

Planning for Integrated Command and Control Centre in Indian Cities

Saoni Sanyal^{1,*}, Dr. Nilanjana Dasgupta Sur²

¹ Department of Urban Planning, SPA Delhi, Address- Master Para, Post- Katwa, District- Burdwan, West Bengal 713130

² Department of Urban Planning, SPA Delhi, Address- Department of Urban Planning, School of Planning and Architecture, 4 Block B, I.P Estate, New Delhi 110002

Abstract

The Integrated Control and Command Centre (ICCC) is instrumental in enhancing global cities' efficiency, resilience, and sustainability as the central hub for urban management. By integrating diverse technological solutions and data sources, the ICCC enables real-time monitoring, analysis, and control of urban systems, aiding informed decision-making in city planning. Urban planners leverage the ICCC to assimilate data from various sectors such as traffic management, public safety, utilities, and environmental monitoring, fostering a holistic understanding of urban dynamics. This data-driven approach empowers planners to anticipate challenges, identify trends, and devise effective strategies for sustainable development, including optimizing traffic flow and implementing targeted interventions for environmental sustainability. Moreover, the ICCC serves as a centralized platform for emergency response and fosters citizen engagement through smart governance tools, enabling residents to access real-time information and provide feedback. However, challenges like lack of infrastructure, governance, funding, and skills hinder its holistic implementation. As technology continues to advance, the role of the ICCC will evolve, presenting new opportunities for innovation and sustainable urban development. Proposed in all Smart Cities of India under the Smart Cities Mission, Integrated Control and Command Centres (ICCCs) are operational in 100 cities, with Agartala, Indore, and Vadodara highlighted for sustainable business models. Yet, challenges persist in creating comprehensive ICCC models. Therefore, the main objective of this paper is to investigate and strategize the implementation of ICCCs in Indian cities for improved governance and urban resilience.

Keywords: Integrated Control and Command Centre (ICCC), Smart Cities, Infrastructures Development

Received on 30 May 2024, accepted on 03 October 2024, published on 06 November 2025

Copyright © 2025 Saoni Sanyal *et al.*, licensed to EAI. This is an open access article distributed under the terms of the [CC BY-NC-SA 4.0](#), which permits copying, redistributing, remixing, transformation, and building upon the material in any medium so long as the original work is properly cited.

doi: 10.4108/eetsc.6204

1. Introduction

India is experiencing a rapid surge in urbanization, with approximately 34% of its population now residing in cities, a stark increase from just 18% in 1960[1]. This significant urban growth has brought forth a myriad of critical challenges for the country's urban centres. Among these challenges are the proliferation of slums, inadequate local governance structures, financial instability, and deficient

urban planning, leading to soaring housing and office space costs[2,3]. Compounding these issues is the prevailing administrative framework, primarily orchestrated from the national or state level, which may not fully comprehend the intricate dynamics of a densely populated urban economy. This centralized approach often results in overlapping service responsibilities and a dearth of localized decision-making power. Moreover, the imperative for climate-resilient economic development further amplifies the complexity of the economic and structural obstacles confronting Indian cities. Consequently, there is a

*Corresponding author. Email: saonisanyal1999@gmail.com

mounting demand for devolved, decentralized control over urban economies and more robust urban planning mechanisms to foster inclusive and resilient economic growth[†]. Scholars and policymakers are actively examining the political implications of urbanization and its associated challenges, striving to develop actionable strategies to address issues like regional disparities, environmental degradation, and social inequity[4].

Indian cities grapple with a range of challenges stemming from high population density, inadequate infrastructure, and rapid urban growth. These challenges include urban slum expansion, strained water and sanitation systems, and reduced quality of life. Centralized administrative structures often struggle to grasp urban complexities, leading to overlapping service responsibilities and limited local control [2,5].

Tackling these issues requires a focus on inclusive economic growth, decentralized governance, and climate-resilient development. Population growth exacerbates congestion and strains public services, especially housing and transportation. Rural migration adds to these pressures, underscoring the urgency of sustainable urban development strategies that ensure fair resource access.

Despite obstacles, Indian cities offer opportunities for innovative solutions and holistic urban planning that prioritize resident well-being and environmental sustainability in the long run.

