a single platform with an account, username and password for everyone involved. Students can utilise this platform to engage with one another and share ideas. All information, including manuals, write-ups and videos are hosted on this platform. Students and teachers can communicate with professionals in their fields using the ask-an-expert option.

d. Capacity building for teachers: Practical demonstrations in constructive approaches such as inquiry, activity and project-based learning has been included in the teacher's capacity building exercise. This training will build on the instructors' existing skill-sets, ensuring that any transition is managed gently, seamlessly and successfully. Each semester, the teacher's capacity building is conducted within two 5-day workshops through online sessions and handholding.

Figure-4: Existing Plan of Inter College School
Source: Agra Revised Detail Project Report Estimated 2019

Figure-5: Entry Gate of the Nagar NigamInter College School,
Source: Authors

Figure- 6: Tajgang area just outside the Nagar Nigam Inter College School.
Source: Authors

Basic requirements of municipal schools:

Modifications to the physical environment:

While the school's infrastructure is adequate, certain minor improvements are required:

a. A water filtration plant is required for clean drinking water
b. Improvement of the school's toilets and sanitation
c. The school's environment can be improved by using BaLA (Building as a Learning Aid) by painting on the walls of classrooms and hallways to explain the curriculum themes and creating a vibrant learning environment in the process. Children are continually receptive to different sensory experiences and subconsciously assimilate inputs from their surroundings. The school environment can be improved to create learning opportunities at every turn of the building's contours to realise this potential. It can be carried out directly by the Municipal Corporation, with contractors providing need-based assistance in identifying areas for improvement and sharing designs where appropriate.

Computer Lab:

Technology-based learning solutions create a virtual learning environment that makes education more engaging and enjoyable. The IT-based education solution programme establishes an atmosphere in which learning and evaluation are enjoyable and the learning possibilities are equal for children in rural and urban areas.

"Equal knowledge for everybody" and "Assessment is Fun." To promote student retention and instructor effectiveness, it is advocated that technology classrooms be gradually integrated into the school. Under Ed-Value, the following aspects will be addressed:

a. ***Computers:*** A modern digital lab will be set-up for the school, complete with computers, scanners, printers and other essential hardware/software to teach students and instructors about technology-enabled learning as well as IT-skills and training.
b. ***Projection equipment:*** Use an interactive projection device like the one shown below, as well as a high-quality projection system.
c. ***Extended Curriculum:*** The school's existing computer lab can be reinforced by adding a relevant computer education programme, ensuring that students are well-prepared for the difficulties of the modern workplace and are able to benefit from the global digital revolution. Computer labs can be utilised for computer-assisted study of academic courses as well as train students on information technology. The curriculum structure focuses on the student's overall development and preparation as a global citizen. It includes WHO-recommended Life Skills, the 4Cs of 21st Century Skills (creativity, critical thinking, teamwork and communication), and information, media and technology skills (Agra Smart City Limited, 2019).

Locations of municipal schools:

Two locations were identified in the ABD area.

Table-2: Location of the schools

S. No.	Location Name	Proposal
1.	Agra Nagar Nigam Inter College School, Tajganj, Agra	Retrofitting and Equipment
2.	Girls High School, Tajganj, Agra	Retrofitting and Equipment

Agra Nagar Nigam Inter College School, Tajganj

The Nagar Nigam Inter College School is in the precinct of the Taj Mahal, at a distance of 600-m from it.

The medium of study is Hindi and classes are from 6th to 12th standard, with three or more sections for each class. Higher classes (9th to 12th) have four or more sections. It is an only boy's school till the 10th standard and offers co-education in 11th and 12th standards. The total number of students is approximately 900. Children from Tajgang as well as the neighbouring areas come here to study. Although the condition of the Nagar Nigam Inter

College School is better than the Nagar Nigam Girls School as some of the rooms are not in working condition, e.g., the physics lab, chemistry lab and library. The number of equipment in the labs is also insufficient and not all of them are working. The technical glitches and lack of proper internet connection hinder the functioning of the classes.

Smart components used in the classrooms:

a. Interactive Multimedia Content
b. Projection Equipment
c. Miyawaki Forest

Girls High School, Tajgang:

This school lies in the vicinity of the Taj Mahal in the Tajganj area (ABD area), within a 500-m radius. The school is affiliated with the UP Board and the medium of teaching is Hindi. It has classes from 6th to 10th standards. Every class is divided into two or three sections with around 60 students per section. There are around 600 students studying in this school. Presently, there are 10 teachers. There were only 400 students in the school before the smart classes project was implemented. Post smart classes, an increase in the students' admission has been observed.

Smart Classes Equipment:

a. Projector
b. Cameras
c. Speakers
d. White Boards
e. Monitors
f. Pen drives (Syllabus is stored in it)
g. Mouse
h. Smart Projector Pens

2.2.1 Challenges in the project

Unlike traditional classrooms, smart classrooms integrate education and technology with the internet, giving students access to web-based online learning through smart devices and provides teachers with innovative teaching tools to teach virtually through interactive programs.

Figure-7: Existing Plan for Girls High School
Source: Agra Revised Detail Project Report Estimated 2019

Figure- 4: Students studying in the smart classroom
Source: Authors

Figure- 9:Open Air Theatre
Source: Authors

However, there are significant logistical obstacles that come with implementing such programs, particularly in municipal schools, which frequently lack the necessary physical infrastructure. Some of these are:

a. The implementation of such schemes is frequently hampered by the construction of existing buildings.
b. Seepage and dampness through the roof.

2.2.2 Risks involved in the project

The deployment of smart classrooms in municipal schools carries the following risks:

a. Effective maintenance of smart boards and projectors
b. Teachers' and students' ability to adapt to the changing technology and learning environment. The program's effectiveness is dependent on the teachers' and students' willingness to accept the smart learning methodology.

2.2.3 Features and Benefits

Due to the execution of this project, admissions to these schools have increased by at least 6% in comparison to prior years. The ongoing teacher training programs have been organised to familiarise teachers with smart classes. So far, smart courses have been introduced in 23 classrooms across the two Nagar Nigam schools.

The evolution of a school can be viewed in terms of four factors that influence the quality of education:

a. Cognitive Environment: For pervasive learning
b. Social Environment: For a healthy school culture
c. Administrative Environment: For good professional connections
d. Physical Environment: For a pleasant learning environment

When all four factors of creating an active learning environment are addressed, schools become more effective. Some NGOs or contractors intend to collaborate with the Municipal Corporation of Agra's Value initiative to improve the active environment in these schools. To improve the quality of education, a holistic quality improvement programme has been conceived to create an active environment in a school, with emphasis on enhancing learning outcomes. The school will be outfitted with a mix of teaching and learning resources, technology infrastructure, administrative assistance, infrastructural enhancements and necessary capacity building efforts for teachers and the school administration as part of the programme. To ensure that the programme is effective, active project management and monitoring and evaluation is done.

2.3 Key findings from the interviews, surveys and primary data collection:

Smart classes in the municipal schools in Tajganj were developed as a tool to improve the teaching and learning experience of teachers and students. The redevelopment of the two municipal schools will benefit the population of the area because Tajganj is home to

Figure- 10: White board placed on top of the existing black board
Source: Authors

Figure-11 E-Toilet near the open air theatre
Source: Authors

Figure- 12: School Ground
Source: Author

Figure- 13: Books storage in Library at the Girls High School
Source: Authors

Figure- 14: Library Reading Area
Source: Authors

Figure- 16: Music Room in Girls High School
Source: Authors

Figure- 16: Music Room in Girls High School
Source: Authors

low-income families who cannot afford to send their children to private schools. The data from the two municipal schools was gathered through questionnaire interviews with six students and four teachers from the Girls High School and seven students and five teachers from the Nagar Nigam Inter College School, along with physical observations of both the schools. The students selected for the survey were from various classes and the teachers taught a variety of subjects.

Key findings from teachers/vice-principal:
Primary data was gathered from a total of nine teachers. The questions were asked in accordance with the objectives. Initially, they were given a five-day training to help them grasp how smart classes work, but the teachers believe that this is insufficient. Before Covid-19, they had received little training. Now, they want a thorough revision of what they had learned prior to the pandemic. Educators believe that the deployment of smart classes and general reconstruction has resulted in a 10-12 per cent boost in the overall grades of the students. Participation of students has also increased. Now, they ask more questions and participate in discussions. They work more efficiently in class, on assignments and at home. There has also been an increase in the number of admissions.

Teachers claim that there are enough gadgets in the classroom, but not all of them are functioning. The school lacks an efficient internet connectivity due to the availability of only one modem which is unable to cover the entire school. Some teachers also expressed dissatisfaction with the white boards being hung on top of the black boards. They require a black board for in-class activities and work. The syllabus is provided to them on pen drives, which can stop working or become corrupted by viruses. They don't have any technical support to overcome such malfunctions.

During the Covid-19 pandemic, teachers were not able to take classes. Although some teachers tried to teach through the online medium, but no support was provided to them by the school authorities. Even students were not able to attend the classes because of lack of gadgets in their homes. So, overall smart classes did not help much during the pandemic.

Key findings from students:
Overall, all the students interviewed were satisfied with their smart classes and enjoyed them. They were unfamiliar with this new form of teaching by using audio visual experiences, but they were eager to learn as much as they could. They also mentioned that their overall understanding has improved and that they are now better able to comprehend mathematics and science subjects. Although all classrooms have been converted to smart classes, not all subjects are taught using smart classes.

When asked about the pandemic, they said they had a lot of difficulties during lockdowns and that many of their friends dropped out of school due to financial difficulties. Also, due to lack of infrastructure and devices at home, many students were unable to participate in the online classes. Covid-19 created a void in their education.

3. Discussion and Conclusion

This entire project is a good initiative to improve education. It involved improving the skills of teachers and students. In the initial stage of the programme, the teachers were trained on how to teach in the smart classes and how to use technology to enhance the study experience for the children.

During the initial stage of the project, several challenges were experienced. During the project implementation, proximity to the Taj Mahal resulted in prolonged processes for the necessary construction approvals. During the operational phase, students and teachers experienced technical issues with the computers and other electronic devices. They needed dedicated services of technicians to resolve the equipment glitches.

They are also promoting new initiatives such as Miyawaki plantation, e-Toilet, rainwater harvesting and open gyms which are hardly seen in other schools. The officials claim that such initiatives will educate the students on environmental sustainability. Improvement in the quality of education and admission of new students are clearly evident in both the schools. The smart features being used in the school teaching pedagogy is attracting parents and students. Private schools are known for extensive use of smart classes. Using smart classes in public schools may improve the performance and perception of municipal and public schools. The improvement of the environment of the two public schools impacted their admission volume which increased significantly, beyond their capacity. However, smart classes were not helpful during the pandemic largely due to technical issues.

3.1 Implications (the impact assessment framework to be included here)

An impact assessment framework has been devised to derive the implications of the project.

Inputs:
This includes the allocated financial resources for the development of smart classes. The total project cost is Rs 0.61 crore.

Process:
The process includes surveying the existing condition of the municipal schools. The desired investments in infrastructure, equipment, capacity building and expenses for teachers' training and administration were made as per the budget. All processes were carried out by the Agra Smart City Limited.

Output:
The resultant output was the renovation of both the municipal schools which were equipped with all the necessary facilities to assist in the teaching and learning process.

Outcomes:
There is a 4-6% increase in student admissions. Students are enjoying the smart classes more than the traditional classes.

Impact:
There is an increase in the level of understanding of the students along with making teachers and students technically literate. The municipal schools are gaining in infrastructure as compared with the private schools.

3.2 Limitations of the research

The limitations of the research are listed below:

- Only a limited number of students and teachers were interviewed due to time constraints
- Data on the long-term impact of the project was unavailable

3.3 Key lessons learnt

The key lesson learnt from the secondary study:

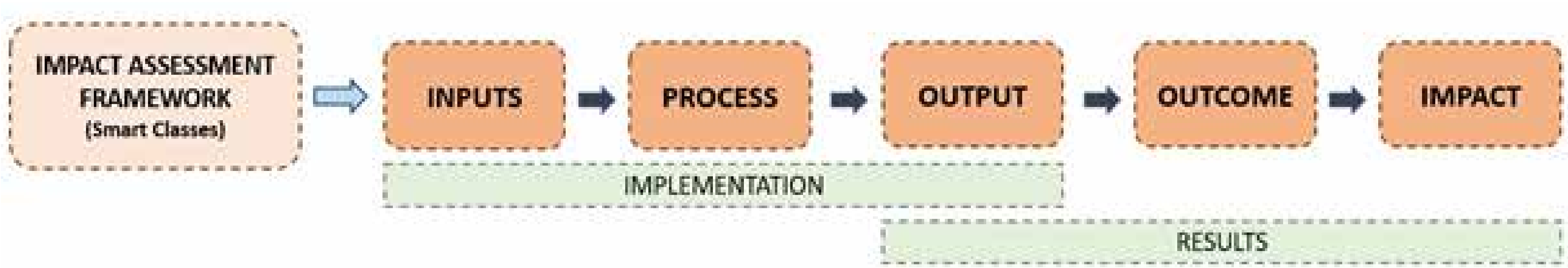

Figure- 16: Impact assessment framework. Source: Authors

Secondary data is very essential for urban planning and research, particularly in times of Covid-19. A careful analysis of the secondary literature is important to get a first-hand observation of the subject and arrive at a preliminary framework for the research. Well-documented literature enhances the overall experience.

The key lesson learnt from the primary study:
While preparing questionnaires, the details of the potential respondents including their age group, background etc was considered. One prominent learning is to have a mix of objective and descriptive questions to comprehend the stories associated with each question.

One of the primary skills is to be patient during surveys, particularly during filling the questionnaires. This enhances the quality of research.

3.4 Recommendations

Firstly, smart classes are a medium to enhance the quality of education, but it is not the only mode of study. The presence of a teacher and the inputs from a teacher cannot be replaced by smart classes. However, smart classes have a significant impact in making classes and teaching more interesting and interactive.

It is observed from the primary study that the online smart classes were not helpful for the students during Covid-19. One of the limitations was the lack of facilities and proper personal equipment for the students.

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A16

Overview of Integrated Command and Control Centre, Agra

Name of the project: *Integrated Command and Control Centre*
Location: *Agra Nagar Nigam Campus, near Sur Sadan, Civil Lines, Agra, Uttar Pradesh*
Year of Project Implementation: *On going (started in 2019)*
Sector: *Technology in Urban Management*
SDG: *SDG 3, SDG 10, SDG 11*
Project Cost: *Rs. 2980 Cr*

Institute: *IIT-Roorkee*
Advisors: *Faculty Coordinator: Dr. Arindam Biswas, Mentor: Ms. Nikita Ranjan*
Students: *Ms. Shipra Verma and Ms. Kritika Sharma*

Keywords: *Smart Information Management, Effective Collaboration, ICCC*

Abstract:

The major goal of the Integrated Command & Control Centre (ICCC) is to break down silos between departments and within departments, and to combine operations in order to better serve the public. It is proposed to construct a single shared operation centre as part of Agra Smart City. This centre will give an integrated picture of all smart component projects described in this document, with the primary aim of serving as a decision-making engine for municipal officials in day-to-day operations or during emergencies.

This centre will combine information from many departments to give a comprehensive reaction mechanism to the city's day-to-day concerns. The City Operation Centre will be fully integrated, providing client-server/web-enabled solutions for incident response management, collaborations, and geospatial display. Various ICT projects will be able to utilize data and intelligence obtained from other elements' operations, in order to supply municipal services more effectively and in a more informed manner.

This research assessed how the ICCC assists citizens and government officials in the proper functioning of a city, using a primary survey and physical observation of a limited set of places due to time constraints.

Case Study: **A16**

1. Introduction

Agra Smart City : Agra city, located in Uttar Pradesh state of India, is governed by Municipal Corporation which comes under Agra Metropolitan Region. . As per provisional reports of Census India, the population of Agra in 2011 was 1,585,704; of which male and female were 845,902 and 739,802 respectively. Although Agra city's population was 1,585,704; its urban / metropolitan population amounts to 1,760,285 of which 939,875 are males and 820,410 are females.

Agra was selected as a smart city in September 2016 in the third round of the Smart Cities Challenge.Following this, a special purpose vehicle (SPV), Agra Smart City Limited, was set up under the Companies Act to implement the development work at the city level. The SPV is headed by the Divisional Commissioner, who will plan, approve, implement, manage, monitor, and evaluate smart city-related projects.

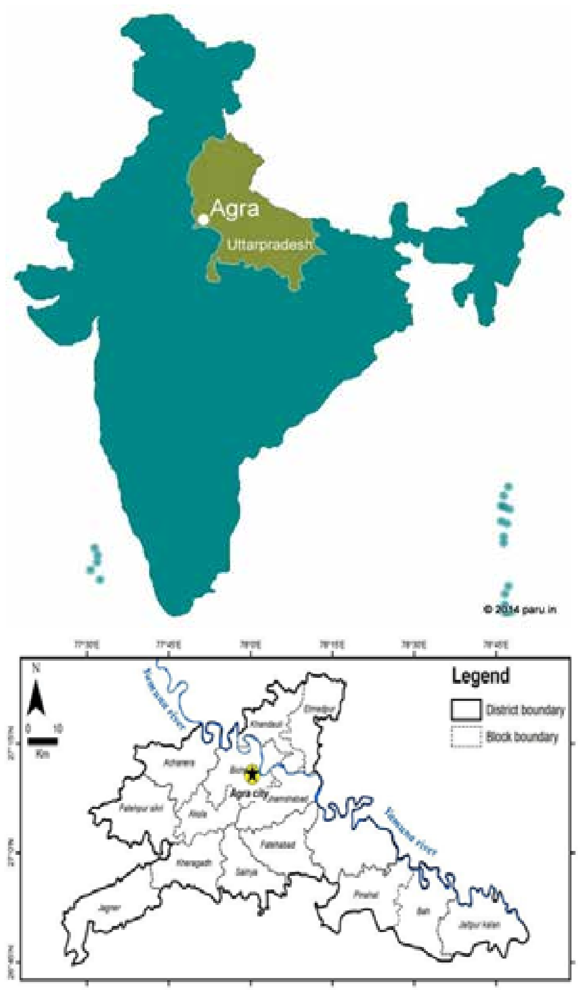

Figure 1. Location of Agra in India, Location of Map of Agra district showing various blocks, Source: (Singh et al., 2020)

The smart city proposal for Agra includes INR 2,133 core makeover plans. 2,250 acres of the area around Taj Mahal, Agra Fort, and other parts of the city will be covered under the project.

Smart Cities Mission is an urban renewal, retrofitting, and extension program of the Government of India, launched in 2015 with the aim of improving the infrastructure and quality of living offered by cities. It was envisioned that each smart city would create an Area Based Development plan to rejuvenate an existing location through either retrofitting, redevelopment or developing a greenfield location. The Pan-city plan would leverage smart solutions for city-wide infrastructure to improve the infrastructure and services available to all citizens.

Agra Smart City vision is based on the aspirations of its people and the analytical assessment of the strengths, weaknesses, opportunities, and threats for the city. The list of citizen suggestions included themes such as "tourist-friendly", "memorable", "livable", "culturally-vibrant", "economically-vibrant", "protect and celebrate heritage", "urban mobility", and "sustainable".

Figure 2. ABD Area and Regional connectivity map, Source: Agra Revised Detail Project Report Estimated 2019

Figure 3. Agra Nagar Nigam Office, Source: Author

The vision statement for Agra Smart City is:

"City of Taj – where history is preserved, the environment is pristine, infrastructure is world-class, and opportunities are plenty – a safe place to live, a great place to tour."

Flagship Projects under the Smart City Project:

- Integrated Command & Control Centre
- Micro-Skill Development Center
- Automated Self Cleaning Toilets
- Smart Health Centre
- Smart Classes

This research paper mainly involves the study of **Integrated Command & Control Centre.**

1.1 Topic and Context

Agra is the administrative capital of the Agra district and Uttar Pradesh's third most populous city. Apart from the Taj Mahal, the city is a prominent tourist destination with a number of UNESCO World Heritage sites, including Agra Fort and Fatehpur Sikri Fort. The Agra Development Authority (ADA) Area has witnessed the extraordinary geographical expansion and population growth in recent decades, growing from 61.80 sq km in 1971 to 520.20 sq km in 2008. The city's population increased from 5.91 lakhs in 1971 to more than 9.78 lakhs in 1991, and the city's population was found to be 12.75 lakhs in the 2001 census. It is now a million-plus city. Despite the significant geographical growth, disproportionate spatial development has resulted in regions of high density in terms of employment and population, putting strain on the city's infrastructure. Agra is rapidly urbanizing. This growing urbanization offers the city a unique opportunity to accelerate its development while also addressing long-standing urban issues. The urban infrastructure development has lagged behind population expansion, resulting in demand and supply shortages in sectors like water, waste management, energy, mobility, built environment, education, healthcare, and safety. A city generates a lot of data and the effective utilization of this data is crucial for the sustainable growth of any region. Therefore, the Agra Municipal Corporation wanted to foster the development of a robust ICT infrastructure(Technology in Urban Management) that supports digital applications and ensures seamless steady-state operations, transportation and traffic management, emergency response mechanisms, and real-time tracking of services and vital city metrics throughout the city and in government departments in order to achieve its goals.

1.2 Significance of the project

The floating population is a big issue in Agra. Tourists and short-term migrants visit Agra for a variety of reasons and stay for varying lengths of time. The city government faces issues in terms of sanitary facilities, toilets, solid waste management, sewage, water supply, and transportation. Furthermore, Agra attracts roughly 19-22 percent of the entire population per day for employment and other official/business/personal purposes from adjacent villages and metropolitan areas. The floating population is estimated to be around 0.3 million people per day (AJS, 2015).

Cities are looking for ground-breaking technology interventions to manage the demand of an exponentially growing population in cities (also attributed to migration from rural areas for better economic opportunities) in order to bring in efficiency and optimization for providing a better living environment to its inhabitants. Compared to the conventional inefficient silo-ed departmental style of the city administration, the Integrated Command and Control Centre platform enables cities to achieve more with less by moving to real-time data-driven decision/policy making with enhanced situational awareness.

The ICCC serves as the "nerve center" for operations management, day-to-day exception handling, and disaster management. It also delivers insights by aggregating complex data sets to derive insights. By integrating multiple systems/applications in different technologies using different platforms into a common platform, the Integrated Command Control Centre reduces the complexity of dealing with multiple systems/applications in different technologies using different platforms to leverage intelligence for making informed decisions. Such successful Integrated Command and Control Centers would become an important component of Indian cities,by providing a long-term solution to the needs of 400 million urban people who are expected to become urbanized over the next 35 years. The ICCC is designed to collect data from a variety of apps and sensors installed across the city, then present actionable data with suitable visualization to decision-makers.

The Integrated Command and Control Centers are designed to be the brains behind municipal operations, exception handling, and catastrophe response. Water, waste management, energy, mobility, the built environment, education, healthcare, and safety will all be captured and generated in real-time by the sensors and edge devices. The ICCC platform, with its various layers and components, will operate as a decision support system (DSS) for city administration, allowing it to respond to real-time events by consuming data feeds from various data sources and processing information from the data sets.

1.3 Aim and Objectives

To analyze the impact of ICCC on promoting a better quality of life for residents and also on enhancing and improving the efficiency of municipal services in the city.

The objectives of the study are:

a. To analyze how ICCC has benefitted the residents of the city. (Citizens)
b. To analyze the role of ICCC in effective monitoring and management of service delivery within the city. (Administration)
c. To evaluate the impact of the ICCC to combat the COVID-19 pandemic in Agra.

2. Contextual Background

2.1 Conceptual framework / Research design

The evaluation framework adopted for the study aims to achieve the broader objectives through a unique set

Figure 4. Command and Control Centre, Source: Author

Figure 5. Command and Control Centre, Source: Author

Figure 6. Cameras installed in the junctions, Source: Author

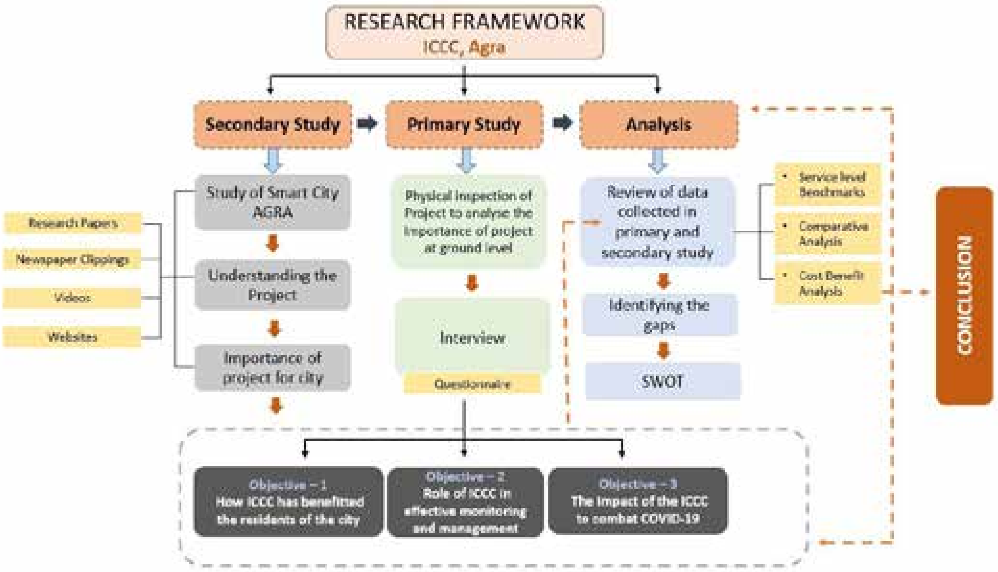

Figure 7. Research Framework, Source: Author

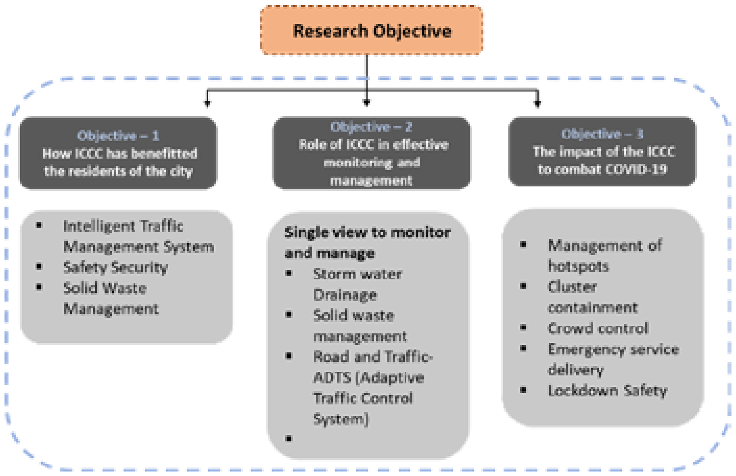

Figure 8. Objective assessments framework, Source: Author

of data analyses for each. The evaluation framework is shown in the table below.

S.No.	Objective	Evaluation Framework
1	To analyze how ICCC has benefitted the residents of the city.	By analyzing reduction in crime rate
		Ease of traffic movement
		Reduction in number of accidents
		Impact on public safety
2.	To analyze the role of ICCC in effective monitoring and management of service delivery within the city.	Number of services linked with ICCC and scalability to other departments
		Ease of service delivery within the city
		Impact on decision making
		Budget of the project
3.	To evaluate the impact of the ICCC to combat the COVID-19 pandemic in Agra.	Service delivery linkage with ICCC
		Lockdown management and monitoring
		Functioning of the 'Agra Model' of combating the COVID-19 pandemic

For conducting the mentioned research, a methodology was devised as shown in Figure 7. It includes analysis of secondary and primary data to achieve the desired objectives of the study.

Extensive analysis of the available secondary literature has been a significant part of the research to arrive at the primary aims and objectives of the study. The institute complemented this data by conducting the primary survey through field visits and interactions with the officials. The primary survey uses open questionnaires and on-site visits t

Command and Control Centre. The data/information obtained from the interview is used to analyse the impact of ICCC on various users.

2.2 Key features of the project

2.2.1 Challenges in the project

a. Different government agencies (local, regional, state) work in silos. Integrating the operations of all was a challenge.
b. Creating synergies between various urban systems like water supply, sewerage, solid waste management, transportation.
c. Covering all parts of the city and all households under the project.
d. Vandalism of the component infrastructure poses a major challenge in the effective implementation of the project.

2.2.2 Risks involved in the project

a. Theft of infrastructure components.
b. The risk involved with the OFC (Optical Fibre Cable) being cut because of any activity/incident, could lead to the entire camera system shutting down.
c. Third-party departments doing underground digging without informing the ICCC could create issues.
d. Since the entire system is cloud-based the risk of a cyber attack always exists.

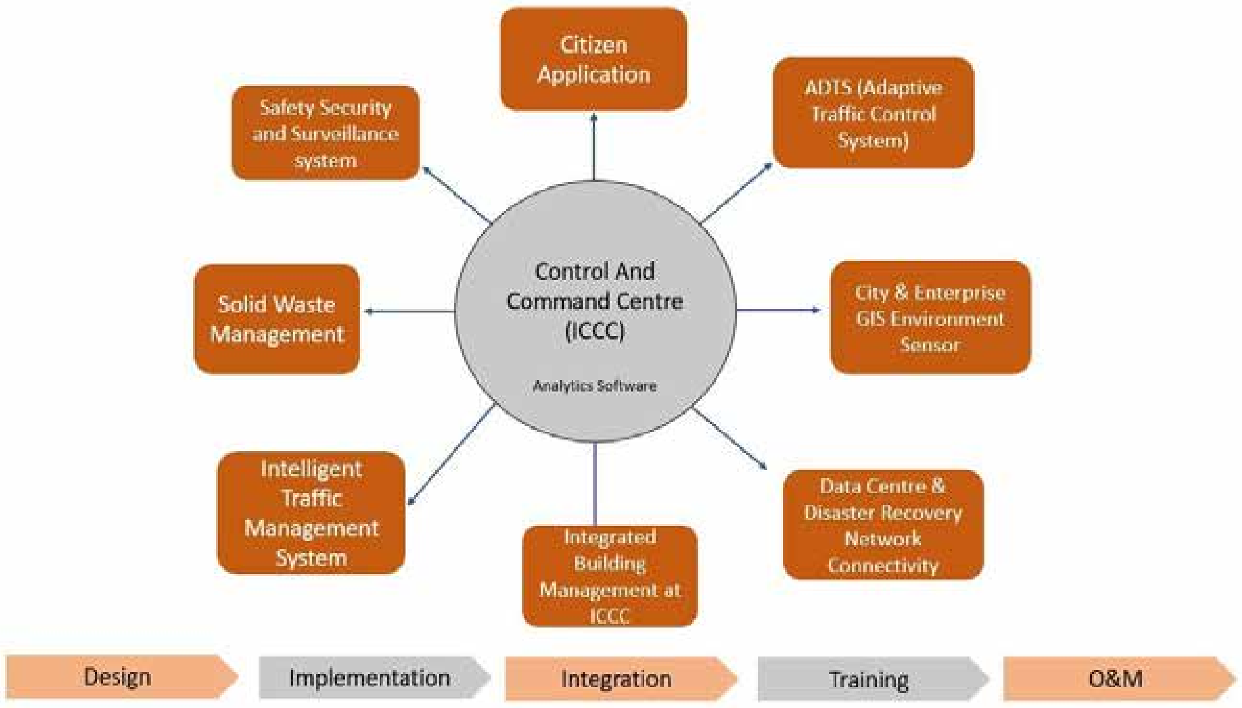

Figure 9. Key Components of ICCC, Source: Detailed Project Report for Information Communication and Technology (ICT) Components

2.2.3 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)

a. The Agra Smart City ICCC is a vital convergent technology that allows all technological implementations in the city to be monitored, managed, and optimized in order to improve the service delivery quality.
b. It's a platform that connects all city services and allows the city to manage cross-functional service delivery.
c. Agra ICCC is integrated to manage the following systems:
    - Safe City Cameras Feed (CCTV): 1250 CCTV cameras have been located in around 240 locations for security and surveillance of the city. The cameras are also equipped with various analytics like facial recognition systems and alert generation.
    - Intelligent Transport Management System (ITMS): ITMS is installed in 43 traffic junctions of the city. ANPR(Automatic Number Plate Recognition) cameras are installed, which capture any traffic violation incident like red light violation detection and no helmet detection along with the number plate. The information is automatically received by the traffic police sitting in ICCC, which issues e-challans to the offenders. It is also linked with the Vahan and Saarthi database along with NIC.
    - Adaptive Traffic Control System(ATCS): ATCS is installed in 63 junctions in Agra. The entire traffic data is captured in ICCC. It works in three different modes. First is the VAC(Vehicle Actuator) mode, which is completely automatic, based on AI learning. The system learns the traffic pattern and flow, and based upon that, the duration of the signal lights is decided. The second is the fixed mode in which a cycle of 180 seconds is equally divided as per the need. The third is the manual mode, which is dependent on the traffic police.
    - Environment Sensors: In 39 locations, environment sensors have been installed in the city. The sensors measure 18/20 parameters on a real-time basis. Data on AQI(Air Quality Index) is stored in ICCC.
    - Emergency Response and Disaster Management: Emergency panic buttons have been located in 43 locations. The distress calls are attended by the ICCC. Fifteen dial-112 vehicles operate within the city and are installed with cameras. Miniature ICCC has also been created in the police control room.
    - ICT-based Solid Waste Management Services: RFID tags have been installed in 3,50,000 households to monitor the collection of solid waste. The information is recorded in the ICCC and also sent to the household. SWM collection vehicles are equipped with a GPS system to facilitate route mapping and

tracking of vehicles. Bin volume sensors have also been installed in some bins, wherein an alert is generated when the three-fourth bin capacity is reached, the nearest vehicle can empty the bins.

- City GIS Platform: The entire commercial and residential properties in Agra have been mapped. Agra Smart City has established an enterprise GIS system that is connected to 12 departments and systems for land, estate, disaster and emergency services, parks and gardens, water, sewerage, roads and traffic, stormwater drainage, streetlights, and capital project monitoring and control.

Replicability/Scalability:

a. ICCC can be seamlessly integrated with additional city-systems in future, including
   - Municipal Corporations Call Center
   - Municipal Corporations Services Portal`
   - Met Department
   - City Application
   - Water Management System
   - Fire Brigade Control System
   - Smart Parking
   - Public Bike Sharing

b. The platform is easily replicable in other regions and can be customized to include the unique input systems, features, analytics, and insights needed by those cities.

Key Benefits:

a. Social:
   - Ensuring public safety through CCTV-based video surveillance, which is helpful in deterring, detecting, and thus dealing with criminal activities.
   - Improved living standards, satisfaction, and urban quality of life through enhancedpublic safety, shortening daily commutes, boosting public health, and creating a cleaner, more sustainable surroundings.
   - Assists in minimizing occurrences, such as the spread of infectious illness, while assuring compliance. ICCC played a significant role in managing the pandemic in the city by monitoring lockdown safety, crowd control, and delivery of essential and emergency services.

b. Technical:
   - Use of cloud-based Data Center Disaster Recovery (DC-DR) to host the common command center and save data related to common command center applications.
   - Real-time field information is sent to ICCC. The data is also stored in the data centre, a copy of which is saved on the cloud.
   - Geo-tagging of the city infrastructure and GIS-based mapping to create a comprehensive system of geospatial maps.

c. City Administration:
   - ICCC uses city technology to assist the governance of city functions, services, vendors, and staff, as well as to effectively administer services for residents from all walks of life.
   - The data from all of these systems and devices provide municipal officials with real-time,comprehensive insights, allowing them to make judgments about current city operations and future growth plans.
   - With the use of advanced technologies, human resources could be put to better use. For instance, with the development of ATCS in city junctions, the traffic police have been assigned for handling crime within the city.

d. Economy:
   - Timely monitoring and effective management reduce loss to the public infrastructure.
   - The use of digital technology for effective management and improved operational efficiency of services within the city reduces the time overrun, thereby reducing the economic loss.
   - Reduction in maintenance loss, because of timely monitoring of systems.
   - Creation of skilled jobs within the ICCC.

e. Environment:
   - Proposed 39 Environment Sensors (6 sensors with special parameters around the Taj Mahal) across the city to monitor air pollution levels.
   - These sensors gather data, based on certain parameters like air pollutants, and ambient conditions (temperature, noise, humidity, pressure, light) on an hourly basis.
   - The data from the sensors can be utilised for dealing with the problem of air pollution

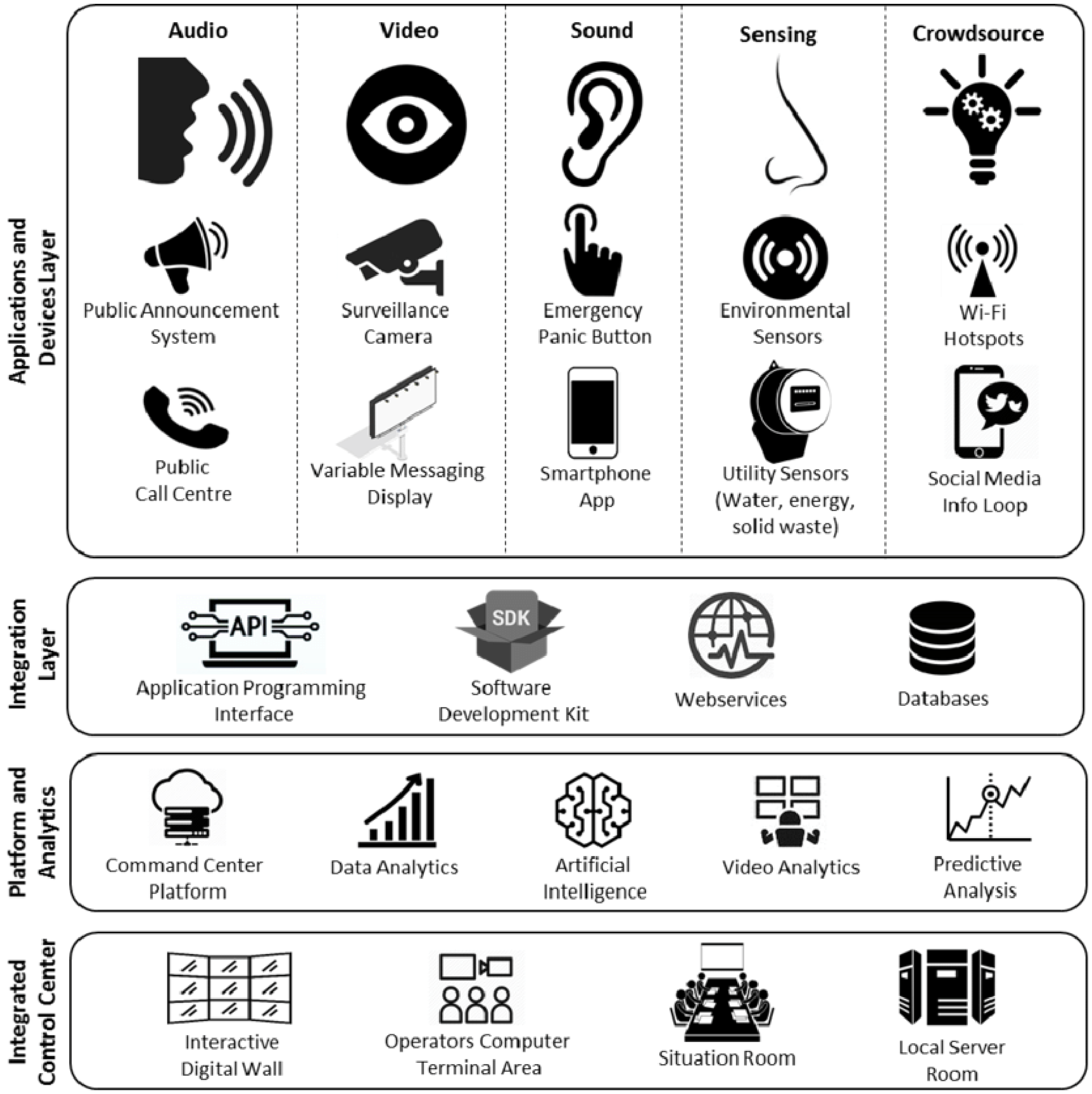

Figure 10. Typical architecture of the Integrated Command and Control Centre in Indian cities, Source: (Praharaj, 2020)

in sensitive locations. Adequate mitigation measures can be adopted by the government after analysing the information from the environment sensors.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

1. Smart City Integrated Command & Control Centre (ICCC) as 24/7 COVID-19 war room:

   The district control room, grocery helpline, security & surveillance functions, traffic monitoring, lockdown monitoring, live telecast of advisories through VMS systems and PA systems, and video conference facility with relief commissioner in Lucknow are all integrated here as part of the smart city mission's integrated command and control centre, which served as COVID -19 war room. In the ICCC, a 25-member team worked around the clock to combine diverse COVID-fighting activities.

   Smart Health Centre:

   The Smart Health Centre, which was built under the Smart City initiative, helps to raise awareness about the numerous Dos and Dont's of Corona. Each patient is given a 3-5 minute briefing on the Corona advice for both general consultation and dentistry clinic. In March 2022, 325 patients sought advice, compared to 675 in February 2022. The pharmacist at Smart Health Centre delivered 1015 hand sanitizers and 935 masks at subsidised rates, providing considerable relief to the people.

   Online Information Portal for Grocery at your Doorstep:

   The Agra District Administration and Agra Smart City collaborated to ensure doorstep delivery. The entire 100 wards of Agra City were surveyed, and specific kirana shops and fruit/vegetable vendors were identified ward by ward, and their mobile numbers were transmitted to various house owners who had provided their mobile numbers during the GIS property survey and SWM RFID tag installation. Bulk communications were sent out by wards regarding grocery stores and vegetable vendors who delivered the stuff to the consumers'houses within 24 hours, and the tariffs for various basic commodities were regulated to prevent stockpiling and price rises. Zomato and Big Bazar also partnered to bring groceries to their doorsteps.

   Agra Smart City Combats COVID 19 using Technology – Launches Agra Lock-Down Monitor App - A Secura (CSR Initiative):

   The Agra Administration, in collaboration with Agra Smart City and Agra Police Department, utilized the ICCC Control Room, which was created by the Agra Smart City Limited at Nagar Nigam Agra.

   In the presence of the IG, Agra Range; SSP Agra; Municipal Commissioner, SP Traffic; and other Agra Police and Agra Smart City officials, the Divisional Commissioner, Agra, launched the Agra Lockdown Monitoring App at the Command & Control Centre.

   This cutting-edge video surveillance system is used to properly monitor numerous sites throughout Agra in order to regulate crowds and combat COVID 19. The AI-based Analytics, the first of its kind, to battle COVID-19 in Agra, is the most recent example of these initiatives.

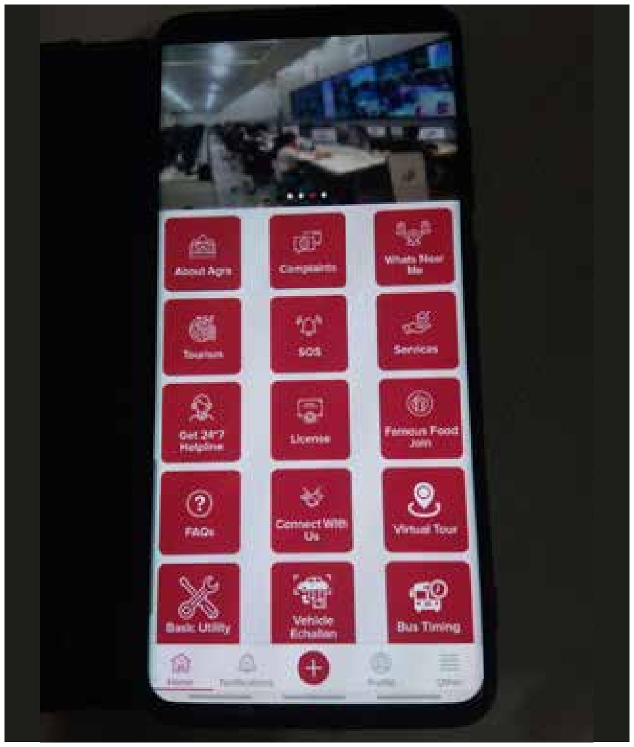

Figure 11. 'Mera Agra' App Interface, Source: Author

2. Due to ICCC's CCTV surveillance initiative, the crime rate has decreased by 4-5%.
3. Operation and maintenance issue: vandalism is seen in several places, which leads to inefficient working of ICCC.
4. There are a lot of facilities provided to the citizens by ICCC, but there is a lack of awareness, caused due to the lack of awareness programs.

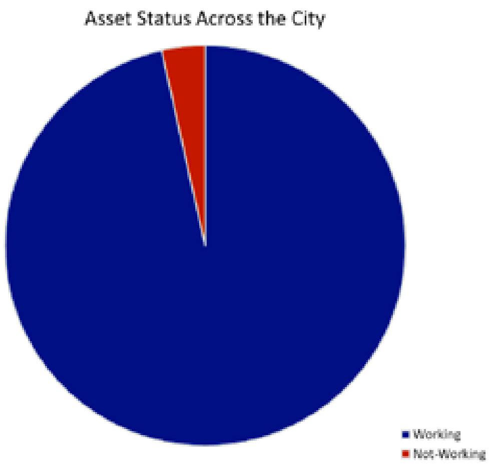

Figure 12. Working and non-working assets in the city, Source: Author

5. Not functional in all locations: it is observed from the primary survey and the data from ICCC,about the equipment not working in all the locations, leads citizens to take traffic rules lightly.
6. A new app is under process by ICCC for citizens, known as ***'mera agra app'***. This app will provide citizens with one single platform to tackle city-related problems. For example e-challan, water metering, filing complaints, what's near me, tourism and basic utilities, etc.

3. Discussion and Conclusion

One of the key goals of Agra's smart city mission is to improve the safety and security of Agra residents and the tourists who come to see the Taj Mahal, the city's heritage monument and a symbol of love, affection, and love. Another goal was to increase the law enforcement and public awareness among Agra inhabitants on different aspects such as traffic rules, safe driving, solid waste, and improved sanitation, all of which will improve residents' quality of life and municipal service efficiency. Therefore, as part of the 'Smart Solution' for the city, ICCC was developed to improve infrastructure and services through the use of technology, information, and data. Projects such as a city-wide video surveillance network, real-time monitoring of environmental quality, large-scale installation of smart energy and water meters, and the development of intelligent transportation and traffic solutions are among the typical smart solutions proposed in the approved proposals.

The first objective of the study was to analyze the benefits of ICCC for the residents of the city.

ICCC integrates the operations of various departments in the city. With the ability to accept, intelligently correlate, and share data with city operations and planning stakeholders, the goal is to improve safety, security, and public services in Agra. As a result of these smart applications and systems, there has been a considerable change in the behavior of the citizens. People are adhering to the traffic rules. However, it was found that this was the case only in those ITMS junctions where the ANPR cameras were functioning properly. The presence of CCTV surveillance across the city helps ensure public safety. The surveillance cameras have not only helped deter crime but also protect the city infrastructure from theft and vandalism. This is assisted by the panic buttons across 43 locations in the city. The awareness in the public about these facilities, like panic buttons, remains to be assessed. Also, the criteria for the selection of 43 locations should be analyzed to assess their functional viability. Public announcement systems also exist in key locations of the city. The ambient noise levels however, hampered their efficient functioning.

Services like transportation, solid waste management, city surveillance, GIS-based city mapping have been linked to the ICCC. The integrated functioning leads to efficient service delivery. However not all departments have been linked to the centre. The scalability to other sectors will further enhance the functioning. The use of technology in service delivery has led to better decision-making on the part of the city officials. This was experienced during the COVID-19 pandemic. The Agra model of handling the situation was well appreciated. Another advantage of the use of smart technology is that the human resources could be put to better tasks. The huge amount of data generated in the ICCC is stored in its data centres and on cloud. This data could provide insights to the officials and lead to informed decision-making.

The district control room, grocery helpline, security & surveillance functions, traffic monitoring, lockdown monitoring, live telecast of advisories through VMS systems and PA systems, and video conference facility with relief commissioner in Lucknow are all integrated here as part of the smart city mission's integrated command and control centre, which serves as COVID -19 war room. In the ICCC, a 25-member team works around the clock to combine diverse COVID-fighting activities.

Technology alone is not capable of making a city smart. Smart cities are built by smart people. Informed and responsible citizens form the essence of any smart city. The use of cutting-edge technology is important for growth and development but so is the involvement of the people of the city. Only then can our cities be truly smart in all aspects.

3.1 Implications (the impact assessment framework to be included here)

Input: The Bharat Electronics Limited is a Navaratan PSU and it is one of the 9 PSU under the Ministry of Defense of India. The Bharat Electronics Limited (BEL) consortium has been granted Rs. 336 crore to Agra Smart City Project.

Synergy and Bookman are part of the BEL collaboration for Agra Smart City. BEL is the project's system integrator for smart waste, CCTV, video analytics, smart transportation, surveillance, Intelligent Traffic Management System (ITMS), and violation.

Measurable Outputs:
Agra city has installed the following:

a. 790 Fixed Box and 326 PTZ cameras
b. 43 Emergency Panic Buttons
c. 50 Body-Worn Police Cameras
d. 48 Upgraded UP Dial 100 vehicles
e. Automatic Number Plate Detection Cameras at 43 Junctions
f. Red Light Violation Detection Cameras at 31 Locations
g. Adaptive Traffic Control Systems at 62 Junctions
h. 39 Environmental Sensors

The Integrated Control and Command Center receives data from various systems for analytics, visualization, alerts, and event triggers.

Key Impacts:

a. Interconnected systems, data, and advanced analytics to address social, residential, commercial, and national threats
b. Use of technology for integrated and efficient control and management platform
c. Ability to adapt a structured approach to handling incidents effectively and efficiently
d. Effective replacement of legacy and manual systems with automated and hybrid processes
e. Ongoing business process reengineering, training of leaders, and capacity building in city staff in managing the command center
f. Focus on safeguarding personal data
g. Effective use of video wall via adequate training

3.2 Limitations of the research

The audience ICCC is catering to is huge, as it is a pan-city project. The primary survey is limited to the administration and officials only. This added a degree of subjectivity to the responses which could not be cross-verified with other sources.

As ICCC is a pan-city project, it was difficult to survey all the locations physically

3.3 Key lessons learned

Research work primarily involves the study of secondary and primary literature. Secondary data is essential when we think of doing any research work, particularly in times of COVID-19, when such uncertainty persists concerning the field visits and interviews. Also, careful analysis of the secondary literature is necessary to get a first-hand observation of the subject and arrive at a preliminary framework for the research. Well-documented literature enhances the overall experience.

The primary survey included discussions with the officials. Cooperation of the authorities is a crucial factor. The officials in Agra provided the best on-field support.

3.4 Recommendations

The project is working well overall, but there is a lack of citizen awareness about the benefits and opportunities that they receive from the ICCC. One example is the panic button, which is not very obvious where it is placed and should be displayed more prominently. The panic buttons are mostly found at traffic intersections, but not in shady areas, where they may drastically reduce the city's crime rate, if implemented.

The ICCC is a massive data repository, but it appears that the data is notbeing utilized to its full potential.

This information might be used in academia, such as planning and architecture schools, to improve cities; however, it is not widely available to students and researchers. If the information gathered is shared with students and other research institutes, it will aid in the establishment of similar projects in other cities.

Figure 13. Impact assessment framework, Source: Author

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A17

Critical Assessment of Dehradun Smart City Water ATMs

Name of the project: *Critical Assessment of Dehradun Smart City Water ATMs*
Location: *Dehradun, Uttarakhand*
Year of Project Implementation: *2019*
Sector: *Technology in Urban Management*
SDG: *SDG 6*
Project Cost: *1.98 Crore INR*

Institute: *IIT-Roorkee*
Advisors: *Faculty Coordinator: Dr. Arindam Biswas, Mentor: Sagar Sinha*
Students: *Mr. Dibyank Darshi*

Keywords: *Water ATMs, Water Purification, Service Efficiency, Waste Management*

Abstract:

Water being an essential resource for a human living should be one of the primary goals to deliver for any government. Water ATMs are a resource developed to dispense safe and cheap water. Under the Smart City Plan in the ABD area in Dehradun, providing safe drinking water at nominal rates through an array of Water ATMs was proposed. In this context, 24 locations were identified for setting up Water ATM units.

Dehradun was selected to be developed as a Smart City and the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes (Government of India, 2016).

This project is an integration of water resource procurement, its processing and service delivery which gives out different research areas to ponder but this research paper focuses on the identification of locations where the facility is most needed, the water resource processing techniques employed and its justification and the management of waste generated during the functioning.

The developed facility of Water ATM is very user friendly and flexible in terms of service delivery. The quality maintained is also commendable, but the purification technique employed over-purifies the water which filters out the natural beneficial minerals as well, at the same time-wasting a good share of water while purification. Moreover, the water being wasted is not reused in any form. Along with-it other wastage from the facility such biodegradable containers are not being recycled for any revenue generation which leaves a huge gap for innovative development for the facility.

Case Study: **A17**

1. Introduction

A new form of coin-operated or electronic card-operated water vending machine; popularly known as the water ATMs (Automated Teller Machine) is gaining popularity as a 'smart' yet a 'low-cost' technology to provide safe water at nominal rates in India (Sarkar, 2019). Water ATMs can be visualized as public water dispensing and purifying units which are installed in various public places such as train stations, bus stops, places of worship and slums where the demand for drinking water is high.

1.1 Topic and Context

Water ATMs are being currently experimented with as a market-based solution on the idea of social entrepreneurship to provide safe drinking water to the urban poor who are inadequately served by the public utility network. It is believed that water ATMs have tremendous potential to reduce waterborne diseases affecting the lives of millions of people in India and can minimize plastic waste and prevent plastic contamination as posed by the booming packaged water industries (Sarkar, 2019). ATMs water provides a solution to the safe drinking water challenge.

As a part of the Smart City Plan to ensure wide availability of drinking water in public places, the City of Dehradun has initiated the works to install Water ATMs at 24 locations in Dehradun.

Drinking water has been a huge problem in Indian cities irrespective of region. Nowadays this problem has got intensified by the older supply lines having pipe cracks. With the common passage of supply lines and drain water, the supply line gets contaminated with the drain water. This results in a supply of contaminated water in households which in turn spread diseases.

The geographical area for this project is the total ABD area for the Smart City Dehradun.

The target population for this project are the daily commuters, urban poor as well as citizens of the city who don't have access to safe drinking water and can use this facility for their sustenance.

1.2 Significance of the Project

The Composite Water Management Index (CWMI) of NITI Aayog has confirmed that 70 per cent of India's water supply is contaminated. Globally, India is ranked 120th among 122 countries in WaterAid's water quality index (Desai, 2019). It is a harsh reality that many households cannot afford a personal water purifying unit but on the other hand, 70% of the country's used water is polluted. This results in 21% of infectious diseases associated with unsafe water. Hence, through the Water ATMs, safe and drinkable water can be supplied, and the poor condition of drinking water availability can be addressed to some extent.

The cheap availability of water and easy to use mechanism of Water ATMs make them a viable solution for both households as well as people who are either commuters or out of their living space for work and don't have a reliable source of drinking water. Households can continue using the municipality supplied water for other household works, only for drinking, cooking and intake specific works, water can be brought from the Water ATMs. This use case is only valid in cases where municipality supplied water is not of drinking standard.

Also, it will help in achieving the Sustainable Development Goal to ensure sustainable access and management of water for all by 2030.

1.3 Aim and Objectives

The aim of the study is to evaluate the efficiency of the project in the context of resource usage, waste management as well as the locations selected for the project.

The objectives of the research are

- Evaluation of the process and final locations of Water ATMs
- Study of the water delivery process starting from its source with emphasis on selection of water purification technique.
- Evaluation of project on basis of usability, quality and feasibility.

Figure 1.1: Functional Water ATM. Source: Author

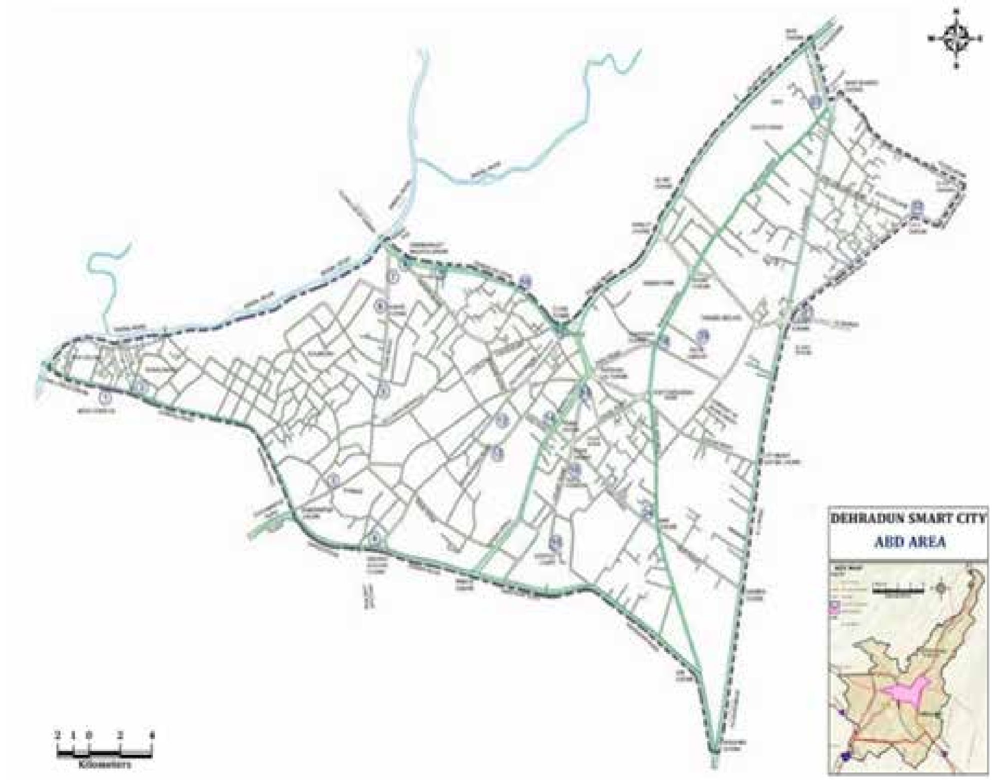

Figure 1.2 Different Locations of Water ATMs within the ABD Area of Smart City Dehradun. Source: (Almondz Global Security Limited, Rudrabhishek Enterprises Limited, 2019)

2. Contextual Background

2.1 Conceptual Framework/Research Design

Research on an already developed project is a complex task since it has to deal with the study of the proposed project, its executed project version and its improvisation and then study of industry norms and standards to finally carry out a discussion and formulate opinions. In the same light, a research framework is developed as shown in figure 1which is recurring in nature. The research is designed to be conducted in a categorized manner since every objective of the research requires a different set of data and analysis. Accordingly, for each objective, the relevant methodology is devised to achieve the objective in a systematic and concise manner. The methodology can be observed in the table below.

Now, to conduct these steps very close contact with relevant officials and institutions is necessary for which visits are planned along with a close-ended survey of officials as well as the consumers.

The expected outcome of the visit is to have relevant and necessary data and information to analyze and evaluate the techniques employed to devise the project structure and functioning, to infer if this should be the model for other forthcoming similar projects or is there a need for improvisation in the techniques being employed along with checking, if any important dimension of the project has been left unattended and how it can be associated in the overall project scheme.

2.2 Key features of the project

2.2.1 Challenges in the project

- Identification of locations which require this facility most.
- Advertisement and encouragement to citizens to use this facility.
- Developing trust towards the purity of water dispensed through this facility.
- Maintaining optimum purification order as per the water fetched and not employing unnecessary techniques.

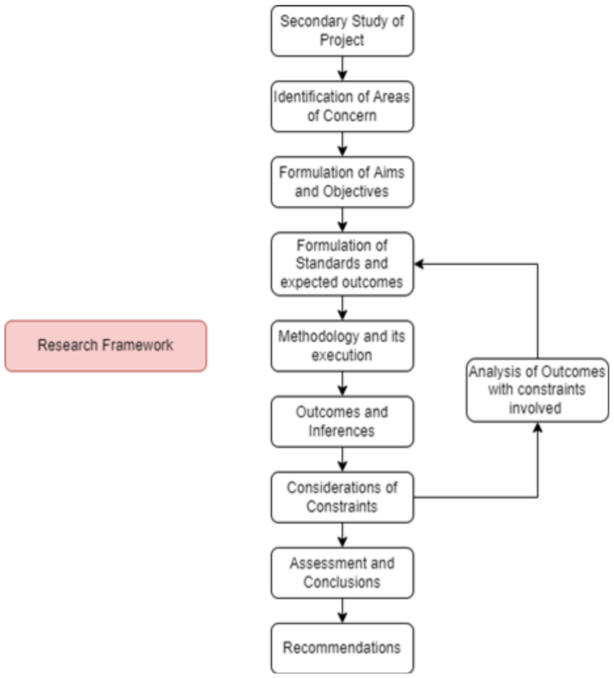

Figure 2.1: Research Framework. Source: Author

Objective	Methodology
Evaluate the process and final locations of Water ATMs	Locate the areas with maximum footfall, commercial areas and need for drinking water on basis of work hours.
	Locate the areas where piped potable water is not supplied.
	Study of Water ATMs, their delivery efficiency and their service radius.
	Coincide the lacking areas with the workable Radius of Water ATMs location.
Study of the water delivery process starting from its source with emphasis on selection of water purification technique	Study of sources from which water is sourced and the quality of water.
	Study of the optimum purification technique needed for the water type.
	Study of Purification technique being employed
	Evaluate the techniques being employed if optimum, overdone or underdone and list out the benefits and harms of the processes.
Evaluation of project on basis of usability, feasibility and efficiency.	Observe the water dispensing and distribution methodology to evaluate the ease of usability for consumers
	Based on resource procurement and purification, enumerate operational and maintenance costs.
	Compare with the cost of services to find the feasibility of the project on self-sustenance.
	Study of the whole process to enumerate the waste generated and by-products.
	The strategy of usage of waste and by-products such as paper cups and reject water.

Table 1 Objective with Methodology. Source: Author

2.2 Key features of the project

2.2.1 Challenges in the project

- Identification of locations which require this facility most.
- Advertisement and encouragement to citizens to use this facility.
- Developing trust towards the purity of water dispensed through this facility.

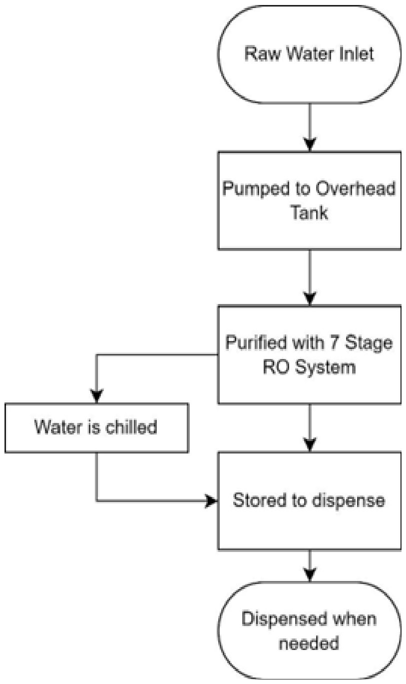

Figure 2.2: Water Treatment Process. Source: Author

- Maintaining optimum purification order as per the water fetched and not employing unnecessary techniques.

2.2.2 Risks involved in the project

- Since water is not packaged, the risk of infection increases.
- Unfair usage of this water for packaging and selling as bottled water.

2.2.3 Features and Benefits

- Automated Treated Water Dispensing unit in a public place.
- Low cost of water.
- Facility to display water quality and online dissemination of reports.
- Coin/RFID card-based system.
- Usage of Paper cups instead of plastics.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

Water ATMs are developed as a safe drinking water solution for the urban population during their day-to-day travel within the target development area, currently this facility doesn't target households because the municipal water supply is adequate and good in quality.

The Water ATMs have been installed under Public-Private Partnership (PPP) model. Under the concession agreement, the concessionaire is setting-up Water ATMs including designing, financing, constructing/installing, operating and maintaining Water ATMs and vending water from Water ATMs for a period of five years.

After the completion of the Concession Period, the utility will be handed over by the Concessionaire to DSCL in optimum running condition. Under the Project Works, 24 water ATMs have been installed and they are functional.

Figure 2.3: Meeting with Contractor and Official. Source: Author

The locations for the Water ATMs are selected based on three factors which are

iv. Feasibility: The location possesses the required facilities for the developed Water ATM. The facilities required are the water supply connection, clear height for overhead water connection and electricity connection. Along with this, a proper drainage facility and a clean-dry environment are necessary.
v. Visibility: It is a public facility; hence it should be visible and easily accessible for the citizens to make it popular and usable.
vi. Footfall: Places with higher footfall will need this facility most. Since places with high footfall are generally business areas, marketplaces and office areas, so this facility has a high share of potential customers in these areas. This is a low-cost facility under the Public-Private Partnership model. Hence, to make it financially feasible and profitable for the private party volumes in the facility is very necessary. Therefore, based on the primary footfall survey, areas with the highest footfall were recognized and Water ATMs in such areas were installed.

Raw Water is sourced from the Jal Board which already delivers water within the IS 10500:2012 which is the Indian Standard of Drinking Water. As shown in figure 4 below, Raw Water is first pumped into the overhead tank and then it is passed through the 7-stage Reverse Osmosis system to purify the water from any viruses, and bring down its TDS to a range of 60 to 100 ppm and pH around 7 or in Alkaline range. Further, water is chilled down and then stored to finally dispense through the dispensing unit.

S. No	Chemical Parameters	Units	Result of Analysis	Desirable Limits (IS 10500:2012)
1	Turbidity	N.T.U.	<1.0	Max 1
2	Colour	Hazen Units	<1.0	Max 5
3	pH- Value	-	7.00	6.5-8.5
4	Odour	-	Agreeable	Agreeable
5	Total Dissolved Solids	ppm	472.0	Max 300
6	Total Alkanity, as $CaCO_3$	mg/L	167.5	Max 200
7	Total Hardness, as $CaCO_3$	mg/L	196.0	Max 200
8	Chlorides, as Cl	mg/L	11.9	Max 250
9	Reactive Silica, as SiO_2	mg/L	4.7	Not Specified
10	Nitrate	mg/L	0.7	Max 45
11	Phenolic Compound	mg/L	<0.001	Max 0.001
12	Ammonia	mg/L	<0.1	Max 0.5
13	Sulphide	mg/L	<0.05	Max 0.05
14	Sodium	mg/L	79.91	Not Specified
15	Copper	mg/L	<0.01	Max 0.05

Table 2 Raw Water Test Results, Dt. 17 Sept 2021. Source: Author's findings based on an interview

Raw inlet water Test reports as shown above in Table 2, were obtained from the contractor during the meeting as shown in figure 5; this analysis clearly indicates that even the raw water supplied to the Water ATM is drinkable. During the interview with the concerned official, he stated that using the "RO System" is a popular trend that is why it is being employed here, further he added that using the RO System is degrading the quality of water by filtering out the beneficial natural minerals essential for humans. According to him, the only concern in the available water is "Faecal Septage" which is treated by Jal Board and still can be treated with just Biological Oxygen Demand Treatment and UV Treatment.

The water dispensing and distribution are seamless and very easy to use. The facility offers two options for the operation, first is using the fully automatic dispensing machine by feeding the machine Rs 1 coin in the required number and then collecting purified water through the dispenser, or the facility can be used through the operator employed to the facility along with a choice between chilled water and normal water. Charges for either are same with no limit on the amount of water. This process is elaborately described in figure 6 below.

Amount of Water	Price
300 millilitres without Biodegradable Container	Rs 1
300 millilitres with Biodegradable Container	Rs 2
1 Liter without Container	Rs 3
5 Liter without Container	Rs 14

Source: Primary Survey

Table 3 Charges for Facility. Source: Author's findings based on an interview

As shown in Table 3, charges are taken for the respective amount of water which combines to give out the Consolidated Average Revenue from sales per month from 24 Water ATMs. In the last quarter, the total sale from the water ATMs has been around Rs 55,000. Another source of revenue for Water ATMs is advertising on the facility façade. The revenue from advertising space ranges from 5,000 to 10,000 depending on the location of the Water ATM. According to the contractor, the minimum cost of running each Water ATM is around Rs 18,000 which makes this project loss-making under situations like the third Wave of Corona Virus and also in the Winter Season when people avoid going outside or using public properties. That is why in the previous quarter the project faced several losses. Better Revenue is expected in the next quarter. All of these factors in a categorized form of revenue sources and operational costs have been visualized in figure 7 below.

The Water Purification technology employs a 7-stage Reverse Osmosis System, which rejects and wastes

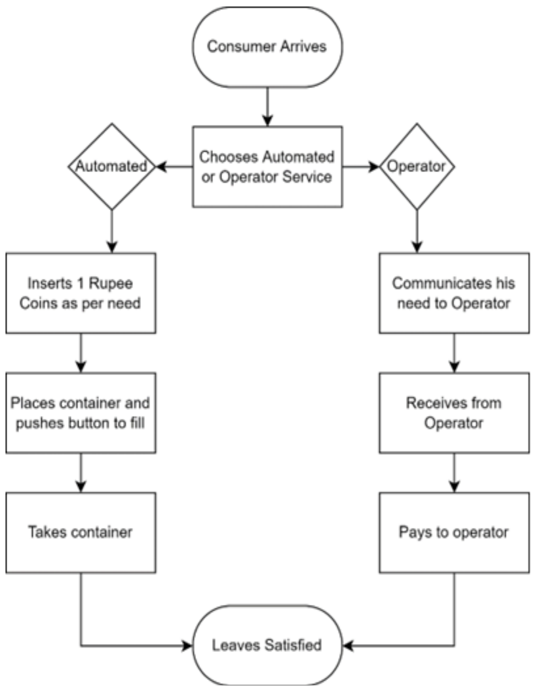

Figure 2.4: Research Framework. Source: Author

a significant share of water during the purification process. In the Water ATM Facility, the claimed proportion of Purified Water to Reject Water is 90% and 10 % respectively, which is much less than other RO systems in the industry. The reason behind this was a good quality raw water being taken for purification. Still, 10% can hold a significant volume if higher sales incur in future. At present, the rejected water is only being used for cleaning purposes to some extent and the rest is drained out.

The facility doesn't use plastic containers instead Biodegradable containers are used to enable people without bottles and cups to use the facility. At present, the used biodegradable containers are not being utilized in any manner and they are simply disposed of.

A different purification technology is being used in a couple of Water ATMs, which is the Capacitive deionization Technique, which is better than the Reverse Osmosis system in terms of operational costs, and usable water efficiency as well as water quality. The drawback is the initial cost of the machine and setup, so it is being set up to see its compatibility and will be preferred in the coming Water ATMs.

The primary survey executed by the research team on the consumers of Water ATMs reflected that the consumers are very pleased and content with the functioning and service of the facility, especially the ease with which it can be used and the quality it maintains. The cost of service is also very minimal and could be afforded by them.

3. Discussion and Conclusion

Water ATM facility is serving mainly the urban working population which goes out of their household for any work, Water ATMs provide a cheap, reliable and safe source of drinking water to them, which is very well accepted by the citizens.

The model used to develop the Water ATMs was Public-Private Partnership (PPP) mode in Built-Operate-

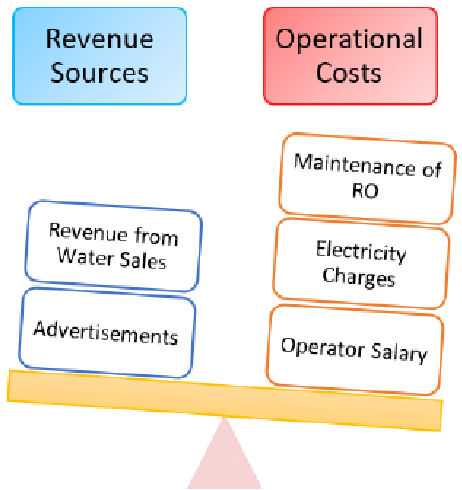

Figure 2.5: Factors responsible for revenue sources and operational costs. Source: Author

Transfer mode which worked out very well with recommended specification wise development of the facility and its functioning. Further, keeping it cheap and accessible to all is a great feat to achieve.

The basis on which the locations for the Water ATMs were selected was fair since high density in high footfall areas and resulting steady growth is a testament to that. Further, the factor of Visibility also enables the facility to hold a good advertising space giving the facility an extra source of income. Since Water ATMs are dependent on the piped water supply as well as it has infrastructural requirements, the feasibility factor also holds significant importance.

The sourcing of water resources is taken care of by the Jal Board, which delivers drinkable inlet water and as per the findings from the analysis of Water Test Results and the interview with Smart City official, it is established that there is no need for Reverse Osmosis Technique to purify water in this scenario, instead, BOD technique and UV filtration is more than enough to deliver safe and natural minerals rich water along with minimal wastage of water.

The user-friendly interface to use the facility along with the availability of operators for other varied options makes the Water ATMs very usable for the consumers, but one use-case of this facility remains untouched which is the use by households since households in Smart City Area are getting regular and drinking water standard supply to their homes. The revenue generated by the facility as of now reflects that it is not sustainable but the point to note is that majority of operational months have been struck by coronavirus and revenue in the last quarter remained low due to the winter season. Hence, the coming quarter is a big opportunity for the project to prove its mettle and make itself profitable. Lastly, the efficiency and waste management strategy of the facility lacks any vision or innovation. The rejected water is just being used for the cleaning purposes and the rest is drained, wasting a significant share of water, making the facility inefficient as well as developing an environmental scare. Now, drinking water in biodegradable containers is offered completely substituting plastic products which is a very positive step in the direction of an eco-friendly approach. But the biodegradable containers are not being used in any form and are just disposed of. The consolidated waste from all the Water ATMs will be a significant and regular source of biodegradable waste which can be recycled for revenue generation. Hence, efficiency and waste management need a complete revamp and innovative vision to make things better.

3.1 Implications

First implication of this project is the availability of safe and purified water from a reliable source which can be used at a very minimal cost.

Secondly, it gives an option of chilled water, since Dehradun faces a harsh summer too, a cheap and reliable source of chilled water will be very beneficial for the citizens.

Moreover, the automated dispensing option can ensure no contact and quick dispensing which can be very helpful to counter the rush business hours.

3.2 Limitations of the research

There have been some limiting factors during the conduct of this research, first is the limited knowledge of purification systems and industry development of water dispensing machines.

The second was the limited support from the officials of DSCL (Dehradun Smart City Limited) in terms of file sharing as well as sharing of data sources, the questionnaire handed over was returned unfilled neither data of any primary survey was shared. Thus, the inferences drawn are majorly based on primary and secondary data.

3.3 *Key lessons learnt*

Water ATMs hold a complex array of processes from procurement to service delivery and after service delivery management. Hence, there can be a lot to learn both from success and shortcomings.

Scenario-based development and improvisation: Standardization and trend adoption is very important in projects on a big scale but not in projects which directly involve an essential resource, water. Therefore, scenario study and specific problem identification should be done before formulating projects which use critical resources which can help improvise the standards recommended as per the scenario.

User-friendly services and processes: Making processes user friendly and automated makes facilities ready to work round the clock and very efficient. Hence, automated technology and a user-friendly interface improve service delivery.

Development of close looped, nature-identical processes: Just developing an alternative for a non-eco-friendly facility is not enough but a closed loop should be developed between resource procurement and resource disposal.

3.4 Recommendations

The factors employed to deduce the locations were spot on, but no scientific technique or simulation was employed and documented to distribute and finalize the Water ATMs locations which keep the locations of Water ATMs under review. Simulation before finalization of locations will be better to fine-tune the even distribution of Water ATMs across the development area in terms of footfall as well as reach to Water ATMs for everyone.

A keen and thorough study of the situation and then improvisation of standard procedures can be the better way out. Therefore, before employing a water purification technique for Water ATMs, it should have been assessed that this technology is not even needed and will do more harm than good. Retention of the natural form of water as much as possible should be the approach when selecting a water purification technology. Just BOD treatment and UV treatment will be enough for Water ATMs, and it should be developed as a water dispenser and facilitator than a water purifier which will help to bring down the one time as well as the operational cost by a significant margin.

Talking about the financial feasibility of the project, earlier discussed topics have contributed to the hike of the lowest operational cost for the facility. Hence, the costs should be brought down, and further income sources should be generated to make this project financially feasible. Some approaches can be used such as the use of rejected water in some sort to generate revenue further Biodegradable cups can be collected and approached towards waste to wealth strategy again generating some revenue, giving financial strength to the overall project.

Water ATMs are currently very user friendly and accessible to all, but their services can only be availed with coins or cash, limiting a section of consumers who don't use a physical form of currency as much. Therefore, QR codes can be introduced to the facility along with the coin-based automated system. Automating the facility is the way forward to cut down the operator cost making the facility more profitable and lucrative for investors to come forward and invest. Hence, the focus should be on full automation of the facility by virtue of coins, Radio-frequency identification (RFID) cards and quick response (QR) codes with a single operator for a batch of Water ATMs so that they can be attended to, secured and repaired since vandalism is a big threat to public projects in India.

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A18

Critical Assessment of Dehradun Integrated Control and Command Center

Name of the project: *Critical Assessment of Dehradun, ICCC*
Location: *Dehradun, Uttarakhand*
Year of Project Implementation: *2018*
Sector: *Technology in Urban Management*
SDG: *SDG 11, SDG 17*
Project Cost: *294.41(Crore) INR*

Institute: *IIT-Roorkee*
Advisors: *Faculty Coordinator: Dr. Arindam Biswas, Mentor: Mr. Sagar Sinha*
Students: *Mr. Dibyank Darshi and Mr. Parakh Hemant Katre*

Keywords: *Integrated Command and Control Centre, Traffic Management, Citizen inclusion*

Abstract:

Integrated command and control centre is a product of the ongoing wave of Internet and Communication Technology. Employing this power of technology at the city level can give enormous benefits to the governing departments in functioning and delivery of all the required facilities as well as to the citizens to get them a better and personalized experience with smooth, consistent service delivery and better communication with officials and other stakeholders.

Dehradun was selected to be developed as a Smart City and the purpose of the Smart Cities Mission is to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to smart outcomes (Government of India, 2016).

The core idea behind this project is to ensure better service delivery and functioning of service departments which will eventually benefit the citizens. In addition, the ICCC deals directly with the citizens in many processes, in which the initiator and major stakeholders are the citizens themselves. Hence the transparency and smoothness of the processes are very important. In a similar light, this paper aims to assess the approach and functioning of ICCC in processes where citizens are primarily involved by direct interaction with citizens and stakeholders, hands-on experience on mechanisms and study of frameworks.

The approach and functioning of the ICCC have been very consumer-friendly, keeping the usability and ease. The priority of the ICCC is to maintain the transparency and smoothness of all the processes. Further, all the processes are time-bound and clubbed to a relevant official at every level keeping an official accountable at all times. This interlinking, time-bound approach has kept things very smooth and result-oriented which has been readily accepted by the citizens. Still, there is some development yet to be made in the public feedback and inclusion mechanism. Moreover, the traffic management system is yet to employ innovative scenario-based solutions given the inputs and infrastructure they have but the progress made so far is incredible and hopefully shortcomings will be overcome with time.

Case Study: A18

1. Introduction

An integrated command and control center is a collaborative approach toward the smooth and seamless functioning of a city and its services by the virtue of real-time data availability and its sharing across different offices, departments and sectors. ICCC enables quick interdisciplinary data sharing which usually takes a longer time resulting in delays in service delivery as well as problem resolutions. Along with this, since it is a collaboration of different departments, in any critical state of emergency it can be used as a common portal for collective analysis and decision making. In the recent past, during the Covid-19 waves several Integrated command and control centres including the "Dehradun Integrated Control and Command Center" played a huge role in the control of the city by redirecting help wherever needed and controlling unnecessary gatherings. A separate covid control room was set up within the ICCC for easier control and command.

1.1 Topic and Context

Dehradun Integrated Command and Control Center is being developed as a common platform to operate, monitor and control the relevant services being offered to the smart city. A city has a number of different functional departments such as Traffic, Fire, Police, Water, Waste Management etc. Each of these departments has a large array of data which are very difficult to analyze together. To address this difficulty ICCC has been developed to collect, overlap and analyze the data to develop aggregated city-level information. Further, this data can be developed into relevant actions based on the need and can be delivered to the relevant stakeholders and citizens. There are several cases when data needs to be shared among departments. For example, if the electricity department points out that the street lighting or the overall electricity line of a certain sector is disturbed during night time, the police department can act on it and increase patrolling in that area to negate any unforeseen criminal activities due to darkness. Another use can be when the environmental sensors detect smoke, it can intimate the fire department and solid waste management department as well since smoke can also be detected from the common practice of burning waste, which will require the solid waste department on the spot too for clearance and issue penalty.

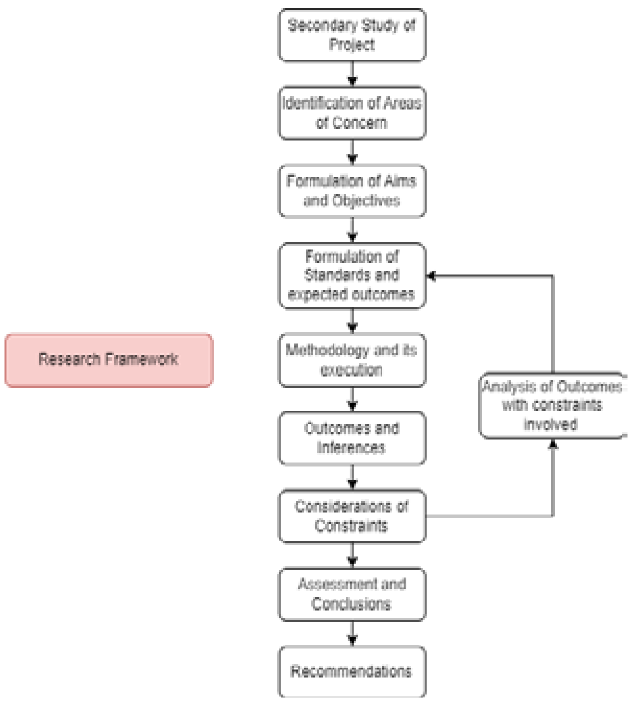

Figure 2.1: Research Framework. Source: Author

Some of the major aspects which can be addressed through this intervention are

- Efficient Management of Utilities: When data of service and projects of different departments are available to use, minimal utilities will be wasted due to bad coordination as well as it will support reuse of utilities,
- Disaster Management and Emergency Response System: Availability of all the departments will allow better situational analysis.
- Efficient Traffic Management: Common infrastructure for all departments can cater for the huge data requirement for traffic management.
- Enhanced safety and security
- Asset Management
- Organized Workflow Management
- Coordinated decision making

1.2 Significance of the Project

Integrated command and control centre holds a significant role in the development of a smart city, since a smart city is not only about the latest technology and infrastructure, but also aims to develop innovative techniques which require a lot of data sharing, brainstorming and collective development. However, the rigid and close-ended mechanism of service departments is a bottleneck for all the aforementioned requirements. Hence, the advent of a collaborative platform like an Integrated command and control centre is necessary for the development of a Smart City.

1.3 Aim and Objectives

The aim of the study is to assess the approach of ICCC in functions where citizens are initiators and major stakeholders.

The objectives of the research are

- To study the assessment framework approach for grievance redressal with the support of ICT.
- To analyze the Traffic Management system and Penalty Challan System for the Traffic offences.

2. Contextual Background

2.1 Conceptual Framework/Research Design

Research on an already developed project is a complex task since it has to deal with the study of the proposed project, its executed project version and its improvisation and then study of industry norms and standards to finally carry out a discussion and formulate opinions. In the same light, a research framework is developed as shown in figure 1which is recurring in nature. The research is designed to be conducted in a categorized manner since every objective of the research requires a different set of data and analysis. Accordingly, for each objective, the relevant methodology is devised to achieve the objective in a systematic and concise manner. The methodology can be observed in the table below.

Table 1: Objective with Methodology. Source: Author

Objectives	Methodology
To study the assessment framework approach for grievance redressal with support of ICT	Study of service delivery and complaints resolution framework used by ICCC Analysis of the Framework of Complaint Resolution Survey of officials and consumers to study the ground reality. Check service delivery records and complaint resolution records and its efficiency. Inferences and recommendations
To analyze the Traffic Management system and Penalty Challan System for Traffic offence	Study of the Traffic Management System and Challan System employed. Analysis of the Framework for the Challan System Experience of real-time tracking of offence and issuance of online challan Survey of Officials and citizens Assessment of the responses of both officials and citizens. Inferences and Recommendations

Now, to conduct these steps a close contact with relevant officials and institutions is necessary for which visits are planned along with a close-ended survey of officials as well as the consumers.

The expected outcome of the visit is to have relevant and necessary data and information to analyze and evaluate the techniques employed to devise the project structure and functioning, to infer if this should be the model for other forthcoming similar projects or if there is a need for improvisation in the techniques being employed along with checking if any important dimension of the project has been left unattended and how it can be associated in the overall project scheme.

2.2 Key features of the project

2.2.1 Challenges in the project

- Development of modern infrastructure.
- Segregation of zones within the city and clubbing based on similarity.
- Overlapping of data from different departments.
- Data Security

2.2.2 Risks involved in the project

- Data loss and data theft, since data of the whole city is at stake.
- Electricity or Internet loss can leave the city standstill.

2.2.3 Features and Benefits

- Public Address System
- WAR Room
- Control and Command Centre for all the smart and city services

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

ICCC is developed as a common centre for the control and surveillance of the whole Smart City as well as the services offered to the citizens and society as a whole. In this direction, WAR Room is developed where all the collected data across sectors is displayed in real-time in a consolidated way, giving an atmosphere and space for analysis, planning and execution all at once which helps in critical situations such as natural disasters or any emergency. The WAR Room along with the facilities played a huge role in controlling the city during the covid-19 outbreak across different waves, still contribute by accompanying the covid control centre within.

For the surveillance and data, 395 bullet cameras, 40 dome cameras along with 36 Pan Tilt Zoom cameras have been installed across the Smart City area. Other than these, 66 box cameras along with public information system, Emergency Call Box and Public Wi-Fi are installed for the Buses. Full campus camera surveillance along with Wi-Fi has been installed in 22 Aanganwadis to keep them connected and under control. A public Announcement System has been installed at 24 locations to convey messages to citizens which can also be used in the time of emergency.

The approach and vision of ICCC are very clear in the scenarios where the citizen is the major stakeholder and initiator. ICCC aims to keep those processes as transparent as possible with prompt action and clarity of proceedings and legalities involved.

The public Grievance System is a very essential aid to citizens to register their grievances and expect a quick and complete solution. In Dehradun ICCC, an attempt has been made to keep the proceedings quick and totally transparent by virtue of two strategies, first is the data management system, where a citizen can register the grievance anywhere and anytime without visiting the office and struggling to file any grievance at all. Once the grievance is registered then through data management systems and operator concerned department is intimated and they must accept and register the complaint. Since data of all this process is present anytime, higher authorities can easily check the pending grievances and ask the concerned department to resolve them. Adding a layer to this strategy, Dehradun ICCC specifically made a framework where a complaint will be addressed on a timely basis. Within stipulated time the work has to be finished or a satisfactory reply is to be given, or else it will escalate to a higher authority. Similarly, if no action is taken the complaint will be escalated to the higher authority and so on as illustrated in the following figure.

This step has been welcomed by the citizens with open hands since the experience before this system was slow and not very efficient. It took them a much longer time just to get the complaint registered and after that there is a lack of transparency on the status of the complaint as well as who is taking care of it. The introduced system has made the process smooth and fluid with a faster rate of resolution.

To set up the traffic management system variety of technology with the required infrastructure is developed and built. The majorly used ones include:

- **Red Light Violation Detection (RLVD) System**: This whole system in simple words keeps a check on all the Traffic signals via required cameras and sensors. The software analyses the traffic flow and traffic lights and detects the vehicles which jump and ignore the red light.
- **Speed Violation Detection (SVD) System:** This system is very essential and helps a lot in reducing the number of accidents. In this system, speed guns are installed, and they track the speed of vehicles in real-time. If they cross the permitted speed limit then

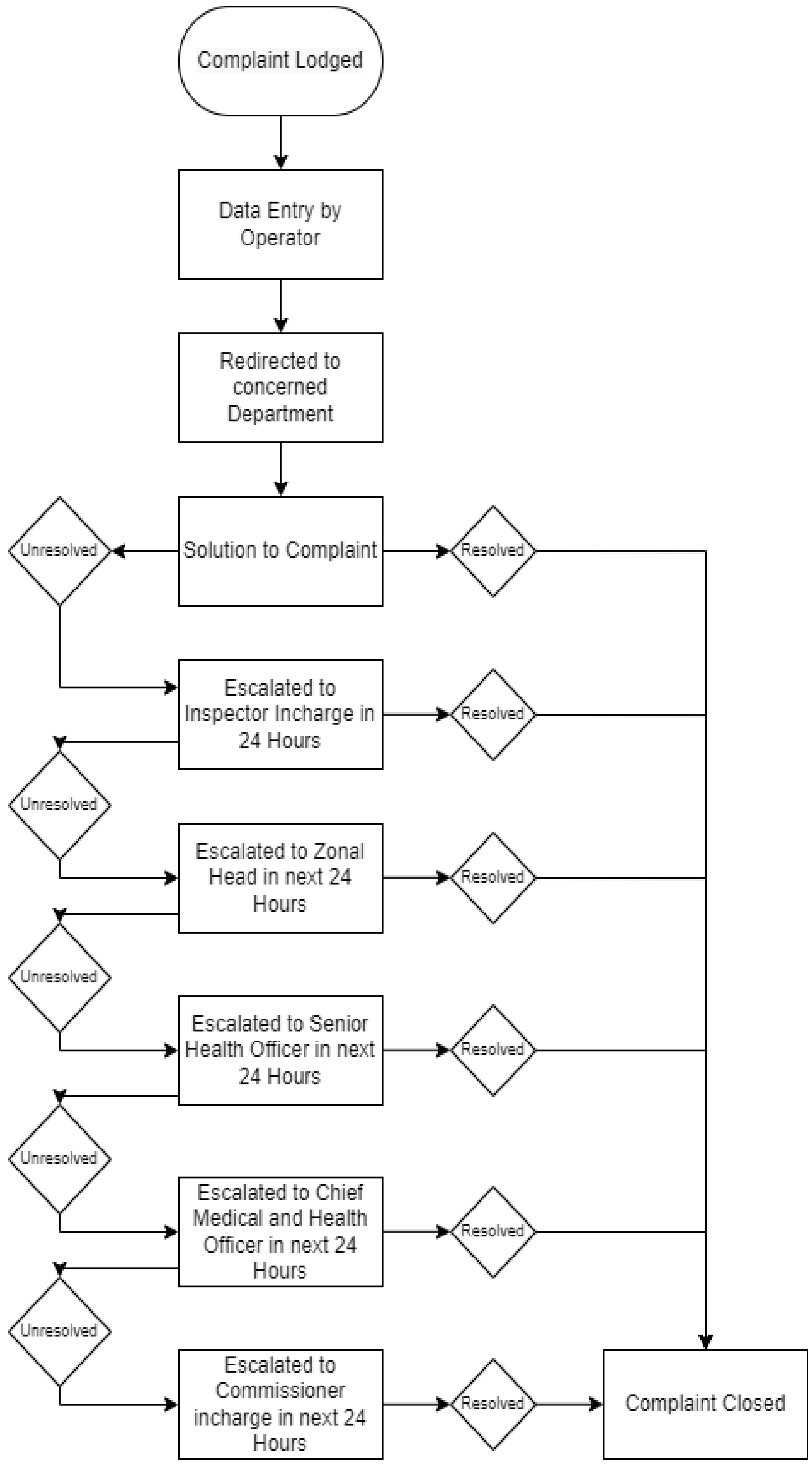

Figure 2.2: Complaint Redressal Framework by DICCC. Source: Author

the violation is detected and a challan is issued.

- **Traffic Accidental Report System:** It is a real-time reporting system in which accident is reported immediately and likewise help concerned departments take charge accordingly. This saves much time and each second less taken can save a life in such critical situations.

These systems actively help in the Traffic Management of the city, majorly in the enforcement of traffic rules in the city. Whenever a violation is detected by the system, the concerned police official in ICCC gets intimated. The police officer manually registers the complaint to keep a safe record and proceeds to generate challan for the offender. The challan generated is communicated to the offender through SMS and letter/email means. If they are left with no response, then the case is escalated to the courts for further proceedings and judgement.

There are some more systems developed which are not actively participating in any of the functions as of now, like the sensors detecting the type of vehicle and count of them. The use case of this feature can be the identification of restricted heavy vehicles inside the city boundary. As of now, there is no restriction on the movement of heavy vehicles inside the city. Hence, this feature is not employed actively yet.

Citizens have mixed feelings towards these systems, the majority feel these steps are in the right direction and this will ensure a rule-abiding society and will help in habituating citizens to follow the rules since all the vehicles are on 24-hour surveillance with cameras and sensors on every other road. Whilst some people feel that this will increase the unnecessary burden on them and the traffic and accidents scenario will still remain the same.