The need for effective city management and robust emergency response systems underscores the importance of Integrated Command and Control Centres (ICCCs) in Indian cities. As urbanization accelerates and cities become more complex, efficient management of resources, infrastructure, and public services becomes imperative. ICCC serves as a central hub where data from various city systems, such as transportation, public safety, and utilities, are integrated and analysed in real-time. This integration allows for proactive decision-making, rapid response to emergencies, and optimization of city operations. By coordinating efforts across different agencies and stakeholders, ICCC enhances overall city resilience, improves public safety, and ensures better utilization of resources. In India's dynamic urban landscape, investing in Integrated Command and Control Centres (ICCCs) is vital for fostering sustainable cities capable of addressing urban challenges. Significant progress has been made under initiatives like the Smart Cities Mission, Digital India Project, and National E-governance Plan (see Figure 1).

The ICCC initiative in India has been implemented in several phases, with 20 cities selected in Phase 1, known as "Lighthouse cities," and 13 cities in the Fast Track Round of Phase 2 as depicted in Figure 1. The ICCC project covers

various sectors such as e-governance, smart transport, heritage, and city surveillance. The Lighthouse cities are expected to provide valuable learning experiences for the Smart City project implementations. The ICCC Awards recognize the impact and thematic components of the initiative, aiming to capture the sectoral as well as cross-sectoral aspects. The program has faced challenges but has delivered tangible results, contributing to the urban transformation of the participating cities[6].

However, despite these advancements, there remain notable gaps in knowledge and areas requiring further exploration within the Indian context. One such area is the need for deeper research into the scalability and sustainability of ICCC implementations across diverse urban landscapes in India. Even though the ICCC project's early phases have yielded insightful information, it is imperative to assess these centres' long-term efficacy and flexibility, particularly in smaller areas. Furthermore, little study has been done on how ICCC interventions affect socioeconomic factors, particularly those related to community involvement, equity, and inclusivity[7].

Furthermore, given the rapid technological advancements, ongoing research is essential to identify emerging technologies and best practices for enhancing the resilience and functionality of ICCC systems in addressing evolving urban challenges. India can reinforce its activities under the International Council of Chemical Cycles (ICCC) and guarantee their continued relevance and efficacy in promoting sustainable urban development by tackling these knowledge gaps and encouraging joint research and innovation.

Problem Statement: Rapid urbanization in Indian cities poses significant challenges in both infrastructure and administrative sectors. To address these issues and establish an efficient and transparent governance system, the exploration of integrated tools becomes imperative, with Integrated Control and Command Centres (ICCCs) serving as crucial planning instruments to effectively harness and coordinate diverse urban data sources.

Therefore, the aim of this paper is to thoroughly investigate and strategize the implementation of ICCCs within the urban framework of Indian cities. To achieve this aim, four main goals have been meticulously studied step by step. Firstly, to analyse existing research to understand the foundational design principles and architectural frameworks of ICCCs. Secondly, to develop a cyclical framework outlining the key operational stages of an ICCC for efficient urban management. Thirdly, to examine the implementation and impact of ICCCs in Indian cities, highlighting best practices and lessons learned. Lastly, to formulate a detailed implementation plan to integrate ICCCs with administrative structures for enhanced

governance and urban resilience. Through these goals, this paper seeks to provide comprehensive insights and strategies for the effective deployment of ICCC in Indian urban local bodies.

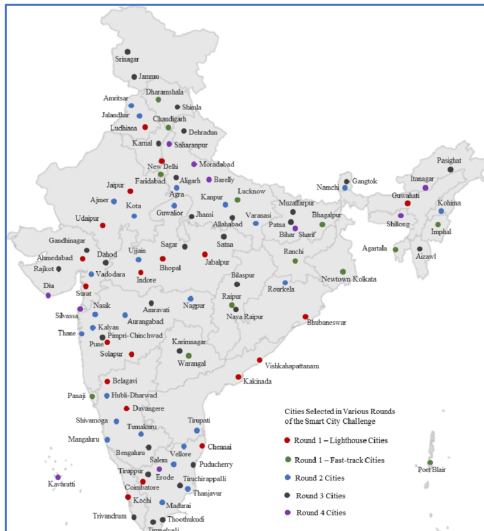


Figure 1. Smart City with Integrated Control and Command Centre Projects in Different Rounds

2. Literature Review on Design and Architecture of ICCC

In the field of urban planning in India, Integrated Control and Command Centres (ICCCs) function as centralized hubs for real-time data monitoring and decision-making, enhancing the efficiency and resilience of city management in the face of evolving urban environments. These centres are crucial in addressing urban issues such as traffic congestion and public safety, thereby promoting sustainable and inclusive urban development. Moreover, studies emphasize the significance of collaborative governance frameworks and technological innovations, including the integration of AI and IoT, in maximizing the effectiveness of ICCC operation.

2.1. Concepts and Definition

An Integrated Command and Control Centre (ICCC): is a centralized facility that integrates information and communication technologies (ICT) to enable the monitoring, analysis, and management of various operations and activities. It serves as the "brain and nerve centre" for organizations, providing a comprehensive overview of the situation and facilitating real-time decision-making(8)

2.2 Conceptual Cyclical Framework of an ICCC

An ICCC operates within a cyclical framework comprising four main stages. As described in Figure 2-

- Firstly, in the Data Acquisition and Integration stage, data is collected from diverse sources like sensors, cameras, databases, and social media. This data, whether structured or unstructured, undergoes pre-processing steps such as cleaning and filtering before integration into the system.
- Secondly, in the Information Analysis and Visualization stage, collected data is analysed using various tools like data visualization dashboards and artificial intelligence algorithms to identify trends and potential threats. The processed information is then presented for operators' understanding.
- Thirdly, in the Decision Making and Collaboration stage, operators collaborate and make informed decisions based on the analysed information, often utilizing decision support systems. Communication and collaboration tools facilitate discussions and coordinated actions.
- Lastly, in the Action and Response stage, decisions are translated into actions, like resource deployment or issuing alerts.

The effectiveness of these actions is monitored, and the cycle restarts with data acquisition to assess impact and adapt further actions if needed. The four stages of ICCC operated cyclical framework is given below in figure 2. The specific components and functionalities of an ICCC will vary depending on the organization's needs and the nature of its operations. Security and privacy are crucial considerations in designing and operating an ICCC. Training and user support are essential for ensuring effective utilization of the ICCC.

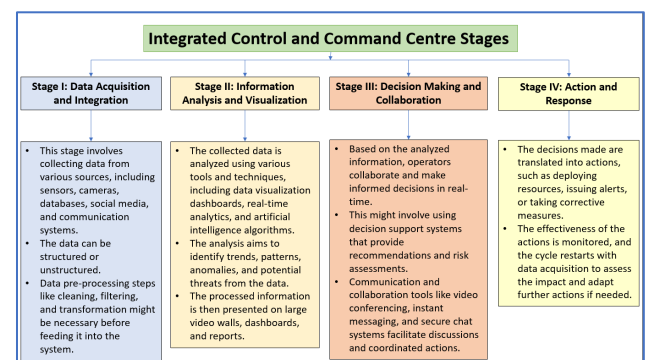


Figure 2. Stages of ICCC Process

Source: Integrated Command and Control Centre – Smartnet, NIUA

2.3 Architectural Layout and Technology Choices

The architecture layout and technology choices can be divided into the same cyclic stage-wise division for better understanding.

2.3.1 Stage 1 - Data Acquisition and Integration

A. Data Acquisition –

- *Architectural Layout-* Network design has been initiated, with mention made of the positioning of CCTV cameras, sensors, and cameras, as well as the integration of main stakeholder offices, utilizing databases sourced from social media. These components are primarily intended for the collection of raw data, both structured and non-structured.
- *Technology Choices-* Real time data capture from different sources such as Cameras, weather stations, CCTV, sensors, Traffic monitor Station (Traffic plat reorganization and Real time update Cameras)(9)

B. Data Transfer and Storage-

- *Architectural Layout-* Data are transferred through fibre network cables, which are primarily stored in data lakes and warehouses for the subsequent stage of data filtering and integration.
- *Technology Choices-*
 - ❖ Apache Kafka: A streaming platform for handling high-volume data streams.
 - ❖ Hadoop: A framework for storing and managing large datasets.

C. Data Integration –

- *Architectural Layout-* Data are extracted, transformed, and loaded between systems (which can include Informatica Power Centre, Talend Open Studio, and API management platforms) to facilitate communication between disparate systems and applications. Data quality tools are utilized in this process(10).
- *Technology Choices-*
 - ❖ Apache Spark: A distributed computing framework for large-scale data processing.
 - ❖ Trifacta Wrangler, Open Refine
 - ❖ ETL/ELT Tools (E=Extract, T=Transform, L=Load)
 - ❖ API Management Platforms
 - ❖ Data Quality Tools

2.3.2 Stage 2 - Information Analysis and Visualization

- *Architectural Layout-* Streaming analytics engines are employed to analyse data streams in real-time, and data mapping and transformation are also conducted at this stage, where it is defined how data will be transformed and mapped to target systems. Following this, a second level of data integration is performed(11).
- *Technology Choices-*
 - ❖ Tableau and Power BI: Business intelligence tools for data visualization and reporting.