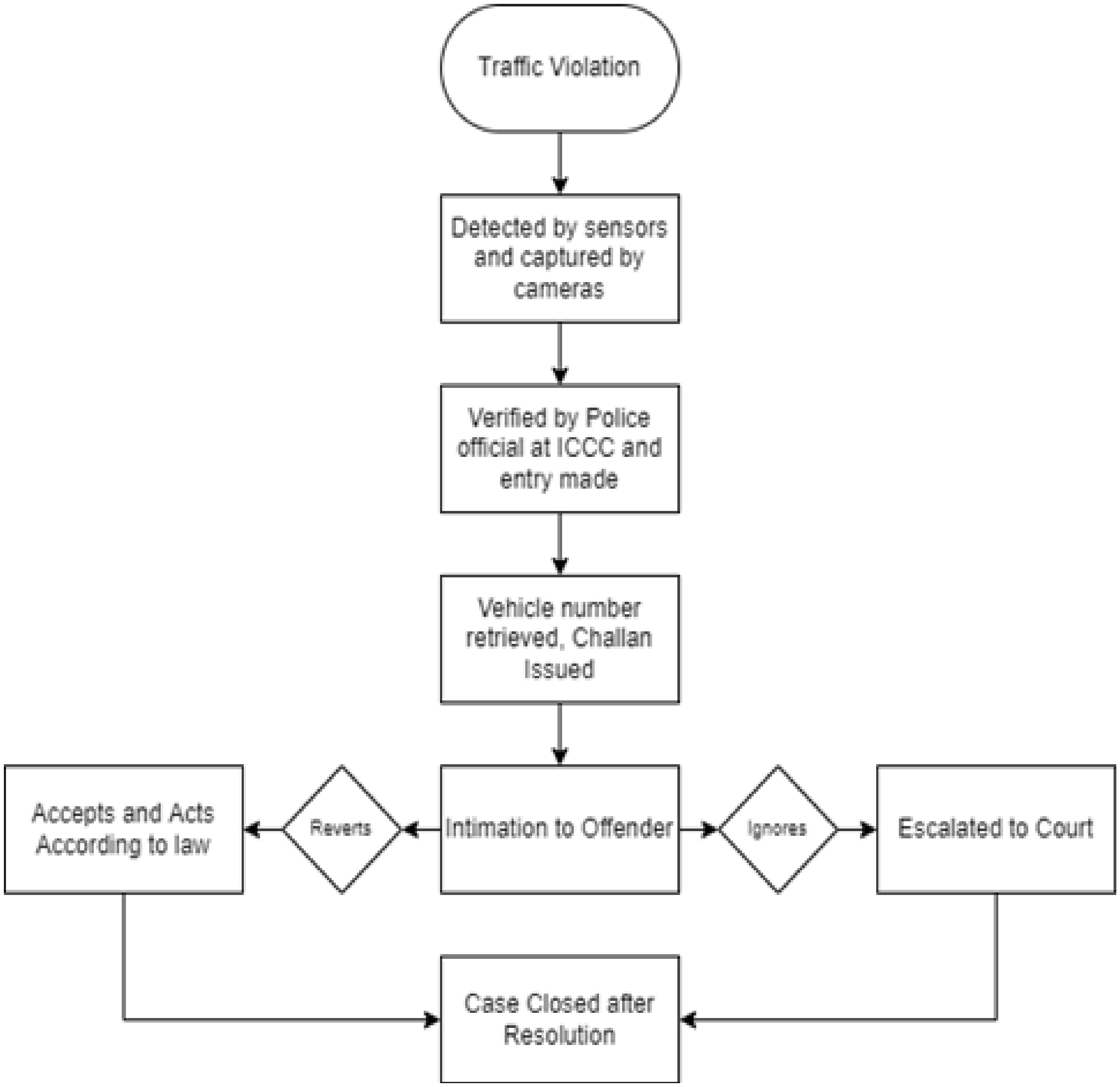

Figure 2.3: Framework for Traffic Offences. Source: Author

In cases when accidents are reported immediately concerned departments like the Department of Medical Health and Family Welfare, Govt of Uttarakhand and the Police department, Dehradun are informed and redirected to the site of the accident for immediate help. This quick service saves many lives. Citizen perception towards this system is very positive since earlier it used to take much time to even reach the hospitals and then for all the formalities which drastically reduced the chances of survival.

3. Discussions and Conclusions

The vision for development and the execution of the ICCC has been on point with industry-standard infrastructure and implementation of the same. All the installed devices and sensors are working to their full potential and are being maintained regularly. Still, the data generated is not being fully utilized and there is huge potential for analysis with the varied form of data being collected on a daily basis. Just to list a few use cases, the first can be the use of Information and Communications Technology to assess the traffic volume and passenger volume for buses for real-time optimization of routes for the buses. With the growth of this system, artificial intelligence will figure out a pattern in the traffic volume and then act accordingly. This will work flawlessly until a special occasion arises where it needs to be recalibrated. Similarly, there can be several use cases to track down complex patterns and then improvise the services accordingly. Though computers cannot do analytical reasoning, computers are much more capable of figuring out patterns and handling complex data.

In most complaint redressal frameworks, there is a provision of escalation of the matter to the upper hierarchy but either it is very complex or the function for escalation of the matter lies in the hand of executing officer which makes the escalation very unlikely. Thus, the process gets very slow and delayed. Moreover, it gives a scope of corruption. The introduction of a time-bound response system clubbed with the escalation of matters to higher authority works has worked flawlessly with complaints getting resolved right at the ground level.

The traffic management system works efficiently and with good accuracy, but in the case of emergency vehicles such as Ambulance, and Fire Trucks, it fails to recognize them and issues challan to them also. Therefore, a human resource in the form of a Police official needs to be deployed to rectify such unusual cases and ensure that no such error occurs.

3.1 Implications

First implication which can be drawn out is that the Complaint redressal mechanism which has been developed is very keenly woven to keep the major stakeholders in the loop with a time constraint which makes the whole hierarchy of relevant officials directly responsible for acting on a complaint which has been registered.

Secondly, giving the citizens the option to reopen the case, as many times as they want is a major step, it will enhance the citizen satisfaction.

Thirdly, the seamless challan system which can be paid and resolved on the go and does not create nuisance and time loss is a good solution, which also ensures no corruption.

3.2 Limitations of the research

There was limited support from the officials of DSCL (Dehradun Smart City Limited) for carrying out the analysis. The inferences drawn are mostly based on primary data and secondary data but the experience with the ICCC officials was very smooth which made this research possible.

3.3 Key lessons learnt

ICCC facilitates different service departments to come together and work better with higher efficiency. With their vision and approach, they have developed such mechanisms from which several lessons can be learnt, some of them are:

- Ease of accessibility and transparency to citizens: Functions and processes with direct involvement of citizens need to be as transparent as possible with quick response and easy to operate, then only trust will be developed, and involvement of citizens will foster.
- Escalation of matter based on time: Making time a function for the escalation of assignments to the office bearers of upper hierarchy will compel the relevant officials working on the ground level to work efficiently and keep track of time which will make unnecessary delays a thing of past.
- Significance of human resource : Keeping a human resource at every checkpoint even after automation is very necessary because Machine Learning and Artificial Intelligence are still developing, and they can't handle rare and uncommon scenarios.
- Importance of automation: The use of automation and real-time tracking, and complaint registration eliminates the possibility of corruption or any abuse of political or any power, which makes it essential to adopt.

3.4 *Recommendations*

The grievance redressal system developed by ICCC is very quick and smooth, but the same framework is being used for the feedback as well. Though, this framework works very efficiently in case of grievances, the same does not follow in case of feedback. To discuss feedback and make something meaningful out of the input, back and forth communication is very essential which is not available in the existing system. Hence, there is a scope for the development of a separate framework and portal for the feedback system.

While developing the Feedback portal, a drive for public inclusion can also be planned. Since citizens do not have any experience in this regard, they should be briefed about what type of expectations authority has and what type of feedback is relevant for them. This drive will give clarity to citizens on what feedback to give, on what all topics and the procedure for the same.

The involvement of citizens holds a key role in the development and functioning of a city. A city has a wide array of services catering to a large geographical area which requires a minute and keen responses for holistic development which is not possible without public feedback and inclusion. As citizens observe and face the problems firsthand they can report it first too along with proper feedback on how things can be better for the future and what the stakeholders have to learn from the past mistakes.

Traffic Management System with all the capabilities it has can maintain records for each vehicle and driver giving them scores on their driving style, manners and how often they make an offence. Good records can be incentivized by some reward or addition of points which can be redeemed in a rare case of offence by them. This will urge citizens to drive within the rules, develop good driving habits and gain more driving points.

Machine learning and artificial intelligence can be employed to derive essential data which can help the drivers to be safe around the black spots. For example, if there is a sharp turn and it is a black spot, it can be analyzed beyond what speed or due to what type of manoeuvre, the accident probability increases, and the same can be informed to the drivers well ahead of the black spot through signs. Further, Artificial Intelligence can be employed to track down vehicles with distinguished behaviour which can be due to drunk drivers, sleepy drivers or any unhealthy intention it can be tracked down and stopped before anything happens.

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A19

An analysis of E-Pathshala Project in Kanpur, Uttar Pradesh

Name of the project: *e-Pathshala*
Location: *Kanpur, Uttar Pradesh*
Year of Project Implementation: *2017*
Sector: *Education*
SDG: *SDG 4 - Quality Education*
Project Cost: *Rs 2.71 crore*

Institute: *IIT-Roorkee*
Advisors: *Faculty Coordinator: Dr. Arindam Biswas, Mentor: Ms. Nikita Ranjan*
Students: *Ms. Shiksha Singh*

Keywords: *e-pathshala, Kanpur Smart City, Quality Education, Information and Communications Technologies (ICTs).*

Abstract:

The Digital India initiative has pushed for widespread use of Information and Communication Technologies (ICTs) in educational settings. E-Pathshala, a joint initiative of the Ministry of Education, the Government of India and the National Council of Educational Research and Training (NCERT), was created to showcase and disseminate all educational e-resources for students, teachers, parents, researchers and educators including textbooks, audio, videos, periodicals and a variety of other print and non-print materials. (E-Pathshala — Vikaspedia, n.d.)

The Kanpur Smart City Limited (KSCL) under the Smart City Mission of India and project umbrella of 'Sampann Kanpur' and catering to their "Smart City Goal 4: Provide Quality Education", had proposed to set up an ICT initiative, e-Pathshala in six different schools of Area Based Development (ABD) in Kanpur. The idea was to use a variety of strategies to improve learning outcomes of school children. Empowering teachers by teaching them how to use e-content and interactive strategies is one of the techniques. The administration believes that by combining traditional blackboard-based teaching with interactive multimedia approaches, students will have a better learning experience which will lead to higher results. Teachers and pupils have been more cautious after the outbreak of the pandemic and are avoiding learning in restricted rooms. As a result of the pandemic, there has been a move towards online schooling which is likely to have an even greater impact on these patterns. In this context, e-Pathshala has attracted a large number of students and has given a safe online education than traditional education. (KSCL, n.d.) (IDR, 2020)

This study evaluates and analyses the impact and effectiveness of e-Pathshala in Kanpur. It examines the effect of the e-Pathshala project by using a questionnaire for survey of different stakeholders of the project. E-Pathshala is found to be beneficial for users. Students are overwhelmed with the e-Pathshala effect on their changing attitude towards education. The primary issue that emerged in this study is the COVID-19 effect. E-Pathshala is not only the central attraction of online study for the students but it also provides them with leisure reading material and health-related guidelines to remain fit in the scenario of COVID-19 pandemic. This study also seeks to recommend improvements that can be made in the e-Pathshala project and its administration to enhance user experience.

Case Study: **A19**

1. Introduction

In today's competitive environment, high-quality education is a must. Every element of our lives is influenced by technology. In the Indian educational environment, Smart Classes are a modernised way of instruction that provides excellent education to kids by assisting them in better concept formulation, concept elaboration, enhancement of reading skills and academic accomplishment. (KSCL, n.d.)

Differentiated modalities of teaching and learning are important to implement deeper levels of growth and conceptual development in academic activities. The educational system must provide a variety of possibilities for pupils to develop interests while also organising intellectual growth and progression throughout childhood and adolescence. ICT has become an important tool for teachers and students in developing and delivering curricula. (KSCL, n.d.)

From communication to education, technology has aided us in every facet of our lives. Smart Classes are a new way of teaching that manifests this technology in the educational front. It makes use of educational materials, 3D animated modules and movies, and it is used by all prestigious schools. This concept of creativity as well as the interactive learning process has piqued the interest of students. The Smart Classroom concept has not only made teaching more enjoyable, but it has also given pupils the opportunity to improve their academic performance. (KSCL, n.d.)

"Smart School and Smart Classes" is a novel educational concept. Computers, projectors, internet access and other multimedia devices such as home theatres are common in Smart Classes. In such a new context, the teacher's function is also altered. The e-Pathshala Project's main goal is to improve the quality of learning for pupils by implementing ICT in school education. Learning Support Services can help in improving the quality and standards of school instruction. In terms of ICT-enabled teaching learning material or Digital Learning Resources, model lesson plans (for the explanation of ideas), self-learning tools and standardised evaluations, ICT can give extra teaching aids.

1.1 Topic and Context

Since independence, India has made significant progress in school education, particularly in terms of overall literacy, infrastructure and universal access to and enrolment in schools. This has resulted in a significant increase in the need for qualified primary school instructors. (KSCL, n.d.) In future years, the government will need to address the shortage of well-qualified and properly prepared teachers. Simultaneously, the demand for high-quality education is rising continuously. The need for addressing teachers' professional development, manners and keeping up with current education is becoming increasingly apparent. Along with this growing need for high-quality education, Covid-19 has increased the demand for digital education manifold. According to UNICEF (2021), during Covid-19, not only did students and teachers react positively to digital classes, but the demand for introduction of e-Pathshala also grew. (UNICEF, 2021)

Citing the educational benefits, various cities under the Smart City Mission have included e-Pathshala in their proposals and installed them in already built government schools. These projects have resulted in the benefit of underprivileged students. (Bedi, 2016)

Kanpur Smart City Limited (KSCL) had also proposed to implement e-Pathshala under their smart city proposal and identified six locations in the city where these facilities would be built. E-Pathshala has been installed in six different Government schools of Kanpur City as mentioned in Table 1.

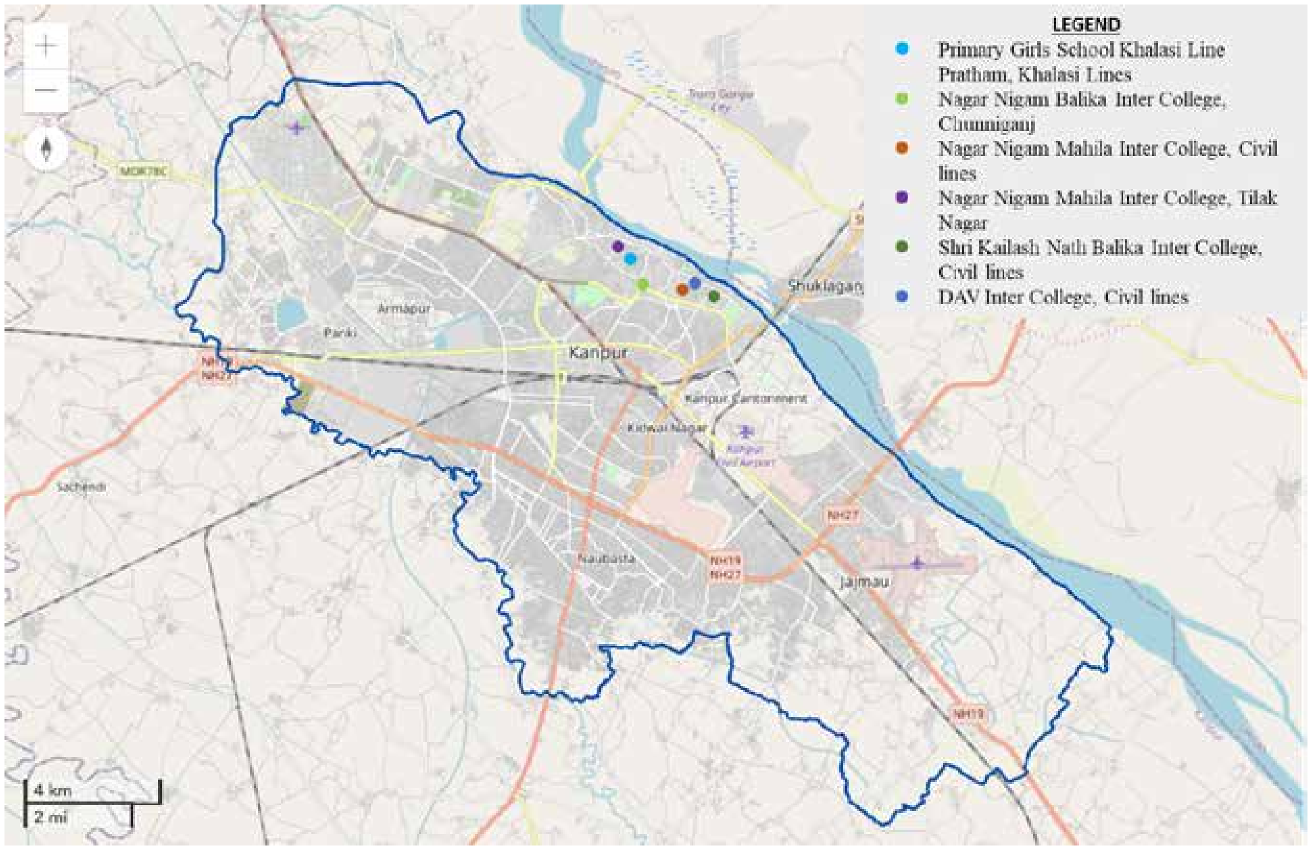

Figure1. Locations of six schools in the ABD area, Kanpur. Source: Author

Table 1. Details of six schools where e-Pathshala has been implemented

S. No.	Name of School	Location	Category	No. of Classes
1	Primary Girls School, Khalasi Line Pratham	Khalasi Lines	Primary School	1
2	Nagar Nigam Balika Inter College	Chunni Ganj	Inter College	1
3	Nagar Nigam Mahila Inter College	Civil Lines	Inter College	1
4	Nagar Nigam Mahila Inter College	Tilak Nagar	Inter College	1
5	Shri Kailash Nath Balika Inter College	Civil Lines	Inter College	1
6	DAV Inter College	Civil Lines	Inter College	1
Total				6

Source: Author

1.2 *Scope of the project*

The project was started in 2017 and completed in 2021. The initial cost of this project was Rs 2.40 crore. The target population were teachers and students of the selected government and government-aided schools.

The six schools are in Kanpur's ABD area. The location of these six schools was determined using ABD criteria. The schools were chosen based on the number of government and government-aided schools in the ABD area, as well as the population and density of children in each school. These six schools have been marked on the city map in Figure-1.

This study has been conducted to assess the project's efficiency and to quantify the project's benefits to users. This research will also look into the effects of online education on the teachers' and students' physical and emotional health.

1.3 *Significance of the project*

E-Pathshalas are an important part of the Smart City Mission and has various learning benefits, which deemed their importance and significance such as:

a. It offers digital textbooks for all subjects, as well as graded learning resources and opportunities to participate in exhibitions, tournaments, festivals and seminars.
b. Education has become accessible to all.
c. Emphasis is given to the development of interactive curriculum-based content.
d. This initiative met with a lot of enthusiasm and user acceptance as was concluded by this study.
e. It is very helpful for communication in providing informal and vocational training as well as formal education.
f. English speaking, highly qualified and techno perceptive workforce faculty was provided for learners.
g. As it is completely free, education has become available to every class of people.
h. It has aided youngsters in achieving their learning objectives (like increased depth of understanding and retention of course content; more meaningful discussions; emphasis on writing skills, technology skills and life skills like time management, independence and self-discipline.

1.4 *Aim and Objectives*

The aim of the project was to evaluate and analyse the impact and effectiveness of the newly developed e-Pathshala project of Kanpur Smart City on teachers and students.

The objectives of the research are:

a. To evaluate the benefits of integrating education with e-learning.
b. To study the impact of digital screens on the physical and mental well-being of students.
c. To assess the role of technology in the improvement of educational processes and in providing user-friendly and qualitative content.

2. Contextual Background

In 1972, during the 4^{th} Five Year Plan, Educational Technology (ET) scheme was established. Six State Institutes of Educational Technology (SIET) received 100 per cent funding, and states and UTs were granted aid for the purchase of radio/cassette players and colour televisions. In addition, Computer Literacy And Studies in Schools (CLASS) Act recognised the relevance of ICT in education. This initiative began as a trial project in 1984-85, using BBC microcomputers. During the 8^{th} Plan (1993-98), the initiative was adopted as a Centrally Sponsored Scheme, and its scope was expanded to include financial subsidies to educational institutions as well as to the new government and government-aided secondary and higher secondary schools. The availability and use of software was restricted with coverage limited to just higher secondary schools.

The Prime Minister established the National Task Force on Information Technology and Software Development (IT Task Force) in July 1998 to make specific recommendations on implementing IT in the education sector including schools, through the Vidyarthi Computer Scheme, Shikshak Computer Scheme and School Computer Schemes. Smart Schools were recommended as a demonstration project in each state on a pilot basis. During the next five years, 1 to 3% of the total budget was to be spent on providing computers to all educational institutions up to and including secondary and higher secondary levels. Based on previous experience, a need for a reform of the ICT @ Schools scheme was identified for the following reasons: (Ministry of Education, n.d.)

a. ***Expansion with focus on quality and equity:*** There was a need to broaden the scheme's reach to include all government and government-aided secondary and higher secondary schools across the country, with a focus on educationally backward areas and those areas with a high concentration of SC, ST, minority and weaker sections of the society. There was also a need to ensure a stable power supply in areas where the electrical supply was irregular along with internet connectivity, especially Broadband.
b. ***Demonstration effect:*** Smart schools must be established at the district level to act as showcase examples for other nearby schools.
c. Teacher engagement and enhanced in-service and pre-service training: Because ICT education will be provided to all secondary and higher secondary students, each school will require an individual ICT teacher. Similarly, all teachers need pre-service and in-service training on how to effectively use ICT in the teaching and learning process.
d. Development of e-content: To improve the children's comprehension levels in many areas, it is also necessary to produce and deploy relevant e-content.
e. Monitoring and management structure: To ensure optimal delivery of established targets, a solid monitoring and management structure must be put in place at all levels.
f. Creation of online web-based portal: The School Administration Committee, Parent Teachers Association and local bodies must be involved in the programme management as well as creation of an online web-based portal for real-time monitoring and transparency, according to the scheme. Furthermore, independent monitoring and assessment was planned. As a result, the scheme was updated on 9th January 2010 with the consent of the Cabinet Committee on Economic Affairs (CCEA) for implementation for the remaining duration of the 11^{th} Plan. (***ICT Information and Communication Technology School Scheme***, n.d.)

2.1 *Conceptual Framework/Research Design*

Qualitative and analytical research has been selected as the appropriate method for this study. Questionnaire interviews of various stakeholders were undertaken for this purpose. The aim & objectives of the study guided the primary and secondary study (Table-2 and Figure-2). The study was done in 4 out of 6 different government schools installed with e-Pathshalas in Kanpur, built under the Smart City Mission. Table-2 gives the objective-wise data and analysis technique required for the study and Figure-2 shows the corresponding research framework.

Table-2: Conceptual framework under the objectives

Objectives	Data required (specific indicators with source and tools/techniques of obtaining the data)	Analysis Technique
Objective a	1. Gross Enrolment Ratio 2. Improvement in grades 3. Dropped-out ratio 4. Student-centered learning 5. Flexibility (learning as per the learners' timing) 6. Exposure to different and more examples 7. Access to a large knowledge base 8. Interactive 9. Sharing of resources 10. Better opportunity 11. Time saver	Through interviews with school authorities, teachers and stu-dents
Objective b	1. For how many hours do students use the phone/ digital screen 2. Purpose of using a digital screen (Study/ Entertainment) 3. Awareness and following guidelines for physical and mental health 4. Facing any physical or mental health issues like anxiety, depression, eye and body pain	Through question-naire survey for students & teachers

Objectives	Data required (specific indicators with source and tools/techniques of obtaining the data)	Analysis Technique
Objective c	1. Factual accuracy 2. Content free from technical glitches 3. Correspondence on topics/ subtopics and learning outcomes covered in the textbook/subject area 4. Pedagogic/Andragogic structure 5. Language and Comprehensibility 6. Format of content presentation appropriate for Age/Class/Level 7. Pace of the programme 8. Duration of the program appropriate for Age/Class/ Level	Through question-naire survey for students & teachers

Source: Author

The Research framework for the whole study including data collection, analysis and conclusion is given in Figure-2.

The detailed attributes of the project and information regarding the students and teachers' perceptions, satisfaction and efficiency were collected. The methodology adopted for collecting the information can be divided into four different categories:

a. Interviews with the city administration
b. Interviews with school authorities
c. In-depth interviews of the teachers
d. Interviews with the students

Interviews with the city's administration
Interviews with the city's administration were taken to collect data and analyse it from an administrative point of view. This includes the following data collection:

a. Initial and Operation & Maintenance cost of the project.
b. Completion date of all the e-Pathshalas.
c. Basis of choosing the schools for e-Pathshalas.
d. Maintenance period for all set-ups.
e. Challenges they faced during the implementation of e-Pathshalas.

Interviews with the school authorities
Interviews with the school authorities were taken to collect data and analyse it from the society's point of view. This includes the following data collection:

a. Total number of students and teachers in the concerned school.
b. Gross enrolment ratio and dropped-out ratio.

Interviews of Teachers
Interviews of teachers were undertaken to gauge their satisfaction with the project. Survey questions covered user satisfaction and problems in the following key areas:

a. E-content evaluation.
b. User-friendly and easily accessible nature of digital classes.

Interviews of Students
Student interviews were undertaken to gauge their satisfaction with the project. Survey questions covered user satisfaction and problems in the following key areas:

a. E-content evaluation.
b. User-friendly and easily accessible nature of digital classes.
c. To check the benefits and problems solved by e-classes.
d. Challenges they faced - health issues, learning environment or any other.
e.

On the basis of these methods, four questionnaires (one for each) for in-depth interviews of all the stakeholders - city administration, school authorities, teachers and students, were prepared.

After collecting the data with the help of questionnaire interviews, it was analysed for the selected benchmarks under the set objectives. On the basis of beneficiary response (positive or negative), we evaluated and analysed the impact and effectiveness of the newly developed e-Pathshala project on the teachers and students.

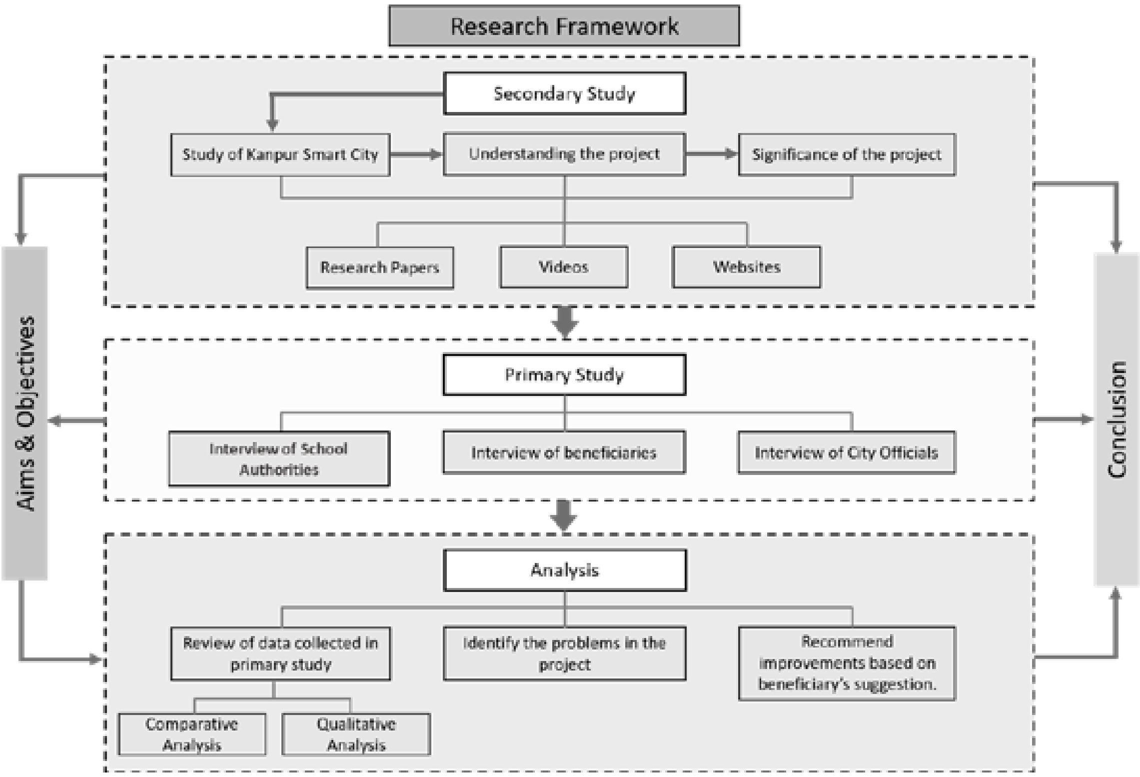

Figure-2. Research Framework for the study of E-Pathshala project in Kanpur. Source: Author

2.2 Key features of the project

2.2.1 Challenges in the project

a. Identification of schools where new e-Pathshala projects need to be installed was a major challenge for KSCL. As there are so many government and government-aided schools in the ABD area, selecting only six schools was a big challenge.
b. Existing infrastructure issues of the selected schools was another challenge. Some schools have poor infrastructure like leakage of lintel in the rainy season which creates problems for the installed systems and also increases the maintenance cost of the system.
c. During COVID-19, schools were online through an e-Pathshala portal. But mostly due to lack of provision of mobile phones and internet connectivity the students were unable to participate. So, the lack of provision of any digital medium and unstable internet connectivity during COVID-19 was a major concern where this project lagged.

2.2.2 Risks involved in the project

a. The first risk associated with the project was that there was no proper training strategy in place for teachers. It created unsafe online learning, increased the risk of cyberbullying and also wasted the time of both students and teachers while operating the system.
b. The use of mobile phones by students, who

don't have complete knowledge of data security and safety was another risk. It was not safe for the students as some of their personal photos and videos could get viral on social media and increased the risk of cyberbullying.

c. The project also suffered in terms of improper execution and delay in inauguration because of the small and temporary set-up of government employees. As there were no separate teams structured for KSCL, the Nagar Nigam teams worked on this project. Due to the change of persons posted for the execution work, the project suffered and also the O&M increased. Delay in inauguration and handover resulted in improper benefit to teachers and students.

2.2.3 *Features and Benefits*

a. The project helps to upgrade the standard of students and the government schools. It promotes innovative thinking, develops effective communication, instils personal, social and civic responsibility and eventually leads to high productivity by instilling scientific, economic, technological, information, multicultural literacy and global awareness. It also promotes innovative thinking, develops effective communication, instils personal, social and civic responsibility and eventually leads to high productivity. (***How to Improve Education System***, n.d.)

b. The project provides better infrastructure facilities for students in order to increase their attendance and attentiveness. Buildings, classrooms, laboratories and equipment, collectively known as education infrastructure, are critical components of educational learning settings. There is significant evidence that high-quality infrastructure, among other things, allows better education, increases student outcomes and lowers drop-out rates. (Janssen Teixeira, Jeremie Amoroso & James Gresham, 2017)

c. Technology exposure to students of government schools who don't have better economic conditions. It helps to address issues such as archaic teaching techniques, teacher shortages, poor teacher-to-student ratios and outmoded teaching materials. (Rawal, 2019)

2.3 *Key findings from interviews, surveys and primary/secondary data collection*

The results of the study from primary and secondary data and the key findings from interviews of various stakeholders are presented below:

a. Interviews with the city's administration

Kanpur city has many government and government-aided schools in the ABD area where KSCL planned to construct e-Pathshalas in six of them under the Smart City Mission. These were started as pilot projects. KSCL spent Rs 2.71 crore on the project. This is the total cost for construction and implementation of the e-Pathshalas and for operation & maintenance for the next five years. After this time period, the schools will bear the maintenance cost of the e-pathshalas.

The combination of government and government-aided schools having high population and density of students and which performed well in terms of education within that ABD area were selected for the implementation of e-Pathshalas. The design and number of classes in each school were similar and followed the design guidelines provided by the government in different orders The project was completed on 31st December 2021.

City officials respond negatively to any selected service benchmark for evaluation of these e-Pathshalas for a comparative analysis between them. To date, no special event has been organised by the administration to advertise the e-pathshala project, as COVID-19 delayed the completion and inauguration of the e-pathshalas.

Training regarding the usage and functioning of equipment was given by government officials to the teachers. But they have not responded regarding the training status for teaching.

KSCL will implement more such projects after they

Table-3: Onsite observations of the six schools

S. No.	School Name & Address	Status of E-pathshala	Inauguration & Handover	Class Capacity	Status of the installed hardware and other assets
1.	Primary G School Khalasi Line Pratham, Khalasi Lines	Installed	Yes	60	Whiteboard, green boards, projector, chairs, attendance recorder, AC, CCTV, fire extinguishers, acoustic false ceiling and all assets are installed
2.	Nagar Nigam Balika Inter College, Chunni Ganj	Installed	No	60	Whiteboards, green boards, projector, chairs, attendance recorder, AC, CCTV, fire extinguishers, acoustic false ceiling and all assets are installed
3.	Nagar Nigam Mahila Inter College, Civil Lines	Installed	–	–	–
4.	Nagar Nigam Mahila Inter College, Tilak Nagar	Installed	Yes	60	Whiteboards, green boards, projector, chairs, attendance recorder, AC, CCTV, fire extinguishers, acoustic false ceiling and all assets have been installed
5.	Shri Kailash Nath Balika Inter College, Civil Lines	Installed	Yes	50	Whiteboards, green boards, projector, chairs, attendance recorder, AC, CCTV, fire extinguishers, acoustic false ceiling and all assets have been installed
6.	DAV Inter College, Civil Lines	Installed	No	60	Whiteboards, green boards, projector, chairs, attendance recorder, AC, CCTV, fire extinguishers, acoustic false ceiling and all assets have been installed

Source: Primary survey on 21 February, 2022

Figure-3: E-pathshala project installed by KSCL in different schools. Source: Author get some positive response from the public regarding e-Pathshalas after the normal schools start. They will also implement Abhyudaya class under the Abhyudaya scheme for civil services and preparations of competitive exams.

b. Onsite observations

On-site visual observations of these six schools have been recorded (as shown in Table-3), but not completely for Nagar Nigam Mahila Inter College, Civil Lines. The observations were recorded during our visit to the schools.

As per our observation, in all the six schools e-Pathshala was installed successfully with proper guidelines. The schools in which e-Pathshala was implemented by KSCL are shown in Figure-3. In 3 out of the 6 schools, the e-Pathshala project was inaugurated and handed over to the school authorities. In 2 out of the 6 schools, the e-Pathshala project was neither inaugurated nor handed over to the school authorities. Due to delay in reaching the Nagar Nigam Mahila Inter College, Civil Lines we were unable to observe and asked the authority regarding the capacity of the classes and status of the inauguration and handing over of the project.

From the observation, it was found that the capacity of 4 out of the 6 schools is 60 and for Shri Kailash Nath Balika Inter College, Civil Lines, the capacity of the class is 50. In all the schools there is provision for chairs for students in the classroom as per the capacity of the classes along with small windows in each classroom for lighting and ventilation purpose.

Provision for projector, white boards, green boards, internet facility, acoustic ceiling, lights, air conditioners (AC), Closed Circuit Television (CCTV), attendance recorder, fire extinguishers and other necessary assets have been provided in each of the classes as shown in Figures 4 & 5.

c. Interview with school authority

Four out of six schools were visited and interviews conducted with the school authorities. They mentioned the total number of students and teachers in the schools as shown in Table-4.

Table-4: Student-teacher ratio in the six schools

S. No.	School Name & Address	Number of Students	Number of Teachers	Student-Teacher Ratio
1.	Nagar Nigam Balika Inter College, Chunniganj	300	23	13:1
2.	Nagar Nigam Mahila Inter College, Tilak Nagar	900	26	35:1
3.	Shri Kailash Nath Balika Inter College, Civil Lines	325	17	19:1
4.	DAV Inter College, Civil Lines	240	15	16:1

Source: Primary Survey on 21 February,2022

As per Rashtriya Madhyamik Shiksha Abhiyan (RMSA) the student-teacher ratio should be 30:1. (Project Management Consultancy for implementation of Smart City Mission projects for Mangaluru city Smart Road Package - 05 det, 2019). For Nagar Nigam Mahila Inter College, Tilak Nagar, the student-teacher ratio of 35:1 is high in comparison to the other three schools. This shows the need for the project in schools to provide quality education to students. It can be made possible by making teachers work easily without increasing their corresponding number in the school. Thus, teachers can provide their time, mentorship and better focus on each & every student.

Regarding benefits of e-Pathshala, the school authorities mentioned that e-pathshala was set up in only one class, so they used to teach a class for a day in a week and for that day the attendance of the students of that class (whose turn it was) was high as compared to other days. It shows that the implementation of the e-Pathshala project increased the enthusiasm of students to come to school and attend the e-classes, which reflects the positive side of the project.

The problems faced during the lockdown were lack of mobile phones because most of the students belong to a poor background (i.e out of 50 students only 10 have phones). Another issue was the insufficient/unstable internet connectivity which compelled the school authorities to hold classes for all. In a normal scenario, the infrastructure and internet connectivity created major problems.

Figure-4: E-pathshala installation status in DAV Inter College, Civil Lines. Source: Author

Figure-5: E-pathshala installation status in Shri Kailash Nath Balika Inter College, Civil Lines. Source: Author

d. Interview of Teachers

In the on-site surveys, 6 teachers of 2 schools (3 teachers of each school and of different subjects) were interviewed in which e-Pathshala was inaugurated and handed over to the school.

For analysing the impact on the physical and mental well-being of students, keeping in mind the Covid-19 phase, continues during and after the implementation of e-pathshala, we selected some benchmarks to evaluate the effect of digital learning on the students. As per the teachers' interview, a 40-minute class of a subject in a day was taken by the teachers and the students attended the classes on "e-Pathshala" and "Diksha" Apps with the help of mobile phones and television. They provided little homework i.e both digital and pen-paper based assignments to students and according to them, a maximum of 15- 20 minutes were taken by the students to complete each subject's homework. Regarding guidelines for physical health and mental wellness, 6 (100%) teachers agreed that both the e Pathshala portal and the school provided the ergonomic aspects ie yoga, exercises, mental wellness and learning environment guidelines to students. As per these interviews, we came to the conclusion that each student used the digital screen for 6-7 hours daily for digital learning.

For evaluation of e-content, we selected 8 parameters and a few sub-parameters. All 6 teachers responded positively to all the selected parameters and sub-parameters. For factual accuracy, all 6 (100%) teachers agreed that the content which was presented through text, diagrams, pictures, maps, data, audio/videos, animation, simulation, etc had no factual errors. For content pieces free from technical glitches, all 6 (100%) teachers agreed that the sound was in sync with the visuals and that there is general usability in terms of rendering and visual experience. For correspondence with topics/subtopics covered in the textbook, all 6 (100%) teachers agreed on the relevance of the content with the topics/subtopics. For Pedagogic/Andragogic structure, the 6 (100%) teachers agreed that content presentation was supported by relevant examples, the learning was outcome-oriented, all 6 (100%) teachers agreed that it was simple and easy to use , all 6 (100%) teachers agreed that the structure was whole to parts/ parts to the whole, and all 6 (100%) teachers agreed that spatial continuity of message forms - corresponding words and pictures were presented near rather than far from each other. For language and comprehensibility, all the 6 (100%) teachers agreed that the content had no grammatical errors and was presented in a manner that was understandable as per the grade/level of the learner. For the format of content presentation, all 6 (100%) teachers agreed that content had been presented in a format that was best suited for the theme. For the pace of the program, 4 (66.67%) teachers agreed that the content was appropriately paced leading to ease of comprehension but 2 (33.33%) teachers mentioned that for some of the subjects e.g mathematics and computers, the pace of the program was a little fast. Regarding the duration of the program, all 6 (100%) teachers agreed that the content was of appropriate duration to sustain the attention of the learners.

For user-friendly and easily accessible data, all 6 (100%) teachers agreed that digital learning was easy to use and also that all the data was available easily in the App which solved many problems and made the work fast and systematic.

To evaluate the benefits of this project, we chose some benchmarks and asked several questions from the teachers. All 6 (100%) teachers agreed that the e-Pathshala project provided student-centred learning and that they were able to access a large knowledge base at one place. All 6 (100%) teachers also agreed that the classes become more interactive for the students and the teachers. All 6 (100%) teachers agreed that e-Pathshala was a source for sharing of resources like e-content, e-video, e-library and so on, which makes learning easy, fast and more understandable. All 6 (100%) teachers agreed that the project was a better opportunity during and after Covid-19. All 6 (100%) teachers also mentioned that it was a time-saver. Previously, they used to take a lot of time to make typical diagrams on the board and students would get distracted at that time but because of the digital classes, this was no longer a problem.

e. Interview of Students

In our on-site surveys, we interviewed 20 students from 2 schools (10 students from each school and from different standards) in which e-Pathshala was inaugurated and handed over to the school.

For analysing the impact on the physical and mental well-being of students, keeping in mind the Covid-19 phase, continues during and after the implementation of e-Pathshala, we selected some benchmarks to evaluate the effect of digital learning on the students. As per the students' interview, a 40-minutes class of a subject in a day i.e 6 hours per day for all subjects and students attended the classes on "e-pathshala" and "Diksha" Apps with the help of mobile phones and television as per the availability. They also mentioned that they got less homework i.e both digital and pen-paper based assignments and according to them a maximum of 15- 20 minutes were taken to complete each subject's homework. To find the mental wellness and addiction to mobile phones, we asked the total time they used the mobile phones and the purpose behind it. Out of 20 students, 9 (45%) students used mobile phones for 3-4 hours, 3 (15%) used them for 4-5 hours, 6 (30%) used them for 5-6 hours and 2 (10%) used then for 6-7 hours. Out of 20 students, 9 (45%) students used mobile phones to attend classes, do homework, play games and for entertainment. Another 5 (25%) students used mobile phones to attend classes, do homework and play games, while 3 (15%) students used mobile phones to attend classes and do homework only. Only 3 (15%) students used mobile phones to attend classes and do homework only. We also asked about their health-related concerns, all 20 (100%) students responded negatively about anxiety, depression and eye and body pain. 17(85%) students responded negatively towards the unfavourable home learning environment and 3(15%) students mentioned that they face the unfavourable home learning environment.

Regarding guidelines for physical health and mental wellness, 20 (100%) students agreed that both the e-Pathshala portal and school provided ergonomic aspects, yoga, exercises, mental wellness and learning environment guidelines to students. Also, 20 (100%) students were aware and followed the guidelines.

For the evaluation of e-content, 8 parameters and some sub-parameters were selected . All 20 (100%) students responded positively to all the selected parameters and sub-parameters. For factual accuracy, 20 (100%) students agreed that the content presented to them through text, diagrams, pictures, maps, data, audio/videos, animation, simulation, etc had no factual errors. For content pieces free from technical glitches, all 20 (100%) agreed that the sound was in sync with the visuals and 20 (100%) students also agreed that there was general usability in terms of rendering and visual experience. For correspondence with topics/subtopics covered in the textbooks, all 20 (100%) agreed on the relevance of the content piece. For Pedagogic/Andragogic structure, all 20 (100%) agreed that the content presentation was supported by relevant examples, and that the content learning was outcome-oriented and was simple and easy to use, while the structure was whole to parts/parts to the whole, and all 20 (100%) also agreed that spatial continuity of message forms corresponding words and pictures were presented near rather than far from each other. For language and comprehensibility, all 20 (100%) agreed that the content had no grammatical errors I was presented in a manner that was understandable as per the grade/level of the learner. For the format of content presentation, they all 20 (100%) agreed that it had been presented in a format that was best suited for the theme. Regarding pace of the program, 16 (80%) students agreed that the content was appropriately paced leading to ease of comprehension but 4 (20%) students mentioned that for some of the subjects e.g mathematics and computers, the pace of the program was a little fast. With regard to duration of the program, all 20 (100%) agreed that the content was of appropriate duration to sustain the attention of the learner.

For user-friendly and easily accessible data, all 20 (100%) students agreed that digital learning was easy to use (user-friendly) and also that all the data was available subject-wise in the App which helped in finding content easily and that it is accessible to all students.

To evaluate the benefits of this project, we chose some benchmarks and asked several questions from the students. Out of 20 students, all 20 (100%) agreed that the e-Pathshala project provided student-centred learning. They all 20 (100%) also agreed that flexibility (learning as per the learners' timing) was higher in online education and that they got exposure to different and more examples in different subjects. All 20 (100%)

students agreed that they were able to access a large knowledge base at one place. They all 20(100%) also agreed that the classes become more interactive with other students and teachers as well. All 20 (100%) students agreed that e-pathshala was a source of sharing of resources like e-content, e-video, e-library and so on, which made learning easy, fast and more understandable. All 20(100%) agreed that this project is a better opportunity during and after Covid-19.

3. Discussion and Conclusion

With the Coronavirus outbreak, online learning has become an important aspect of education. With such a large education system in the country, online learning methods have a significant problem in meeting the needs of the educational sector. The purpose of this study is to assess and analyse the impact and effectiveness of the Kanpur Smart City's newly established e-Pathshala project on instructors and pupils. The performed research was divided into two phases: The first phase gives thorough information about the e-Pathshala project while the second phase provides detailed information about the e-Pathshala project. KSCL executed e-Pathshala projects in six government and government-aided schools as part of the Smart City Mission of India's "Sampann Kanpur" initiative to host educational resources for students, teachers and parents. The response from the participants determines the success of the e-Pathshala initiative. A questionnaire-based survey was undertaken in the second part of the paper to confirm the success of the e-Pathshala project. Despite the fact that the results suggested that online learning via e-pathshala is the future of education, it still faces several challenges.

The reactions of the targeted audience can help determine the effectiveness of the e-Pathshala project. As a result, a survey was performed to obtain the perspectives of instructors and students from the six e-Pathshala-implemented schools in Kanpur on online learning through the government's e-Pathshala project. The results were favourable with the majority of respondents favouring online learning and seeing this initiative as an important step in sustaining the study's continuity during the COVID-19 era. A large number of users saw online learning as a valuable and required educational tool. Despite the challenges affecting the performance of the web-based learning technique, users reported that the overall experience of online learning was positive and that it successfully addressed the educational needs throughout the lockdown period.

According to the analysis, majority of teachers gave a good feedback about online learning. This can be interpreted as their acceptance of and contentment with the online learning methods. In addition, the research includes information on the learners' attitude regarding government efforts and online learning. Despite the fact that the study covers a lot of ground in terms of the initiative's efficacy, it does have certain inevitable limitations.

After considering the total user experience and learning benefits that the beneficiaries of these e-Pathshala programmes received, it can be concluded that this project has been a success in providing good education to students and raising the standard of education. As this study shows, e-Pathshala provides an accessible and effective approach to learning, which draws both teachers and students.

3.1 Limitations of the research

There have been some limiting factors during the conduct of this research. First, the inauguration of e-pathshala in two schools was not done initially because of the corona's third wave and then because of elections in Uttar Pradesh.

Second, because of the limited time schedule and the election period, in one school teachers and students were not available and in another one we were not able to reach on time.

Third, due to the Covid-19 pandemic, there were no new admissions and no exams which affected the overall research work.

3.2 Key lessons learnt

This study gives us the opportunity to learn various lessons. First, to understand the research methodology and the processes involved in writing a research paper. Second, the method of making questionnaires and conducting interviews of various stakeholders; Reflecting their viewpoints and findings in the research paper. Third, to conduct primary and secondary studies and develop a research framework. Fourth, to understand that operation & maintenance (O&M) are the biggest hurdles in the success of a project.

3.3 Recommendations

Based on the study, three recommendations were offered. First, to get a better outcome the number of e-Pathshala classes needs to be implemented on the basis of the total number of students studying in a school. With a strength of 900 students (as in Nagar Nigam Mahila Inter College, Tilak Nagar), if we implement e-Pathshala in only one class then only a limited number of students can take advantage for a limited period (maybe 1 class studied once in a week in e-Pathshala class).

Second, the training module can be improved and utilised on a broad-scale for regular training of computers/ICTs and subject teachers. It will build confidence in teachers, save time, make processes and work more effectively to provide better education exposure (collaboration of online and teacher knowledge) to the students.

Third, accessing online material can bring significant risks. To raise awareness of safe online learning and combat cyber bullying, the government should develop communication materials aimed at students, instructors and parents.

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A20

Adaptive Traffic Control System (ATCS)

Name of the project: *Adaptive Traffic Control System (ATCs)*
Location: *Srinagar city, Jammu and Kashmir*
Year of Project Implementation: *2022*
Sector: *Mobility/ NMT*
SDG: *sustainable cities and communities (SDG 11)*
Project Cost: ***15 Rs. Crore***

Institute: *IIT-Roorkee*
Advisors: *Faculty Coordinator: Dr. Arindam Biswas , Mentor: Ms. Shraddha Pandit*
Students: *Mr. Nesar Ahmad Saleh*

Keywords: *Adaptive traffic control, Smart City, sustainable, congestion*

Abstract:

The traffic controlling system in most of the Indian cities is still implemented by two regular traffic control systems, Automatic traffic controlling and manual controlling that needs manpower to control the traffic. Most of the automatic traffic signals functions on synchronized fixed time period basis which is not an effective method to control and operate the signal in the current traffic condition. This leads to poor traffic signal timing, which is the main reason of traffic congestion and delay in most of the congested areas of India. Thus, to enhance the existing traffic management system, the Smart cities of India are increasingly focusing on the Adaptive Traffic Control System (ATCS). The main benefit of ATCS is that it modifies the traffic signals with the varying stream of traffic patterns and simplifies traffic crowding.

Under the gamut of AMRUT scheme, Srinagar smart city is also implementing this ATCS. The main benefit of this project in Srinagar smart city is to reduce congestion, accidents and delays, improve pedestrian safety, optimization of timings at select junctions, monitoring and operations from centralized control room with integration measures and Help SMC and Traffic Police with modern and real-time monitoring of traffic control in the city. This paper is a comparative study and performance assessment of ATCS in Srinagar smart city.

The research methodology consist of two progressive efforts. The first effort is focused on the first objective, which analyse the effectiveness of Adaptive Traffic control system in Srinagar Smart City. The next effort is focused on the second objective to carry out a literature review and collect as many data as possible about understanding the mechanism of adaptive traffic control system (ATCS) from previous studies.

The main finding of this paper is that the most common rationale for ATCS deployments is to handle daily and weekly fluctuations in traffic flows. SSCL frequently extends their ATCS from the time funding is made available until the time an ATCS is fully operational, and they are pleased with the performance of their ATCS.

Case Study: **A20**

1. Introduction

Congestion in traffic has long been known as an economic, social, and environmental hindrance that has a negative impact on human productivity, fuel consumption, air pollution, and general quality of life around the world. Congestion and delays are the most visible indicators of current transportation systems, which have exacerbated a number of environmental and social issues such as air pollution, energy consumption, productivity loss, and a higher risk of automobile accidents. Traffic lights are the limiting elements of urban mobility and are the principle source of congestion in the cities. As a result, improved urban mobility demands the reduction of traffic congestion through a well-managed and effective traffic signal as well as its control (Kajal Dubey, Tushar Gupta, 2020).

Like the other cities of world, the traffic scenario in Indian cities has also become a topic of concern due to the increased need of transportation and an enormous rise in the number of vehicles in the past few decades. As the number of vehicles on the road network increases,, the pressure on infrastructure is huge which urges for an updated traffic regulation system. On the other hand, traffic overcrowding has become an image of Indian cities due to high density of motorized vehicles on the roads, social interaction, human behaviours, and inefficient traffic control system. One of the main factors which has increased congestion is the inefficient traffic light system that controls traffic at the congested junctions. Now a days, the traffic controlling system inside the cites is implemented by two regular traffic control systems such as Automatic traffic controlling and Manual controlling that needs manpower to control the traffic. Most of the automatic traffic signals functions on synchronized fixed time period basis while this is not an effective method to control and operate the signal in the current traffic condition. This leads to poor traffic signal timing which is the main reason of traffic congestion and delay in most of the crowded areas. Adaptive signal control technology, On the other hand, alters signal timings in real time, gives a quick response to changing traffic patterns, and makes traffic congestion easier to manage. As a result, the Adaptive Traffic Control System (ATCS) is a useful traffic management tool (Kajal Dubey, Tushar Gupta, 2020).

Smart city mission have been looking into systems that adjust to changing traffic circumstances in cities by the hour and day for a long time. Although the Adaptive Traffic Control System (ATCS) is not wholly new to India, the National Smart Cities Mission has contributed to a greater understanding and implementation expertise. An A employs cutting-edge technology to improve stream of traffic flow by presenting a data collection and handling network that processes and sends information back to the current network, that will adjust to changing traffic parameters and provides real-time signal timings to the traffic controller (Zulqarnain H. Khattak, Michael D. Fontaine, 2019).

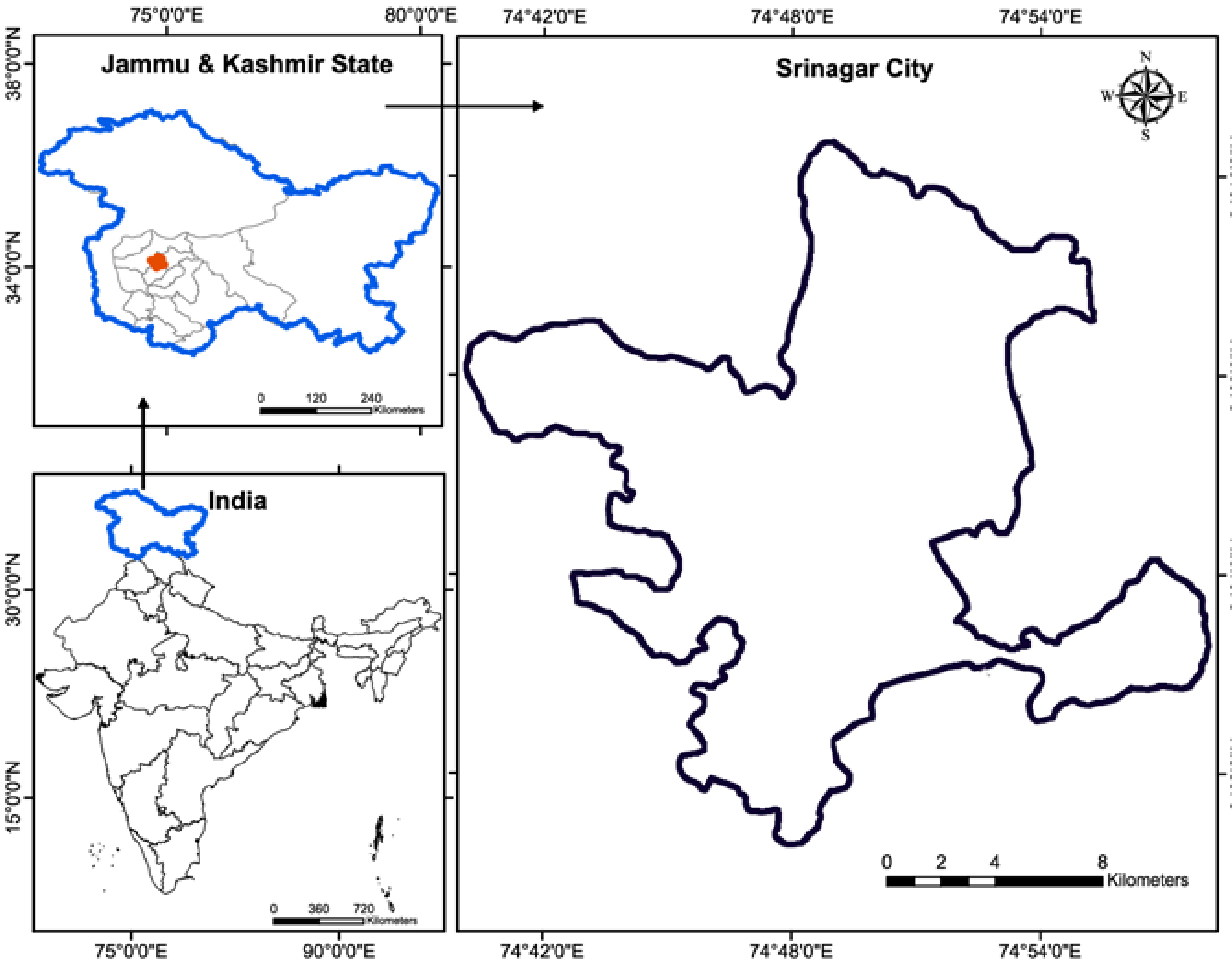

Figure 1: Location Map of Srinagar
Source: Srinagar Municipal Corporation (SMC)

Smart City and the growing emphasis on ATCS

By 2050, it is expected the world's urban population will be double. By 2030, city will become more congested and six out of every ten people will in the city, and by 2050, this number will rise to seven out of ten. Every year, approximately 60 million more people move to cities. ((Yizhe Wang, Xiaoguang Yang, 2018)).

Cities must become smarter as the world becomes more urban. Major urbanization necessitates innovative and novel approaches to dealing with the complications of urban living; it necessitates new approaches to dealing with issues such as traffic congestion, energy waste, environmental protection, and resource management; as a result, there is an increased demand for intelligent, sustainable environments that provide a high standard of life to the residents of a community (Rupali, 2018).

There is no specific definition of a Smart City which is acceptable universally; it concepts is differ from region to region and city to city, based on the residents' standard of improvement, resources, aspirations, willingness to change and modify. To introduce cities in the Smart city Mission, some definitional boundaries are required. The image of a smart city in the dreams of every city resident in India includes a list of public infrastructure and services that explains their level of desire. To meet the desires and wishes of every city resident, urban practitioner and designers should try to improve the overall urban eco-system, as exemplified by the main basic of comprehensive development-institutional, infrastructure, physical, social , and economic (Report on Smart City Mission-India, 2018)

In April 2017, The SSCL project was accepted in the Round 3 challenge. All the projects related to The smart city are implemented into two parts: (a) Area Based Development (ABD), which is estimated to cost Rs. 2869.24/- crores, and (b) Pan City Solutions, which is estimated to cost Rs. 765.03/- crores (SSCL, 2017).

1.1 Topic and Context

Srinagar is northernmost city of India and the Indian union territory of Jammu and Kashmir largest city and the summer capital. It is located on the banks of the Jhelum River in the Kashmir valley, a branch of the Indus River, as well as the Dal and Anchar lakes. The city has the population of over a million people. Srinagar city is famous for its natural water fronts, gardens, and house boats. It is also famous for its traditional Kashmiri handicrafts such as dried fruits and Kashmir Shawls. It (SSCL, 2017).

Main vision (SSCL) is to transform Srinagar into a socioeconomically, resilient, vibrant and eco-friendly city that celebrates its natural and cultural heritage while creating harmony and opportunities for all. Srinagar smart city aspires to improve the quality of life for its citizens by leveraging cultural heritage or tourism and it's natural beauty through innovative and inclusive solutions (SSCL, 2017).

Within SMC limits, an Adaptive Traffic Control System (ATCS) is being implemented as part of pan-city solutions as part of the AMRUT scheme. Delhi Integrated Multi-Modal Transit System (DIMTS) was assigned the project on February 20th, 2017, and an agreement was signed on March 16th, 2017. Phase one of this implementation included the installation of a Control Room at the Srinagar state police (SSP) office and the installation of traffic lights at 33 Srinagar intersections.

Envoys were assigned Phase II on January 9, 2020, and an agreement was signed on March 13, 2020. The project's scope was limited to an additional 33 junctions. These 33 junctions will be controlled by the Command Centre set up for Phase – I. (ITS Srinagar City, 2017).

1.2 Significance of the project

The adaptive traffic control initiative changes the timing of red, yellow, and green lights to meet changing stream of traffic patterns and reduce congestion. The following are the primary advantages of this project:

- Safe and secure crossing of vehicles and pedestrians at intersections.
- Reduction of delays, conflicts, congestion and long queues with smoother flows.
- Savings in vehicle operating cost and value of time.
- Reducing the human and economic costs of traffic crashes.
- Fuel consumption benefits
- Reduction in air pollution
- Reduction in the time it takes to develop signal timings
- Prioritize for public transit and emergency responders
- Shorter cycle times—improved pedestrian response
- Roadwork and special events are handled. (SSCL, 2017).

1.3 Aim and Objectives

The aim of the study is to analyse the impact of Adaptive Traffic control system (ATCS) on improving the traffic conditions of Srinagar city

The objectives of the research are:

a. To analyse the role of Adaptive Traffic control system (ATCS) in augmenting the urban mobility of Srinagar city through an efficient and sustainable traffic management.
b. To provide a detail insight on the mechanism of Adaptive Traffic Control System (ATCS) of Srinagar city and its comparative benefits over conventional methods.

2. Contextual Background

The traffic signal is a signalling device that is widely used throughout the world at key areas such as major intersections to manage pedestrian crossings and traffic movements. A well-designed algorithm can improve road traffic handling capacity by decreasing traffic congestion at traffic lights, as well as waiting and travel time for vehicles and pedestrians. An inefficient algorithm, on the other hand, can result in traffic congestion and increased waiting time. Various traffic signal control strategies have been presented in recent years to achieve this goal.

In India, the first fixed-timer traffic signal was erected at Eg more Junction in Chennai in 1953, yet there are still too many vehicles in cities, and the numbers are growing every day. Because people who disobey traffic regulations make their roadways dependent on Traffic Police that is why Indian roads require regular surveillance at every intersection. This presents a significant issue for traffic cops, who will require cooperation from the people, pedestrians, and commuters in order to effectively manage traffic. Because to one person's impatience, the entire stretch of road becomes jammed. Machine learning has been an important subject of research for the last 20 years, considering the difficulty of maintaining the balance between vehicle and pedestrian mobility due to its uncertain and dynamic character. In 2011, Mumbai implemented a sophisticated traffic management system, in which cameras measure the strength of traffic signals that are synchronized to assist commuters in catching green lights, and any security concern can be addressed through constant monitoring by the control center. 'Intelights,' India's first 3-D smart traffic signal system, was launched in Mohali, Punjab, in 2019. It proposes an intelligent traffic management system that regulates traffic lights using a wireless sensor system that provides a bird's eye view. According some research predictions for the future year, in mid-

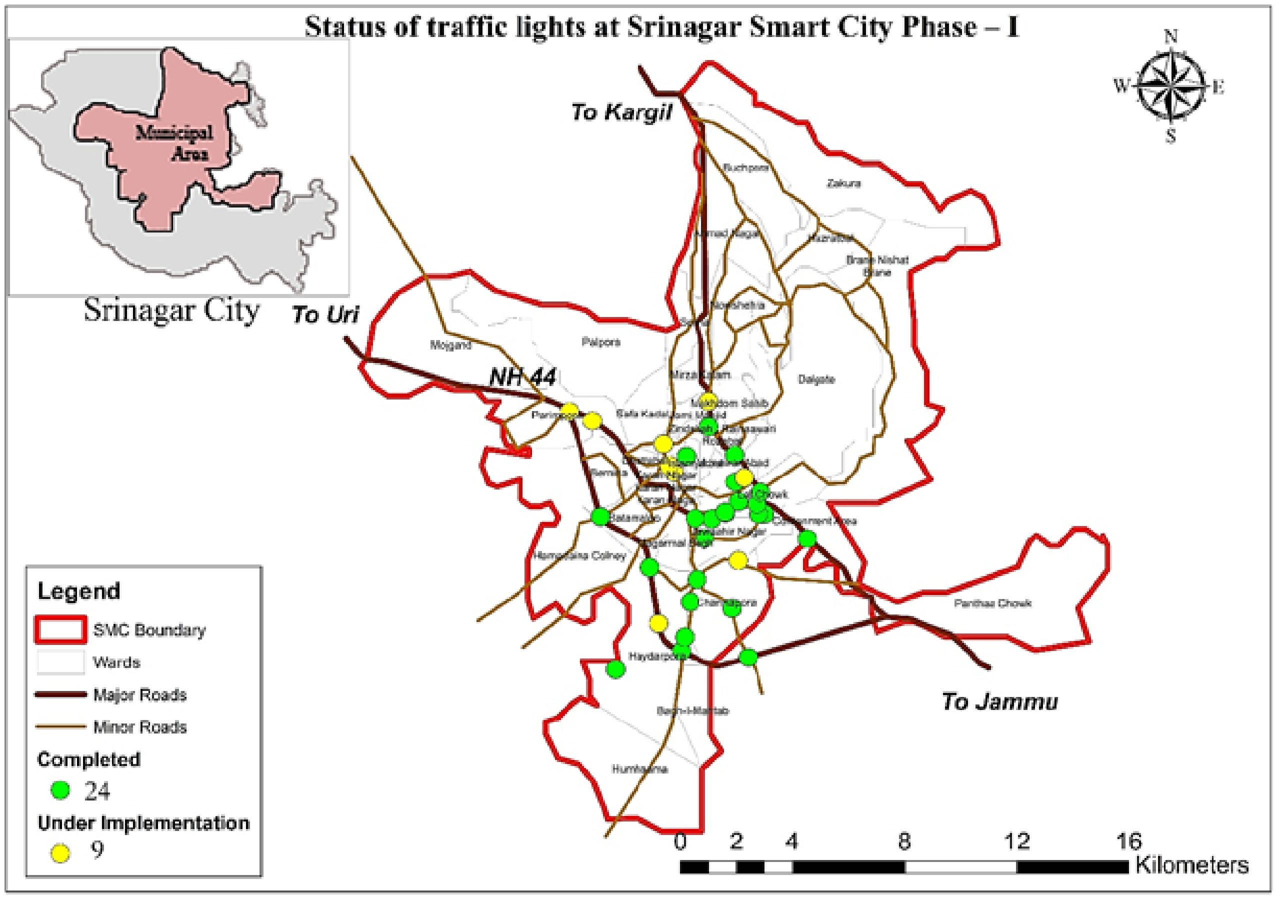

Figure 2: status of traffic lights at Srinagar Smart City Phase 1. Source: Srinagar Municipal Corporation (SMC)

2021, Delhi will appoint a virtual officer to manage movement in the National Capital based on real-time stream of traffic flow. The traffic lights will change colour from red to yellow to green depending on the amount of traffic, not at set intervals.

2.1 Conceptual framework / Research design

For present research paper, a significant number of aspects need to be considered in the process of decision-making which is difficult and time-consuming. The Multi Criteria Technique based on GIS is highly effective in such circumstances due to its capability to manage huge volumes of spatial data from different sources (Dar et al., 2018). In this work, ArcGIS 10.5 software is used for GIS-based analysis. When doing fundamental activities in the software, tools like erase, union, identify, dissolve, clip, intersect, and merge are employed. The data imply in the analysis can be divided into two categories. Raw data from Srinagar Smart City Limited (SSCL) and Srinagar Development Authority (SDA) are used as primary data. Secondary data which is used for current study consist of the processed data gained from different literature reviews. In general the current study is completed in five following stages:

- Stage one: area digitization.
- Stage two: identifying the location of implemented, under implementation and to be implement ATCS in Srinagar city
- Stage three: case studies of different countries for comparative analysis of different control tools
- Stage four: interview with the Srinagar official for collection of primary data
- Stage five: findings and recommendations

The overall structure of the study included two chronological efforts. The first effort is concentrated on the first objective, which analyse the effectiveness of Adaptive Traffic control system in Srinagar Smart City. The next effort is focused on the second objective to do literature review and collect as much relevant data as possible about understanding the mechanism of adaptive traffic control system (ATCS) from previous studies for the comparison.

2.2 Key features of the project

2.2.1 Challenges in the project

The main challenges that reported by Srinagar officials for the implantation of the ATCS in Srinagar Smart city is consist in:

a. Lack of specialised ITS contractors to work in Srinagar
b. Local contractors from J&K State demobilised many times due to various reasons and were not willing to mobilise again for the works
c. Trenchless Ducting could not be undertaken due to lack of knowledge on GIS Maps of underground utilities
d. Limited working hours for ducting and civil works to avoid traffic diversions
e. Frequent law and order problems lead to de-mobilisation and re-mobilisation was difficult and time taking
f. Outdoor field activities are very difficult during rainy days and winter seasons, especially experts visiting from outside valley

2.2.2 Risks involved in the project

The main risks that reported by Srinagar officials for the ATCS project in Srinagar Smart city is consist in:

a. The maintenance software Cost is too high for the city
b. the system is extremely costly to maintain
c. the system need for manpower to maintain
d. Additional overhead for maintenance/licensing
e. Highly expensive in term of communications and training.
f. in order to get most benefits there is necessity for extensive experience

2.4.1 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)

g. Safe and secure crossing of vehicles and pedestrians at intersections
h. Reduction of delays, conflicts, congestion and long queues with smoother flows
i. Savings in vehicle operating cost and value of time
j. Human and economic costs of traffic crashes can be reduced.
k. Real time monitoring and reporting at centralised control centre will benefit the city residents and improve quality of life
l. Improvement in incidence response and reporting

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

ATCS, which is mostly famous as real-time stream of traffic control tools, modify signal timings in real time based on traffic circumstances, system capacity and demand. Despite the fact that the Srinagar Smart city has at least 34 ATCS in place and another 32 on the way, many traffic signal practitioners in the city may not be familiar with these systems. Although their operational benefits have been established, some in the traffic signal world remain skeptical. These systems are measured to be costly and sophisticated, and there is necessity of high level of detection and communication upkeep.

Main rationale for ATCS installation, according to questioner responses, is to handle daily and weekly fluctuations in traffic flows. SSCL usually considers numerous systems when acquiring an ATCS. Since funding becomes available until the time the ATCS is fully functioning, an ATCS installation takes on average 5 years. While traffic jams still exist in the city, they have been reduced considerably. The average waiting time has been reduced by 20%.The SSCL are satisfied with their ATCS operations and frequently expand their ATCSs

Expertise is required for a successful ATCS

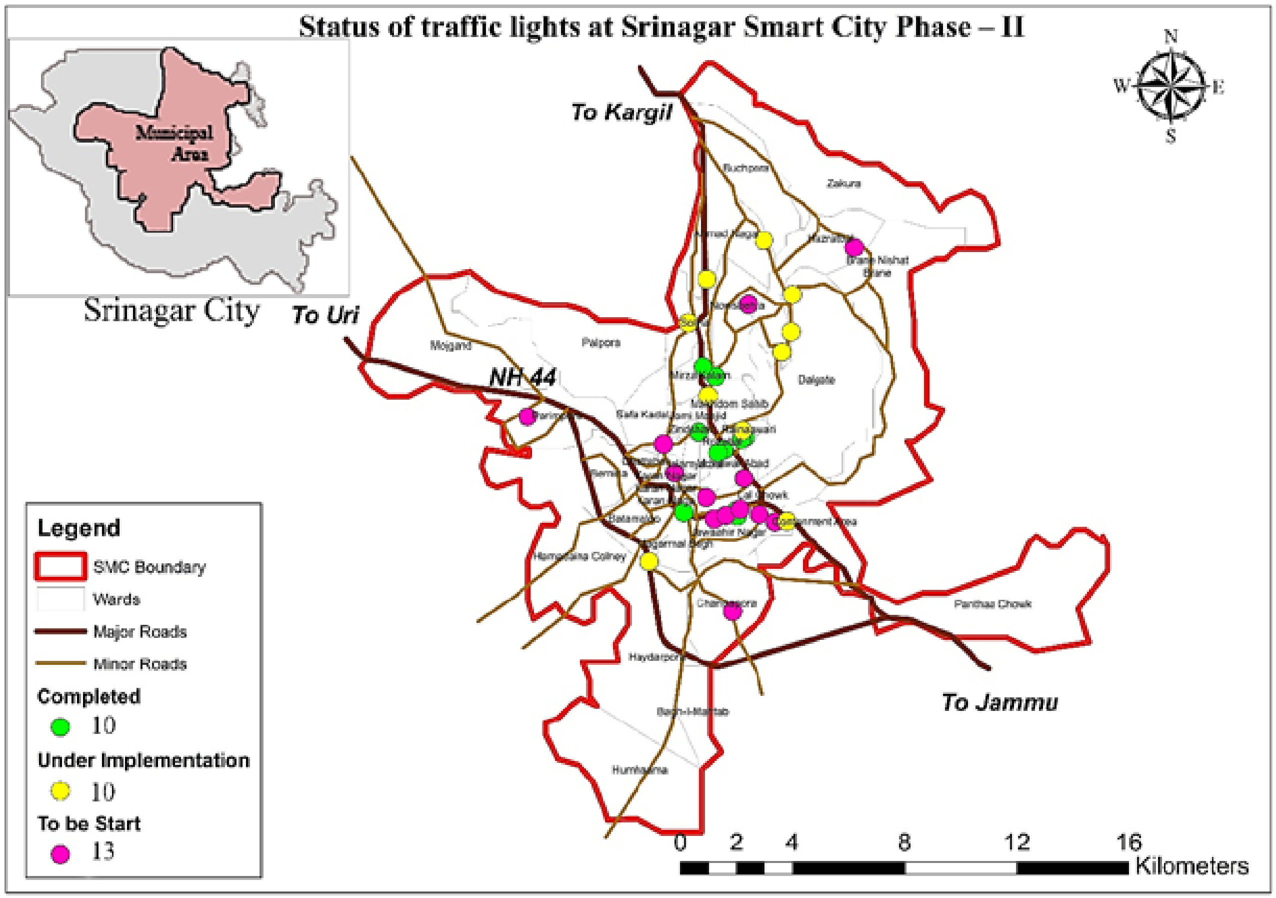

Figure 3: status of traffic lights at Srinagar Smart City Phase 2. Source: Srinagar Municipal Corporation (SMC)

implementation. Despite the fact that many agencies use ATCSs to eliminate labour-intensive signal timing plan maintenance, questioner respondents acknowledged that adaptive traffic control system are merely tackles for the management of traffic flow and must be observed and regulated by expert personnel. The most essential criteria for removing institutional hurdles for ATCS deployments are conducting training and hiring experts within an ATCS agency. Although ATCS operations are not often regarded as complex, it seems that adaptive traffic control system users are rarely given the opportunity to fully understand their systems.

ATCS has slightly higher detection requirements than traditional traffic-actuated control systems. The SSCL is pleased with how the ATCS handle minor detector failures.

According to a evaluation of the many extensively used ATCS, different systems use similar tactics to deal with changes in the demand and distribution of traffic. However, because each and every tool is unique, comparing the algorithms and adaptive logic of the various tools is difficult without a side-by-side comparison. Field applications of different tools are more distinct as compare to their logics, making side-by-side field comparisons prohibitively costly. As a result, among other things, there are few literature that demonstrate one particular ATCS operational concept is superior to another.

3. Discussion and Conclusion

The findings of the present research were based on a review of the literature and responses to a questionnaire: Originally, the main questionnaire was sent to Srinagar smart city officials who implement ATCS in Srinagar Smart City.

According to the responses, Srinagar Smart city deploy their ATCSs in operating situations where the systems are able to function well. The most common rationale for ATCS deployments is to handle daily and weekly variations in stream of traffic flows. The average waiting time has been reduced by 20%. Multiple systems are commonly considered by agencies when acquiring an ATCS. Since funding is made available until the time an ATCS is completely working, an ATCS installation takes about 5 years on average. SSCL mostly extend their ATCSs, and they are satisfied with their performance.

An ATCS detection requirements are somehow higher as compare to those of traditional traffic- control tools. The SSCL is pleased with how the ATCS handles minor detector failures. ATCS are mostly operated by Windows and sometimes used the Advanced Traffic Management Systems that are available (ATMSs). With newer ATCS deployments, integration with an ATMS, which is not typical, has become increasingly widespread. ATCS software, in the opinion of the majority of users, is one of the components that needs to be improved. Surprisingly, ATCS experts do not believe that communications of ATCS cause more difficulties than traditional traffic control system communications. Communications, on the other hand, play a significantly larger part in ATCS deployments and, as a result, must be maintained on a regular basis, which is one of the key operational expenditures for ATCS users.In general, SSCL would use the same ATCS system again. More ATCS signals attract additional attention inside the agency, resulting in more resources to maintain and operate the ATCS.

3.1 Implications

Traditional traffic control tools timing function with transit oriented development (TOD) plans are known to have various disadvantages. While ATCSs are known to have several advantages. ATCS perform best in situations when there is a high amount of nonrecurring overcrowding, such as special events and incidents, and in places where stream of traffic demand fluctuates. As per previously stated, an adaptive traffic control is not always "the answer" in every case. That is vital to remember an ATCS deployment won't be able to completely solve all traffic overcrowding problems. As an alternative, ATCS could be viewed as a system that can contribute to a reduction of traffic congestion by improving transportation network operational control and management. The main advantage of an ATCS deployment is operational efficiency, which is evaluated by the decrease of delays, stops, and other destructive traffic performance indicators. The introduction of ATCS enhances traffic operations safety only inadvertently by lowering some efficiency-related performance measurements, which are closely correlated with some safety metrics.

3.2 Limitations of the research

The limitations of the research are listed as below:

a. The research is limited to the work done on Adaptive Traffic Control Systems under Smart City Mission Srinagar.
b. Limited access to data
c. have not incorporated users experience
d. time constrain

3.3 Key lessons learnt

The Key lessons learnt from the current research paper are listed as below:

a. Understanding the research methodology and processes involved in writing a research paper.
b. The procedure of making questionnaires and Reflecting the respondent viewpoints and findings in the research paper.
c. Carry out Primary and Secondary studies, and develop a research framework.
d. Operation & maintenance are the biggest hurdles in the success of a project.

3.4 Recommendations

Consider forming an ATCS Coalition, which might function as a forum for sharing ATCS deployment experiences and lessons learned. Agencies with fewer

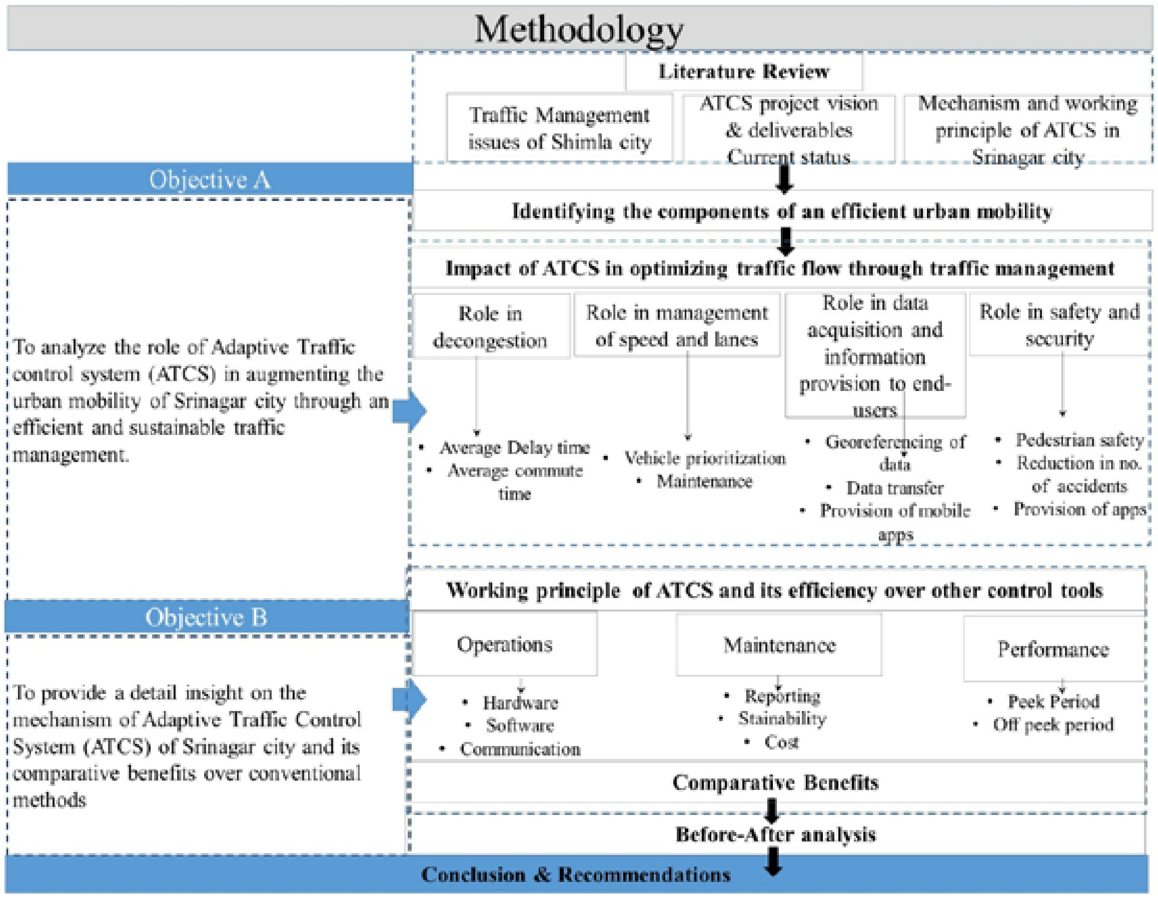

Figure 4: research framework for the study of ATCS in Srinagar Smart City. Source : Author

resources for Adaptive traffic control system may mainly benefit from such a collaboration. One of the initially tasks might be to look into the variables that prevent new agencies from deploying an ATCS.

To evaluate the true benefit–cost ratios of ATCS deployment, more research is needed. Comprehensive evaluation studies are required to highlight all of the costs and benefits of an adaptive traffic control system placement (containing examination of the long-term operational savings resulting from long-term variations in stream of traffic demand).

More research into the various financing sources used to implement ATCS is required. It is also vital to conduct research into the amount of cash is required to support different components of adaptive traffic control system installations. Moreover it could be looked into how agencies decide whether or not to deploy ATCS, and whether or not those choices are made in consultation with operational staff.

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A21

An assessment of Smart Home Tag Platform with Integration of Solid Waste Management System using NFC Technology

Name of the project: *An assessment of Smart Home Tag Platform with Integration of Solid Waste Management System using NFC Technology*
Location: *New Town (Rajarhat), Kolkata*
Year of Project Implementation: *2021*
Sector: *Technology in Urban Management*
SDG: *SDG 6, SDG 7, SDG 11, SDG 13,*
Project Cost: *Rs. 42.86 lakhs*

Institute: *Indian Institute of Engineering Science and Technology, Shibpur*
Advisors: *Coordinator: Dr. Souvanic Roy, Mentor: Dr. Tuhin Subhra Maparu*
Students: *Mr. Shriyanshu Kumar*

Keywords: *-Solid Waste Management, Technology, Smart Home Tag, Near Field Communications (NFC), GIS.*

Abstract:

As part of its smart city mission and to improve the environmental condition of the city, New Town (Rajarhat) Kolkata has adopted the Smart Home Tag Platform with integration of Solid Waste Management System using Near Field Communication (NFC) Technology. This project ensures digital confirmation of the service delivery by the solid waste collection team at premises-to-premises level. The NFC-enabled mobile device carried by the workers collect the information from NFC tags and send it to the server database. The all-weather and tamper resistant NFC based outdoor tags are unique to the premises and are physically attached to the wall of the premises. The tags are geo-marked and registered to the premises over a specialized GIS tagging unit on cloud-based GIS platform. Whenever a solid waste collection is made, the tag is scanned and authenticated at every premises using an NFC enabled smartphone and a dedicated android application. The database is updated and the waste bin information is displayed on the web/ mobile based application. Th information is analyzed for detailed MIS reports and other real-time alerts for taking any action, if needed. The waste collection process is expected to be streamlined with the usage of these technologies. As has been observed through the user satisfaction survey, most of the users at New Town Kolkata are extremely satisfied with the new service. Incorporation of NFC based smart technology has definitely improved the Level of Service (LoS) of the solid waste management system in New Town Kolkata. However, there are still some scopes of improvement of the system. The NFC tags installed at the premises may also be used to extend other services (e.g. municipal tax collection) to the citizens in future.

Case Study: **A21**

1. Relevance of the project in the urban context of New Town (Rajarhat), Kolkata

About 62 million tons of Municipal Solid Waste (MSW) is generated annually by urban India posing a huge burden on the environment and a significant part of the MSW is left untreated. The Swachh Bharat Mission which was flagged off on October 2, 2014, is the country's biggest-ever cleanliness drive, in which Solid Waste Management (SWM) is considered one of the six major components [1]. One of the stated objectives of the Mission is to ensure door-to-door garbage collection and proper disposal of municipal solid waste.

Another important drive initiative of the Central Government, the Smart Cities Mission was launched on June 25, 2015, with the objective to promote cities that provide core infrastructure, a clean and sustainable environment and give a decent quality of life to their citizens through the application of 'smart solutions' [2]. The focus is on sustainable and inclusive development by the creation of replicable models and accordingly 100 cities have been selected to be developed as Smart Cities through a two-stage competition. The New Town Kolkata was selected as one of the cities to be developed as a smart city.

The New Town (Rajarhat), Kolkata is a newly developed planned satellite town on the north-eastern fringes of Kolkata. It has been planned as a services hub, providing best-in-class urban infrastructure facilities and government service delivery while preserving the cultural heritage of the state. The city is divided into three Action Areas – Action Area 1, 2 and 3. Action Area 1 of the city is contiguous with Nabadiganta Industrial Township Authority (NDITA), which is the largest Information Technology (IT) hub in eastern India, employing over 1.5 lakh IT and IT allied professionals [3]. To improve its environmental condition as outlined in the Swachh Bharat Mission and to improve the quality of life of its citizen, New Town Kolkata plans to give significant efforts in the Municipal Solid Waste Management of the city.

Nowadays, a number of urban local bodies (ULBs) are using various communication technologies such as NFC, RFID, wireless sensor networks, etc. to solve the issues of solid waste collection as high technology can capture and store data with fewer mistakes while manual record and report will have many issues [4]. As part of its smart city mission and to improve the environmental condition of the city, New Town Kolkata has adopted the Smart Home Tag Platform with the integration of Solid Waste Management System using Near Field Communication (NFC) Technology. This project ensures digital confirmation of the service delivery by the solid waste collection team at a premises-to-premises level. It also has potential for integration with larger municipal services in future, e.g. health and tax services. The waste collection process is expected to be streamlined with the usage of these technologies.

2. Objectives of the project

Major objectives of the project, as stated in the report prepared by the Webel Technology Limited [5], are as follows:

- To have a ground-level customer satisfaction measurement system and an alert system for the upkeep of Level of Service (LoS) provided by the Solid Waste Management team of the New Town Kolkata Development Authority (NKDA).
- To ensure digital confirmation of solid waste collection by the solid waste collection team at a premises-to-premises level.
- To provide a correct view of the waste collection system by focusing on a closed-loop approach.
- To create Key Performance Indicator (KPI) based Level of Service reports and ensure a more effective way of Solid Waste Management.
- To capture on-ground data and creation of cloud-based Geographic Information System (GIS) mapping of the present premises and their validation.

3. Aspects of the project

3.1 Technology

The system consists of NFC tags attached to the premises containing the waste bins, NFC-enabled mobile device, NFC integrated web/ mobile application and database server. The NFC-enabled mobile device carried by the workers collects the information from NFC tags and sends it to the server database. The all-weather and tamper-resistant NFC-based outdoor tags are unique to the premises and are physically attached to the wall of the premises. The tags are geo-marked and registered to the premises over a specialized GIS tagging unit on a cloud-based GIS platform.

Whenever a Solid Waste collection is made, the tag is scanned and authenticated at every premise using an NFC-enabled smartphone and a dedicated android application. The database is updated and the waste bin information is displayed on the web/mobile-based application. Thus, the solid waste collection of the bins and worker's job schedules are being monitored using the tracking and monitoring system.

Figure 1: NFC tag installed on the outer wall of a premise in New Town Kolkata
Source: Authors

3.2 Data

The digital input is recorded and then analyzed for detailed MIS reports and other real-time alerts for taking any action, if needed. The platform also allows the addition of different types of filters for the purpose of visualization and analysis. In the reporting section, predefined reports in the form of graphs and tables also help in the analysis of data. Visualization of the feedback data is possible for the door-to-door level as well as in a region-wise aggregate level. A chronological view of monitoring day-on-day progress analysis is also possible. One may get granular data for service quality availability and real-time alerts over time. Thus, data used for analysis can be year-on-year, region-wise, cross-referenced and auto-alerts type. The platform also provides analytics of the data for improved and informed decision-making.

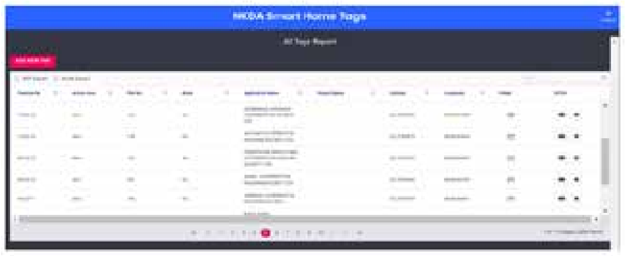

Figure 2: Overview of the NFC tag data report (sample page)
Source: NKDA

Figure 3: Overview of the cleared bins (scanned tags) report (sample page)
Source: NKDA

Figure 4: Overview of the Action Area wise data report (sample page)
Source: NKDA

3.3 Planning

The solid waste management process at New Town Kolkata, using Smart Home Tag Platform and Near Field Communication (NFC) Technology, is shown in Figure 5

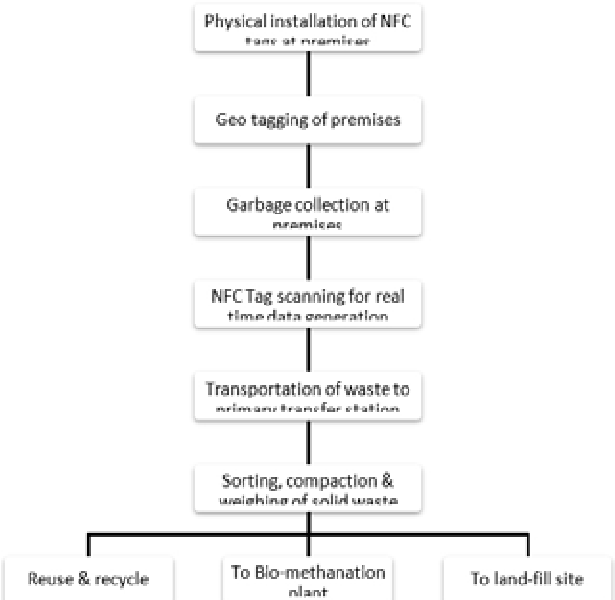

Figure 5: Solid waste management process at New Town Kolkata
Source: Authors

The GIS platform has a threshold capacity of 10,000 premises and initial installation has been capped at 3000 premises. The platform, moreover, provides flexibility to add, edit and remove any premises in future. The Platform has a separate Admin access web-based dashboard for viewing details, whenever required. Important features of the smart solid waste collection and tracking system is elaborated in Figure 6.

Figure 6: Features of the NFC based smart solid waste management system
Source: Authors

3.4 Stakeholders

The major stakeholders of this project are the New Town Kolkata Development Authority (NKDA), Govt. of West Bengal as the city authority and the citizen of New Town Kolkata as the primary beneficiary. NKDA is responsible for ensuring the installation, operation and maintenance of this project, whereas, Modern Nursery Pvt. Ltd. which has been engaged by NKDA is responsible for the collection of waste and scanning of NFC tags. Both are also responsible for taking corrective action where necessary.

4. Project implementation

4.1 Implementation

Total number of premises in which the tags have been installed is 2096 out of the total initial target of approximately 3000 premises.

4.2 Quality of implementation

NKDA provided 26000 bins of 10L capacity to households for waste collection. Households/ premises are responsible for the segregation of dry (inorganic) and wet (organic) waste. Waste is collected by 16 two-compartment vehicles to the primary transfer station. There, it is compacted and the gross weight is checked. After that, the waste is taken onward for recycling/ reuse and/or landfill sites.

4.3 Operational and maintenance issues

Initially, 25-30 tags were reported to be damaged or stolen. In those houses, NKDA reinstalled the tags in the inner part of the boundary walls of the premises.

5. Level of utilization

Out of the total 2096 tags (premises), approximately 2000 tags are scanned on a daily (average) basis which is the same as the total number of waste bins cleaned from the premises. The remaining bins remain uncleaned. This happens when no one is found to be available at those

Figure 7: Overview of the NFC tag dashboard (sample page)
Source: NKDA

houses/ premises at the time of waste collection.

Total indicative cost of the project is approximately INR 42.83 Lakhs.

NKDA also houses a Bio-methanation plant where energy is produced from the waste collected from the premises. The energy obtained from the plant is used to light up street lights with indicators on them. The indicator shows a signal whenever the street light uses

Figure 8: Bio-methanation plant at New Town Kolkata
Source: Authors

Figure 9: Street lights using energy from the Bio-methanation plant
Source: Authors

energy obtained from the bio-methanation plant.

6. Feedback from users and other stakeholders

The salient observations from the survey conducted to obtain feedback from the users and other stakeholders are listed as follows:

- Most of the people in New Town (Rajarhat) Kolkata have smart NFC tags installed on their premises and the system is running well till now.
- People did not report vandalism or stolen NFC tags; however, the authorities found few cases of theft or damage of tags in some areas.
- People reported that the waste is collected daily and NFC tags are also scanned on a daily basis.
- However, the time of waste collection is not fixed. Sometimes, the waste collectors come in the morning and sometimes in the afternoon or evening.
- People (users) reported that many of them have been provided with only one type of waste bin, primarily the blue bins (for dry/ inorganic waste) by

the authorities. Green bins (for wet/ organic waste) were kept mostly in front of the shops.

- On average, nearly 60% of the people are extremely satisfied with the service of the NKDA waste collection facility, whereas, the rest of them were somewhat satisfied.

Figure 10: Available waste bin (blue only) at the premises
Source: Authors

7. Gaps in the project

Following gaps may be identified for the project:

- Timing of waste collection is not fixed and thus unreliable. This has caused trouble for many users as they cannot plan for disposing of waste at a particular time.
- Segregation of organic and inorganic waste at the source is not carried out properly. One of the reasons is an inadequate supply of various types of waste bins by the authority.
- The project could not cover 100% of the premises (primarily the non-residential buildings). NFC tags could not be installed for the community bins or waste bins at the public places.