- ❖ Amazon Kinesis and Microsoft Azure Stream Analytics: Cloud-based platforms for real-time data analytics.
- ❖ IBM Watson and Google Cloud AI Platform: AI platforms for developing and deploying machine learning models.

2.3.3 Stage 3 - Decision Making and Collaboration

A. Decision Making –

- *Architectural Layout-* Historical data can be analysed and future outcomes predicted by data algorithms, aiding in risk assessment, resource allocation, and proactive decision-making. Real-world scenarios are simulated by systems like VBS3 and Unity, enabling teams to practice and evaluate different decision paths before deployment.
- *Technology Choices-*
 - ❖ Machine Learning and Artificial Intelligence (AI)
 - ❖ Simulation and Modelling Tools (VBS3)
 - ❖ Augmented Reality (AR) and Virtual Reality (VR) ((Dataversity - Data Integration for Integrated Command and Control Centres: 2023)(9)

B. Collaboration–

- *Architectural Layout-* Audio-visual meeting rooms and conference rooms should be provided for online/offline meetings with various stakeholders. Sharing best practices, lessons learned, and operational updates can be facilitated through platforms with secured chat systems. Situational awareness platforms such as Esri ArcGIS and SAP Situation Room offer a shared view of the operational environment, including real-time data, maps, and critical alerts, thereby promoting coordinated action.
- *Technology Choices-*
 - ❖ Blockchain Technology: Securely storing and sharing sensitive data across organizational boundaries
 - ❖ Platform like Microsoft team, Zoom, Google Meet for Video conferencing
 - ❖ Miro, Mural platform offers Virtual whiteboards and shared digital canvases for brainstorming

2.3.4 Stage 4- Action and Response

A. Action and Response–

- *Architectural Layout-* For communication and alerting, a mass notification system such as Everbridge or One platform can be utilized to send emergency alerts quickly and reliably to a diverse audience. Platforms like ServiceNow and BMC Helix ITSM enable incident tracking, task assignment, and coordination of response efforts across teams. Real-time updates and instructions are visually disseminated through displays in public areas, guiding occupants during emergencies. Specialized software can be introduced, providing mobile command posts with comprehensive tools for

tracking resources, visualizing the operational environment, and coordinating response activities.

- *Technology Choices-*

- ❖ Mass Notification System
- ❖ Incident Management System (IMS)
- ❖ Digital Signage and Public Information Displays
- ❖ Command Post Applications

B. Security–

- *Architectural Layout-* The vast amount of processed data must be secured throughout the process. To achieve this, restricted data access control is required, which restricts access to sensitive data based on user roles and permissions. Data encryption is also necessary. Additionally, auditing and logging are needed to track data access and modifications for traceability and compliance.

- *Technology Choices-*

- ❖ Data access Control
- ❖ Data Encryption
- ❖ Auditing and Logging.

By carefully selecting technology choices and incorporating scalability considerations into the design of an ICCC, cities can build a resilient and future-proof system capable of effectively managing urban operations and adapting to evolving challenges and opportunities(8,12)

2.4 Integrated Control and Command Centres in Indian Cities (National Case Study)

All 100 Smart Cities in India have operational Integrated Command and Control Centres (ICCCs) as of 2023, as confirmed by the India Smart Cities Awards Contest (ISAC) 2022 organized by the Ministry of Housing and Urban Affairs(13). However, a comprehensive assessment requires in-depth analysis of individual ICCCs and their performance across all IMAF dimensions. The ICCC Maturity Assessment Framework (MAF), developed by the Smart Cities Mission, is a tool to assess the maturity level of ICCCs across various aspects like functionality, technology, governance, and citizen engagement. It uses a scoring system to categorize ICCCs into levels of maturity (Level 1 - Emerging, Level 2 - Developing, Level 3 - Mature, and Level 4 - Leading). So according to this framework, some ICCCs might excel in specific areas like technology but lag in citizen engagement or governance, affecting their level of maturity. The current status of few cities in India who has operational ICCC's in place have been given below:

2.4.1 Pune Integrated Control and Command Centre

The Pune Integrated Command and Control Centre (ICCC), inaugurated in 2020 on a site area of 27,348 square feet, boasts a built-up area with key infrastructure

components covering 1,683.7 square feet of floor space. It accommodates 24 workstations for operators, a NOC room with six workstations, a conference room, a data centre facility, and an impressive 3x2 video wall. With a total of 80 members, this collaborative effort involves stakeholders including Smart City Development Corporation Limited, Pune Municipal Corporation, Pune Police, Pune Mahanagar Parivahan Mahamandal Limited, and the Pune Metropolitan Region Development Authority (PMRDA), along with active citizen participation. The Pune ICCC enhances citywide monitoring and response capabilities across several areas and is a tribute to effective municipal governance and technological integration.