8. Inferences / Recommendations

Salient features of the Smart Home Tag Platform with the integration of Near Field Communication (NFC) Technology for smart waste collection and monitoring system at New Town (Rajarhat) Kolkata are listed in Table 1.

Table 1: Salient features of the NFC-based solid waste management process

Sl. No.	Salient Features	Comment/Remarks
1.	Physically installed NFC tag	Geo marked tags registered to premises.
2.	Scanning of NFC tag	Digital input after waste collection for real-time data.
3.	Graphical and tabular report generation	For analysis and preparation of detailed reports and adopting corrective actions (if required).
4.	Cloud-based GIS platform	One may add, remove and edit any premise and admin dashboard for detail viewing. It supports up to 10,000 premises.
5.	Public grievance redressal system	For any grievances from the service provider to the user.
6.	Waste disposal and monitoring	Monitoring with GPS tracker.
7.	Bio-methanation plant	Being used to provide energy to lit street lamps.

Source: Authors

As has been observed through the user satisfaction survey, most of the users at New Town Kolkata are extremely satisfied with the new service. The incorporation of NFC-based smart technology has definitely improved the Level of Service (LoS) of the solid waste management system. However, there are still some scopes of improvement of the system. For example, waste collection can be scheduled with fixed timings at the premises. This will help the users to pre-plan their schedules. Secondly, proper planning may be adopted to segregate the waste (bio-degradable/ non-biodegradable) at the source as well as at the transfer stations, if required. This segregation will help the bio-methanation plant to get more waste, and thus, generate more energy from the waste. Thirdly, appropriate measures may be taken to extend the facility to the remaining premises of the city. The NFC tags installed at the premises may also be used to extend other services (e.g. municipal tax collection) to the citizens in future.

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A22

Integrated Command and Control Center, Chandigarh Smart City

Name of the project: *ICCC for Smart City Chandigarh*
Location: *Chandigarh, Punjab*
Year of Project Implementation: *2021*
Sector: *Information and technology*
Project Cost: *Rs 295 Crore*

Institute: *Faculty of Architecture and Ekistics, Jamia Millia Islamia*
Advisors: *Dr. Hina Zia, Dr. Nisar Khan*
Students: *Ripu Daman Singh, Yogesh Bharadwaj, Shahbaz Khan*

Keywords: *Intelligence, Datacenter, Cloud, Analytics, Risk Mitigation, Services*

Abstract:

With increasing urbanization, the operational issues are increasing which in turn affects the quality of services offered to the citizens, various government agencies provide several ICT-based services and provide a wealth of information that can be utilized in anticipating the problems within the city.

Today's threat landscape is very sophisticated. Recent data shows that once a hacker manages to bypass traditional data center edge security, 60% of them begin exfiltrating data within hours. However, because most data centers are not adequately segmented or secured, 85% of these intrusions aren't discovered for weeks and more than half are discovered after months. This is one reason why the data center is increasingly the target of choice for criminals. Datacenter security is very critical to adopting the new technology and providing a manageable and compliant infrastructure with a threat-centric approach that addresses security across the entire attack continuum - before, during, and after an attack.

Analytics is an artificial intelligence-based platform in ICCC which is designed to drive business value through advanced machine learning capabilities. This is a modular and scalable platform architecture built on big data infrastructure and capabilities to ingest data from varied sources.

Case Study: **A22**

1. Introduction

1.1 Topic and Context

The case study involves a thorough study of the ICCC projects mainly E-governance, ICCC, SCADA (Supervisory Control and Data Acquisition), and Utility Mapping of Chandigarh city. ICCC campus is considered as the brain of the city, the study involves detailed reports of the projects undertaken and operation of ICCC. In this project, the main feature is to identify certain data followed by its analysis for the administration that can take corrective steps accordingly. For instance, in analyzing a particular disease that has broken out in a certain area, ICCC acts as a support engine to the emergency response system by providing an interface to coordinate among multiple departments such as the police, traffic police, fire, ambulance, hospital, etc. and ultimately providing alerts and predicting issues, enabling timely decision and support action. A unique feature of the solution will be real-time data visualization, which will help in the continuous monitoring of various critical parameters across the city.

ICCC will control and monitor the CCTV cameras, automatic number plate recognition system, red light violation detection system, speed violation detection system, an e-challan system enabling the automatic challan generation for the traffic violators, Adaptive Traffic Control System, and other smart solutions like dynamic message boards, public addressing system in Chandigarh.

1.2 Significance of the project

Chandigarh smart city initiative demanded measures that not only provide citizens with smart technologies but also deal with certain major issues in the city such as issues related to power supply, pollution, power cuts, traffic jams during peak hours, pollution due to increased vehicles, information regarding public transport, disaster management, safety and security, and online monitoring of vehicles. Hence, the report includes the detailed vision of the project and measures taken by the administration regarding the initiative for curbing the aforementioned problems.

1.3 Aim and Objectives

The aim of this study is to establish an understanding of a collaborative framework where input from the functional departments of Chandigarh Municipal Corporation and other stakeholders such as transport, water, fire, police, etc. can be assimilated and analyzed on a single platform, consequently resulting in aggregated city-level information.

The objectives of the study are:

a. To study various projects of Chandigarh Smart City and analyze the projects on the grounds of feasibility and impact.
b. To study and analyze the implications of the projects, challenges faced during execution, etc.
c. To study the various projects under ICCC, risks and challenges involved as well as the efficiency of the project.
d. To study and analyze the Chandigarh smart city through the lens of Innovation, Scalability, Replicability, and capacity building programs, and their benefits
e. To recommend suggestions that may help benefit the project based on field survey and site observations.

2. Contextual Background

The Integrated Command Control Centre (ICCC) is set to provide services to citizens in areas of traffic management, health and water. This system also includes advanced video analytics and generates automatic event alerts for events like abandoned baggage, illegal parking and crowd detection. The Intelligent Traffic Management System (ITMS) wherein traffic rules enforcement such as red light violation detection, speeding, and automatic

Figure 1 Map of Chandigarh, Map Courtesy: Chandigarh Smart City Ltd.

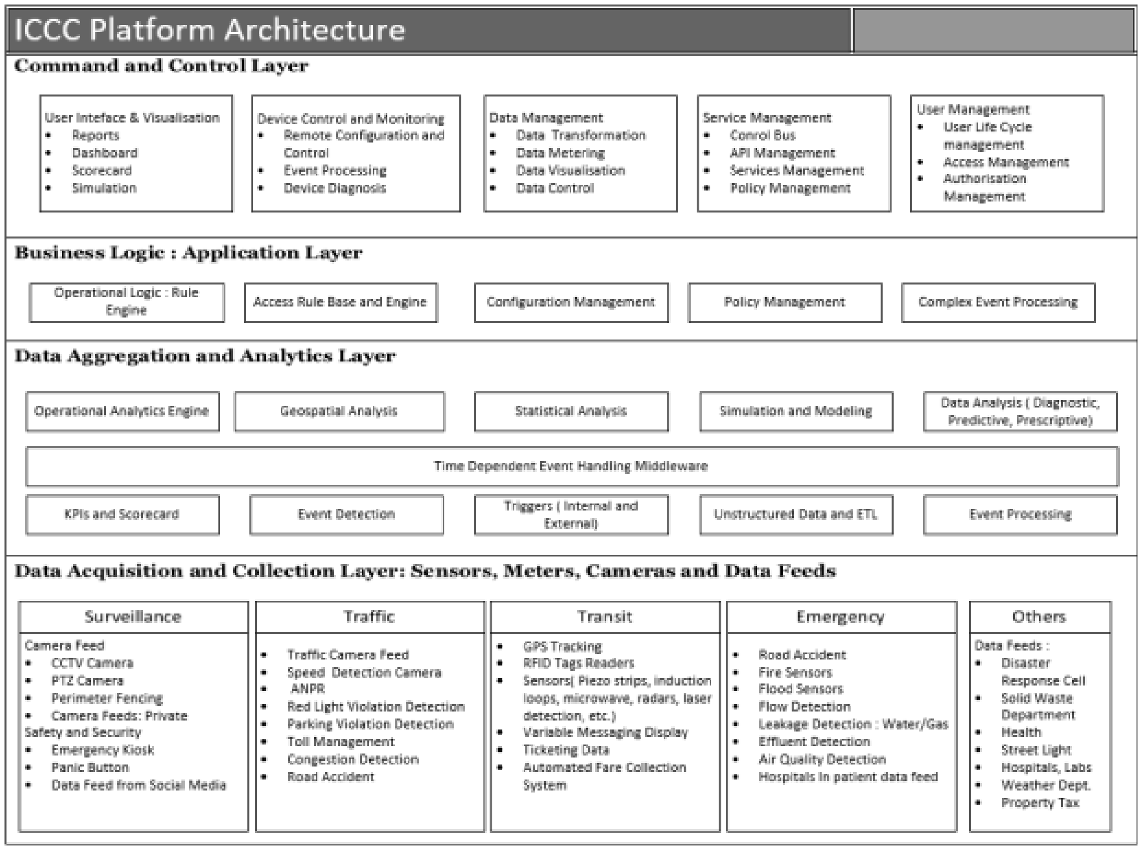

Figure 2 Architecture of Chandigarh App, source: https://smartnet.niua.org/sites/default/files/resources/iccc_maturity_assessment_framework_toolkit_vf211218.pdf

number plate recognition has been installed at two locations in the city. This will help in making roads safer and reduce traffic accidents in the city.

The surveillance cameras with analytics have also been installed at the entry and exit of a parking lot which not only helps in effectively monitoring its operation but also provides vital inputs like the color, make and model of the vehicle entering and exiting the parking area. This information can be used to generate alarms for blacklisted vehicles and search them based on their attributes. This system also includes advanced video analytics and generates automatic event alerts for events like abandoned baggage, illegal parking and crowd detection.

The Chandigarh Smart City Limited (CSCL) signed a contract with Bharat Electronics (BEL) for the implementation of the Integrated Command and Control Center (ICCC). KK Yadav, Commissioner, Chandigarh Municipal Corporation and CEO, Chandigarh Smart City signed the contract on behalf of CSCL and Prabha Goyal, General Manager, Panchkula represented BEL.

The contract worth Rs 295 crore includes civil construction of the Integrated Command and Control Center (ICCC) Complex, including buildings for ICCC, SCADA Systems (Supervisory Control and Data Acquisition) of all utility services, and Police Command and Control Centre (PCCC). The command centers shall have on-premise data centers hosting relevant solutions for all field systems and data analytic tools. This will help in informed decision-making, better disaster management and smarter governance.

Besides making roads safer, the Adaptive Traffic Control System (ATCS) shall monitor real-time traffic conditions and use artificial intelligence as well as machine learning technology to improve signal timing. This system shall be installed on 40 junctions. A public address system and variable message signs shall be installed to disseminate information to citizens in the audio-visual format. For communication, a city-wide optical fiber cable backbone of around 250 KMs shall be installed.

Cameras shall reduce incidents like vehicle theft, irresponsible driving, loitering, illegal parking, trespassing, etc. They will also improve women's safety indices. TMS and ATCS solutions shall not only help improve traffic conditions but also make roads safer by enforcing traffic laws on violators. Variable message signs and public address systems shall broadcast real-time information to commuters on the move. This system shall help in better management of events and incidents in the city and efficient disbursal of governance services.

Implementation of EGovernance Services

One of the primary objectives of Chandigarh under the Smart City Mission is to enhance the efficiency of municipal services and promote a better quality of life for residents. In order to achieve these objectives, Chandigarh desires to foster the development of a smart ecosystem that supports digital applications and ensures seamless steady-state operations and real-time tracking of services and vital city metrics throughout the city and in government departments.

The overall objective of this component is to improve the interaction between the city administration, residents and other city dwellers with an overarching objective of making urban services more accessible for all by providing access through multiple channels e.g., web platform, citizen facilitation centers (E-sampark), Mobile Application, etc. Key objectives of this module include:

- Establishing a digital platform for government and citizen interaction.
- Improving the quality of services offered to local citizens and bringing up the service levels.
- Improving the internal management of the agencies providing citizen services.
- Promoting administrative functions to be carried over online.
- Engage citizens in the process of governance through interaction.
- Empower citizens through access to knowledge and information and make the working of the government more efficient and effective.
- Enhanced transparency, convenience and empowerment; less corruption; revenue growth; and cost reduction.

Integrated Command and Control Center

One of the primary objectives of Chandigarh under the Smart City Mission is to enhance safety and security, improve the efficiency of municipal services and promote a better quality of life for residents. In order to achieve these objectives, a robust ICT infrastructure that supports digital applications and ensures seamless steady-state operations, city management, surveillance, emergency response mechanisms, and real-time tracking of services and vital city metrics throughout the city and in government departments is required.

The key objective of this project is to establish a collaborative framework where input from different functional departments of Chandigarh Municipal Corporation and other stakeholders such as transport, water, fire, police, etc. will be assimilated and analyzed on a single platform; consequently resulting in aggregated city-level information. Further, this aggregated city-level information can be converted into actionable intelligence, which would be propagated to relevant stakeholders and citizens.

Objectives

- Establishing a digital platform for government and citizen interaction.
- Improving the quality of services offered to local citizens and bringing up the service levels
- Improving the internal management of the agencies providing citizen services.
- Promoting administrative functions to be carried out online.
- Engage citizens in the process of governance through interaction.
- Empower citizens through access to knowledge and information and make the working of the government more efficient and effective.
- Enhanced transparency, convenience, and empowerment; less corruption; revenue growth; and cost reduction

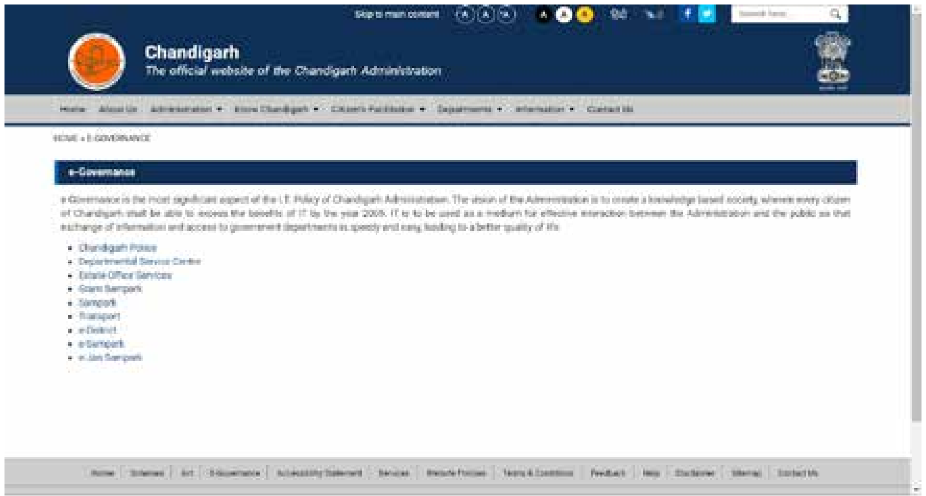

Figure 3 E-governance interface

Figure 4 ICCC Campus Chandigarh, 3d Visualisation source: Chandigarh Smart City Private Ltd.

Provision of SCADA for Solid Waste Management (SWM) for Route Management, Efficiency of Collection, Mobile Application, Daily Management of Solid Waste Including Dry / Wet as per Swachh Bharat Standards and O&M for 5 Years

In order to introduce ICT for improving SWM, this project aims at integrating ICT with door-to-door collection functions within the SWM operations in MCC. It is also envisaged that the solution proposed under this project will get integrated with the Integrated Command and Control Centre of Chandigarh Smart City. The objective of the project is to incorporate ICT by introducing analytical tools for enabling automated decision-making that will help in the effective monitoring of solid waste management operations. CSCL will implement the project and will handover to MCC for operation and maintenance.

The broad objective of the proposed system is to improve the efficiency of collection, transportation, and disposal of solid waste from Chandigarh by implementing reliable Smart digital solutions to monitor, track and manage various SWM tasks through citizen empowerment and door-to-door collection thereby reducing/resolving the customer complaints with a positive feedback mechanism.

The work of creation of infrastructure i.e. CAPEX part will be done by CSCL and the project will be handed over to MCC for operation and running. The OPEX part will be the responsibility of the MCC.

SCADA System for Recycled Water Distribution Network pan-city

The Tertiary Treated (TT) Water SCADA project is being implemented to monitor the quantity and quality of recycled water to save the precious water resources being used for irrigation purposes in the city. Presently, the TT Water is being supplied to all the sectors without any automatic monitoring resulting in the non-equitable distribution of TT Water. The proposed SCADA system will include monitoring of BOD, COD, TSS, pH, DO, residual chlorine, as well as flow measurement, pressure measurement, etc. by installing various analyzing equipments and sensors.

Underground Utility Mapping

The objective of the project is to provide improvised information on municipal functions including planning, development, and management covering various components, i.e. roads, infrastructure, utilities or service lines, etc. It will involve mapping of all the underground utilities along with allied components (i.e. manholes, chambers, road gullies, valves, etc.) including integration/ superimposition of the above on a geo-referred base map of Chandigarh.

2.1 Conceptual framework / Research design

Chandigarh Smart City Limited (CSCL) has also planned to launch a 'single city, single app' on April 1. The e-governance project will initially have services, including online building plan approval, fire NOC, RTI, e-Awas, grievance monitoring, electronic human resource management system (e-HRMS), and other digital services of the Municipal Corporation and UT Administration.

Apart from this, the CSCL has also planned that every residential and commercial property in Chandigarh will be given a unique ID, which will be linked to various municipal services. Under this, digital door numbering will be done throughout the city wherein every residential and commercial property will be given a unique ID which will be linked to services such as water supply, electricity supply, property tax, etc.

The project is aimed at ensuring effective delivery of various public services in addition to improving the collection of bills, property tax, and garbage collection among others in the city.

2.2 Key features of the project

Implementation of E-governance Services

- E-governance services have involved 71 operational as well as administrative services under this scheme, which deals with almost all the city-level governance services.
- All the 71 services under the E-governance scheme come under both UT as well as Municipal Corporation and to curb the confusion and tension between the two bodies, it automatically transfers the scope of work to the particular department which is responsible for the providing the services or the portion of the services, whatsoever may be the requirement.

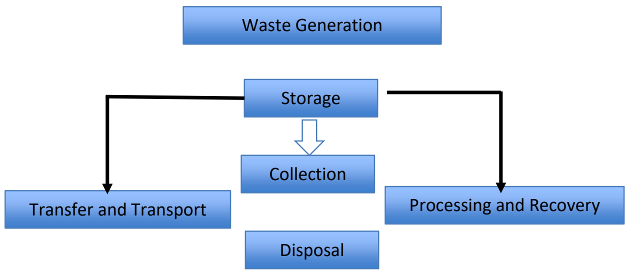

Figure 5

Figure 6 Interface of E-governance website, Showing Interactive Chandigarh

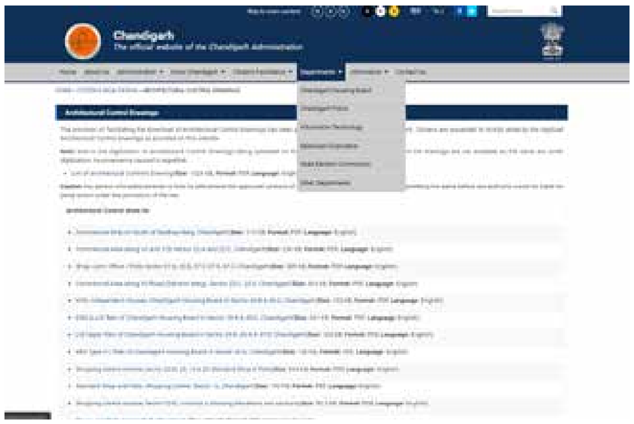

Figure 7 Architecture control Drawings

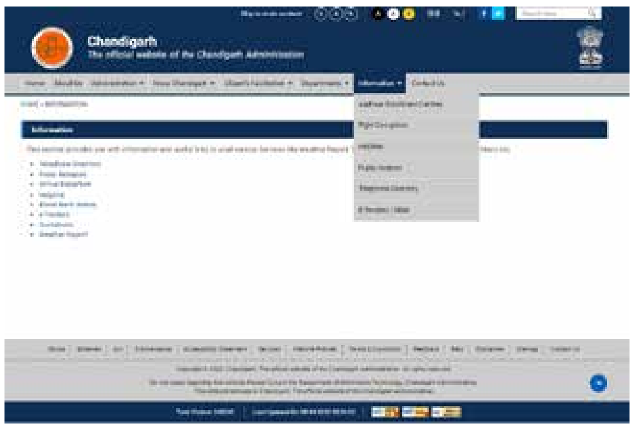

Figure 8 Information Center

Figure 9 : Integrated Command and Control Center (ICCC), and Supervisory Control And Data Acquisition (SCADA) Center

- The dashboard is very user-friendly, it allows people to navigate and avail the services, information, etc. related to the Smart City Chandigarh. The adaptive interface allows to operate with both PC & smartphones.

Integrated Command and Control Center (ICCC)

The establishment of the Integrated Command and Control Center (ICCC) has been done in a very innovative way by dividing the campus into three blocks, namely Police Command and ControlCenter (PCCC), Integrated Command and Control Center (ICCC), and Supervisory Control And Data Acquisition (SCADA) Center, where the police command control center is dedicated to all the surveillance and traffic-related tasks, and ICCC building is the brain of the city.

Optical fiber was laid out around 280km by BEL, with an extra conduit laid throughout for future expansion. ICCC has a total number of 21 stakeholders providing several operational services including an emergency response system. It also has a unique feature to provide amenities and assist old aged people with just a phone call, the service is free of cost. Adaptive Traffic Control System (ATCS) for 40 junctions, Intelligent Traffic Management System(ITMS) is developed according to the Indian traffic conditions, mainly focusing on the city Chandigarh. It also has 267 locations for the city surveillance system, with a PTZ camera box, video analytics, and video management system, The whole system is AI-based and is processed and reviewed in real-time, which in itself is a state of the art initiative. Automatic Number Plate Recognition (ANPR), Red Light Violation Detection (RLVD), Over Speed Detection System (OSDS), and E- challan Devices are also introduced with AI-powered systems which consider human error before sending it to review in real-time. There is a total of 40 junctions where there is a public address system and a dynamic message display system with 2 speakers each in the junctions. This will be very helpful in case of emergencies mitigating the risks and managing the traffic in extreme conditions.

- Geographic Information System (GIS) implementation & integration with ICT helps in a deeper understanding of the city and monitoring the city conditions
- Smart parking, public bike sharing, ITS, SWM, IPT, utility management, meteorological dept., E-governance solutions, etc. are included in ICCC providing operational benefits to the projects.
- Chat bot-based application for seamless coverage and integration with social media and all the other verticals of Govt. dept.
- ICCC has the capacity to store data for around 30 days which is later purged and kept for 180 days, which has a total capacity of 3 petabytes.

Provision of SCADA for Solid Waste Management for Route Management, Efficiency of Collection, Mobile Application, Daily Management of Solid Waste Including Dry / Wet as per Swachh Bharat Standards and O&M for 5 Years

- Supply, installation & commissioning of GPS Devices for SWM vehicles (450) to track and monitor the

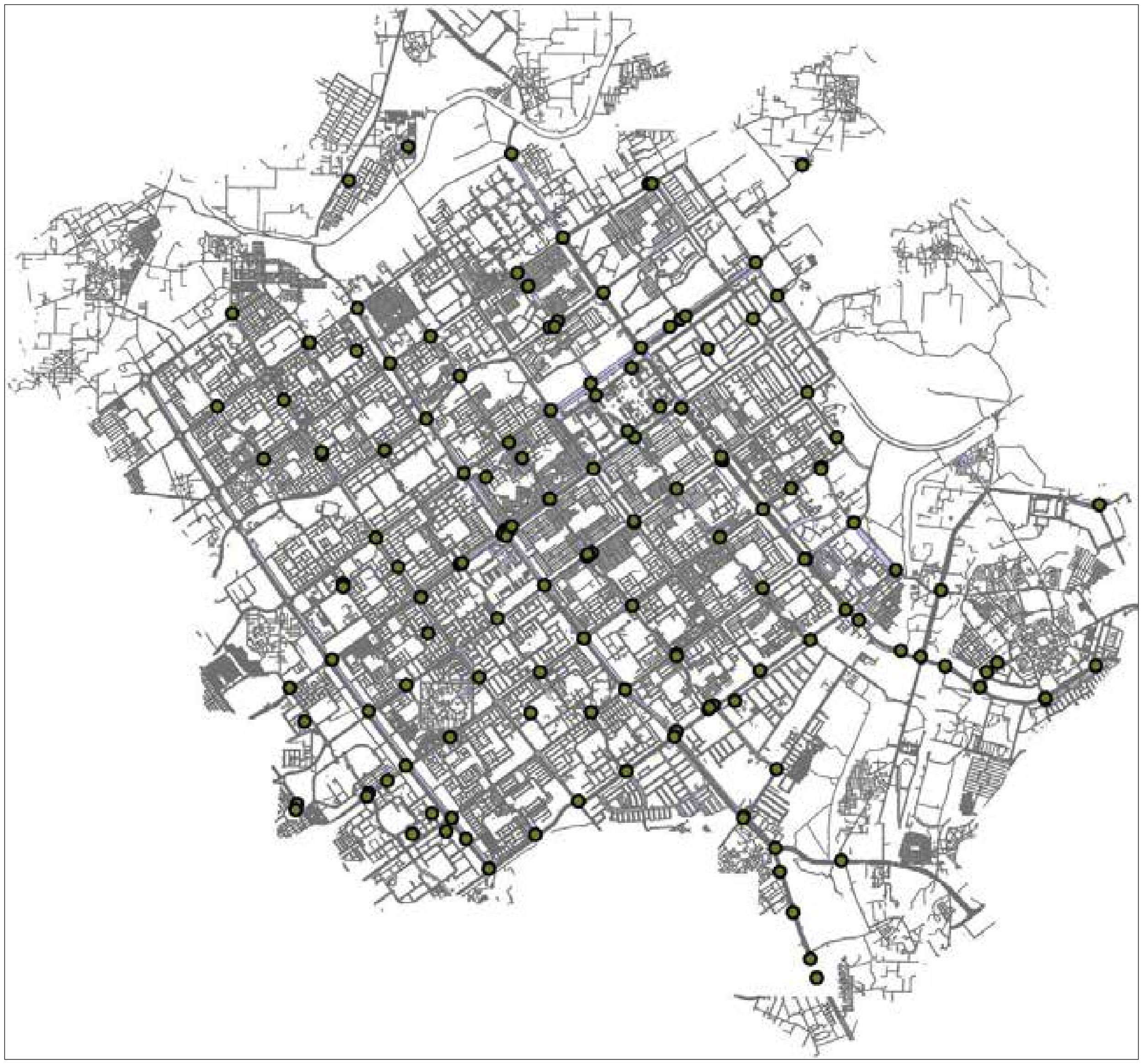

Figure 10 Traffic Junction in the city

Figure 11 Server Room, Source-Author

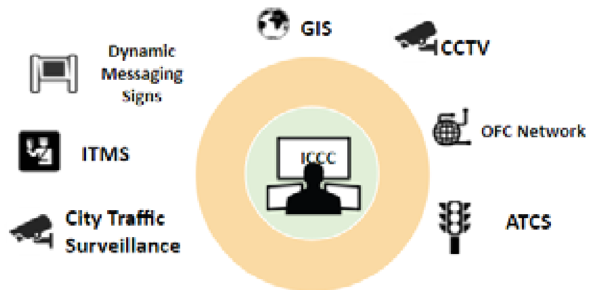

Figure 12 ICCC Chandigarh Features, Source: Chandigarh Smart City Ltd.

vehicles for smooth handling of the operation.

- Supply, installation & commissioning of biometric attendance devices at the depot locations for capturing driver and other SWM on-ground support staff attendance on a day-to-day basis.
- Data preparation for SWM routes, capture location of transfer stations, drivers, vehicles, field staff.
- Data preparation for vehicles, drivers and office locations of all departments.
- Capturing and storing all the biometric (fingerprints) info of drivers and other SWM on-ground support staff.
- Geo-fence creation as per requirement, deployment of SWM application to support, door-to-door collection system, user management, integrated GIS map of the area of operations, citizen app. to have a dashboard for SWM vehicles to track vehicles and share feedback, Citizen Complaint Management System, Fuel Management.
- Deployment of SWM application to support the project, feed the data, and maintain the project.
- Establishment of control center with video wall as per specifications.
- Deployment of operations support staff (12) for a period of 5 years.
- Supply and O&M of sim cards for connectivity of GPS to host location for 450 vehicles.
- API for integration with Integrated Command and Control Center of Chandigarh Smart City.

Underground Utility Mapping

- Development of maps for the city with all the details of geo-morphological data which will be generated by collecting baseline data, data validation, field verification, data integration.
- An accurate and detailed representation of all utilities in the city is carried out by doing a LIDAR survey, which will assist in carrying out repair works.
- Better co-ordination for services by various departments, reduction in overlapping responsibilities will increase efficiency in operating as well as monitoring. It will also help risk mitigation as well as reduce stress among citizens during commute.

2.2.1 Challenges in the project

a. Video applications might need architectural consideration.
b. Infrastructure cost and overhead & Operational cost and overhead including manpower,
c. Maintain the infrastructure for scalability & redundancy
d. Private cloud challenges
e. Lots of duplication in infrastructure and operational tools
f. Additional operational overhead
g. Coordination between the stakeholders and agencies involved
h. Chaos was created due division of control and powers between the Municipal corporation and the UT department.
i. Unique traffic behavior and roads
j. Management of SCADA services was a major challenge to operate on such a large scale.
k. Developing API which is 'I'm Chandigarh' app to develop such interface which is user friendly.
l. Managing the expenses, operations, and installation to be separated.
m. Optimize corruption in the system, and ease the citizens.

2.2.2 Risks involved in the project

a. Delay in handing over the ICCC and data center building
b. Delay in the approval of SRS and CSCL
c. Raw power availability at ICCC and DC building
d. Integration of issues with external systems/ applications
e. Schedule over-run
f. Delay in acceptance of the certificate.

2.2.3 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)

a. g.Scale and elasticity of the cloud increased redundancy and centrally managed public cloud system.
b. Readily available pre-integrated operational tools, no operational overheads, agility and numbness to SW changes
c. Potentially better data protection, storage and retention control, cost-saving with data-intense applications like video
d. Potentially better data control over infrastructure, storage and any other retention at city level
e. Leverage the best of both by having the core control and non-data sensitive and private cloud and security applications.
f. Optical fibre reduces the long term costs involved and also reduces the risk of cybercrime
g. AI-based E-challan System considers human behaviors and errors before highlighting them for further actions.
h. Chatbot provides seamless services without any issues.
i. Separating ICCC from the Police command control center (PCCC) and SCADA services.
j. Creating a web portal for SWM tracking and feedback for drivers as well as for citizens.
k. Developing an Advanced AI-based Traffic Control System instead of SCOOT and SCAT.
l. Public Addressing System for 40 junctions.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

From Interviews

1. ICCC projects are very well executed and have shown promising results and benefits for the citizens. The common citizen app. named "I am Chandigarh"

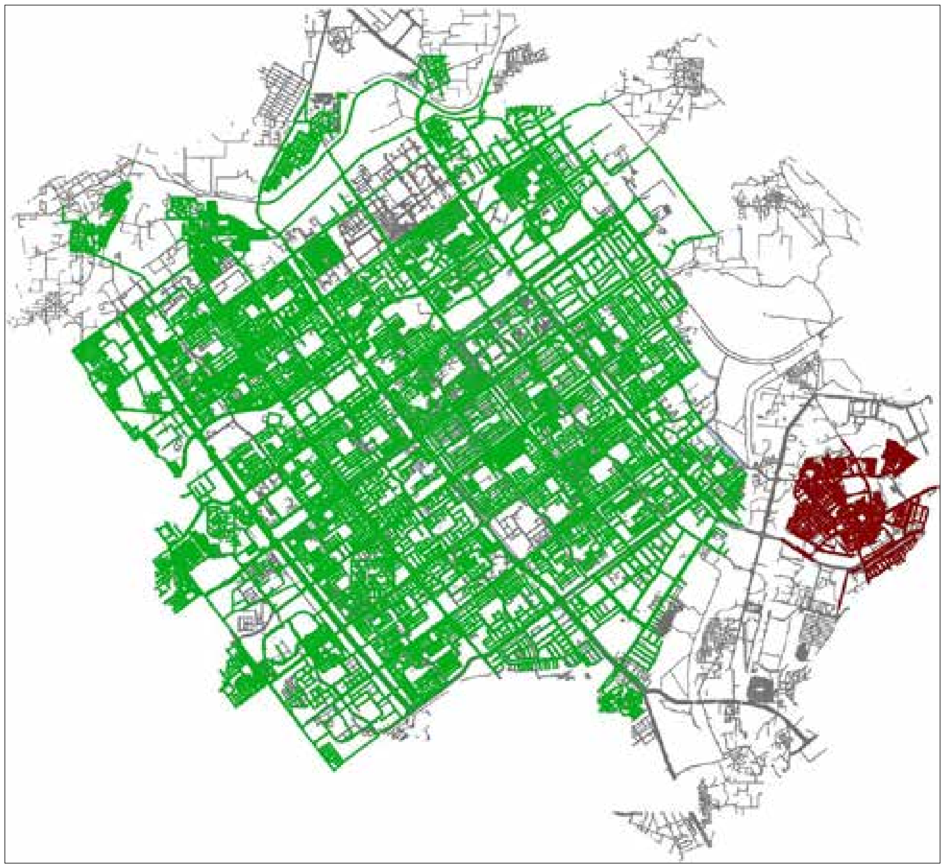

Figure 13 Water Supply Map, Source: Chandigarh Smart City Ltd.

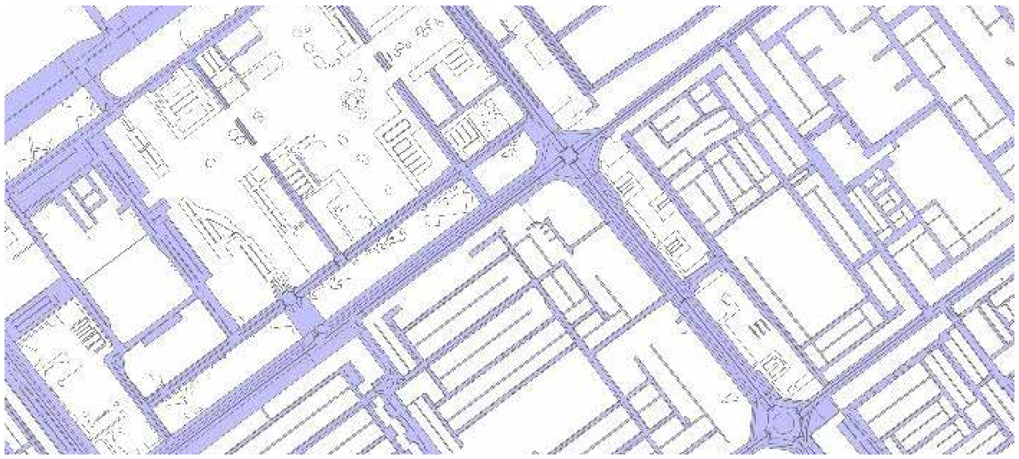

Figure 14 GIS Road MApping of Chandigarh

has been integrated with all the operational and e-governance services, and also has a surveillance system. UT Chief Architect, Kapil Setia, praised the project as he said " It is a very good project, and may benefit the city if executed properly".

2. The e-governance services include 71 services and departments. It also combines and segregates the services of the UT department and Chandigarh Municipal Corporation.
3. BEL laid down the 280 kms of optic fibre even-though, the scope of work assigned for them was only 240 kms, this shows the intention of improving and strengthening the city infrastructure facilities.
4. The solid waste management SCADA is an efficient and effective management of resources. It is being engaged in the solid waste collection by installing GPS devices in waste collection vehicles and monitoring them from the operational command and control center. Live location will be shared with citizens to keep track of waste collection vehicles.
5. SCADA for solid waste has impacted tremendously in: optimization of routes for waste collection efficiency, door to door efficiency, registration of complaints.
6. Chandigarh now, has an Automatic Traffic Violation Detection System.
7. ATCS has proven to be beneficial as it reduces travel time and carbon emission.
8. A new public announcement system can act as a medium to run awareness programs, announcements for stop line violations (which is a deterrent instead of issuing a challan), and other important information sharing.
9. Information like 'Time to Airport', 'Time to ISBT 43', 'Time to Railway Station' can also be displayed, which keeps the drivers informed.
10. GIS data can help to understand urban expansion in terms of residents as well as geographical area. For example, how should a city expand? What do its residents need more of? Are the outskirts of the city capable of sustaining additional growth?
11. Map applications that are used on smartphones and in vehicles rely heavily on GIS data to keep their maps updated to the second. Consumers rely on these navigation systems to traverse safely and efficiently.
12. GIS can help answer many different questions regarding transportation, from identifying dangerous intersections and improving road optimization to choosing the right location for a new road or rail route.
13. Entry and Exit points of Chandigarh were not monitored for any kind of blacklisted vehicle. With the introduction of ICCC, 20 entry and exit points of Chandigarh are monitored to understand the vehicles coming and going from the city.
14. Traffic Police had to issue challans manually in Chandigarh (on-field generated) and they had no provision to issue challans during the night for red light violations, this challenge has now been resolved.

From Survey:

A user survey was carried out, asking a few questions online followed by a field survey, where people were asked about their awareness of the projects, reviews and their opinions on the projects, which were taken under ICCC. The findings from the survey are listed below:

1. The citizens were asked about the 'I'm Chandigarh app', its interface and the satisfactory level of the services provided by the app.

Figure 16 ongoing discussion with Chandigarh Smart City team involved in several Projects regarding various Projects

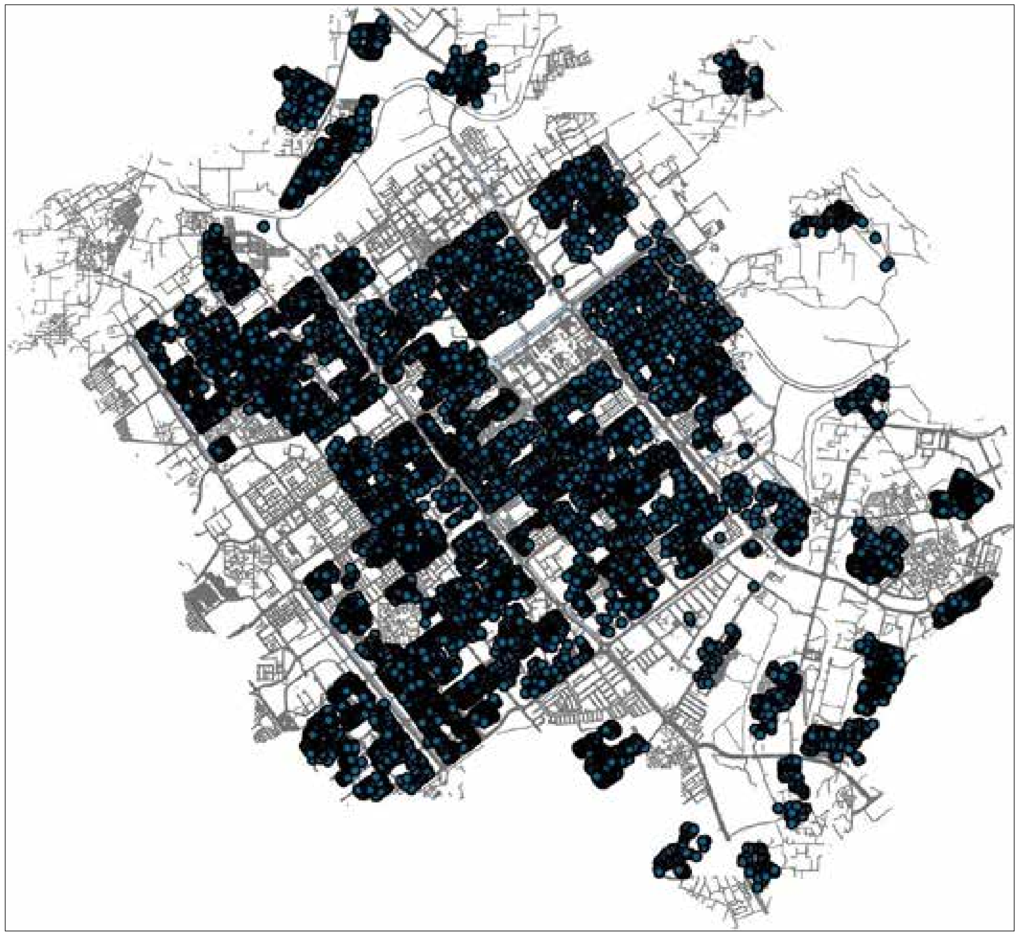

Figure 15 Solid Waste Pickup Points, Source: GIS Map Provided by Chandigarh Smart City Ltd.

Figure 17 Image showing field survey carried out, Source- Author

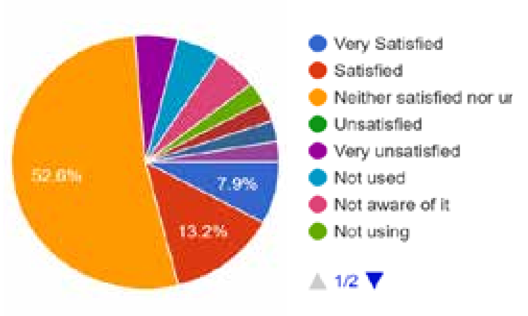

Figure 18 survey for I'm Chandigarh App, Source- Author

Inference: The neutral response may be reflecting a lack of awareness among people or any glitches faced by the people during availing of the services.

- The citizens were also asked about the emergency response system and its efficiency. It was launched temporarily during the spread of COVID-19 as a COVID response system. The response from the citizens is shown in the graph below:

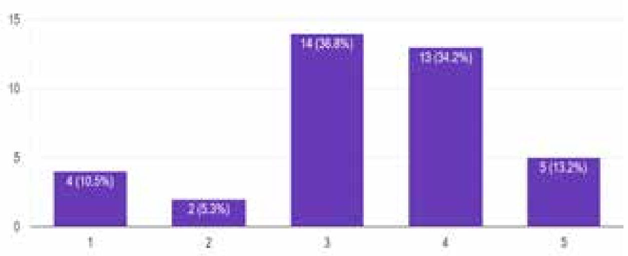

Figure 19 Survey Regarding Emergency response system, Source- Author

Inference: During the pandemic, when ICCC was started as a trial, the efficiency of the command center can be seen in the above survey.

- The Citizens were asked to rate the Adaptive Traffic Control System, Surveillance System, and Dynamic Message Display System.

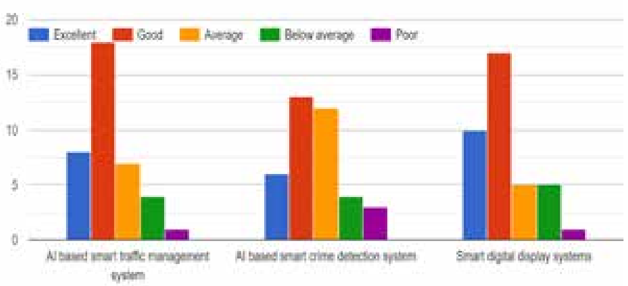

Figure 20 Survey regarding traffic management system, AI-based smart crime detection system, Dynamic Message display system, source- Author

Inference: Overall people were satisfied with the initiatives and the implementation of the above-mentioned projects.

3. Discussion and Conclusion (1,800 words, heading Bold; 14 font size)

ICCC:

ICCC campus itself is an innovative strategy as the campus has three buildings for the Police Department Control Center, Integrated Command Control Center, and Centre for SCADA monitoring. The various integrated services are SCADA for Water and Waste Water, Municipal Solid Waste Management, Smart Lighting (LED), Smart Parking, Public Bike Sharing, Intelligent Transport System (CTU), and Intermediate Public Transport. The project has very successfully incorporated all the possible aspects. The Chandigarh Smart Initiative focuses its major budget on ICCC platforms. The projects deal with aspects of Innovation, Replicability, Expandability, as well as Capacity building in ULBs. Projects like PBS is also being monitored by ICCC through the app.

The decisions taken to curb the threat of cybercrime and prevent the hosting of data are quite commendable. In operational services, the concessionaires are involved in facilitating proper service delivery such as BEL laid

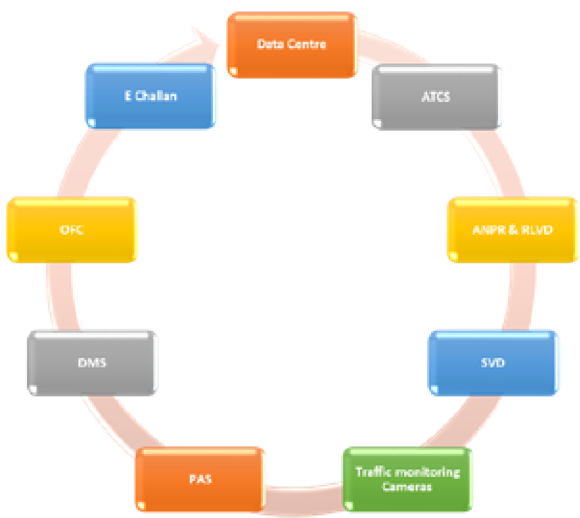

Figure 21 ICCC Projects centrally operated

an extra 40km of Optic Fibre, a selfless act in making the project successful. The convergence factor of the project is very high due to the efficient implementation and execution of the projects, the capacity-building programs have been a major factor in the success of the project.

Opting BEL has been a positive factor in the project as the city has benefitted from their expertise in the field and their dedication throughout the implementation of the project including the data storage, quality of the project, case solving, or flagging issues has been noteworthy. BEL has played a significant role and has provided Chandigarh with the best services and in a greater perspective, building a great nation.

Credit shall also be given to the Chandigarh Smart City and PMC which is EGIS, who have continuously been solving issues throughout the project. The research and development carried out by the team, the dedication of the team and proposal of art technologies such as advanced UAF, DDOS, Firewall, Intranet systems, developing advances Traffic management system, smart e challan system has been exemplary.

3.4 *Implications (the impact assessment framework to be included here)*

The projects incorporated under the ICCC program in Chandigarh Smart City have a very positive impact and focus on easing normal people's lives as well as reducing stress and providing comfort to the people. The project-wise implications are listed below:

ICCC: No Automatic Traffic Violation Detection System was available in Chandigarh until now. Also, there was no mechanism to check for stolen vehicles in the city, it was very difficult to trace the vehicles using 10-year-old cameras. Now, this can be done automatically during day and night-time. Only fixed and manual timing of the traffic junctions was working in the city, now with the

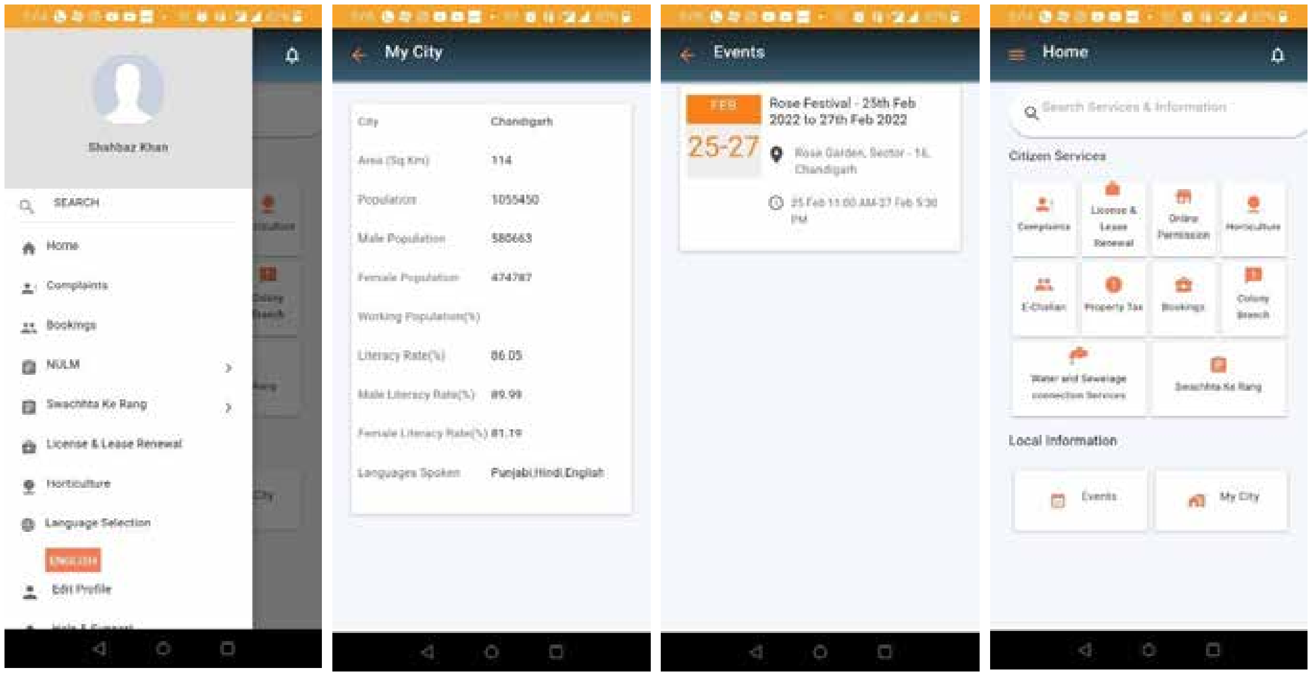

Figure 22

help of ICCC, signal timing can be configured as per the real-time traffic conditions locally. There was no mechanism to create a green corridor automatically and it has to be conducted manually, now it can be done from the Police Command and Control Center (PCCC) itself. There was lack of real time visibility of traffic conditions in the, now there will be an AI-based engine that will keep evaluating the traffic conditions of the city and update the cycle timing as per the need (based on local and central traffic conditions).

Dynamic message signs can be used to inform about the traffic congestion proactively and help in reducing the congestion. The Integrated Command and Control Center of Chandigarh is the state-of-the-art platform used for the integration of various services being provided by the Chandigarh administration. In case of any event/incident, a pre-defined standard operating procedure is followed for its resolution. In addition to integrating the services and providing the dashboard, the ICCC platform also analyzes the data to find patterns and create co – relation in different departmental data.

- SCADA TT Water: Better management in operation and maintenance of recycled water. Improved monitoring of daily production as well as consumption of TT Water. It will help to generate better revenue in the future keeping in view the assured quality and quantity of TT Water.
- SCADA SWM: There have been multiple positive implications such as : i).Optimization of routes to cover optimum no. of houses in the minimum time span, ii). daily collection of garbage from each house, iii). identification of fuel consumption of each vehicle to optimize vehicle routes and iv). reduction of fuel consumption per vehicle. This, eventually, facilitates the citizen to dispose garbage, track the SWM vehicle on their phone and complain through the same mobile application in case of any issue. Also, citizens can track the status of their complaints. In addition, drivers can contact the call center through a mobile application in case of any emergency.

3.5 Limitations of the research

The time frame allotted to complete such an extensive amount of survey and report preparation, as the time required to compile and analyze the data and draw inferences from the data provided and forecast the possible outcomes is very less.

The dependency on secondary data is also a major limiting factor for this study as it won't be possible to analyze the outcomes of the project on the general public. In order to assess the workability of the project as well as the positive/negative impacts on the general public only physical interviews and surveys must be used.

The lack of coordination between the agencies led to several mixed views and responses, which became very difficult to assess. Also, the limited time frame for a stay made us very difficult, to analyze the projects.

Most of the projects are still in progress, construction work is going on at most of the sites, especially in the ICCC campus, hence it is not possible to assess the project in its full swing.

3.6 Key lessons learned

The key lessons learned are listed below:

1. Ease in operation with one center, increased efficiency in departments.
2. Ease in controlling and monitoring of waste.
3. ATCS has been generated especially for the city of Chandigarh considering Indian driving conditions.
4. Considering human error will reduce stress among citizens and promote people to follow traffic rules.
5. Minimizing chances of cybercrime, and also cost reduction in LCCA.
6. All solutions provided by AI including E-services on a common platform.
7. Adaptive mode for controlling and mitigating the risk during disasters etc.
8. SWM vehicles' smart GPS based fuel management increases the affordability of all the operational services provided at a single platform
9. Easy to use 'I'm Chandigarh app' for people of all ages and categories.
10. There are some glitches in the apps, such as PBS which need to be looked upon.
11. There are some grey areas in terms of network, which makes the whole ICCC services a little difficult to reach the citizens. Such as places near Sukhna Lake and Governors Bungalow.
12. SCADA for Waste Management allows organized and smooth functioning of the SWM program as well as the capacity Building of the workers in order to segregate waste and operate the waste.
13. The administration team shares posts among Municipal Corporation and Chandigarh Smart City Ltd. which makes the management smooth and coordination between the agency becomes easy.
14. The scalability of the project can be seen in the ICCC campus as half of the site has been left for future expansion, and an extra conduit has been laid for optic fiber.
15. Innovation can be seen on the ICCC campus, as they have divided the ICCC initiative into three buildings.

3.7 Recommendations

ICCC has been efficiently executed yet a few recommendations for the project and its administration part have been elaborated below:

The rift between agencies and departments should be dealt with carefully. The 'I'm Chandigarh' App. can be improved by incorporating all the web portals and dashboards for e-governance services and also providing data related to traffic, weather forecast, etc. This will provide the citizens with all the necessary details to commute or to avail any other related service/s.

The interface of the app shall also include amenities for the disabled. In the SCADA for SWM, there should also be sections for recyclable waste segregation such as glass, metals, etc. Integrating with 'I'm Chandigarh' app. for a project like public bike sharing is also recommended. A few points are listed below:

- Issue of the network in some areas shall be looked upon and improve the conditions so that citizens can access the services equally throughout the city area.
- The glitches in the apps shall be identified and rectified in order to ease the interface for the users.
- Inter-agencies coordination shall be improved as Chandigarh is administered by Municipal Corporation as well as UT, hence more effort is needed under this banner. As well among several stakeholders also, as interviewing the PBS concessionaire, it was highlighted that they face difficulty in availing power supply or police department to lodge complaints.
- Initiatives shall be taken in order to make the smart city program a long-lasting success story for other cities. This will ultimately generate more employment.

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A23

Battery Operated Cart Service for movement of Elderly and Differently Abled

Name of the project: *Battery Operated Cart Service for movement of Elderly and Differently Abled*
Location: *Chandigarh*
Year of Project Implementation: *2020*
Sector: *Urban Mobility*
SDG: *SDG 3, 7, 9, 11, 12, 13, 17*
Project Cost: *1.27 Crores INR*

Institute: *Faculty of Architecture and Ekistics, Jamia Millia Islamia*
Advisors: *Dr. Hina Zia, Dr. Nisar Khan*
Students: *Ripu Daman Singh, Yogesh Bharadwaj, Madiha Khanam, Tanya Ahmed*

Keywords: *e-carts, battery-operated carts, golf carts, NMT*

Abstract:

With the rise in the number of vehicles on roads, cities across the globe are facing major challenges leading to climate change and congestion. In India where development is on an exponential rise, Chandigarh is no exception. Having the highest per capita ownership of private vehicles and the highest density (878 Vehicles/ 1000 People), the city has the second-highest per travel emissions in the country.

Despite various traffic management strategies, city transport often struggles to regulate traffic and congestion, which leads to poor urban air quality in the city centres. For very short trips, the rapid increase in electric sharing vehicles can be seen that can act as a feeder service and support the overall transport system in a city. The service of 10 e-carts in Sector 17 is more focused on providing comfort and convenience to the elderly and differently-abled and enhancing the quality of time spent by the visitors in the area. The project will lead to a better life for the residents, safer short trips, and better air quality.

This research aimed to examine the battery-operated cart service in Sector 17 of Chandigarh and employed both qualitative and quantitative methods to evaluate the impact of the project on the users and the city. Various professionals and officials directly associated with implementing and executing the project were interviewed. Questionnaires and site visits facilitated the findings of the project. Analysis of the key features, innovations, benefits, and risks involved in the project will help in further improving the system and making it a city-wide success. The research also suggests some ideas that can be adopted in Chandigarh to remove some discrepancies from the system.

Case Study: **A23**

1. Introduction

1.1 Topic and Context

Being a modern city, Chandigarh is becoming a premier centre in North India for education, information technology, and medical institutions. The decadal growth rate indicates the high growth and better living standards in the city that led to an astounding increase in the number of privately-owned motorised vehicles. As a result, the city faces various issues such as traffic congestion, parking problems, and vehicular pollution.

As a Smart City, Chandigarh has a big vision of promoting Non-motorised Transport (NMT) as a foundational sustainability mobility concept. According to Chandigarh's Smart City Proposal (SCP) report, the goal is to introduce low carbon mobility options along with the promotion of last-mile connectivity through battery-operated carts (e-carts), e-rickshaws, public bike sharing programs, elderly & handicap friendly streets, more walkable and cycle-friendly streets.

The Area Based Development (ABD) region considered under the SCP includes Sectors 17, 22 and 35 for the enhancement of intra-sector movement for the elderly and differently-abled. Sector 17 is the Central Business District (CBD) of Chandigarh, Sector 22 consists of Shastri Market in the centre and mobile market at the periphery of the sector, and Sector 35 Market has electronic goods, clothes, and services shops. All three sectors were studied for connectivity and potential, and it was decided that the prime focus for the e-carts service will be on Sector 17 and can later be implemented for market areas of Sector 22 and 35.

Therefore, Sector 17 (having the highest footfall) was selected as a pilot project which is a CBD that houses crucial businesses, financial institutions and offices such as a general post office, library, multi-level car parking, and hosts markets for various recreational activities, high-end retail brands, and daily needs.

Figure 1.1: Heat Map for Sec 17. Source: EGIS

The demand assessment was carried out on the basis of overall footfall and targeted age groups. Nearly 30% of the total population is more than 50 years old and Sector 17 witnesses a daily average footfall of 25000 people of which 5% are elderly or differently abled. The service routes of e-carts within the Sector 17 market area were defined by the footfall, pedestrian network, public transport and intermediate public transport, and availability of space of operation. Therefore, 3 loop routes were identified initially for 10 battery-operated carts for Sector 17.

The battery-operated carts project was divided into 3 phases. Phase I was concerned with civil work, procurement of e-carts and selection of O/M operator; Phase II marked the beginning of operation for 2 years; Phase III included handing over the operation to the facility manager/UT Admin. The foundation of the project was laid down on 20th January 2020.

M/s Egis International SA is the Project Management Consultant (PMC) for implementing projects in Chandigarh Smart City including the e-carts project under the Smart Cities Mission of MoUD, GOI. The PMC's scope is to assist Chandigarh Smart City Limited (CSCL) in designing, managing and finally implementing the projects within the Chandigarh administrative boundary.

As an implementation agency, CSCL supports system planning, and contracts for operation, monitors the operator and system performance and helps in coordinating with various government agencies and departments for the smooth operation of the project.

CSCL has procured 10 battery-operated golf carts from M/s Sutlej Automobiles and has selected a private agency, M/s Secure Guard, to operate and maintain (O&M) the project for 2 years. This includes the day-to-day operation of the e-carts, management of the e-carts and charging stations, and training for drivers.

S.No	Item	T0	T + 3months	T+1 years	T+2 years	T+5 years
1	Demolition/ Dismantling of Existing Ramp					
2	Building new Ramps					
3	Procurement of Vehicles					
4	Selection of O/M operator					
5	Start of Operation					
6	Project to UT Admin/Facility Management					

Figure 2.1: Project Phasing. Source: EGIS

S. No.	Project Name	Projected Cost (in Cr.)	L1 (Name of Organisation)	Cost As per Lowest Bid Received	Status
1	Battery Operated Golf Cart (10 nos) for elderly and Disabled in Sec 17	1.27	M/s Sutlej Automobiles	0.47	Project Completed
2	Operation and Maintenance of Battery Operated Cart (10 no's) for Movement of Elderly and Disabled in Sec 17		M/s Secure Guard	0.63	O & M in progress

Figure 2.2: Project phases, cost, and status. Source: CSCL

1.2 Significance of the project

Sector 17 has a PSP (Public, Semi-Public) and commercial land use that stretches along the area of 1.3km X 0.8km comprising police ground, police housing colony, Inter State Bus Terminal (ISBT), bank, other government offices, and retail areas. As per the Chandigarh Mobility Plan, there is high pedestrian traffic in core areas of the city such as Sector 17.

The visitors have to walk nearly 500 metres or more from the parking lots within the sector in order to use the market area. This also means that the user either has to walk the entire length of Sector 17 or has to remove the parked car from one parking lot to the other situated next to the destination within Sector 17. If the visitor is elderly or differently abled, it becomes quite challenging to move around and within the CBD of Chandigarh.

The aim of the e-carts service is to provide seamless connectivity in the CBD by substituting it with non-polluting and non-motorised transport. The service is more focused on providing comfort and convenience

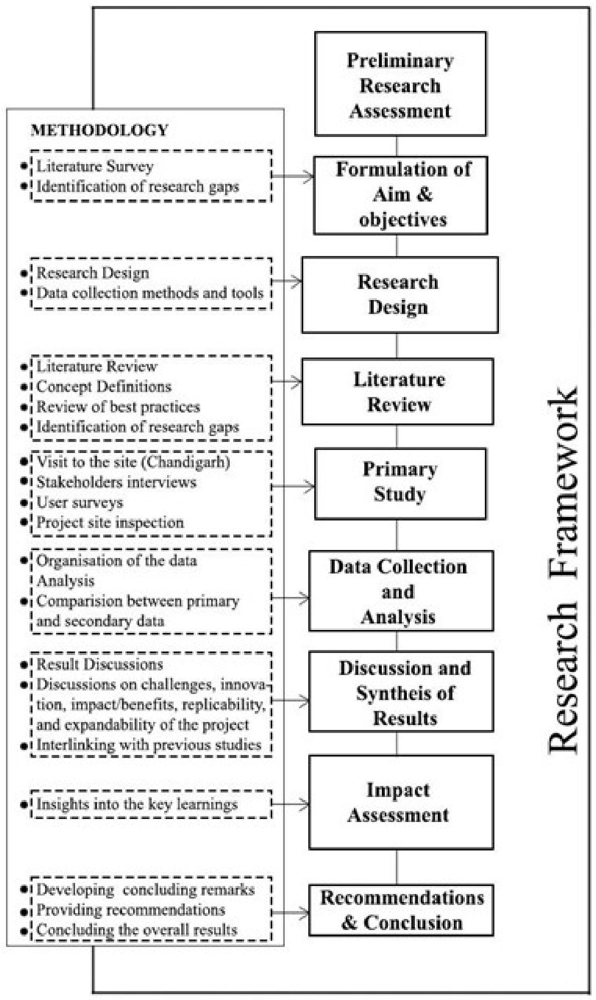

Figure 2.3: Graphic for research design. Source: Author

to the elderly and differently-abled and enhancing the quality of time spent by the visitors in the area. Through the introduction of the e-carts in the Sector 17 area, it is envisaged that this will aid the movement of elderly and differently-abled visitors within the market. However, the project plays a crucial role in enhancing mobility in the city centre and is inclined towards reducing the parking demand in the area due to the availability of cheaper commutes.

1.3 Aim and Objectives

The aim of the study is to analyse the role of e-carts for intra-market movement in the Sector 17 area of Chandigarh, which plays a crucial role in providing last-mile connectivity for elderly and differently-abled people in the city centre.

The objectives of the study are:

1. To study the key aspects of the project
2. To review the service provided by the e-carts in Sector 17
3. To analyse the impact of the project on the city and its users
4. To review the literature regarding the battery-operated carts
5. To understand the views of various stakeholders regarding the e-carts project
6. To evaluate the further applicability of the project
7. To suggest the possible modifications to facilitate better functioning of the project

2. Contextual Background

2.1 Conceptual Framework/Research Design

To address the key research objectives mentioned above, this research uses both qualitative and quantitative methods and a combination of primary and secondary sources. In a nutshell, the collected qualitative information is described as challenges, innovation, impact/benefits (direct and indirect), replicability, and expandability of the project. The SAAR team tested Sector 17 to inspect e-carts for issues and problems faced while using the service. Quantitative data were obtained from secondary data sources. The qualitative analysis has been incorporated with the quantitative results in the discussion part of the report.

Data sources

Primary data sources

The primary data collection was carried out in Chandigarh from 14th to 16th March 2022. The SAAR team visited Sector 17 to get an overview of the e-carts project operations. The team observed the site condition, took photographs of the infrastructure, and used the service first-hand (by riding the e-carts using different routes within Sector 17).

Discussions and semi-structured interviews were done with multiple stakeholders such as CSCL officials, PMC officials, Chief Architect UT, Chief Engineer, Project Supervisor of e-carts project, members of Heritage Committee, Academia (from Chandigarh College of Architecture), Architects in the city, drivers of the e-carts, citizens, and the users of different age groups and gender.

To understand the perspectives about the e-carts project in the city, the team interacted with the following official stakeholders:

- M/s Egis International SA from Chandigarh Smart City Limited: Mr Arun & his team
- Project Supervisor of e-carts project, CSCL: Mr Vijay Kumar
- Chief Engineer, UT Administration: Mr C. B. Ojha
- Chief Architect, UT Administration: Ar. Kapil Setia
- Principal, Chandigarh College of Architecture: Ms Sangeeta Bagga
- Teaching Faculty, Chandigarh College of Architecture: Ar. Deepika Gandhi

Questionnaires were also prepared to understand the general perception of the public in Chandigarh about the e-carts project. The insights followed after the collection of the primary data helped in formulating discussions, analysis, and conclusions.

Secondary data sources

The preliminary studies were carried out in the months of January, February and March 2022. The secondary data sources include reports provided by Chandigarh Smart City Limited (CSCL) in the form of Contract Procurement Document, Detailed Project Reports, official presentations, and other project documents.

In addition, various government websites, reports and management documents were also referred for the literature review. The data obtained from the census, surveys, Chandigarh master plan, statistical data, policies, regulations, standards, and case studies (national and international) were also taken into account for the research.

This research is an attempt to learn about the ins and outs of implementing and operating the e-carts project in Chandigarh. The purpose of the study is to learn and showcase the city's initiative where one can facilitate the exchange of the best practices. The report highlights key innovations, risks, challenges, threats, and suggestions for the e-carts project. This will help in promoting cross-learning among the cities across India and beyond.

Literature Review

To improve mobility and promote NMT in cities, traffic management can help in providing safety and reliability to the users. As the cities are evolving and their city centres become more prone to congestion and related problems, traffic management strategies that discourage the use of personal motorised vehicles can be employed to reduce a lot of pressure on such areas. For example, creating car-free zones/neighbourhoods can only be done if people have access to affordable, better public transport, and Intermediate Public Transport (IPT) such as auto, shared auto, taxis, shared taxis, and e-carts in the area.

Another case can be demarcating low emission zones (LEZ), which means an area where vehicles emitting pollutants have restricted access, or even zero-emission zones (ZEZs), where any vehicle emissions are not allowed (so only pedestrians, cyclists, fully electric public transport & paratransit are permitted). These measures are already in place in many countries and have helped in improving the air quality in respective areas. (Richard et al., 2019)

Therefore, battery-operated carts can have a greater impact even if these are feeder services. The battery-operated carts deployed in Sector 17 are the golf carts. Golf carts come in different models depending upon the mode of energy used for the operation of the cart

Figure2.4. Battery recycling management. Source: GIZ GmbH (2020), Environmental impact of e-mobility in the Lake Victoria Region, Western Kenya.

Figure 2.5: E-cart in Sector 17. Source: Author

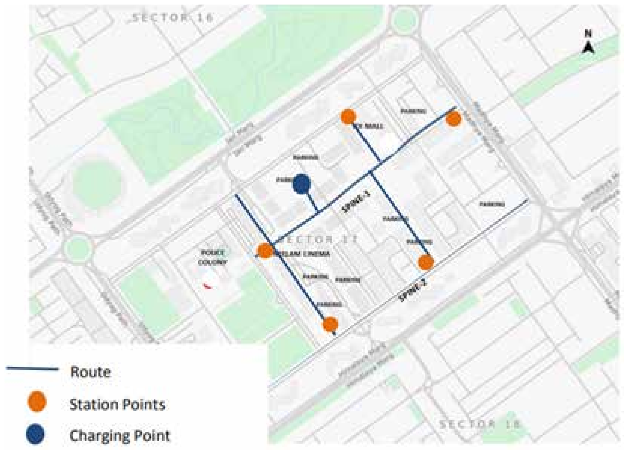

Figure 2.6: . Identified Spines in Sec 17. Source: EGIS

such as solar panels, batteries, and electronics. As per the number of seats, the models can vary in size as well. In recent times, these have become more functional, affordable, durable and reliable, and can be used for a longer time period. (Saleh et al., 2021)

Also known as electric utility vehicles (EUVs), battery-operated golf carts are used as a means of shared transport to provide accessibility in spaces such as airport terminals, theme parks, shopping malls, educational institutions, hospitals, hotels, and corporate campuses spread over acres of land. The benefit of providing an alternative form of mobility in the form of such carts is that these promote the restriction of motorised vehicles inside the campuses and promote environmental sustainability.

The EUVs are not as fast as your cars and might not meet that level of performance criteria, but their application can actually be more suited in places that require low-speed EUVs, say, college campuses. You might wonder why these are more desirable. EUVs do not create noise pollution, they are slow thus increasing pedestrian safety, and they are cheap to buy and have a longer life. So, for short trips around any development, these prove to be more desirable than cars. Recent studies suggest that in congested cities, small-format EUVs are continuously replacing full-size combustion-powered vehicles. (Thomas Bartman, 2018)

In fact, if you look at some major cities across the globe, it is no surprise that these cities have started charging congestion taxes for access to city centres. In the case of EUVs, these are small comparatively and do not emit tailpipe pollution, they are therefore exempted from many congestion taxes. The research shows that the critical limitation that is preventing EUVs from replacing the traditional auto market is the battery performance. In the due course of time, battery cost is declining and technology is improving, EUVs are sure to gain momentum and might replace their traditional counterparts. (Thomas Bartman, 2018)

As almost all electric vehicles run on Lithium-ion (Li-ion) batteries, it would be very short-sighted to not discuss the waste generated by Li-ion batteries on the environment. The life-cycle analysis of Li-ion batteries suggests that the waste disposal of these batteries is very much a concern.

As per recent studies, a Li-ion battery can hold and discharge electricity for the next 7-10 years after being taken off the road as it is typically left with 70% of the capacity. Therefore, before introducing these batteries, the repurposing of Li-ion batteries should be taken into account for various purposes such as storing solar energy, home energy storage, and backing up traditional electric grids. As an example, Toyota has launched an initiative where old batteries are paired with solar panels to power 7-Eleven stores in Japan. Other countries can learn from such practices and help in the conscious use of Li-ion batteries. (GIZ GmbH, 2020)

So, if countries are encouraging the use of more EUVs, they should simultaneously plan to recycle the batteries and manage waste disposal judiciously. As the NMT trend is on the rise, various countries have already set standards for battery waste management where the recycling rate for the entire battery is also fixed. Therefore, for cities making the transition to electric mobility, it is crucial to strengthen a regulatory framework to ensure the suitability of electric vehicles in the longer run. (GIZ GmbH, 2020)

2.2 Key features of the project

2.2.1 Challenges in the project

- With a focus on visitors with specific demographic profiles, the service might create a hindrance in the day-to-day operations of the market area and might be a hurdle for other visitors in the market.
- The proposal might face rejection on the grounds of utilising public space for moving a vehicle.
- Requirement of level grading and widening of passage is required at a few locations.

2.2.2 Risks involved in the project

- Negligence of the intended user groups in using the service
- Issues in recharging the battery of the e-carts
- Differential level differences act as a hindrance in the movement of e-carts.
- Shortage of the e-carts

2.2.3 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city

- Keeping in mind the heritage importance of Sector 17 and its CBD status, 10 battery-operated golf carts (each of 8 seaters running at an optimum speed of less than 20 km/hr) were procured, which ferry around on-demand basis.
- As of the date of writing this report, the service is free for all citizens.
- The availability of wide walkways and the presence of pedestrian plazas between the building blocks of the market area in Sector 17 help in ensuring the easy manoeuvring of the battery-driven carts.
- Post-Covid, the 10 golf carts have served more than 600 persons/day covering a total distance of almost 300km while following the social-distancing protocols.
- The service is provided on an on-call basis and has helped in improving the connectivity of the North and South plaza in Sector 17.
- The spine routes for the e-carts operation in the sector were predetermined to facilitate the fleet on the spine lines in order to maintain uniformity in operations.
- Initially, three loops were identified: Loop 1 runs from Neelam Cinema via Multi Level Car Parking (MLCP)to Bus Stop at Madhya Marg, Loop 2 follows the route from Indian Coffee House to Sindhi Sweets, and Loop 3 is formed in the intermediate spaces of Bank Square.
- The charging station is provided at the MLCP in Sector 17 for charging the batteries of e-carts during off-duty hours.
- The e-carts are facilitating intra-market movement thereby promoting low carbon mobility and the project lends an identity to Sector 17.
- The service can help suppress the parking demand and supply in the area by substituting it with non-motorised transport.
- In addition, the e-carts service helps in making commuting easier and more convenient by reducing travel time for the senior citizens and differently-abled in the market area of Sector 17.
- Through the addition of e-carts as an option of mobility, the supply and demand in Sector 17 are expected to be reduced.
- The project helps in improving the last-mile connectivity in Sector 17.
- When the service becomes fare based in the near future, it is expected to add economic value to the area.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

In the meeting with the PMC M/s Egis International, officials were briefed about the projects taken under the Smart City Mission for Chandigarh. The e-carts project in Sector 17 was taken up under ABD as a pilot project. Provided on an on-call basis, the project is successful in providing last-mile connectivity for the users.

After meeting with the project supervisor, it was found that the status and movement of the e-carts are monitored through a mobile application called 'GTROPY', which is a GPS Vehicle Tracking application. It is exclusive for the operator only and contains several

Figure 2.6: Application's User Interface shows various tracking features for the e-carts service. Source: CSCL

features such as vehicle list, kms summary, my geo fences, driver list (with phone numbers), search vehicle, idle time and speed of each e-cart, etc.

While having discussions with the project supervisor and drivers of the e-carts, it was found that a logbook is filled up by the drivers of each cart to record the number of riders and is later sent to the CSCL on a monthly basis.

3. Discussion and Conclusion

3.1 Implications

The introduction of battery-operated e-carts as a feeder service is one of its kind in the plaza space. After interacting with users of different age groups, it was found most of the users were satisfied with the e-carts service. Although the service is intended for the elderly and differently-abled only, the main users of e-carts observed on-site were women and children. Other than that, city officials and shopkeepers also use the service. As informed by the drivers of the e-carts, only 10% of the total visitors account for the elderly and differently-abled population. Although the e-carts are exclusively made for the elderly and specially-abled, the main users are women and children.

As the project is in the operation and maintenance phase, the service is free of cost for all citizens. The models of revenue are required to be explored to make this a long-term service. CSCL is handling the project right now and will later be handed over to the Municipal Corporation Chandigarh (MCC) for maintenance in the longer run. Although e-carts run on an on-call basis, no provisions are extended beyond calling the e-carts beyond waving a hand. Other measures such as mobile applications can be developed for the ease of bookings of the service in the area.

In recent times, a push towards the adaptation of cleaner technology is taken up over growing concerns of air pollution and vehicular emissions. Currently, not even one percent of the vehicles in India are electric. The e-carts project is in line with the programme Faster Adoption and Manufacturing of Electric Vehicles (FAME) Scheme. (GIZ GmbH, 2020) Thus, e-carts are a step towards growing mobility throughout the country by providing demand incentives, establishing charging station networks, and promoting awareness among the people. Indirectly, the e-carts project can create awareness among the users and might help reduce the parking demand and supply in Sector 17.

3.2 Limitations of the research

The limitation of the research was that the study was conducted over a period of 3 days and a continuous evaluation could be done. Although the research has touched upon e-waste management it can be explored further as its in-depth discussion is beyond the scope of this report.

3.3 Key lessons learnt

Golf carts are low air and noise polluting, thus providing environmental sustainability in the area. Regarding the financial side of the project, a revenue model is required to be put in place for the operation of these e-carts. The routes of the e-carts are now modified as per the need of the market area. Initially demarcated three routes of the e-carts are now upgraded into six routes that run at an average speed of 15 km/hr within Sector 17. The general waiting time for the users is 5-10 minutes.

Although users were quite content with the service, there were multiple issues raised by the users about the frequency of the e-carts. Sometimes users have to wait for the service for half an hour or more due to lunch hours or sudden e-carts breakdowns. As per the supervisor of the project, the e-carts occasionally experience punctures, breakdowns, or battery related charge issues. So, due to the maintenance requirement, the number of e-carts is reduced in Sector 17. According to the supervisor, drivers take turns to have lunch so that many e-carts remain operated during the lunch hours as well.

The running time of the e-carts used to be from 9:30 a.m to 6:00 p.m. Sector 17 is a shopping plaza and sees the major footfall after 6:00 p.m. After the SAAR team's suggestion to extend the timings of the service, the time has been extended to 9:00 p.m. Now, the e-carts are deployed in two shifts (starting from 18th March 2022): one shift of 6 e-carts from 9:30 a.m. to 6:00 p.m and another shift of 4 e-carts from 12:30 p.m. to 9:00 p.m.

3.4 Recommendations

The e-carts project has great potential for replicability in many areas across Chandigarh. While having discussions with the operators, drivers and users, we came to the conclusion that the e-carts are more required in other areas such as the Postgraduate Institute of Medical Education and Research (PGIMER) in Sector 12 and Government Medical College & Hospital (GMCH) in Sector 32 where a lot of patients use the campus and find it difficult to walk and move around. So, it is more of a social need in the hospitals that can provide convenience to the patients. Other than this, the model can be implemented at the Punjab University Campus where the footfall is usually far more than in Sector 17.

The uniform planning of Chandigarh will allow the ease of replicability in other parts of the city as well besides the ABD area, and hence can be implemented to further strengthen the e-mobility sector under SCM. Additionally, to serve the purpose of the feeder service from bus stops to important destinations, this pilot project can be scaled up and furthermore can be linked with CTU Chandigarh Transport Undertaking services through mobile applications.

It was also noticed that e-carts do not function on holidays/festivals when the footfall at Sector 17 is more than usual as the drivers had their days off on such occasions. Therefore, it is important to extend the services on such important occasions. The model of e-carts in operation at Sector 17 is an eight-seater model. The literature review suggests that different seating options for e-carts can be proposed in the areas as per the fleet size and the footfall influx.

When the e-carts were procured initially, they comprised lead-acid batteries but recently are replaced with Li-ion batteries for better performance of the e-carts. The study suggests that most of the e-waste generated in Chandigarh is taken care of by informal sectors. (Khaiwal et al., 2019) As the city is intending to increase its share in NMT and EUVs such as e-carts, it is necessary to enhance the e-waste collection and disposal mechanism for sustainable recycling of Li-ion batteries for a long-term success that will help in reducing environmental damages.

The literature review presented in the report provided insights into the existing gaps that can be bridged using various means. Further research helped in identifying the key aspects of the project. The assessment of e-carts and the service led to pinpointing the major issues that are necessary to facilitate improvement. The role of various stakeholders and their perspectives was thoroughly analysed in the research. The research provides a basic framework that is believed to contribute to the key learnings and shortcomings in the future implementation of such projects in the city and elsewhere.

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A24

Integrated Command & Control Centre: Faridabad

Name of the project: *Integrated Command and Control Centre*
Location: *Faridabad, Haryana*
Year of Project Implementation: *2020*
Sector: *Information and Technology*
SDG: *No Poverty (SDG 1), Gender Equality (SDG 5), Decent work and Economic growth (SDG 8)*
Project Cost: *168 Crores*

Institute: *Faculty of Architecture and Ekistics, Jamia Millia Islamia*
Advisors: *Dr. Hina Zia, Dr. Nisar Khan*
Students: *Amitesh Vijay Maurya, Prateek Gangwar*

Keywords: *Technology, Safety, Security, Traffic Management.*

Abstract:

In the past few years, urbanization has led to unsustainable growth leading to various issues primarily related to transportation and crime. The energy consumption and utilization is a concern in the current scenario. Therefore, to leverage technology under the smart city plan, everything requires to be built around a centralized system of resources in one place, that's when an integrated control and command Centre ICCC came into the picture. ICCC was designated to tackle both day-to-day and emergency situations (natural calamities) serving the communities. The required smart initiatives under the ICCC project such as smart roads & smart parks along with the ICT components of the ICCC installed are one step towards the efficient and sustainable community. Although the scope of improvement with the public participation remains and must be followed for better provisions for the users.

Case Study: **A24**

1. Introduction

1.1 Topic and Context
Integrated Command and Control Center (ICCC) is a flagship project of Faridabad Smart City Limited (FSCL). The physical infrastructure of the command center is implemented and functioning. As per the detailed project report (DPR), this project is envisaged to be the nerve-centre for all the smart city operations by aggregating information across multiple applications deployed across the city, and then provide actionable information with appropriate visualization for decision makers.

The ICCC project falls under the category "Technology in Urban Management". The project is located in Faridabad sector 20A. The stretch of the project is limited to the ABD area of the city which comprises sectors 19, 20, 20A, 21B and 21D. The project started in February 2020, and was implemented in 3 phases with 50 out of 153 identified locations to be completed in each phase. By March 2022, all the three phases had been completed, and 143 feasible locations of 153 identified locations were functioning.

The target population for the project can be bifurcated into (i) directly influenced limited to sectors of 19, 20, 20A, 21B and 21D and (ii) partially influenced -involving the commuters on the N.H. 44 (Mathura Road) and the Bypass Road. Also, the project includes stakeholders such as Faridabad Police, Faridabad Traffic Police, Faridabad Municipal Corporation along with the city residents.

This report will detail out the project of ICCC along with its constituents such as ICT infrastructure in the field consisting of cameras, automated traffic signals, public announcement systems, etc. along with the Smart Roads (Sector 21B and Sector 21D) and Smart Park (Sector 21B) functioning with the help of ICCC in the city.

1.2 Significance of the project
The ICCC project in Faridabad was envisioned to focus on following primary objectives:

a. Safety & security,
b. Solution for traffic problems,
c. Implementing traffic rules and regulation, &
d. Citizen services.

The integrated command & control center with the help of Artificial Intelligence (AI) and Video analytics gives insight into the different data collected. Currently this data is being utilized for controlling the traffic violators, identifying and intercepting the carjackers and other anti- social elements, warning and informing the first-time offenders and commuters. The real time data helps the decision makers in taking appropriate and quick decisions to resolve the immediate issues and plan for future issues. This aggregated city level information can be used to generate actionable intelligence for the relevant stakeholders and citizens. For example: with the help of camera surveillance, the water logged areas are identified and the relevant officials of the municipal corporation informed for appropriate action.

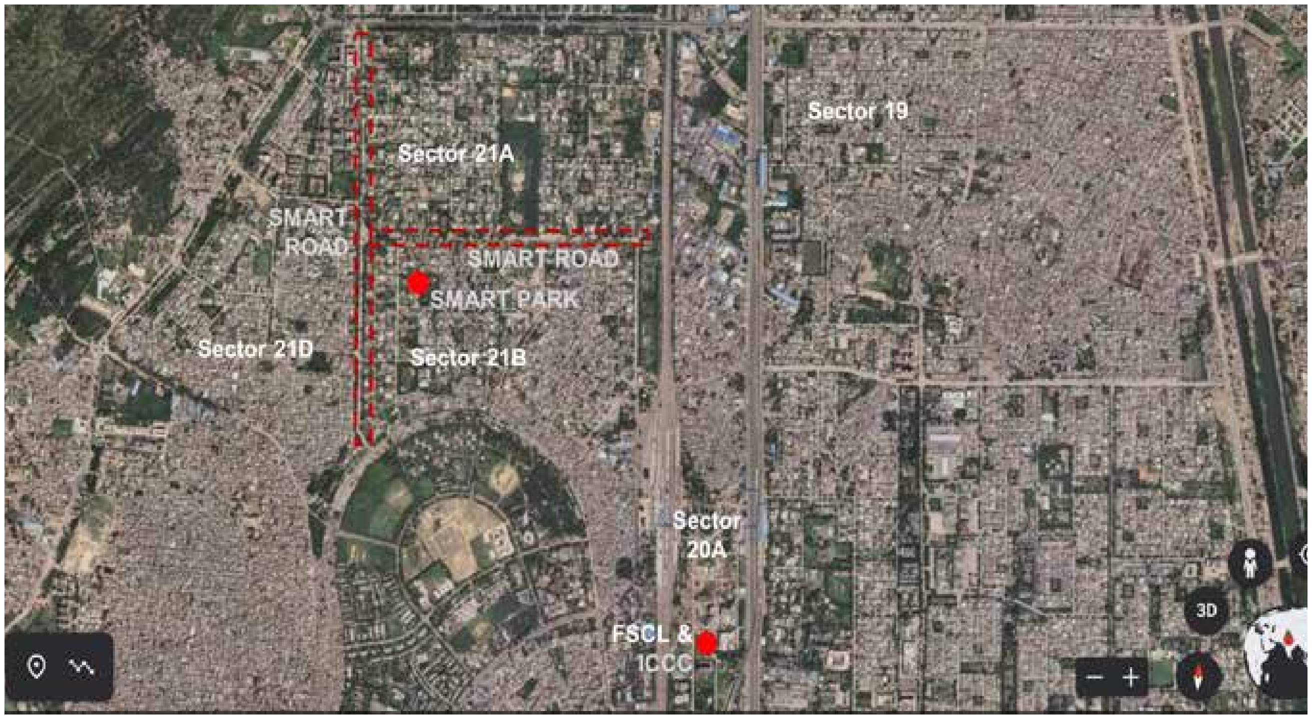

Figure 1: Faridabad ABD area map
Source: Google Earth

1.3 Aim and Objectives
The aim of the study is to analyze the impact of newly developed smart services (Smart traffic management, Smart roads & Smart parks) under ICCC on the daily life of residents and commuters in Faridabad.

The objectives of the study are:

1. Understanding the constituents (cameras, sensors, AI, data-centre) and functions of ICCC
2. Understanding the smart initiatives driven by ICCC (such as Smart roads & smart parks)
3. Analyzing the feedback of stakeholders
4. Comparing with the examples of other cities
5. Analyzing the achievements and shortfalls of the project
6. Recommendations for improvement

2. Contextual Background
Faridabad has been selected among the 100 smart cities in India for which it receives funding from the Ministry of Housing & Urban Affairs (MoHUA), Government of India for projects under its smart city proposal. Faridabad smart city proposal includes several Pan City and Area Based Development initiatives with a focus on both infrastructure and ICT advancements in the city and at strategic locations. Most of the ICT initiatives proposed and being implemented by Faridabad city have been identified with a predominant objective to improve public safety and surveillance, traffic management, public services quality, emergency response and real time tracking of services.

The project outcomes report by FSCL enumerates following before and after situations with implementation of ICCC project:

1. As per the FSCL pre & post implementation study, on one of the corridors-
   a. the average travel speed increase is in the range of 16% to 42%.
   b. the reduction in average delay is in the range of 19% to 50%.
   c. the estimated annual fuel savings in the year 2020 due to implementation of ATCS is about Rs. 2.33 crores.
2. The Water logging issue in the area was monitored in real-time and reported to the concerned authority for action.
3. Street lights were monitored for low light situations

through CCTV cameras installed in the area and the authorities took preventive measures in the reported areas.

4. With the decision of all stakeholders FSCL set-up the COVID19 Data Management Control Room to synchronize different data management portals such as ICMR portal, Covid19 portal, Covid19 facility app & Bed Management portal with the help of ICCC.

2.1 Key Stakeholders

The primary stakeholders of this project are: Faridabad Metropolitan Development Authority (FMDA), Govt. of Haryana, Faridabad Smart City Limited, Faridabad City & Traffic Police, Faridabad Municipal Corporation (FMC) and citizens of Faridabad City. Following table describes the primary stakeholders and their interest level/roles.

Primary Stakeholders	Interest / Role
Citizens	Improved City services / Maintain Quality & Value services
Faridabad Municipal Corporation	Ease of providing services / Seamless connectivity with other IT projects / initiatives
Faridabad City & Traffic Police	Proactive actions for complaint resolution / Integration with CCTV Surveillance and receive real-time feeds of cameras to help administration monitor its assets and secure
Faridabad Smart City Limited	Improved coordination with other departments

Source: (Site Surveys & E-Surveys, Author)

The research was conducted in three phases starting with the secondary data collection and compilation which includes reviewing the DPR of the project, News articles, published interviews, information from official websites of FSCL and Ministry of Housing and Urban Affairs, etc.

Next phase was the site visit and interaction with the officials of the project such as FSCL CEO, DGM-IT, Tech Advisor to CEO, & PMC. The interviews were conducted torein force the secondary data collected. The interviews and interaction with the stakeholders such as DCP Traffic Police - Faridabad, Police Commissioner - Faridabad, Additional Commissioner-FMC along with the feedback from the residents of the city were conducted to record their views towards the initiatives.

The third and the last phase was to identify the most relevant literature/best practices/case-studies/standards for the analysis and conclusion part of the report, where the collected data from various sources was documented to underpin conclusions andrecommendations.

The research aims to

i. bring out the impact of ICCC with all ICT installations, Smart Roads & Smart Parks on the residents' quality of life;

ii. point out the direct benefits, expandability, replicability, etc in the project as well as the challenges and suggestions to improve the positive impacts of the project.

The best practices applied in the ICCC implementation in various cities gathered through interactions with the officials and stakeholders are presented as below.

CASE-1 - Bhubaneswar Smart City

The ICCC opted to lay their own infrastructure for data transfer so that they can sell the additional bandwidth for revenue generation. But the issue was that ICCC could not find any buyers for the bandwidth at later stages.

CASE-2 - Bhopal Smart City

Data is pooled and collated at different data centers at different levels i.e., state level & city level SCMRCs (Safe City Monitoring and Response Control Centre). One can reach the state level data center and request for city data and real-time data can also be obtained.

CASE-3 - Ludhiana Smart City

The data security issues have been addressed with the formulation of 12th plan (Cyber Security - Strategic Approach for XII Plan) with the key priority of strengthening the National Cyber Alert System for

Figure 2: Location of Smart Road (Bhiduri Rd)– Sector 21 B
Source: Google earth

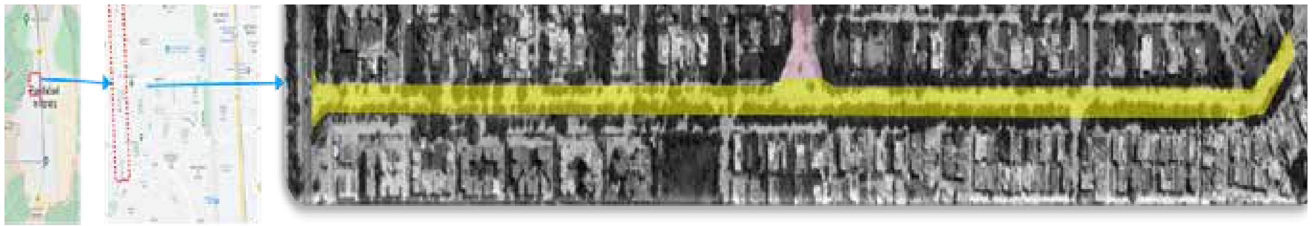

Figure 3: Location of Smart Road (Chamunda Rd)– Sector 21 D
Source: Google earth

Police Commissioner

Additional Commissioner (FMC)
figure 2

FSCL Team

Potential areas with seating arrangements

Columnar Lights

Tree in middle of footpath

rapid identification and response to security incidents and information exchange to all desired elements that are critical for cyber security, to reduce the risk of cyber threat and resultant effects.

2.2 Key features of the project

2.2.1 Challenges in the project

a. The operation and maintenance of the projects - due to limited life of sensors 4-5 years a constant identification and resolution of errors is required for efficient functioning of the projects.
b. Safety and security of the ICT equipment - against vandalization and theft.
c. Data security & Data Sharing – as online connectivity increases the vulnerability of the system towards cyber threats.
d. Under-utilization of data – data is available in large quantities, it is a challenge to identify its full potential and put it to optimum utilization.
e. Sustainability of the projects in the long run - to meet the operational and management costs, a feasible revenue model is required for the long-term functioning.
f. Interdepartmental coordination – if not efficient, can lead to delays in the approvals and hefty payments for the government work becomes a hindrance in speedy implementation.
g. Stoppage of work for smart roads during the covid period became a nuisance for the residents.

2.2.2 Risks involved in the project

a. Cyber security threat
b. Potential misuse of the citizen data
c. Network failures may result in extensive halt of the city
d. Vandalization of the critical equipment

ICCC – Traffic Management System

Regular Parks (Ekam Park Sector 21D & Huda Park)

Smart Park - Sector 21D

2.2.3 Features and Benefits *(social, technical, city administration level, impact on environment and economy) to the city (expected and observed)*

a. AI enabled automated and integrated traffic management
b. Real time monitoring for identification and resolution of issues such as street lighting & water logging
c. Decreased traffic violations, accidents and thefts – due to automated AI enabled surveillance and signaling.
d. Creative use of PA systems at traffic lights, for instance playing music at certain times(peak hours) to reduce the stress of commuters
e. ICCC acts as a tool for coordinating operations of multiple agencies
f. Underground services and covered storm water drainages
g. LED columnar lights for glare free and effective lighting
h. Conservation of existing trees and grating around at the base of the tree

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

The key finding from the interactions with the various stakeholders and the city residents in the project locations are as below;

a. For sustainability of ICCC planning of a revenue generation model is a priority.
b. People are only aware of traffic management and surveillance functions of ICCC.

Table 1. Key features installed on Smart Road.