2.4.2 Ahmedabad Integrated Control and Command Centre

The Ahmedabad Integrated Command and Control Centre (ICCC), inaugurated in 2019 on a 4181 square meter plot, features a total built-up area of 2239 square meters. Its infrastructure components cover 521 square meters, emphasizing disability-friendly design and housing essential facilities such as a meeting room, conference hall, cafeteria, server room, and an impressive 9x3.55-inch LED video wall. The center is dedicated to the implementation of digital services and public grievance redressal, fostering public awareness through a communication and citizen information outreach system using Video Management Devices (VMD). With a membership of 89 individuals, the project's main stakeholders include Smart City Limited, the Municipal Corporation, the police, and actively engaged citizens. The Ahmedabad ICCC stands as a testament to comprehensive urban governance, employing advanced technology for efficient citywide services and management.

2.4.3 Jabalpur Integrated Control and Command Centre

The Command-and-Control Centre in Jabalpur serves as a comprehensive hub for managing city operations, aimed at enhancing citizen welfare. Powered by Information & Communication Technologies, it ensures seamless integration of smart components. Operating under Jabalpur Smart City Limited (JSCL) at Old Transport Nagar, the facility spans three stories with over 10500 square feet of built-up area. It features cutting-edge IT infrastructure, including a 30x9 square foot video wall, 18 PRI telephone lines with recording, and a conference room accommodating 50 individuals. With ample Internet leased line and MPLS connectivity, stakeholders such as Jabalpur Municipality Corporation, Jabalpur Smart City Limited, and Jabalpur Police Corporation benefit from its services.

Table 1. Comparison matrix of Indian ICCC with Assessment framework

Case Study City	Capability Assessment	Stage 1	Stage 2	Stage 3	Stage 4	Services Covered
Pune Integrated Control and Command Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability Assessment	Communication	Command & Control Capability Assessment	1. Transport - Intelligent Traffic Monitoring System Smart Parking, Number Plate Recognition, Red Light Violation detection, and CCTV Surveillance 2. Social Infrastructure-Booking facilities
		High	Medium	Medium	Medium	
	Technological	Data Acquisition	Configuration Layer/ SOP	Data Analytics and Co-relation Layer	Command and Control Layer	
		High	Medium	Medium	Medium	
	Government	Governance Framework	Support to Field Force	Decision Making Framework	Knowledge Management	
		Low	High	Medium	Low	
Ahmedabad Integrated Control and Command Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability Assessment	Communication	Command & Control Capability Assessment	1. Physical Infrastructure-solid waste Management system - GPS vehicle monitoring system WASH-Efficient management of water supply. 2. Citizen awareness - Mobile app 3. Transport-monitoring MRTS, BRTS Intelligent traffic Monitoring system
		High	High	Medium	Medium	
	Technological	Data Acquisition	Configuration Layer/ SOP	Data Analytics and Co-relation Layer	Command and Control Layer	
		High	High	High	Medium	
	Government	Governance Framework	Support to Field Force	Decision Making Framework	Knowledge Management	
		Medium	High	Medium	High	
Jabalpur Integrated Control and Command Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability	Communication	Command & Control Capability Assessment	1. Physical Infrastructure-Solid waste Management

City and Centre	Capability Assessment	Stage 1	Stage 2	Stage 3	Stage 4	Services Covered
Pune Integrated Control and Command Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability Assessment	Communication	Command & Control Capability Assessment	1. Transport - Intelligent Traffic Monitoring System Smart Parking, Number Plate Recognition, Red Light Violation detection, and CCTV Surveillance 2. Social Infrastructure-Booking facilities
		High	Medium	Medium	Medium	
	Technological	Data Acquisition	Configuration Layer/ SOP	Data Analytics and Co-relation Layer	Command and Control Layer	
		High	Medium	Medium	Medium	
	Government	Governance Framework	Support to Field Force	Decision Making Framework	Knowledge Management	
		Low	High	Medium	Low	
Ahmedabad Integrated Control and Command Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability Assessment	Communication	Command & Control Capability Assessment	1. Physical Infrastructure-solid waste Management system - GPS vehicle monitoring system WASH-Efficient management of water supply. 2. Citizen awareness - Mobile app 3. Transport-monitoring MRTS, BRTS Intelligent traffic Monitoring system
		High	High	Medium	Medium	
	Technological	Data Acquisition	Configuration Layer/ SOP	Data Analytics and Co-relation Layer	Command and Control Layer	
		High	High	High	Medium	
	Government	Governance Framework	Support to Field Force	Decision Making Framework	Knowledge Management	
		Medium	High	Medium	High	
Jabalpur Integrated Control and Command Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability	Communication	Command & Control Capability Assessment	1. Physical Infrastructure-Solid waste Management

Source: Maturity Assessment Framework and Toolkit to unlock the potential of Integrated Command and Control Centres, 2018 and Author

Upon reviewing the data presented in Table 1, it becomes apparent that the Indian Integrated City Command and Control (ICCC) system predominantly faces challenges in technological advancement and government support. While the initial stage of Data Acquisition tends to be well-established, there is a notable deficiency in subsequent stages such as data analysis and decision-making processes. A key contributing factor to this gap is the shortage of skilled professionals in planning roles within the ICCC, municipality, and smart city entities. The lack of comprehensive analysis often leads to inaccurate decision-making and underutilization of infrastructure resources.

Addressing this issue requires an emphasis on capacity-building programs for municipal personnel and staff, alongside increased public awareness campaigns to promote the adoption of digital services. These efforts aim to transition towards sustainable, paper-free Urban Local Body (ULB) infrastructure, fostering more efficient and effective governance processes.

2.5 Integrated Control and Command Centres in International Context

ICCC not only enhances city management and public safety but also holds the potential to bring about positive social, economic, and environmental transformations, aligning with the evolving needs of India's dynamic urban landscape. These have been demonstrated by different global cities through best practices. Some have been listed below:

2.5.1 Rio Operations Centre, Rio De Janeiro, Brazil

Established in April 2010, the Rio Operations Centre emerged as a pivotal initiative for enhancing the resilience of Rio de Janeiro. Triggered by the devastating consequences of heavy rains leading to landslides and the loss of 68 lives, the Centre, inaugurated in December 2010, aimed to integrate daily city operations and manage crises effectively. Designed with technological expertise from partners like IBM, Bilfinger, Cisco, Samsung, and Google, the Operations Centre employs Google Earth technology for georeferenced data integration. The Control Room, equipped with a 60m² video wall, enables 200 controllers in three shifts to monitor the city in real time. The Crisis Room facilitates emergency meetings, while the Press Room ensures constant communication with the media. The 1746 Hot Line encourages citizen engagement, allowing reporting on city services and receiving information. Operating in three key areas—risk prevention and management, daily city operations, and major events—the Centre has significantly reduced emergency response times by 30%. To process the generated data, the City Hall introduced the Big Data department "PENSA – Ideas Room" in June 2013, fostering research and analysis for improved service delivery. The Rio Operations Centre, with an initial cost of R\$20 million, represents a collaborative effort involving nearly 30 city departments, public agencies, and utility companies, achieving notable impacts such as a 30% reduction in emergency response times and enhanced efficiency in public transportation. Overcoming barriers like departmental rivalries and information withholding, the Centre stands as a dynamic model of integrated decision-making, contributing to the daily learning process and resilience of Rio de Janeiro. Continuous training and simulation exercises address the challenge of qualified human resources, ensuring the Centre's effectiveness in managing diverse urban challenges(14).

2.5.2 Integrated Centre for Security and Emergency in Madrid (CISEM), Madrid, Spain)

In the wake of the major terrorist attack on Madrid's commuter trains in March 2004, which underscored the critical need for enhanced coordination among first responders, the City of Madrid initiated a comprehensive project to establish a unified Command and Control Centre for Security and Emergency Services. The lack of centralized command and control during the 2004 incident highlighted the necessity for a system capable of organizing a unified response to multiple incidents simultaneously. The project, launched in 2005 and completed in 2007, integrated physical and technological components to support Security and Emergency Services. IBM provided the software for a service-oriented architecture (SOA), enabling seamless coordination among first responder agencies. The command-and-control centre, developed by global technology company Indra,

consolidated information from various sources, including video feeds and mobile computers. A common mobile infrastructure was deployed to ensure interoperability among different agencies, and a multilayered, redundant communications infrastructure was established to ensure continuous communication. The project, with an approximate cost of 20 million Euros, significantly improved emergency management capabilities in Madrid. The integration of systems and data sources provided emergency managers with a comprehensive view of situations, reducing confusion and enabling faster decision-making. This resulted in a 25% reduction in response time, as managers could deploy the right assets more efficiently. The project faced challenges in integrating various applications used by different entities and external organizations, but its success demonstrated the transformative impact of an integrated approach to emergency management(14).