Smart Features
Columnar Lights
Tactile flooring
Underground services
Covered storm water drainage
Tree grates

Source: (Site Surveys & E-Surveys, Author)

c. People are satisfied with smart traffic management system.
d. Majority of the people are neither satisfied nor dissatisfied with smart roads, at the same time 35-40% of people voted for the highest level of satisfaction.
e. People are not satisfied with the maintenance of smart park, lack of drinking water, security guards, cleanliness.
f. There are blindspots in the park due to vegetation overgrowth.
g. No sense of ownership of the park amongst the closeby residents as not many of them visit the park.

h. The regular parks have less number of activity zones.

Table 2. Key features installed in Smart Park.

Smart Features
Smart Poles
Smart Kiosk
Water ATMs
Smart Toilet
CCTV Camera
Public Announcement System
Mobile Operator Tower

Source: (Site Surveys & E-Surveys, Author)

i. Majority of people are neither satisfied nor dissatisfied (43%), Satisfied (29%) and unsatisfied (9.5%) with smart park features.
j. Shortcomings of the smart park are regarding maintenance related to facilities (toilets, drinking water, damaged equipment) and cleanliness.
k. Well planned green environment around the city, cycle tracks, walkways, dustbins, lane distribution for roads, specific corners for public gathering etc. are requested by people.
l. Going cloud based is better for establishing ICCC projects and integration of e-services.

3. Discussion and Conclusion

3.1 Implications

The Impact Assessment Framework as drafted in the DPR of ICCC categorizes the impacts in four categories namely i) Government investment ii) Safety results iii) Social benefits iv) Economic benefits. Details given in Figure-5

3.2 Limitations of the research

a. The research is limited to physical observation and behavioural analysis only and not oriented to the empirical data study.
b. Study includes ICCC data centre and only two projects i.e. Smart roads and smart parks were studied.
c. Due to the sample size and the on the spot user surveys and feedbacks penetration of bias could be present

3.3 Key lessons learnt

a. Awareness amongst the people through maximum feasibility of the project can be achieved as found in the survey
b. A lot of data is generated by ICCC which could be a revenue generation model for sustainability of the projects.
c. A lot of data is generated by ICCC which could be a revenue generation model for sustainability of the projects
d. As per the feedback from Police and Traffic - there is a need to expand the ICCC Project at PAN City level quickly for harnessing the effective output
e. The people were more inclined to have the basic aspects of ROAD such as lights, drains, footpaths and less concerned with smart features such as smart light, tactile, underground services, etc.

3.4 Recommendations

The Smart city projects have been implemented and are functioning to fulfill their objectives. The following recommendations are made for future development from the surveys, interactions and feedback of the stakeholders and users following project based improvements have been identified for the smart city projects.

ICCC project

a. Making FSCL a competing consultant - for the other organizations for data handling and processing in the new setups as a revenue generation model.
b. Training the young staff - to improve the capacity building of the organization for operation, maintenance and reducing dependency on PMC.
c. ICCC can be an effective tool for integrating functioning of all agencies by making it a one stop e-service platform for efficient and easy access by citizens
d. Mapping all the underground services through GIS for ease of identification and rectification to avoid unnecessary overlaps and delays.

SMART ROADS

a. Bifurcation of the Undivided roads - by placing the "Median Strip" in the middle of the smart roads
b. Placing the Street furniture - in the green area provided adjacent to footpath for sitting at 21D road
c. Light pollution - is to be avoided by checking the average Lux as specified by 'EESL guidelines' ranges between 8-15 lux for minimal disturbance to birds taking shelter on the trees present in the vicinity

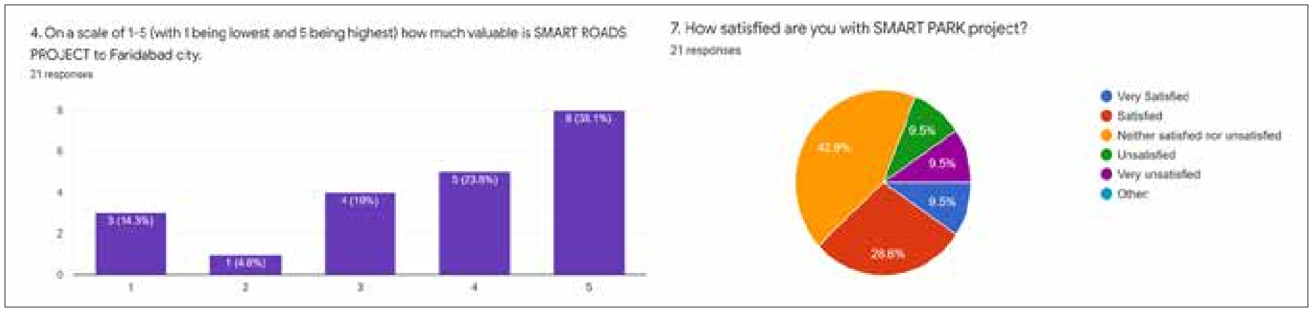

Figure 4: The responses of the user survey
Source: User survey

Figure 5: Impact assessment framework details as per DPR
Source: FSCL_DPR ICCC

d. The placing of trees - in the middle of the roads and footpath hinder the flow of traffic and should be relocated at appropriate place
e. Addition of dustbins on the roads to avoid littering by commuters and facilitating cleanliness
f. Speed breakers & Table top crossovers for safety of pedestrians
g. No speed detectors or cameras on road to monitor thefts or accidents

SMART PARKS

a. Park selected for SMART initiatives - must be located on the main roads and be accessible to wider population for maximize usability
b. Security & Safety - of the instruments and visitors can be enhanced by placing human element along with the cameras
c. Appropriate lighting and camera placement for maximum coverage and avoiding the blind spots formation in the park due to foliage and structures
d. Maintenance of the SMART Park (pump room, plants, vegetation, solid wastes, etc) on the regular intervals to be inspected and the accountability be set.
e. Universal accessibility is missing

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A25

Smart Governance using Geospatial Technology

Name of the project: *Smart Governance using Geospatial Technology*
Location: *Vadodara, Gujrat*
Year of Project Implementation: *2016*
Sector: *IT Sector*
SDG: *SDG 3 - Good health & wellbeing, SDG 6 - Clean water & sanitation, SDG 8 - Decent work & economic growth, SDG 13 - Climate action*
Project Cost: *Rs15 Cr.*

Institute: *Kamla Raheja Vidyanidhi Institute for Architecture and Environmental Studies*
Advisors: *Prof. Ainsley Lewis, Dr. Binti Singh*
Students: *Himanshu Deshpande, Pushkar Toshniwal, Anirudh Bhambure*

Keywords: *Geospatial technology, Internet of Things (IoT), artificial intelligence (AI).*

Abstract:

Geospatial technology supports the creation, management, analysis, and visualization of geographic data. Geospatial data and geospatial technology are essential for Smart City Management and Functional Applications. This paper discusses the Geospatial technology used for governance in smart city missions taking the case of Vadodara City and its impact on the city. Geospatial technology and its applications have been carefully explored in this study to establish their usefulness in smart cities and their development.

A smart city concept is supposed to improve city life by digitizing numerous infrastructure sectors such as transportation, health, energy, education, and vironment. Identifying and gathering meaningful information from large amounts of data generated in rapidly increasing urban areas. Many countries have adopted smart city principles to manage resource shortages, transportation congestion, and environmental issues. Open data is an example of a notion. The internet of things is described using terminologies such as open data, networked systems, and the internet of things. The Internet of Things (IoT), artificial intelligence (AI), cloud computing, big data, and geospatial intelligence are all examples of the developing technology. Geospatial Intelligence (GEOINT) is a new technology that is intended to help in managing development issues of smart cities and bring solutions to a variety of problems that the cities confront.

Case Study: **A25**

1. Introduction

Cities are development engines for any nation's economy, including India's. Urban regions are home to almost 31 percent of India's present population and account for 63 percent of the country's GDP (Census 2011). With rapid urbanization, cities are predicted to house 40% of India's population and generate 75% of the country's GDP by 2030. This necessitates the creation of complete physical, institutional, social, and economic infrastructure. All are critical to increasing the quality of life and drawing people and investments to the city, thus initiating a virtuous cycle of growth and development. Smart Cities are a vital step in that direction. The goal of the Smart Communities Mission is to promote cities that offer basic infrastructure and fine quality of life for their residents, a clean and sustainable environment, and the use of 'Smart' Solutions. The strategic components of area-based development in the Smart Cities Mission include city improvement (retrofitting), city renewal (redevelopment), and city expansion (greenfield development), as well as a Pan-city project in which Smart Solutions are applied to more significant areas of the city. Pan-city development envisions integrating selected Smart Solutions into the city's current infrastructure. Smart Solutions will incorporate the use of technology, information, and data to improve infrastructure and services (Ministry of Housing & Urban Development, Government of India, 2015).

Figure 01: Smart Solutions in different sectors

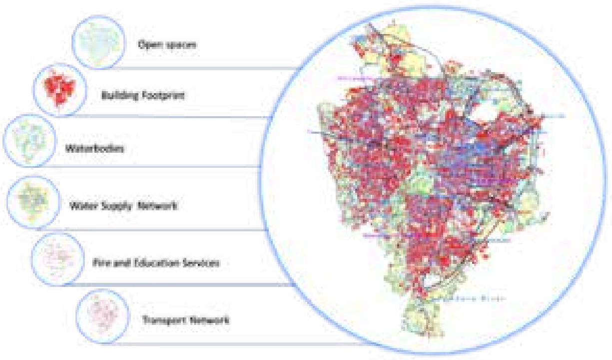


Figure 02: Layers for Vadodara GIS

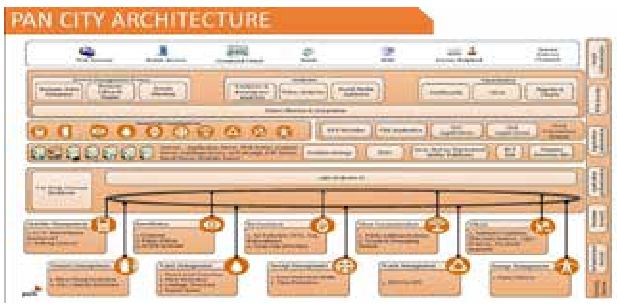


Figure 03: PAN City Structure

Figure 04: Location of Vadodara City

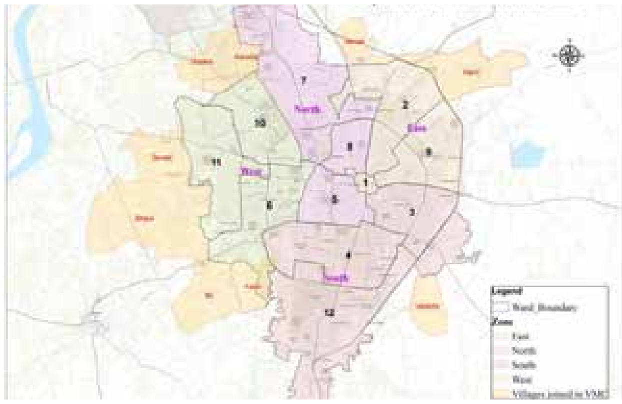


Figure 05: Map Showing administrative limit of VMC

Figure 06: Issues faced by Modern Cities

The heritage city of Vadodara is the cultural capital of Gujarat. Its transformation from a cultural to a smart city necessitated the digitization of its data through the use of GIS technology. Managing the assets of such a megacity required the Vadodara Municipal Corporation to view all of its data on a single platform to simplify intra- and inter-departmental information interchange, encouraging better efficiency in decision making and execution. The clever answer at hand was to digitize and upgrade all existing data by the Ministry of Electronics and Information Technology's recommendations.

1.1 The Topic and The Context

"Cities, in the past, were built on riverbanks. They are now built along highways. In the future, they will be built, based on the availability of optical fiber networks and next-generation infrastructure. Our government's vision is to build 100 smart cities across the country and Geospatial Science & Technology (GS&T) is the means to realize this vision," said union urban development minister, M Venkaiah Naidu on January 23, 2017, while addressing a conference of the Geospatial World Forum. He said that geospatial technology (GST) uses satellite navigation systems and computer databases known as Geographical Information Systems (GIS) to develop, collect, store, and retrieve geographic and spatial information of any location. "Through the use of real-time data and data analytics, GST enables efficient, effective, relevant, and integrated planning," Naidu explained. The widespread use of ICT and geospatial information systems is a common thread running across the NDA government's urban development projects, including the Smart City Program, Swachh Bharat Abhiyan (Urban), and Pradhan Mantri Aawas Yojana (Urban), AMRUT, and HRIDAY. (Press Trust of India (PTI), 2017).

Smart Governance using Geospatial Technology - Improving interdepartmental efficiency of working together by digitizing maps that are available in the department and creating an inter-departmental data exchange platform by extracting different types of information through digitized maps.

The project "Smart Governance using Geospatial Technology" is executed by Vadodara municipal corporation (VMC) under the PAN City Project of Vadodara Smart City Mission for Vadodara city. Vadodara is Gujarat's one of the biggest city and was previously known as Baroda. The city is located on the banks of the Vishwamitri River, close to Gujarat's capital, Gandhinagar. According to the 2011 census, the population of this city is close to 2 million people.

The Maratha royal family used to dwell at the Lakshmi Vilas Palace, which is now free to the public to visit and explore. The palace is home to the whole Gaekwad Dynasty and also houses the Maharaja Sayajirao University of Baroda. The university is recognized as the largest in the state of Gujarat. Vadodara's identity may be defined by its diverse culture, catholic viewpoint, and general enlightenment. Vadodara has seen the development of the medium and large-scale industry. The city has made enormous economic leaps, with major industrial complexes and public undertakings such as Gujarat Refinery, Indian Petrochemicals, Gujarat State Fertilizers, Heavy Water Project, Oil & Natural Gas Commission, etc. Today, the city is known as Gujarat's cultural capital and a center of educational activity. Vadodara consists of 220sq.km of the area at the altitude of 35.5meters above sea level. The city is divided into four zones and 12 wards under VMC limits (Vadodara Municipal Corporation, n.d.).

The Project falls under the IT department of VMC from data collection to its management and how it can be used for the purpose of governance. The project has its direct impact on VMC and indirect impact on the overall City stakeholders which includes various departments of the VMC and also the citizens through online platforms via the city's smart governance app and VMC website.

1.2 Project Significance

The project covers a wide range of problems related to Municipal Revenue, Public Transport, Roads, Underground Utility networks, Solid Waste Management, Town planning, Information Technology, and Citizen Governance. It also covers many topics such as interdepartmental reliability and the ability to work jointly, city surveillance, health care, and Disaster management.

Problems related to public welfare coordination between the departments managing the cities assets to view all its data collection on a single platform so as to facilitate intra and inter-department information exchange those promoting higher efficiency in decision making and its execution and up-gradation of all existing data based on the guidelines provided by the ministry of electronics and IT. Through this project, an enterprise-wide GIS solution is implemented for the creation, storage & maintenance of GIS data. A web-based GIS application for various VMC departments and citizen modules is developed. This will help VMC and Vadodara Smart City work fast and efficiently, making governance more citizen-friendly and cost-effective — it increasingly relies on online services to bring about accountability and transparency, particularly by using mobiles to reduce the cost of services and provide services without having to go to municipal offices; forming e-groups to listen to people and obtain feedback; and using online monitoring of programs and activities with the aid of a cyber tour of work sites.

1.3 Aims and Objectives

The present study aims to develop a database by collating relevant data sets from different departments and bringing it on a single platform for the VMC. The aim evolved from the digitalization of data to an application site.

The study's objectives are:

a. 100% filling of data gaps by creating a single digital platform for all departments;
b. Reduce complaints and increase efficiency for citizens;
c. Extracting relevant information from collected data and managing it;
d. To use GIS as a solution for the creation, storage & maintenance of data; and
e. To Develop a web-based GIS application for various VMC departments and citizen modules.

2. Project Background

Smart Utilization of Vadodara City's Potential for Improving Quality of Life for Citizens by Providing Equal Access to Best Quality Physical Infrastructure, Social Infrastructure, and Mobility by Leveraging State-of-the-Art Technology; thus transforming Vadodara into a Futuristic Global City with a focus on enhancing the economy, protecting the environment, and preserving the city's identity and culture

2.1 Conceptual Framework / Research Design

The project began with an initial support framework. The final methodological framework project then further evolved over a period of time.

2.1.1 The Top Line Features

- 3D GIS: Capability to scale the current application to visualize the city in 3D;
- City Expansion: Current Geospatial solution coverage is citywide. The current platform can expand with an increase in city boundary, add more users, more layers, and more department applications;

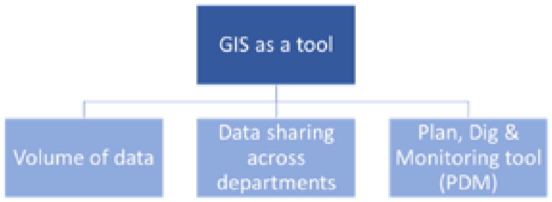


Figure 08: Initial Framework

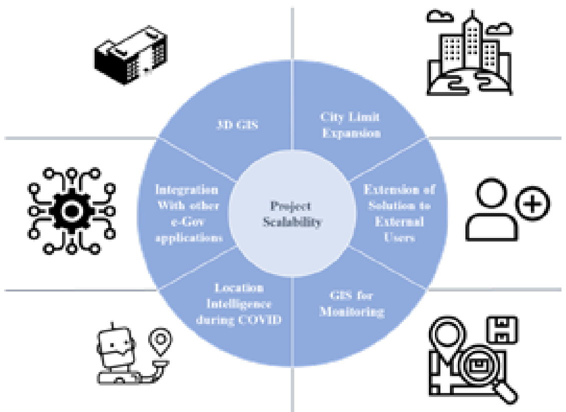


Figure 09: Replicability & Scalability Features

- Services for External Users: The solution is to be extended to external utilities like Telecom service providers, electricity service providers, development authority for Spatial Database Infrastructure (SDI) of a city;
- GIS for Monitoring: City Bus and Garbage vehicles monitoring will be extended to monitoring of other municipal and services vehicles like water tankers, maintenance vehicles, fogging vans, etc. by adding GPS devices and bringing the identical vehicles under the monitoring platform;
- Location Intelligence: The exact location-based information is made available in the form of an interactive map to the administration to identify COVID clusters and potential containment zones; and
- GIS Integration: Current platform is integrated with the current Command & Control Center (CCC)

Figure 10: Project Methodology

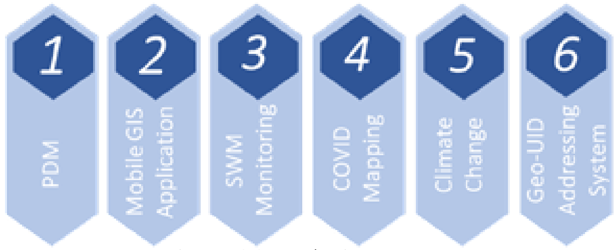


Figure 11: Exclusive Features

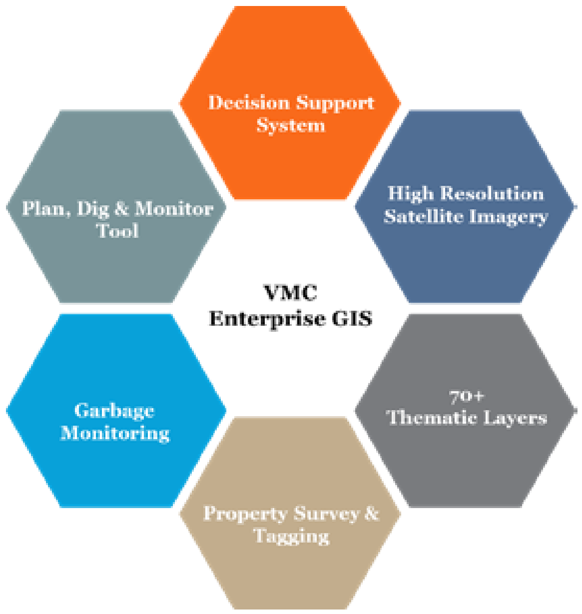


Figure 04: Location of Vadodara City

platform IBM IOC and will be integrated with Municipal ERP and other applications.

2.1.2 Methodology Adopted

2.2 Key Features of the Project

2.2.1 The Challenges

a. Data collection gathering it, analyzing it, and creating it digitally;

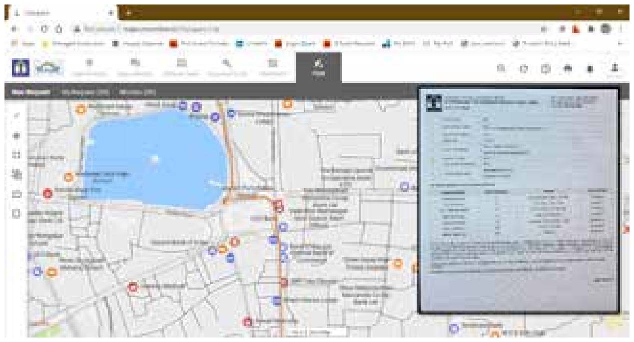


Figure 12: Tool for taking permission of field work

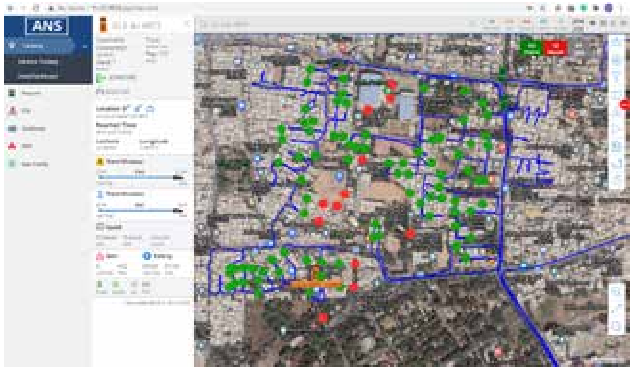


Figure 13: Tracking Movement and Pickup of Door-to-Door Vehicles

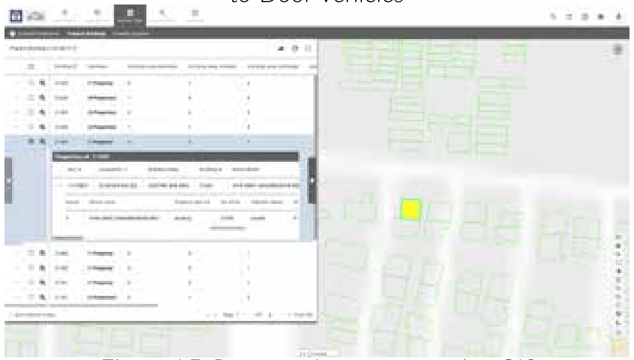
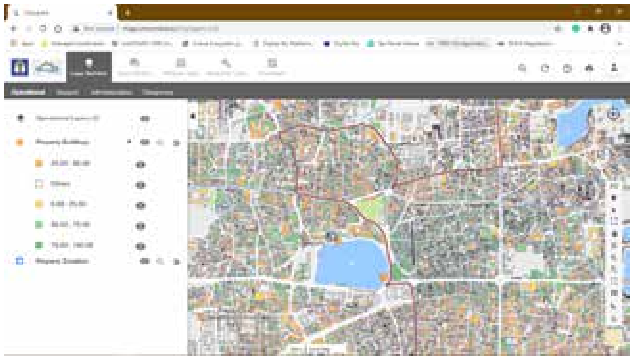


Figure 15: Property Assessment using GIS

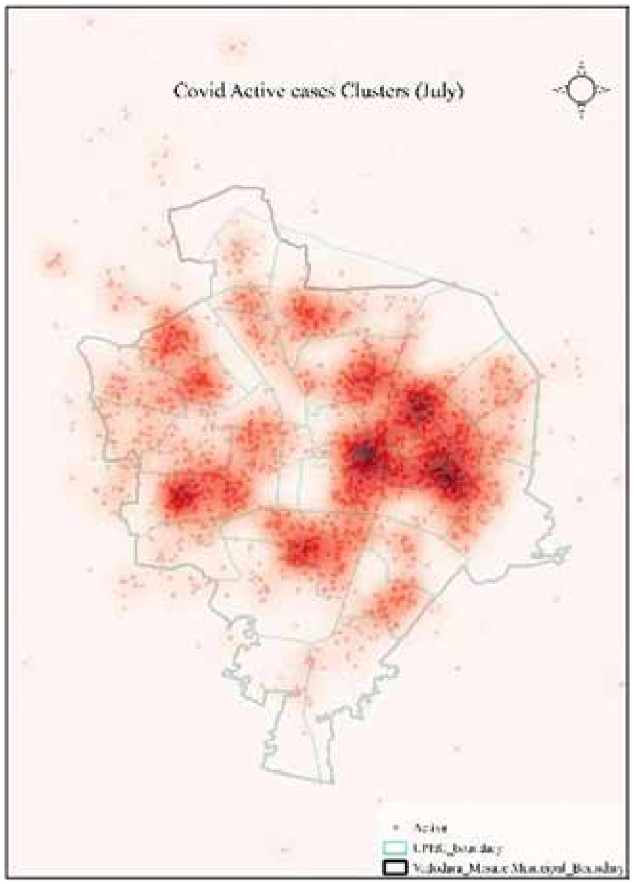


b. There were certain limitations with the technology used, e.g., awareness;
c. People's mindset to use online platforms; and
d. The gap in communication between officials and beneficiaries.

2.2.2 The Risks

a. rejection by the officials to continue the GIS program after looking just the abstract without checking its impact, which it has caused on site; and
b. As the project is based on a digital platform, there is a risk of data loss.

Figure 16: COVID-19 Case Locations Mapped on GIS (VMC Website)



Active Cases

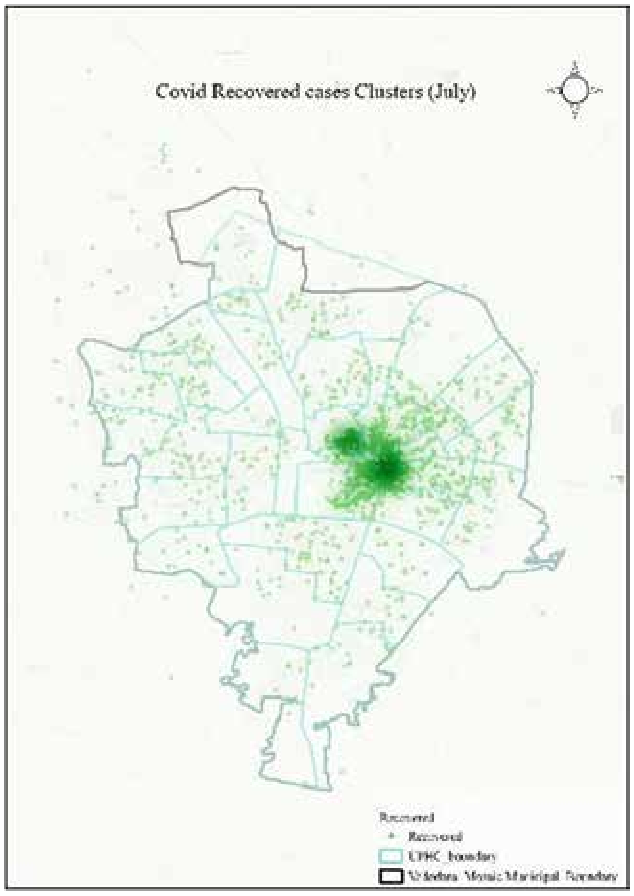
Figure 18: Hotspot of Active Cases

2.2.3 Features and Benefits (social, technical, city administration level, impact on the environment and economy) to the city (expected and observed)

a. Preventing haphazard digging, executing unified decisions across external agencies and departments;
b. Integration of GIS with a mobile application for citizen-centric services;
c. Door-to-door effective service without any extra cost;
d. COVID Mapping using property database and effective containment zonation;
e. Mapping AQI data, demarcation of flood-prone zones, and land surface temperature maps. Providing a synoptic view for the planner; and
f. Geo-enabled unique ID generation for households for future use of service provider companies (delivery).

2.2.4 Benefits

a. Plan, Dig & monitoring (PDM) tool is used by the various departments of VMC and different service providers. This will reduce the frequent road digging and unnecessary expenses to the VMC;
b. The garbage monitoring system provides accurate door-to-door garbage collection services; for this, more than 22000 routes are provided and monitored; and



Recovered Cases

Figure 17: Hotspot of Recovered Cases

c. Under the property survey and tagging project, more than 6.6 lakhs VMC properties have been surveyed and tagged under different categories.

2.2.5 The Impact

The possible impacts of using geospatial technology for good city governance are given in Table 01 & 02 (Annex One).

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

Key findings from the discussion with project officers Dr. Janak Joshi sir & Dr. Ashwini Mudaliar madam for the Smart Governance using Geospatial Technology project under Department of IT (VMC) are as follows:

GIS is used not only for data collecting but also as a tool in smart governance initiatives, Departments will get easier access to the data related to the projects for e.g.

- Plan, Dig, and Monitor (PDM) tool is also being created, which will be used by several VMC Departments, as well as external utilities and network service providers, to request for digging permission using GIS (NOC). This will limit the frequency and haphazardness of road digging and prevent VMC from incurring unnecessary costs.
- This GIS map monitors waste, and all of the layers are interconnected with other ICCC applications. The worker will not be able to give excuses as the routs are allotted to them with the help of GIS
- More than 6.6 lakh VMC properties have been surveyed and tagged as part of this initiative (Assessed); it will help in the identification of defaulters
- During the peak of the pandemic, the GIS team at ICCC, Vadodara, mapped all COVID cases–positive, recovered, and deaths–on a daily basis. The property database created during the property survey was used to geocode the cases.
- Using the case locations, a pattern showed the spread of the coronavirus in the city.
- COVID clusters were determined, and containment zones were created using the case location. The data from the Health Department was also used to map containment zones.
- Citizens can find the location of nearby hospitals in case of emergency
- CCTV cameras placed to identify hotspots around the city helps control traffic and other unwanted activities For, e.g., spitting, Breaking Signal, etc.
- Also, it identifies the areas which are illegally encroached on.
- Domestic animals are tagged and tracked to avoid accidents on roads.
- A citizens portal created for residents of Vadodara will be a local Google with maximum accuracy and information. Citizens can use the portal:
- To locate nearby toilets;
- To reserve a nearby facility. The citizen can also verify the facility's availability for the specified day, as well as one day before and after the selected date; and
- Citizens of Vadodara can register their complaints on this app regarding various issues, e.g., garbage, water supply, and street lighting.

Findings from the secondary data provided by the officials

- This map is prepared with the help of low-lying areas identified by the Fire Department. The map also depicts the existing water bodies in the city. From 2009 to 2019, Effect of Urbanization: Land Surface Temperature Maps was useful in studying the influence
- of urbanization on the local climate. Also useful for the GPCB's climate change assessment framework. Also crucial for climate-resilient city planning measures.
- Mapping Air Quality across Vadodara using ICCC environment sensors helps depict pollutant dispersion over the city as determined by Environment sensors set at various points throughout the city. The color RED is due to the industrial estate. Different pollutant distributions may be shown, and time-based analytics can be conducted effectively.
- Mobile GIS for People, integration with My Vadodara App (one app for facilitation, complaints, and information), giving citizens real-time tracking of dustbin locations and waste collection vehicles, and other citizen-centric utilities.

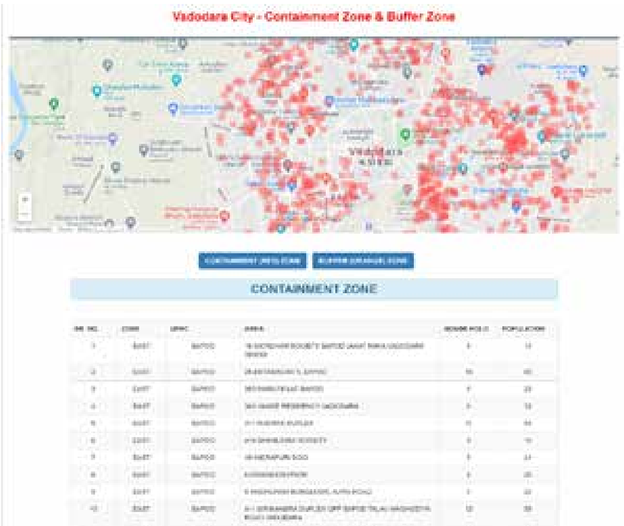


Figure 19 Contamination Zones and Buffer Zones

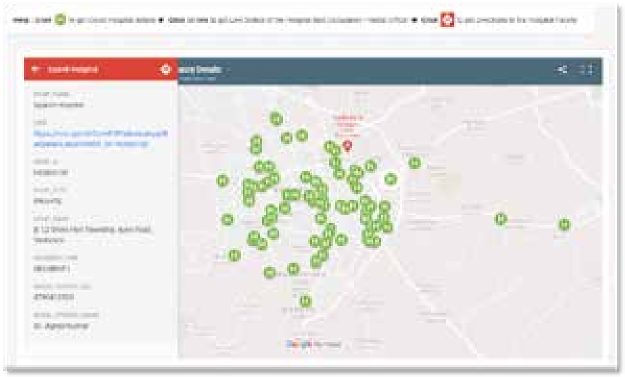


Figure 21: Location of nearby hospitals


Figure 25 Tagged Animals On road

Citizens can find VMC citizen services such as UPHC, Ward Office, Toilet, and Heritage locations on My Vadodara Mobile App

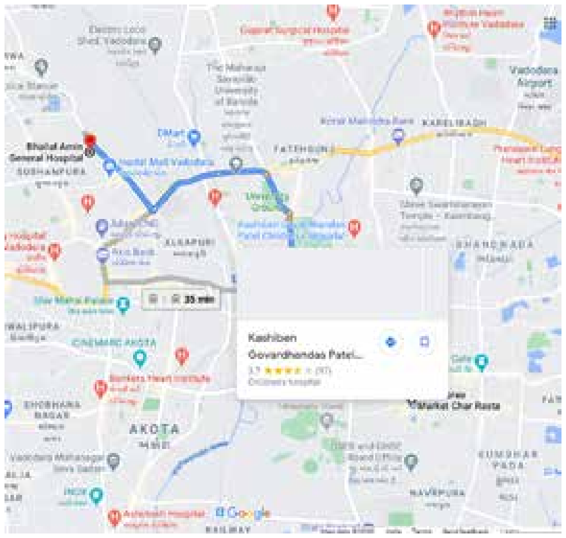


Figure 20: Directions to nearby hospitals


Figure 22: Spitting on road


Figure 23: Encroached vehicles on open plot


Figure 24 Tagged Animals on Road

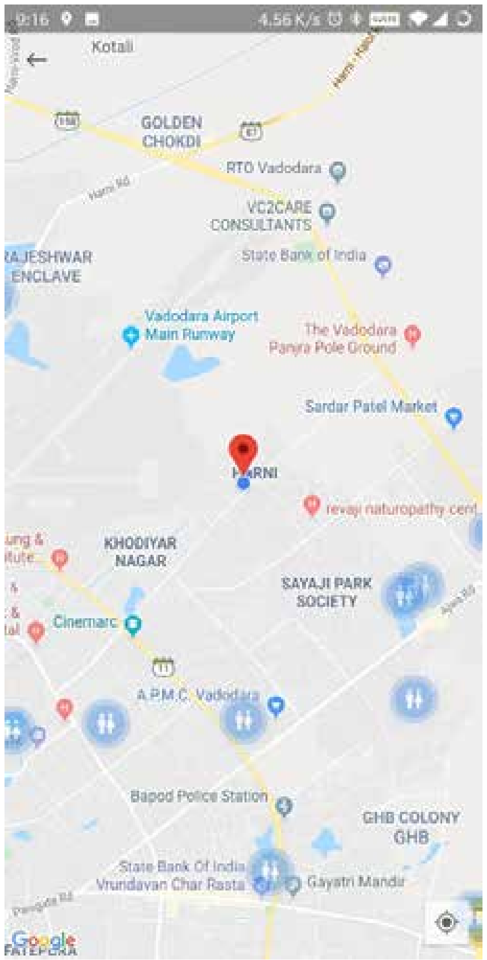


Figure 26: Location of Public Toilets

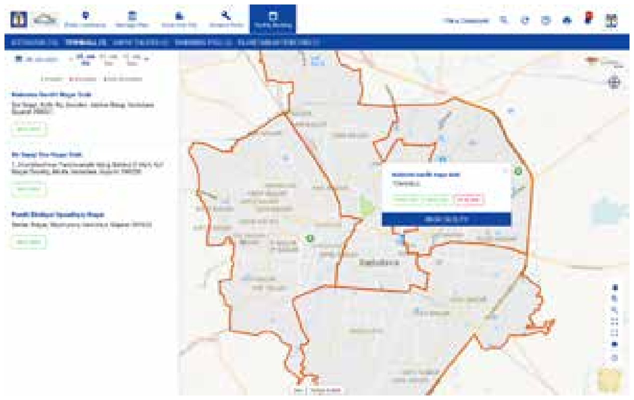


Figure 28: Water logging prone areas

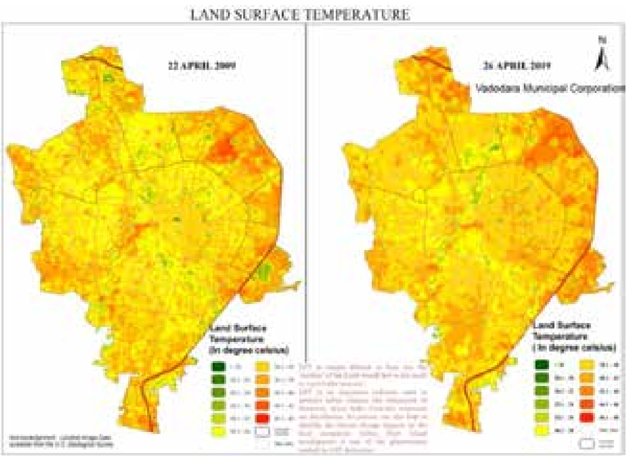


Figure 29: Land Surface Temperature

This single same app is also used to update the information by authentic registered users and used to update the facilities and information

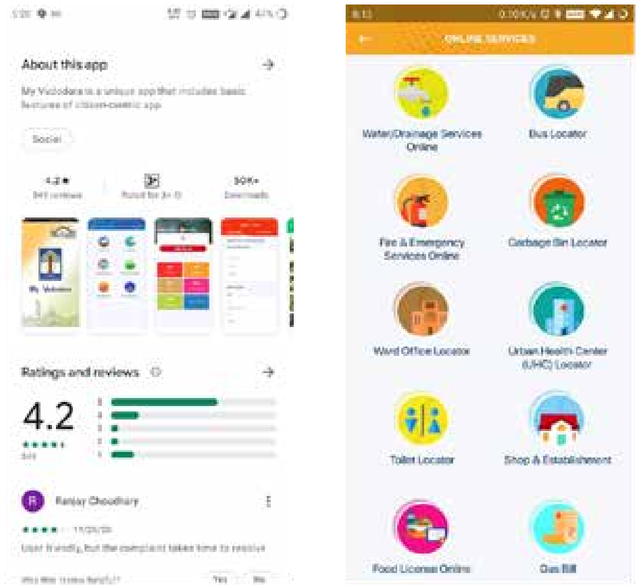
The Storm Water Department's in-house GIS team created a Field Data Collector module to find underground storm water manholes. This was achievable since manhole locations had already been mapped during the manhole layer digitization project and could be accessed and used by the appropriate department's field workers.

3. Inferences

3.1 *Implications (the impact assessment framework to be included here)*

The framework's implications and impacts have been investigated as per how the project has and will affect the governance as well as the lives of the citizens-

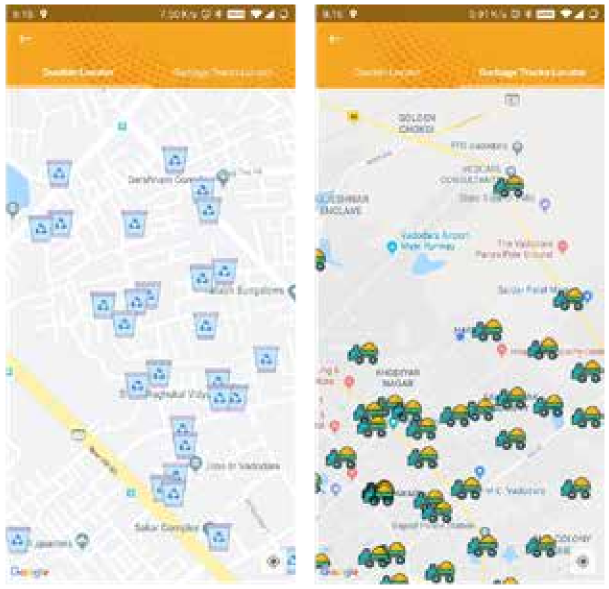
1. Tracking Movement and Pickup of Door-to-Door Garbage Vehicles-This tool has assisted officials in monitoring garbage trucks and assuring their proper arrival to citizens.
2. Property Assessment using GIS-This technique



My Vadodara Mobile App (Downloads and Reviews)

Citizen Services

Figure 31: Mobile Application



Dustbin Locator

Garbage Truck Locator

Figure 18: Hotspot of Active Cases

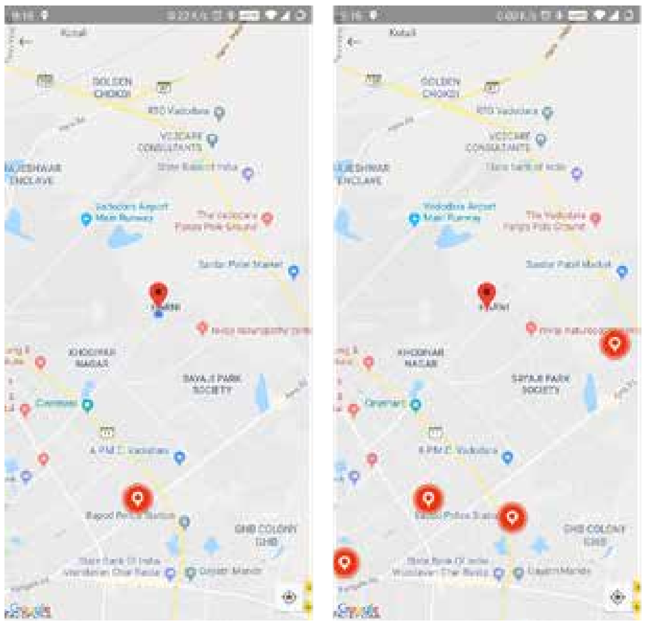


Figure 18: Hotspot of Active Cases

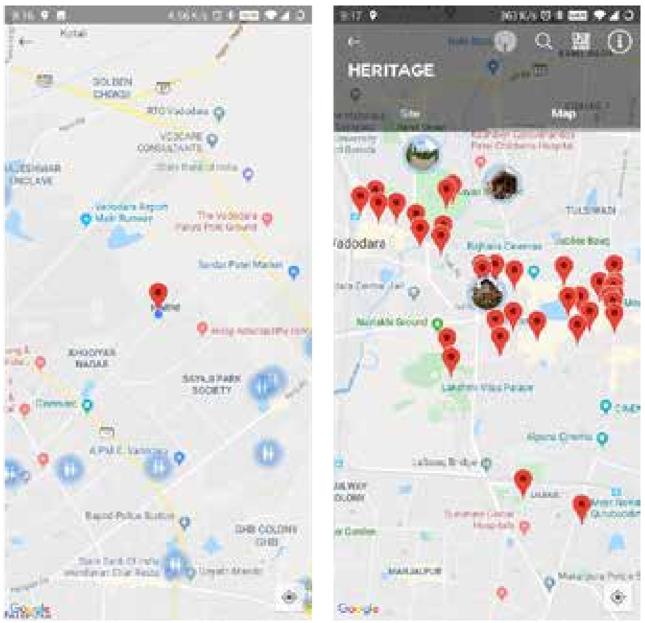


Figure 32: Locations in Mobile Application

has assisted the government in generating revenue through the collection of property taxes as well as keeping track of population growth.

3. Citizens' Portal-My Vadodara App acts as a communication medium for smooth functioning between citizens and government.
4. Use of GIS to map areas prone to Water Logging and flooding-The datasets are combined to identify locations that are likely to flood. It was helpful to have a solution for such spots and water logging prone areas, as reported in the field.
5. GIS to track COVID-19 spread across Vadodara over time-This mapping assisted in locating COVID clusters and defining containment zones. This aided officials in locating the most impacted locations and isolating disease propagation.
6. Installation of CCTV cameras across the city-The entire city is under CCTV monitoring, which aids in traffic control and other undesirable actions such as spitting, breaking traffic signals, and so on, therefore ensuring law and order. Domestic animal tagging has reduced the rate of night accidents to a much extent

3.2 Limitations of the research

This research is limited to the type of analysis, and such governance can be done in cities with less population and comparatively small areas.

Also, the whole governance structure was built on what VMC officials felt about the difficulties that people encounter, on a daily basis. Citizens' perspectives on their needs and input on the gaps they experience in the existing system are limited, indicating a lack of public engagement.

Certain data from the past, in the form of hand-drawn sheets, cannot be implemented on the GIS platform, which can aid in predictions and issue solving.

The citizen's portal is hosted on an internet platform that can only be accessed via a smart device. Its service is limited to individuals who face a barrier to using such gadgets.

This system has certain constraints for catering the population growth and development growth.

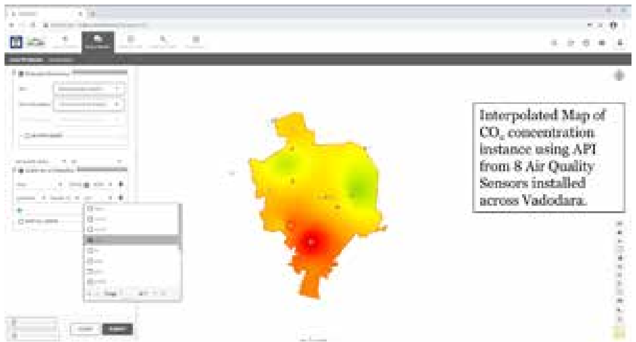
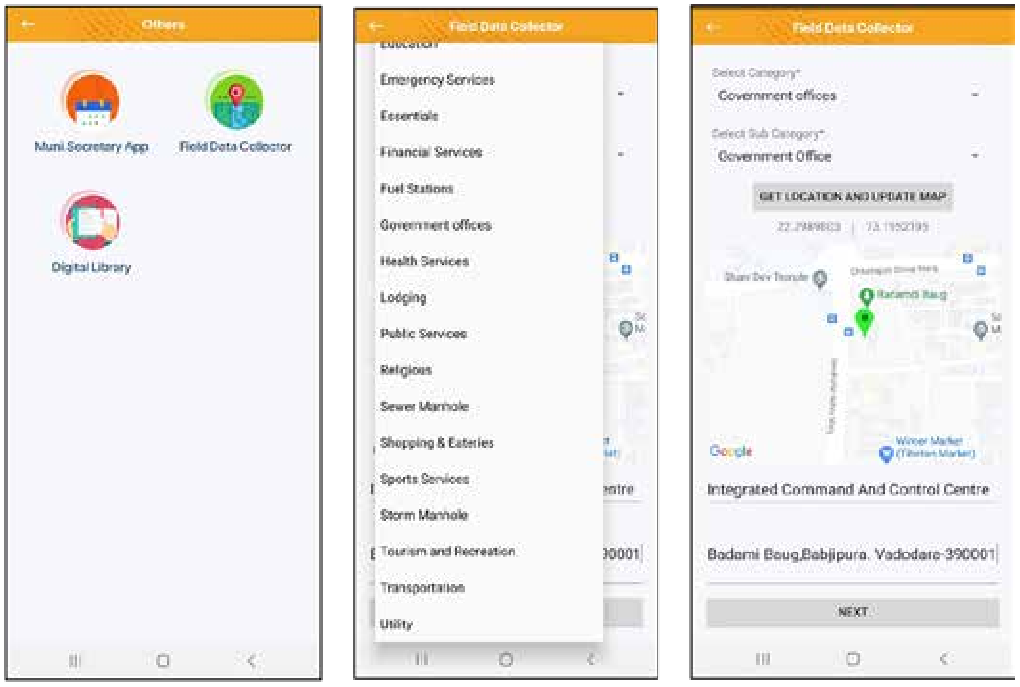


Figure 30: Interpolated Map of CO2 concentration

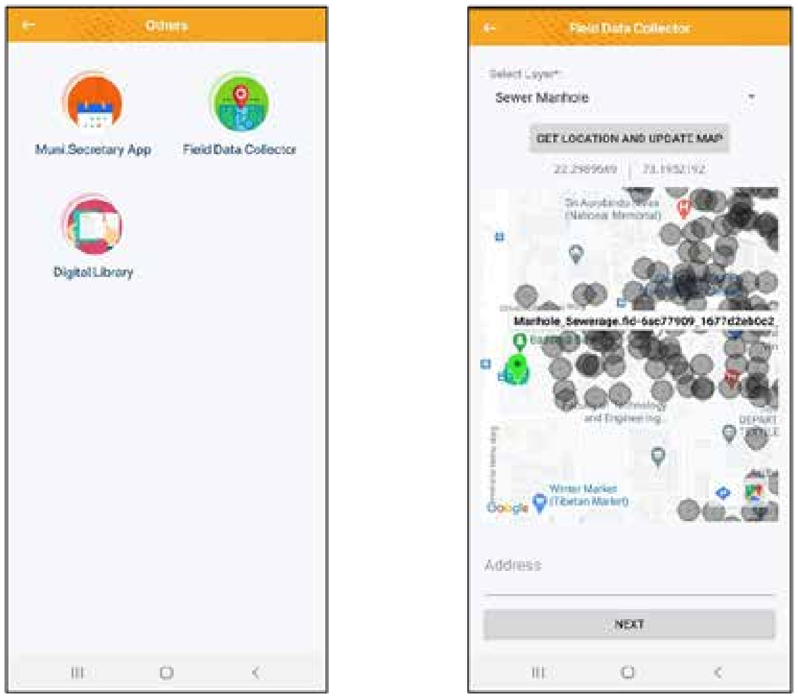
3.3 Key Learning

- Geospatial data not only reduces the data divide across departments but also facilitates intra- and inter-departmental collaboration;
- This initiative minimizes the time and expense of work done by departments while also increasing transparency;
- Geo-special data provides a centralized platform for all agencies to collaborate on and facilitates contact between authorities and beneficiaries; and
- Using the technology, innovative initiatives may be created and implemented inside smart cities, bringing the government one step closer to self-sufficiency.



Field Data Collector **Usage Location Identification**

Figure 33 Mobile Application



Field Data Collector **Manhole Location Identification for Storm Water Department**

Figure 34: Mobile Application

3.4R ecommendations

- Because so much work has been put into this project to provide a single platform for the volume of data, thorough maintenance and ongoing updating will benefit this project in the long run with efficient operation.
- The digital platform designed for various administrative departments and local residents is assisting them in resolving difficulties and complaints; thus, making this digital platform more user-friendly would encourage individuals to interact with authorities.
- People's participation and awareness of the platform will add value to the initiative.

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A26

Smart Roads in Walled City, Jaipur

Name of the project: *Smart Roads in Walled City*
Location: *Jaipur, Rajasthan*
Year of Project Implementation: *2019*
Sector: *Transportation*
SDG: *SDG 11 and SDG 11.2*
Project Cost: *145 Crore INR*

Institute: *Malaviya National Institute of Technology, Jaipur*
Advisors: *Dr. Nand Kumar, Dr. Bhavna Shrivastava, Dr. Pooja Nigam, Dr. Niruti Gupta , Sangeeth S Pillai*
Students: *Harshita Kaur, Sanjay Choudhary, Harneet Kaur, Vratika Ahlawat, Amil Kumar, Medhavi Chowdhary, Satyam Kumawat, Rhitwik Gupta, Shreshtha Sachdeva, Kshitiz Agarwal, Prerna Jasuja*

Keywords: *Smart Roads, Smart Mobility, Sustainable Transportation*

Abstract:

Jaipur, one of the renowned cities of India, has been selected and is developing as a Smart City. Growth in population, vehicle users and unregulated commercial activities inside the walled city have led to an increasing transformation of the urban fabric, resulting in demand for improved travel patterns, parking spaces, non-motorised vehicles and availability of multiple means of travel. The aim and focus of this project is on reimagining and adapting existing roads and their immediate environment to ensure that the promise of Smart mobility is delivered. Thus, a typical Smart Road will be cemented with concrete and equipped with intelligent parking sensors, data capture capabilities, responsive to changes in the environment, and most importantly, be well-connected. Roads will 'communicate' with cars, bicycles, traffic lights and even the city. The roads will be 'alive'. They will be well-equipped with amenities like footpaths for pedestrians, NMT zones, bus stands, street furniture, common utility ducts, Smart toilets, Water ATMs, Smart lights, signages and green spaces. These amenities have been assessed according to the existing condition of the roads after due consultation with the authorities, users and other stakeholders to highlight the real picture of the project so as to draw conclusions in the form of key lessons learnt and recommendations for further implementation.

Case Study: **A26**

1. Introduction

Streets in Indian cities are filled with magic, weaving stories through the interplay of people travelling through for travel, business and other activities, giving them a unique identity. Occupying approximately one-fifth of the total urban land area, streets are a city's most valuable urban asset. However, due to rapid urbanisation, economic development and growing wealth among households, India is at the crossroads of an ever-increasing demand for transportation and growth in the number of vehicles. This has made it critical for Indian cities to introduce sustainable mobility measures to ensure a safe, equitable and liveable future for its citizens.

Smart roads deals with four basic criteria:

- Self-awareness: The ability to monitor the road conditions (even traffic status) automatically and in real-time
- Information interaction: The ability to link intelligent devices to monitor roads and vehicles while connecting to a sensor network and databases within an intelligent communication system
- Self-adaptation: The ability to automatically adjust to various circumstances
- Energy harvesting: The ability to collect green energy from pavements, sub-grades and other infrastructure and supply to the Smart road system or other objects.

Smart Roads in Jaipur emphasise the need for creation of pedestrian-friendly infrastructure and promote walking and cycling as an integral part of urban development. This will help the Indian transport culture to be more sustainable while ensuring that citizens' reclaim their streets from the clutches of the cars. In the name of complete streets, the transformation aims to redesign the streets with high-quality footpaths, segregated cycle tracks, safe pedestrian crossings and regulated on-street parking. This basically means to improve accessibility for all the citizens, regardless of age, gender and physical ability.

1.1 Topic and Context

The Smart Cities Mission has emphasised the need to create pedestrian-friendly infrastructure and promote walking and cycling as an integral part of urban development. To achieve this, the 100 Smart Cities need to redesign and transform over 40,000 km of streets into complete streets by 2030.

The most significant work being undertaken under the Smart City Mission is the development of a 'Smart Road' in the walled city which includes features such as CCTV camera on every electric pole, Wi-Fi system, intelligent lights, environment monitoring system, information display system, charging points, dustbins with sensors and safe movement for pedestrians.

1.2 Significance of the Project

Jaipur is the tenth-largest metropolitan city in India and the capital of the largest Indian state of Rajasthan. The city has a glorious past due to which even today it is well-known throughout the world. Jaipur is one of the first planned cities of India. The walled city also serves as the Central Business District (CBD), hosts a dense concentration of tourist attractions and caters to almost 60% of the city's commercial activities. Since it is a part of 'The Golden Triangle' with Delhi and Agra, the city attracts foreign and domestic tourists in large numbers.

Factors such as growth in population, increase in the number of personal vehicles along with unregulated commercial activities inside the walled city has led to an increasing demand for travel patterns, parking spaces, non-motorised vehicles (to reduce pollution) and availability of multiple means of travel. Thus, the role of Smart Roads comes into play to bridge all the lacunas creating problems for the users and further affecting the functioning of the city.

1.3 Aim and Objectives

The goal for Smart mobility for Area-Based Development (ABD) is to improve pedestrian mobility by increasing the share of NMTs from 15% to 25% and ensuring 100% barrier-free access in the area by 2019. The Smart Roads project includes the construction of high-tech roads having Smart technology to facilitate the functioning of these roads.

The aim of the study is to understand the pros and cons of the project and to conclude various lessons and takeaways for further development.

The objectives of the study are:

- To understand the need and significance of the project.
- To understand the selection process.
- To collect valuable qualitative inputs from stakeholders and users.
- To assess the facilities provided.
- To understand the impact of the project on the users.

2. Contextual Background

Jaipur is known as one of the first planned cities of India based on the Prastara principles prescribed in the Shilpa-shastra or Vastu-shastra. Here the emphasis is given to the cardinal directions with a modified grid layout of 3x3 with main streets or paths being the grid lines. It is among the first two cities in India which have been identified as UNESCO World Heritage Cities.

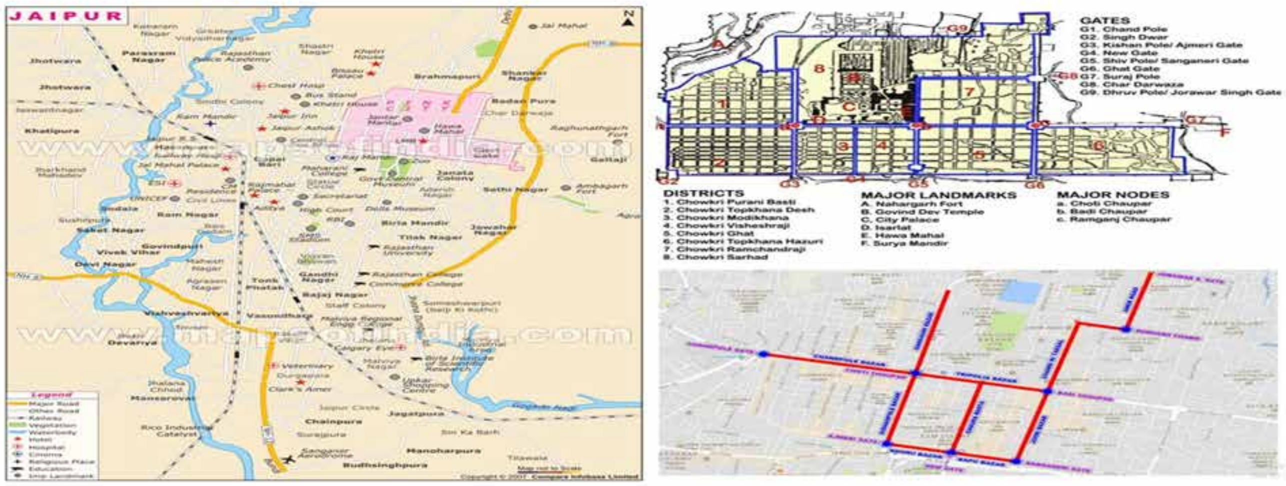


Figure-1: Location and Plan of Old City Jaipur

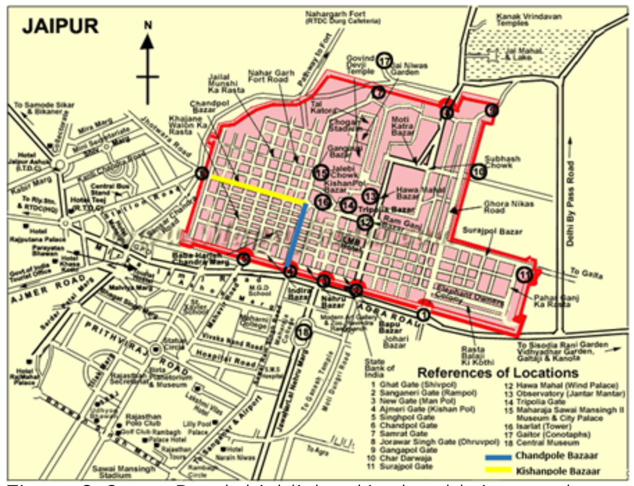


Figure-2: Smart Roads highlighted in the old city map layout depicting all intersections and main roads

The walled city continues to serve as the CBD of the area catering to approximately 60% of the city's commercial activity. It also hosts a dense concentration of tourist attractions and trade.

2.1 *Conceptual Framework/Research Design*

A specific methodology was adopted to objectively and quantitatively evaluate the impact of Smart Roads in Jaipur city. The methodology includes process mapping from selecting the roads in Old Jaipur, declaration of performance measures including utility ducting, user preference movement, etc.

Data has been collected from secondary sources such as the Detailed Project Report (DPR) of the Smart Road – ICT and various other sources. Along with secondary database, the information gathered from primary surveys and interviews was analysed to determine the situation of Smart Roads in Jaipur.

2.2 *Key features of the project*

Specific preferences have been given to frame the global concept of Smart Road. These are as follows:

- First preference to the physically disabled people.
- Second preference to pedestrians.
- Last preference to vehicles.

Utilities in Smart Roads are provided in such a way that for maintenance and laying of these in the future will not require dismantling the road and will not create any inconvenience to pedestrians or vehicles. Thus, the utilities are mostly placed under footpaths or in utility ducts.

Pedestrian Facilities

- Street Lights: Under Smart City Roads, Smart Lighting is provided based on data analytics. Their luminosity can be increased/decreased as per daylight and weather conditions. Lighting of alternate lights during low traffic density by Lighting Operations Management Software has also been provided for.
- Pedestrian Crossings: Under the Smart City Roads design, Pedestrian Crossings ensure uninterrupted and safe movement of physically disabled people and pedestrians.
- Bus Stands: Bus Stands under Smart City Roads provides multiple facilities to users like sitting areas, Wi-Fi hotspots, CCTV cameras, Navigation Screens, etc.
- Pedestrian Sit-outs: Multiple facilities like Pedestrian sit-outs and cycle parking are provided under the Smart City Roads to enhance the leisure of pedestrians.
- Pedestrian Footpaths: Under Smart City Roads, footpaths improve the quality of walkability of pedestrians. It provides smooth and safe movement with a number of pedestrian facilities.
- Dustbins: Dustbins are provided at regular intervals to ease the collection of waste.
- Smart Parking: This facility enables citizens with real-time information about available parking slots and allows them to book spaces in advance using mobile apps. The parking system will be integrated with a payment gateway facilitating payment by cash as well as other kinds of cashless modes.
- Landscaping and Art Structures: Under the Smart City Roads, Landscaping and Art & Sculptures are provided to improve the surrounding beauty of the footpaths & roads and make them visibly appealing.
- Smart Poles: Under the Smart City Roads, Smart Poles provide multiple facilities such as Wi-Fi Hotspots, CCTV Cameras, Charging Points, Displays etc.

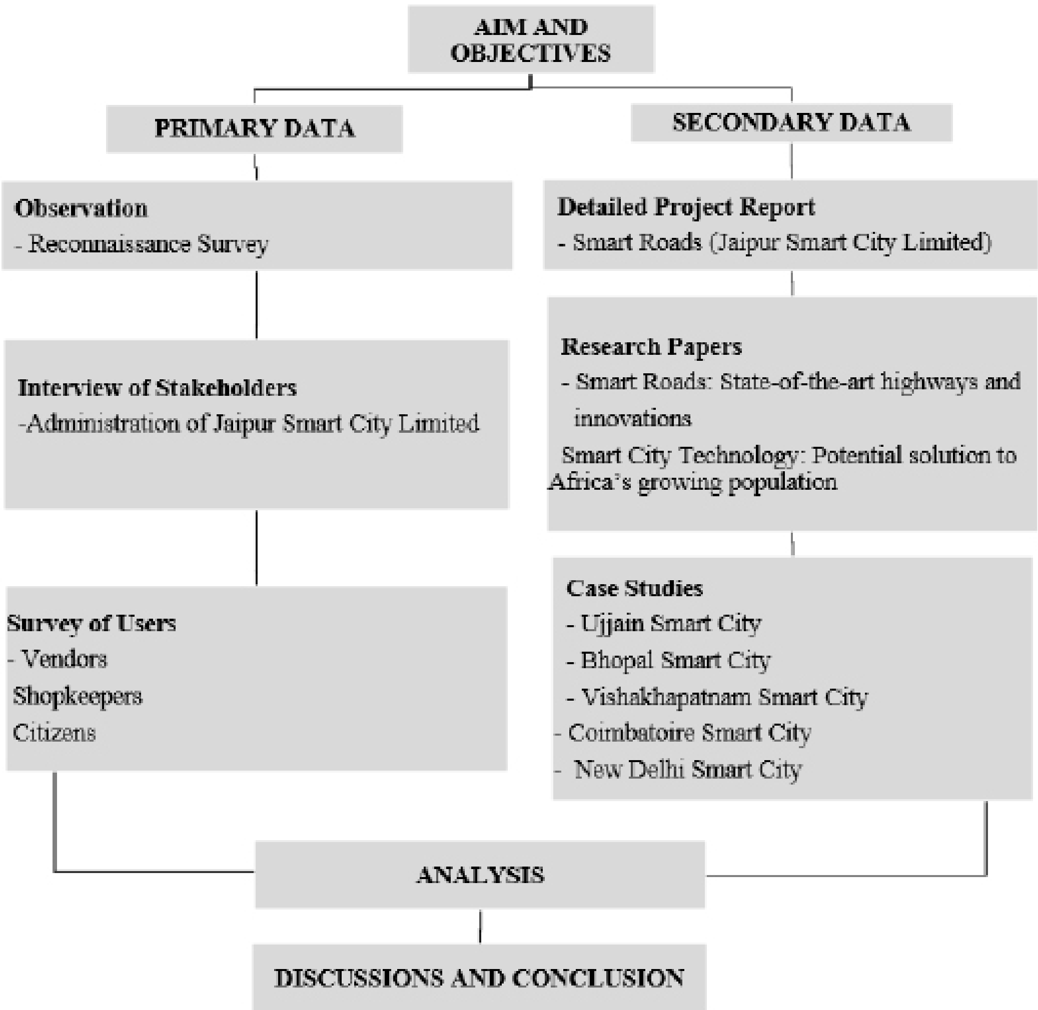


Figure-5: Methodology adopted for the research

Table 1: Proposed Smart Roads

S.No.	Name of Roads	Length (in m)
1.	Kishanpole Bazar	780
2.	Choura Rasta (New Gate to Choura Rasta)	825
3.	Johari Bazar (Sanganeri Gate to Badi Chopar)	780
4.	Tripolia Bazar (Choti Chopar to Badi Chopar)	750
5.	Gangori Bazar (Choti Chopar to Langer ke Balaji Road)	705
6.	Chandi Ki Taksal (Badi Chopar to Chandi ki Taksal Subash chowk)	990
7.	Nehru Bazar	383
8.	Bapu Bazar	384
9.	Chandpole Bazar	878
10.	Amer Road (Subhash Chowk to Jorawar Singh Gate)	598

Table 2: Proposed Junctions

S. No.	Name of Junctions	Area (in Sqm)
1.	Ajmeri Gate	2655
2.	Choti Choupar	10398
3.	Badi Choupar	10264
4.	Sanganeri Gate	2762
5.	Subhash Chowk	1700
6.	Chandpole Gate	3750
7.	New Gate	1514

2.2.1 *Challenges in the project*

- Inadequate and obsolete infrastructure facilities
- Lack of open spaces
- Traffic congestion
- Haphazard parking
- Lack of public awareness
- Lack of coordination and poor maintenance

2.2.2 ***Risks involved in the project***

- Abuse of buildings of historical or archaeological importance
- Encroachment by the informal sector
- Irregular solid waste collection and disposal
- A mix of conflicting non-conforming land use
- Poor dwellings and unhygienic conditions
- Environmental dispossession

2.2.3 ***Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)***

- Effective movement of NMT
- Surveillance provides real-time scenario of the roads
- Laying of utility ducts, improving feasibility
- Smart lighting and light poles as safer and sustainable lighting options
- Proper pedestrian crossings and footpaths

2.3 Key findings from interviews, surveys and primary/ secondary data collection

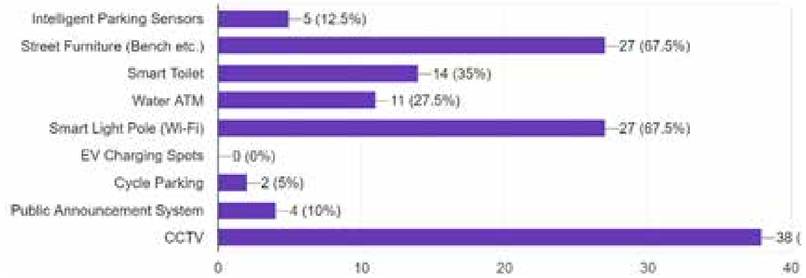
Interviews with key officials explained that the Smart Roads project was being implemented to modernise the market in the Pink City. Only two out of the eight identified roads had been completed by the Jaipur Smart City Limited (JSCL) since the project was not cost-effective. The project has been completed on the roads of Kishanpole and Chandpole markets while work is still under progress on the other roads. Various shopkeepers suggested, "We are in favor of constructing Smart Roads in the entire walled city, but the work should be completed on time. When the road in Chandpole market was being constructed we had to shut our shops for six months". Shopkeepers said that even after the Smart Road came into use, traffic congestion could still be seen. "Traffic jams were common when the roads were being constructed but even now, when the construction is over, there is no change, since the commuters are unable to see the specific markings. Moreover, the new rule is also not being enforced properly," said one of the shopkeepers. Conversations with locals suggest that "There are various benefits due to the Smart streets in the walled city like smooth functioning of the Non-motorized transport, provision of utility ducts, smart electric poles, drainage problem has been resolved and provision of Smart parking. There is no hindrance to pedestrian movement now, so overall the implementation of Smart streets in the walled city of Jaipur has been a good decision by the government."

A primary survey was conducted on two stretches: Ajmeri Gate to Choti-Chaupad and Choti-Chaupad to Chandpole with three categories of stakeholders - shopkeepers, vendors and citizens. As compared to the proposed facilities it was found that certain facilities were not present on-ground. This is summarised as follows:

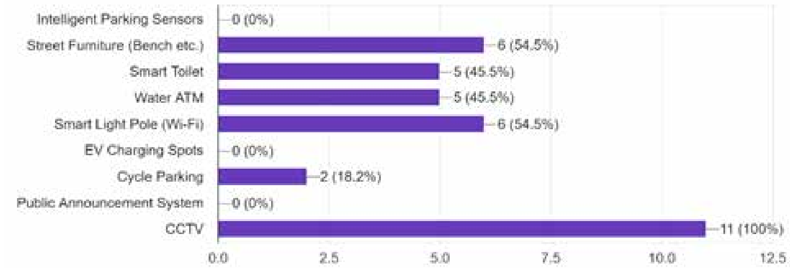
- Street Lighting: The streetlight poles were present and functional before the project initiation and presently as well.
- Pedestrian Crossings and Footpaths: The crossings and footpaths are present on both the stretches.
- Bus Stands: No bus stand is present or has been built under the project.
- Pedestrian Sit-outs: Sit-outs are not present at regular intervals on the Choti-Chaupad to Chandpole stretch, while on the Ajmeri Gate to Choti-Chaupad stretch, the sit-outs are majorly present only along one side of the road.
- Dustbins: There are no dustbins on both the stretches. However, shopkeepers have kept personal dustbins for their use. The electrical panels on the roads have been covered and are being used as dustbins by the people.
- Smart-Parking: Parking sensors are present on the Ajmeri Gate to Choti-Chaupad stretch but these could not be found on the Choti-Chaupad to Chandpole stretch. However, even those which are present are not functional so far. Proper signage has been provided for parking, but no one follows it. Also, no cycle parking spaces have been allocated on the stretch.
- Landscape and Art-Structures: Landscaping has been done around the trees but is not fully present on both the stretches. Also, there are no art structures on the roads.
- Smart-Poles: As per the project details, the Smart poles have Wi-Fi, EV charging points, speakers, CCTV cameras and environmental sensors but the speakers are not functional as found in the primary survey.

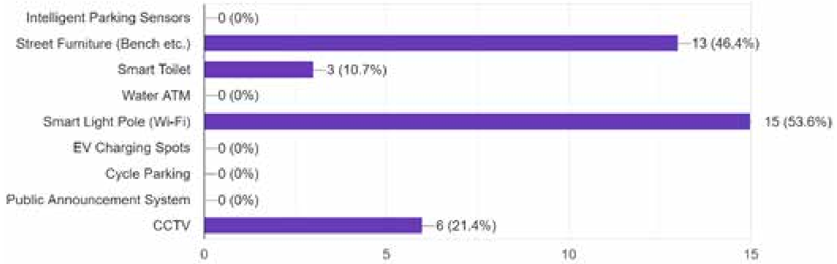
Figure-6: Street lights, Median over utility duct and Pedestrian crossing

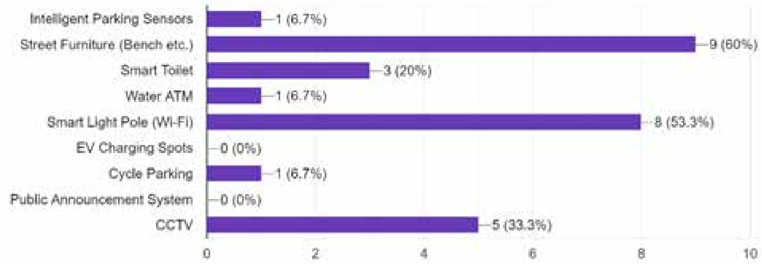
Figure-7: Pedestrian Walkways at Kishanpol Bazar Road

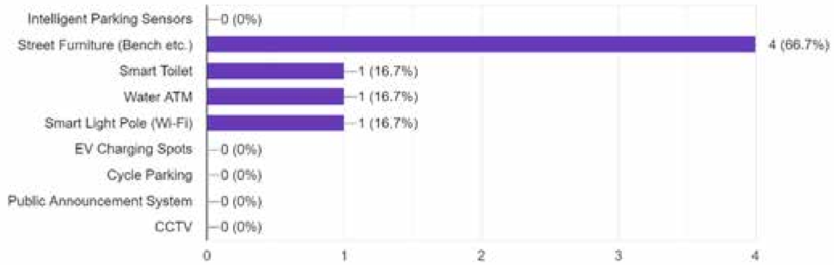
<table>
<tr><th>Focus Areas</th><th>Inferences</th><th></th></tr>
<tr><td>Awareness of features installed on both the roads</td><td>The primary survey revealed that the people were only aware of the common facilities: CCTV cameras, Wi-Fi and street furniture. At the same time, most of the features were unnoticed by the vendors, shopkeepers, and the citizens. These include intelligent parking sensors, EV charging spots, cycle parking and public announcement system. The Water ATMs and Smart toilet services have been proposed but have not yet been executed on-site.</td><td>


Survey findings as per responses from shopkeepers


Survey findings as per responses from citizens


Survey findings as per responses from vendors
</td></tr>
<tr><td>Features being used by the users</td><td>No user has availed any of the smart services apart from street furniture, Wi-Fi, and CCTV camera due to unawareness.</td><td>


Survey findings as per responses from shopkeepers


Survey findings as per responses from citizens


Survey findings as per responses from vendors
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<table>
<tr><th>Focus Areas</th><th>Inferences</th><th></th></tr>
<tr>
<td>Difficulties faced by the users while construction was going on.</td>
<td>The users faced many issues during construction which included traffic congestion, maintenance and cleanliness, parking and blockage of the stormwater drains. Shopkeepers faced a decreased footfall leading to reduced sales. Similarly, vendors had to relocate themselves till the work was fully implemented, which led to a loss of their regular customers.</td>
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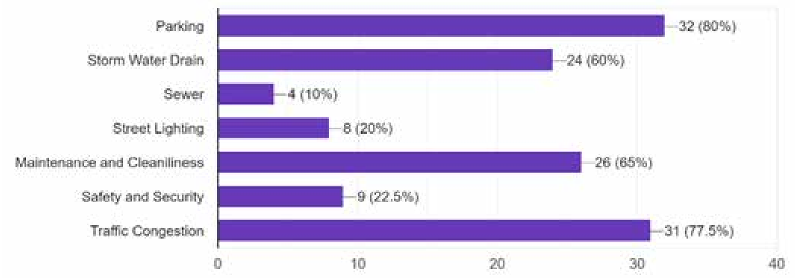
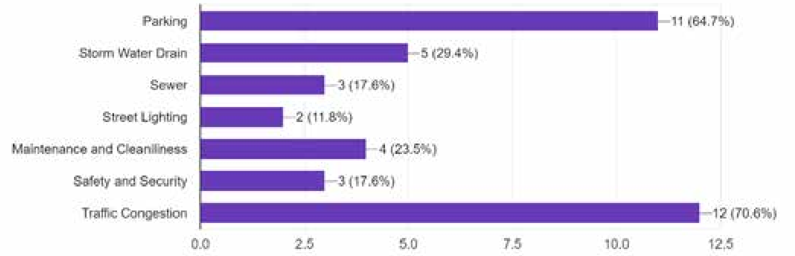


Survey finding as per responses from shopkeepers


Survey findings as per responses from citizens
</td>
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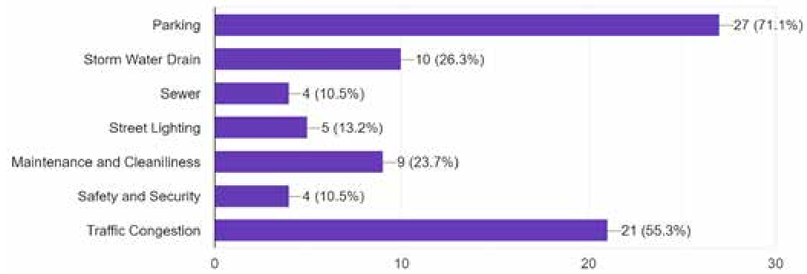
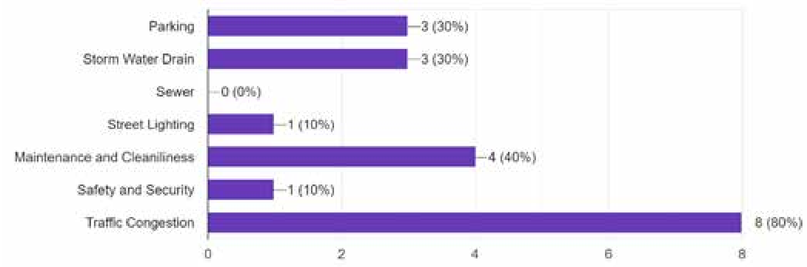
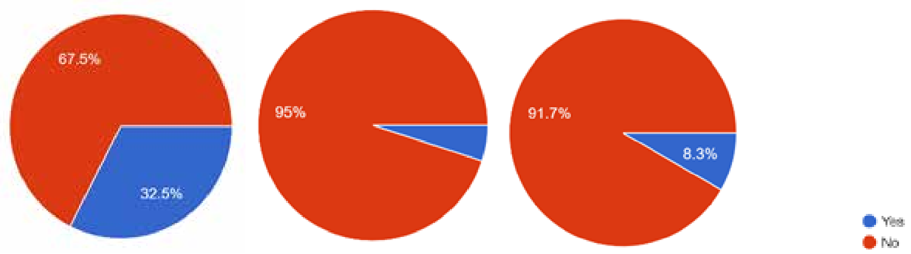
<tr>
<td>Difficulties after the completion of the project</td>
<td>These problems were majorly resolved as soon as the work was completed. As per the survey 65% of shopkeepers, 85% of citizens and 66% of vendors felt that the project was successful in improving the infrastructural facilities.</td>
<td>


urvey findings as per responses from shopkeepers


Survey findings as per responses from citizens


Survey findings as per responses from vendors
</td>
</tr>
<tr>
<td>Involvement in decision making</td>
<td>Majority of the users reported that they were not directly involved in the decision-making process. Although, the shopkeepers said they have a representative to address their problems.</td>
<td>


Survey findings as per the responses from shopkeepers, citizens, and vendors.
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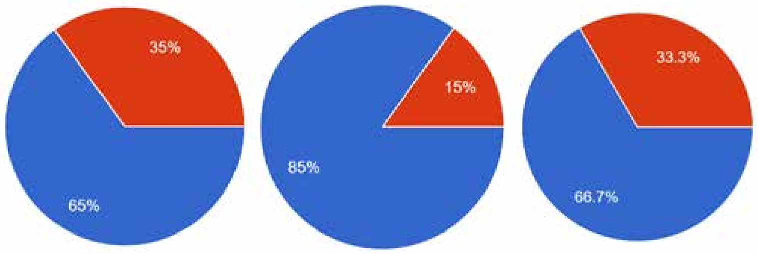
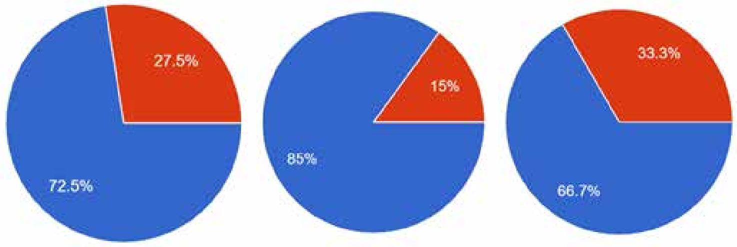
Focus Areas	Inferences	
Project has been successful in improving the infrastructure (Bhopal Smart city Limited).	The primary survey shows that the users found the project successful in improving the infrastructure as there has been an improvement in terms of the physical appearance of the roads and the addition of certain features.	 Survey findings as per the responses from shopkeepers, citizens, and vendors Yes No
Positive change after the Smart City initiative	Two-thirds of the users found positive changes after this Smart City initiative and felt the need for such projects in all marketplaces.	 Survey findings as per the responses from shopkeepers, citizens, and vendors. Yes No

Figure-10: Focus Areas, Inferences and Statistics for the Primary Survey
Source: Primary survey done (March, 2022)

Stretch Name	Landscape and Art Sculptures		Smart poles				
	Landscape	Art Sculptures	CCTV	Speakers	EV-Charging Module	Weather Sensors	Adaptive Lighting (Motion Sensors)
Ajmeri Gate to Choti-Chaupad	✓	×	✓	×	×	✓	✓
Chhoti Chaupad to Chandpole	×	×	✓	×	×	×	×

Stretch Name	Bus Stands	Wi-Fi Hotspots	Water ATMs	Navigation Screens	Smart Parking	Smart Toilets
Ajmeri Gate to Choti-Chaupad	×	✓	✓	×	✓	✓
Chhoti Chaupad to Chandpole	×	×	✓	×	×	×

Stretch Name	Utility Ducts	Pedestrian Facilities			Street Furniture	
		Street Lights	Pedestrian Crossing	Footpaths	Sit-outs	Dustbins
Ajmeri Gate to Choti-Chaupad	✓	✓	✓	✓	✓	×
Chhoti Chaupad to Chandpole	✓	✓	✓	×	✓	×

Figure-8: Check List for various facilities on Smart roads

Figure-9: Images clicked at the Stakeholder meeting with Jaipur Smart City Ltd

3. Discussion and Conclusion

The Smart Roads project for the Area-Based Development (ABD) in the walled city of Jaipur has not been cost-effective until now as it has been implemented in only two out of the eight proposed roads. As of now, Rs 45 crore has been spent out of the Rs 145 crore that has been allocated. So, there is a need to rethink the proper implementation of the project. There are various benefits due to the construction of Smart roads in the walled city like the effective movement of non-motorised transport, surveillance due to CCTV cameras installed on the roads, laying of under utility ducts, Smart lighting, Smart parking, proper pedestrian crossings and footpaths, Smart light poles, dustbins and various other facilities for the citizens to improve their quality of life.

To ease the life of citizens, Smart Cities have been evolving and progressing into large-scale, urban expansion projects making technology an integral part of the city's ecosystem. As technology advances, the concept of a Smart City also evolves from merely incorporating technology to becoming futuristic demonstrations of cutting-edge technology. The vision behind India's Smart Cities is building a green, sustainable and resilient infrastructure. In other words, what India is building today, the world will follow tomorrow.

3.1 Implications

The project has been assessed through a framework analysis of primary and secondary data to draw conclusions and recommendations for further proposals.

The city's initiation of the Smart Roads project has positively affected the people's lives. There has been improvement in the cleanliness of the roads since the utility ducts have been placed underground in the median of the road. Smart features like Wi-Fi, street cameras, water ATMs, Smart toilets, environmental sensors and Smart lights have led to ease of living. Although there has been a specific gap in implementing some features like parking sensors as they are not yet functional and are still in the initial phase.

3.2 Limitations of the research

The Detailed Project Report (DPR) for Smart Roads-ICT has specified various ideologies and visions for civil works and Smart initiatives. Still, somehow it lacks in comprehending the actual work as only construction drawings can be seen for the various works but they have not yet been implemented. The Smart Roads has been a popular Smart City project in Jaipur, but reliable sources for its assessment have been a limitation in the research as there is no post-impact or maintenance report for the same.

Regardless of the government's Smart City initiatives, there is a significant lag due to unawareness among the people, which is one of the major drawbacks of the project.

3.3 Key lessons learned

Jaipur has a specific city dynamic to itself, with the walled city being the center of attraction, so choosing a suitable site for the implementation of the Smart Roads project became a priority to boost the functionality of the roads. To prevent disputes by the stakeholders involved in the Smart Roads, proper participation was needed from the authorities to acknowledge their challenges to ensure optimal project performance. The construction and user aspect of the project seemed to overlap, which eventually caused obstacles in the timely completion of the project.

Public participation must be encouraged as it contributes to better decision-making and provides them the opportunity to influence decisions that affect their livelihood.

3.4 Recommendations

The Smart Roads-ICT has been a significant project for developing Jaipur as a Smart City and its impact has been multi-dimensional. On one hand, there have been many disparities, issues and challenges in the implementation and completion of the project, while on the other hand, it's been a great initiative towards Smart road infrastructure as evident by the before and after scenarios. This can be analysed in the case of utility ducting and also can be seen as a pilot project for various walled and old cities of the country.

The construction and user preferences should be handled differently to develop optimal functional proposals. The use of technology and database generated should be made available to various authorities and stakeholders engaged in the governance of the Smart City. Awareness should be created among the citizens to follow specific guidelines while using the Smart Roads to encourage them to use offsite parking spaces and increase mobility through non-motorised and pedestrian movement. Proper financing and audit should be maintained to keep transparency between the regulating authorities and the project users.

After the survey, it was concluded that the vendors have been issued Smart cards but are still fined for standing on the road. Therefore, a proper government-authorised zone should be allocated for their benefit, which will help reduce the load on existing roads. Also, during the execution of the project, the shopkeepers faced decreased footfall due to the inconvenience caused by the construction work. This could have been avoided either by continuing the work in smaller patches or by providing an alternative place for their shops while the work was in progress.

Cycle track should be present between the pedestrian and the parking areas while currently it is present between the parking and the carriageway. The street furniture should be at regular intervals on all the roads with proper signages but presently, there are no dustbins, leading people to throw waste on the road, causing unhygienic conditions and collection of garbage at various places.

The department involved in maintenance should be vigilant towards the functioning of the roads and remove roadblocks to maintain harmony between various user groups such as street shop owners, NMT vehicle owners, other vehicle owners and pedestrians. There should be proper financing and regular audit to maintain transparency between the regulating authorities and the users.

The Smart Roads project should be a learning lesson for a smarter city which can also be applicable to other similar cities.

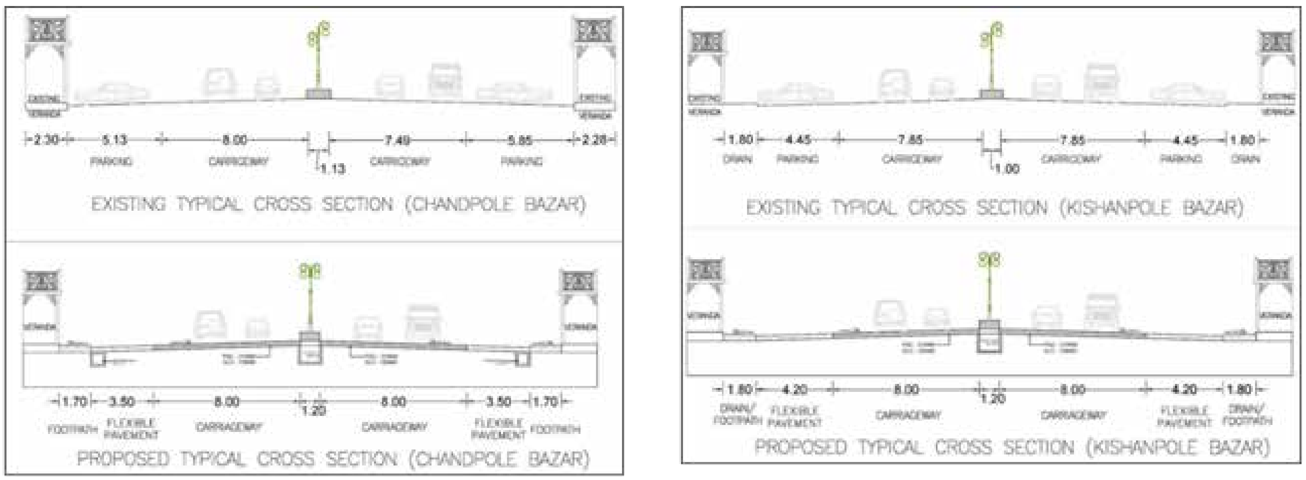


Figure-11: Cross-Sections of the Roads Prior and Post-construction

References

1. Bhopal Smart City Limited. (n.d.).
2. Coimbatore Smart City Limited. (n.d.).
3. Echendu, A. J., & Okafor, P. C. (2021). Smart City Technology : a potential solution to Africa's growing population and rapid Urbanisation . Development Studies Research , 13.
4. Jaipur Smart City Limited. (2017). DPR on Jaipur Smart Streets. Jaipur Smart City Limited;, Jaipur. Retrieved 2021
5. New Delhi Smart City Limited . (n.d.).
6. Pompigna, A., & Mauro, R. (2021). Smart Roads: A state of Highways innovations in the Smart Age . Elevier , 15 .
7. Ujjain Smart City Limited. (n.d.).
8. Vishakhapatnam Smart City LImited . (n.d.).

Annexures

Survey Area

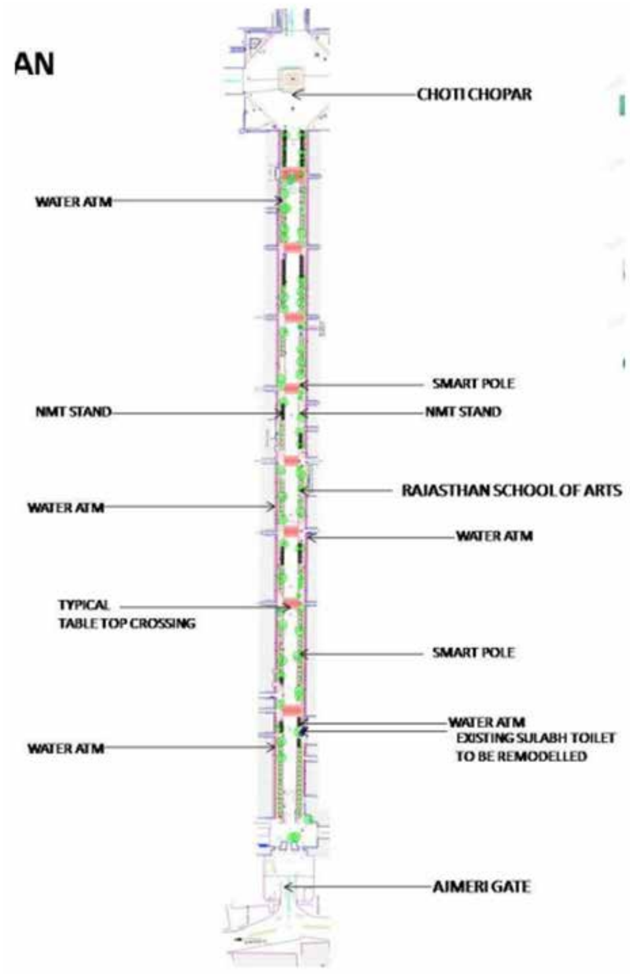
Kishanpole Bazar: From Chandpole Gate to Choti Chaupad: 780m
Chandpole Bazar: From Choti Chaupad to Ajmeri Gate: 878m

Typical Smart Road Characteristics (DPR)

- Intelligent Parking Sensors
- Data capture capabilities
- Responsive Environment
- Communicate with various modes of transport
- Separate lanes for footpath and NMT
    - o Bus Stands
    - o Street Furniture
    - o Common Utility Duct
    - o Smart Toilets
    - o Water ATMs
    - o Smart Light Poles
    - o Signages
    - o Green Spaces

1. Utilities (Ducts)
2. Pedestrian Facilities
    - o Street Lighting
    - o Pedestrian Crossing
    - o Footpaths
    - o Bus Stands
        - Wi-Fi Hotspots
        - CCTV Cameras
        - Navigation Screens
    - o Pedestrian Sit-Outs
        - Cycle Parking
    - o Dustbins
    - o Smart Parking
    - o Landscaping and Art Sculptures
    - o Smart Poles
        - CCTV Cameras
        - CO2 Sensors
        - EV-Charging module
        - Weather sensors
        - Adaptive Lighting (Motion Sensors)
        - Announcements

Sections and Layout to be Cross-Checked



STAKEHOLDER QUESTIONNAIRE

Regarding Smart Roads Project and DPR

1. What were the criteria for selecting Smart Roads in Jaipur?
2. Which major bodies are involved in the proposal, implementation, construction and regulation of Smart Roads?
3. What were the project case studies other than Karnataka Smart Roads (mentioned in DPR)?
4. Was there any pilot project considered before initiation of the project?
5. Who were the major professionals involved in the making of the DPR for Smart Roads? (Engineers, Planners, Architects, etc.)
6. What was the methodology adopted for the proposals and implementation of Smart Roads?
7. Are there any street-specific proposals after various surveys (Not mentioned in DPR)?

Regarding Facilities of Smart Roads

1. Who looks after the functioning of various facilities/incharge of execution and inspection?
2. DPR explains various facilities like:
    - Street Lighting: Lighting Operation Management Software?
    - Are there any software experts working on the same? Who is part of the management?
    - Smart Parking with the help of mobile apps: Which apps are being used?
3. Are Smart Roads planned to be environmentally responsive? What environment responsive methods have been taken?
4. Which is the maintenance model for Smart Roads?
5. How many facilities have been provided on the constructed roads?

Post-Implementation/Post-Impact

1. Various challenges faced in the implementation of the project are:
    - Approvals (Traffic Police etc)
    - Citizen denials
2. What were the challenges faced while completing the project within the given time period?
3. What were the risks involved with the project?
4. What were the financial roadblocks of the project?
5. Is there any chance of completing the project for other roads? What is the time period? If not, then why?
6. How do you think the project can be more cost-effective?
7. What are your suggestions or recommendations for this project?

SHOPKEEPERS QUESTIONNAIRE

Name:
Shop No.:
Stretch Name:

- o Chandpole to Chhoti Chaupad
- o Chhoti Chaupad to Ajmeri Gate Residence Area/ Stretch:
- o Walled City
- o Outside Walled City

Q1. Are you aware of the initiative taken by the government for the Smart Roads Project?

O Yes O No

Q2. What is your mode of travel, and where do you park?

		Parking Location (If Applicable)
By Foot		
Private Car		
Private 2-Wheeler		
Cycle		
Public Transport		
Private Taxi/ Cab		

Q3. Are you aware of the Smart features installed during the project?

Features	Are you aware?		Do you use them?	
Intelligent Parking Sensors	Yes	No	Yes	No
Street Furniture (Benches, etc)	Yes	No	Yes	No
Smart Toilets	Yes	No	Yes	No
Water ATMs	Yes	No	Yes	No
Smart Light Pole (Wi-Fi)	Yes	No	Yes	No
EV Charging Spots	Yes	No	Yes	No
Cycle Parking	Yes	No	Yes	No
Public Announcement System	Yes	No	Yes	No
CCTV Cameras	Yes	No	Yes	No

Q4. Did you face any problems during the execution of the project?
O Yes O No
Comments: ____________________

Q5. Have those problems been resolved now?
O Yes O No
Comments: ____________________

Q6. What were the difficulties faced by you before and after the project was taken up?

Difficulties	Before the project	After the project	Comments
Parking	Yes No	Yes No	
Storm Water Drain	Yes No	Yes No	
Sewer	Yes No	Yes No	
Street Lighting	Yes No	Yes No	
Maintenance and Cleanliness	Yes No	Yes No	
Safety and Security	Yes No	Yes No	
Traffic Congestion	Yes No	Yes No	Time:

Q7. Were you involved in the suggestion/decision-making of this project?
O Yes O No
Q8. In your opinion, has this project been successful in improving the infrastructure facilities?
O Yes O No
Comments: ____________________

Q9. Did you find any positive change after this Smart City initiative?
O Yes O No
Comments: ____________________

Q10. In which other areas should this type of project be incorporated?
____

VENDORS QUESTIONNAIRE

Name:
Stretch Name:
- o Chandpole to Chhoti Chaupad
- o Chhoti Chaupad to Ajmeri Gate
- o Residence Area/Stretch: Walled City
- o Outside Walled City

Q1. Is it blocking the pedestrian way (Observation)?
O Yes O No
Q2. Have you taken permission from the Government to establish the kiosk?
O Yes O No
Q3. Do you always stand at this location?
O Yes O No
If No.: Distance between the various locations:
____
Q4. Do you pay for using this location:
O Yes O No
If Yes, to whom:
O Private O Government
Q5. Do you know of any Official Vending Locations in the area:
O Yes O No
Q6. Are you aware of the initiative taken by the government for the Smart Road Project?
O Yes O No

Q7. Are you aware of the Smart features installed during the project?

Features	Are you aware?		Do you use them?	
Intelligent Parking Sensors	Yes	No	Yes	No
Street Furniture (Benches)	Yes	No	Yes	No
Smart Toilets	Yes	No	Yes	No
Water ATMs	Yes	No	Yes	No
Smart Light Pole (Cameras, Wi-Fi)	Yes	No	Yes	No
EV Charging Spots	Yes	No	Yes	No
Cycle Parking	Yes	No	Yes	No
Public Announcement System	Yes	No	Yes	No
CCTV Cameras	Yes	No	Yes	No

Q8. What were the difficulties faced by you before and after the project was taken up?

Difficulties	Before the project	After the project	Comments
Parking	Yes No	Yes No	
Storm Water Drain	Yes No	Yes No	
Sewer	Yes No	Yes No	
Street Lighting	Yes No	Yes No	
Maintenance and Cleanliness	Yes No	Yes No	
Safety and Security	Yes No	Yes No	
Traffic Congestion	Yes No	Yes No	Time:

Q9. Did you face any problems during the execution of the project?
O Yes O No
Comments (Where did you stand during that time?): ___
____

Q10. Have those problems been resolved now?
O Yes O No
Comments: ____________________

Q11. Were you involved in the suggestion/decision-making of this project?
O Yes O No

Q12. In your opinion, has this project been successful in improving the infrastructure facilities?
O Yes O No
Comments: ____________________

Q13. Did you find any positive change after this Smart City initiative?
O Yes O No
Comments: ____________________

Q14. In which other areas should this type of project be incorporated? ____________________

CITIZENS QUESTIONNAIRE

Name: ____________________

Age:
- o 15-35
- o 35-65
- o 65+

Stretch Name:
- o Chandpole to Chhoti Chaupad
- o Chhoti Chaupad to Ajmeri Gate Local
- o Tourist
- o Residence Area/Stretch:
- o Walled City
- o Outside Walled City

Q1. How often do you visit the place?
- o Once a day
- o Once a week
- o Multiple times a week
- o Once a Month

Q2. Are you aware of the initiative taken by the government for the Smart Roads Project?
O Yes O No

Q3. What is your mode of travel, and where do you park?

		Parking Location (If Applicable)
By Foot		
Private Car		
Private 2-Wheeler		
Cycle		
Public Transport		
Private Taxi/ Cab		

Q4. Are you aware of the Smart features installed during the project?

Features	Are you aware?		Do you use them?	
Intelligent Parking Sensors	Yes	No	Yes	No
Street Furniture (Benches, etc)	Yes	No	Yes	No
Smart Toilets	Yes	No	Yes	No
Water ATMs	Yes	No	Yes	No
Smart Light Pole (Wi-Fi)	Yes	No	Yes	No
EV Charging Spots	Yes	No	Yes	No
Cycle Parking	Yes	No	Yes	No
Public Announcement System	Yes	No	Yes	No
CCTV Cameras	Yes	No	Yes	No

Q5. What were the difficulties faced by you before and after the project was taken up?

Difficulties	Before the project	After the project	Comments
Parking	Yes No	Yes No	
Storm Water Drain	Yes No	Yes No	
Sewer	Yes No	Yes No	
Street Lighting	Yes No	Yes No	
Maintenance and Cleanliness	Yes No	Yes No	
Safety and Security	Yes No	Yes No	
Traffic Congestion	Yes No	Yes No	Time:

Q6. Did you face any problems during the execution of the project?
O Yes O No
Comments: ____________________

Q7. Have those problems been resolved now?
O Yes O No

Q8. Were you involved in the suggestion/decision-making of this project?
O Yes O No

Q9. In your opinion, has this project been successful in improving the infrastructure facilities?
O Yes O No
Comments: ____________________

Q10. Did you find any positive change after this Smart City initiative?
O Yes O No
Comments: ____________________

Q11. In which other areas should this type of project be incorporated?
Comments: ____________________

1.Shopkeepers Survey Analysis: 40 respondents

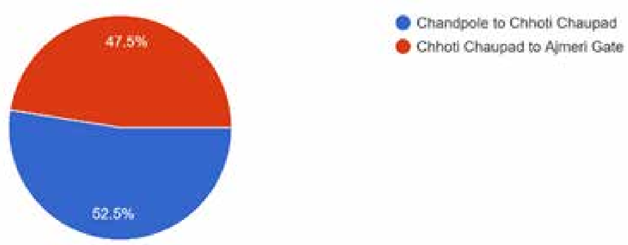


Chart 1: Stretch Name

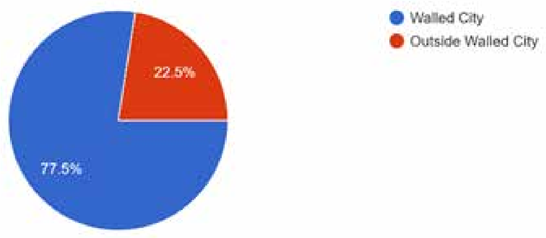


Chart 2: Residential area

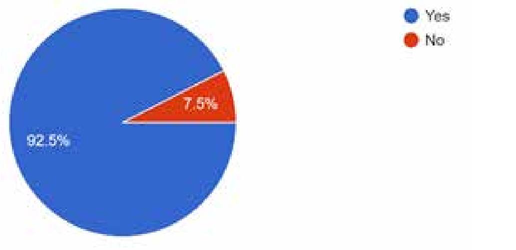


Chart 3: Awareness of Smart Road initiative

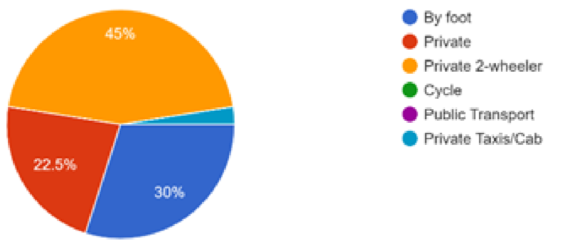


Chart 4: Mode of Travel

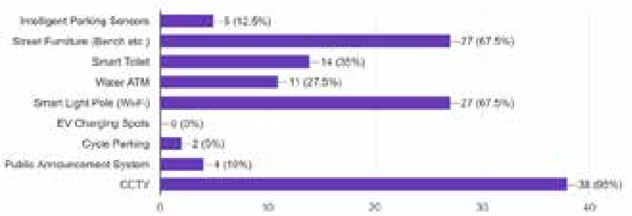


Chart 5: Aware of the Smart features installed

Chart 6: Smart features used

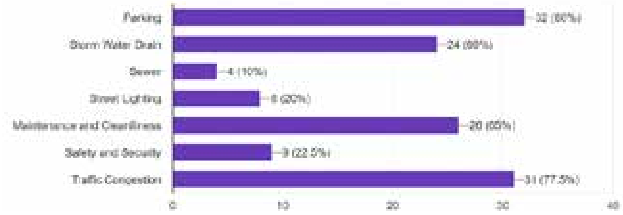


Chart 7: Problems faced before the project was taken up

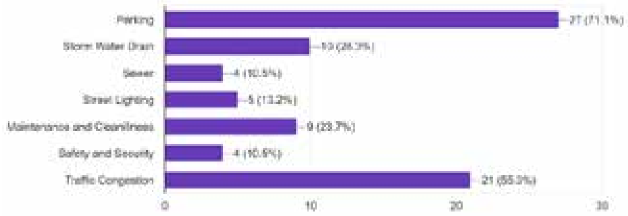


Chart 8: Problems faced after completion of project

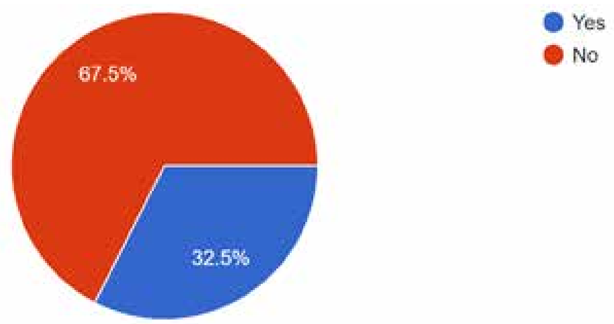


Chart 9: Involved in decision-making

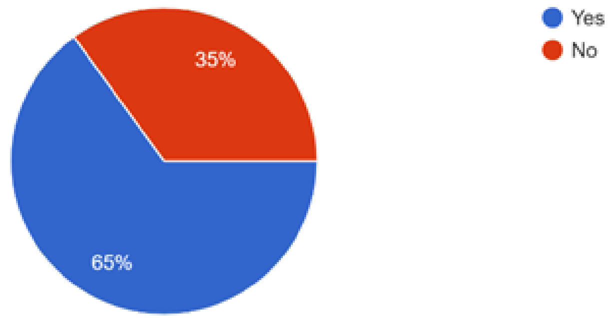


Chart 10: The success percentage of the project

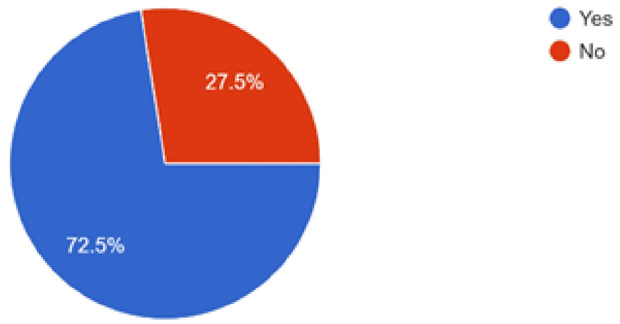


Chart 11: Positive change percentage

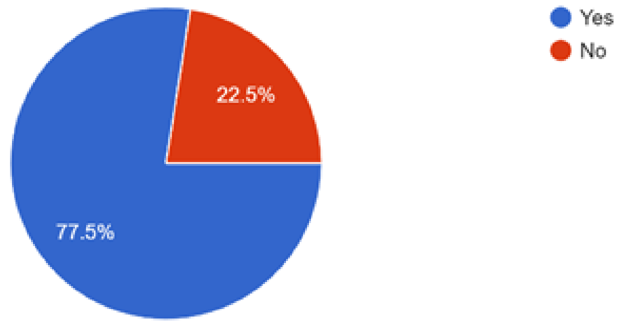


Chart 12: The project should be incorporated in another area

2. Citizens Survey Analysis: 20 respondents

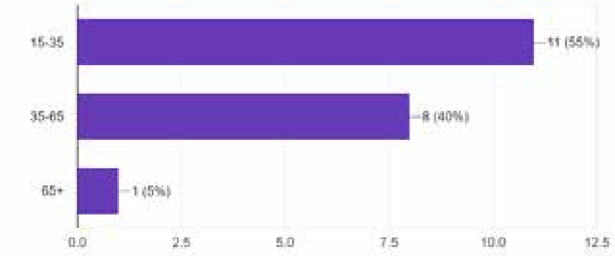


Chart 1: Age group

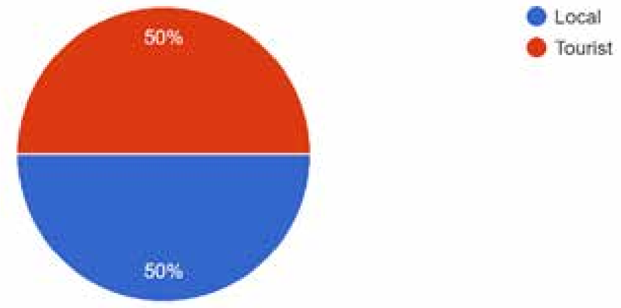


Chart 2: Type of visitors

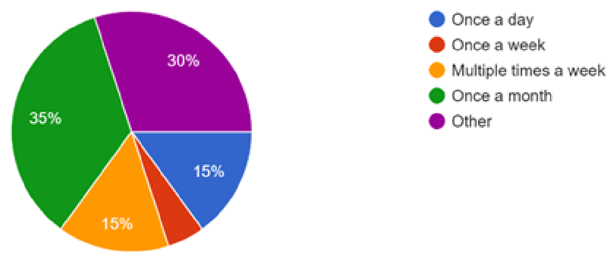


Chart 3: Frequency of visit

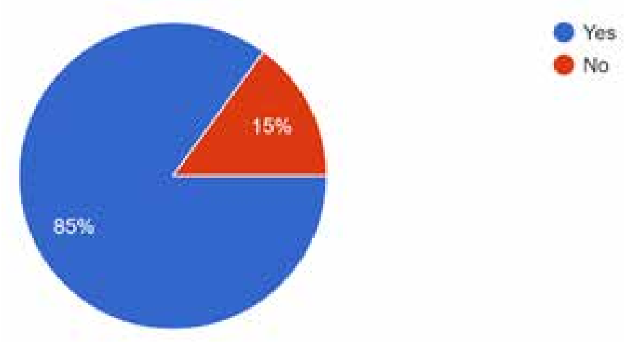


Chart 4: Awareness of Smart Roads initiative

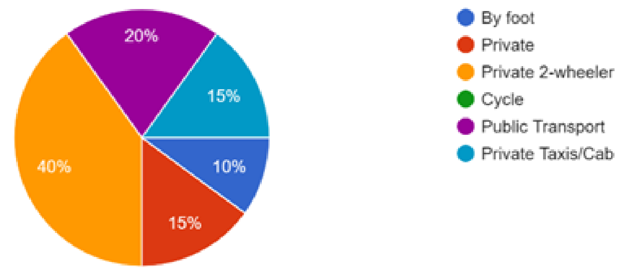


Chart 5: Mode of Travel

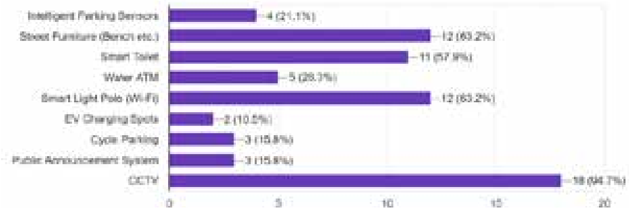


Chart 6: Aware of the Smart features installed

Chart 7: Smart features used

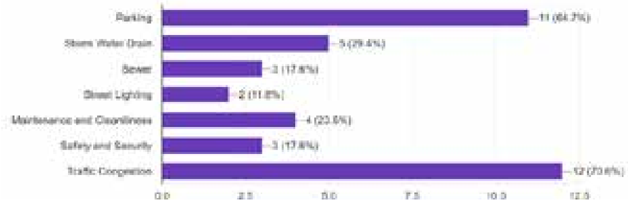


Chart 8: Problems faced before the project was taken up

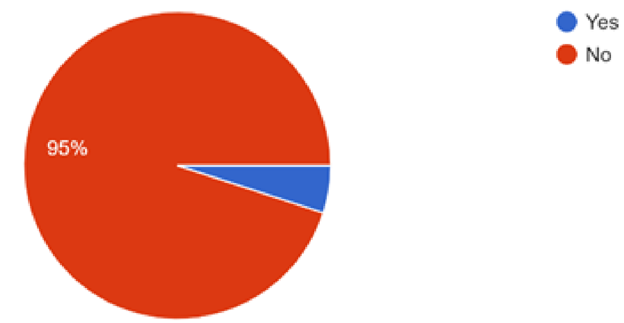


Chart 9: Involved in decision-making

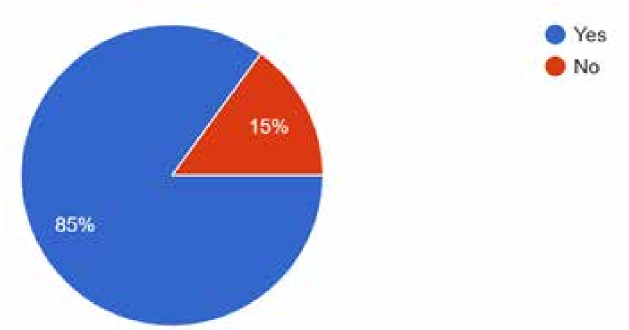


Chart 10: The success percentage of the project

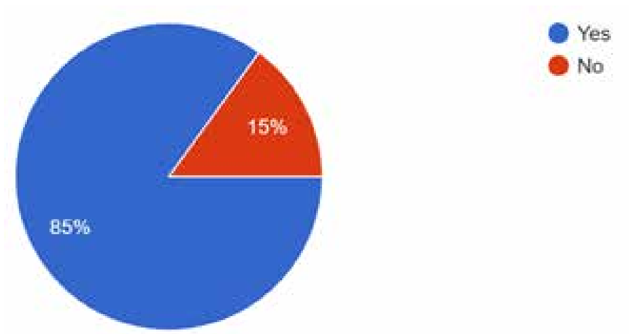


Chart 11: Positive change percentage

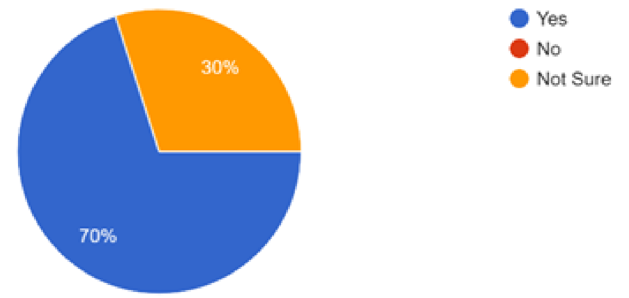


Chart 12: The project should be incorporated in another area

3. Vendors Survey Analysis: 12 respondents

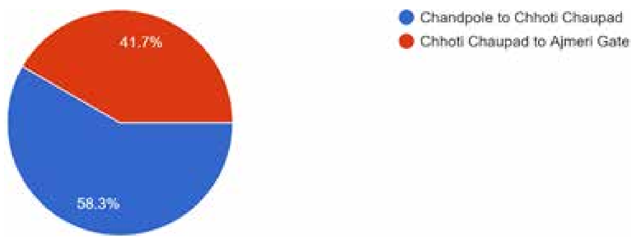


Chart 1: Stretch Name

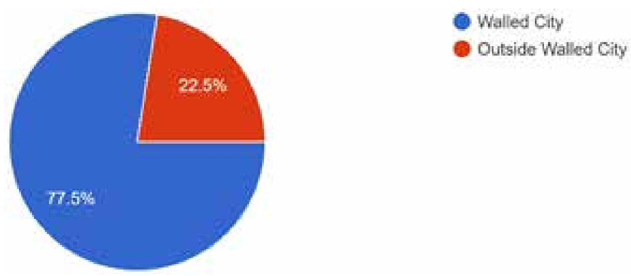


Chart 2: Residential area

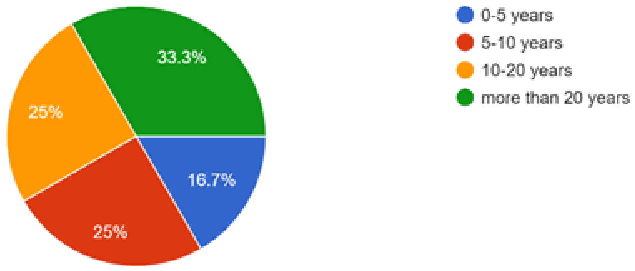


Chart 3: Work duration

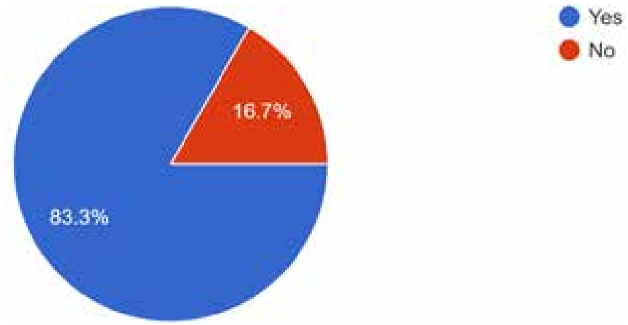


Chart 4: Hindrance to pedestrians

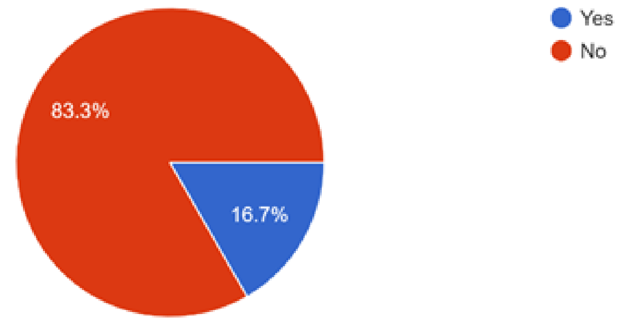


Chart 5: Permissions from authority

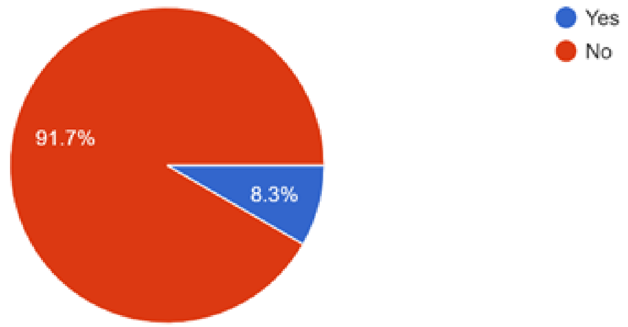


Chart 6: Knowledge of official vending areas

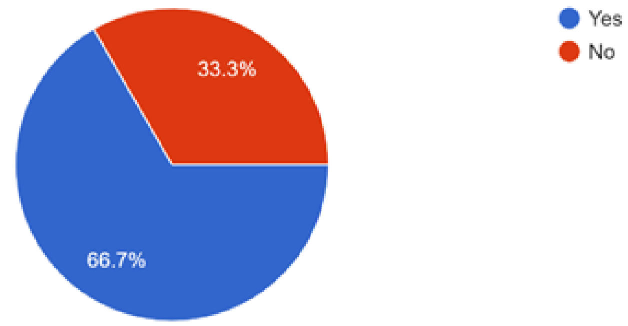


Chart 7: Awareness of Smart Roads initiative

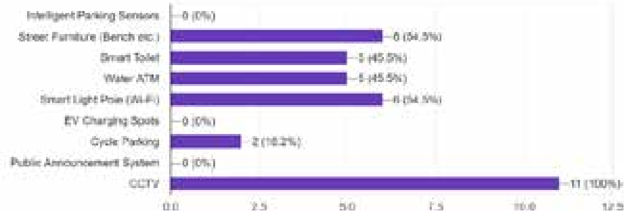


Chart 8: Aware of the Smart features installed

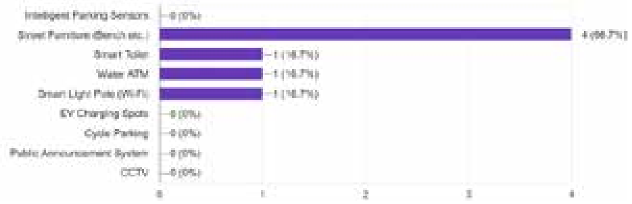


Chart 9: Smart features used

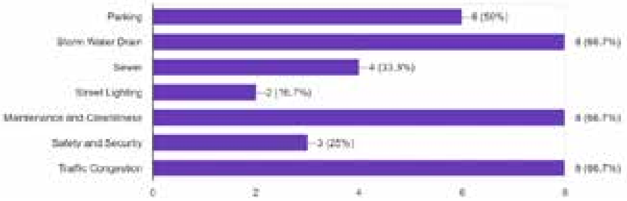


Chart 10: Problems faced before the project was taken up

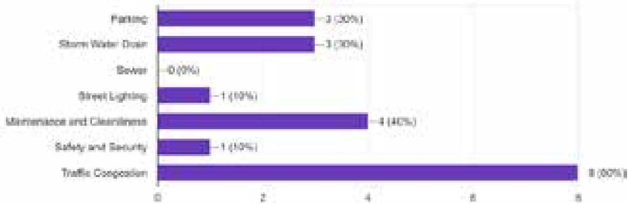


Chart 11: Problems faced after completion of project

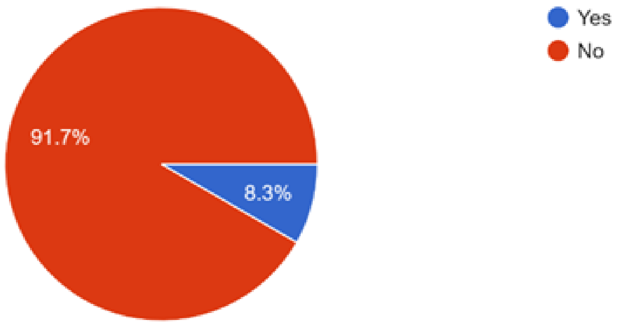


Chart 12: Involved in decision-making

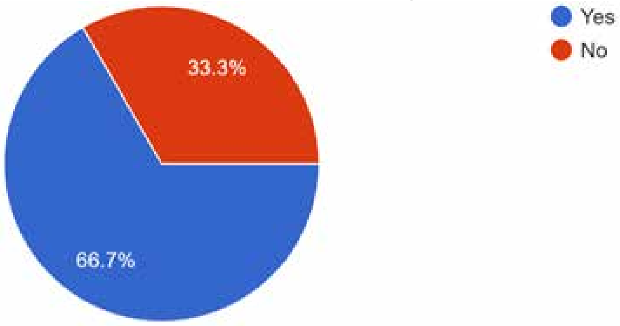


Chart 13: The success percentage of the project

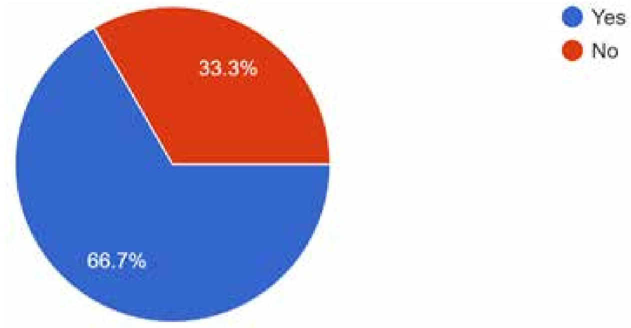


Chart 14: Positive change percentage

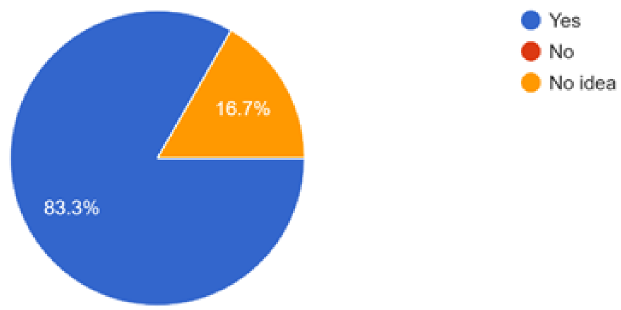


Chart 15: The project should be incorporated in anoth-er area.

A27

Integrated Command and Control Center, Jaipur

Name of the project: *Integrated Command and Control Center*
Location: *Jaipur, Rajasthan*
Year of Project Implementation: *2019*
Sector: *Infrastructure*
SDG: *Goal 16 (Peace, Justice and Strong Institutions), Target 16.1 Significantly Reduce all forms of Violence and Related Death Rates Everywhere*
Project Cost: *Rs 44.4 crore*

Institute: *Malaviya National Institute of Technology, Jaipur*
Advisors: *Dr. Nand Kumar, Dr. Niruti Gupta, Dr. Pooja Nigam, Ar. Sangeeth S.Pillai, Ar. Bhavna Shrivastava*
Students: *Pallavi Rani, Prisha Singh, Harshita Kaur, Sanjay Choudhary, Kunal Agarwalla, Shubhi Mahawar, Abdul Sakur*

Keywords: *Smart city Jaipur, Command, and Control Center, ICOC*

Abstract:

Jaipur is one of the first planned cities of India. Its beautiful Architecture, planned growth and cosmopolitan character has endowed it with a uniqueness in India's urban setting. The Ministry of Urban Development, Government of India has outlined certain visions and objectives of Smart Cities wherein a number of key characteristics are required. A Smart City should be capable of becoming both environmentally sustainable and attractive to citizens with businesses requiring a new kind of intelligent infrastructure. The Integrated Command and Control Center (ICCC) will become the heart of Jaipur Smart City for monitoring, maintaining and addressing the needs of millions of people with quality services and facilities by bringing multiple systems together. This will increase situational awareness by providing insights using data for civic officials across urban functions through integrating the available sensors in the city.

Cities have conceptualised projects which enable them to do more with less, enhance operational efficiency and deliver timely and quality services to citizens. The ICCC acts as the "nerve center" for management of operations, day-to-day exception handling, disaster management, planning and policy-making. The ICCC is envisaged to aggregate information across multiple applications and sensors deployed in the city and then provide actionable information with appropriate visualisation for decision-makers. They need to coordinate the activities, and also require a thorough understanding of everything happening in the metropolitan area so as to properly allocate the limited resources to provide the best response to each incident. It has the ability to capture and integrate information to give managers the understanding and insight required to quickly make the right decisions.

Case Study: **A27**

1. Introduction

The Control and Command Center will be used for monitoring the various components of Jaipur Smart City namely, traffic, water, ICT (Information and Communication Technologies) components across the city, emergency situations, etc. The ICCC will collect and analyse information from various departmental command centres and applications for better planning of the city. The insights and information generated will be helpful in managing incidents across the city and do better planning for development. This smart technology is under implementation or has been implemented in cities like Nagpur, Pune, Bhopal, Ahmedabad, Vizag, Rajkot and Vadodara under the Smart City Mission. This will help in event monitoring and Standard Operating Procedures (SOPs).

1.1 Topic and context

Jaipur city has a population of about 31 lakh. It has a skewed population density. From 1951 to 2011 the population of the city grew five times. There is a need to manage the city properly by implementing Smart solutions i.e., Smart facilities for pedestrians, equipping Smart solutions for bus stands like Wi-Fi hotspots, CCTV cameras, Navigation Screens and Smart parking solutions to reduce waiting and searching time for a parking space. Work for the establishment of a Video Conferencing (VC) Room and a Command-and-Control Centre shall be carried out on the ground floor of the Jaipur Smart City Limited (JSCL) building. The works shall also include modification developments in the existing office area.

The VC Room shall be used for communicating with multiple people, analysing and executing and monitoring the decisions taken. On the other hand, the ICCC shall be used for monitoring the diverse sections of Jaipur city, for example, live traffic conditions, water resources and their availability and ICT components, etc.

The space requirement for the ICCC Video Conference Room and server room, etc has been deliberated by discussions between JSCL and PMC (Project Management and Consultants). It has been decided to have ICCC in the existing JSCL office. There are modifications/realignments required for the existing office layout and set-up by execution of architectural finishes, electrical points, air conditioning, fire alarm systems, and other discipline works for constructing the ICCC. The VC Room shall be used for communicating with multiple people, analysing and executing and monitoring the decisions taken. (AV Solutions 2019)

1.2 Significance of the project

"A Smart sustainable city is an innovative city that uses Information and Communication Technologies (ICTs) and other means to improve the quality of life, the efficiency of urban operations and services and competitiveness while ensuring that it meets the needs of the present and future generations with respect to economic, social and environmental aspects". The ICCC will manage the utilities for the Area-Based Development (ABD) region and in future be capable of managing the utilities of the entire city. The key objective of building in the CCC for the Smart City is to establish a collaborative framework where inputs from different functional departments such as transport, water, fire, police, e-governance, etc can be collected and analysed on a single platform, resulting in aggregated city-level information. Further, this information can be converted into actionable intelligence, which would be propagated to relevant stakeholders and citizens.

1.3 Aim and Objectives

The aim of the project is to provide Integrated City Operations Center (ICOC) with a combination of Command and Control, Data Visualisation and Sensor Integration Technologies into a common operating picture that improves the functioning of communities with response to effective management of planned and unplanned events. (Report, 2018)

2. Contextual Background

2.1 Conceptual Framework/Research Design

A Central Command and Control Center has to be established to display the various dashboards, videos, status and information on a suitable Video Wall Establish, an operations workspace from where the operations staff can undertake various monitoring and controlling activities, take status and send necessary commands to the different smart elements. The whole area will be covered with 184 cameras, 120 surveillance and 64 video analytical systems.

It will provide the necessary IT and Non-IT infrastructure and environmental requirements for the Command-and-Control Centre, establish a Network Operation Centre and Security Operations Centre to provide network and security management functions.

The Ministry of Urban Development has outlined certain visions and objectives for Smart Cities. To enable this to happen a number of key parameters are required:

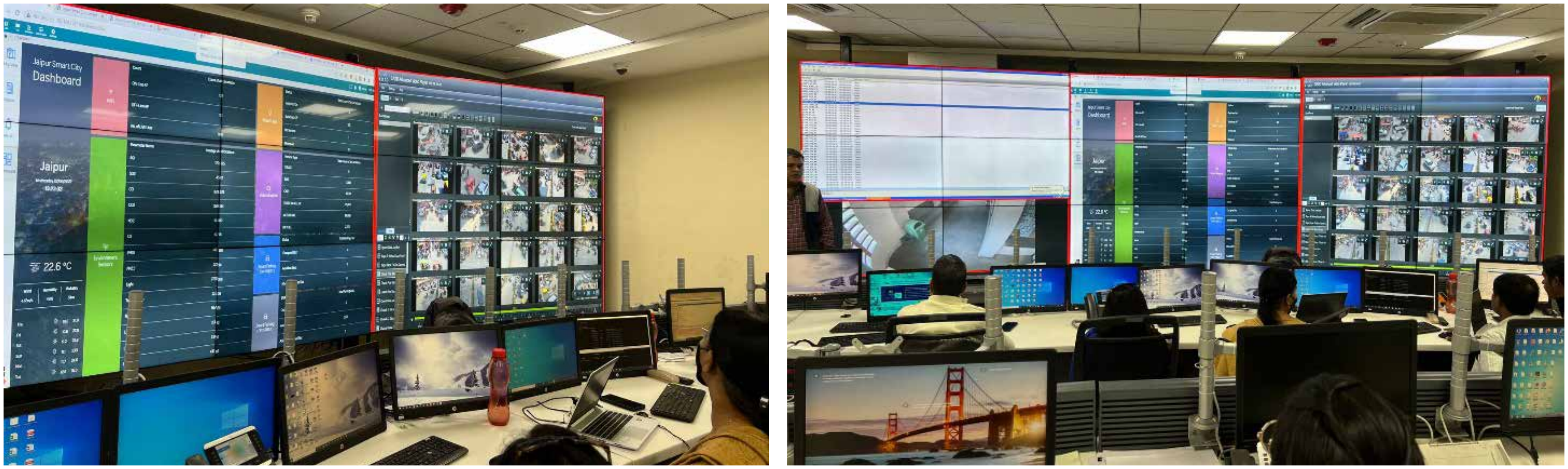


Figure 1 Command and Control Center, Jaipur

The city will be fitted with instruments and data aggregation mechanisms that allow the collection of increasing amounts of data about city life. These sensors, actuators, cameras and other instruments and aggregation systems will need to transfer data to receive commands from the back-end. The data from different sources and city systems has to be available and be easily aggregated to gain greater insight into what is going on in the city. Detailed, measurable, real-time knowledge about the city will therefore be available at every level so that it can be easily accessed by everyone or by a technical system to be able to use it to help fulfill their role or achieve their goals within the context of the overall effective functioning of the city.

In addition, analytics and decision-making systems will be able to use this knowledge effectively both, by city managers and planners and by citizens to support real-time decision-making for effective actions to be identified and meet future requirements.

The city will also be automated to enable appropriate city functions to be delivered transparently, reliably and effectively without the need of direct human intervention by notifying the relevant authorities.

The continual interaction between the physical and digital worlds enables the decision-making processes to be much more open and inclusive so citizens, policymakers and businesses can work together effectively to manage the city for the benefit of everyone.

All this needs careful attention by using new urban design models and tools in conjunction with evolved urban planning models and tools.

There needs to be capacity building and training to efficiently manage, use and operate these new systems.

It needs simulation, testing and certification frameworks to implement the computational and communication systems to enable all this. The ICT plays a crucial role in each of these. (JSCL 2018)

2.2 *Key features of the project*

The ICCC will require the following components for centralised monitoring and decision-making as per the scope defined:

i. Construction of Command-and-Control area
   a. Monitoring Area
      - Video Wall
      - Video Wall Controller
      - Video Wall Management Software
   b. Construction of Server Room
      - Supply and installation of Server Racks with all required accessories
      - Network Rack
   c. Access Control System for Doors
   d. IP Surveillance System for Server, UPS Room and Monitoring Room
      - Supply and fixing of IP Dome Camera and video streaming should be given to Central VMS Software (this is a separate tender, Bidder requests to check the compatibility).

Integration testing is essential to ensure that deployment of additional Smart City application does not disrupt the ICOC operations and affect infrastructure in terms of performance and security. The technical tasks to be carried out are:

ii. ***Functional Testing:*** Ensuring that the functionality as described by the department works adequately on the ICOC environment. The definition and review of the parameters for functional testing shall be the responsibility of the concerned department

iii. ***Performance Testing:*** Ensuring that all installed active equipment meets the expressed performance requirements. The definition and review of the parameters for performance testing shall be the responsibility of the Bidder and the Composite Team, respectively. (AV Solutions 2019)

Table-1: Area allocations for various rooms

Area dedicated to	Area (In Sqm)	Remarks
Ground floor carpet area	440	Total Area
Proposed Control and Command Centre room	95	Included in the Total Area
Proposed Video Conferencing room	43	Included in the Total Area

a. Challenges in the project
   - Overlap of multiple projects
   - Ownership of the project
   - Storage of large data

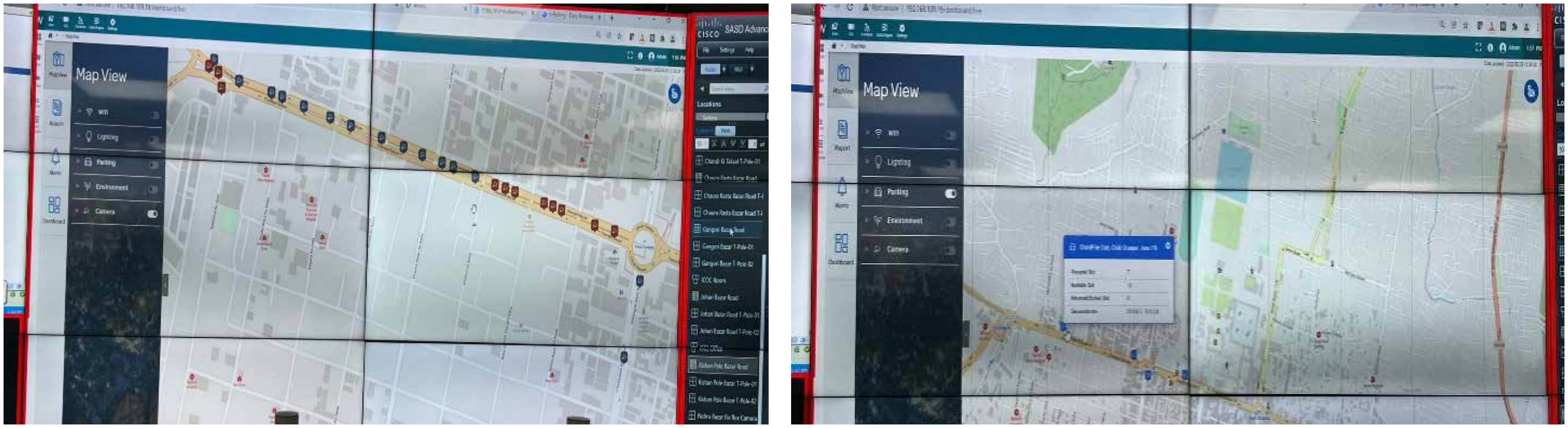


Figure 2: Location of (a) Cameras (b) Available parking slots along a specific road

Figure 3: Air Quality Monitoring through environment emission sensors

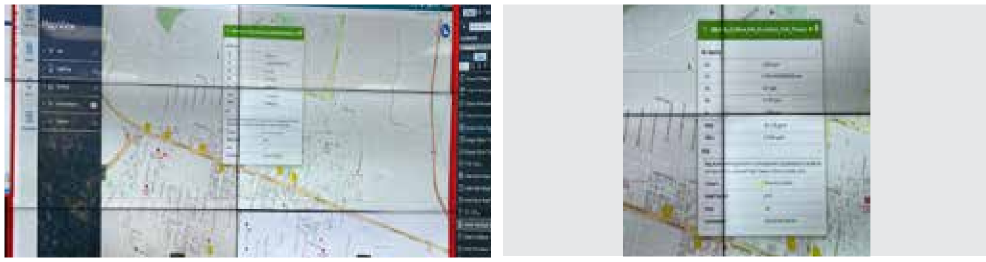


Figure 4: Location of (a) Smart Street lights (b) Wi-Fi routers along the road

- Disputes with the contractor
- Animals like rodents damaging the equipment
- Encroachment by shops and vendors
- Public awareness

Risks involved in the project

- Data Handling
- Security
- Misuse of data
- Maintenance of machinery

b. Features and Benefits

- Cameras hav been installed along two major roads - Chandpole Gate and Kishanpole Bazaar. (Near Choli Choupar)
- Access Controller Management Software to monitor and manage each and every entry-exit
- The whole area will be covered with 184 cameras, 120 surveillance and 64 video analytical systems
- To ensure availability of other peripheral infrastructure such as CCTVs like bullet cameras, fix box cameras, CC cameras in the specified area, and availability of supporting infrastructure
- Smart Parking Management System to give real-time monitoring of available slots, occupied slots, advanced booked slots and Geo-coordinates of the off-street parking areas. Smart parking is under the testing phase located at Ram Nivas Bagh and SMS parking
- Air quality monitoring devices to give accurate information about the amount of SO_2, CO, CO_2, NO_2 etc. present in the air and also classify information on the basis of various categories, index pollutants and time-based monitoring
- Smart Lighting to be provided based on data analytics. Luminosity can be increased/ decreased as per daylight and weather conditions
- The total storage provided for all such operations and storing of the data will be approximately 196Tb.

2.3 *Key findings*

Studies for the research includes report studies, meetings with officials in offline and online mode, assessment of on-the-ground sites, interaction with users and officials from various departments, shop owners, general public etc. The key findings from the research included:

i. It is a great initiative by the government in the public domain
ii. The devices installed on-site are efficient which are capturing real-time data
iii. The data captured by the devices are of sound quality and can be used by various departments such as:
   a. Rajasthan Pollution Control Board
   b. Rajasthan Traffic Police Department
   c. Nagar Nigam Heritage, Jaipur
   d. Rajasthan Police Department, etc.
iv. The project is helping in various aspects like crime reduction, monitoring of traffic and pedestrians, solving parking and congestion issues, sewage management, etc.
   Despite the installation of sensors at prime locations, various problems and issues are not being solved completely due to a number of factors like:
   a. Public awareness
   b. Inefficient public participation during the planning and implementation processes
v. There is a problem of data accessibility by other departments from the data collecting authority
vi. The data collected by ICCC is not shared efficiently with other departments. In the case of Yadgar Police station, the collected data was shared but was not used by the department because of unknown reasons
vii. The data collected by ICCC is of good quality, but due to lack of synchronisation between various departments, the data was not explored to its full potential
viii. Various devices are not working efficiently due to their inappropriate locations
ix. There is a problem of maintenance of the devices and sensors installed at the site
x. The air quality sensors have few limitations due to which they have been suspended for further projects
xi. The CCTV cameras installed under the Smart City Mission don't have night vision. (Report, 2018)

3. Discussion and Conclusion

This integrated system helps in proper real-time monitoring of the total area of the project which is worth Rs 44 crore and which will be a control system for the overall functioning of the city through installed cameras and surveillance along various areas and zones.

3.1 *Implications (The impact assessment framework)*

The installed devices are working well on the locations, capturing real-time data, which is monitored, stored and analysed by the control center with the help of PCs and screens, etc, which could help in solving various issues. There are a few devices or sensors which are not working efficiently or not providing major help due to their incorrect locations and poor maintenance, etc. There is a problem of data accessibility by various concerned departments like Pollution Control Board, Traffic Management Authority, Crime Management Authority, Nagar Nigam etc, to which the captured data is very useful and can be put to correct and safe use which could help the public and government.

3.2 *Limitations of the research*

The research involved various limitations which include:

i. Limited time
ii. Accessibility for the expert government officials and the concerned people
iii. Visiting public places during peak Pandemic situations

3.3 *Key lessons learnt*

On the basis of the studies done for the research, the following are the various key lessons learned from the project:

i. Public participation at each stage of designing, planning and implementation of the project should be encouraged
ii. It is very important for all the departments to work collectively and discussions should be done regularly

3.4 *Recommendations*

On the basis of the research which includes report studies, meetings with officials in offline and online mode, assessment of on-the-ground sites, interaction with users and officials from various departments, shop owners, general public, etc., the following are the various recommendations:

i. Participation of general public at the ground level and at each stage from planning to implementation
ii. The pilot survey should be done before implementation
iii. Proper monitoring and maintenance of the devices and sensors installed at the sites
iv. Synchronisation between various concerned authorities and departments at all stages
v. Data to be accessible to other concerned and trusted departments for better use and solutions

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A28

Digital Library Solution For Tumkuru Central Library

Name of the project: *Digital Library Solution For Tumkuru Central Library*
Location: *Tumakuru, Karnataka.*
Year of Project Implementation: *2019*
Sector: *Education oriented Project - Citizen Centric*
SDG: *SDG 4, SDG 8 and SDG 9*
Project Cost: *8,933,250.00 INR*

Institute: *Manipal School of Architecture and Planning*
Advisors: *Prof. Purushottam Kesar*
Students: *Anusha Evangelin M*

Keywords: *ICT, Digitalisation, Samrt City,*

Abstract:

Today Information technology and networks are the major tools to shape our society. In the context of Indian higher education institutions like universities and research and development organizations, it plays a vital role. The Impacts of Information and communication technologies have led to the shaping of a paperless society. It is now possible to digitize and store information in the form of high-quality graphics, network texts, color images, voice signals, and video clips at a relatively affordable cost.

The Digital Library solution is part of Tumakuru Smart Cities Limited (TSCL) development. The report provides a better comprehension of the use of the Digital Library in Tumakuru. The project's fundamental objective is to provide users with content from any place and assist them with receiving the rewards of current innovation. Evaluating the Digital Library, the report describes the digital libraries' concepts, processes, and services. It also discusses the challenges and opportunities offered/faced by digital libraries.

Case Study: **A28**

1. Introduction

Tumakuru city is the headquarters of the Tumakuru district located in southeast Karnataka. (Ref Figure 1.1) Tumakuru City Population- 3,05,821 (2011 Census)

- Area- 48.21 Sq. Km.
- The population of the ABD Area- 43,941
- ABD Area- 5.48 Sq. Km.

1.1 Topic and Context

Tumakuru city is an educational hub housing two medical colleges, five engineering colleges, and many degree and PU colleges. Hence, the Library with relevant educational materials catering to the students and aspirants of competitive exams is the need of the hour. Tumakuru Central Library, located in the city's heart, houses a great collection of Kannada Sahitya and literature that can be easily accessed from different parts of the district. The Library is visited by readers of all age groups coming from various castes and taluks/villages. Therefore, the concept of the Digital Library was conceived to facilitate the readers and the avid readers in accessing the content without any restriction.

The Digital Library is an Education oriented Project - Citizen-Centric project facilitating "Read it anywhere" conceived and implemented by Tumakuru Smart City in 2019. Tumakuru Digital Library is the first digitalization library project implemented in India under the Smart City mission. It is an exquisite approach, and the uniqueness of this Digital Library makes it stand the conventional Libraries. It has a seamless collection of Digi-base with the facility. As of now, more than 26,000 users (students, teachers, lecturers, industry professionals, government officers, children, etc.) are using the facility, with not less than 20 users at an instance accessing the portal/ application. Many cities have appreciated the initiative and have been making efforts to emulate the same.

1.2 Significance of the Project

- The digital library system at Tumakuru Central Library allows citizens to access digital content and e-books from anywhere.
- This project invites users from different parts of the city to improve their learning and gain knowledge easily.
- The monitoring of the borrowing is easy with ICT (Information and Communication Technology) interventions.
- The mobile app developed for Tumakuru Digital Library offers a collection of new releases, bestsellers, newspapers, journals, etc.
- This project also plays as a platform to bring out the talents of young minds and recreates the art of writing with the touch of technology.

1.3 Aim and Objectives

The study aims to examine the impact of the Digital Library in Tumakuru city. The report develops the framework to evaluate the project and analyze the user activity.

The objectives of the study are:

- To identify the facility provided to the Digital Library Tumakuru.
- To understand the type of readers targeted and analysis the user activity.
- To analyze and report on the process of Digital Library.
- To assess the Digital Library considering the sustainable development goals and their relevance to the project.

2. Contextual Background

The concept of the Digital Library was brought into the light to enable the readers and knowledge enthusiasts, to help in accessing the content without any restrictions.

2.1 Conceptual Framework/Research Design

The purpose of the study is to assess the impact of the Digital Library in Tumakuru on the end users, considering the different parameters. The details and specifications of the project were provided by the Tumakuru Smart City Authority to acquire primary data. Secondary data will be obtained through the use of accurate and reliable questionnaires for the identification and description of potential links between positive and negative outcomes. This study used a non-experimental, empirical research

Figure 1.1: Tumakuru District
Source: Webpage 1 (https://en-academic.com/dic.nsf/enwiki/11648458)

Figure 1.2: Typical Conservancy Lanes in Shivamogga

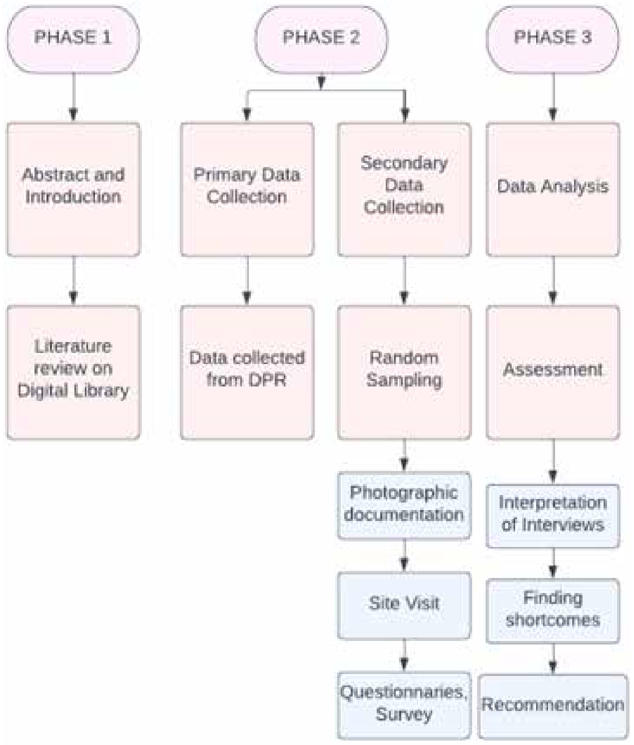

Figure 2.1: Research Methodology
Source: Author

design. The study will involve the analysis of the user activity and the outcomes of the Digital Library.

There were questionnaires prepared and interviews conducted with a group of people ranging in age from 25 to 35 who visited the Digital Library for their educational purposes. The Questionnaire for semi-structured interviews is covered in Annexure 1. The survey was conducted to find Digital Library user views, ideas, and suggestions. More specifically, the survey aims to identify, prioritize and manage the key issues and concerns affecting Digital Library.

2.2 *Key features of the project*

2.2.1 *Challenges in the project*

- Finding a suitable location for a Digital Library near the Tumakuru Central Library.
- Challenges in training library users.
- Conducting seamless public/student education sessions to explain the Tumakuru Digital Library.
- Adaptability to technology was always a challenge.
- The transition from a conventional to a technology-driven system.
- Collaboration with education institutions and organizations.

2.2.2 *Risks involved in the project*

- Issues related to cyber security and data protection.
- Recruiting and developing skilled workers, including in-house training for existing employees.
- Damage or repair of the computer may require financial assistance.
- Proper maintenance and operation of internet, cloud, and management services.

Figure 2.2: Digital Library Tumakuru
Source: Author

2.2.3 *Features and Benefits*

Features provided to Digital Library

- Relevant Hardware and Software provided to Tumakuru Central Library.
- 20 All-In-One Touch-Based Desktops in-housed for the Public Use.
- Free internet is facilitated within the Digital Library.
- For backup and security, electronic securities such as UPC and CCTV are used
- Web Portal for Tumakuru Central Library which can be accessed from anywhere and anytime.

Benefits of Digital Library

- Open access publications (e-Book, e-Journals, e-Patents, e-Magazines) are available on the e-Journal and e-Book platforms for free of cost.
- More students are visiting the site to view educational videos and e-resources.
- Digital Library enhances the in-house reading facility.
- Web-based and app-based remote access to subscribed users of the Digital Library.

2.3 *Key findings from the interviews, surveys, and primary/secondary data collection*

The key findings of the survey are the following:

- The majority of the users visiting the Digital Library are students preparing for competitive exams.
- The study shows that an increased number of male users were found compared to female users.
- From the day of launch, the number of subscriptions has increased
- Different types of content are used depending on the users.
- On analysis, it is found that over 76% of the registration is from Tumakuru along and more than 8000 readers from Karnataka. (Source (Tumakuru smart city limited. (2018). Detailed project report on Digital Library)).
- Students approximately around the age 24-34 visitor the Library in a higher ratio compared to other group.

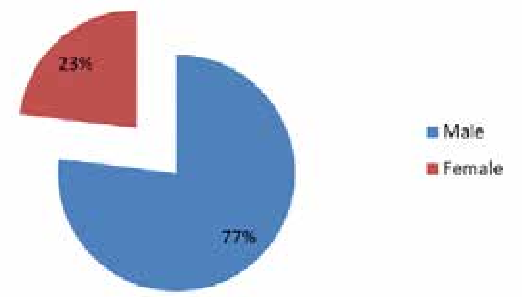

Figure 2.3: Gender ratio of visitors to the Digital Library
Source: Report by smart city officials

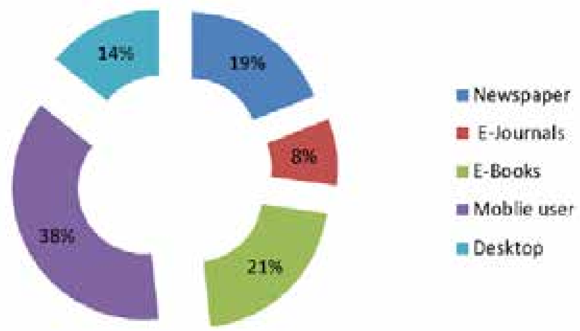

Figure 2.4: Content Accessed by different users in the Digital Library
Source: Report by smart city officials

3. Discussion and Conclusion

3.1 *Implication*

Server for Digital Library:

The server can be accessed by visiting the url https://tumakurudigitallibrary.in/ (Figure 4). The website contains more than 58,000 E-Books under Literature, Textbooks, Children's Books etc. [E-Books include Children's Books, History, Literature, Science and Technology, Geography, Religion etc.]. It also provides space for Blog writing, and access to different journals, newspapers, magazines and educational videos. Free internet is facilitated within the Digital Library.
It was found that the speed of the web portal gets lowered during website upgradation and the server sometime gets hanged during traffic on the website.

Safety and security:

Safety and security was the primary concern. An individual was assigned to check on users at regular intervals. The Library kept a proper registration book at the entrance to identify visitors. With the help of the registration book, damage and repairs to the computers were identified. Due to security reasons, bags and electronic devices, such as pen drives and USBs, were not permitted in the Library.

Physical infrastructure:

The room allocated to Digital Library is located on the first floor, neighboring the Tumakuru Central Library. The Library was furnished with 20 All-In-One Touch-Based Desktops.

A need for proper racks or shelves to store bags and shoes was found (Figure 6). The location of the Library is in the makeshift room, where infrastructure issues can be observed. The facility will be shifted to the new building – City Library being built by TSCL by 2022.

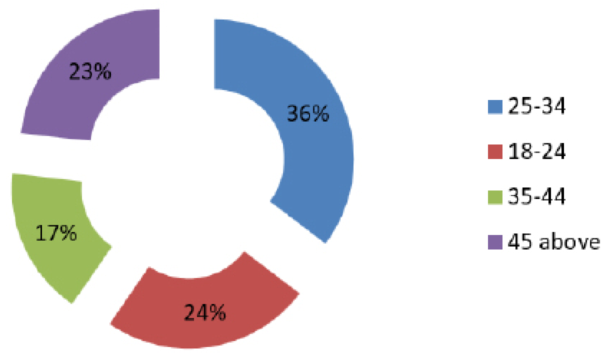

Figure 2.5: Age-wise distribution of Visitors to Digital Library
Source: Report by smart city officials

Impact on SDG:

SDG Number	Goal	Indicator	Remarks
4	Quality Education	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	DL provides access to different e-sources and e-contents improving educational quality.
8	Decent work and economic growth	Promote sustained, inclusive and sustainable economic growth, full and productive environment and decent work for all	Indirect positive impact on gaining knowledge and building a financial career
9	Industry, innovation and infrastr-ucture	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation	Openness to different disciplines helps in fostering the information on the particular fields

Figure 2.6& 2.7 : Infrastructure for storage
Source: Author

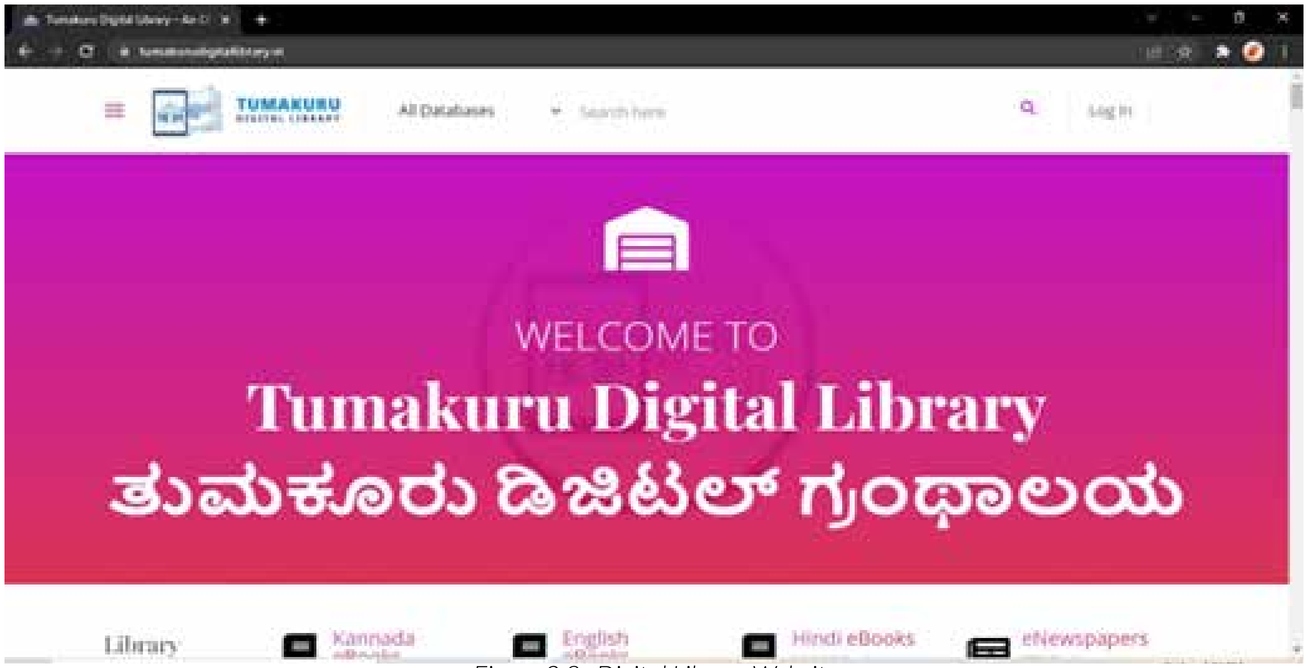

Figure 2.8 : Digital Library Website
Source: Webpage 2 (https://tumakurudigitallibrary.in/)

3.2 Limitations of the research

- The majority of the information gathered and broke down in this setting has been done on the subjective premise of information assortment. The organized interviews led (group of users) can't be projected as overviews to depict the evaluation on Digital Library.
- The opinions and data collected are from the limited number of site visits.

3.3 *Key lessons learned*

- Giving access to a digital library consumes a lot more time than going to a physical library.
- Digital libraries are comparatively cheaper than print libraries.
- As cost is concerned, resources available in the digital collection are more than in print libraries.
- Difficulties in maintenance and operation of both physical and social infrastructure of the Library.

3.4 Recommendation

Additional computers for the user, to save their waiting time.

Proper storage racks or shelves to place the user properties like bags or shoes.

Maintenance of physical infrastructure to avoid the complaints like stumbling of water.

Increase the speed of the website.

Providing proper access to physically challenged people and elderly people could increase their visits to the digital Library.

Provision for air conditioning, since there are numerous systems in one room.

An alternative source of power supply could be tapped in for example solar energy could be utilized to consume electricity.

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A29

Smart Education – Shivamogga

Name of the project: *Smart Education*
Location: *Shivamogga, Karnataka*
Year of Project Implementation: *2019*
Sector: *Educational Sector*
SDG: *SDG 04 Quality Education.*
Project Cost: *15 Crore INR*

Institute: *Manipal School of Architecture and Planning*
Advisors: *Prof. Yogendra Singh Yadav*
Students: *Sanjana Shaji, N Hari Chandana*

Keywords: *Smart, Classroom, Multimedia, ICT, Assessment, Student, Teacher*

Abstract:

Smart classroom is technology-based learning that is proposed as a solution to increase the capabilities of students. This mode of teaching and learning make the education system more attractive and interactive, in addition to helping educators to develop an engaging session. The design principles of a smart classroom are aimed to bridge the gap between students and instructor, to help the instructor teach more efficiently, and to make the environment more conducive for teaching and learning.

The objective of this study is to determine the effect of e-learning and smart classrooms at government-run schools in Shivamogga city, Karnataka. The study involved Students, Teachers, School Management and Government as the key stakeholders. It's been observed that Technology-enabled teaching-learning encompasses a variety of techniques, tools, content, and resources aimed at improving the quality and efficiency of the teaching-learning process. There are a variety of options available for the teacher to utilize various modes/ICT tools for effective pedagogy ranging from projecting media to support a lesson, multimedia self-learning modules, and simulations to virtual learning environments. Each such device or strategy also involves changes in the classroom environment, an understanding of which has a bearing on its effectiveness. The availability of a wide range of such teaching-learning materials will catalyze the transformation of classrooms into a collaborative classroom environment.

The results show a significant difference in the students' academic performance in conventional and smart classrooms. In addition, the enrollment rate of students has also gone up in the year 2021-2022. The convergence of Information and Communications Technology (ICT) with learning methodologies is having the most profound impact on the society and economy. It is also clear that when such technologies are deployed in schools, they are being embraced enthusiastically by teachers and students.

Case Study: **A29**

1. Introduction

The Ministry of Housing and Urban Affairs (MoHUA), Government of India (GoI) has rolled out the Smart Cities Mission on 25th June 2015. Shivamogga was selected under the second round of smart city mission among 100 cities to be developed as smart cities in India due to various achievements, initiatives, and all-inclusive approach. Accordingly, Shivamogga city had submitted a "Smart City Proposal" (SCP) to the Ministry with the required consent of the Karnataka government and statutory authority of Shivamogga Municipal Corporation.

1.1 Topic and Context

In view of the changes that society is undergoing because of globalization and the growth of new technologies, education is a critical component in the development of cities. Shivamogga's proposal incorporates smart city solutions, which involve the use of technology, information, and data to improve the city's infrastructure and services (Smart Solutions Projects). Shivamogga Smart City Limited (SSCL) plans to set up e-learning and smart classroom programs at government-run schools, in keeping with the smart city goal. Smart classrooms are based on the intersection of three axes that interact in the design and usage of the learning environment:

- The ergonomy and architectural design of the classroom.
- The integration of technology, particularly ICT, in a way that is useful, invisible, justifiable, and extensive.
- An innovative pedagogical methodology, appropriate to that space, that improves the efficiency and satisfaction of learning, and is based on teaching principles such as collaborative learning, project-based learning, curricular globalization, student autonomy, educational co-responsibility, and so on.

Strengthening the education system plays a vital role in enabling long term sustainable goals. The Shivamogga district comprises a 17.52 Lakhs population, wherein the average literacy rate is 80.45%. While the average literacy rate of Shivamogga city is 87.78%. As per 2015-16 statistics, the pupil-teacher ratio was 19 in primary, 13 in higher primary, 16 in high school and 30 in senior secondary school. As per Student Achievement Tracking System, Karnataka (SATS) data, there are about 92 government-run educational institutions in Shivamogga Urban area which includes 18 schools providing primary schools, 62 schools providing higher primary education, 10 schools providing high school education and 2 are PU Colleges.

The smart education project is a Pan City project initiated in 2016 and completed in 2020. In Shivamogga, government-aided higher education schools have been identified to carry out the Smart Education Mission. Out of 68 government-aided schools in Shivamogga, this project is being executed in 45 schools. The total budget of the project is estimated as 15 crores. This project aims to provide ICT labs, Chromebooks, digital classrooms based on the no. of Pupils in the schools. It is estimated that each school will be allotted at least one Smart Classroom with Chromebooks in ICT Labs and one digital classroom. The stakeholders for this project are students, teachers, school management and the Educational Department. While efforts are made to find the impact of smart education on students, teachers and find the difference between traditional teaching and smart teaching methods.

For both citizens and government, it is vital to have e-learning and smart classrooms in schools. For citizens (young citizens) these projects enable

- Better quality of education, and
- Wider reach of academics.

It is vital for the government to facilitate technological advancements such as e-learning and smart classrooms in order to ensure quality modern education reaches the young minds and in turn leads to sustainable development.

1.2 Significance of the Project

Smart classes enhance the learning experience with their resourceful, technology tools. It increases the facilities to students with easy access to online information, it enhances the interactive learning experience. Smart classes help teachers to deliver lectures more efficiently. It has digital boards, projectors, computers, LED screening facility, Internet Facilities, ICT Labs, etc., It Focuses on achieving the SGD Goal -04 – Quality Education. Smart classroom-based education was proposed through a four-track program.

1.3 Aim and Objectives

The aim of the study is to examine the impact of Smart Education in Government schools and develop a framework to evaluate the project and to further implement the smart education program in other government schools in Shivamogga.

The objectives of the study:

- To identify the facilities provided in the schools under the smart education mission.
- To identify the impact of digital education on stakeholders.
- To understand the views of stakeholders in digital classrooms, technology usages in the classroom.
- To identify the difference between traditional learning and smart learning and implement the techniques in other schools.

2. Contextual Background

Quality education for school children is an essential requisite in today's competitive world. Technology has impacted us in every aspect. Digital learning/ classrooms are one such technological advancement in education. Digital learning refers to the application of digital technologies within learning, teaching and assessment practices in a school. These digital technologies are constantly evolving. Depending on the application of these technologies in classrooms or in teaching methodology, these classrooms are broadly

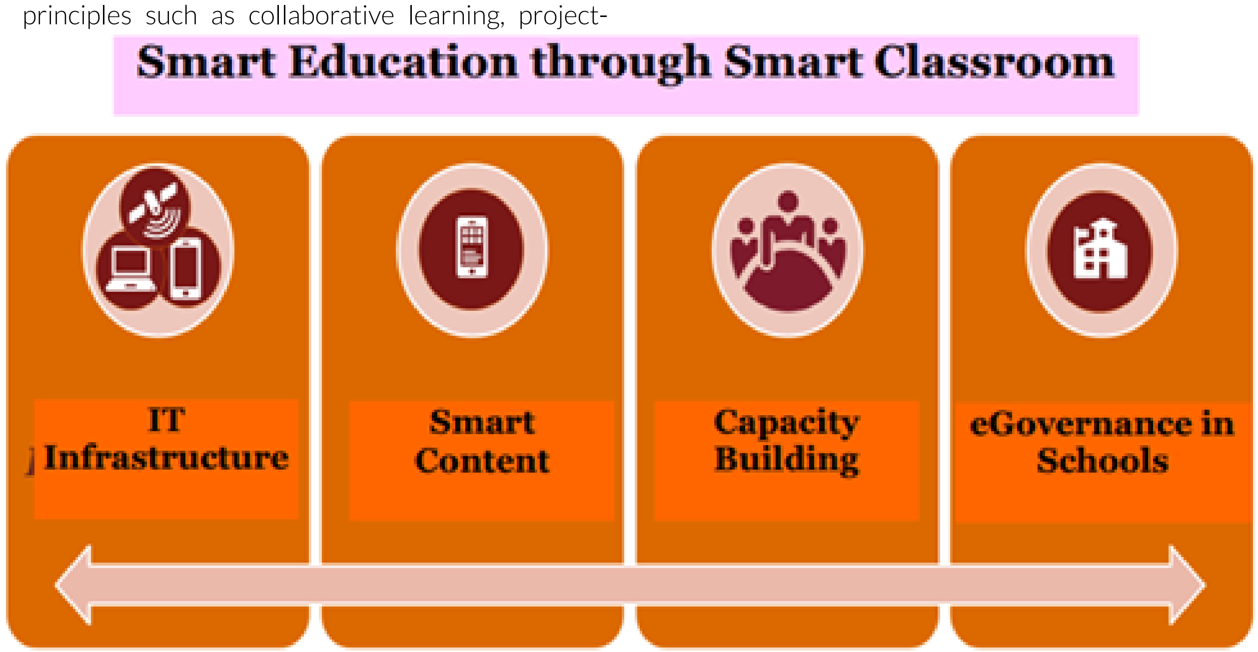

Figure 1.1: Smart Education Through Smart Classroom
Source: Final Detailed Project Report "Implementation Of Smart Education In Government Schools Of Shivamogga"

categorized as digital classrooms, smart classrooms, virtual classrooms, and future classrooms.

2.1 Conceptual Framework/Research Design

The The framework for the project is as follows:

2.1.1 Introduction

The introduction will include the research question which is how smart classrooms improve the academic performance of the students and the summary of the proposal.

2.1.2 Literature review

Literature on the topic: Literature studies were done on Chandigarh and Uttar Pradesh smart classroom projects to understand the challenges faced during various stages of the project.

Literature on Method: Literature studies on method was done based on research papers to identify the framework for evaluating the classroom based on four dimensions and their annotations.

2.1.3 Methodology

2.1.3.1 Data collection

The data were collected through multiple sources including a primary survey, development of a questionnaire and analysis, interactions with Shivamogga Smart city Limited Office, school headmasters, and secondary research (central and state initiatives, flagship programs in e-learning and smart classrooms across the country, analysis of e-learning projects in other smart cities). We also carried out discussions with major stakeholders including teachers, students, and management to assess their primary and secondary needs.

2.1.3.2 Survey

The surveys (primary) were aimed at understanding the current status of digital learning/teaching through four dimensions and their annotations in Govt.Model HPS, English Medium, Durgigudi, Shivamogga.

2.1.4 Preliminary Findings

From the literature review and site study were analyzed and important categories and their relationships were identified. This included the features and benefits, risks involved and the challenges of the project.

2.1.5 Statement of limitations

Limitations to the research were identified to look into the alternatives and the weaknesses of the project.

2.1.6 Conclusions

Conclusion covers the key lessons learned and the recommendations for the project.the role of SDGs in smart education is also analyzed through the SDG impact assessment tool.

The questionnaire is included in Annexure 1 and Annexure 2

2.2 Key features of the project

The smart education project focuses on providing one smart classroom in every school.

- Interactive learning management system - This will have various modes, Simulation Mode, 3D Modeling and Animation, Drawing and Diagrammatic mode, Live and offline mode
- E- libraries- As part of e-library project taken up under smart cities, e-library infrastructure is being provided in 9 schools and 2 PU colleges.
- Studio option - The studio will help teachers and students to create content and record lectures that can be viewed later and also conduct live-streaming lectures.

2.2.1 Challenges in the project

- Lower enrolment rates in schools due to lack of basic amenities and infrastructure.
- The Digital and ICT facilities are limited.
- Lack of smart classrooms. Accessibility- the children in government schools do not have enough opportunity to learn to build concepts beyond the schools.
- Flexibility.
- Inefficiency – it's a challenging task for teachers to keep a tab on every child in the class, recognize current understanding levels and modify the content and delivery accordingly
- Training of tutors to understand this model.

2.2.2 Risks involved in the project

- Highly depends on ICT components such as the bandwidth of the internet, cloud services, and management services.
- The technology used in smart classes is expensive and complex.
- High maintenance costs are incurred.
- Security and safety issues.

Figure 2.1: Government Higher Primary School, Durgigudi, Shivamogga

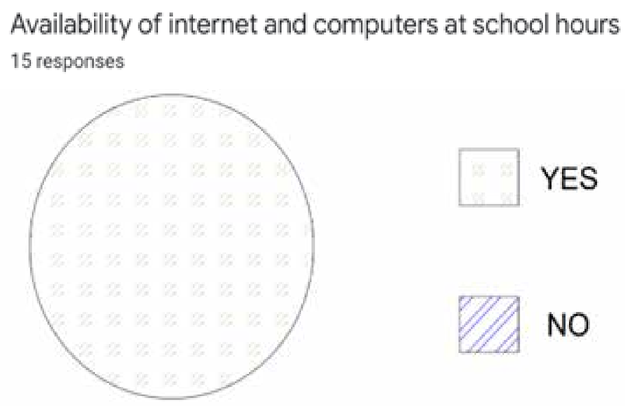

Figure2.2: Survey Findings - The Availability Of Internet And Computer At School Hours.

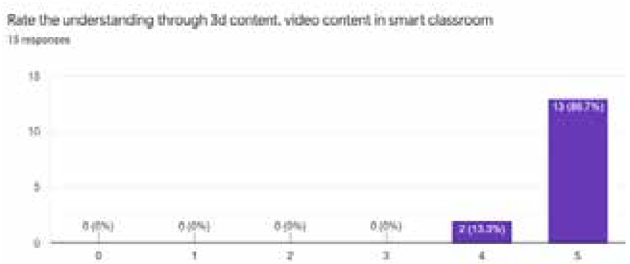

Figure2.3: Indicating The Understanding Levels Of Students In Smart Classrooms.

Figure2.4: ICT LAB In Government Higher Primary School. Durgigudi, Shivamogga

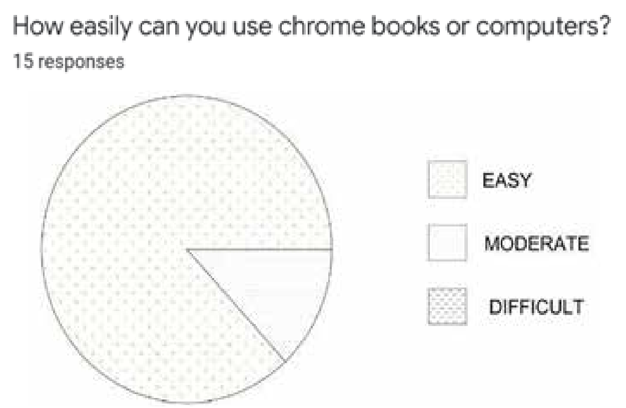

Figure2.5: Survey Findings - The Availability Of Internet And Computer At School Hours.

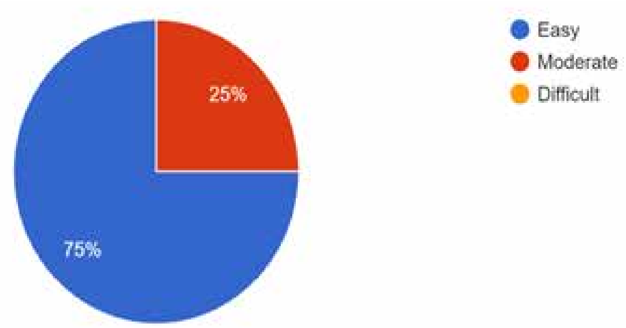

Figure2.6: Access The New Equipment In Smart Classroom

2.2.3 *Features and Benefits*

- It increases the access to online resources for students.
- It improves teaching skills through digital awareness.
- It helps in the automatic streamlining of the activities in school.
- It improves students' skills.
- The quality of education has improved.

2.3 *Key findings from the interviews, surveys, and primary/secondary data collection*

Key findings from DPR of Smart Education - Shivamogga Smart City: Primary Data

- Proposed ICT Labs and Smart classrooms in government higher schools.
- Introduce smart education in classrooms through smart classrooms such as IT infrastructure, Smart content development, capacity building, E-Governance scheme.
- Few schools have preliminary IT intervention which can be upgraded easily with few interventions.
- Digital content is provided by the Government of Karnataka. But due to a lack of basic infrastructure visual content could not be provided.
- Major challenges in schools are Teacher-student ratio, lack of basic infrastructure amenities, sanitation etc.,

Key Findings from stakeholders based on the survey:

A survey was conducted in Government High School, Durgigudi, Shivamogga. Government high school, Durgigudi is one of the selected schools in the ABD area for implementing smart education programs. The total strength of the school is 919 members out of which 346 members are a high school. SchoolNet India is the service provider through K-Yan technology. This school consists of three smart classrooms and one ICT lab. The survey is conducted based on the framework for evaluating smart classrooms.

Resources	The convenient level for accessing the internet and sharing digital resources etc.,
Enhancement	The level of facilitation of learning and teaching by using digital devices.
Management	The convenient level for conducting flexible pedagogies.
Presentation	The convenient level for presenting content and sharing learning outcomes.

A questionnaire is being produced as part of the survey to analyse the smart education project. In smart classrooms, it's critical to have a stable network. We discovered that the network was not disrupted and that all pupils were able to use the computers/desktops throughout school hours. The students acclimated to the new technology rapidly.

As shown in the graph, about 86 per cent of students can understand the subject taught in the new schooling techniques. Changes in the teaching approach were implemented, allowing students to improve their understanding. The student-teacher relationship has been developed.

A projector, stylus, and whiteboard are included in each smart classroom. Chromebooks are offered to pupils as part of the ICT labs. These books are used in class to view textbooks, share knowledge, and prepare presentations. The E-library, which includes textbooks, journals, and articles that can be read from anywhere, is available to all students through the portal. Since Chromebooks became a part of the ICT labs, everyone has had the opportunity to use them and become familiar with new educational technologies. Each smart classroom had a dedicated charging point for Chromebooks to be charged after schooling hours and are used during schooling hours.

Teachers were adequately trained on how to use the smart classroom. Even though the transition from blackboard and chalk to whiteboard and projector was completely new to them, they were able to adjust. As a result of the new teaching methods, they were able to make more informative presentations for pupils. This aided them in making the class sessions more participatory. Teachers have a modest level of adaptation to new technology in terms of controlling projectors, producing online content, and creating videos for presentations.

The graph depicts teachers' ability to adapt to technology in the classroom. Teachers had some difficulties at the beginning of the project because they were new to these technologies. They had difficulty preparing digital content, making videos, understanding the user interface, and uploading content material for students, despite the fact that they had received adequate training. These obstacles were subsequently alleviated as a result of regular school training sessions conducted to teachers and adaptation to new technologies.

"There is a hike in school admissions after implementing this project. The interest in students to learn new things, work on desktops, and innovative thinking has increased. They were very interested in digital classrooms which offer animated videos for their regular classes. The students were able to learn new technology much faster than us so they helped us in a few things in operating the digital classrooms. The only drawback is there is no supporting infrastructure such as a classroom that can accommodate full class strength. - Mrs Nusrat Jahan, Assistant Teacher"

"There were no challenges while implementing the project. There was a positive response from all stakeholders as well. The teachers in the schools were given a training program on smart classrooms by SchoolNet India and a refresher programme is conducted every 6 months for teachers. The admission enrollment in Durgigudi school has climbed up; the students from other private schools joined this school

Figure2.7: ICT Lab in Government Higher Primary School, Durgigudi, Shivamogga

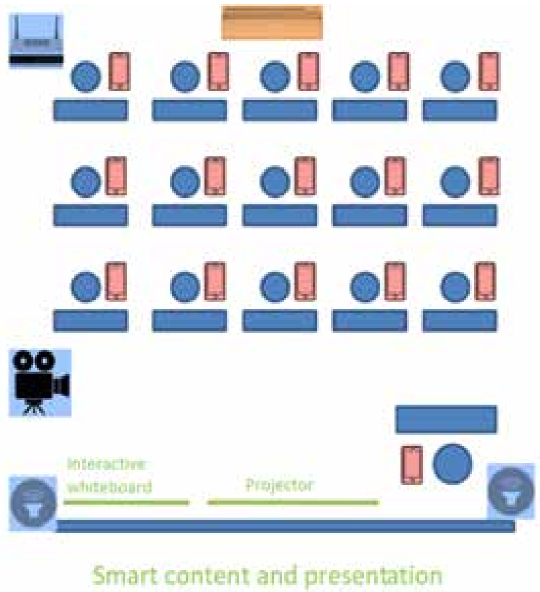

Figure 2.8: Example Of Smart Classroom Layout

Figure2.9: ICT Lab in Government Higher Primary School, DurgiGudi, Shivamogga

after implementing this project. The dropouts from school have decreased. - Mr Pradeep Kumar B, Senior Urban Planner, SSCL".

3. Discussion and Conclusion

3.1 Implications

Impact assessment framework for sustainable development.

Smart education mission has a direct positive impact on achieving:

- Goal -04 - Quality education.
- Goal -05 - GenderEquality.
- Goal -09 - Industry, Innovation and Infrastructure.

Smart Education In Government School

The Smart Education Project contributes to the achievement of the Sustainable Development Goals because it has a positive influence on Purpose -04 Quality Education, which was the project's main goal. It also contributes to Goal 05, gender equality, by providing equal opportunities to all people, regardless of gender, and educating society about gender equality. Because smart city development includes smart education, Goal -09- industry, innovation, and infrastructure have a positive impact because it concentrates on improving school infrastructure.

3.2 *Limitations of the research*

The findings of the study had to be seen in the light of some limitations:

- Limited access to secondary data.
- The project cannot be accessed from an economic point of view.

3.3 Key lessons learnt

The Smart Education project aimed to provide high-quality education to all children. Providing supportive infrastructure in schools, provided an opportunity for economically disadvantaged children to receive a better education. When this is implemented in all government schools, the distinction between them in terms of education is gone. By providing E-Libraries, stakeholders would be able to access information from anywhere at any time.

However, the scope of the project can only be met in the long run. the project is implemented on an experimental basis and will become fruitful if students are exposed more to the smart education curriculum

Smart classrooms are defined by the intersection of four axes:

- **Resource:** The convenient level for accessing the internet and sharing digital resources, etc
- **Enhancement:** The convenient level for accessing the internet and sharing digital resources, etc. and air condition
- **Management:** The convenient level for conducting flexible pedagogies
- **Presentation:** The convenient level for presenting content and sharing learning outcomes.

The project was assessed using these four parameters mentioned above and the key findings are:

- Adequate training for teachers: The adoption of technology in education has led to an unprecedented transformation from teacher-centric education towards student-centric education. Virtual classrooms and various online tools are helping to continue and enhance the engagement between the teacher and students as close to the classroom-type experience. Going forward, smart classrooms are making everything possible from teachers and parent meetings to staff/management meetings, providing the necessary interactivity therefore it is important to make teachers aware of the newer technology. The teachers were not aware of every possibility of the programme.
- Adequate contact hours: the students are now exposed to smart classrooms for only a few hours a week. and the remaining hours are spent in the conventional classrooms. This is in contrast with the scope of the project. Even though the curriculum has changed the teaching methods remain the same
- Adequate infrastructure: the smart classroom sessions need to be conducted in a way that a whole class can attend the class at once. infrastructure limitations led to the reduced effectiveness of smart classroom education. the strength of each class was 50 but the ITC lab capacity is 25 students.
- Adequate funding: the service charges are rising as the schools move forward with technology and are not included in smart city funds. Schools are burdened with service charges.

3.4 Recommendations

The classroom has to have a different shape in times to come. It is just like a laboratory where different hardware such as projector, tape recorder, recorder player, overhead projector, epidiascope, computer etc. are lying around. Different types of software are also available to improve the process of teaching-learning. Normal classrooms have turned into smart classrooms. To achieve this following recommendation are made

The smart classroom should be used in schools to make students aware of the optimum use of technology in their studies.

- The curriculum in all academic activities should be connected to the Smart Class. The teacher should make proper use of Smart Class to clarify the topic.
- The projects, seminars and home assignments, all should be given by taking digital learning into account. New concepts and up to date information should be given to students through the Smart class.
- The guidance of the teacher must be there with the student while using the smart class so that they do not get distracted from the right path.
- Seminars, conferences and workshops should be organized to provide the teachers with the updated knowledge of using technology (smart class) in the classroom so that they in turn are able to motivate their students for their success in academic achievement.
- Students should be given the proper instruction related to the topic before using the smart class and they should be about the benefits of using the smart class.

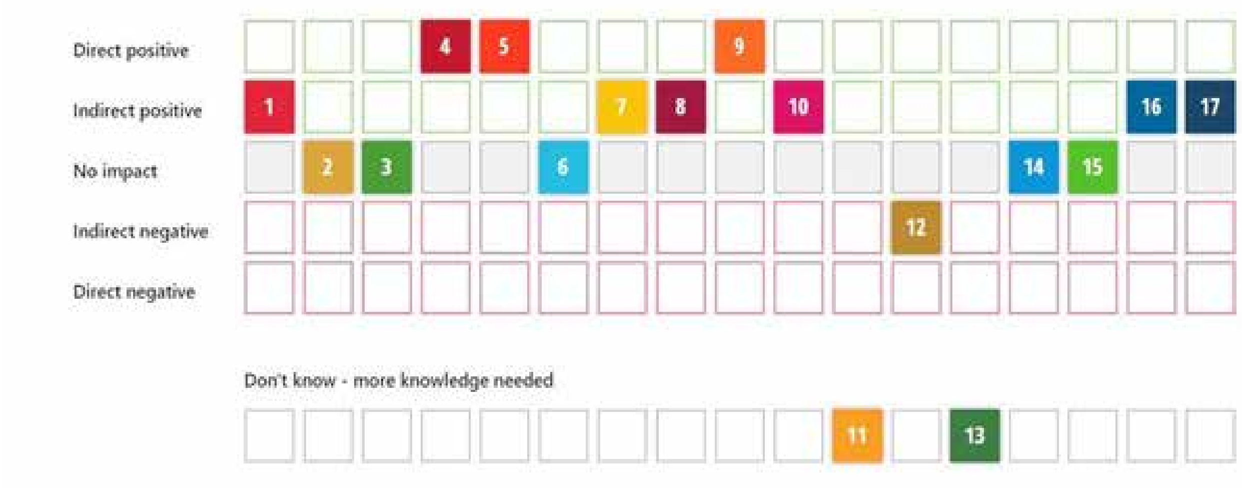

Figure 3.1: Impact Assessment of Sustainable development

Figure 3.2: Sustainable Development Goals

A flexible structure adapted to users' needs, comfortable, with multiple resources, socially and digitally connective, personalized, tidy, open to its immediate environment and the world, and finally, safe for its users and safe in its technological equipment should all be considered in the design and implementation of a smart classroom.

Framework of Assessment

Variables/Parameter	Measuring items
Resource The convenient level for accessing to the internet and sharing digital resources, etc	I can get on the internet to search for learning materials I can get on the internet I can share digital resources with peers I can get the videos that the teacher uses in class I can get digital learning resources. I can find that computer sockets in the classroom when I need to use them The Bandwidth of internet
Environment The convenient level for the indicators of the physical environment, like temperature and air condition The convenient level for the indicators of the physical environment, like temperature and air condition the convent level for the indictors of physical environment like temperature and air conditioning, natural lighting in classes, libraries	Temperature in the classroom is suitable for concentrating on learning. I don't feel sleepy in the classroom because of the fresh air in the classroom. No unnecessary noises exist in the classroom. Light in the classroom is enough for reading books or digital books. I can hear teachers and other students clearly
Enhancement The level of facilitation of learning and teaching by using digital devices	I can get the correct answer for questions. I can get learning guidance from devices. I can work with peers for learning tasks. Teachers can assess my practice instantly. I can accomplish tasks by using devices.
Management The convenient level for conducting flexible pedagogies	I have an adequate workspace for the placement of textbooks, tablet PCs and other Resources. Adequate space exists for easy movement among workstations, resources and exits. The layout in the classroom is suitable for my ways of learning. The podium, blackboard and projector are at the right place for teaching and learning
Presentation The convenient level for presenting content and sharing learning outcome	I feel the digital devices promote my sharing. I understand teaching content better with the multi-screen display. I feel the network promote my sharing. I can share my learning outcomes with others
Infrastructure	Digital infrastructure in classrooms No. of smart classrooms per class Staff rooms for teachers Toilets Playgrounds Digital library Computer labs – ICT labs No of desktops

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A30

One City, One Center for All: An assessment of the Integrated Command and Control Center at Mangalore

Name of the project: *An assessment of the Integrated Command and Control Center*
Location: *Mangaluru , Karnataka*
Year of Project Implementation: *2018-till date (ongoing)*
Sector: *Governance*
SDG: *3,9,11,13,16 SDGs*
Project Cost: *23.70 Crore INR (CAPEX-14.51cr and OPEX-9.19 cr)[1]*

Institute: *Manipal School of Architecture and Planning*
Advisors: *Boorla Venkataramana*
Students: *Raghav Chawla, Joshi Aishwarya Anil, Vanlalruatfeli Bawitlung*

Keywords: *Command Control Center, Smart Governance, Smart city, Digitalization, Sustainability*

Abstract:

The Integrated Command and Control Center is one of the 65 projects under the Mangaluru Smart City Proposals. Karnataka Urban Infrastructure Development & Finance Corporation Limited (KUIDFC) is the state's nodal agency for the Smart city mission.KUIDFC has proposed that the KMDS be the data centre for holding data from all seven cities. Integrated Command Control Center is a Pan City project. It is a way forward for centralizing, structuring, and smart city infrastructure management through the IoT (Internet of Things)method. This helps in regular monitoring of the city's infrastructure, public services, and facilities, all under one roof via technology.

The project has focused on creating a centre that enables a coherent and smart flow of information through various infrastructural systems to provide easy access to public services and maintenance. The project went online in 2020 during COVID 19 pandemic and proved to be a very important instrument in management for the city administration. The project is implemented in a phase-wise manner. The first phase is completed, focusing on four packages: Solid waste management Intelligent Transport Management System, Citywide Surveillance, and Disaster management. All the packages are active with their benefits and issues discussed in this report. The second phase is ongoing, focusing on more projects under the ITMS(Intelligent Transport Management System).

In this research, the focus is on understanding the functioning of ICCC, adherence to SDGs, and identifying data gaps. The data collected is analyzed through various assessments such as ICCC maturity assessment, Sustainable development goal toolkit, and interviews and observations. Through the analysis of gathered data, some recommendations have been included at the end of the report.