Table 2. Comparison matrix of International ICCCs with Assessment framework

Case Study City	Capability Assessment	Stage 1	Stage 2	Stage 3	Stage 4	Services Covered
Rio operations Centre	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability Assessment	Communication	Command & Control Capability Assessment	Emergency Operation Centre, CCTV surveillance, public awareness, 2. Transportation - Public Vehicle monitoring
		High	High	High	High	
	Technological	Data Acquisition	Configuration Layer/SOP	Data Analytics and Co-relation Layer	Command and Control Layer	
		High	High	High	High	
	Government	Governance Framework	Support to Field Force	Decision Making Framework	Knowledge Management	
		High	High	High	High	
Integrated Centre for Security	Functional	Data Acquisition and Visualization Capability	Data Analytics and Co-relation Capability Assessment	Communication	Command & Control Capability Assessment	Safety and security, Reducing Confusion in Emergency situation and Faster Decision making.
		High	High	High	High	

and Emergence in Madrid	Technological	Data Acquisition	Configuration Layer/SOP	Data Analytics and Co-relation Layer	Command and Control Layer
		High	High	High	High
	Government	Governance Framework	Support to Field Force	Decision Making Framework	Knowledge Management
		High	High	High	High

Source: Maturity Assessment Framework and Toolkit to unlock the potential of Integrated Command and Control Centres, 2018

In international case studies, a key distinction observed in Integrated Command and Control Centres (ICCCs) lies in their approach to control various aspects of infrastructure with greater detail and efficiency (Table 2). These systems often focus on smaller segments of infrastructure, emphasizing technological advancement and effective fund allocation. Additionally, training and capacity-building programs for staff play a crucial role. In contrast, many Indian cities typically have a single ICCC that oversees smaller parts of each infrastructure domain, potentially obscuring the city's overall needs and gaps. To develop a functional ICCC algorithm for a specific city, a comprehensive gap analysis assessment is necessary. This assessment would prioritize infrastructure programs based on their ranking and determine the level of detail required for integration with the ICCC.

3. Challenges and Considerations

Implementing and operating an Integrated Command and Control Centre (ICCC) in Indian cities presents challenges related to governance, data privacy, and cultural acceptance. Inter-departmental coordination, data sharing concerns, and perceptions of surveillance versus inclusive governance hinder its deployment, despite its successes in enhancing safety, security, and urban services. Therefore, building a mature ICCC across various aspects, including functionality, technology, governance, and citizen engagement, presents several challenges for Indian cities(15). They are:

3.1 Functionality

- Limited integration and data sharing: Silos between departments and agencies lead to incomplete data capture and hinder holistic view of the city's operations.
- Lack of standardized operating procedures: Inconsistent responses to incidents and inefficient resource allocation due to absence of standardized protocols.

- Inadequate manpower and training: Insufficient personnel with expertise in operating and maintaining the complex functionalities of ICCCs.

3.2 Technology

- Cybersecurity concerns: Ensuring data security and system resilience against cyberattacks requires robust solutions and continuous updates.
- Outdated technology infrastructure: Legacy systems lacking compatibility with newer technologies create challenges in integration and scalability.
- Financial constraints: Limited budgets restrict access to advanced technology solutions essential for enhancing ICCC capabilities(16).

3.3 Governance

- Interdepartmental coordination issues: Lack of efficient collaboration between agencies leads to delayed decision-making and hinders effective response to critical situations.
- Accountability and transparency concerns: Unclear ownership of responsibilities and lack of transparent reporting raise concerns about accountability.
- Legal and regulatory framework: Evolving legal and regulatory landscape surrounding data privacy and technology use requires constant adaptation and updates(17).