Case Study: A30

1. Introduction

1.1 *Topic and Context*

The ICCC is a part of Smart City Proposals by Mangalore Smart City Pvt Ltd under the Smart City Mission initiative by the Government of India. ICCC is a "Pan City" project and is being developed in three stages-Design & Development Phase, Project Facilitation &Implementation Phase, and Operations & Maintenance Phase. This is a "smart governance and administration" project which aims at Smart Governance through the IoT[2] model. The ease of access to public services and efficient coordination of the infrastructural network are key objectives of developing a command center. The infrastructure network includes Governance, Healthcare, Transport networks, Surveillance, Connectivity (Virtual), Energy systems, Disaster management, and Security infrastructure[3].

The project is located in MG Road, Lalbagh, Mangaluru, Karnataka. Mangaluru has become one of the first cities in India to implement the command and control center completely Evident from the war room created during the COVID19 Pandemic helped the agencies monitor the situation and address issues from the residents. The ICCC went online after Chief Secretary Shri T M Vijay Bhaskar, Chief Secretary of Karnataka, Smart City Mission Director Shri Charulata Somal, and Shri. Nazeer, Managing Director, MSCL, who visited ICCC and inspected the live applications, "expressed confidence that the entire project can be operational within next two to three months" (Mangaluru Smart City command control centre has gone live, 2020). Although the construction is proposed to be finished by May 2022, the Center is already functional. The ICCC was integrated with the Mangaluru City Corporation building. The residents being the main stakeholders as they are the ones who are going to get benefitted the most have already witnessed the efficiency of the System during COVID19.

1.2 *Significance of the Project*

Integrated Command and Control center becomes the most vital part of the Smart City Mission for any city as it controls and monitors most of the other "smart infrastructure" installations. The ICCC becomes a unified system through which major components of a city's infrastructure and Governance can be managed through technology, all under one roof. For a city like Mangaluru, this becomes crucial to monitor and maintain its other smart city initiatives such as Smart Market, Smart Roads, Smart Parking, etc. This Center will help residents ease access to public services and infrastructure. It also helps in simplifying issues addressed in the process for the residents. Safety, one of the major concerns in any big city, is also a part of the system under the CCTV surveillance network. The Disaster Management & Emergency Response section, which got activated during the Pandemic, has helped the residents get a telemedical response and related instructions, hospital bed allocation, and even food arrangements in case various NGOs manage food supplies for migrant workers. The cell is active and can manage any disaster as per the ICCC framework. (Mangaluru becomes data-driven with Integrated Command Control Centre, 2021). The Smart City aims to manage disasters and responses through live tracking emergency response vehicles. This Center acts as a gateway between administration and citizens, where citizens can get access to help and address grievances. The Municipal Corporation also enjoys many benefits of having an ICCC in the city as it takes care of infrastructure management and brings about smart interventions to the problems faced by the citizens and the administration.

1.3 *Aim and Objectives*

This research aims to understand the functioning of the ICCC framework in the real world and critically analyze

Figure 1 Karnataka
(Source: Map created in GIS Software)

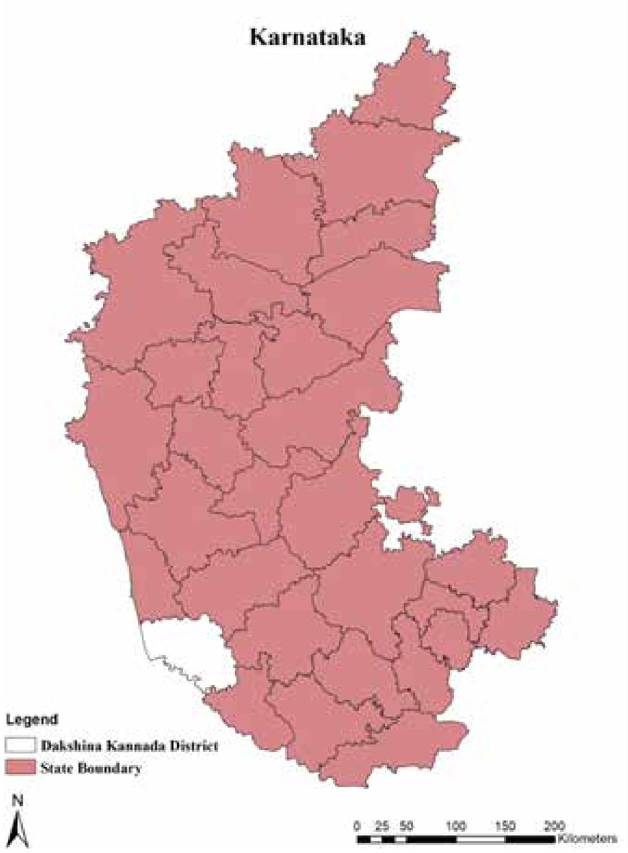

Figure 2 Dakshina Kannada district in Karnataka
(Source: Map created in GIS Software)

Figure 3 Mangaluru City
(Source: Map created in GIS Software)

the impact of this project on residents and the city's Governance and infrastructural needs.

Objectives-

- To understand the functioning of ICCC and its correlation with other projects under the smart city mission.
- To study the impact of the project through stakeholders
- To analyze the adherence to Sustainable Development Goals(SDGs)
- To identify issues and gaps in implementation, if any, and provide recommendations.

2. Contextual Background

Mangaluru holds great significance for the state of Karnataka, along with Bangalore and other major cities. It is one of the major port cities in the country and the only city in Karnataka to have all four modes of transport -air, road, rail, and sea. Mangaluru is an administrative capital apart from being an industrial, commercial, and start-up hub. The city has the administrative headquarters of the Dakshina Kannada district. It is also the only Indian city to be ranked in the top 50 livable cities globally (Quality of Life Index by City 2017, 2017). Due to these and other such factors, Mangaluru has become one of the most important Smart Cities for the KUIDFC in terms of smart infrastructure management. It acts as a tool for the government to control pan-city infrastructure and monitor everything under its jurisdiction.

Figure 4 ICCC was integrated into the MCC building at Lalbaug (Source: Map created in GIS Software)

2.1 Conceptual Framework/Research Design

The project has been divided into three major phases: Design & Development Phase, Project Facilitation &Implementation Phase, and Operations & Maintenance Phase as per DPR.

Phase one focuses on the Architectural design and development of the project. This phase also includes designing and developing One Touch Mangaluru Projects, City Wide CCTV surveillance, IT connectivity, and supporting infrastructure. This is followed by formulating the hierarchy and dependency network of various components. (Berger, 2018) The First Phase of the project was in 2019, with the following systems incorporated –

- Intelligent Transport Management only Vehicle Tracking System
- Solid Waste Management system
- Smart poles (15)
- Air Quality Sensors(5)
- DMER (Disaster Management and Emergency Response System)
- UMS(Unified Messaging System)
- One-Touch Mangalore (web app is online)

The second phase is the Project Facilitation &Implementation Phase. In this phase of the project, selecting a System Integrator takes place. The requirements for SI are laid down, and a project plan is formulated. This phase mainly focuses on strategy building for integrating Smart city projects with the ICCC and laying down various standards and procedures for the same. This also builds up the basic System infrastructural requirements(majorly IT) (Berger, 2018).

The Third Phase is the Operations & Maintenance Phase. This is the phase where the ICCC starts operating (goes live). As per reports, the ICCC became functional during the Pandemic in 2020. This operational phase activates the management and administration section, and monthly reports are also generated (Berger, 2018)

Figure 5 Hotline (Source: Authors)

Research Design

This research aims to understand the functioning of the ICCC framework in the real world and critically analyze the impact of this project on residents and the city's Governance and infrastructural needs. For this, the research methodology is as follows

Collection of Data-

Primary Sources-

- Site visit- Major points focused-
- Architectural Design and observation of the functioning of the Department
- Interview with authorities- including questionnaire

Secondary sources-

- Detail Project report – Mangalore Smart City
- Articles and blogs for the study of public feedback and awareness
- ICCC maturity assessment framework and toolkit
- Sustainable development goals impact the assessment toolkit.
- Analysis of data

The data collected has been analyzed to understand the functioning, benefits for the users /administration, and various issues in initiatives under ICCC. The Sustainable Development Goals are assessed using the SDG assessment toolkit to understand which goals ICCC adheres to.

2.2 Key features of the project

- The project is one whole system that becomes the platform for the seamless flow of information between various infrastructural bodies and other public services to produce smart solutions.
- Business intelligence and data analysis refer to all the methods, technologies, and strategies used to interpret, analyze, and draw inferences from the data collected.

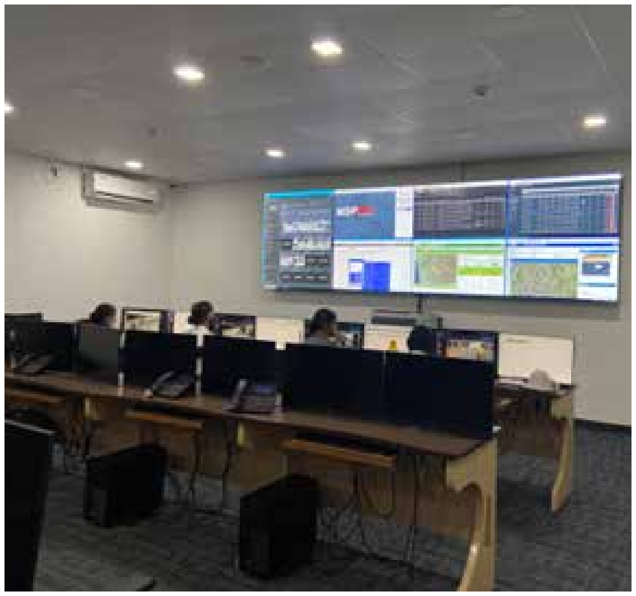

Figure 6 Space for 20 staff members (Source: Authors)

- GIS integration- The GIS is integrated with ICCC to achieve better management of IoT as they can now be geolocated. This would help in identifying locations for certain infrastructural works like where can be the waste dumped sustainably, placement of environmental sensors, etc
- SDGs – The project correlates to many SDGs, majorly Goal 11-Sustainable cities and communities, including Urban Governance.
- The Center has round-the-clock surveillance through CCTV cameras, which record the footage 24/7.

2.2.1 Challenges in the project

- Multiple systems across the city have to be integrated with ICCC to provide the required data for analytics.
- Data management is tough as the data is of varied sizes, types, and uses. The data acquired from road surveillance is a huge amount of data due to living feed compared to data from environmental sensors that are fixed, such as AQI.
- Managing various vendors with different contract durations is a hectic process and causes delays.
- The ICCC must be in line with all the departments, which causes multiple connection points that can become a point of failure.
- Extensive operations such as long-term data storage, round-the-clock surveillance, and then data analysis require robust architecture design and can sustain ICCC for a long time without changing the layout.
- Many systems exist in silos, and integration of them is a very big challenge for the management.
- Component failure may lead to data loss as the backend system could have the DR infrastructure support, but the distributed wireless sensors might not have the ability to store a large amount of data.
- Multiple citizens' connections in peak hours with ICCC and DC might lead to server overload.
- Dependency on GPS tracking devices for Intelligent Transport Systems.
- Due to the complexity of the systems, highly skilled staff is required.

2.2.2 Risks involved in the project

- The mismatch between the duration of contracts between Smart City and vendors can cause errors and delays in the implementation.
- There is no integration with 102, 108, etc., hotlines with ICCC, so the data collection will render useless if this integration does not happen in the future.
- Due to lack of full control, certain systems like the GPS-enabled bus system might fail because the driver can switch off the GPS.
- The central government's circular on selection criteria of vendors, which does not focus on QCBS[4] might lead to poor quality of work or delays.
- There are a few single-point failures, such as dependency on GPS for ITMS.

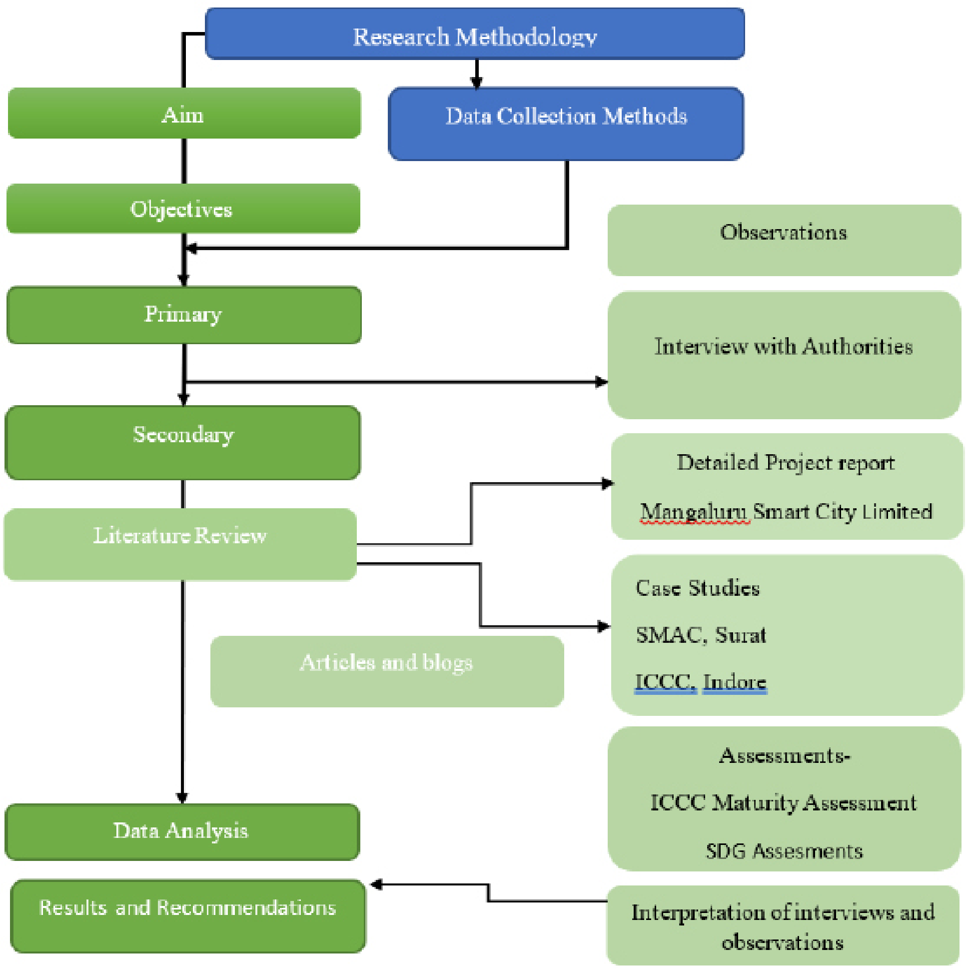

Figure 7 Research Methodology (Source: Authors)

2.2.3 Features and Benefits (social, technical, city administration level, impact on environment and economy) to the city (expected and observed)

- Features & Benefits through the establishment of the Center.
- Centralized Governance, one Center to control all the physical infrastructure in the city
- Issues addressal
- Ease of access to Public services
- Security and safety through Surveillance (CCTV Monitoring)
- Disaster and emergency response mechanism (Recent use – COVID-19 Pandemic)
- Sustainable development (adherence to SDGs)
- Environmental analysis-AQI, Advisory

Features & Benefits through the functioning of the Center (Use cases)

- Alert generation and the automatic dispatch would trigger an immediate response to an incident. UMS is also used for awareness creation.
- System management through IT with fail-safe features to ensure availability of Smart city features at all times.
- Integrating Intelligent Transport Management System (ITMS) would provide easy access to public transport.
- Round-the-clock surveillance with real-time analysis.

2.3 Key findings from the interviews, surveys, and primary/secondary data collection

As stated above in the research design, the primary sources of data were site visits, interviews, questionnaires, and observations

Figure 8 Environmental sensor data on the display wall (Source Authors)

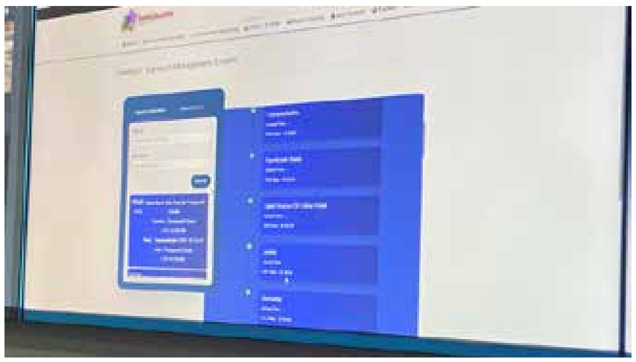

Figure 9 Bus tracking system on 1Touchmangaluru website (Source Authors)

Key findings from semi-structured Interviews with smart city officials

Refer to Annexure 1 for a full interview

From the interview with Mr. Manoranjan Rao (Deputy General manager, Mangalore Smart city ltd), the ICCC has already become a vital component of the city's infrastructure management. The functioning of ICCC is very systematic in terms of efficiency, response, and security. The ICCC played a major role in handling the crisis response mechanism during the COVID-19 Pandemic. It served as the central base of operations. It handled all the emergency responses such as ambulance, COVID hotline, Hospital bed allocation, Travel permits, etc. It also accommodated the police officers, medical staff, and others during the Pandemic.

According to Mr. Manoranjan Rao. The first phase of the project was completed in 2019. The second phase is ongoing.

The ICCC has four packages-

- Solid Waste Management
- ITMS-Intelligent Transport Management System
- Surveillance
- Disaster management and emergency response system

In addition to this- UMS (Unified Management System)

Solid Waste Management System

The SWM is done in a very innovative way. Around 90,000 houses are equipped with QR codes along with the collection vans.

The garbage collector is supposed to scan the codes after collection, which is then updated in the system and is visible on the monitor at ICCC. The collectors are compensated based on weight and kilometers traveled.

The residents can also scan their QR codes if their garbage was not picked up, but this is yet not available as the app is not released to the public. The application is ready for the android platform but not for IOS (iPhone).

Observations-

The software, hardware, and infrastructural components are given to various vendors with different contract durations, making the functioning difficult.

The display wall shows ample information for authorities to take quick action.

Key Benefits for the citizens –

- Systematic way of garbage collection
- Grievance addressal from anywhere through application

Key Benefits for Municipal Corporation –

- Intelligent monitoring of waste collection
- Easy tracking and grievance addressal

Issues-

- The workers are hesitant about the scanning system as it is additional work.
- The workers do not go to every house to collect garbage, or they do not scan the codes
- The Mangalore City Corporation owns these vans. When they go out of the corporation limit, they are assigned a supervisor, but that data is not shared with ICCC

ITMS (Intelligent Traffic Management System)

Mr. Manoranjan explains that the basic aim of this system is to help people plan their trips better. The ITMS is currently only applicable to city buses. This works on the principle of PIS(Public Information System) and monitoring. The entire journey of the bus can be monitored through GPS.

There are two types of data in this -One is user data, and the other is data for authorities. User data includes only vital information for a user to plan his travel, such as time of arrival, next bus &, etc. Whereas for the authorities, it provides all monitoring data.

Observations-

The section on the display wall shows all the information pertaining to the driver's location, along with alerts and reports about their trips.

As explained by the officials, there are currently 285 buses equipped with GPS, but only 150 are connected as the bus driver has the option to turn it off.

Figure 10 ICCC, Mangalore Smart City office (Source Authors)

Figure 11 SWM -live (Source Authors)

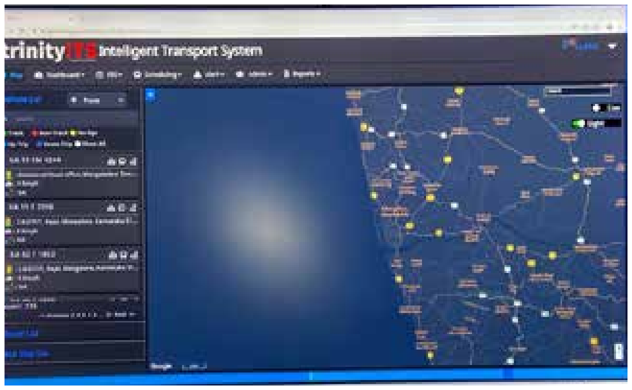

Figure 12 The ITMS screen showing bus locations on the left window (Source Authors)

Figure 13 Surveillance footage -LIve stream from the CCTVs at junctions and smart poles with PTZ cameras (Source Authors)

Figure 14 Smart Pole with 4 fixed focal length cameras, one PTZ, and a digital screen showing information related to AQI (Source Daijiworld Media Network - Mangaluru (SP))

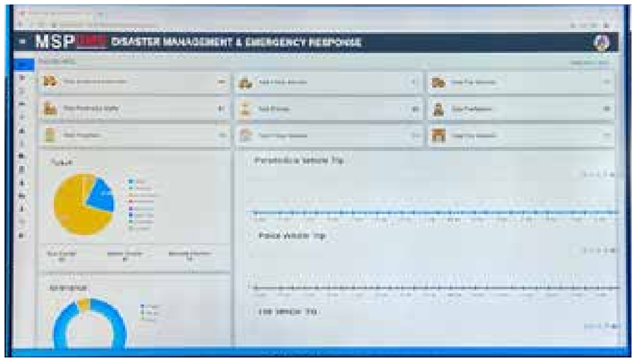

Figure 15 DMER screen showing the number of emergency response vehicles and the total number of disasters (Source Authors)

The PIS information is displayed on only smart bus stops and the Chalo app.

Key Benefits for the citizens –

- Ease of making their travel plan as they can see the next bus, arrival time, travel distance, and time.
- PIS – users will be able to see which is the next bus, and what is the estimated time of arrival, origin, and destination. By knowing this, citizens would be able to choose an alternative mode of transport if necessary,

Key Benefits for Municipal Corporation –

- GPS-enabled tracking system helps the authorities know if the driver has changed course, monitor the driving, and alert traffic police in case of violation, rash driving, or any accident.
- Since the users can book a ticket through the Chalo app, it becomes easier for authorities to track real-time transactions centrally, the number of trips, the required number of buses, and the study of origin and destination for future planning.

Issues-

- The bus drivers can see other bus drivers' locations through which they try to delay other drivers. The drivers switch off the GPS.
- The Smart bus stop vendors and Smart city do not match the contract duration.
- The app from Mangalore Smart City Ltd is not yet released to the public.

Surveillance

The lanes were developed specifically for residential and The surveillance system includes monitoring traffic and citizens through CCTVs across the city. According to Mr. Manoranjan Rao- Surveillance is mainly focused on crowd management. Crowd management focuses on monitoring the order during a major event, or large public gathering. There are around 15 Smart Poles equipped with four cameras, each of fixed focal length and one PTZ (pan, tilt & zoom) camera. The city police use this extensively for crime detection, inappropriate behavior in public places, etc.

In the figure below live stream from the CCTV cameras is shown on the display wall. The staff also showed live tracking through PTZ cameras with 360 rotation.

Observations-

- Surveillance is very efficient in monitoring the public, crime detection has also taken place, and theft cases have been solved by tracking the movement of the culprit.
- The display quality of the fixed, as well as the PTZ cameras, is very good as most of the required information to track a vehicle or a person is visible.
- Data Sharing- According to Mr. Manoranjan Rao all the data, including the live feed, is shared with the city police. The footage from cameras is not shared with the public at any cost, only with police and on court order.

Key Benefits for the citizens –

- Faster response - In case of theft or any mishap, the citizens can file a complaint with the police; the police can directly use either stored or live feed from the cameras to address the issue faster.
- Sense of safety – A person feels safe in a controlled environment (What factors are linked to people feeling safe?, 2020).

Key Benefits for authorities –

- The most benefitted agencies would be the Traffic police and the police department of the city as they can live track every movement in the city.
- The real-time feed gives police the ability to take immediate reaction such as alerting nearby police chowki or even other agencies such as Quick response force, etc.
- Facts can be verified through footage in case of a claim in courts.

Issues-

- According to Mr. Manoranjan currently, there are no ANPR Automatic Number Plate Recognition, Red Light Violation Detection (RLVD), and Speed Violation Detection (SVD) Systems in place, so all the monitoring is done manually.

Disaster management and emergency response system

This cell played a major role during the COVID 19 Pandemic. The ICCC went online in 2019. This cell was the central base of operations for COVID response and has functioned well. The cell is also responsible for responding to any other disaster or mishap as well.

Observations-The DMER section on the display wall shows the locations and status of all the emergency response vehicles. Through an interactive menu, the staff member can easily monitor the vehicle and alert a nearby vehicle to respond to the disaster.

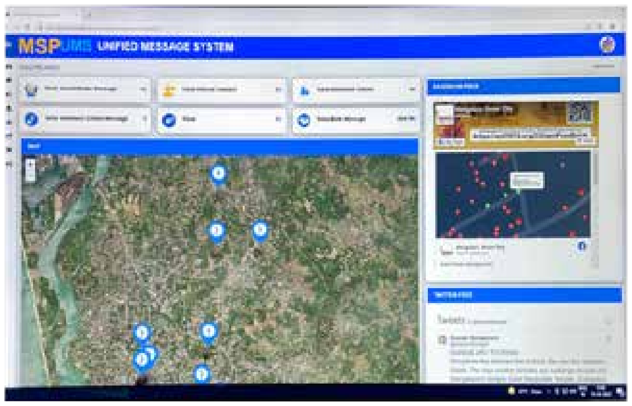

Figure 16 UMS screen showing the location of smart poles and live messages on various social media handles (Source Authors)

Figure 17 Server Room (Source Authors)

Figure 18 Biometrics Control Entry (Source:authors)

Key benefits to the users

- Quick response to distress calls
- Monitoring various environmental attributes helps in issuing an early warning to the citizens.

Key benefits to the Authorities

- One-stop management of the emergency response mechanism.
- Alerts can be sent through UMS about a disaster
- DMER can track all the tickets till they are not solved

Issues- As explained by Mr. Manoranjan Rao, The DC office has shifted their operations here during COVID, 1077 hotline was here, but now they have moved back to the DC office. There are many features like ambulance tracking, hospital bed allocation, and fire tender tracking, but the data from 108, and 102 hotlines are not shared with ICCC; hence this data is not being utilized.

UMS Unified Messaging System

This is a mass alert/warning system in which a text message or a popup is sent to mobile devices by the government to warn against a disaster, sudden change in rules, or curfews. This system was extensively used during COVID for sending out RTPCR test appointments, Curfew timings, Vaccination appointments, and bed allocation.

- The key benefit for users is that they do not have to seek basic information from secondary sources about a disaster or any orders issued by the government, they can simply receive a message through UMS.
- The key benefit for authorities is that they can issue warnings, alerts, or messages across multiple platforms to reach citizens.

Figure 19 SMAC, Surat
(Source: Surat Smart City)

Figure 20 Indore ICCC
(Source: Times of India)

Issues: There is a disagreement between authorities regarding financial factors as none of the bodies (DC office, MCC, and ICCC) has a provision or protocol for this.

Data management and security

All the data is currently stored in the servers present at ICCC. The management follows an open data policy, so all the data is available to the public except CCTV footage data.

For all the four packages, there are separate vendors for Software & hardware development and installation. This causes data to be fragmented and might cause errors. The management will shift this Data to ICOP (Integrated City Operation Platform), which is a front-end application.

The authorities can see all the data for seven cities at one central location, ICOP. The KMDS will host all the data, this will be a soft migration of data.

Observations-

The main aim is to make data available at a common interface. This also increases data safety and reduces the risk of data loss as KMDS will use a cloud-based server. Data redundancy and data centers are also in place for the same.

The PCs utilized by the staff (20) all have disabled USB ports to prevent data theft except five, which are help desk PCs.According to the official, there has been no hacking attempt because the data does not hold any commercial value.

To prevent hacking, there are multiple firewalls installed and regular inspection is also done.

Public Participation

According to the official, the people don't understand ICCC because of its complexity for a layman. They do not show interest in learning about it. The public has been invited many times, but no significant input was observed.

The next step to increase public participation would be through feedback from the apps which are not yet released to the public. Reasons being political pressure, the app is only available for one platform, etc.

Key findings through case studies

SMAC, Surat and ICCC, Indore

he Smart City Centre is an Integrated Command and Control Centre launched in June 2016. The centre has been operational since then. The ICCC at Indore was completed only in seven months, and Indore became the fifth city to have a functional Command and control centre.

The centre collects all the information from various departments and sends it to the Surat Municipal Corporation for decision making. Automated sensors and other systems send data to ICCC for analysis and real-time tracking. It provides a centralized approach toward disaster management as well, and all the departments are connected to ICCC, Both projects work similarly to the ICCC at Mangalore, with differences being in terms of implementation. There are a few systems that are yet to be incorporated in the Mangalore ICCC such as Water Treatment Plant (WTP) SCADA Sewage Treatment Plant (STP) SCADA, Citizen Grievances and Redressal System, Property & Water tax (both SMAC and ICCC already have these operational), Automatic vehicle location system(AVLS)and Automated Fare Collection System(AFCS)(operational in Indore ICCC).

SWM – the Indore ICCC has more tracking and monitoring functions.

Results and Impacts-Round the clock surveillance and monitoring of the city help in crime detection, safety, management, and maintaining infrastructure efficiency.

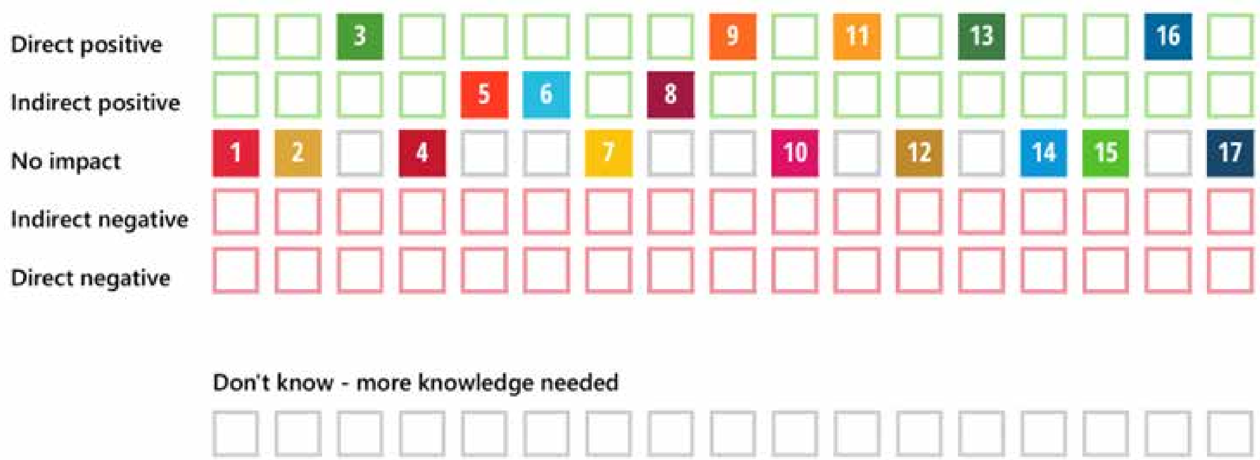

Figure 21 SDG Assessment Toolkit results

When all the functional information comes to a common platform, it becomes easier and more efficient to make decisions than the earlier practice of requesting different information from multiple departments. (Surat bags overall best smart city award, 2020).

3. Discussion and Conclusion

3.1 Implications

ICCC maturity assessment framework (ICCC Maturity Assessment Framework and Toolkit, 2018)

- Based on three aspects-
- Functional
- Technology
- Governance

Refer to Annexure 2 for a full assessment

Results-74.39 % Maturity rating (overall)

Functional maturity -81.82%

This assessment shows how functional is ICCC in terms of management of services provided by the ICCC and by the city. It also focuses on Transport management, Disaster response, safety and security, and convergence of these aspects.

81.82% is a high score which suggests the ICCC is functioning well in the above parameters.

Technological maturity-84.21%

This assessment provides results about the methods, technology, and equipment used for making the ICCC functional. This includes assessing hardware and software capabilities, for instance, data analytics, data storage, sensor data, etc.

84.21% is again a high score similar to the functional maturity assessment, as the Center cannot function without having good technological support or framework.

Governance maturity-57.14%

This assessment covers the governance framework, which includes working for staff, various policies, and SOPs. Without a well-structured framework, the ICCC won't be able to work to its full potential regardless of the technology available.

50% is a very low score as compared to the two above. The major issue is jurisdiction and ownership, for instance, the garbage vans are owned by MCC, but ICCC does the management. The ICCC does not have all the decision-making powers. It has to go through DC's and MCC's offices. There are different vendors with different contract duration, and also the current team managing the ICCC is there only for one year.

SDGs(Sustainable Development Goals)

The sustainable development goals are assessed by using the SDG impact assessment toolkit (Sustainable, 2022) The result comprises five types of relations-Direct positive, Indirect positive, and no impact[5] Indirect negative, and direct negative. (Source (Sustainable, 2022))

SDGs Identified are

Direct positive:3,9,11,13,16
Indirect positive:5,6,8
No impact:1,2,4,7,10,12,14,15

Table 1 SDG Goal assessment

SDG Goal	Impact
Direct Positives	
Goal 3- Good health and Wellbeing	Through the use of UMS, citizens can be alerted. The ICCC worked efficiently during the Pandemic (COVID 19) as a backbone for the city administration to provide emergency response.
Goal 9- Industry, Innovation, and infrastructure	There is extensive use of technology, for instance, the use of QR codes for scanning in SWM, Smart poles, Smart bus stops, etc. The development of ITMS for City buses is another innovative way to ease the access to public transport.
Goal 11- Sustainable Cities and Communities	The ICCC aims to monitor the environment through various sensors like AQI, Temperatures, Storm warning systems, etc. Through ITMS, sustainable and efficient transport is planned. The city-wide surveillance system helps in reducing crime and also improves crime detection. All the information regarding emergency response during a disaster is available at the Center, such as the location of fire tenders, and ambulances.
Goal 13- Climate Action	The Center is focused on reducing the impact of human activities on the environment through the Smart City mission.
Goal 16- Peace, Justice, and Strong Institutions	The ICCC hosts all the live feed from the CCTV cameras and also shares it with the police department. There are traffic police constables present in the ICCC for regular monitoring and issue of challans. The police were able to use the surveillance system to solve cases and monitor major events.
Indirect Positives	
Goal 5 – Gender Equality	Through ICCC there is no provision as of now, but they have planned to integrate police patrolling vans to ensure women's safety.
Goal 6- Clean Water and Sanitation	The ICCC hosts the Municipal water management system data
Goal 8-Decent Work and Economic Growth	There is a training and internship facility available at ICCC

Source-SDG assessment toolkit (Sustainable, 2022)

3.2 Limitations of the research

- This research is limited to understanding the functioning of the ICCC
- Quantitative surveys based on daily or weekly activity mapping are beyond this research's scope.
- Public surveys and questionnaires are not included. Only the authorities' interviews are included as the app is not available to the public for feedback.

3.3 Key lessons learned

a. An ICCC is an important component of the Smart City Mission for all 100 cities. It provides a common platform for various systems that run the city.
b. One of the most crucial parts of the functioning mechanism for ICCC is coordination with governance bodies. In the case of Mangalore, there is a very good relationship between MCC & Mangalore Smart City Ltd, which enables the Smart city to develop the projects smoothly.
c. A holistic approach is the best approach when it comes to city infrastructural needs. All aspects should be covered like the Transit system, Safety, and Security, and waste management. These should be centrally controlled for smooth operations and monitoring.
d. A city can be very efficiently maintained via the ICCC as it proved to be a backbone in terms of management for all the operations of various civic bodies across the city during the Pandemic.
e. Through ICCC, an immediate response can be generated to any disaster or mishap in the city as all the departments are interconnected. Maximizing the use of technology such as UMS is very important in creating awareness, guiding citizens properly & providing necessary services. Through round the clock monitoring, a city can become safe and disciplined in very less time, as evident from the reduction in the number of challans issued during the beginning and today(300 per day to 100-150 today)
f. ICCC, combined with MCC or any municipal corporation, in general, can make citizens' lives easier. For citizens, services such as Smart Bus stops with PIS, SWM with QR codes, Grievances addressal through the application, etc., make ICCC the support mechanism for the municipal Corporation to carry out its functions more precisely and efficiently.

3.4 Recommendations

Award of tender

Quality cum Cost-Based Selection (QCBS) – Evaluation based on the cost committed by the bidder and the technical qualification of the bidder. This method should be focused more on ensuring the quality of service and products and reducing completion time.

SWM-

- There should be a method such as a levy of penalty on either the garbage collector or the vendor for not scanning the QR code or not collecting the garbage.
- At least one member from Municipal Corporation should be present to monitor or advise on the functioning.
- There should be an awareness campaign done before the release of the app to make citizens aware of the initiative.
- There should be full public disclosure about how the QR codes are safe and would not lead to addressing tracing by a third party.
- The dump yards can be further used for the development of recreational parks

ITMS

- The contract duration of the vendor should match Smart City's duration.
- There should be a fail-safe procedure if a bus driver turns off the GPS unexpectedly. For instance, as the driver can turn it off, there should be a supervisor who can call up and ask the reason. Another way would be to block the option of turning it off altogether.
- There can also be a similar initiative towards Auto rickshaws or local taxis.

Disaster Management and emergency response

- There has to be an integration between the DC office and ICCC. ICCC's disaster cell has useful information that can prove vital during a crisis.
- Integration of various hotlines such as 100, 108,1077, etc., should be done with ICCC as its Center. This can be combined with UMS, which will help control the response faster as it will become a centralized process.

For Phase 2

- The state and central government should provide clear financial protocols for projects which involve Smart City and Municipal Corporations.
- The QCBS should be the way forward for awarding projects
- Feedback from the public should be considered with utmost importance and for that, the Applications should have a feedback form/section. Annexure 1

Assessments and parameters

Table 2 Assessments

Integrated Command and Control center		
Assessments		
	Parameters	Typology
1.1 Data		
Control	Collection- How and what quantity of data is collected	Interview
	Control- Who controls the data, who has the authority over it	Interview
Type		
	Nature of Data collected-qualitative or quantitative	Interview
	Full Public Disclosure -Community Data	Interview
1.2 Framework		
	Administration & Governance model -Hierarchy -Workforce	Observations
Observation	There is a proper hierarchy followed for work division	
	Data Channeling	Interview
	Fallback Procedure (fail -safe)	Interview & Observation
Observation-	Data Centers and Data Redundancy are present, migration to KMDS will upload all Data to a Cloud-based system	
	Command & Control Standard operating procedures	Interview
	Technological Assessment	
1.3 Architectural Aspects		
	Space Requirements -Accommodation for a team -Space for equipment & furnishings -Workplace condition(ergonomics and proximity)	Observa-tions
	The Display wall consists of all the packages along with AQI and Environmental Sensor data. The required accommodation is available for a workforce of 20 professionals The server room is equipped with fail-safe measures. A separate power room for supply to the entire workspace is also present The workplace is in good condition with basic facilities like air conditioning, biometric security features, etc	
1.4 Infrastructural aspects		
	Flexibility	Interview
	Maintenance -Regular preventative maintenance -Regular System checks -Update -Repairs	Interview & Observation
Observation	Regular maintenance is done . There are fire safety measures installed	
1.5 Risk Assessment		
1.6 ICCC Maturity Assessment	Functional , Technological& Governance assessment	ICCC maturity and framework assessment toolkit
1.6 SDGs		
	Identified Sustainable Development Goals	Obser-vations & Toolkit
Toolkit results	SDGs Identified are 3,9,11,13,16 (direct positive Indirect positive-5,6,8 No impact-1,2,4,7,10,12,14,15	

(Source Authors)

Interview with authorities
Meeting between **MUDD Team** and Mangalore Smart City

Date:15.03.2022

Location: Mangalore Smart City Office, MCC building, Mangalore

Participants	Designation
Arun Prabha	General Manager, Smart City
Manoranjan Rao	Deputy General Manager
MUDD Team Purushottam Kesar	Faculty
Aishwarya Joshi	Student
Vanlalruatfeli Bawitlung	Student
Raghav Chawla	Student

Interviewer – MUDD Team

Interviewee- Mr.Manoranjan Rao

Deputy General Manager (IT)

Introduction given by Manoranjan Rao about the project- The first phase of the project was completed in 2019, and the second phase is ongoing.

The ICCC has four packages-

- Solid Waste Management
- ITMS-Intelligent Transport Management System
- Surveillance
- Disaster management and emergency response system
- In addition to this- UMS (Unified Management System)

In addition to this- UMS (Unified Management System)

- Solid Waste Management System-Under this system, individual dwelling units, and the garbage collection vans are equipped with QR codes. The collector has to scan the QR code after the garbage has been collected. There are currently 90,000 houses that are already equipped with the codes. The daily report is sent to MCC

Issues-
- The contract between SWM workers and the company is not good. They are hesitant about it, it's additional work for them.
- The workers do not go to every house to collect garbage.

This system aims to monitor the garbage collection and monitoring, and all the vehicles are fitted with GPS, and their location can be traced. Whether they have gone to their designated wards or not, how many vehicles are in transit is also monitored. The billing or their compensation is based on the kilometers they have traveled and the weight of the garbage collected. The garbage is then dumped into the dump yard.

2nd phase would include ward wise weighing of the garbage (right now, they are all collectively done at the dumping yard)

The users or the residents can scan the QR Code to address their complaints. For example, if the garbage was not collected from their homes, they can file a complaint through an app. (not yet released)

MUDD Team- Is the Corporation coordinating with the Smart city in this?

Manoranjan Rao-Yes the System uses cloud-based data management. The user ids and passwords are shared with Corporation for them to analyze. The supervisor has been given an app to register, monitor & address the grievances.

Mangalore City Corporation owns the vehicles, and these people then go out of the corporation limit and data packages. Whenever the vehicle goes out of the boundary limit, there is an alert on the system. The vehicles are then allotted a supervisor. People can complain about the garbage on the road or of not collected from their homes via calling the 106 number but that data is not shared with ICCC.

MUDD Team- Who maintains the software, does the Corporation has a say in this?

Manoranjan Rao-No. the maintenance is with the vendor under the contract. The contract covers implementation and maintenance for 5 years.

MUDD Team- Is the Smart City ready to give full control to the Municipal Corporation?

Manoranjan Rao-The Smart City is ready to hand over the project to the corporation discussions are also going on, it is their willingness to take.

MUDD Team-How are the funds allotted?
Manoranjan Rao-There is an escrow account to which all the funds can be transferred.

MUDD Team-Why has the Corporation not yet taken over, what are the current issues?

Manoranjan Rao-This would be like additional work, extra cost, checks, and balances.

MUDD Team- What are the impacts of the implementation?

Manoranjan Rao- The SWM started 6 months ago. The feedback has to be given by the citizens but the app has not yet been released to the public (The development of the app is complete).

The SWM is in place but there is no person from Corporation to monitor it.

ITMS-Intelligent Transport Management System

Manoranjan Rao- The main aim of this is to make people plan their trips better. The system is supposed to provide all the information required to plan their journey by checking the bus route, stops, schedule &, etc all digitally available via the app.

The ITMS is only applicable for buses, the city buses are equipped with GPS (285 but only 150 are connected) installed by Chalo

The Chalo app is free of cost which provides the user interface and a pre-loaded card is also in process. Raw Data has been provided to the Smart City (APIs) only for private buses

NURM buses -40 in number equipped with GPS

Issues- The bus drivers can see other bus drivers' locations through which they try to delay other drivers. The drivers switch off the GPS.

MUDD Team- Are you planning to release the software?
Manoranjan Rao- Yes, but some problems are there like -political pressure during the inauguration. The app can be released to the public only then they will come to know about the problems regardless of how many measures they have already taken to make it robust.

MUDD Team- Has the software been given to a vendor?
Manoranjan Rao- Yes, Madras Security Services Pvt Ltd. They are responsible for the installation and production of software, hardware, Smart poles, etc with maintenance.

MUDD Team-What was the budget?
Manoranjan Rao-The budget was 39 cr but they quoted 24 cr only(45% negative)

QCBS-The smart city had proposed the same but the circular from the central government asked not to go with QCBS. Two more bids were considered to make it L1

For the 2nd phase, Smart City wanted to go for QCBS but again L1 according to the government circular. Now there is a pre-evaluation committee that judges the bids. Due to this process, there is a significant delay, this project was supposed to be completed within 9 months but it took 2.5 years. (2018 finalized)

MUDD Team- Is ITMS Integrated?
Manoranjan Rao- Yes it is integrated, but the app is not yet released.

User Interface & Authority Data
Authority data will have more points – Whether the driver has completed the trip. Timestamps, rash driving, jumping signals, etc. But the user data will have fewer points such as the expected time of arrival of the vehicle, destination & which is the next bus.

MUDD Team- You haven't put up any signboards?
Manoranjan Rao- Yes we have one on the bus stops which shows all the information. It is not the part of the normal bus stand it is a part of the Smart Bus stand only. Smart bus stand has its vendor, the contract is only for one year, so there is a mismatch of contract duration between Smart City and them. There are 20 Smart bus stops in place with PIS (Passenger information system)

MUDD Team- Will the MCC take over all the installed infrastructure?

Manoranjan Rao- Yes immediately, The smart city is an SPV that is supposed to build the infrastructure make it operational, and then hand it over.

Surveillance
Manoranjan Rao- The main objective under Surveillance is crowd management. The surveillance cameras are put up at junctions to monitor traffic violations also.

MUDD Team- What is meant by Crowd management?
Manoranjan Rao- We has mainly put injunctions, where we can monitor traffic violations. But it cannot scan the number plates as of now that system will come in 2nd phase because the vendor did not invest.

For video analytics, we need to buy higher licenses for individual applications. For ANPR and red light violations, there are special cameras required, which are not installed only surveillance cameras are there.

Now there are 15 smart poles in place, each smart pole has 4 fixed lens cameras and one PTZ (pan, tilt, and zoom) camera. Entire 360 surveillance- during an event everybody can be monitored for inappropriate actions, theft cases have been solved by using these cameras by tracking every movement of the culprit.

MUDD Team- Is the Data then given to the Traffic police?
Manoranjan Rao- Firstly- The traffic police constables come to ICCC (4 traffic constables) with wireless equipment from morning 9 am to 6 pm every day, they issue challans from here by monitoring through video, around 300 challans were issued daily but now the number has been reduced to 100. The same feed is also shared with the police station.

The data is stored for 20 days on the server then it is put in a drive and is stored permanently.

This is also used in crime detection. Extensively used by police.

The second thing is this data (footage) is not shared with the public at all, only shared with police and court on order.

MUDD Team- All the Data is not shared with the public or only the footage?

Manoranjan Rao- Only footage is not shared, the rest is available on the web app.

MUDD Team- Have you prepared any protocol for data sharing?

Manoranjan Rao- No, we have not framed anything it is an open data policy provided by the government (mainly APIs)

Disaster management and emergency response system-

Manoranjan Rao- Disaster management and emergency response system. The district has got a disaster management cell which is at present in the DC office. During COVID waves 1&2 they shifted operations here .1077 hotline number was connected with ICCC and there were around 40 people here. All emergency response was generated from here including the permits, consultations &, etc. All the coordination for food supplies for migrant workers was also done from here.

2nd Wave was not so intense, we were involved in hospital bed management. (allocation of beds according to RTPCR number)

Other mishaps like someone has fallen into an open-pit etc were all monitored and responded to from here. All other disasters like landslides, flooding &, etc were also handled from here. But now 1077 has shifted back to the DC office. There is no connection with the DC office and ICCC for disaster management now.

MUDD Team- What is the future of this cell then?
Manoranjan Rao- It has to be taken over by the DC office. The entire system is developed based on Disaster management SOPs. The application is from bottom to top but the report format to be submitted is given by Center so the correlation is difficult.

MUDD Team- You has so many apps for different uses, how is all this managed?

Manoranjan Rao- We have separate vendors for separate apps. We have got ICOP (Integrated City Operation Platform) which is supposed to be hosted by KMDS, Bangalore. ICOP connects all the seven cities to the government. All the data will be moved to KMDS except Surveillance data.ICOP is a front-end application, all the data as of now is collected in our servers but then it will be available in ICOP through a cloud-based server via KMDS. The advantage is that all the data will be centrally stored and management will be able to look up data for any city. Data Centers & Data redundancy systems are available to make it robust. The existing servers will be used for the second phase.

MUDD Team – Is the ICOP used for increasing efficiency or safety?

Manoranjan Rao- it is used for providing a common interface on which you can run any application.

It is service-oriented architecture. More like a data extraction tool to run the application. KMDS will only manage the data.

MUDD Team- Can any amendments be then done here, if any new type of data is required?

Manoranjan Rao- Yes amendments can be done here, KMDS is only hosting the data

MUDD Team- Currently there is a close relation between ICCC and MCC, so what will happen once the data is shifted to KMDS?

Manoranjan Rao- This process is just a soft migration of data. ICCC comes under DC and is working in synergy.

UMS -Unified messaging System-

MUDD Team- You have to coordinate with various telecom vendors for pushing the message?

Manoranjan Rao- No, the vendor is supposed to do that with 5-year maintenance under contract. The bandwidth is not sufficient.

SMS gateway is available -2 types of providers

Private & Government
Each gateway provider has a tie-up with telecom vendors. There are two selection criteria, the efficiency of transmission and cost.UMS was used extensively during COVID. The efficiency was around 90%. Popup messages don't cost. DC & MCC are divided on the cost factor because there is no provision for payment.

MUDD Team- How much public participation was there in the ICCC setup and other piolet projects? What role did they play?

Manoranjan Rao- The people don't understand what it is so very less participation. They are invited but they don't understand so the concentration is very low. We have spent 14 crores but it is not visible to the public unless the app is available.

For phase 2 mainly traffic management is there along with smart parking. We wanted to connect patrol vehicles but there is a loss of coordination as the data from 100, 108, etc hotlines does not come to ICCC

MUDD Team- What happens if the server fails or some accident has happened the how is the system run?

Manoranjan Rao- That is done by data redundancy, data systems, and KMDS. The data is secured from hacking via firewalls and inspections are done.

MUDD Team- Have there been any data leaks or data loss or theft?

Manoranjan Rao- Regular inspections are done, no pc has enabled USB ports(20) except 5 which are help desk pcs.

MUDD Team- How much staff is there?
Manoranjan Rao- 5 permanent staff

MUDD Team- Are there any special provisions for Women?

Manoranjan Rao- There is a hotline that connects to police patrolling vans for women's safety. But this is not connected to ICCC yet.

Functional Maturity Assessment Criteria

Maturity Rating	Low	Medium	High
Score	<50%	51%-80%	>80%
Simplified Scoring	Yes=1	No=0	N/A information not available)
		Score	Total
Funtional Assesment			
Data Acquisition and Visualization Capability Assessment			
Have sensors devices, and activators been deployed as a part of field infrastructure?	Yes	1	
Are the sensors deployed on the field geo-referenced?	Yes	1	
Do the sensors provide real-time data?	Yes	1	
Is the sensor data available at the command center?	Yes	1	
Is the domain application data available at the command center?	Yes	1	
Is the sensor data available in a geo-referenced manner at the command center	Yes	1	
Is the data from the respective domain application/ smart solution available in a geo-referenced manner at the command center?	Yes	1	
Data Analytics and Co-relation Capability Assessment			
Is the data from sensor/ systems analyzed with data from other sensors/ applications based on the time of the event?	Yes	1	
Is the data from sensor/ systems co-related to data from other sensors based on the location of the event?	Yes	1	
Does the co-relation from multiple sensors/ systems result in the generation of alerts/ exceptions?	Yes	1	
Does the co-relation offer prescriptive actions from the event?	Yes	1	
Command & Control Capability Assessment			
Does the system offer standard operating procedures based on alerts?	Yes	1	
Does the system provide a real-time view in terms of video, geo-location post generation of alert?	Yes	1	
Are the standard operating procedures (SOP) defined to include the point of contact responsible?	Yes	1	
Are the standard operating procedures defined to include action for Is the person responsible?	N/A		
Are the standard operating procedures defined to include pre-requisites?	Yes	1	
Are the standard operating procedures defined to include procedures?	Yes	1	
Are the standard operating procedures defined to include on-field/premise assets?	N/A		
Communication			
Is the communication protocol (mode, contact details, alternates) included in the SOP?	Yes	1	
Does the system provide for audio communication over multiple channels to the first respondent?	N/A		
Does the system provide for video communication to the first respondent?	No	0	

Maturity Rating	Low	Medium	High
Does the communication channel provide for recording and playback?	Yes	1	
	Total Score	18	22
ICCC Functional Maturity Level		81.82%	
Technology Assessment			
Data Acquisition			
Integration with Sensors	Yes	1	
ETL Capability	Yes	1	
Integration with Video Feeds	Yes	1	
Integration with Data Feeds and Publishing Data Feeds	Yes	1	
Configuration Layer			
Configuration of SoP, Alerts	Yes	1	
Configuration of GIS	Yes	1	
Configuration of SLAs	Yes	1	
Configuration of Data Security Features	Yes	1	
Configuration of Network Control	N/A		
Configuration of User Access Control	Yes	1	
Data Analytics and Co-relation			
Sentiment Analytics	Yes	1	
Predictive Analytics	N/A		
Prescriptive Analytics	Yes	1	
Diagnostics Analytics	Yes	1	
Descriptive Analytics	N/A		
Video Analytics	No	0	
Command and control			
Operations	Yes	1	
SoP Control	N/A		
Access Control	No	0	

Maturity Rating	Low	Medium	High
Device Control	No	0	
Sensors Control	Yes	1	
Field Force Control	Yes	1	
Asset Control	Yes	1	
	Total Score	16	19
ICCC Technological Maturity Level		84.21%	
Governance Assessment			
Governance Framework			
Approved Data Governance policy is in place?	No	0	
Approved Co-Creation and Data Sharing policies are in place?	Yes	1	
Approved CCC Management Structure is in place?	Yes	1	
Approved CCC Resourcing Policy is in place?	N/A		
100% CCC Seat occupancy SLA monitoring is in place?	No	0	
Interns onboarding policy is in place?	Yes	1	
ICCC Training and Capacity annual udget is in place?	Yes	1	
Support to Field Force (Vendors, Contractors, Officers, Employees etc.)			
Does Field Force use a mobile app connected with CCC?	Yes	1	
Does Field Force use ICCC GIS service for day-to-day operations?	Yes	1	
Field Force can communicate two ways with City CCC?	N/A		

Maturity Rating	Low	Medium	High
Field Force SLA monitoring is in place?	N/A		
Scientific Work/ area allocation through ICCC analysis?	N/A		
Decision Making Framework			
City Leadership can decide on a weekly and daily basis using ICCC analytics?	Yes	1	
Area-wise/ Department-wise KPIs are configured in ICCC?	No	0	
City Leadership can assess the performance of its City Leadership can assess the performance of its officers/ employees through KPI compliance using ICCC?	No	0	
Knowledge Management			
Is Knowledge Management application/ services are operational for managing knowledge example critical documents, case studies, local knowledge etc.?	Yes	1	
Stakeholders can update any piece of information or intelligence in Knowledge base using ICCC interface?	No	0	
FAQs for services, processes, and utilities are made available to citizens?	No	0	
	Total Score	8	14
ICCC Governance Maturity Assessment		57.14%	
Maturity Rating	Low	Medium	High
Marks Awarded	1	2	3

Maturity Rating	Low	Medium	High
Score	<50%	51%-80%	>80%
Overall Integrated Command and Control Maturity Assessment:			
ICCC Maturity	Functional	Technological	Governance
Score	81.82%	84.21%	57.14%
Overall Score	74.39%		
	2-Medium Maturity		

(Source (ICCC Maturity Assessment Framework and Toolkit, 2018))

4. Citations

[1]CAPEX and OPEX represents capital expenditure amount and operation cost respectively

[2]The Internet of things (IoT) is the inter-networking of physical devices, "connected devices" and "smart devices", buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. (Gillis, 2021)

[3]Security infrastructure includes CCTV surveillance , PAS(Public addressal systems) & cyber security

[4]Quality cum Cost-Based Selection (QCBS) – Evaluation based on the cost committed by the bidder and the technical qualification of the bidder. Quality-Based Selection (QBS) – Evaluation based on the technical qualification of the bidder. (Work through the PPP process, 2011)

[5]Direct positive impacts are related to goals which are directly being addressed by the project

Indirect positive impacts are those goals which are indirectly being addressed via completion of one goal but the project might not have any aims and objectives towards it.

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A31

Integrated Command and Control Center, Indore

Name of the project: *The Integrated Command and Control Centre (ICCC)*
Location: *Indore, Madhya Pradesh*
Year of Project Implementation: *2018*
Sector: *Information and technology in urban management*
SDG: *SDG 9, SDG 9.c - Industry, innovation and infrastructure*
Project Cost: *Approximately Rs 200 cr.*

Institute: *Maulana Azad National Institute of Technology (MANIT), Bhopal*
Advisors: *Dr. Yogesh Kumar Garg, Dr. Vinay Mohan Das, Dr. Rahul Tiwari*
Students: *Ms. Khushi Pandya, Ms. Kanishka Singh, Mr. Aryan Deori*

Keywords: *Indore, ICCC, ITMS, Surveillance, Monitoring, Smart City.*

Abstract:

Urbanization have been a challenge for India but recently governance agencies have realized it's potential. In order to optimally cater to the burgeoning urban population, urban services, citizen's needs and efficient governance must be integrated. On these lines, Indore planned for the Integrated Command and Control Center (ICCC) as a pan-city initiative under the smart city mission. Such proposals are meant to influence the lives of people of the whole city and are not restricted to ABD (Area Based Development). Therefore, Indore's ICCC project has developed a collaborative framework integrating various functional departments like a municipal corporation, city transport companies, water supplier, police, solid waste management, e-governance etc. The project was planned with an integrated approach where the state nodal department i.e. Urban Administration and Development Department (UADD) prepared a consolidated DPR for ICCC, which was to be developed for major 7 cities (i.e. Indore, Bhopal, Jabalpur, Gwalior, Ujjain, Sagar, Satna.). The department further floated an RFP on behalf of all 7 participating Smart cities, keeping a vision that the economy of scale will bring down project costs substantially and monitoring at the state level for all the cities would be easier. The Indore ICCC project initially planned to integrate over 25 services in 2025, whereas, until date, only services like Intelligent Traffic Management System (ITMS), Indore 311, Integrated Solid Waste are expected to be integrated completely along with partial integrated Automatic Vehicle Location System (AVLS), SCADA. For SPVs, the interface at ICCC gives a real-time and unified view of operations, so that information can be shared across different agencies to accelerate problem response and improve project coordination. Therefore, an ICCC platform for city administration certifies better situational consciousness as also for the betterment of the citizens in any given circumstance. Whereas the Indore ICCC project is yet to integrate several major services, which become important in the light of the fact that five years have already passed since the start of the project, giving the course of interaction with the smart city along with stakeholder consultations, the main learnings from the project are centralized procurement process may hamper the project ownership by the city administration and also that surfeited infrastructure need trained and quality human resource for utilizing ICCC infrastructure. This case study will further focus on documenting the present status of the ICCC project. Thereafter, discussing various steps with the utilization of assessment, can be improved.

Case Study: **A31**

1. Introduction

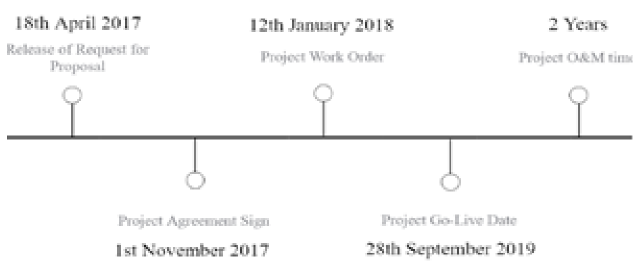
In India, a new era of technocratic minds is altering urban planning and governance systems. Smart cities, according to the Indian government, are those that use technology, information, and data to enhance infrastructure and services, resulting in 'smart solutions'. In accordance, the Madhya Pradesh Urban Administration and Development Department (MPUADD) has envisaged establishing common cloud-based data center for Smart Cities (CCDCSC) and Integrated City Command and Control Center (ICCC) for each city to execute operations for 7 cities (i.e. Indore, Bhopal, Jabalpur, Gwalior, Ujjain, Sagar, Satna). On one hand, consolidating these 7 projects at the UADD level would bring down the project costs substantially and monitoring at the state level for all the cities would be easier, but on the other hand, integration of services, operations and maintenance became a change at the city level as a requirement of all the cities were different.

1.1 Project overview

Indore, being one of the most populated and biggest cities in Madhya Pradesh, has been chosen as one of the 100 Indian cities to be transformed into smart cities under the Smart City Mission. The Indore Smart City Development Limited (ISCDL), to keep pace with the speed of urban development, has set up an Integrated Command Control Center System (ICCC) under the pan-city development approach. It is a common platform where all the information from various sources, like city operation centers and applications, will be stored. All the information collected will be analyzed for better planning of the smart cities, using an integrated analytical layer / BI engine etc. These insights/trends will be helpful in managing incidents across the state and individual cities and do better planning for the development and delivery of smart city projects. To monitor and connect with various municipal services and to receive real-time data, this project of ICCC is envisaged to be the brain for city governance, traffic management and disaster management. So far, six applications have been integrated at ICCC Indore, ranging from waste management to water supply to traffic management, and more than 25 services are planned to be integrated at ICCC Indore

Our study covers the detailed scope, specifications of the proposed information, communication technology initiatives of Integrated Command and Control Center (ICCC) and Smart Features; including **Intelligent Traffic Management System (ITMS),** Indore 311, Integrated Solid Waste Management, City Enterprise GIS, Electrical SCADA, IMC Property and water Tax.

a. Project timeline



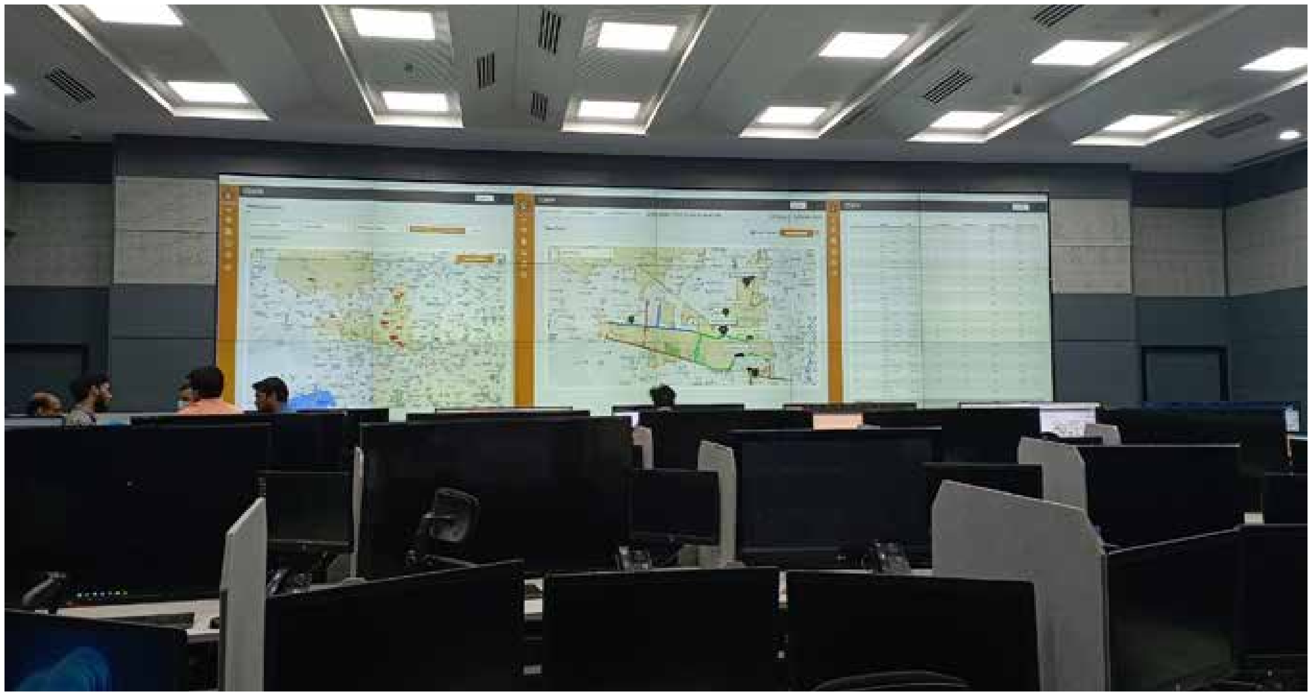


Figure 1: ICCC

b. Key stakeholders:

This umbrella project necessitates coordination across several departments and multiple stakeholders. The following are the key stakeholders whose engagement fueled the project and made it possible to develop effective project governance.

- Madhya Pradesh Urban Administration and Development Department (MPUADD)
- Indore Smart City Development Ltd,
- Indore Municipal Corporation,
- IMC Divisions (water department, fire department, etc.)
- Implementation Agency
- Line department (police, health, energy etc.)
- Citizens of Indore city

1.2 Significance of the project

ICCC facilitates data collection and collaborative monitoring, enabling faster data analysis and decision-making. Intelligent operations capability provides integrated data visualization, real-time collaboration, and deep analytics, which supports planning in an improved manner at the times of crisis, to coordinate and manage response efforts and improve the overall efficiency. During the second wave of Covid-19, medical officers were stationed at ICCC Indore round-the-clock to advise on incoming calls, media cell, health officials, food supplies management and coordination station at ICCC to monitor and deliver services to the citizens.

The ICCC interface displays processes in a standardized and real-time manner. The authority may easily communicate information across agency lines to accelerate problem resolution and improve project coordination. For instance, the tracking, positioning and monitoring of the waste collection vehicles, and arranging a similar vehicle in case of absence of any prescribed waste collection vehicle in any area, is very well managed by the help of ICCC in Indore. The ICCC will help in anticipating the challenges and minimizing the impact of disruptions. The ICCC is structured to command, regulate and combine the IT strength, which is being produced and operated at different locations across the city of Indore.

The implementation of the Integrated Command and Control Centre (ICCC), has a significant impact on the functioning of city resources. The following are the intangibles and tangibles that ICCCs intervention addresses:

- Better management of utilities and quantification of services.
- Help create and measure KPIs for delivery of utilities to citizens.

- Disaster Management and Emergency Response System.
- Efficient Transport Management.
- Enhanced safety and security.
- Asset Management.

1.3 Aim and Objectives

The study aims to evaluate the impact of the ICCC in terms of functioning, governance, and technology, as well as to determine how urban operations have improved over time in comparison to traditional operations management.

Objectives of the Study

- To study the working and coordination of the command-and-control center and aggregate IT asset, which is being utilized at different locations across Indore.
- To study the integration of services of Indore Municipal Corporation at a central location.
- To study infrastructure, which should be robust and scalable to integrate new services, to be monitored in future as and when required.
- To assess the financial and user-interaction aspect of aggregating all the data at the Indore level as well as at state level.

2. Contextual Background

2.1 Conceptual framework / Research design

The research assesses the ICCC ecosystem on the following dimensions:

- **Functional:** Functional coverage refers to the city utilities and services such as water, wastewater, waste management, roads, traffic, and streetlights, social infrastructure.
- **Technology:** Technological coverage refers to the technological capability, scalability and security components etc**.**
- **Governance:** Governance essentially refers to the people's side of the system, with emphasis on the governance policies , to operate the ICCC efficiently.

The overall scheme of the project

- **State level Cloud-Based ICCC Platform -** A common platform for all smart cities of state is formed for integration, analytical and operational capabilities. and Other cities can also leverage a stable platform in future.
- **Cloud Service Provider (CSP) -** Leverage the public cloud and data saved on the Cloud Service Provider by 7 cities individually.
- **City ICCC Establishment -** Each City has its ICCC base, connected with a Cloud-based services platform.
- **Master System Integrator -** For unified solution formation, end-to-end operations management and integration of various city applications and data analytics.

Research framework

- Study the details about the formation working and significance of ICCC.
- Study the various facilities provided by ICCC Indore.
- Comparative study of ICCC Indore with a similar city furnished with the ICCC facility.
- Assessment of the working of the provided facilities under ICCC.
- Analysis of the gathered data, and responses and documentation of the work.

Expected outcomes of the study

- Perquisites on consolidation of 7 projects.
- Follow-up or case study for future similar projects.
- Enhanced urban service delivery.
- Standardized operating procedure.
- Increased resilience as a result of the project.

2.2 Key features of the project

This ICCC project is composed of three main parts: a command center, an analytic division, and an alert production mechanism for municipal services, traffic, natural disasters, and public complaints. The ICCC assists the department in engaging with field support employees to resolve citizen complaints. Integration and correlation of data from many source systems aids in the identification of the issue's fundamental cause, which aids in the improvement of city operations.

A few points on which the ICCC is working recently are :

1. **Intelligent Traffic Management System** (ITMS): consist of key modules like Adaptive Traffic Control System (ATCS), which will help in optimizing the traffic at junctions and traffic Enforcement Management System. This will help in improving commuter safety. This solution will be integrated with ICCC to monitor and control, with the help of the Traffic Police department, for intelligence city management and emergency response.
2. **Enterprise GIS**: It is a GIS-based map system that allows government entities to provide location-based services and information. The City Enterprise GIS e-portal will offer services such as: finding locations, ward information, public service information, updated notifications from various government agencies, the location and significance of various Government Offices, and an event calendar for various public services such as vaccination schedules.
3. **SCADA**: Sewerage Treatment Plant (STP) SCADA: Integration with field sensors helping inefficient use of Sewerage Treatment Plant (STP). This is achieved by monitoring threshold limits and analysing historical data from different weathers to optimize the plant resources in a particular month /weather.
4. **Automatic vehicle location system (AVLS) and Automated Fare Collection System (AFCS):-** This System enables authorities to get real-time data in a structured format from ground operations. Both applications help in identifying collections from different modes of payment on different routes. Analytics, with passenger information and fleet management, helps in efficient route planning within available resources, to meet citizens' needs and to plan and promote cashless modes.
5. **Integrated Solid Waste Management (ISWM)- An**t essential activity that the IMC provides for its people is: Integrated Solid Waste Management (ISWM), which is the most important municipal function and a requirement for other more complex municipal services. ISWM's ultimate goal is to keep track of, collect, process, and dispose-off solid waste, created by households in a cost-effective, ecologically and socially responsible way.
6. **Indore 311** (Citizen Grievances and Redressal System)- This is a mobile application that is accessible to more than 3 Lakhs citizens of Indore. A heat-map on the ICCC screen helps the authority plan and prioritize actions for specific areas. Grievances that are going to cross threshold limits trigger a defined action plan to address the issue on priority.
7. **IMCERP Property Tax and Water Tax**: Representation of demand and collection data, as well as citizen payment trends, aided in the improvement of tax collection. Property records at the ICCC will not only provide with real-time data of all the properties, but will also relieve the authorities of its reliance on outside services to monitor property and tax records

Table i: List of Citizen Centric Services

List of Citizen Centric Services	Available Online	Integrated with ICCC
Indore 311	Yes	Yes
Integrated Solid Waste Management	Yes	Yes
City Enterprise GIS	Yes	Yes
Automatic Vehicle Location System	No	Yes
Automatic Fare Collection System	No	Yes
Electrical SCADA	No	Yes
IMC Property and water Tax	no	Yes
STP SCADA	No	Yes

Source: (smartcities.data.gov.in,3 Feb' 22)

2.2.1 Challenges in the project

1. The estimated cost per city was approximately 200 cr.
2. Lack of technical expertise to manage data centers, and also coordination between various departments for data sharing can be a major challenge.
3. Time and cost are required to create physical infrastructure and make it a confederated system.
4. To empower and support the workforce to understand, learn, and adopt the new ways of working, to fully realize the potential benefits of this fundamental change.
5. Coordination among various cities can also be a major challenge leading to delays in projects. Even

a single departmental delay can hamper the whole coordinated system (State or city level platform).

6. The 'Knowledge Management Repository', 'File Tracking System' and 'Document Management System' developed by HPE, have not been properly utilized or incorporated in the cities.
7. Since it entails various departments involved in distinct works, preparation of well-defined use-cases and standard operating procedures for showing key outcomes from the integrated applications, can be a grinding work.

2.2.2 Risks involved in project

1. Capacity at various levels may be insufficient to coordinate with various agencies and manage project implementation. This is specifically noticeable with respect to the technological issues and also a few internal issues in terms of management of various collegiality.
2. Lack of skilled manpower to run the ICCC after it is transferred to Indore Smart City Limited. This can be seen in terms of analytical aspects, as is visible in its inefficiency in data analysis and asset management.
3. Inordinate implementation delays would increase the project cost and severely limit the benefits realization, which was indistinctly detectable in terms of disputes with the implementing agency.
4. Asset Management: effective utilization of ICCC and related assets.

Figure 3: Interview with the officials

Figure 4: Vehicle tracking System

2.2.3 Features and Benefits

ICCC enables the collation of information and collaborative monitoring, thus helping in the analysis of data for quicker decision-making. Intelligent operations capability ensures integrated data visualization, real-time collaboration and deep analytics that can help different stakeholders prepare for emergencies, coordinate and manage response efforts, and enhance the ongoing efficiency of city operations. The city can rapidly share information across agency lines to accelerate problem response and improve project coordination. Furthermore, the ICCC will help in anticipating the challenges and minimizing the impact of disruptions.

Initially, this 'Integrated Command and Control Centre' connected and combined city-level information, received from numerous applications and managed by corresponding application vendors. This was further converted to actionable intelligence, which was then circulated to pertinent stakeholders and citizens. This ICCC project enables the assembling of information and collaborative monitoring, thus helping in the analysis of data for quicker decision-making.

2.3 Key findings from the interviews, surveys (public, site visit), and primary/secondary data collection

The integrated command and control center of Indore has a comprehensive list of more than 25 proposals and services. They are planning to further implement and expand their network of the ICCC mechanism, which shows that this project is scalable to integrate new services. Currently, 6 services have been integrated at ICCC,namely- Integrated Solid Waste Management (ISWM), IMC property/water tax, STP SCADA, Automated Fare Collection System (AFCS), Automatic Vehicle location system (AVLS), Indore 311.

Table 2: Services and their benefit

Application	Data set	Benefits to Authority, Decision-making & Actionable
Integration of Solid Waste Management (ISWM)	SWM vehicles status	Helps to identify the vehicles operating on ground for door to door garbage collection
		Helps to identify the availability of vehicles in all zones
	Region wise vehicle details	Decisions can be taken on the requirement of increasing or decreasing the vehicles on ground for each zone.
		Ease to check the zones performance
	Zone and ward wise vehicle alert data	Helps to identify the quality of services being delivered in each zone
IMC Property/ Water Tax	Water Tax demand, collection and penalty data	Property-type wise zone and ward wise performance can be measured in term of tax collection, outstanding penalties
		Preferred mode of transaction can be identified for further decision-making
		If the ward-wise collection of water tax against the demand for a month does not meet the threshold of specified amount, then a notification to the concerned authorities will be triggered from ICCC for necessary action
Automated Fare Collection System (AFCS)	City transport ticketing transaction	Authority can easily identify the revenue generated from each route, equipment or transactions
		Helps in decision-making by data comparison. Assess service-quality and decision-making using data of route-wise allotted vehicles, with its status and revenue data pertaining to different modes of transaction. Leads to Data Smart Vision of Smart City mission
Automatic vehicle location system (AVLS)	GPS data with device ID, longitude, latitude, location data and timing etc.	Authority can evaluate performance of the city bus transport, which further helps to take decision about scheduling
		Increases the adherence and ensures that each bus schedule is followed thoroughly
		Helps the authority to optimize the solution
STP SCADA	STP SCADA lab analysis data	Helps the authority to monitor performance of STP SCADA
		Authority can easily monitor different parameters like TSS,TKN,TP&FC
Indore 311	Citizen complaintsw	Helps understand service-quality as perceived by citizen
		Used to evaluate application / department performance by CEO/ commissioner
		Helps to identify the problem statements for each service, for which citizen logs complaint

Specifically, the 'Integrated Solid Waste Management' service of the ICCC Indore is very well accomplished and executed, which is visible all around the city

The Indore Smart City Mission is planning to enlarge its ICCC services. Currently there is a lack of technical assistance, due to which the data generated and the built ICCC infrastructure has not been utilized to its full capacity.

The ICCC element of Indore Smart City Mission has a clear vision for future expansion and to bring various elements of city management on one integrated platform, for swift and effortless assessment.

3. Discussion and Conclusion

The most visible improvement in civic administration, catalyzed by Indore Smart City Development Ltd is: citywide digital interventions like ICCCs, to integrate and monitor city activities. The ICCCs may add relevant solution-components based on each city's needs and requirements, in order for the facility to become the city's civic management center.

Indore Smart City Development Ltd is now able to monitor traffic, track and manage vehicles for door-to-door garbage collection (operating on the ground). It also keeps an eye on the city and manages many other services, thanks to the integration of this project. This center collects real-time functional information from all departments and the public, assisting thems in meeting civic service delivery criteria on a daily basis.

Although ICCC Indore has successfully developed a vast infrastructure and has integrated 6 services so far, yet due to a lack of technical assistance and data analysis, Smart city Indore is not able to use the infrastructure to its full capacity.

3.1 Recommendations

Peer learning should be undertaken across all seven cities to exchange unique experiences of using their respective ICCC and problems faced in terms of technical support.

To utilize the data collected to generate revenue, the Indore Smart City Development Ltd can share the data in accordance with the data privacy act of the Indian government with a third party, to help in analyzing the data and in exchange they can also use the data.

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A32

Smart Governance in Pandemic Management: Practices and Challenges

Name of the project: *Smart Governance in Pandemic Management*
Location: *Sagar, Madhya Pradesh*
Year of Project Implementation: *2020*
Sector: *Smart Governance*
SDG: *SDGs targets 3.3, 3.8 and indicators 3.d*
Project Cost: *approximately 30 Crores*

Institute: *School of Planning and Architecture, Bhopal*
Advisors: *Aparna Soni*
Students: *Soura Manna*

Keywords: Smart governance, pandemic management, Integrated Command and Control Centre (ICCC), Smart Cities, Sagar city

Abstract:

The COVID-19 pandemic in India, especially in the urban centres, exposed the insufficiency and incapacitated preparedness for a disaster, and also brought to light the innumerable areas of improvement, the power of technology, and the perseverant frontline human resources in fighting the pandemic. The narrative is best encapsulated by mentioning the innovations, impromptu measures, and use of technology by all actors. This case study focusses on discovering such innovations where the State and technology played a major role in managing the crisis.

In the past decade, smart governance infrastructure development has been a priority area for the Government of India, with States and urban local bodies following pursuit. When the pandemic struck, the States innovated and decided to use the smart governance infrastructure of the Smart Cities Mission for pandemic management. One such effort was identifying Integrated Command and Control Centres (ICCC) across smart cities in India for effectively managing the pandemic.

This study highlights how the two pillars of 'smart governance' and 'disaster management' can be synthesised for efficient emergency responses. It is focussed on exploring best practices and innovative measures in pandemic management by Sagar city in Madhya Pradesh. It also narrates the experiences of various stakeholders and suggests areas of improvements. The assessment and recommendations of this study may be applied for future interventions within cities with comparable characteristics.

Case Study: **A32**

1. Introduction

The city of Sagar in Madhya Pradesh established the ICCC in October 2019 under the Smart Cities Mission, soon after which the COVID-19 pandemic struck. Responding to the emergency, the city innovatively formulated a mechanism through the use of existing infrastructure installed in the Integrated Command and Control Centre (ICCC) to achieve maximum resilience against the pandemic. The ICCC smart governance infrastructure was innovatively used to provide for the four components of pandemic management, i.e., disease spread and resource management, awareness to control the spread, preparedness and real-time responses, and communication and engagement with citizen.

1.1 Topic and Context

This study is situated at the confluence of two prominent developments that Indian cities experienced in the last decade. The first is the digital revolution embarked upon by the Smart Cities Mission, and the second is the COVID-19 pandemic that necessitated innovation in healthcare infrastructure and management in cities.

1.2 Scope of Research

For the purpose of this study, the case of Smart City Sagar in Madhya Pradesh has been selected. The research includes the study of the Integrated Command and Control Centre (ICCC) that was created under the Smart Cities Mission in 2019 with the objective to develop it as a dedicated platform for data-based civic functions provisioning. It is this digital heart of the city, used as the 'war room' for the city's pandemic management, where the battle against COVID was fought digitally. The study

area is limited to the Sagar Municipal Corporation (Sagar Nagar Nigam) area, as shown in Figure 1 and considers the period between the inception of the Sagar Smart City Limited (SSCL) in October 2017 and March 2022.

The important events influencing the study are the National- and State-level lockdown periods, wherein the role of ICCC as the pandemic management centre and the use of digital infrastructure was studied at length. The stakeholders considered in this study are the State authorities and government officials, the end users, and the service providers (both private and public). The study documents how a civic data function platform, the ICCC under SSCL, was transformed into a pandemic management platform (Figure 2), and how the processes of varied domains of service were converged through the use of data functions by ICCC. This study highlights how the two pillars of 'smart governance' and 'disaster management' can be synthesised for efficient emergency responses during pandemics.

1.3 Significance of the Project

In smart cities, to harness the full extent of the smart technology, different start-ups, agencies, actors, and public authorities collaborate. All these collaborative efforts shown in Figure 3 are coordinated by the ICCC through

Data collection, analysis, and dissemination for effective real-time responses

Convergence of the service domain of different agencies through data management

Effective resource and manpower management

Communication with different levels of services through a single window/platform

Without the mechanism of the ICCC, the whole process would be labour-intensive, slow, and ineffective.

1.4 Aim and Objectives

The aim of the study is to explore how existing smart governance infrastructure may be used innovatively for effective and efficient pandemic management.

The objectives of the research are:

- To identify the components of pandemic management and enlist the services, protocols and practices required
- To identify the existing smart governance infrastructure and document their innovative use for pandemic management
- To identify the direct and indirect stakeholders involved and their role in pandemic management and detail the supporting institutional framework to appreciate the collaborative governance efforts
- To suggest the areas of improvement for future efficiency enhancement and discuss the issues and challenges faced by the stakeholders

2. Contextual Background

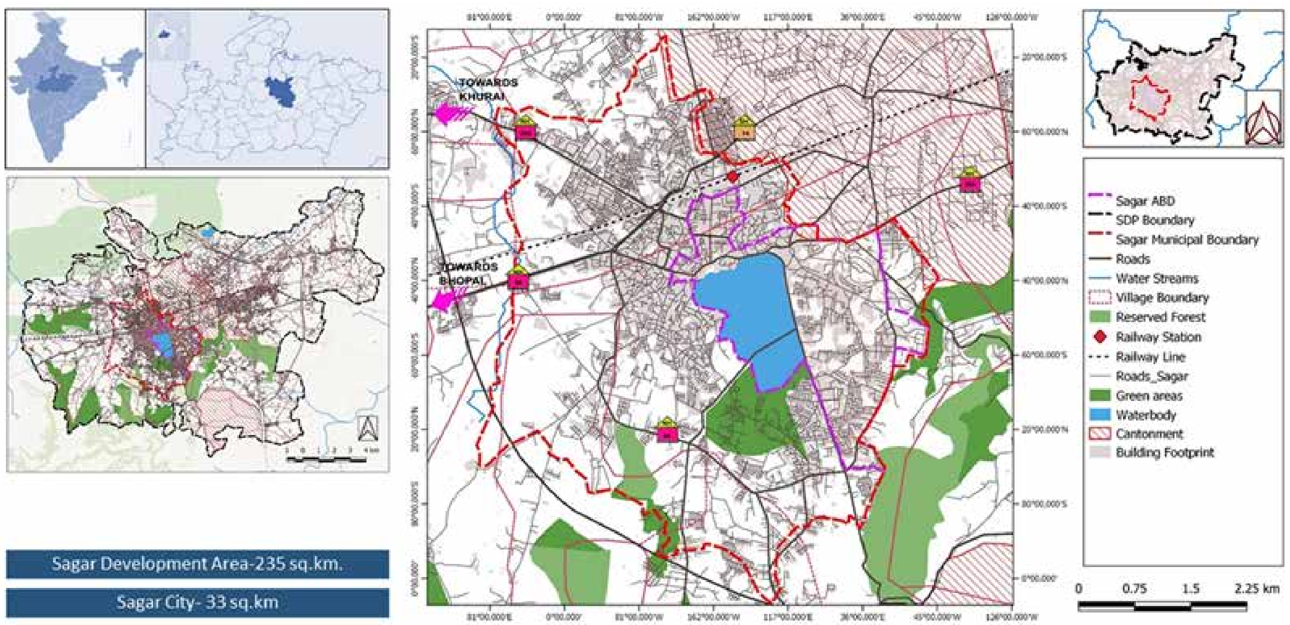


Figure 1: Regional Setting of Sagar City Showing the Municipal Boundary. Source: Generated by Author

Figure 2: Importance of ICCC in Pandemic Management. Source: Generated by Author

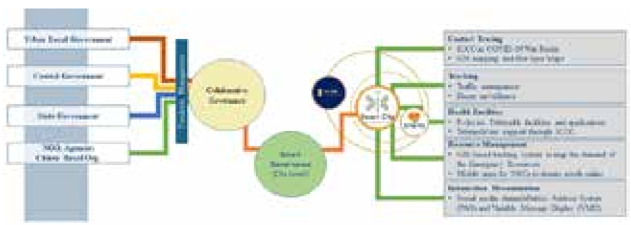


Figure 3: Pandemic Management through Collaborative Governance and Smart City. Source: Generated by Author

In Sagar, there were 21,410 people infected by COVID-19 (till February 2020) with the death toll reaching 438 (National Heath Mission, 2022). The lack of pandemic management experience, coupled with the unavailability of healthcare services due to the exhaustive demand for both equipment and manpower, resulted in mismanagement, and was followed by poor governance decisions affecting people's lives. The lack of inter-departmental and cross-agency communication further delayed emergency responses. Efficient service delivery with real-time responses of the issues at hand was the need of the hour.

2.1 *Conceptual Framework/Research Design*

As a solution, a smart approach through the use of ICT in governance came forward as an opportunity. It connected the government with social media channels, which enabled data dissemination in easier ways with responses generated faster than ever (Atta Ullah, 2020). The Smart City big data generated and analysed, acquired through installed sensors in different areas of the city (meant to monitor the urban issues), were used for decision-making during the pandemic (Jing Wang, 2021). Various State agencies and actors came on a common platform using smart governance infrastructure to effectively manage the pandemic as shown in Figure 3.

The methodology followed for the assessment of the components of smart governance infrastructure leveraged for pandemic management in Sagar is illustrated in Figure 4. Important components of the methodology are given below.

To begin with, it was important to understand the basic practices and processes that the ICCC adopted. Thus, the intervention of the ICCC in pandemic management were understood thoroughly from interviews with the e-governance managers, ICCC operators, and the data provided by SSCL. Simultaneously, literature on smart governance for pandemic management was studied to build an assessment framework and indicators. After forming a preliminary impression and the literature review, four criteria were selected for the assessment of the current practices:

1. Intervention of ICCC in management and control
2. Online heath facilities
3. Information dissemination
4. Delivery of essential commodities in the lockdown areas

The aforementioned criteria were comparatively assessed with national and international best practices. Their performance on good governance criteria like Accountability, User-Friendly Interface, Transparency, Efficiency, and Effectiveness of the Service Delivery Mechanism were studied. Finally, the performance of Sagar ICCC was measured. The gap in existing infrastructure was identified.

City	Brief description of the best practices of Smart Governance	Learnings
Kerala[1]	Information of the different levels of contact of agencies on an open platform	Data dissemination and awareness drive
	Helpline available for food and ration items for the people in containment areas	Effective delivery for the needy
Singapore[1]	AI based surveillance and drone-based surveillance	Effective surveillance with technological intervention
	On-call or video consultation with COVID-affected patients and regular check-ups	Telemedicine facility for the well-being of citizens
	Bluetooth based contact tracing mobile application for the contact tracing of people with possible infection	Chain-breaking measures through smart attributes
	Delivery to the people through portal registration	Effective delivery for the needy
Hangzhou, China[1]	Public Services and Management Platform (PSMP) for data collection, analysis and dissemination	Single-window platform for data management
	Online health consultation and online prescription	Telemedicine facility for the well-being of citizens
Jaipur, Rajasthan[1]	Workshops on relief operation of COVID-19	Capacity building for better service delivery

Table 1: Literature Review with Best Practices

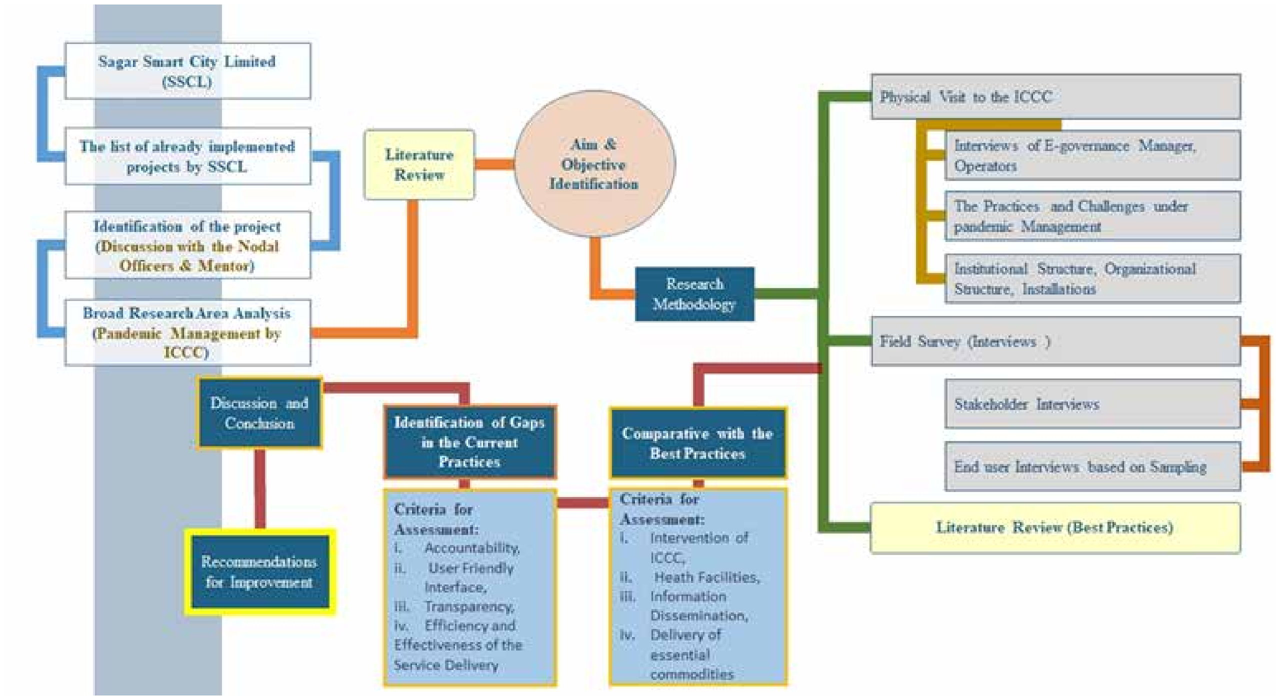


Figure 4: Research Methodology. Source: Generated by Author

An important component of the methodology was the study of the best practices of pandemic management to be reviewed and comparatively assessed to recommend improvements in the current framework of the management in Sagar. The practices of Sagar when compared with international and national best practices also highlighted newer areas of improvement. Finally, recommendations and areas of improvement in the existing system were suggested.

The table 1 illustrates the cases studied, their key features and the learnings drawn.

The study draws keenly upon the case of the State of Kerala that experienced an epidemic due to the Nipah virus in 2018. The State used its experience of managing the Nipah epidemic and improved their practices during COVID-19. The Kerala Nipah Management Plan included a three-level governing body as shown in Figure 5, consisting of State-, District- and institution-level bodies for the protocols and implementation (Department of Health Services, Kerala, 2021). The structure of activities may be looked at as three components, chain-breaking mechanism through surveillance, testing and patient care to control the outbreak, and a keen focus on capacity-building and coordination between agencies.

The COVID-19 management plan of Kerala had a structure similar to that for Nipah management, but to deal with the immense pressure of the outbreak, a Rapid Response Team (RRT) was formulated to coordinate with the State-level bodies to enable lockdown measures. The 'Smart Responses to COVID-19: A Documentation of Innovative Actions by India's Smart Cities during the Pandemic' study indicates the success of the early and effective responses.

2.2 Key features of the project

The development of the Integrated Command and Control Centre (ICCC) in Sagar was a part of the development of the seven smart cities in Madhya Pradesh, namely, Bhopal, Gwalior, Indore, Jabalpur, Sagar, Satna and Ujjain. The projects were implemented by Bhopal Smart City Development Corporation Limited (BSCDCL). It was conceptualised as a Common Cloud-based Control and Command Application, Data Centre,

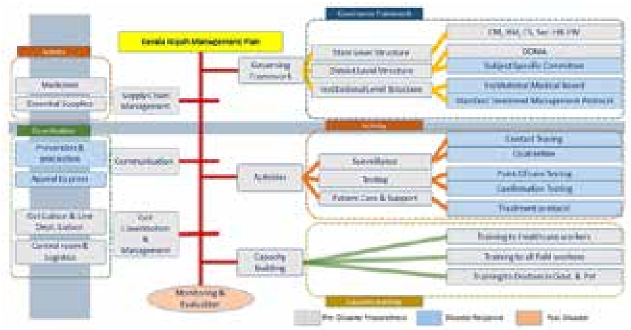


Figure 5: Kerala Nipah Management Plan. Source: Dept. of H & FW, Kerala

Disaster Recovery Centre with city-based control and analytics (BSCDCL, 2017), envisaged for smarter management of different operations and integration with ICT-based technology acting as the backbone.

- The development of the ICCC was aimed to be the single source of 'truth' for the civic function of the city with the platform for data receipt, analysis and disseminating capabilities.
- It was also developed to be an Emergency and Disaster Management Platform, to integrate with multiple multi-media sensors' interfaces.
- It was also meant to act as an integrator and correlate online and offline interaction with Intelligent Work-Flow Management with Advanced Historical Records Management, with advanced industrial-grade cybersecurity features.
- After the inauguration of the ICCC in Sagar in 2020, a major task allotted was pandemic management. Due to the sheer scale of the disaster, technological intervention was needed for effective and efficient service delivery.

Pandemic Management Practices

The example of local governments employing e-governance as a tool to facilitate and simplify governance processes are far more common than crisis aversion of this scale through ICT. In an urban setup, smart governance harnesses stakeholder collaboration

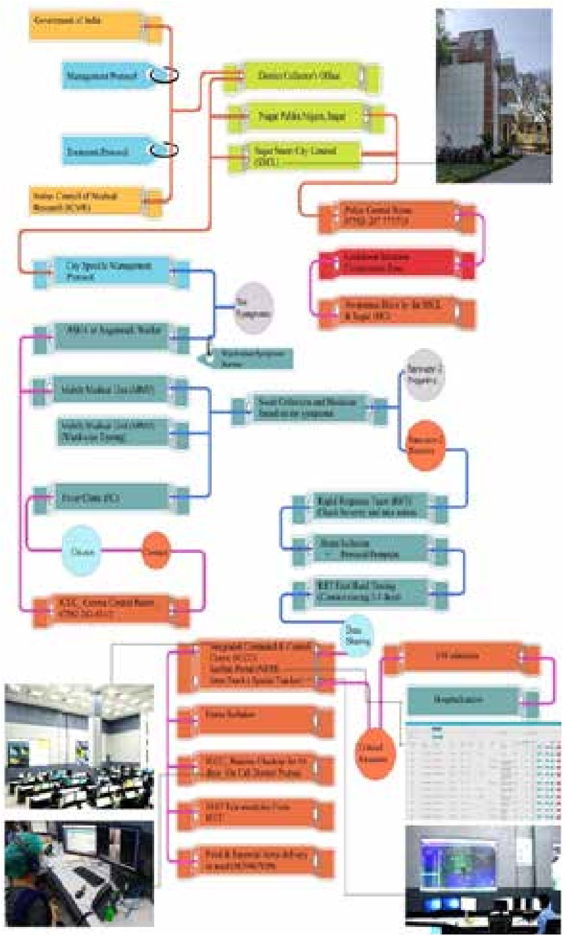


Figure 6: Practices of Smart in Pandemic Management. Source: Data by SSCL, Chart generated by Author

through the use of ICT. In Sagar, the ICCC has been used to facilitate

- Information collection, analysis, and dissemination,
- Surveillance and diagnosis, and
- Risk assessment

The broad flow of information and the system of pandemic management has been depicted in Figure 6. The system represents a collaborative one between the District Collector's office, the Municipal Corporation and several citizen-based agencies for the implementation of several services. The ward-wise symptom surveillance, patient data collection, and contact tracing are manual processes which are managed and handled by the corporation. The processing of this data is done by the ICCC. Online surveillance and services like telemedicine, video consultation, patient situation survey, and ambulance contact are also under the ICCC's scope of work. Apart from data management, data dissemination through awareness drives and delivery logistics in the containment area is the collaborative effort of different agencies and NGOs.

Derived from the understanding of the system developed, there are five key areas where ICCC had a significant role to play. The following section explains them in detail. Though these steps mark significant progress in pandemic management in India, there are areas of improvements. The challenges, risks and benefits are discussed for a holistic appreciation of these efforts.

Data Collection

The Asha and Anganwadi workers under Sagar Municipal Corporation (SMC) are employed for ward-wise door-to-door surveys to check for symptoms associated with SARS-COV-2 and boost an awareness drive. The people with symptoms are tested by Mobile Medical Units (MMU). If the tests are positive, SMC deploys a Rapid Response Team (RRT) for treatment and first-hand contact tracing for 2-3 days of the infection. The data of the patient is uploaded on the Sarthak Portal by the District Collector's Office, which is then managed by the ICCC.

The distribution of these facilities has been mapped on the SMC city map as in Figure 7.

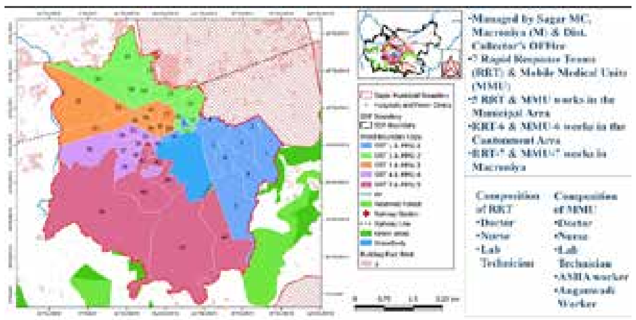


Figure 7: Working Ward Locations of the MMU and RRT Teams. Source: Data by SSCL, Map generated by Author

Challenge: Technological intervention in data collection is lacking, leading to lesser efficiency and labour-intensive processes.
Risk: Due to the data being collected and shared manually, effective data management is slow and sometimes faulty. Too many back-and-forth movements of the data also make responses slower and leaves real-time data updates as an area unserved.
Benefit: Data management by the ICCC is effective for surveillance over home-quarantined people and isolated areas.

Telemedicine and Lockdown

The operators of the ICCC facilitate telemedicine, delivery of essential commodities, and provision of hospitalisation by ambulance for patients. After contact tracing, the probable infection-prone areas are marked as quarantine areas with the help of the Police Control Room.

Challenge: Only verbal exchanges for examination of patients, based on their symptoms.
Risk: Without physical examination, faulty diagnosis is a possibility.
Benefit: Contact-free consultation and less crowded hospitals.

Ambulance Management by Intelligent Traffic Management System (ITMS):

ITMS in ICCC with the use of adaptive traffic control can make a green corridor (making every signal of the planned route green and the intersecting routes red) in any part of the city upon getting prior information of the movement. The green corridor is delineated through identifying the shortest route to reach a destination, which is communicated through phone or GPS, as shown in Figure 8.

Awareness Practices

Sagar Smart City runs awareness drives through digital posters, advertisements and statistics from the Variable Message Sign (VMS) at 11 locations and announcements via the Public Address Systems (PAS) at 12 locations in the city and Macroniya Nagar Palika combined as shown in Figure 9 and 10, and through social media channels

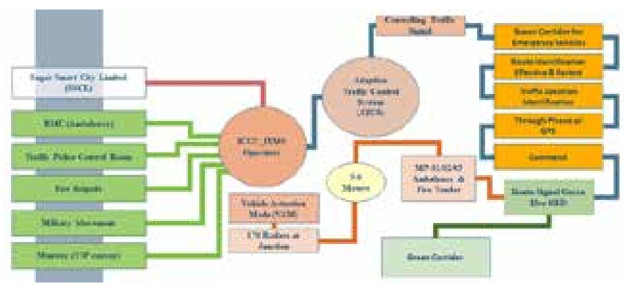


Figure 8: Practices of ITMS. Source: Data by SSCL, Chart generated by Author

Challenge: Ambulance movement is based on data from traffic control. No GPS-based surveillance over the emergency vehicles leads to slow mechanisms and data lags.
Risk: Difference in on-ground situation especially at the intersections. There is no live location communication.
Benefit: Barrier-free movement of emergency vehicles saves time and lives.

such as Twitter, Facebook and public websites, to name a few.

A major part of the awareness drive is done by the Nagar Palika Nigam, Sagar (SMC) through

Quarantine protocol of the waste collection vehicles

- Pamphlet distribution through the RRT and MMU teams and newspaper reports
- Public representation videos in the news

Challenge: To involve different private players in the practices.
Risk: Check quality of commodities delivered.
Benefit: Decreased trips and movement of people out of houses to ensure social distancing.

Logistics and Capacity Building

The logistics and supply system for essential commodities, upon being contacted through the number on the Smart City website, was carried out through different processes.

- Medicines through MMU and RRT during check-ups
- Food items through the police or NGOs
- Ration items through the police for the needy in quarantined areas

The capacity building was focused on training operators to deal with the huge mass of calls and create the maximum awareness through those calls. Doctors and nurses in the ICCC were trained to provide help through the telemedicine facilities.

2.2.1 Key Challenges of the Project

There are challenges that the project faces:

- The data received from the field by the RRT and MMU are the sole data providers, which is through a manual process, and thus results in a slow response and less accountable mechanism.
- The back-and-forth movement of the data between different agencies takes almost 48 hours after the detection of a positive case, leading to the risk of infection spread.
- The lack of digital integration of the processes also makes the data flow mechanism of the system slow and fragmented.

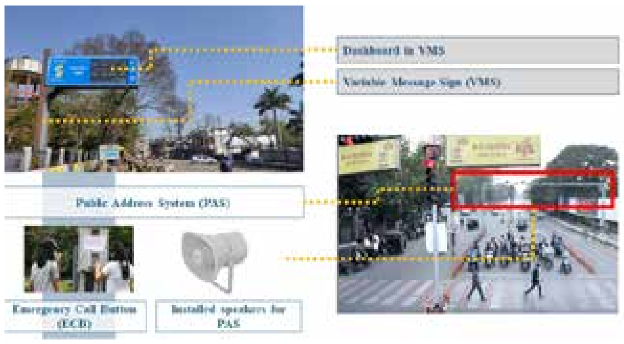


Figure 9: Pictures of PAS & VMS. Source: Generated by Author

- The citizens' perception of service delivery depends on several factors. One of them is their socio-economic status, influencing their perception of the need for ICCC.
- The literacy rate in Sagar is less than the national average, which is an obstacle in integrating digital processes at the citizen or houshold level.

2.2.2 Benefits of the Project

- Real-time responses to the situation at hand with efficient and planned decision making.
- The data collection, analysis and dissemination done by ICCC avoided labour-intensive processes, an essential requirement during a pandemic.
- The people got seamless access to essential commodities and emergency services.
- Access to digitally updated data reduced dependency on secondary data for speculative decision-making.

2.2.3 *Risks Involved in the Project*

The criticism of the smart system lies with the use of selective and incomplete data collection.

- People with no recognition in the system are completely non-existent in the data and thorough misunderstanding can result from this situation (Söderström, 2020). 'No recognition' here can be the population without access to telecommunication services, internet, or mobile-based technologies. Thus, a considerable section of the society remains vulnerable and under-served. To explore this weakness of the project, a stakeholder perception was considered as necessary.
- There is a potential risk of the exclusion of a section of the society that is digitally illiterate, lack exposure to online governance services, and are economically challenged with no access to internet.
- Policy decisions made by the data-driven analysis can be faulty if it does not include a representation of 100% of the population. As the data lacks inclusion of every section of the society, the system decision for management practices may have a biased outcome.

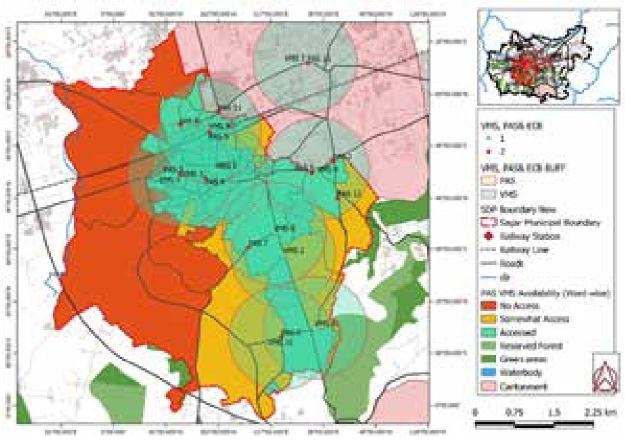


Figure 10: PAS, VMS Locations with 1-km Buffer. Source: Generated by Author

Challenge: To reach every household in the city within a time limit, digital literacy is necessary. VMS dashboards are hard to interpret for a section of the society.
Risk: The strategic location of the PAS, VMS is needed to reach as much of the population as possible. However, as shown in Figure 10, the access range of 1 km does not cover a significant area of the city.
Benefit: An increased awareness drive.

2.3 Key Findings from Interviews and Field Survey

The feedback and experience of the stakeholders, majorly citizens, were decided to be assessed on the two aspects of (i) awareness about the ICCC and (ii) its role in pandemic management and their experience with any of the services provided and controlled.

The sample size of the field survey was calculated with the help of Cochran's formula with a 7% confidence. Based on the above, a sample size of 196 was decided, which was distributed according to the ward-wise population of Sagar.

The field survey results indicate the following observations:

- The majority of the population is unaware of the Corona Control Room Services by the SSCL, except for the grievance redressal system of the Madhya Pradesh Government (181), as shown in Figure 11.
- People in the age group of 18-30 years are more aware of the services due to their exposure to social media.
- Spatially, the economically progressive wards showed considerable awareness.
- Satisfaction with the services is average, as discussed with all the interviewees, but the service delivery perception has an inclination over the bad service of Corona Control, as shown in Figure 12 and 13.

3. Discussion and Conclusion

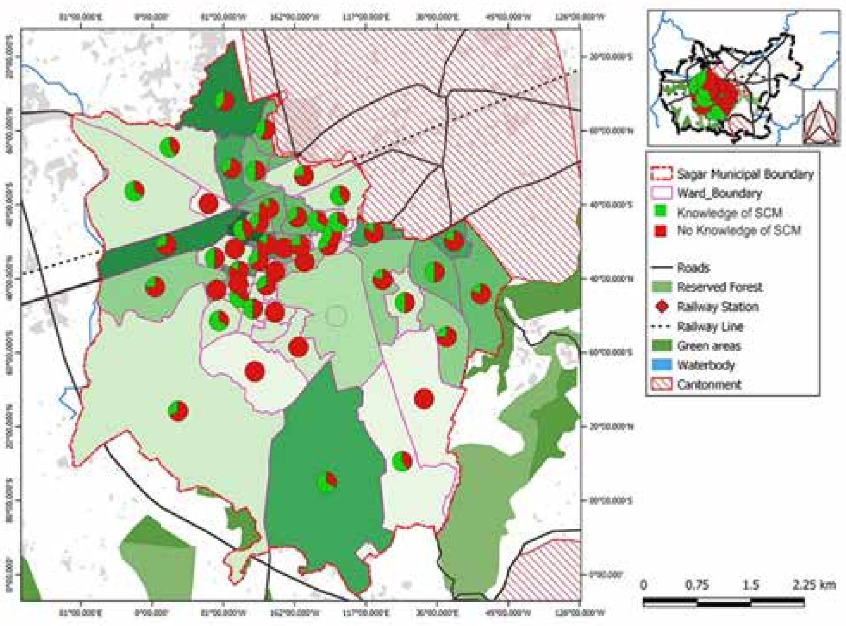
3.1 Implications

The smart governance infrastructure in case of Sagar catalyses the mitigation process in the war against COVID-19. The comparative analysis of the practices assesses the effectiveness of the process. Thus, the impact of the management process on the city's population can be assessed. For the comparative assessment, four parameters are taken from the literature review of the Deloitte study on the pandemic management in Indian Smart Cities. These four parameters are studied and assessed in detail to understand the impact on the city

Figure 11: Knowledge of Smart City Corona Control Room. Source: Generated by Author

- The Spatial Representation of the Survey Shows that wards with HIG Population such as Civil Lines, Gopal Ganj and near CBD Gandhi Chowk, Mohan Nagar and Near BMC i.e Baghraj, Shivaji Nagar are more aware.

- Though the Service Satisfaction Survey indicates average satisfaction for the majority even for the Covid affected families.



Ward wise Survey to identify the extent of Knowledge of the Smart City Corona Control Services (196 Smapes)

Figure 12: Awareness Survey Results Ward-Wise. Source: Generated by Author

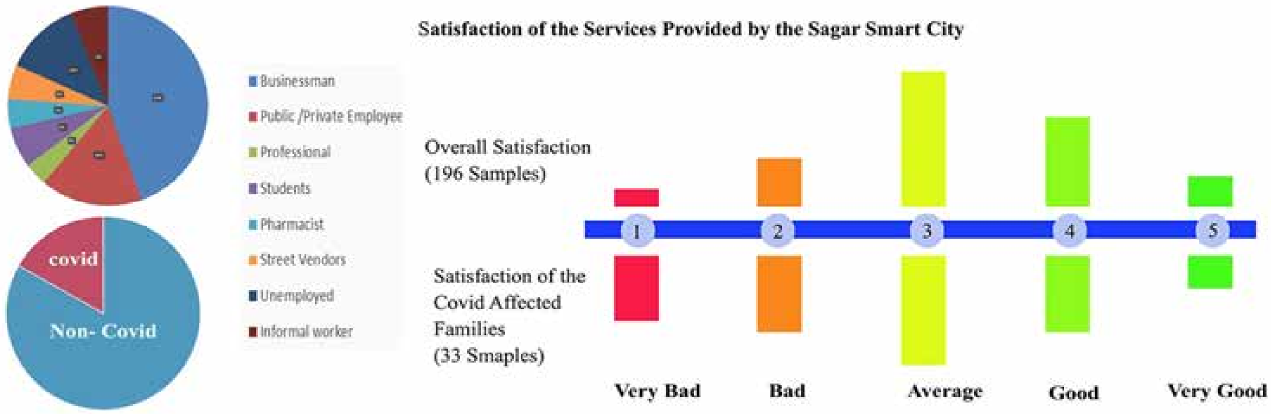


Figure 13: Service Satisfaction Survey. Source: Generated by Author

1. Stakeholder Discussions

An economics scholar from Dr. Hari Singh Gaur University in Sagar has the notion that the efforts of the government for the pandemic management can only be fully effective when decision-making will be more inclusive, and more citizen engagement will be encouraged. The economic recovery model has to be visualised for the city for the benefit of the people.

A doctor from Sagar indicated the need for more educational and research facilities in the medical field which will eventually strengthen the healthcare infrastructure of the city.

Pharmacists from five locations such as Teen Batti (CBD of the city), Parkota, Chakra Ghat, Civil Lines and Tilli near Bundelkhand Medical College (BMC) were interviewed, and they indicated that pharmacists deliver medicines to the homes of their known customer base but there is no government portal for the delivery processes.

An Asha worker from Civil Lines pointed that the safety of the frontline workers should be the first priority.

S No.	Practices	Best Practices		Practices in Sagar	Impact	Critical Appreciation
Integrated Command and Control Centre (ICCC) as the COVID-19 War Room						
1	Open Platform Contact Information of Control Room	The information of the different level contact of agencies on an open platform	Kerala	Control room, grievance redressal, telemedicine and delivery services contacts on an open platform	Public awareness of emergency services	Published on websites and variable message sign (VMS) and public address system (PAS), distributed as pamphlets. However, ineffective in generating awareness, as found in stakeholder interviews.
2	Real-Time Data Collection and Visualisation	Public Services and Management Platform (PSMP) for data collection, analysis, and dissemination	Hangzhou, China	Sarthak Portal By National Heath Mission (NHM) in ICCC Sagar and Intro-track for Spatial Visualisation	Immediate responses and faster services; effective timely delivery of services	Slower data collection due to lengthy administrative processes and lack of digital integration of various agencies
3	Surveillance	Artificial Intelligence-Based Surveillance and Drone-based Surveillance	Singapore	Manual surveillance by Mobile Medical Unit (MMU) & Rapid Response Team (RRT)	Infection control and ensuring lockdown measures	Labour intensive process
4	Contact Tracing	Bluetooth based contact tracing mobile application for contact tracing of people with	Singapore	Aarogya Setu App by GoI, manual first-hand contact tracing by RRT for 2-3	Infection control	Labour-intensive and lengthy process
Health Facilities						
5	Telemedicine	On-call or video consultation with COVID-affected patients and regular check ups	Singapore	24x7 on call doctors and nurses for telemedicine and check-up for COVID patients twice a day	Less contact while providing health services and surveillance updates of the patients	Effective management and surveillance
6	Telehealth Facilities	Online health consultation and online prescription	Hangzhou, China	Mostly private ventures	Health check-up at home, quarantine measure	No intervention from SSCL to institutionalize
7	Remote Capacity Building of Healthcare Workers	Workshops on Relief Operation of COVID-19	Jaipur, Rajasthan	Online workshops for the operators	Effective management	More citizen engagement through capacity building is needed
Information Dissemination						
8	Dashboard on City Web Portals	Dashboard, Contact Information and Awareness Ads	Municipal Corporation websites, Smart City Web Portals	Dashboard, Contact Information and Awareness Ads	Information on Sagar Smart City Limited (SSCL) website, Nagar Palika Nigam, Sagar Website	Effective awareness drive and emergency information dissemination
9	Awareness through VMS and PAS	Dashboard, Contact Information and Awareness Ads	Smart City Mission, India	Dashboard, Contact Information and Awareness Ads	11 VMS & 12 PAS Location	Effective awareness drive
10	Awareness Drive & Dashboard on Social Media Channels	Dashboard, Contact Information and Awareness Ads	Smart City Mission, India	Dashboard, Contact Information and Awareness Ads	Sagar Smart City Facebook & Twitter handles	Effective awareness and public relation drive
Delivery of Essentials						
11	Helpline and call centres for delivering essentials to the needy	Helpline available for delivering food and ration items to people in containment areas	Kerala	Helpline for delivering essentials to the needy people, delivery by NGOs and Police	Effective delivery	Less institutionalisation
12	Medicine & Essential Commodity Delivery Mechanism	Delivery to the people through portal registration	Singapore	Mostly private ventures; Medicine by RRT & MMU to COVID patients	Effective delivery	No intervention from SSCL to institutionalize

Table 2: Comparative Impact Assessment Framework of the PracticesGenerated by Author

and critically appreciate the process. The comparative assessment is shown in Table 2.

From Table 2, we can observe that the impact of smart governance practices in pandemic management lies in an effective and efficient service delivery. The labour-intensive process of data management can be replaced by smart, digitally-equipped institutional integration. The institutionalisation of several processes is necessary to provide better service delivery. Through the integration of different private players in the process, services such as telehealth facilities, delivery logistics of essential commodities, etc. can be availed by a section of society that can afford the private endeavours. The integration not only provides better service but can also be used as economic recovery regime for business owners. The overall smart integration of the processes will be very resourceful for every section of the society.

3.2 Limitations

The research on the smart governance in pandemic management of Sagar has certain limitations:

- Sagar is Tier-III city, so the implications of the practices in Sagar are limited to the city of a similar scale. Bigger cities in India have more complex attributes in management due to the factors of larger populations to cater to, congestion, and infrastructural gaps much larger than those in Sagar. Thus, research implications may not be generalised for each and every Indian city.
- According to the Sagar Development Plan, the economy of the city is not diverse enough. The prospect of in-migration from other cities is lesser as compared to cities based on the service sector. The exposure radius of contraction is less, hence, the chain-breaking mechanism is easier and cannot be generalised.
- According to the Census of 2011, the average literacy rate in Sagar is 72.08%, which is lower than the national average literacy rate of 74.4%. Digital literacy is even lesser at 3.97%. (Office of the Registrar General & Census Commissioner, 2011). So, there is a probability of underperformance of the pandemic management framework due to the comparably lower literacy in the case of Sagar. Thus, the performance implication cannot be applied as a general implication.

3.3 *Key Lessons Learnt*

The lessons learnt from the assessment of the pandemic management practices at Sagar are:

1. The ICCC acts as the brain of the city for data acquisition, analysis, and dissemination processes. So, effective structuring of the processes through ICCC is beneficial for the overall management process.
2. The whole labour-intensive process of the pandemic management is managed by the ICCC on a cloud-based data structuring. The introduction of online services made the existing data collection system more effective and efficient. The registration processes and the surveillance processes can easily be monitored from the ICCC operating center. The reduction in the manpower involved in these sections provides the opportunity for other manual management works.
3. The importance of the ICCC infrastructures such as the Variable Message Sign (VMS), Public Address System (PAS) and social media handles provides a better mode of communication with citizen for data dissemination through dashboards and awareness drives.
4. The pandemic management may learn from international cases and adopt best practices like Bluetooth-based Android phones for effective tracing.
5. The success of the Smart Cities Mission in installing the infrastructure in the cities was a necessary precursor that Sagar was lucky to have. Otherwise, additional technological intervention or structural installation at the time of the need could have been a very difficult task.

Data management by ICCC can be best depicted as in Figure 14.

3.4 Recommendations

Recommendations based on the assessment are:

1. Too many back-and-forth movements in data sharing in the mechanism, between the District Collector's office, ICCC and SMC, are making the process of real-time data update and availability slower and lengthier than other similar technologies. A linear domino-style data acquisition mode with all the stakeholders is recommended for the common platform, as shown in Figure 13 and 14.
2. The awareness of the citizens posed a challenge for the frontline workers as family members of the patients, being exposed to the virus, were suggested to stay in isolation at home. They, often being asymptomatic, refused to follow the protocol and increased the risk of exposure to a greater population. A robust awareness framework and vigilante network are recommended for the city.
3. The strategic location of the PAS and VMS should ensure 100% coverage of the city.
4. More focus on citizen engagement in decision-making through focus groups and public surveys is needed. Capacity-building and mass volunteering have been successful methods for increasing manpower from disaster management perspectives.
5. A web portal for the promotion of vendors,

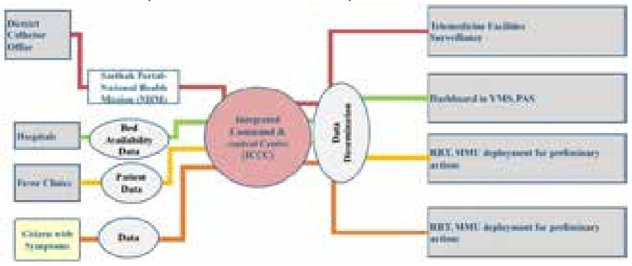


Figure 14: Data Management by ICCC. Source: Generated by Author

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A33

Assessment of Integrated Command and Control Centre : Bhopal Smart City

Name of the project: *Integrated Control and Command Centre, Bhopal*
Location: *Bhopal, Madhya Pradesh*
Year of Project Implementation: *May 2018*
Sector: *IT Connectivity and Digitalisation*
SDGs: *SDG 9.5 (Building Resilient Infrastructure), SDG 11.3 and 11.6* ***(Making cities more inclusive, safe, and sustainable)***
Project Cost: *Rs. 29.9 crores*

Institute: *School of Planning and Architecture, Bhopal*
Advisors: *Prof. Natraj Kranthi*
Students: *Aditya Ashwin Verma*

Keywords: *ICCC, urban function monitoring, smart components, public participation, real-time data*

Abstract:

Integrated Command and Control Centres (ICCC) were established under the Smart Cities Mission of the Government of India. The initiative aims to improve service delivery in cities and make them smarter by deploying smart components to monitor real-time urban functions for better preparedness and response. Diverse sectors and components are covered under this initiative, such as smart parking, smart poles, smart lighting, integrated traffic management systems, smart bins, environmental monitoring, etc. With the inception of ICCC, urban functions management has improved significantly, resulting in real-time interventions and helping the municipal authority save lives and costs. However, it has been observed that the citizen-centric platform that ICCC claims to be is facing certain limitations. This study aims to address these issues faced by the ICCC in Bhopal Smart City and assess its working mechanism. For this purpose, a literature review was undertaken to identify common issues faced by ICCCs in different countries. Stakeholder consultations with officials from the ICCC in Bhopal were conducted. Primary household surveys were also undertaken to understand the people's perception about ICCC Bhopal. Further, the Likert scale was employed to assess user perception about various components. The assessment's results indicate a significant improvement in the quality of urban function monitoring. However, recommendations to increase awareness, offer data as open source, and improve the inter-departmental data sharing mechanism, the GPS tracking system and public bicycle sharing system were given.

Case Study: **A33**

1. Background

In recent decades, cities have become the engines of growth and development, resulting in increased pressure on them. With increased urbanisation, significant attention is being drawn towards the efficient management of cities. Due to this, urban function monitoring and service provision by urban local bodies has become a complex task. This has created an urgent need to monitor real-time data in order to plan cities in a better manner.

As a result of the fourth industrial revolution, big data, the internet of things (IOT), artificial intelligence (AI), mobile-friendly design, etc. have become an integral part of day-to-day activities. To cater to the increased need for data monitoring and storage, the Government of Madhya Pradesh (GoMP) initiated the Common Cloud-based Data Centre for Smart Cities (CCDCSC) . As a part of this, Integrated Command and Control Centres (ICCC) were set up in seven cities of Madhya Pradesh (MP) to monitor city-specific functions. The related data is stored in CCDCSC. Under this project, ICCC oversees, monitors and controls various urban functions to provide real-time solutions. Key components of ICCC are smart parking, smart poles, smart lightings, Integrated Traffic Management Systems (ITMS), smart bins, environmental monitoring, etc.

The Smart Cities Mission (SCM) was launched in 2015 for improving the quality of life of urban citizens with technology as its backbone. Smart cities aim to provide core infrastructure and a decent quality of life to its residents by using information and communication technology (ICT). Under SCM, the strategic components of area-based development (ABD) include city improvement, redevelopment and city extension, along with pan-city initiatives. Redevelopment is undertaken in the identified portion of the city, i.e., the ABD area, which serves as a model for developing the remaining parts of the city. These areas are envisaged to host the world-class infrastructure and services. Under the pan-city initiatives, it is envisaged to provide smart solutions covering a majority of the remaining areas.

1.1 ICCC Bhopal

ICCC is considered to be the 'brain' for the city and looks into the management and monitoring of various day-to-day city operations or urban functions, exception handling, and disaster management through the use of technology handling complex datasets. These include the capture and generation of real-time data of various infrastructure or utilities such as water supply, solid waste management, energy, education, healthcare, safety, etc. ICCC acts as a Decision Support System (DSS) in the administration of the city and responds to real-time events or data feeds (GoI, 2018).

ICCC in Bhopal was launched in the year 2018 to monitor multiple city-level civic utilities and services. These services include smart lighting, smart parking, smart traffic and transport, smart waste management, and smart water (Express Computer, 2018). ICCC Bhopal is a nodal facility that collects real-time data from a number of sensors and monitoring devices across the city. The data thus collected is displayed on large screens and continuously monitored for patterns, discrepancies, alerts, etc. at the ICCC facility, and used further for various planning purposes (GoI, 2018). ICCC Bhopal is playing a significant role in handling and monitoring complex datasets. Such centres are vital for a large city like Bhopal with a population of 18,86,100, as per the Census of India in 2011.

1.2 The Need for and Significance of ICCC Bhopal

Bhopal is an important tourist destination. The city is referred to as 'The City of Lakes' as it has a significant number of natural and man-made lakes. It is also considered one of the greenest cities in the country and has been among the top-ranked cities under the Swachh Bharat Mission . Blue-green infrastructure across the city adds to its quality of life. Over a period of time, the city's service requirement witnessed a significant rise, leading to a need for better data monitoring. Presently, ICCC Bhopal is catering to such needs. This centre is also being used for monitoring emergency responses such as the COVID-19 pandemic.

The conventional siloed approach may not suffice the need for better data monitoring, particularly for a city like Bhopal. With the recent digital revolution, the use of advanced digital technologies for monitoring urban functions is an imperative choice. Improved DSS is vital for addressing complex urban services and providing real-time solutions. Hence, the role of ICCC is significant and can be considered as a stepping stone towards effective urban management using smart technologies. Without the integration of such technologies, the delivery of services by the concerned authorities would become difficult and may lead to significant financial losses. For example, the use of smart bins and route optimisation under ICCC has enabled reduction in fuel consumption and lesser expenditure on fuel .

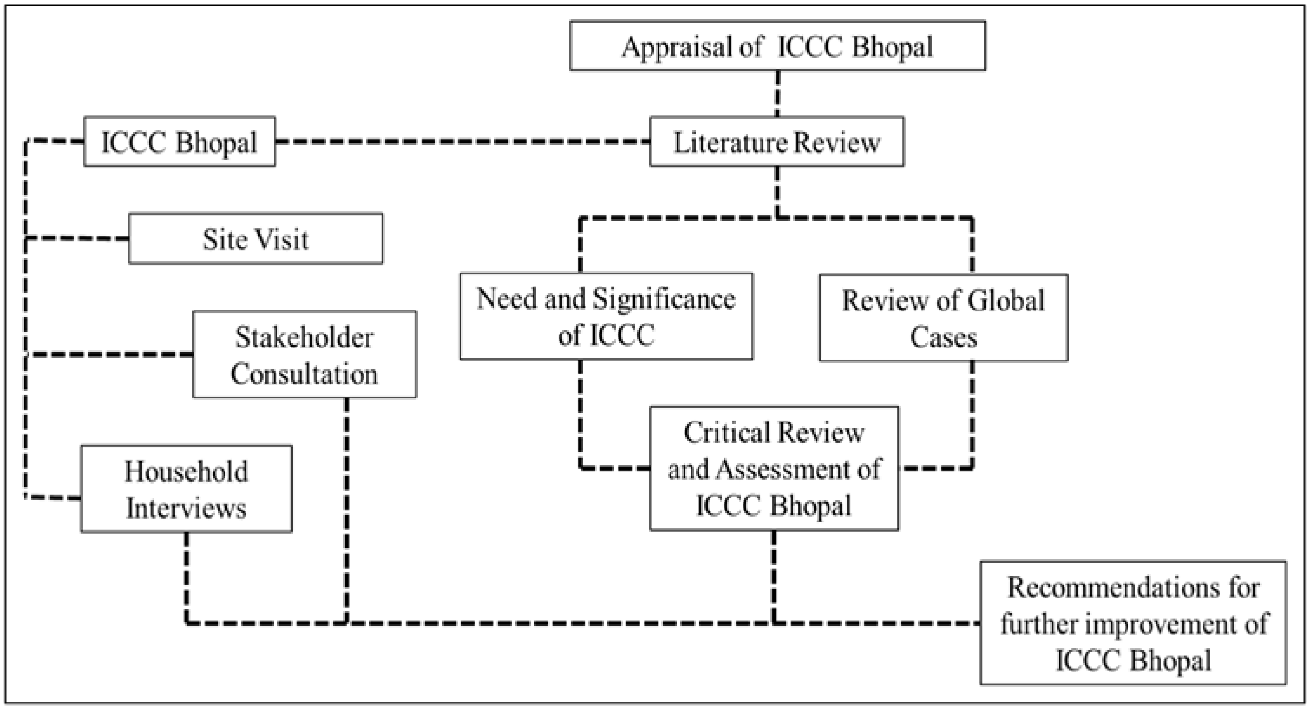

Figure-1: Methodology for Appraisal of ICCC Bhopal

2. Materials and methods

As a part of Smart Cities & Academia towards Action & Research (SAAR) , an assessment of the ICCC facility at Bhopal was taken up. A few identified services of the ICCC, such as smart poles, smart lighting, integrated transport management system, public bike sharing system, etc., have been assessed, with an aim to critically appraise the functioning of ICCC Bhopal. Key objectives of the study include the critical appraisal of the identified services and their systemic integration, quantification of the citizen's perceptions, analysis of public participation, and recommendations for the real-time data and its applicability in the future. A review of related global cases was also done. Additionally, field surveys were conducted to assess the ICCC Bhopal. These included stakeholder consultation or interviews, and household sample surveys. After a comprehensive analysis of the data collected and responses received, recommendations have been given. The methodology is shown in Figure-1.

2.1 Review of Global Cases

In the past few decades, cities across the world have been constantly attempting to integrate technology for regulating urban functions. In the 1980s, the integration of technology for intelligent city began with the concept of new urbanism in the United States of America. The term 'smart cities' was first mentioned by the cities Cyberjaya and Putrajaya of Malaysia in 1997. These cities were developed as intelligent garden cities. Later, the concept of smart cities gained traction in 2008, when International Business Machines Corporation (IBM) first registered the trademark 'smarter cities'. IBM uncovered how cities across the globe could become smart with the use of information and communications technology (ICT) in their day-to-day functioning. They began with a 100 smart cities campaign, initially collaborating with 100 renowned cities of the world to get urban governments on their agenda of being able to appropriate the smart city vision and ideas. Their notion of a smart city was based on three core principles, i.e., planning and management services, infrastructure services and human services. Since then, cities around the world have been creating ICT infrastructure to excel in the race of being a smart city.

2.2.1 Command and Control Centres in Rio De Janeiro, Brazil

As a response to Atlantic storms that hit Rio in 2010, the city explored options for an integrated command room to help monitor the disaster situation. This coupled with mega sports events like the FIFA 2014 World Cup and the International Cup 2016 fast-tracked the setting up of two Command and Control Centres. Through these centres, security arrangements during major events in the city, traffic monitoring, disaster risk mitigation and response, etc., were done. Although these centres have been instrumental in contributing towards monitoring and managing the above-mentioned functions, the data for such functions could be archived only for a period of 90 days and not for long-term purposes (Gaffney et al, 2016). Besides, these centres were used primarily as IBM's nodal centres for marketing. Moreover, IBM was trying to become an obligatory passage point in implementing the urban technologies (Söderström et al, 2014).

2.2.2 CISEM (Integrated Centre for Security and Emergency in Madrid, Spain)

Madrid suffered a major terrorist attack in 2004. A lack of systematic coordination among various concerned departments such as fire, police, health, etc. was considered to be one of the reasons for a delayed response to this emergency situation. A need was felt for a more effective platform through which such emergencies could be handled effectively. As a result, the CISEM was set up in 2005-06 to control, command and coordinate various security and emergency services such as the local police, firemen, mobility agents, sanitary resources, etc. All these services were based on the Geographic Information System (GIS) platform integrating emergency sub-systems such as planning, mobility, positioning, etc. CISEM aids in providing accurate responses to emergency challenges, analysing overall services, helping in joint cooperation of activities, etc. (Geospatial World, 2012).

2.2.3 Lessons Learnt from the Global Cases

The compatibility of rapidly changing advanced and emerging technologies with the previous or older versions was found to be a challenge. Due to this, there is a danger that present technologies may end up becoming obsolete soon. This in turn can cause huge losses in the capital invested. The role of private players in controlling and managing such command centres can also possibly become an impediment in the smooth functioning of the system. As observed in the case of Rio De Janeiro, the private players may turn as the de facto controlling authorities and become an obligatory passage point in the implementation of urban technologies. After the expiry of the contract tenure of the private companies, managing the centres with the same efficiency by government authorities may become a challenging task. Therefore, there is a need for building the capacities of concerned offices or authorities in controlling and maintaining command centres.

2.2 Functioning of ICCC Bhopal

The ICCC Bhopal has a state-of-the-art facility (Figure-2) and collects data related to various urban services through a number of sensing devices installed across the city. Integrated data sets are obtained from these monitoring sensors and used for analysis. At ICCC Bhopal, data related to traffic management systems, smart parking, smart lighting, solid waste management services, water management systems, municipal e-governance, etc., are received and displayed on a dashboard. As an output, the system provides alerts on any emergencies and the concerned officials can contact the relevant departments to undertake real-time actions (Smart City Bhopal, 2021).

The ICCC Bhopal consists of the following four layers:

1. Applications and Data Layer – It comprises of various sensors and cameras within the city limits that collect data and transmits it to the command centre. Data is collected from billboards, signages, advertisements, etc., which are controlled from the command centre.
2. Integration Layer – This layer essentially integrates data from various devices into one place. Various datasets are collected in different file formats and later converted to a compatible format for Artificial Intelligence (AI). Additionally, this layer also hosts short message services (SMS) and payment gateway services.
3. Platform and Analytics Layer – It computes technological power to analyse the collected datasets and finds out patterns or relevant indications from it. This is the most important layer and is usually considered the 'brain' of ICCC. It links and analysis various datasets. Under this layer, four main types of analytics are undertaken, viz., predictive, diagnostic, prescriptive and video analytics.
4. Integrated Centre Layer – It is a physical structure of the ICCC consisting of the dashboards, large screens, situation rooms, servers, etc.

2.2.1 Components of ICCC Bhopal

1. Intelligent Transport Management System (ITMS) – The ITMS was installed across the city to ensure effective traffic management. All major junctions

Figure 2: The State-of-the-Art Facility at ICCC Bhopal

are installed with cameras for traffic surveillance and monitoring (Figure-3). It consists of a Red Light Violation Detection System (RLVDS), Automatic Number Plate Recognition (ANPR), Variable Message Boards (VMB), and an Integrated Challan Management System (ICMS). The RLVDS uses cameras and AI to automatically recognise vehicles violating traffic rules. ANPR is used to identify the vehicle owner using the Regional Transport Office (RTO) records. After the confirmation of the violation of rules, ICMS creates a digital challan. The challan is then sent to the vehicle owner both by post and SMS. The challan varies according to the type of offence, i.e., for not wearing a helmet, jumping the traffic signal, triple occupancy on a two-wheeler, excessive speeding, etc. AI is also used for tracking stolen vehicles. Once the vehicle's number plate is detected through ANPR by any of the cameras, an alert is displayed. This information is communicated from the ICCC to the concerned traffic police coordinator for necessary action. ITMS is also used for vehicle counting, analysing real-time traffic dynamics and accidents at each junction.

2. Smart Poles and Smart Lighting – More than 150 smart poles were installed across the city. These uniquely designed poles are geo-tagged and integrated to the centralised system for real-time data transfer. These poles are usually equipped with the following:
   - Wi-Fi: With more than a thousand access points across the city, free internet upto a maximum of 50 megabytes per day is being provided through these smart poles. At any given point, the number of internet users can be found out along with their geo-tagging details.
   - Billboards: Besides the smart poles, the city is also equipped with billboards. Presently, there are around 120 such billboards. These can be used for advertisements or public notices.
   - Environmental sensors: The environmental sensors in the smart poles are used for collecting real-time environment-related data in the immediate vicinity and mapped thematically. Through this system, ward-wise data on various environmental parameters such as carbon dioxide emissions, particulate matter, pressure, temperature, etc. can be collected and analysed.
   - Smart lights: Smart lights installed on the smart poles work on an astronomical calendar using AI. The locations of these automatic smart lights are displayed on the dashboard of the ICCC on a GIS map (Figure-4). Any malfunctioning smart light can be identified for repair or replacement.
3. Solid Waste Management Services (SWMS) – Under this component, the following five key services are undertaken.
   - Monitoring of ward offices: This helps to ensure smooth functioning.
   - Vehicle tracking: Dynamic and live vehicle tracking of SWMS vehicles in the city is done through the Global Positioning System (GPS). Information about the malfunctioning of the tracking system can be acquired.
   - Route map chart mapping: Whenever the smart bins under the SWMS become full, information is displayed on the dashboard. This information is then used to decide a route map for waste collection, optimising time and distance. These route maps can be viewed on a GIS platform and are displayed on the dashboard. Full bins are emptied on a priority basis.
   - Trip weight monitoring: This is used for the purposes of solid waste generation and waste segregation (wet and dry waste). The amount of waste generated is mapped based on the number of trips.
   - Report generation of the waste: Periodical reports are generated on various parameters such as waste generation, frequency of waste collection, etc.
4. Smart Parking – Smart parking stations equipped with state-of-the-art technology like smart sensors, cameras, dashboards, etc. were opened in the city. Through this system, parking surveillance, identification of vacant parking slots along with their exact location, etc. can be done. Presently, smart parking is successfully operational and has enabled vehicular traffic decongestion to a great extent, particularly in busy locations such as Maharana Pratap Nagar and New Market.
5. Public Bike Sharing – With an exponential increase in automobiles in the city, a shift to Non-Motorised Transport (NMT) modes was imperative. In order to promote the same, a Public Bicycle Sharing (PBS) system was initiated. Under PBS, bicycles can be used through the use of a QR code-enabled chartered app from the nearest docking station. Nominal user charges are admissible based on the

Figure 3: Methodology for comprehensive conservation plan

Figure 4: Smart Light Information

usage time. The data of active users, parked bicycles, etc., are displayed on the dashboard of the ICCC, with a 24x7 live feed from the docking system to ensure monitoring and safety. The bicycles are GPS-enabled and can be tracked.

2.3 Field Surveys

In order to understand and assess the ground situation regarding the functioning of service delivery, the filed surveys were conducted. As a part of this, stakeholder consultation/ interviews with concerned officials and household surveys in identified neighbourhoods of Bhopal were taken up. The field visits were done in two stages: (i) Stakeholder interviews and (ii) Household surveys in the identified locations of the city. The site visits to the ICCC were conducted in February and March 2022. The perceptions thus collated were analysed on a Likert scale and recommendations were given.

2.3.1 Stakeholder Interviews

The concerned staff/stakeholders (Figure-5) at ICCC Bhopal were interviewed. They included nine officials, i.e., Assistant Engineer of ICCC, Management Team, Project Coordinator, etc. The interviews were primarily aimed at identifying and assessing the issues related to the functioning of ICCC Bhopal. The responses of the stakeholders were collected through semi-structured interviews. The questions were mostly related to the most common issues faced by the command centre.

A number of suggestions were given by the respondents. These suggestions commonly include the improvement of inter-departmental coordination, increasing the awareness of the general public about the ICCC, the need for periodical upgradation of the technology, exploration of data potentials for multiple purposes, flexible data policy, capacity building of the officials, reducing dependency on private players, etc.

2.3.2 Household Surveys

A representative random sample of 50 households was surveyed in around 10 identified neighbourhoods, viz., Mandakini Colony, Chuna Batti, Maharana Pratap Nagar, Shahpura, Mata Mandir, Kohefiza, Roshanpura, Kolar Road, Hoshangabad Road, and BHEL. This was done to ensure the geographical spread across the city. Further, the perceived benefits and other related perceptions were collected through structured questionnaires. It was found that only around a fourth of the surveyed sample households (24%) were aware about the ICCC. The survey revealed that the COVID helpline was the most-used service. Around 84% of the sample households had used the service. More than half of the respondents were aware of the public bicycle sharing system (58%) and smart poles (54%). However, awareness about the apps, such as the Chalo App (26%) and Mayor's App (34%), was relatively lesser when compared to other smart components. This points to a need to increase awareness among the general public about the availability of various smart services. The survey details are shown in Figure-6.

2.3.3 Likert Scale Analysis

The quality of service provision was analysed based on the Likert scale. A five-point choice-based criteria was used, ranging from the worst to the best. The following point-scale was used to rate the service: Worst-1, Bad-2, Average-3, Good-4, and Best-5.

ii. Chalo App for Public Buses – More than three-fourths of the users rated the app as 'Good'. Not all the buses were geo-tagged or GPS-enabled, hence the details were not available on the app.
iii. PBS – Around 80% of the respondents rated the PBS as 'Good'. However, the users felt that the cost of the service is high and the service is not very affordable.
iv. COVID Helpline – Almost all the respondents rated the COVID helpline as the 'Best'. During the recent pandemic, this was the most-used service. A number of people benefitted from this service. Information related to the location of hospitals, number of available beds, etc., was provided through this service. However, not all hospitals showed this information.
v. Free Internet – More than 70% of the users rated the service as 'Good' while the remaining rated it as 'Average'. The users reported that the free internet data offered is limited to only 50 megabytes and suggested to increase it.

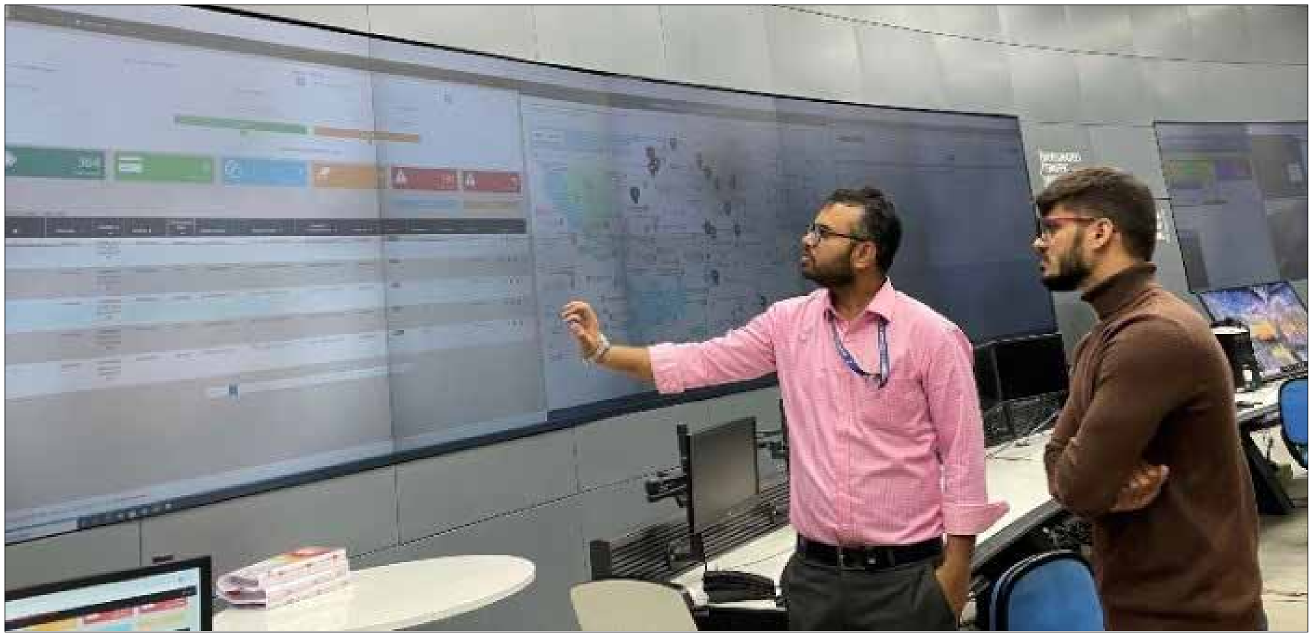

Figure 5: Demonstration of Service Delivery Mechanism of ICCC Bhopal

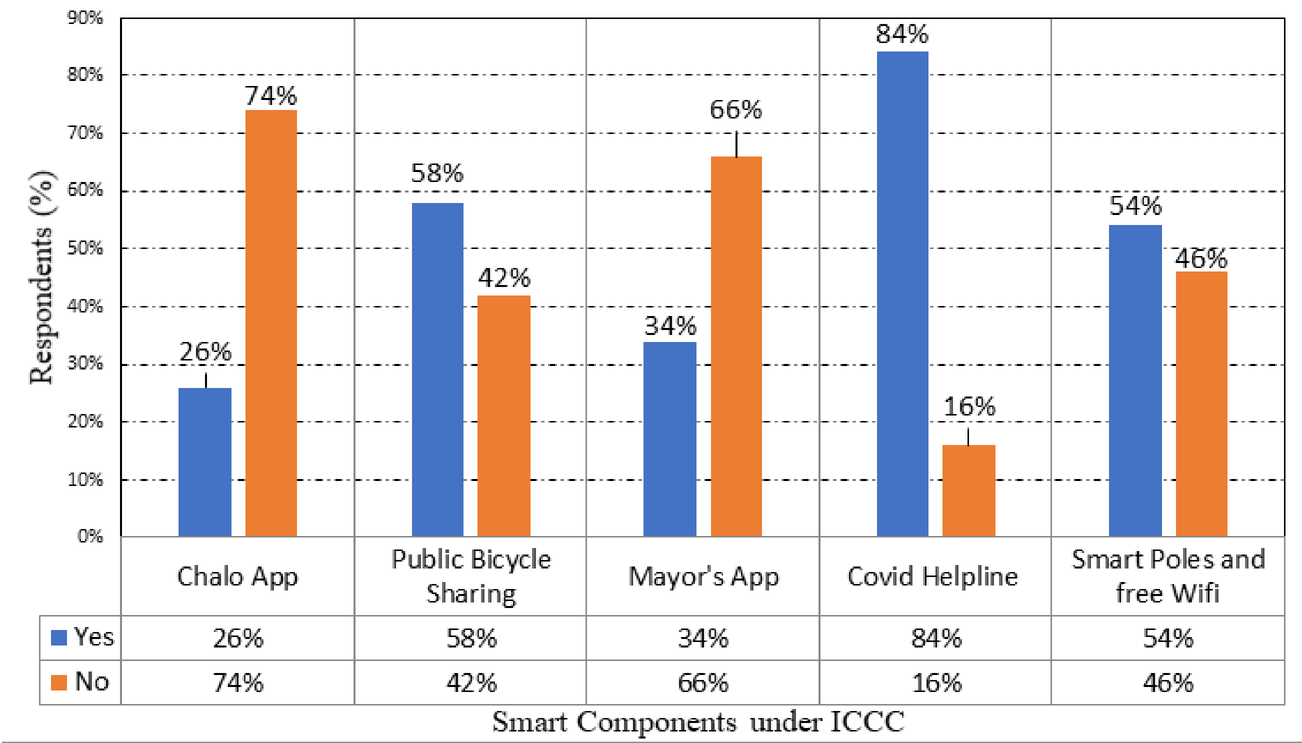

Figure 5: Demonstration of Service Delivery Mechanism of ICCC Bhopal

3. Recommendations

Since its inception, ICCC Bhopal has been successfully contributing to the transformation of the city by effectively delivering smart urban services. In general, a drastic improvement in the service delivery mechanism coupled with the use of the latest technology can be noticed. This has helped increase the quality of life of the citizens. It can be said that the ICCC has been instrumental in making services easily accessible and transparent to the users. However, the following are some recommendations for further improvement of the system:

- There is a need to increase the awareness of these smart services to the citizens. Awareness and public campaign programmes may to be taken up through various modes, i.e., newspapers, television, social media, advertisement hoardings, etc.
- These services may be made more affordable to increase their usage.
- The free internet data offered may be increased.
- There is a need to increase the user base of the smart services
- The easy data-sharing mechanism among the concerned departments can prove to be vital for more effective and efficient delivery of services.
- The smart services need to be extended to the entire city increasing their spread. Offering services across various identified sectors can also be contemplated.
- There is a need to explore the data potential and utilise these data sets for multiple purposes.
- Given the rapid advancements in technology, periodic upgradation and maintenance of technology is important.
- Presently, the ICCC follows a 'pay as you use' policy based on which payments are made to the private company handling and managing the data. Due to this, the private companies involved usually collect as much data as possible for increased margins without ensuring their relevant use.
- The data collected by the ICCC may be made available to the general public as 'open-source data'.
- GPS tracking system and its integration with the Chalo App may be further improved to avoid any inconvenience to the users. This is particularly required for bus timings to ensure timely service.
- Data related to various social infrastructure, such as the health services and education centres, may be integrated.
- For reduced dependency on private players, there is a need for capacity-building of the concerned officers or authorities for effectively controlling and maintaining the command centres.

3.1 Implications

Preserving, showcasing the identity of the city and conserving the heritage has to be done not only to remind us of the past legacy, but also comes with the side benefit of a major tourist attraction that it draws because of the same reason. Even though the results of implementing this project couldn't be assessed, as the work is in progress and had not been open to public access yet, it is clear through the random sample survey conducted that the people of different age groups were interested and are expected to visit the museum once it was open. This project can be hailed as a pilot project in terms of preservation and conservation of heritage buildings and its outcomes and learnings can be used by other cities in their own way.

Figure 7 above illustrates the dimensions of heritage conservation that accrue not only for heritage assets, but also to larger development aspects (across the x-axis). Distinctions across the y-axis on the other hand show the benefits at the community level, and at the city levels.

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A34

Smart Education Campuses in Visakhapatnam Under the Smart City Mission – An Appraisal

Name of the project: *Smart Education School Campus*
Location: *Visakhapatnam, Andhra Pradesh*
Year of project implementation: *2019*
Sector: *Education*
Project Cost (Rs. Crore): *Rs 33.1 Crores*
SDG: *4.3 and 4.7*

Institute: *Dept. of Planning, SPA Vijayawada*
Advisors: *Dr. Ayon Kumar Tarafdar, Dr. Adinarayanane R*
Students: *Mr. Obulesh C., Ms. Atchaya N., Ms. Pranathi G., Mr. Sai Kiran, Ms. Aswathy B., Mr. Joseph*

Keywords: *Smart Education, Smart Classroom, Smart City, Visakhapatnam*

Abstract:

Smart City Mission in Visakhapatnam, coordinated by GVSCCL has prioritized and taken up several municipal schools in the city and invested on upgrading them with smart technologies and infrastructure, aimed at long term development of the environment of education. The purpose has been to retain and attract more students to these schools and make them competitive and at par with other private schools. These schools, catering to the poor sections of the city are now equipped and modernized with digital classrooms, refurbished outdoors, and skilled human resources. This report attempts to study two case schools of this project from this city, and bring out the key achievements, scope of improvement and possibilities of replicability and scalability.

Case Study: **A34**

1. Introduction

Visakhapatnam (also commonly known as Vizag, Visakha, or Waltair) is the largest and most populous city in the Indian state of Andhra Pradesh, as well as the state's proposed administrative capital. It is the headquarters to Visakhapatnam district and one of the four smart cities in Andhra Pradesh, as designated under the Smart Cities Mission of Government of India. As a part of the Smart City Mission, the Greater Visakhapatnam Smart City Corporation Limited (GVSCCL) undertook several noteworthy projects, one of which was converting its schools into smart education campuses. As a part of the research initiative under the "Smart Cities and Academia towards Action and Research (SAAR)" project under the Ministry of Housing and Urban Affairs, Govt of India, coordinated by NIUA, this research report attempts to appraise two of the smart education projects in Visakhapatnam city.

1.1 The Topic and The Context

In line with the Smart City Vision, Visakhapatnam has prioritized the health and education of its residents, particularly children, and has implemented programs to improve educational infrastructure. The Visakhapatnam city has prioritized the improvement of the city's social infrastructure. By upgrading GVMC schools, the project intends to modernize public schools as smart campuses. It would turn schools into 'Smart Campuses' and build a 21st-century education infrastructure for people from all walks of life.

In this context, it is pertinent to mention that the city experienced substantial evolution in the last 20 years with an exponential growth in the school going population. Between 2001 and 2011, the city's spatial extents increased by 91.8 percent. In 2005, the municipal territory was expanded to include Gajuwaka and 32 villages and the Greater Visakhapatnam Municipal Corporation (GVMC) was formed, which resulted in an increase in spatial extents and population. The zones of Anakapalli and Bheemli were added to GVMC's limits in 2013. After the state was bifurcated into Telangana and Andhra Pradesh, Visakhapatnam became the popularly conceived educational hub of the state. The city is placed 122 on the list of the world's fastest-growing cities.

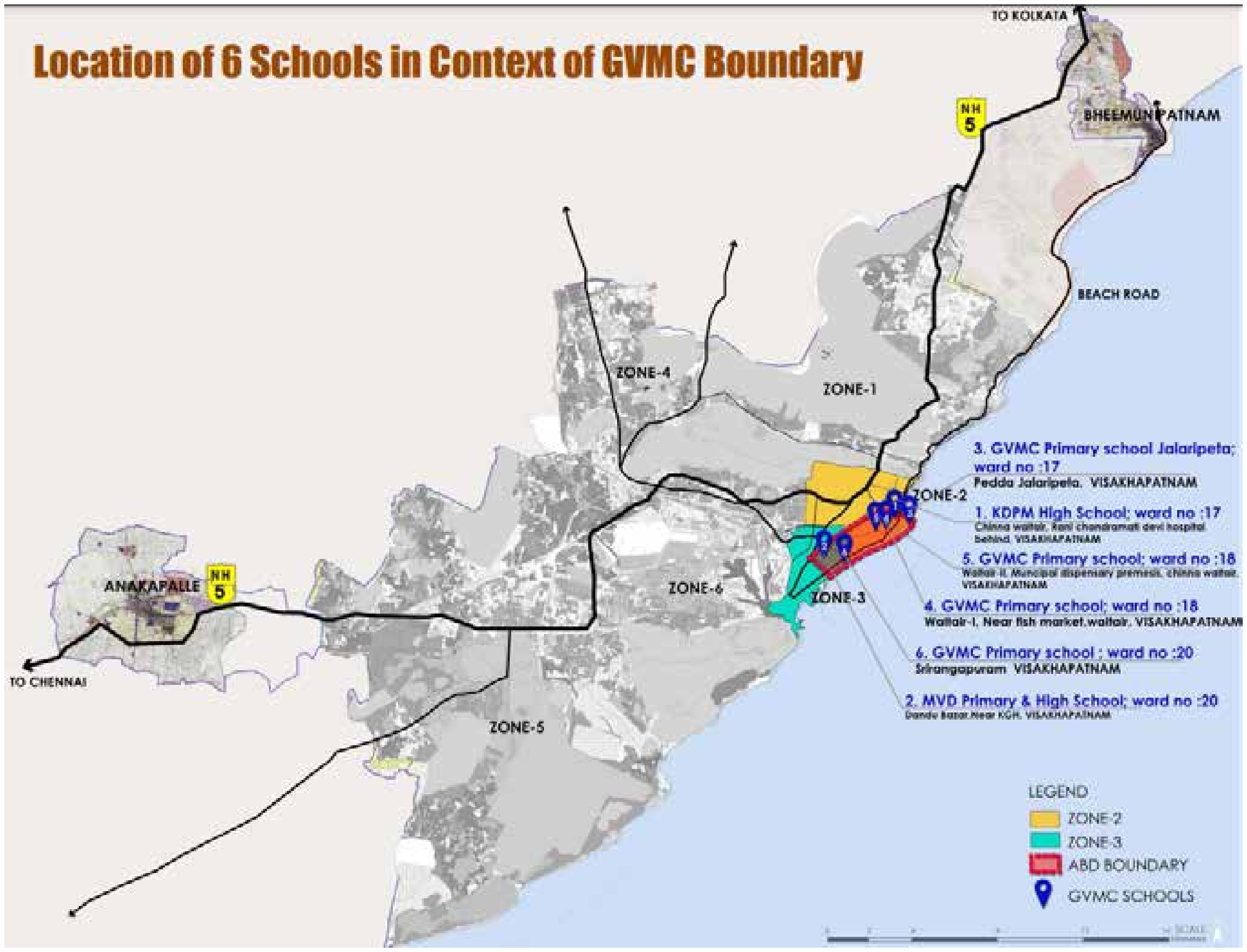


Figure 1: Location of 6 schools in context with GVMC Boundary. Source: NIUA, GOI-2022

According to the 2011 Indian census, Visakhapatnam had 164,129 children aged between 0–6 years, with 84,298 boys and 79,831 girls, with a sex ratio of 947 girls for every 1000 boys. With a total of 1,279,137 literates, the average literacy rate was 81.79 percent in the city, with 688,678 men and 590,459 females as literates (RGI, 2011). The literacy rate at GVMC is 82 percent, which is greater than the district's 67 percent and the state's 68 percent, according to the Census of 2011.

The State's School Education Department oversees the elementary and secondary school education components, According to the school information report for the academic year 2016–17, there were 1,44,268 pupils enrolled in 434 schools in metropolitan Visakhapatnam. Different schools use different forms of syllabus, such as the Central Board of Secondary Education, Secondary School Certificate, or Indian Certificate of Secondary Education. GVMC schools use English and Telugu as their primary languages of instruction.

In this backdrop, the Smart Education Campus project was conceived by Greater Visakhapatnam Smart City Corporation Limited (GVSCCL) with a purpose to develop a concept design for converting GVMC schools into smart campuses. This necessitated a complete renovation of the schools' facilities, as well as the provision of technology-based learning resources for the instructors and students. The project is also mandated to involve creation of clean, attractive and hygienic public spaces within the schools which can attract and encourage students towards extra-curricular activities and sports.

1.2 Project Brief and Locational Attributes

In Vishakhapatnam, there are 147 GVMC schools, including 118 basic schools, 2 upper primary schools, and 27 high schools. In the GVMC's authority, more than 7000 pupils are enrolled in 147 municipal schools. The project has been conceptualized carried out in three Phases, as summarized below.

- Phase 1 - 6 schools taken up within ABD for modernization
- Phase 2 - Subsequently the project was replicated in 25 High schools
- Phase 3 - Providing Integrated Projection system to 154 class rooms in 27 high schools (Classes 8 – 10th grade) in rest of the city.

Particularly, in the first phase, six GVMC schools in zones 2 and 3 of the ABD area (Area Based Development zone of the Smart City Mission) were modernized. The educational institutions which were modernized are:

a. KDPM High School, Chinna Waltair; ward no:17

b. MVD Primary & High School, Dandu Bazar; ward no:20
c. GVMC Primary school, Jalaripeta; ward no:17
d. GVMC Primary School, Waltair-I; ward no:18
e. GVMC Primary School, Waltair-II; ward no:18
f. GVMC Primary School, Srirangapuram; ward no: 20

Out of the above six, as a part of the SAAR initiative and this report, two schools were studied in depth:

a. KDPM High School, Chinna Waltair; ward no:17
b. GVMC Primary School, Waltair-II; ward no:18

Figure 1 (below) shows the location of the 6 schools with respect to the GVMC boundary and the ABD zone boundary.

Figure 2 (below) shows the location of the six schools within the ABD zone as demarcated by GVSCCL.

1.3 Significance of the Smart Education Campus Projects of Visakhapatnam

The purpose of this project, spearheaded by GVSCCL, has been to provide comprehensive education solutions and to transform traditional classrooms by empowering teachers to integrate digital tools and aids into their instruction with ease. The main objective is to assist children in learning as a faster pace and while promoting creativity and critical thinking. The smart campus projects are at advance stages of completion and all school students are presently enjoying the benefits of the initiative and hence, the project is significant. It is aimed to make classroom learning more interactive, more engaging with increased digital awareness and digital literacy. Since the projects are presently in all municipal schools, it is significantly reaching out to the economically challenged strata of children, who are present in good numbers in such schools and who, otherwise, have limited access to digital learning tools.

In the subsequent sections, we shall describe and highlight the components of the smart city mission which were introduced into the project and how it has been mainstreamed into the educational processes.

2. Smart Campus Project Appraisal

2.1 The Study Concept

This report shall first explain the initiatives undertaken in more detail on the basis of the case studies of the two schools studied. Then, the report shall try to bring out the perception of the users and beneficiaries of these tools. Finally, it would indicate the areas and scope of improvement or replication.

The data related to the project was obtained from GVSCCL officials and supplemented with site visits in March 2022, where interviews were held with the school authorities, group discussions with the teachers and students, followed with primary surveys.

The smart campus initiative in phase I is understood to have introduced two typologies of upliftment and upgrading in each of the schools. They are, (a) augmentation of the physical teaching infrastructure in the classrooms for the use of the students and teachers and, (b) creation of better spaces for extracurricular, sports, and recreational activities for the children. In the subsequent sections the project specifications have been discussed in detail.

2.2 Smart Campus Project Summary

The components in the smart education campus project have been predominantly 'physical infrastructure' installations and 'social infrastructure' creation.

2.2.1 Physical Infrastructure Upgrading

The GVSCCL aims to improve advanced and inclusive environment for teaching and learning. Additional classroom and staffroom furniture, hardware, software, digital connectivity, projection and sound systems, display boards and pin-up boards have been installed at key rooms and spaces in the schools. One of the GVMC's key goals is to establish clean, green and digitally advanced education campuses with universally accessible designs in every school. Indoor and outdoor spaces that are attractive, hygienic, functional and have a sense of identity and branding have been developed. Enhancements to the building facade, brighter interior rooms, proper signages, clean toilets, and safe sports areas and play tot-lots have been invested upon. The purpose of modernizing and transforming GVMC schools into Smart Campuses is to create a 21st-century education infrastructure for people from all walks of life. Primarily, the project aimed at improving the classroom experience of the students.

Majority of the classrooms in each of the schools have been fitted with computer systems, high speed internet Wi-Fi connectivity, projection systems, smart display boards and audio-visuals. Seating in these classrooms are spacious, well-designed and comfortable. Certain teachers have been trained to use these equipment and deliver lectures and conduct interactive classes using these tools. Smart classrooms are in use for last 1 year, and have resulted in better levels of attendance and attention of the primary school students, as per the school authorities. In the secondary school, the impact has been far reaching, as students could access audio-visual classes and lectures from long distance and get connected with peer students from other campuses. They also could see complex experimental videos and course units through application videos and audios. Their outreach and exposure has been expanded, as per the school authorities.

The smart classroom is a multipurpose facility that addresses students' academic and training needs, in addition to emphasizing students' digital abilities

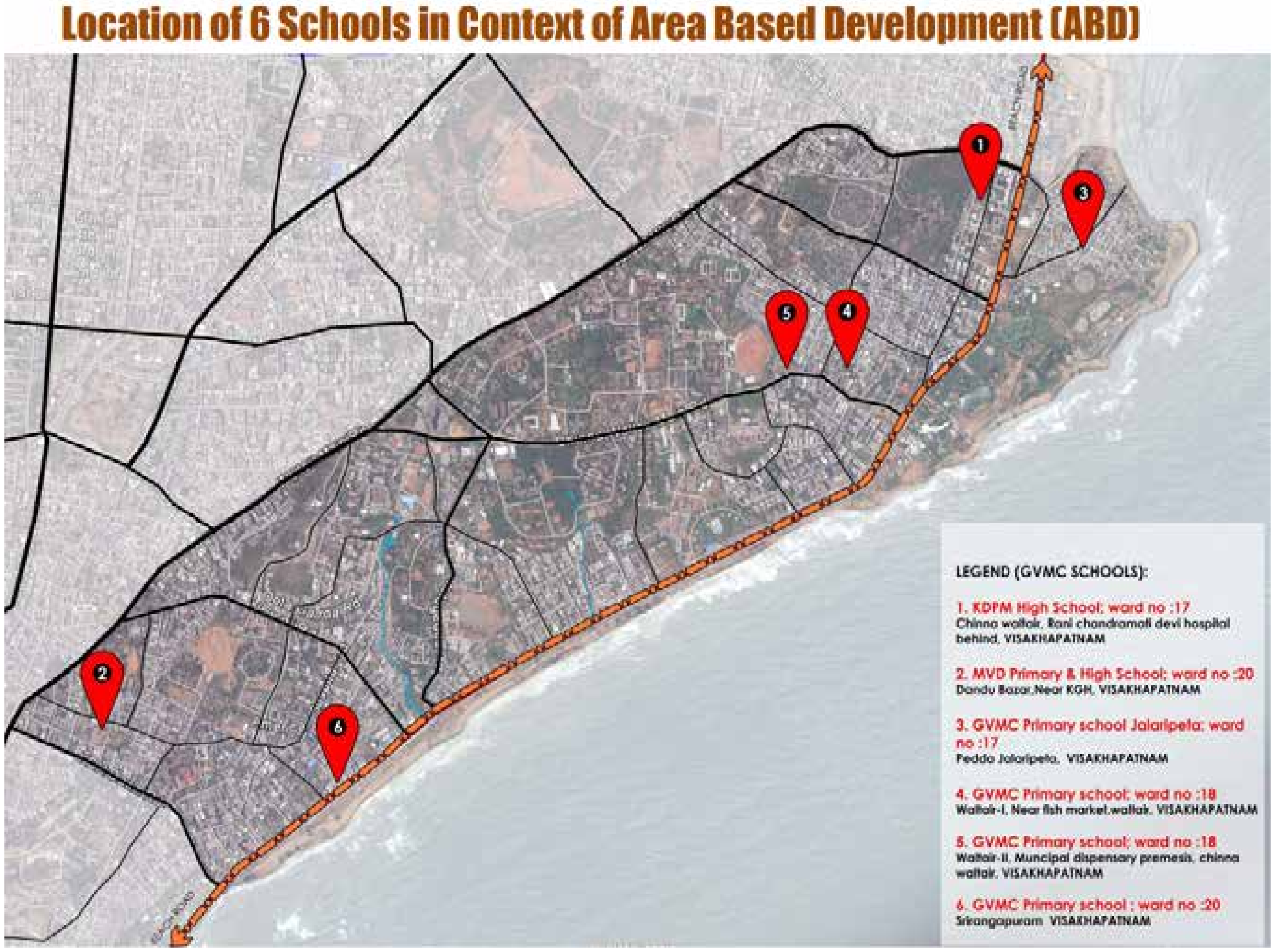


Figure 2: Location of 6 schools in context of Area Based Development (ABD). Source: NIUA, GOI-2022

and taking control of their learning experience. The classrooms aid in the administration of exams and assignments, the alignment of curriculum across teachers, the distribution of tasks, the administration of online evaluations, the sharing of notes, and the distribution of feedback. Through a digital workplace and intuitive design, e-learning encourages critical thinking and problem solving.

Secondarily, the lighting and electrical fixtures, drinking water/RO system, storage and locker facilities, dining facilities, hand wash facilities, proper drainage, locating dustbins for each class room, rain water collecting pit, and compost pit are among the other components, on which investments are ongoing. With sufficient ventilation and new flooring, additional toilets and running water are being envisaged. The school's waste water has connected to the subsurface sewerage system.

2.2.2 Social Infrastructure

Providing active outdoor spaces for sports and extra-curricular activities has been of equal significance to the smart campus projects. Upgradation of amenities in these two schools for teachers and students, by creation of physical spaces and assets that encourage social interaction and agglomeration has been the purpose. Multiple sports facilities like kids play areas with special safe surface treatment and installation, creation of badminton and handball courts, provision of an outdoor auditorium and open theatre space, green open area as a multi-purpose play-ground, have been developed in both these schools within its original plot dimensions. Every space available has been thought out for best possible utilization. The outdoor area have been necessarily well shaded with trees and shades. There have been substantial amount of outdoor seating. Safety and security through the construction of compound wall, fencing and proper designed gates at the entrances and exits have been exemplary. Separate dustbins for segregation of dry and wet waste in the outdoors are noteworthy. These components have encouraged the students to actively play during both the school hours and after the school hours. The schools have also organized sports camps in these schools for further opening their facilities as opportunities for external students to avail from during vacations or designated durations.

In addition, as a part of enhancing the social infrastructure, specially designed capacity building programs have been conducted on various subjects, which have been beneficial to the students, instructors, and staff. Increasing public knowledge on health and hygiene issues, handwashing, nutrition, sanitation, science have been taken up and propagated through awareness workshops. Medical camps are also held to safeguard the pupils' health and safety. The majority of the children come from low-income families, they have limited access to higher end services and therefore these initiatives, infrastructure and opportunities have opened up their network and access to high quality education, recreation, mid-day nutrition and extra-curricular skills.

2.2.3 Benefits Accrued

Under the Smart Cities Mission an initiative has been launched in Visakhapatnam called the 'City Investments to Innovate, Integrate, and Sustain (CITIIS) Challenge'. As a part of this initiative, as many as 44 GVMC schools in Vizag are being given a facelift. This would entail re-painting the buildings, developing the sanitation and drainage in these schools and uplifting the basic hygiene in terms of water supply, toilets, upgrading of windows and doors. Facade improvement works are also included to uplift the overall look and environment of the schools.

Comprehensive upgrading, which is beyond face-lifting, and at present is done in limited number of schools (including the six listed earlier) would entail - equipping schools with technology-based learning resources, external development works for hard scape, soft scape, site furniture, lighting, signage, new play courts, refurbishment of existing playing fields, enhancements to teaching & learning environments in school buildings, refurbishment of existing toilet blocks, and universal

Plate 1. SPAV team discussing with Principal and Admin Staff, GCMC Primary School, Waltier II

Plate 2. Refurbished Play Area for Children in Primary School, GVMC, Waltier II

Plate 3. Smart Classroom, GVMC Primary School Waltier II

Plate 4. Upgraded Classrooms in Upper Primary School, Chinna Waltier

Plate 5. SPAV team inspecting upgraded playground & Multi-Use dais in Primary School, GVMC Waltier II

Plate 6. GVMC Waltair - II Primary School. Teachers and SPAV team

accessible design etc. Before the modernization of GVMC Schools, most of them had a courtyard-corridor typology. There was a horizontal band of verandas running over windows and doors along with column at regular intervals. Most of the schools complained of insufficient classrooms. Those that exist were considered to be in dilapidated state; lacking basic facilities like storage, notice boards, furniture, computers etc. The student enrollment used to be low and attendance and drop rates were alarming. While major interventions to improve daylighting and ventilation are necessary in the long run, introducing smart boards, lighting fixtures etc. have been thought of as phase one and initial cost and time effective solutions to be provide to revive classroom interiors and reinvent teaching and learning process.

Hence, this smart cities program and its offshoot, the CITIIES program, has been a very timely and significant intervention in the city under the GVSCCL. It has completely re-branded the primary and secondary public schools, making them attractive, competitive and advanced in every sense.

3. Stakeholders' Perceptions

The project team of SPAV spoke to the stakeholders of this project in three formats. It had extended discussions with the Principal / Head Teacher of each school to understand the impact of the project in the long term. It then had team discussion with the teaching and administrative staff to understand the implementation, operations and maintenance aspects of the smart components and finally, interacted with the students in detail to understand their perceptions. The findings are presented in the subsequent sections.

Plate 7. Interactive Facelifted Corridor Spaces in Primary School, GVMC, Waltier II

Plate 8. Upgraded Multi-Use Common Area in Upper Primary School, Chinna Waltier.

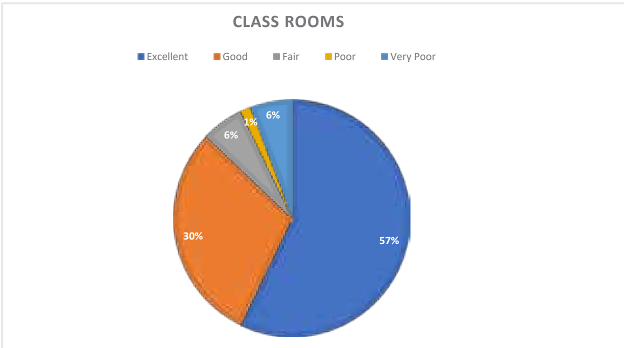
3.1 Viewpoints of the School Administration and Teachers

3.1.1 A Whole New Competitive Edge

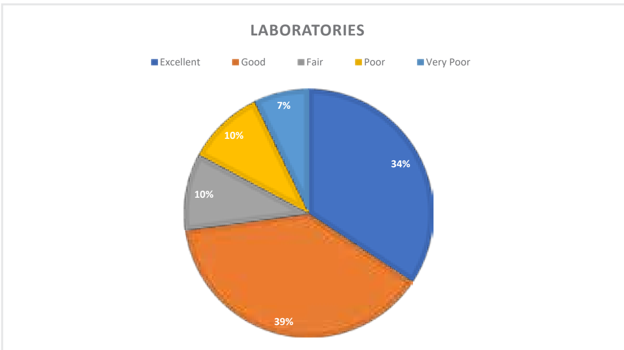
It was felt that with these support initiatives, the GVMC schools can now compete with other private schools (having much better financial and human resources). The smart infrastructure, trainings, better classrooms, and exposure has led to confidence building among the instructors leading to higher quality teaching material, timely organization and checking of assignments and wider tools of dissemination. Teachers felt that by delivering good quality lectures, students have been more attentive and interested in education than before.

3.1.2 Enhanced Efficiency

It was felt that efficiency in administration of education, assignments, examination and delivery of lecture are critical to a school being successful and being reputed. Quality education will not only improve the individual's efficiency, but it will also be an effective tool for increasing and broadening democratic participation and improving an individual's and society's overall quality. All teachers were given training as part of this effort to help them become more familiar with the advanced teaching infrastructure. The trainers made a point of providing all of the teachers with technical information so that they could readily integrate with their particular disciplines.



Graph 1: Rating of Smart Classrooms by Students



Graph 2: Rating of Smart Laboratories by Students

3.1.3 Greater Outreach

It was felt that these initiatives have reached out through word of mouth across the city, thereby attracting a lot of new prospective students from the lower income groups and the under-privileged classes from the city. According to us, this is a very promising factor.

3.1.4 Viewpoints of the Students

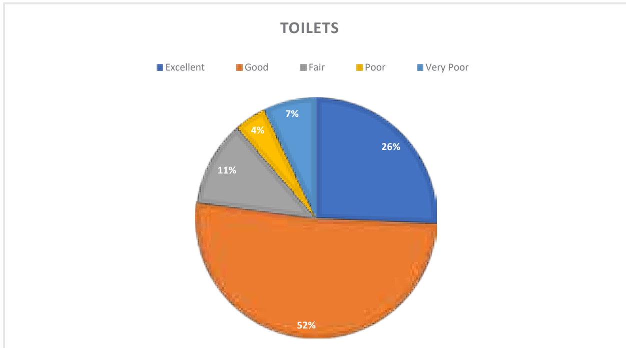
The research team's interactions with the students and understandings from them can be summarized as below:

3.1.5 Better Understanding

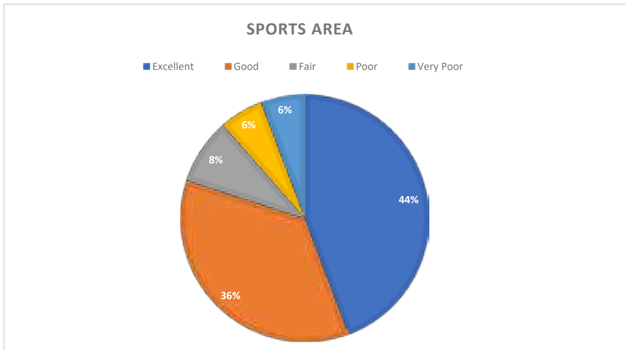
The students felt that the multimedia content, digital classrooms, smart projections and displays which are complimented by lectures aligned with AP State board curriculum, have offered them both an advantage and opportunity learning. It was felt that smart classrooms have the capacity to transform textbook information into audio-video-based interactive information for faster understanding and learning effectiveness. Teachers log in to the multimedia application on their smartphone, remote desktops or in the actual classrooms and can use animation technology to instruct their students for effective learning and interactive sessions for their subjects and chapters according to the syllabus. This has led to increased levels of academic interest and a greater student participation.

3.1.6 Practical Hands-on Skills

Since the teachers had acquired hands-on training, they could convert theory into practical assignment based learning modules leading to students undertaking more number of computer based projects and application oriented activities. This makes the students acquire more skillsets which are practical and industry oriented.



Graph 3: Rating of Toilets by Students



Graph 4: Rating of Sports Areas by Students

3.2 *Effectiveness of the Smart Components*

Students expressed their user perspectives about the smart components in their school premises and a summary of the findings are as below. A sample of 70 students was taken, and they were also asked to appraise the smart amenities on campus.

4. Inferences

4.1 *Implications and Benefits of the Project*

Low enrollment or drop out from municipal schools can be related to a number of factors. It is not about lack of schools alone. There are enough number of schools in contemporary times and yet the enrollment figures are challenged. Lack of stimulation to grasp the course content, lack of stimulation to attend classes, desisting premises that are unhygienic and filthy, lack of proper safety, space or food are equally serious reasons behind drop-outs. The necessity of schooling, poverty, parental literacy, and infrastructure are cross-linked. Majority of children that attend municipal Schools come from low-income or underprivileged backgrounds. There needs to be additional interventions to retain and hold back such students of poorer backgrounds.

At the same time, students finds it easy to learn with the help of technologies, gadgets, equipment and digital platforms rather than only the old conventional teaching methods. Multimedia content that is designed based on the approved AP State board syllabus, and delivered in safe, spacious, hygienic conditions by able and encouraging teachers is the need of the day. The two schools studied in Visakhapatnam, demonstrate a strong model where the students and teachers have both expressed their increased inclination towards the teaching-learning process after the introduction of the smart components on the school premises.

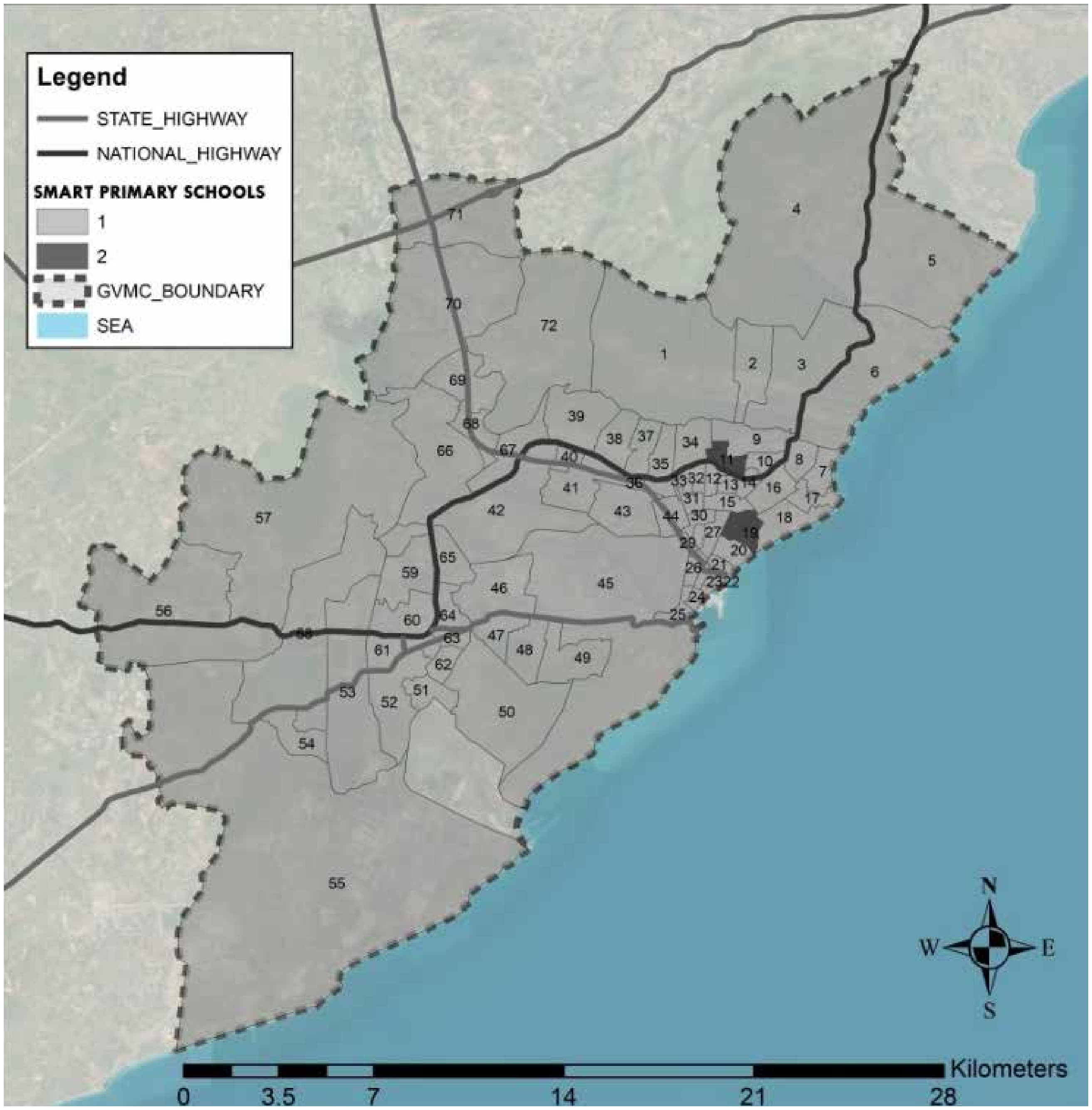


Figure 03: Potential Wards where Smart Municipal Primary Schools can be developed: In 1 or 2 Nos.) based on projected Primary School Going Population of 2041. Source: Author

Teachers observed that digital literacy amongst students had increased remarkably. There have been tremendous improvement students' performance with respect to integration of technology into teaching learning spectrum. Teachers and students got an opportunity to teach and learn in Telugu and in English medium with the help of the Multimedia content. This helped in enhancing their proficiency in academic subjects with multiple learning options. The teachers and students are grooming themselves by exploring to digital books.

It is evident that the GVSCCL's holistic approach to the situation has had an all-round positive impact. Having better sports areas, better toilets, water supply, better landscaping, together is leading to great levels of confidence, sense of belonginess and pride in the students towards their schools. Their confidence level has increased in using technology as well as better spaces. Utilizing opportunities by students to interact/learn with students in other schools through inter-school digital processes have led to sense of positive competition. This helps in attending classes online mode, work on assignments and even works well with online exams too. The benefits of the project can be summarized, as follows,

a. Improved physical health and well-being of students;
b. Improved sense of identity and pride among students and teachers;
c. Improved quality of teaching;
d. Improved learning environment in schools;
e. Improved levels of school safety;
f. Improved academic performance and enrolment of students; and
g. Creating gender inclusive spaces.

4.2 *Scope of Improvement*

While the two school projects demonstrated high levels of achievement and effectiveness on the ground, certain aspects do require additional focus. Maintenance of digital equipment, hardwares and networking requires attention. Municipal school staff may be well equipped to apply and use these equipment, but may not have the technical knowhow to repair and maintain them. Service and maintenance contracts of such infrastructure for extended periods beyond warranty needs to be part of the project and investment. Site visits by engineers and technicians once a month or at dedicated frequency of time needs to be inbuilt in the project components for its sustainability. Periodic feedback loops with students or their parents need to be in-built to ensure that the tools are regularly used in the schools and the teachers are keeping themselves updated with the techniques. Security manpower needs to be provided by for ensuring disciplined use and maintenance of indoor and outdoor infrastructure. Half yearly capacity building programs on use of technology needs to be conducted for long term viability of the project. All these points need to be deliberated upon by the project proponents or the municipal corporation or at an appropriate higher government level, beyond the immediate school management.

4.3 Scope of Replicability and Scalability

The study team has done a small exercise, to estimate the number of primary schools which can be taken up in the city of Visakhapatnam for scalability, and where smart education campus attributes can be invested upon. The estimation is based on basic projections of population for each ward till 2041.Thereafter, the projected primary school going population for each ward has been estimated assuming present age cohorts. As per the planning guidelines of India, the requirement of primary schools in each ward for 2041 has been estimated and then tallied with the existing primary schools present. By understanding the gap between the requirement in 2041 and the present availability, and assuming one municipal school for every 4 private schools, the number of schools which can be aimed to be fully smart and digital has been depicted as a part of the subsequent city map and the table presented in Annex One (Table 01).

4.4 A Summary of Thoughts

Low literacy rates in a city, diminishing school going population, low enrollment rates of schools, or high drop-out rates in the schools of a city are all indications that there is limited attention given by the authorities to the sector of primary education. This is something that require serious strategic intervention. Society with children that have low turn-outs in schools, who are not getting educated, not spending time with peer students – indicate serious shortcoming towards child exploitation, child abuse and a future of grown-ups that may be ill-equipped and less educated. Planned and dedicated attention towards primary and secondary education is intrinsic and fundamental.

Increasing the number of schools in the city is not the only panacea. Various other dimensions need to be parallely looked upon. Locating schools at the right places, with the right facilities and making them attractive enough is equally significant. Their time in the school is qualitatively very important for the students from the viewpoint of learning and overall personality development. It not only educate them, but keeps them safe, happy, well-fed and socially active.

The section 4.2 of this report, indicates conceptually, the projected requirements of primary schools in 2041 in each ward of Visakhapatnam and the manner in which at least one government school in every ward can be converted into a smart school. Visakhapatnam's Smart City Initiative has rightly prioritized and invested upon primary and secondary schools of the municipal corporation and have shown a path to be followed. This report propagates that there is an essential need to replicate the model and scale it to every wards of the city. It is important to scale up such projects across the city with top priority, as the benefits are long term for the society. Investing and developing municipal schools which cater to the lower strata of the society is a responsibility of the city authorities that need rationalization and prioritization.

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Annex One

Table 01: Scalability of Smart Primary Schools (Estimation – 2041)

Ward No	Existing Total Population	Existing Children Population (0-6)	Projected Total Population 2041	Projected Children Population 2041	Primary Schools required (as per URDPFI)	Projected GVMC Municipal Schools	Existing Primary Schools	GAP	Proposed Smart Primary Schools
City	1775101	221888	1873677	234210	375	86	78	40	74
1	24995	3124	19412	2426	4	1	0	1	1
2	21904	2738	22835	2854	5	1	0	1	1
3	31387	3923	33507	4188	7	2	0	1	1
4	27132	3392	23144	2893	5	1	0	1	1
5	43744	5468	22778	2847	5	1	0	1	1
6	26227	3278	32841	4105	7	2	0	1	1
7	25102	3138	32571	4071	7	2	2	0	1
8	25118	3140	30243	3780	6	1	0	1	1
9	27697	3462	19000	2375	4	1	3	0	1
10	26952	3369	25972	3246	5	1	0	1	1
11	18093	2262	36170	4521	7	2	0	2	2
12	21078	2635	35094	4387	7	2	1	1	1
13	18309	2289	34654	4332	7	2	2	0	1
14	21106	2638	26341	3293	5	1	2	0	1
15	21878	2735	34246	4281	7	2	2	0	1
16	27305	3413	31655	3957	6	1	2	0	1
17	26262	3283	33701	4213	7	2	1	1	1
18	15605	1951	30147	3768	6	1	2	0	1
19	25527	3191	33656	4207	7	2	0	2	2
20	22039	2755	22062	2758	4	1	3	0	1
21	18632	2329	28445	3556	6	1	1	0	1
22	20013	2502	23094	2887	5	1	1	0	1
23	19897	2487	27149	3394	5	1	4	0	1
24	16597	2075	25508	3189	5	1	3	0	1
25	18679	2335	24228	3029	5	1	4	0	1
26	23576	2947	23559	2945	5	1	3	0	1
27	19385	2423	27658	3457	6	1	0	0	1
28	19401	2425	27864	3483	6	1	2	0	1
29	17426	2178	27906	3488	6	1	1	0	1
30	12696	1587	27552	3444	6	1	0	1	1
31	21393	2674	17987	2248	4	1	2	0	1
32	26164	3271	18703	2338	4	1	1	0	1
33	21689	2711	26429	3304	5	1	1	0	1
34	24265	3033	20679	2585	4	1	0	1	1
35	31336	3917	23791	2974	5	1	3	0	1
36	16780	2098	12677	1585	3	1	2	0	1

Ward No	Existing Total Population	Existing Children Population (0-6)	Projected Total Population 2041	Projected Children Population 2041	Primary Schools required (as per URDPFI)	Projected GVMC Municipal Schools	Existing Primary Schools	GAP	Proposed Smart Primary Schools
37	26513	3314	25482	3185	5	1	1	0	1
38	25681	3210	21069	2634	4	1	1	0	1
39	29287	3661	23334	2917	5	1	1	0	1
40	25987	3248	24441	3055	5	1	2	0	1
41	24239	3030	34157	4270	7	2	3	0	1
42	23719	2965	25634	3204	5	1	3	0	1
43	12434	1554	25989	3249	5	1	1	0	1
44	16443	2055	3309	414	1	1	0	1	1
45	36258	4532	19865	2483	4	1	3	0	1
46	18142	2268	33553	4194	7	2	4	0	1
47	24923	3115	34769	4346	7	2	4	0	1
48	25883	3235	27792	3474	6	1	5	0	1
49	27234	3404	20364	2546	4	1	2	0	1
50	14338	1792	14606	1826	3	1	0	1	1
51	21725	2716	25989	3249	5	1	0	1	1
52	28059	3507	27605	3451	6	1	0	1	1
53	21749	2719	22489	2811	4	1	0	1	1
54	23644	2956	29488	3686	6	1	0	1	1
55	19853	2482	24332	3041	5	1	0	1	1
56	29242	3655	32363	4045	6	1	0	1	1
57	24103	3013	23700	2963	5	1	0	1	1
58	20965	2621	10897	1362	2	1	0	1	1
59	17335	2167	26877	3360	5	1	0	1	1
60	26775	3347	23267	2908	5	1	0	1	1
61	31008	3876	31683	3960	6	1	0	1	1
62	23536	2942	32189	4024	6	1	0	1	1
63	21449	2681	26782	3348	5	1	0	1	1
64	24575	3072	30249	3781	6	1	0	1	1
65	20419	2552	19979	2497	4	1	0	1	1
66	28579	3572	31747	3968	6	1	0	1	1
67	27528	3441	34900	4363	7	2	0	1	1
68	26102	3263	34063	4258	7	2	0	1	1
69	31922	3990	31019	3877	6	1	0	1	1
70	72682	9085	28141	3518	6	1	0	1	1
71	49198	6150	5743	718	1	1	0	1	1
72	28183	3523	22550	2819	5	1	0	1	1

Note: Above estimation is preliminary and conceptual, indicating a potential target. Exact calculation would need validation, with exact enrollment numbers in each ward's primary schools.

A35

Integrated Command Control Centre in Visakhapatnam Under the Smart City Mission – An Appraisal

Name of the project: *Integrated Command and Control Centre*
Location: *Visakhapatnam, Andhra Pradesh*
Year of project implementation: *2018 onwards*
Sector: *Smart eGovernance*
Project Cost (Rs. Crore): *Rs 196.84 Crores (Approx)*
SDG: *11.3 (enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management)*

Institute: *Dept. of Planning, SPA Vijayawada*
Advisors: *Dr. Ayon Kumar Tarafdar, Dr. Adinarayanane R*
Students: *Mr. Obulesh C., Ms. Atchaya N., Ms. Pranathi G., Mr. Sai Kiran, Ms. Aswathy B., Mr. Joseph*

Keywords: *Municipal Planning, Integrated Command and Control Centre, Smart Governance*

Abstract:

Smart City Mission in Visakhapatnam, coordinated by GVSCCL has been invested and developed a complex and comprehensive computing platform that integrated 15 civic administration departments of the city to deliver real-time smart governance. This system is the Integrated Command and Control Centre (ICCC) which consists of necessary hardware, software and human resources that work towards geospatial integration of large datasets from different departments towards effective and timely governance. GVMC with the GVSCCL pioneered the setting up of this infrastructure which is presently in use by the city police, transport, water supply, sanitation, and many other departments. This report attempts to study this project and bring out the key achievements, scope of improvement and possibilities of replicability and scalability.

Case Study: A35

1. Introduction

The Integrated Command Control Centre (ICCC) of Visakhapatnam was developed and implemented as a solution that enables real-time monitoring of civic issues, urban planning, water and power supply, city and beach surveillance, traffic management, air quality monitoring, and solid waste management, amongst other sectors. It is the most critical and significant outcome of the Smart City Mission for Visakhapatnam.

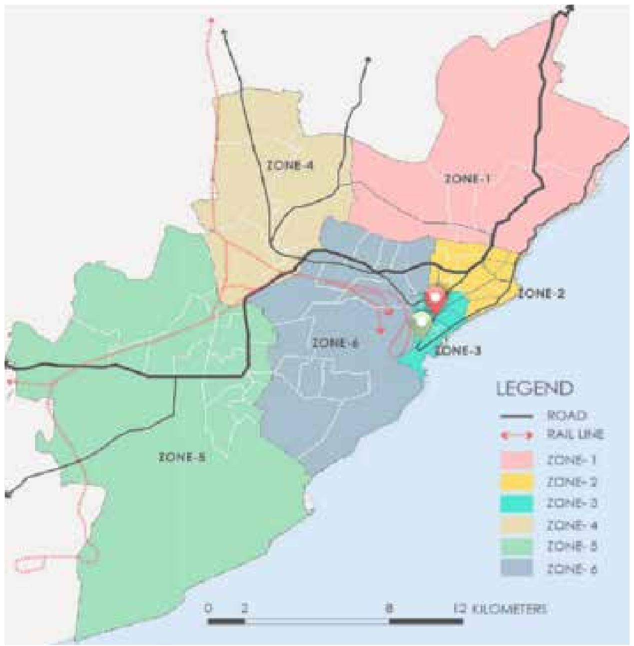


Fig 01: Location of 'City Operations Centre' and 'Viewing Centre' of the ICCC

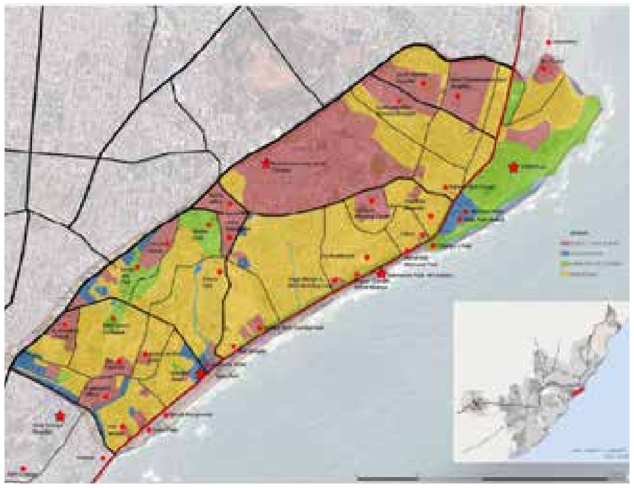


Fig 02: The Area Based Development zone in central Visakhapatnam where ICCC and most of the components of Smart City Mission is located

As a background, it is pertinent to mention that Visakhapatnam (also commonly known as Vizag, Visakha, or Waltair), is the capital of the Visakhapatnam district and one of the four smart cities in Andhra Pradesh, as designated under the Smart Cities Mission of Government of India. It is the largest and most populous city in the Indian state of Andhra Pradesh, as well as the state's proposed administrative capital[1]. As a part of the Smart City Mission, the Greater Visakhapatnam Municipal Corporation (GVMC) had set up the Greater Visakhapatnam Smart City Corporation Limited (GVSCCL), which undertook several significant projects, one of which was setting up the Integrated Command and Control Centre (ICCC) in the city to integrate various sectors of development and city administration and deliver timely, real-time and technically enabled solutions to the citizens.

As a part of the research initiative titled "Smart Cities and Academia Towards Action and Research (SAAR)" which is a project under the Ministry of Housing and Urban Affairs, Govt of India, coordinated by NIUA, Delhi, this research report attempts to appraise the ICCC project in Visakhapatnam city.

1.1 The Topic and The Context

Visakhapatnam is a rapidly developing city with several dimensions of growth. The exponential rise in population, commerce, industry, traffic and transformation of land use in the city in the last one decade is alarming. As Visakhapatnam is projected by many, as the next administrative capital of the State of Andhra Pradesh after the bifurcation of the state, the land value, real estate potential, the industrial and commercial sector and the tourism, have all grown in multiple magnitudes. Between 2001 and 2011, the city's spatial extents increased by 91.8 percent. In 2005, the municipal territory was expanded to include Gajuwaka and 32 villages and the Greater Visakhapatnam Municipal Corporation (GVMC) was formed, which resulted in a planned increase of spatial extents and population. The zones of Anakapalli and Bheemli were added to GVMC's limits in 2013. After the state was bifurcated into Telangana and Andhra Pradesh, Visakhapatnam became the industrial and ITES hub of the state. The city is placed 122 on the list of the world's fastest-growing cities.

Many factors have contributed to Visakhapatnam's present status as an industrial capital, including the presence of steel mills, NTPC, and naval stations. The city already boasts the presence of a large steel plant, an important naval base, a large port and several pharmaceutical industries. The management of the city's infrastructure and traffic has been handled by different departments and in this backdrop, the Greater Visakhapatnam Smart City Corporation Limited (GVSCCL)2 conceived that there is a need to integrate city administration using technology and intelligent computing platforms so that one single command and control centre can synchronize and deliver timely city services through a nodal point. The GVSCCL conceptualized and developed the Integrated Command Control Centre (ICCC) in Visakhapatnam with the help of several technical service providers. The city has two branches of the ICCC, first one is the headquarters at the GVMC headquarters and second one, is at Viewing Center in central Police Commissionerate of Visakhapatnam city. Both the ICCC facilities are spatially located in the city core area.

1.2 Project Background

As a part of the SAAR initiative and this report, the ICCC at the GVMC headquarters was studied in depth for an understanding of the operations of the ICCC and its implications on the city of Visakhapatnam. The ICCC at GVMC (commonly termed as City Operations Centre) has a capacity of 30 high-end work stations for smart enablement and second facility at the Police Commissionerate (commonly termed as the Viewing and Monitoring Centre) has capacity of 18 high-end work stations for smart enablement. Some of the components, which are concentrated at the operation centre, are implemented in Vishakhapatnam's ABD region, while others are distributed throughout the municipal region

Figure 1, as presented herewith, shows the location of City operations centre and Viewing Centre, with respect to the GVMC boundary and with respect to the Area Based Development (ABD) zone demarcated under the Smart City Mission having majority of the components of the Mission.

The Visakhapatnam ICCC project integrates about 15 departments of the city administration, demonstrating more than '60 sub-use cases' for improved city governance and disaster management. The Visakhapatnam ICCC is implemented by a fluent grid system that integrates over 20 smart elements including an ERP system as well as the state level Real Time Governance (RTG) centre, thereby putting in place an e-Governance system in real sense. ICCC aligns with the vison of the CMO of Andhra Pradesh to have a 360 degrees urban real-time governance system. It ensures convergence of information between various

[1]Visakhapatnam is reported to be elevated to the status of administrative capital of Andhra Pradesh state in the future. However, a formal legislative announcement is yet to be made.

[2]Greater Visakhapatnam Smart City Corporation Limited (GVSCCL) is a government formed special purpose vehicle incorporated in lines with Companies Act and functions like a Corporation. It is responsible for coordinating, executing and monitoring the Smart City Mission components in the city. It is a corporation with representatives from various departments of the State Government.

departments through the ICT tools onto one platform thereby driving administrative efficiency, removing duplicity, and bringing out accountability.

The ICCC mainly focuses on increased sanitation and health, public safety, traffic accident reduction, improved administrative efficiency especially about revenue collections, and e-government services, and better preparation for disaster management. The idea is to integrate with a wide range of city systems including city surveillance, traffic monitoring, street lighting, waste monitoring, and utility systems, and align all sub-components into one complete system.

1.3 Project Significance

The ICCC is an extremely significant project for the city as it demonstrates a manifestation of the direct use of human senses as a decision- making platform for city's administration. The ICCC monitors the urban daily life primarily through cameras and sensors, thereby executing the sensory of 'seeing'. The data captured is then processed using geospatial tools into a cognitive process to analyze and arrive at actionable intelligence, thereby executing the sensory of 'thinking'. Finally, the analysis is converted into appropriate actions using machine learning algorithms or human interventions, thereby executing the sensory of 'doing'. The ***'see, think and do'*** are executed in a coordinated and systematic manner based on the rules and SOPs defined by each department of city administration involved.

Visakhapatnam has already iterated and is slowly moving into the zone of responsive cities by executing real time governance in some domains. For example, the IoT enabled smart waste bins with volumetric sensors, used for solid waste management, are monitored in real time in automation which alerts the collection facilities once the bins are filled upto 75%, thereby initiating a timely and efficient solid waste collection and management.

2. Project Appraisal (ICCC)

2.1 The Study Concept

This report shall first explain the concept and components of the ICCC project undertaken, in more detail. The data related to the project was obtained from GVSCCL officials and supplemented with site visits in March 2022, where interviews were held with the ICCC authorities, group discussions with the concerned engineers, followed with primary survey of some of the line agencies involved in the ICCC. The report shall try to bring out the perception of the users and beneficiaries of this platform. The core functions of ICCC are –

a. Operations monitoring;
b. planning;
c. Incident management; and
d. emergency disaster management.
e. Fig. 03 as presented herewith, explains the four main functions; followed, Fig. 04 as presented herewith breaks down these 4 functions into 15 key sub-systems of governance.

These 15 city sub-systems are integrated onto one single platform so that data can be shared on real time and spatial dimension for quick and easy decision making. An executive dashboard provides an integrated view across all the sub-systems and enabled department-level monitoring. Data is also collated across systems for analysis to understand activity patterns and abnormal events, provide timely alerts on actionable events and convert them into incidents mapped with configurable Standard Operating Procedures (SOPs). Visakhapatnam ICCC data is also integrated into Andhra Pradesh state-wide real time governance system (larger state-wide version of command center). The project uses an open data portal for transparent data sharing with all the city stakeholders. Open data facilitates an innovation oriented eco-system for students and citizen entrepreneurs to develop apps on the platform delivering New user cases for citizens and the city administrators.

2.2 ICCC Sub-Systems – A Brief

This section of the report shall now explain the main idea and operations behind each sub-system of the ICCC before discussing the integration of all of them. The data related to this section was obtained from GVSCCL officials and supplemented with site visits in March 2022

2.2.1 Smart Surveillance

One of the most important real-time sub-systems of the ICCC is surveillance. This is directly aligned with safety, security, traffic, and law and order. At 83 junctions across the city, there are 500 cameras installed, 400 of which are fixed cameras and 100 of which, are PTZ cameras which can rotate in all directions, with a zoom range of 500 meters. The surveillance video analytics focuses on crowd gathering, unattended baggage, counterflow, any unlawful happenings, etc. as pre-conceived by the police, traffic and disaster management teams. This sub-component is most in use and is active 24X7. It has data backup for days and has advanced analytical features that can recognize car number plates, etc. It helps in -

- Improving safety in public places;
- Reducing crime rates; and
- In-depth crime investigations.

2.2.2 Smart Street Lighting

The city has a little over 1 lakh LED street lights installed under the mission, out of which 50 IOT-based LED light clusters, which can be turned on, off or dimmed remotely. There are 5200 switches to these LED lights which are integrated and can be operated remotely. These have reduced maintenance cost, improved energy efficiency and enhance security by timely and efficient illumination of public spaces.

2.2.3 Smart Solid Waste Management

In Visakhapatnam's ABD region, there are 50 semi-underground bins and 50 RFID-based compactor bins. Sensors measure the quantum of waste filled in these bins and alert the collection system much before overflow of the bins. Automated and on-demand bin servicing is provided. There is proactive tracking, planning and dynamic vehicle route allocation. Real time waste weight and volume is recorded and transmitted to the transfer stations for the waste management process.

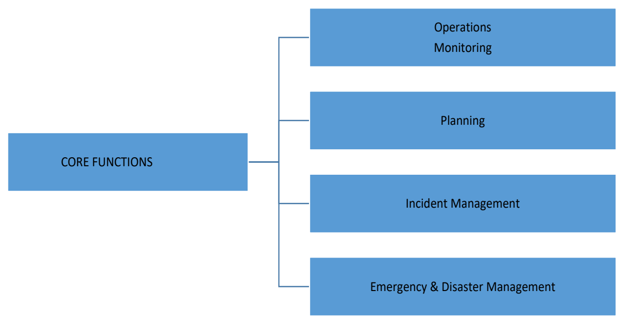


Fig 03: Concept of the Four Key Functions of the ICCC

Fig 04: The 15 city sub-systems integrated into the ICCC

This has helped in:

- Effective monitoring of the workforce;
- Garbage clearing on a need basis;
- Faster grievance resolution; and
- Observations on daily basis helps in futuristic planning.

2.2.4 Public Announcement Systems & Variable Message Display

This sub-system focuses on conveying awareness and administrative messages to the public from the central city operation center. The displays located at various strategic nodes of the city share informative messages to the public like awareness on seasonal diseases, real time information dissemination to people. The public announcement system plays the recorded messages. There are 50 public address systems & 10 Variable Message displays. It multicasts messages to specific locations. The public address system facilitates multiple mike inputs and audio outputs. The display or the audio and video is through the ICCC which can allocate the messages to the designated screens and speakers of the city as desired from the control centre.

2.2.5 Emergency Call Box (ECB)

There are 50 ECBs installed at strategic locations. An ECB is a user-friendly box, where a person in distress and can speak to which gets recorded and transmitted to the ICCC for immediate responsive actions. The facility flaunts a red button and once a person presses it, the Command Call Centre (CCC) at GVMC gets a direct call which can be spatially located with activation of appropriate cameras in that zone. It creates:

- Accessible and reliable SOS channel;
- Spontaneous guidance from authority;
- Deterrence to petty crime and promotes safety with their visual presence; and
- Easy to use conditions.

2.2.6 Integrated Bus Transport System

Integrated bus transport system aims at integrating various elements of the bus transport system in Visakhapatnam like synchronizing the bus movements, bus terminal functions, fleet management, re-routing and re-assigning of frequency of the buses plying. There are 100 GPS fitted public buses which are active in the municipal corporation area which are controlled and monitored using this system. There are 50 bus stops and 5 bus terminals that are incorporated in this integrated bus transport system. It leads to easy supervision of the bus transport system, availability of real time updates to the public and the daily observations help in future public transport planning.

2.2.7 Intelligent Traffic Management System

The intelligent traffic management system in the city has incorporated smart techniques in controlling and managing the traffic of the city. There are 10 ANPR & RLVD junctions, and 50 modern signaling systems. These includes the control of signal timings, capturing of red light violation detection, automatic number plate recognition, emergency corridors etc.

2.2.8 Disaster Management System

The disaster management team works on stimulation and analysis over the previous disasters. The team analyses with coordination with SDMA (State Disaster management authorities) and functions as a 24x7 emergency contact center. There are a total of 278 SOPs (standard operating procedures) enabled with the ICCC system. In the past, ICCC played a pivoted role predicting, alerting and coordinating the preparedness and response phases of emergency situations during cyclones and Covid-19. The emergency information is disseminated through the public announcement systems and apps at designated zones.

2.2.9 WIFI Hotspots

There are public Wi-Fi hotspots provided at 50 locations with 24x7 internet access of high bandwidth and throughput. The data service can be monitored and controlled at the ICCC for these 50 public locations.

2.2.10 Environmental Sensors for Monitoring

Environmental sensors, which are real time pollution monitoring devices, have been installed at 50 strategic locations in the city which measure temperature, humidity, AQI, LUX and noise levels. They also monitor the CO2, NO2, SO2, PM2.5 and PM 10 levels. They disseminate real time environmental info to the citizens.

Plate 01: Smart Semi Underground Bins

Plate 02: Smart Street Lights

Plate 03: Public Addressal Systems

Plate 04: Environmental Sensors

Plate 05: Dashboard with various sub-systems in ICCC

Plate 06: Smart Public Display Screens

2.2.11 Water and Electricity

The city's water and electricity supply departments have aligned their database in SCADA with the ICCC so that in case of emergency planning the supply can be monitored or diverted or enhanced or stopped for various regions of the city depending on the need.

2.2.12 City Contact

City contact center is a 24x7 contact center, which helps in citizen call and register their grievances and service requests. The requests are immediately connected the concerned sub-system and tokens are generated for grievance redressal as per SOPs of the concerned department.

2.2.13 City e-Governance

The city e-governance component under the ICCC function in 3 different domains. The first domain includes Professional tax, Citizen grievances, RTI, Solid waste, ITMS, and veterinary concerns. The second domain includes seasonal diseases, education, town planning, sports, welfare schemes, horticulture, information & public relations. In the third domain, it includes water management, employee self-service, land & estate, open data portal, vigilance, parking lot, maintenance, citizen portal and mobile app. ERP (Enterprise Resource Planning) model is used for the e-governance. In each domain, citizens have an option to choose domain specific service requests or complains or information requests. These requests are then converted into actions and delivered in timely manner. The citizens can track their request status and the Department heads can track the performance of the services of their respective departments.

2.2.14 Citizens' Mobile App

The citizens' mobile app integrated with Pura-Seva and is a smart city application developed by e-governance foundation for the department of municipal administration, Government of AP, where citizens can access and retrieve information of various municipal services from their smartphones. It focuses on various sectors like women safety, crime, domestic fire, medical emergencies etc. The app is integrated with the ICCC database and keeps a track-record of all queries received through the app.

All the above sub-components are monitored at the ICCC. Designated officers from the line agencies are nodal contact points who work with the ICCC team to gather data and resolve issues as identified in the ICCC.

3. Stakeholders' Perceptions

The project team of SPAV spoke to various officials of the municipal administration and citizens in general. It had extended discussions with the ICCC core team and the GVSCCL officers involved. It also interacted with the line agencies who participate and coordinate with the ICCC. The findings are presented in this sections. About 80 samples were collected comprising of citizens (60% and municipal officials 40%) based on which the following perceptions were clearly gleaned:

a. Almost all respondents are satisfied with the ICCC platform in managing civic services of water, electricity, drainage and sanitation. 52% feel the platform in excellent and 48% as good in terms of civic services (Graph 01). Similarly, almost all respondents are satisfied with the ICCC platform in managing transport and mobility (Graph 02).
b. Respondents are satisfied with respect to ICCC's ability to handle emergency situations (Graph 3) and availability of equipment to quickly and effectively respond to actions earmarked by ICCC (Graph 4);
c. In terms of safety (Graph 5) and cleanliness (Graph 6) the responses indicate a substantial improvement and a sense of confidence in the way ICCC's surveillance, PA system, street lighting, and solid waste management are operated;
d. There appears to a scope of improvement in extending the services of ICCC in aspects of sanitation, even though the respondents indicate no negative perceptions, as there are limited applications to currently to link public sanitation, toilets or their cleanliness to the ICCC network (graph 7). The citizens and respondents appear to be satisfied to a large extent with water supply aspects controlled and resolved through ICCC (graph 8);
e. Similarly, in terms of effluent discharge and monitoring of drainage system there appears more scope of innovation even though operations are effective (graph 10). There is high sense of satisfaction in terms of management of traffic through ICCC (graph 9); and
f. Overall, the respondents are very positive to the contribution of the ICCC to the city (graph 11) with 67% perceiving the project as a good venture and 33% considering it to be an excellent venture.

There is always a scope of greater sampling and developing a pan-city survey feedback loop, which collects the responses of the citizen's every 6 months for each sub-system and component. However, this study has restricted itself to purposive sampling of 80 samples carefully selected to represent people who are aware of the ICCC venture and have interacted with the ICCC platform either as a service provider or service taker.

4. Inferences

4.1 Implications and Benefits of the Project

City administrations have always been effective and efficient in their own traditional forms, across India. Systems of city administration, in all dimensions already have pre-set and age old procedures of engineering, planning and operations. City do not stop to function even if there is no smartness element. However, it is important to understand that in spite of the traditional time tested engineering systems existent, the zeal and vision of a city to embark upon a new ICCC platform which cuts across the silos of each department and attempts to integrate them, is an extremely noteworthy and positive intention. GVSCCL with the help of the Central Government of India, tapped into this opportunity and embarked upon this ambitious and comprehensive project of developing an ICCC. There are several implications and benefits of such a platform, which came out through the discussions with the key officials. They are summarized as below.

4.1.15 Creation of Single Platform Data Infrastructure with Spatial Attributes

The foremost benefit and positive implication for the city is the creation of a massive data infrastructure at a single point. Data exists in various Departments in various formats and scales and often inaccessible amongst the Departments and the citizens. ICCC has accumulated, digitized and integrated data of various types on the common spatial platform of the city. This overlying of large number of data sets, standardized for cross-sectoral analysis and decision making is an asset of great significance for any city. Visakhapatnam is fortunate to have evolved this data infrastructure on open, geospatial, and normalized format which can be used by multiple users.

4.1.16 Open Data Access and Services

The ICCC has not only create massive sets of extremely valuable data, but made it accessible to the public and the Departments. This saves time, cost and efforts to create and search of data. It makes people and administrative staff aware of what information is available and lacking. It also drives the system to keep data updated and spatially referenced. Citizens are more aware of the services offered by the municipal bodies than before and can utilize the benefits of the services to a greater extent.

4.1.17 Enhanced Efficiency - Time Bound Response

The ability to retrieve data, put forth a complain or request and then track the status of the request is a powerful tool in the hands of the citizens. It enhances the need to address grievances and faults at a faster pace and streamlines the use of resources in order to address the issues pointed out by the citizens. This improves response time situation of crisis and quality of life also.

4.1.18 Predictability and Accountability

The functions of the ICCC are designed in such a manner that each department associated has the option to study the data and the operations for a particular duration in the past and then predict, simulate, forecast, or iterate scenarios for developing better designs and models. It also clarifies about who or which section is responsible or best suited to deal with an issue and creates better systems of workflows and operating procedures in the long term.

4.1.19 Overall Benefits

In general, in addition to the implicit benefits and implications as suggested above, there are more direct and implicit benefits which affect day to day operations, workflows and services in a positive manner as shown below:

a. Improved access to physical infrastructure - water

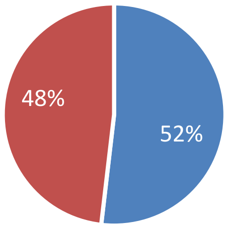
supply, drainage, solid waste, etc.;
b. Improved traffic management;
c. Reduced levels of crimes at public places;
d. Improved response to emergency situations;
e. Improved monitoring of air and water quality;
f. Reduced time to repair and fix service faults; and
g. Improved physical health and well-being of citizens.

4.2 *Scope of Improvement and Replicability*

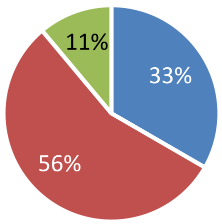
The overall performance and efficiency of the ICCC at Visakhapatnam is well appreciated by the citizens and all stakeholders. There is immense benefit to the city and the municipal corporation in automating operations, future planning and predicting situations. There are a few aspects which can be looked upon to further strengthen the positive pillars of the ICCC system as below:

a. Only few components of the ICCC are spread over the entire municipal area, as the main focus of applications are in the ABD zone. There can be phased and targeted components which can be scaled and replicated on other zones of the city;
b. Environmental sensors that monitor environmental quality can be scaled up spreading to every ward of the city and beyond for better monitoring;
c. Applications that can predict waterlogging with rainfall and drainage capacity estimates for different zones than help in traffic diversions;
d. Modules that can disseminate emergency predictions at ward level through sms or app or any other mass dissemination system can be worked upon;
e. The emergency call box services can be extended throughout the city;
f. The smart SWM can be replicated in all wards. More underground bins and compact bins can be set up based on future requirements; and
g. The Integrated bus transport system can initiate APSRTC real time tracking for the entire city busses

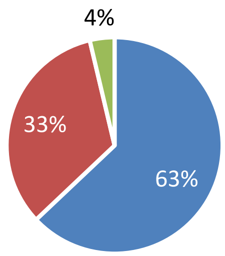
Graph 01: **The ICCC platform's effectiveness in managing civic services**



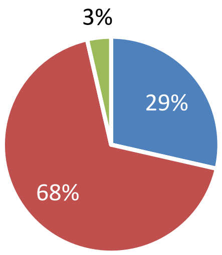
Graph 02: **The ICCC platform's effectiveness in managing civic mobility**



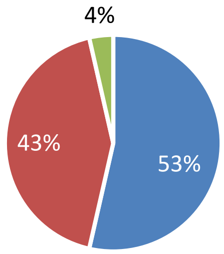
Graph 03: **The ICCC platform's effectiveness in managing emergency situation**



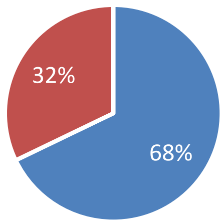
Graph 04: **Equipment required for civic operations through ICCC**



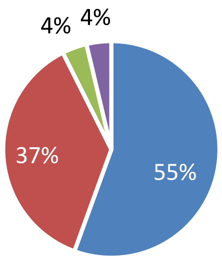
Graph 05: **Do the citizens feel safe in the city through the surveillance at ICCC?**



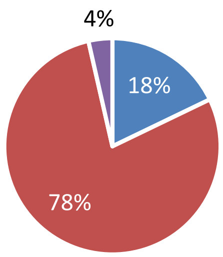
Graph 06: **Does ICCC help in efficient solid waste disposal?**



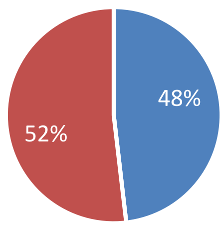
Graph 07: **Does the public toilet facility monitoring & servicing through ICCC helps for its efficient maintenance?**



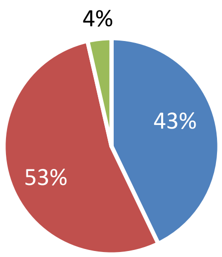
Graph 08: **Does ICCC monitoring helps for reliable and quality water supply in the city?**



Graph 09: **Is city traffic planning control monitoring through ICCC efficient?**

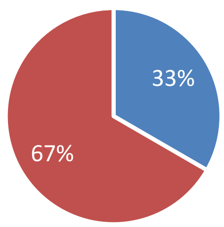


Graph 10: **Is effluent disposal into city water management monitoring efficient through ICCC?**



Graph 11: **How do you rate this Integrated Command & Control center overall?**

■ EXCELLENT ■ GOOD ■ FAIR ■ POOR ■ CANT RATE



and can be integrated with the police app.

There is no end to the possibilities of analysis and cross-sectoral applications and innovations that can stem out from the ICCC database and platform. 'Responsive city planning; is the next possible step in the evolutionary cycle of smart cities where the SEE-THINK-DO paradigm is leveraged to deliver real time governance in smart cities.

Visakhapatnam's Smart City Initiative through the GCSCCL has rightly prioritized and invested upon ICCC and have shown a path to be followed by many other municipalities. This report propagates that there is an essential need to replicate the model and scale the benefits of each sub-system to every ward of the city. It is important to replicate such projects in every capital of each state, as the benefits are long term for the society. Investing and developing ICCC can have direct implications of human development index and ease of living index and many other measuring indexes that look into governance and economic performance. Further developing of the ICCC in Visakhapatnam needs prioritization and necessary support so that the benefits reach out to every citizen in greater proportions than existing.

1. ***References***
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A36

Redevelopment of Chatiram bus stand-Tiruchirappalli

Name of the project: *Redevlopment of Chatiram bus stand*
Location: *Tiruchirappalli, Tamil Nadu*
Year of Project Implementation: *2021*
Sector: *Transportation*
SDG: *SDG 11 - Sustainable cities and Communities*
Project Cost: *Rs. 28.24 Crores*

Institute: *School of Architecture And Planning, Anna University*
Advisors: *Dr.K.Pratheep Moses , Mr.P.Sudharsanamurthy, Ms.K.Madhivadhani*
Students: *Manoj Kumar S, Jeya Shalini A*

Keywords: *Sustainable Development Goal, Redevelopment, Smart city, Bus stand, Infrastructure facilities.*

Abstract:

Tiruchirappalli is an ancient city and the fourth-largest urban agglomeration in the Tamil Nadu state. The Geographic location of the city lies in the centre of the Tamil Nadu state and is well connected with the neighborhood districts. This city has two main bus stands, one is the Central bus stand which connects to all district headquarters of Tamil Nadu and another one is the Chathiram bus stand which provides intro-district connectivity. Tiruchirappalli city is growing fast leading to an increased demand for public transport services and facilities. This has subsequently led to the challenge of providing suitable infrastructure facilities. The Municipalities are keen on providing good public transport in a convenient way but have difficulties providing them within the Municipal limits. But the commuters face lots of issues which slowly transformed into poor passenger handling, unorganized bus bays, lack of infrastructure facilities, traffic congestion, lack of capacity, thereby causing security risks and crime-related activities, etc.

The National Urban Transport Policy (MoUD, 2006) envisages a scenario wherein all city residents have access to jobs, education, recreation, and other such needs within the urban limits, in a safe, affordable, quick, comfortable, reliable, and sustainable environment. The Ministry of Urban Development announced the "Smart city mission (2015)", to develop the 100 cities in India. Tiruchirappalli Municipal Corporation is one of the Smart Cities which was declared by the Government of India. This Corporation focused on enhancing the area-based development programs which are purely related to infrastructure facilities. This Corporation had a decision to redevelop the Chathiram Bus stand under the Area-based Development program. This project has the potential to redevelop the bus stand according to international standards of infrastructure facilities in a sustainable way which will result in a congestion-free Bud-stand.

This report elaborately reviews the project strategies, key focus areas and stakeholders' participation in the locality, and feedback of the commuters on the achievement of the Sustainable Development Goals.

Case Study: A36

1. Introduction

Tiruchirappalli is one of the ancient cities which was initially ruled by the Cholas. Tiruchirappalli lies 10.7905° N and 78.7047° E and its elevation is at 85 m above the Mean Sea Level (MSL). This city evolved from the tourist attraction spot of Rockfort Uchipillaiyar Temple and slowly sprawled around the core of the city. The banks of the River Cauvery controlled the growth of the city on the northern side of the district. The area of Tiruchirappalli city is 167.23 Sq.km and it became the most populated city with a population of 9.16 lakhs in the Delta region. It has a literacy rate of 83.23% as per the Census of India – 2011.

The economy of the city is based on the nearby industries such as BHEL, OFT, HAPP, Golden Rock Railway Workshop, Three industrial estates (SIDCO), Industrial complex (SIPCOT), and other industries including cotton and textile, millings can be found in this city. Trichy is connected with all the district headquarters by the mode of roadways and railways.

1.1 Location

Tiruchirappalli city has two bus stands for inter and intra district/state connectivity from the district headquarters. The road network of the city is well connected with National highways (NH), State Highways (SH), Major District Roads (MDR) and Other District Roads (ODR). Among the Seven National Highways connect to this City, NH 81 (Coimbatore – Chidambaram) connects the Chathiram Bus stand and other State Highways also connected.

Chithiram Bus stand is located in Chinathamani which is near the Gandhi Market and Rockfort Temple. It started functioning from the year 1979. The area extent of the bus stand is 2.05 acres. This is one of the oldest and busiest bus stands in this district which was operated by the Department of Transportation, Tamil Nadu, and maintained by Tiruchirappalli Municipal Corporation. This bus stands generate 5382 trips per day and serves 60,000 commuters. In addition to this, it has a floating population of 20,000 people per day. This bus stand acts as an important node for the surrounding villages and towns. Chathiram Bus stand handles Mofussil intercity bus service, express buses, and sleeper buses belonging to SETC, KSRTC and other private operators. It serves as a boarding point for the northern and western parts of the city. In 2019, the bus stand was closed for the Redevelopment program under the Smart City Mission (2015).

The Municipal Corporation has planned to redevelop the Chathiram Bus Stand under the Area Based Development Scheme, to reduce traffic congestion and overcrowding by the commuters.

1.2 Project Details

Tiruchirappalli Municipal Corporation designed the Chathiram Bus Stand in an area of 7029.08 Sq.m. Chathiram bus stand has been divided into two terminals.

1.3 Significance of the project

Chathiram Bus stand is the nodal point at the beginning and end of the journey for every North, East and West bound bus of the City. This stand is busiest and forced by the road factors to shape the bus stand in the shape of the letter " A" which is centrally placed and surrounded on all sides by the Gandhi market Commercial complex, Institutional zones. Vendors, hawkers, food kiosks and other businesses have encourage the Socio - economic activities.

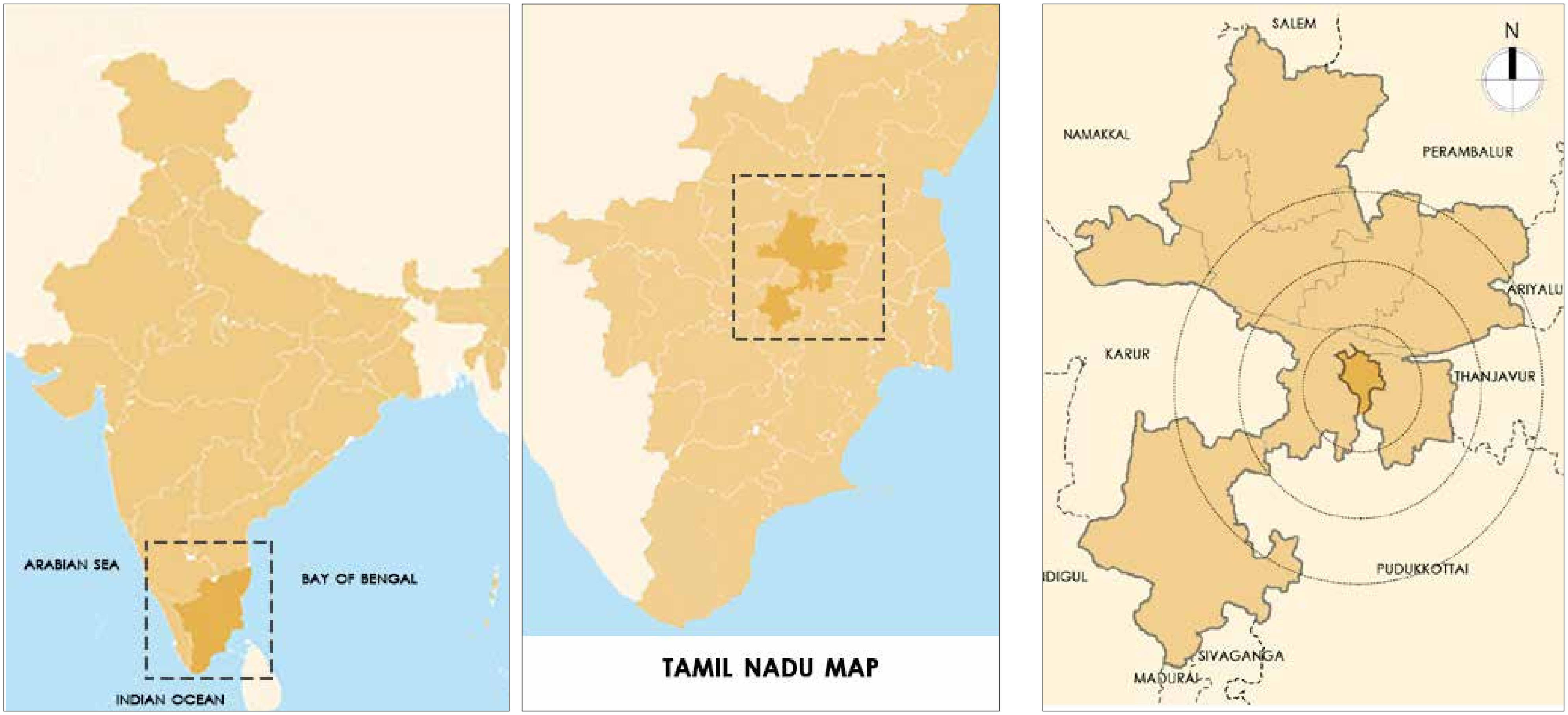

Figure 1: Location of Tamil Nadu in India, Location of Map of Tiruchirappalli district within Tamil Nadu, Tiruchirappalli District map
Source: Author

Figure 2 – Location of Chathiram Bus Stand
Source: Author

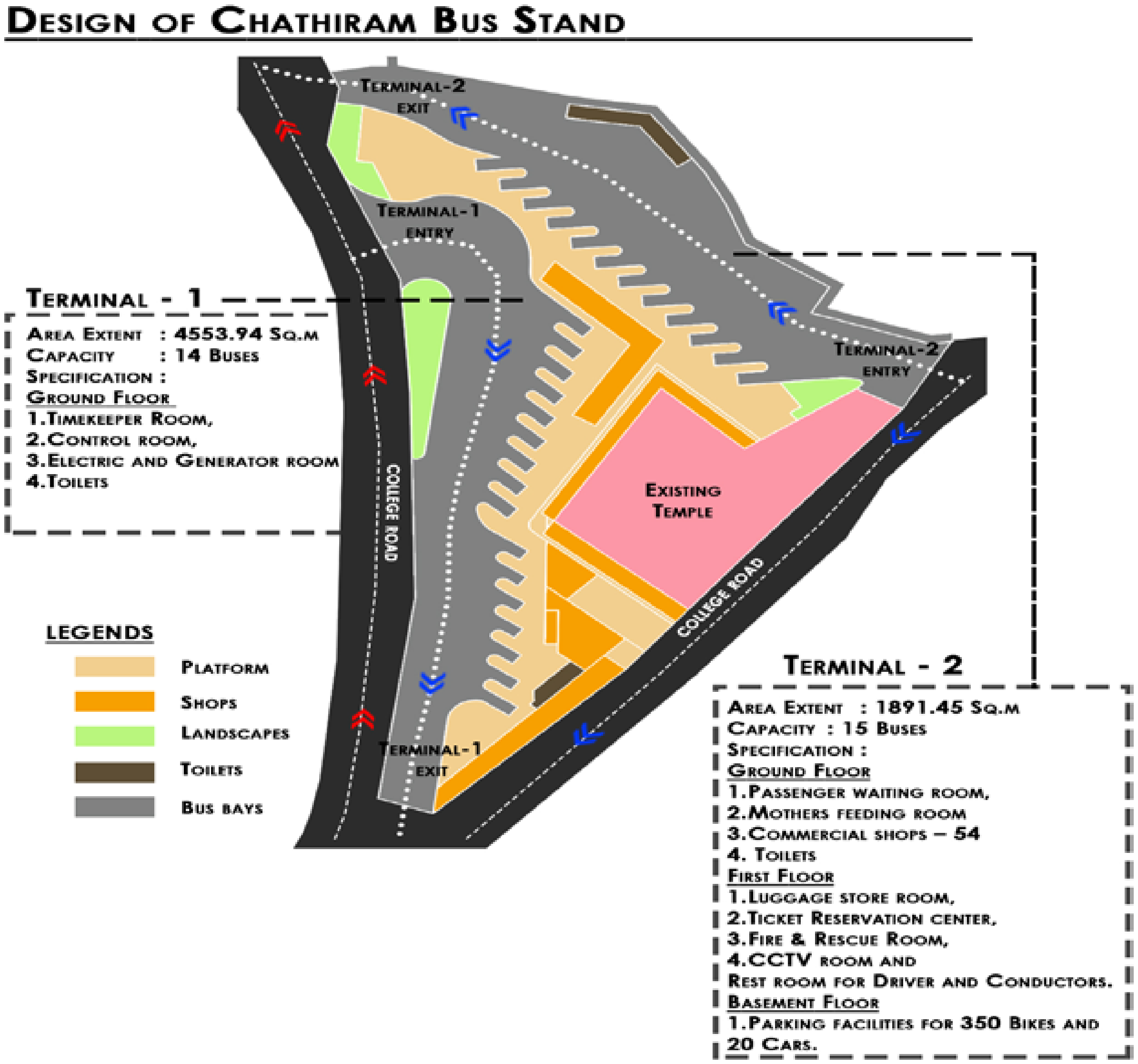

Figure 3: Chathiram Bus Stand Plan; Source: Detailed Project Report

Figure 4: Conceptual views of Chathiram Bus; Source: Detailed Project Report

1.4 *Aim and Objectives*

The aim of the study is to conduct a detailed review of the Chathiram Bus Stand Project from the angle of the commuters using it.

The objectives of the study are:

- To understand the existing scenario of the Study area.
- To analyze the implementation and maintenance of this project.
- To review the extent of Public participation involved in this Study area.
- To analyse and list out the Key learnings and recommendations.

2. Contextual Background

Chathiram bus stand is one of the oldest and busiest bus stands in this district which was operated by the Department of Transportation, Tamil Nadu, and maintained by Tiruchirappalli Municipal Corporation. This bus stand is located in the urban core area which is gradually overcrowded because of being surrounded on all sides by the Gandhi market Commercial complex, Institutional zones. This bus stand is naturally designed with bay type platforms which are parallel to the existing road networks.

At present, the lack of robust public transport infrastructure renders Metropolitan cities struggling to cope with increasing mobility requirements. Numerous research studies have documented the ill effects of a poor or dysfunctional public transport system and associated infrastructure.

The National Urban Transport Policy (MoUD, 2006) recognizes that city dwellers are of utmost importance and that all plans must be centered around their common benefit. With focus on public transportation, the NUTP document emphasizes the following :

1. Encouraging greater use of public transport and non–motorized modes by offering Central financial assistance
2. Enabling the establishment of quality-focused multi-modal public transport systems that are well integrated, and provide seamless travel across modes.
3. Establishing effective regulatory and enforcement mechanisms that allow a level playing field for all operators of transport services and enhanced safety for the transport system users.

2.1 *Conceptual framework / Research design*

Initially, Tiruchirappalli Municipal Corporation faced lots of issues like traffic congestion, irregular bay systems of both public and private buses, poor infrastructure facilities, etc. It was decided to redevelop the Chathiram Bus Stand, by adapting the International design and Sustainable development goals to achieve the Smart City Mission.

The following is the Methodology for this design approach:

Figure 5 – Views of Old Chathiram Bus stand
Source: Detailed Project Report

Figure 6 – Exiting situation of Chathiram Bus stand
Source: Detailed Project Report

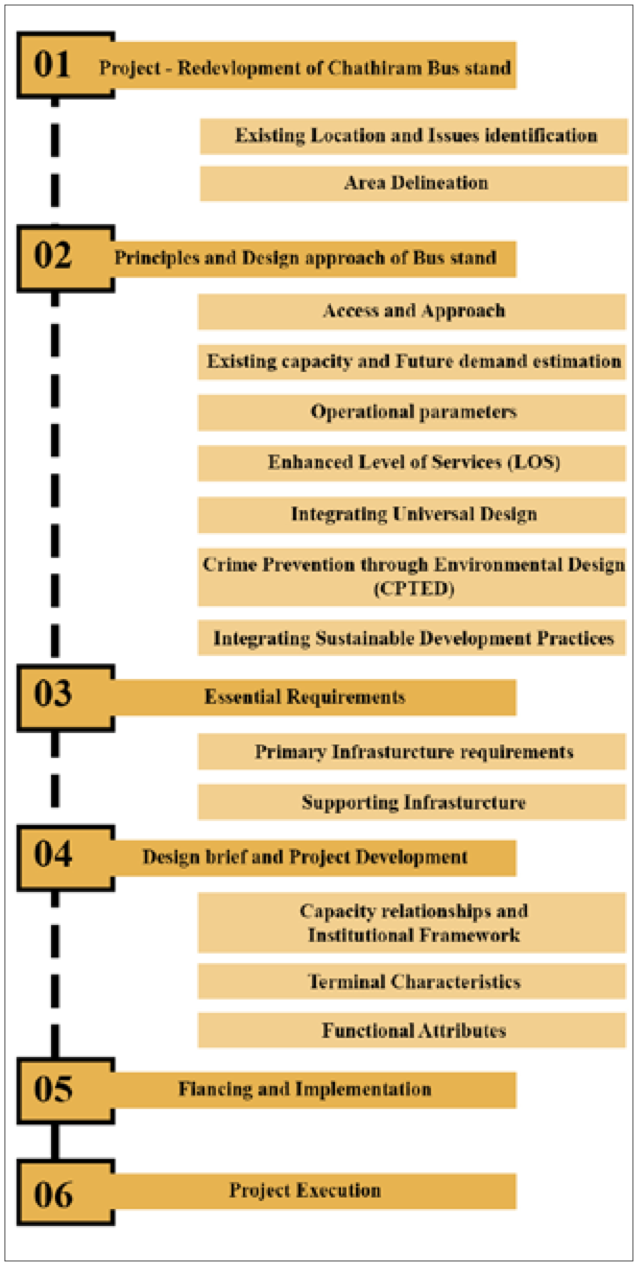

Figure 7 – Methodology adopted in this project
Source: Author

Figure 8 – Features implemented in Chathiram Bus stand;
Source: Author

2.2 *Key features of the project*

a. Major National Highway NH 81 connects the Chathiram Bus Stand.
b. Sub divide into 2 Terminals, One for North and West part of the City & Another one for East and South part of the City.
c. An easy approach to the Central bus stand and Tiruchirappalli Railway station.
d. Providing Bike parking and Car parking facilities, to easy movement for the commuters from nearby areas.

2.2.1 *Challenges in the project*

a. This Bus stand is located in the Center of the adjacent three roads, allocating and changing the feeder service location for all town buses.
b. Stakeholders like commercial shop owners and vendors were shifted to the Bus stand.
c. Heavy traffic congestion happens during the peak hours, surrounding the existing bus stand.
d. Vehicular parking issues arising due to re-routing of feeder services.
e. Land acquisition processes were delayed because the Temple Area that is closely bound to this bus stand.

2.2.2 *Risks involved in the project*

a. Design phase of the Bus stand is a constraint, because of the area allocation which is adjacent to the neighboring road network and institutions.
b. Inside the Bus stand, removal of the unauthorized development (shops and venders) are a challenge.
c. Improper sanitation facilities leads to severe ill-effects to the commuters of the Bus stand.

2.2.3 *Features and Benefits*

a. This Bus Stand has achieved universal accessibility, passenger seating arrangements, parking facilities, pedestrian facilities, signage, drinking water, mother's feeding room, CCTV surveillance, restroom for drivers and conductors, lighting, and finally commercial activities.
b. 54 Commercial shops are planned which will be easily accessible to the commuters within the Bus stand.
c. Large parking facilities to accommodate the 350 Bike parking and 20 Car parking on the Basement floor of this Bus stand.

2.3 *Key findings from the interviews, surveys, and primary/secondary data collection*

Surveys and interviews were conducted on-site, to measure the existing situation of the bus stand and the public perspective was asked directly to the commuters.

2.3.1 *Volume Count Analysis*

The Volume count survey was conducted on 21st March 2022 from Morning at 7.00 AM to the Evening at 7.00 PM. The traffic count was done at every 15 minutes interval. The counted value was used to find out the peak hour traffic flow and critical entrance/entry. Peak hours of Incoming and Outgoing buses are identified as shown in figure 8 & 9.

2.3.2 *Platform survey Analysis*

The Platform survey was conducted on 21st March 2022 from Morning at 8.00 AM to the Evening at 8.00 PM. From volume count survey, the time period of 9.00 AM TO 10.00 AM was identified as the time interval at

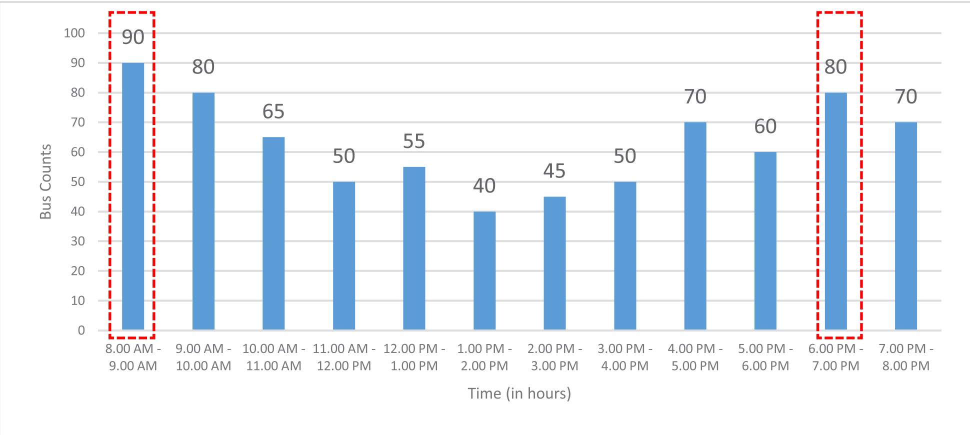

Figure 9: Incoming Bus counts of Chathiram Bus stand ; Source: Author

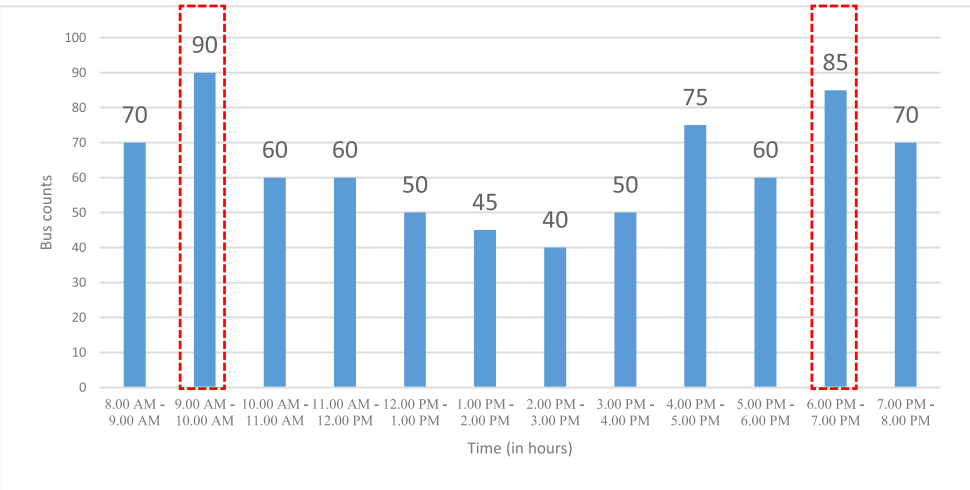

Figure 10: Outgoing Bus counts of Chathiram Bus stand ; Source: Author

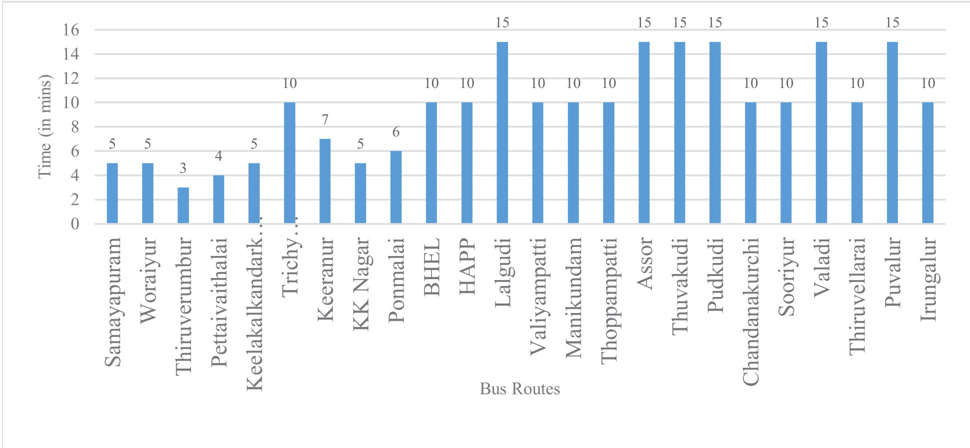

Figure 11: Platform survey in Chathiram Bus stand; Source: Author

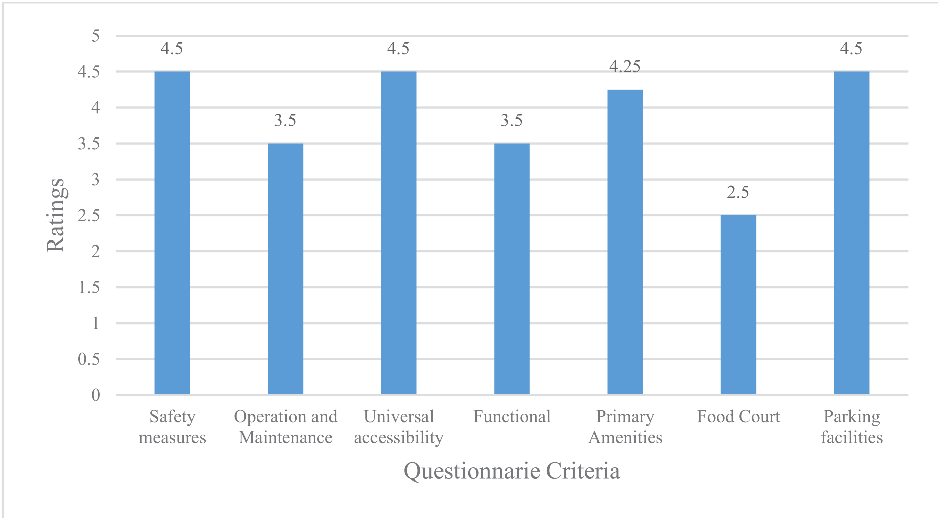

Figure 12: Questionnaire survey in Chathiram Bus stand; Source: Author

which maximum number of buses leaves the bus stand.

A platform survey was conducted for finding the ultimate handling capacity of a platform. The platform consists of a number of bays. In the Platform count survey, the platform was counted separately. The sum of occupancy time and waiting time is commonly called 'Dwell time' as shown in figure 10.

Volume count and Platform survey analysis showed that the incoming and outgoing buses are balanced with scheduled timings in their specified bus routes which are easy to handle the capacity of the Chathiram bus stand.

2.3.3 Stakeholder interaction

According to the Personnel Interviews taken by the Commuters of Chathiram Bus Stand regarding their usability and easy approachable manner. The following are the Questionnaire samples collected, that are annexed as given in Annexure 1. The Questionnaire is converted into the Ratings of the Chathiram Bus Stand as shown in the figure 11.

Finally, the commuters commented about the redevelopment of Chathiram Bus Stand. Tiruchirappalli Municipal Corporation, design approach to the bus stand meets the required infrastructure amenities and Sustainable development goals.

a. Irregular arrangements of bus bays are rearranged with respect to the direction of destination points and that will be subdivided into Terminal 1 which serves North, West direction from the City & Terminal 2 which South, East direction from the City.
b. Underground Bike and Car Parking services are provided for the Commuters. These services will generate the economy and the processes will be an advantage to cut down the cost of Operation and Maintenance Charges.
c. Advanced amenities like Commercial shops, CCTV room, mother's feeding room, waiting lobby, staff restroom, and toilet facilities with universal accessibility will meet the basic requirements of Today's City Infrastructure.
d. The Commercial shops are rented from the Municipal Corporation on an annual basis with the additional supplies of Freshwater, Electricity, and Drainage facilities. The charges will be claimed by the concerned departments.

3. Discussion and Conclusion

3.1 Implications

The implementation of the Redevelopment of the Chathiram Bus stand as shown in figure 13, has led to improved Infrastructure facilities. This bus stand is divided it into two terminals which leads the commuters, to easily identify the Bus routes. Commercial shops and Parking facilities too are additionally designed. This will boost the Socio-economic value of the Chathiram Bus stand.

3.2 Limitations of the research

This study reviewed and analyzed the project implementation from the perspective of the commuters, stakeholders of both commercial shop owners and administrative bodies. It comprised of the assessment of the transformation of the area, by studying the before and after situation post completion of the project. This study evaluates the initial stage of the design approach, organizational setup, documentation of the primary requirements, and capacity of the Bus stand.

3.3 Key lessons learnt

a. Bus stand is an important node for the urban activities and it is necessary to develop it based on the future demands by assessing the current situation.
b. Infrastructure development projects do not satisfy the individual commuter perspective. But overall, the implementation achieved what the demands of the stakeholders in future would be.

3.4 Recommendations

a. Proposal of installing additional signages and public announcements, that would be helpful to access the Bus stand in an easy manner.
b. Provision for ATM centre, Plastic recycle bins that would be an add on advantage to bolster the Local body's economical activities.
c. As per the survey, the passengers expressed their need for additional seating.

Figure 13: Interaction with Commuters and Officials of Chathiram Bus Stand Project; Source: Author

Figure 14: Before and after implementations of Chathiram Bus Stand Project

A37

Integrated Command and Control Center, Pune Smart City

Name of the project: *Integrated Command and Control Center*
Location: *Pune, Maharashtra*
Year of Project Implementation: *2021*
Sector: *Information and technology*
SDG: *SDG 1.*

Institute: *College of Engineering, Pune*
Advisors: *Dr. Arati S. Petkar, Ms. Lisha C. Bendre*
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Keywords: *Rainwater Harvesting, Groundwater Recharge, IoT, Smart Systems, Water scarcity*

Abstract:

Pune is one of the topmost IT hubs in India and is having a lot of potential in terms of technology but still, there are various places their technology can be implemented. Pune Smart City Development Corporation Limited (PSCDCL) came up with an innovative solution that can be implemented within the city which will help to improve the increase the quality of life of all people. Integrated Command and Control Centre (ICCC) is one such initiative taken by PSCDCL which integrates technology and with the help of technology ICCC has introduced many projects. ICCC has installed free Wi-Fi in the city for all people, the have installed flood sensors, emergency box, variable Messaging Display (VMD) etc. in various places across the city. The Integrated Command and Control Center serves as the central hub for managing operations, addressing exceptions on a daily basis, and managing events during disasters. The current study is undertaken in order to assess the said projects and understand their impact on the citizens. The said projects are major agendas of the PSCDCL and to understand the scope of these projects pan India, they must be reviewed through the lens of city planners. Public perception of the said projects will help improve the technology and also private participation in the public sector will be a great step to increase technology. The findings of the current study present an interesting reality and generate curiosity toprobe further into similar initiatives by the corporation.

Case Study: **A37**

1. Introduction

1.1 Topic and context:

Pune is the seventh-most populous city in India and the second largest in the state of Maharashtra. The city is known for manufacturing and automobiles, as well as government and private sector research institutes for information technology (IT) education, management and training that attract migrants, students, and professionals from India, South East Asia. There is a leading growth of IT industries in Pune and with the smart city program launched in the country; Pune is integrating the smart city with its IT firms and Pune Municipal Corporation. Under the Smart City Mission of the Government of India, the proposal from PMC was ranked second in the first challenge round conducted in 2015.

The Pune Smart City Development Corporation Limited (PSCDCL) was established, under the Companies Act 2013, on 23rd March 2016, to carry out the shrewd city proposition inside the Pune City. It is liable for execution of undertakings in the city. It is figured out through value commitment from Government of Maharashtra and Pune Municipal Corporation (PMC), which are equivalent investors. According to brilliant city mission rules (MoUD, 2015), PSCDCL needs to upgrade center framework and work on the current personal satisfaction of residents, make climate more economical and utilize 'savvy' arrangements (PSCDCL, 2016). The brilliant city mission is a metropolitan reestablishment and retrofitting program whose center is to foster resident amicable, livable, comprehensive and manageable city.

The fundamental administrations designated by this mission incorporates arrangement of adequate water supply, admittance to power, Sanitation administration, including strong waste administration, worked on open vehicle and versatility , arrangement of lodging offices to all classes, particularly for poor people, great IT network and digitalization, Good administration, particularly e-Governance and resident cooperation, Sustainable climate, Safety and security of residents, especially ladies, kids and the older, and instruction.

Health (MoUD, 2015). With this mission, PSCDCL is resolved to offer effective and brief types of assistance, to residents of Pune City. PSCDCL through its precise and vital arranging execution process, is said to guarantee the accessibility of all center foundation components in the given stretch of time of 5 years.

PSCDCL expects to accomplish the previously mentioned objectives by distinguishing the genuine requirements and perspectives on the residents; by zeroing in on making more with less venture; by zeroing in on making self-manageable foundation; by zeroing in on minimal expense data correspondence and innovation-based arrangements; by making execution systems which will protect each undertaking can be carried out, in actuality.

An Integrated Command and Control Centre (ICCC) enable operations and management of multiple city service operations, including real time monitoring an improvement of efficiency. This Integrated command and control center is a component of smart city Pune under technology part of project.

1.2 Significance of the project:

The Integrated Command and Control Center serves as the central hub for managing operations, addressing exception on a daily basis, and managing events during disasters. It also reduces the complexity of dealing with multiple systems/application in different technologies using different platform by integrating them to common platform to leverage the intelligence for making informed decisions.

In addition, it analyses complex data sets at an aggregated level to provide insights for better planning and policy making. The ICCC is expected to aggregate information from multiple applications and sensors deployed across the city, as well as to derive intelligence from this for better planning and policy making. Such an effective integrated command and control center is becoming an integral part of Indian cities, sustainably addressing the needs of 400 million urban dwellers, who are expected to become urbanized over the next 35 years increase.

It also provides insights by processing complex datasets at the aggregation level to derive information for improving planning and policy making. The ICCC aims to collect information across multiple applications and sensors deployed throughout the city, providing appropriate visualization and actionable information to decision makers. The Integrated Command and Control Center is used for viewing, correlating, commanding and controlling city operation – including day-to-day scenarios and use case and exception management.

As a result, actionable data is generated for decision makers with appropriate visualizations. While some cities have started to implement ICCC under Smart Cities Mission, with the required applications, network, and sensors, others are still lagging behind.

This shows us that how important is this project for any city and if this project is not present then there will be less effective situational awareness because ICCC uses data and do its analysis then show it to public. ICCC is having data driven decision making so if ICCC is not there then decision making for policy formation and other purpose will be done majorly without analyzed data. ICCC will be used for engaging with on field support staff to address civic issues and citizen grievance so due to lack of command control center the direct engagement with citizens will be loosed.

2. Aim and Objective:

2.1 Aim:

To examine the impact of Integrated Command and Control Center on cities operation and assess its impact on cities livability.

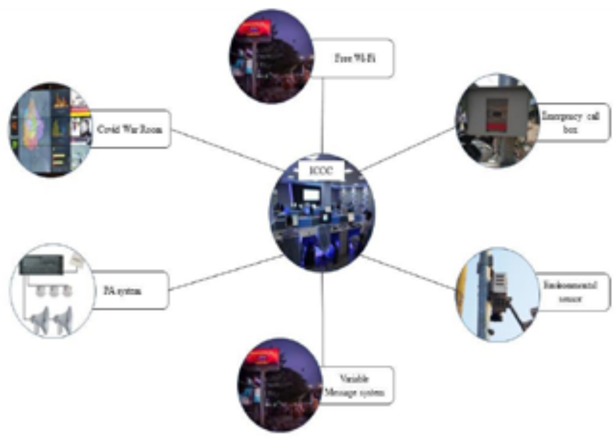
2.2Objective:

The integrated Command and Control Center maturity assessment framework is designed to achieve the following objectives:

1. Realize the true potential of the Command-and-Control Center platform.
2. Maturity assessment of components of the Command-and-Control Center platform.
3. Creation of knowledge exchange for peer-to-peer learning to design innovative and influential use cases through the ICCC platform.
4. Focus on cost-effective information and communication technology (ICT) -based solutions to improve the quality of infrastructure
5. Assessment of the impact of the ICCC platform on improving urban quality of life indicators.

3. Contextual background:

It is intended that the Integrated Command and Control Center of Pune smart city is act as brain in the operations, exception handling, and disaster management of Pune city. The sensors and edge devices located in various locations of Pune city will capture and generate real time data from various utilities such as Wi-Fi, Environment Centre, PA system, emergency box, variable messaging, and Monitoring center.



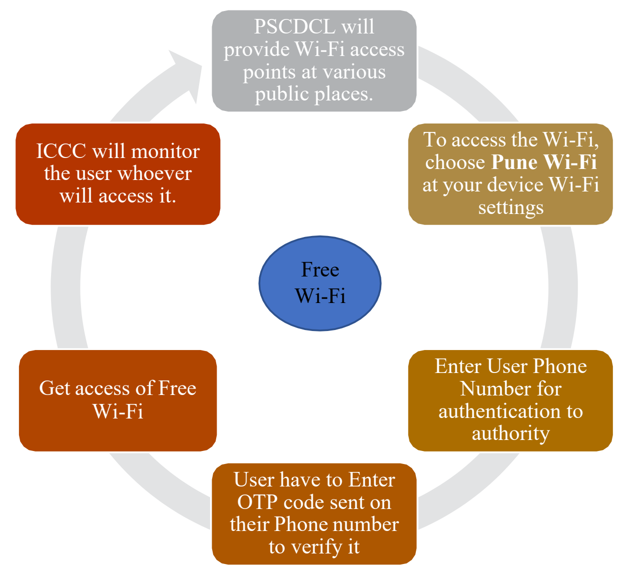
ICCC will act as a decision support system (DSS) through its various layers and components for city administrations in order to respond to the real-time events by consuming data feeds from different data sources and by processing the information from the data.

3.1 Conceptual framework / Research design:

3.1.1 Free WI-FI:

The objective is to provide strong, seamless and highly available Wi-Fi for citizens to collaborate and perform business activities on the go. Wi-Fi services will also reduce the digital divide and provide urban dwellers within Pune a better & faster means for connectivity. The Pune Municipal Corporation (PMC) introduced 150 Wi-Fi hotspots in Pune city on 26 January 2018, the day India celebrated 69 years of being a Republic.

Although the number of current locations is 150, and initially, the free Wi-fi will be available in and around major gardens, hospitals, and near police stations, PMC is planning to soon expand the number of Wi-Fi hotspots to 199. PSCDCL (Pune Smart City Development Corporation Limited) has enabled citizens to use the first 50 MB data at a speed of 1 MB without charges. The log-in name for these Wi-Fi hotspots is „Pune Wi-Fi. This is solution that allows wireless access through various kinds of devices such as smart phones, laptops, tablets, and desktops. All e- governance applications by PMC, state government and central government shall be excluded from this download limit. The public Wi-Fi network architecture design should include latest BIS, DeitY, IEEE guidelines, and WPC standards for access points b) The network should support mesh technology and provide seamless and connectivity with the controllers and backhaul network. Successful Bidder must ensure that the citizen must be able to use same access details (login id/ username and password) The Successful Bidder shall impose restrictions on access and download from malicious sites for City Wi-Fi users.



Free Wi-Fi procedure:

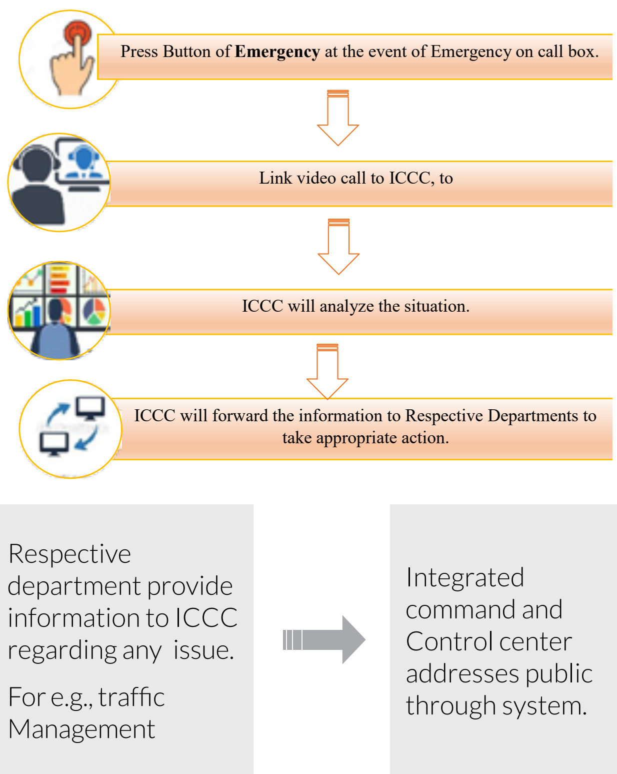
3.1.2 Emergency box:

The emergency box is a box developed for the citizens safety so as to seek help from the required department in the emergency situation for any kind of accidents. This emergency box will enable citizens to establish two-way communication between the ICCC and the person who require emergency. ICCC will then communicate the emergency to the required department for example if anyone require police service and he uses the emergency box the call will be connected to the ICCC and the ICCC member will ask the emergency and then they will tell the police department to reach at the required location. In this way the other department can also be contacted according to the need of the emergency.

The emergency box includes an inbuild color camera which is having night mode to capture key incidence also it is having a micro phone to capture audio. The camera works 24/7 and captures all the live video and it records it and saves it for any required situation.

The details stepwise process of this emergency is given bellow:

1. The emergency box (or panic button) will enable citizens to establish a two-way audio (microphone and speaker) – video (video camera and a video screen) communication link with operation staff at PSCDCL/ PMC Smart City Operations Center (or other locations where control solutions is deployed) through a press of a button.
2. Emergency/ Panic buttons to be strategically located, suitably sized and Identified/clearly labelled for "Emergency". Emergency button once pressed will send a call to the nearest police station.
3. The emergency feature must also be available within the mobile app (sub section of PMC umbrella application to be developed as a part of this tender) which will enable the user to initiate a bidirectional audio – video call with operation staff at PSCDCL/ PMC Smart City Operations Center. In absence of connectivity, the application should send the current location and contact number of the citizen using emergency feature through text message to Smart City Operations Center.



Emergency box

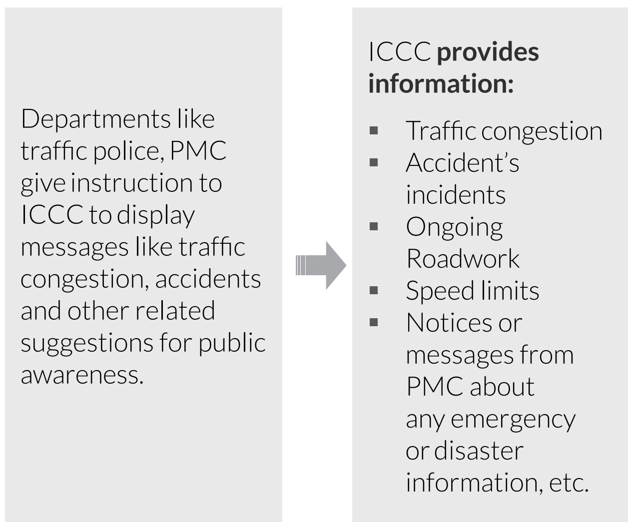
3.1.3 Public Awareness system (PA):

One of the projects of ICCC is Public Awareness system which is a public addressing speaker. The points of the project are included below:

1. The Public Address System (PA) should be capable of addressing citizen at specific locations from Smart City Operations Center.
2. The proposed system shall contain an IP based announcing control connected to the Smart City Operations Center.
3. The announcement which is made from the Smart City Operations Center using the IP based announcing console shall be routed via the network designed as a part of this tender to the various PA system end devices deployed across the city.
4. PA system's master controller should have function keys for selecting the single location, group of locations or all locations, simple operation on broadcasting to any terminal or separated zones.
5. PA system's master controller should facilitate multiple MIC inputs and audio inputs.
6. Public address system to help manage city traffic better.

3.1.4 Variable Messaging Display:

It is very important to connect to people and tell them information which regarding any situation for example during COVID-19 it is important to convey the



Procedure

instruction, during the time of any natural calamity or disaster it is important to tell people. Now, to do this and make communication with people of cities in a digital way ICCC introduced a Variable Messaging Display.

This display will enable PSCDCL/ PMC to communicate effectively with citizens and also improve response while dealing with exigency situations. These will also be used to regulate the traffic situations across the city by communicating right messages at the right time.

1. The variable message display shall consist of variable message signboard with local controller.
2. A VMD software system shall be provided to the Smart City Operations Center for message preparation monitoring and control of the variable message signs. IP based Network equipment shall be provided to connect the VMD with the VMD software system.
3. The VMD software application will allow user to publish specific messages for managing traffic and also general informative messages.
4. VMD software application will provide the normal operator to publish predefined sets of messages. The application shall have an option for supervisor (someone with appropriate authority) to bypass the control during certain situations and to write in free-text mode.
5. VMD software application will allow an operator to seamlessly toggle between multiple VMS points at each workstation in order to send specific messages to specific locations, as well as sending common message to all VMDs. VMD software application will accommodate different access rights to various control unit functionalities depending on operator status and as agreed with the client. Software should be GUI based, and capable to handle 200 VMS signage, user can select desired location in Map, by selecting the location live status of VMS should be displayed.

3.1.5 Environment sensors:
India which is currently 5th most pullulated country in the world having 21 out of 30 most polluted city and at national level, Pune was ranked 79th in air pollution in 2020-21. The city's average PM2.5 during the winter season of 2021 was 59(ug/m3). On the other hand, Pun's peak level pollution in 2021 was 103. The ranking for city was 23th among central and western cities of India according to Centre for Science and Environment (CSE). The pollution level is increasing every year there should be some measures that are needed to be taken now to work on this ICCC introduced Smart Environment Sensors.

The Smart Environment Sensors have the following features in it:

1. Smart environment sensors will gather data about pollution, temperature, rains, levels of gases in the city (pollution) and any other events on a daily basis. It is for information of citizens and administration to further take appropriate actions during the daily course/ cause of any event.
2. Smart environment sensors will enable citizen to keep a check on their endeavors which impact environment and enable the city to take remedial action if required. These environmental sensors can also be connected via 3G or 4G wireless network. It is not mandatory to connect all sensors via MPLS fiber network.
3. PMC's Disaster department gets information from Maharashtra's irrigation department on a daily basis at agreed intervals.
4. The dashboard which is located in the ICCC collects all the data through the environment sensors and then through algorithms there is analysis of the data, when the level of pollution increases from a certain limit then the dashboard shows alert and then ICCC transfers the data and other information to the respective authority so that they can take action.

The sensor currently maintains a real time water level monitoring system which provides information around the following parameters:

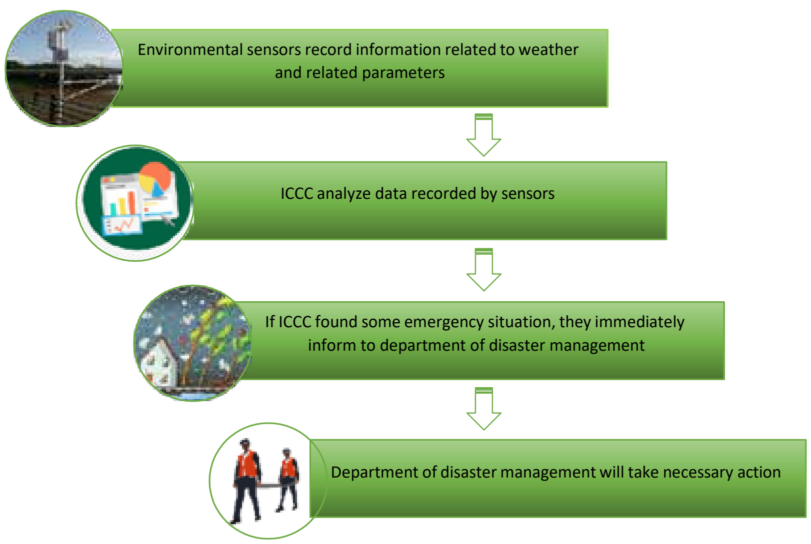
- Reservoir water level and storage status
- Rain fall status in the dams
- Dam discharge status
- River discharge status

PMC will make the information available to successful bidder to be integrated with the environmental monitoring system. Then the bidder needs to make relevant information available on the displays along with other environmental sensor data in consultation with PSCDCL/ PMC.

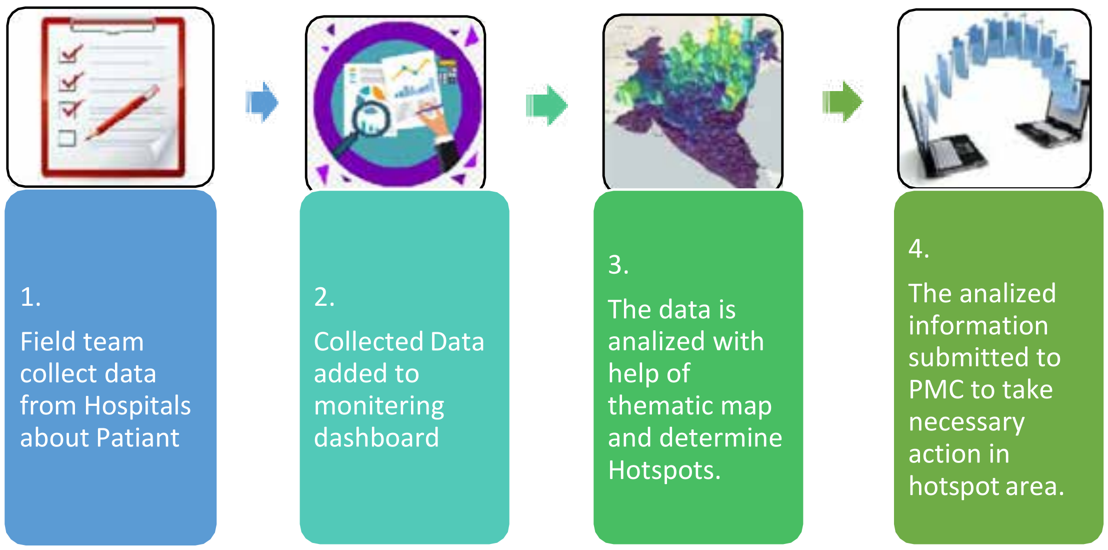
The environment sensors also measure and log the data from locations all such environment sensors will be connected to the network developed as a part of this tender, and communicate information to central command center.

The environment sensor shows the parameters like CO2 or any other type of hazardous environmental situation, and after displaying it on the screen it also gives an alter message on the dashboard screen of ICCC. Also, the data which is collected by the sensor is given to the Disaster Management Department who takes note of it and then take action accordingly like during rainy season it takes the data and then makes actions accordingly, for example during the floor of 2019 which occurred in Pune the Disaster management department used the environment sensor data and then provided the required help to the city.

3.1.6 Covid war room:
In the past few years when the deadly corona virus hit the world the was very hard time for all of us. It was a very new thing for everyone and there was no vaccine for the disease also. India faced a lot of hardships during this time and Pune was also facing huge problems now



Environmental sensor Procedure:



during this time the Pune Smart City Development Corporation Limited tried to help the citizens of Pune in many ways one of which was in association with Integrated Command and Control Center which included covid war room.

Pune Smart City Development Corporation Limited (PSCDCL) has collaborated with Pune Municipal Corporation (PMC) to develop an integrated data dashboard in the city's efforts to fight the global pandemic of corona virus. This dashboard showed data which they use to get through hospitals or central level system. Every time a case use to increase it's which reflect on the dashboard. This data use to get filled in an attribute table which used to get converted into maps. These maps were very detailed and as per the given data it used to show exact locations of the case that occurred positive and they we would also get ward wise maps. These maps were very useful to do analysis and impose rules and regulations accordingly. The maps also created buffer zones where patients were diagnosed positive with COVID-19 infection. As the maps use to get created in the ICCC dashboard and then these maps were sent to the state government and central government so that they can analysis the situation and then give the implementation as per the need of the city. Using heat-mapping technologies and predictive analytics, the city administration will develop a containment plan and the containment zones get reflected on the dashboard. The healthcare operations at the city's "Naidu Infectious Disease Hospital" are tracked at this facility. The Smart City's integrated dashboard also monitors the quarantine facilities and tracks the health of suspected patients and their contacts placed under home quarantine.

Now, then the COVID-19 situation the maps are still been generated but now the dashboard shows various data analytics like the active CCTV location and their display, number of public toilets in the city, live traffic condition of the city and other things that are very useful for daily need of surveillance and record.

4. Key feature of the project:

4.1.1 Pune Smart City Development Corporation had following challenges:

1. A lack of centralized surveillance for the city to manage resources.
2. An inadequate centralized decision support system for coordinating responses to incidents and emergencies.
3. Absence of real-time, authentic information, communication channels, Incident management hub for Pune City.
4. Delay in internal coordination in various departments of the city like Police, Disaster management, etc. Therefore, the response time during critical emergency situations will be impacted.

4.1.2 Risks involved in ICCC:

1. Data from sensors deployed across the city may be used to provide insight into the situation for civic officials across urban functions.
2. Organize and standardize processes for responding to recurring events, issues, and emergencies at the local level.
3. Integrating departments in and outside of local governments and municipal governments to enhance collaboration.
4. The integration of data-driven decision making across the entire city function - from operators to city administrators should be institutionalized for regular operation and during emergencies.
5. Responding to citizen concerns and civic issues with the support staff on the ground.

4.1.3 Features and Benefits:

1. All collected Data is centralized in one place, which can help to operate and monitor easily.
2. In free Wi-Fi system is provided in Government provided public places like school, hospitals, and garden.
3. Emergency call box system, in emergency situation the particular call is forwarded to respective department.
4. In covid Situation they developed covid war room to monitor and tackle covid related problem in all PMC wards to make handle worst situations.
5. In this PMC had team for field survey who helps to collect data related COVID cases and fill data manually in GIS maps to keep watch on present situation.
6. In Environmental sensors shows various parameters and in case of hazardous situation ICCC provide information about it to disaster management department in PMC to take necessary action. e.g., Flood management, CO_2 level etc.

4.1.4 Key findings from the interviews, surveys, and primary/secondary data collection

- PA System can be further used for Promotion & awareness to Citizens. It can be also used for citizen information decimation on selective occasions, incident and disaster
- Integration of upcoming Systems like VTS, SWM / STP to use ICC platform and data analytics.
- In-depth analysis of Environmental Sensors/Flood Sensors data with prompt action at respective administrative unit.
- Community & Public toilets data integration for managing it for better utilization.
- Enhancing ICCC to have city civic service delivery. Disaster and law and order management from common center.

All of the respondents were aware of the government's Smart City plan, according to the study. Despite the fact that inhabitants in the neighborhood had various issues with ICCC elements' actions in this region, locals in Pune believed that some of the steps taken toward a smart city were reasonable. The citizens of Pune encounter a number of technological hurdles and difficulties, which were identified in this study.

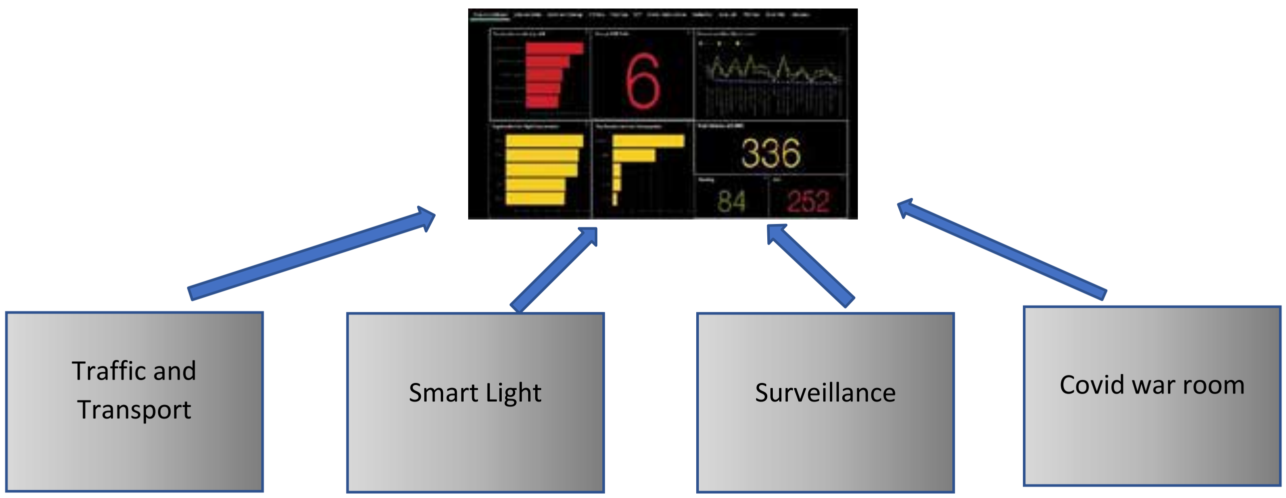
Smart City Operation Centre (SCOC) provides an integrated picture of smart elements and will act as the city administration's decision-making engine. SCOC platform is

provided with integration layer for data normalization so on accept any quite data meaningful analytics are going to be built using data sets at SCOC these will act as decision support mechanism for the town.

5. Discussion and Conclusion:

The Smart City Operations Center will function as the house for all online data and information related to various current and smart elements, connected to other PMC network services through an integration layer.

The Smart City Operations Center will keep track of the city's security condition. The operators will be able to respond in a coordinated and well-planned manner as a result of this. **The Integrated command and control center** must be able to communicate with a variety of security systems and sensors, allowing operators to



Integration of other command centers with SCOC successfully carry out coordinated reaction plans.

The Control Room operator should be able to watch the cameras, gather inputs, analyses data, and make actionable suggestions using the Smart City Operations Center system.

In the integrated command and control room, all servers, storage, software, firewalls, and network switches are installed.

The Smart City Operations Center uses a color-coded display to show the threat level based on the number of alerts and the criticality of the alerts. It also uses a pre-defined method to notify different users in different hierarchies based on the importance of the alerts.

Authorities and senior officials should be able to get real-time information on the security situation, also known as Situational Awareness, via a single dashboard. The following data must be maintained on a real-time dashboard as follows:

1. The numbers of alerts and their status
2. The status of the operators
3. The Command Center's performance

Integrated command and control center is also helps to reduce the cost in security operations by strengthening and better implementation of technology. This integration will help city

administration to make the most of their investment returns, it also reduces incident-related financial losses, any type of accidents and training costs during work.

5.1 Implications

5.1.1 Free Wi-Fi:

- In this most of the times there's login problem and disruption in connection.
- There is a good bandwidth also while many people access a Wi-Fi network at the same time, resulting in a slow connection.

5.1.2 Emergency Box:

- The time interval to get message to ICCC is not too lengthy so there's maximum chances of quick action.
- ICCC have support team to deal with emergency situation as well as fake calls.

5.1.3 Variable messaging display:

- VMD is useful element to provide various information related to public awareness, traffic, any type of emergency, and tracking weather condition in city.
- These boards are observed in public places which canhelps to transfer information quickly.

5.1.4 Environmental sensor:

- The environmental sensors are helping ICCC to know exact weather condition.
- The information related to environment or weather is collected in this and provided to ICCC
- if these sensors detected any emergency related weather or environment ICCC is take immediate action on with help of respective department.

5.1.5 PA system:

- The Public announcement system which broadcast general messages and also any emergency messages.
- This can contribute to fast transfer message by related department and alert public to avoid any life loss due to disaster.
- This PA system is observed in good condition and useful element which operate by ICCC.

5.1.6 Covid War room:

- The covid war room is operation center running in Smart city operation center
- The covid war room helps PMC to get actual condition of covid-19 patients in Pune by collecting data from hospitals
- And with the help of thematic maps and other data types PMC took necessary action to cure Covid-19 virus. There is monitoring team of PMC in covid war room.

5.1.7 Limitations of the research

- Collection of data is one of the main key issues.
- Lack of assessment.

Free Wi-Fi Balgandharv Road

Emergency Call box

Variable Messaging Display

Environmental Sensor

Public Announcement System

Covid War Room

- Project funding and revenue generation modal information.
- Understanding impact analysis.

5.2 Key lessons learnt

- Urban planners develop open land and existing area of a city but to develop city to is also important that there is data analysis, forecasting and consultation and for this technology becomes increasing important as technology is penetrating daily in daily life more and more it will play an important role. New technologies can drive the involvement of local residents in the development of urban areas.
- Currently in ICCC, Pune there are few private companies that are partners with PMC and PSCDCL which are involved in many projects so through this we can see that how public private partnership (PPP) can successfully be integrated.
- During the tough times of COVID-19, ICCC provided a huge support to government in terms of data collection, analysis and forecasting so this help during times of hazards can be very crucial.

5.3 Recommendation:

- The goal of the Smart City Operations Center (SCOC) is to have a comprehensive approach to all smart elements already in operation. Future smart capabilities will be added to the Smart Municipal Operations Center, allowing it to serve as a decision-making engine for municipal administrators in day-to-day operations as well as in emergency situations. As a result of this dynamic response to conditions, both proactive and reactive, the city's operations will be really "SMART."
- When asked about the future plan during the interview with the officials, it was stated that new technology should be introduced, and we agree because in this continuously evolving world, there are a lot of changes happening every day, so we need to work accordingly. We can also take inspiration from other cities that are part of smart cities and what they have done to improve their cities using technology. As we all know, the ICCC will play a critical role in enhancing a city's livability by assuring effective service delivery and faster response to crises and risks.
- The ICCC, we believe, can assist in areas such as smart parking, property tax management, asset management, and water supply management. Cyber security is one of the most pressing challenges that all people confront in today's world, so to address this ICCC and assist people. There are now a few IT firms that have integrated with ICCC, but if more private enterprises do so, PSCDCL/ PMC will profit more and the PPP model will be implemented more successfully.
- The ICCC can implement a data policy to ensure that data is safeguarded and that data theft does not occur. The network will act as the smart city's backbone, and its capacity can be expanded.
- All of these projects have received significant funding, but they have yet to be fully integrated into the urban local government's day-to-day operations. Because there is no best operational model to look up to and no advise accessible on service integrations, there appears to be widespread doubt among completed ICCC projects about where they are now and what goal they are seeking to achieve.
- The evaluation approach is a straightforward way to compare the ICCC ecosystem in Smart cities across the country. These benchmarks would run concurrently with the livability standard and categories of indicators, and would also include the important features of an ICCC that is optimized in terms of governance and technological framework use to assist makes the city more livable and developed.

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ANNEXURE – 1

The questioner which was used to do survey is attached in this annexure below:

1. Name : ....

Free Wi-Fi

2. Do you use Free Wi-Fi provided by PMC?

   ....

3. How often do you use free Wi-Fi?
   - ☐ Daily
   - ☐ Weekly
   - ☐ Often
   - ☐ Never
4. Rate speed of Wi-Fi
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
5. Rate Wi-Fi security
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
6. Do you face any issue of connectivity?
   - ☐ Yes
   - ☐ No
   - ☐ Maybe

Emergency Box

7. Do you use emergency box in event of emergency?

   ....

8. How fast is response in by particular department in event of emergency?
   - ☐ Very slow
   - ☐ Slow
   - ☐ Fast
   - ☐ Very fast
9. Prior to emergency what were the means you used to report an emergency?

   ....

10. Would you prefer emergency box system or direct call system in emergency?

    ....

Variable Message Display

11. Dose VMD helps you in your day-to-day life?
    - ☐ No
    - ☐ Yes
    - ☐ Maybe
12. What type of messages you get from the VMD?

    ....

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Smart cities and Academia towards Action and Research

Part A ***Urban Management***