3.4 Citizen Engagement

- Limited awareness and participation: Lack of citizen awareness about ICCCs and their functionalities reduces opportunities for meaningful participation.
- Communication gaps: Ineffective communication channels and strategies hinder smooth information flow between citizens and authorities.
- Digital divide: Unequal access to technology and digital literacy creates barriers for certain sections of the population to engage with ICCCs(8).

3.5 Additional Challenges

- Sustainability: Ensuring long-term financial and operational sustainability of ICCCs requires robust funding mechanisms and efficient resource management.
- Performance measurement: Establishing clear metrics and tracking progress in all aspects of ICCC maturity presents a challenge.
- Scalability and adaptability: Adapting ICCCs to evolving needs and challenges in rapidly growing urban environments requires constant upgrades and flexibility.

- **Community Involvement:** ICCCs have the potential to enhance community engagement by leveraging social media platforms like Twitter and WhatsApp for public participation in decision-making and emergency response. For example, ICCCs aim to implement Community Protection Programs with volunteers, develop community alert systems, and conduct simulation exercises in public schools to create safer neighbourhoods. While these initiatives remain largely conceptual in India, a glimpse of their effectiveness was seen during the COVID-19 pandemic, when ICCCs acted as control centres—connecting hospitals, helplines, and blood banks, while ensuring basic support for the elderly and COVID patients(14).

4. Comprehensive Plan for Implementation and Coordination of ICCC with Administrative Structure in Indian Cities

4.1 Designing Framework for Functional ICCC

In the design of Integrated Command and Control Centres (ICCCs) in Indian cities, the selection of site location is crucial, often placing them near Urban Local Body (ULB) offices, smart city infrastructure, and other stakeholder buildings. This positioning ensures secure data transfer between various entities. However, longer distances between sites necessitate additional investments in secure technology, Wi-Fi, and jammer infrastructure, thereby increasing project costs. With a fixed budget of ₹150 crore from the Smart City initiative and ₹170 crore from the Ministry of Electronics and Information Technology, stakeholders' input is essential to ensure transparent data transfer and adherence to government regulations. The ideal design framework developed from various case studies is provided below (Table 3):

Table 3. Ideal Design Framework for Integrated Control and Command Centre.

Topic	Minimum	Maximum
Site Location	Middle of the city	Outskirt of the city
Distance	1 km radius of Fire department, Police Department, Collectorate Office and Municipal corporation	2.5 Km radius
Site area	4200 sqm	-
Floor Area	500 sqm	800 sqm

Staff Member	75	85
Main Components	Conference Room, Meeting Room, Data Centre, Control room, Storage, Cafeteria, Server Room	
Total Budget	200 Cr	250 Cr
Time Period (Phases)	<ul style="list-style-type: none"> • Phase 1: Pre construction Phase – 170 days. • Phase 2: Building Construction phase - 190 days • Phase 3: Equipment Installation – 280 days. 	<ul style="list-style-type: none"> • Phase 1: Pre construction Phase – 180 days. • Phase 2: Building Construction phase - 250 days • Phase 3: Equipment Installation – 300 days.
Number of Department	4 (Physical Infrastructure, Mobility and Transportation, Environmental and Disaster Management, Housing Infrastructure-Property tax Management)	7 (Extra involved Department – Energy and telecommunication – E-taxation, Heritage Tourism, Social Infrastructure)
Stakeholders	Municipal Corporation, Development Authority, TCPO, Smart city limited, Police Department, Citizen, PWD, Government Institutions (School, Colleges, University), Hospitals, Medical Universities. All Social Infrastructure facilities, Commercial facilities (Hotels, Retail Shops), NGOs	

Source: Authors

4.2 Implementation Plan for a Successful Integrated Control and Command Centre

The successful implementation of an Integrated Command and Control Centre (ICCC) in Indian cities requires a strategic and systematic approach. This section outlines the key steps involved in the implementation process, including pre-implementation; planning and strategy; implementation; execution and management; monitoring and evaluation; project submission and O&M; and phasing. By following these steps, cities can effectively deploy and operate an ICCC, thereby enhancing their ability to address urban management challenges and improve the overall quality of life for residents.

4.2.1 Pre-Implementation

- **Land Identification:** Identify suitable land or facilities for establishing the ICCC based on accessibility and infrastructure requirements.
- **Consultation and Designing:** Engage urban planners, architects, and technology experts to design the layout and infrastructure blueprint for the ICCC.

- *Building Permission and Plan Approval:* Obtain necessary permits and approvals from local authorities for construction and implementation.
- *Stakeholder Identification and Engagement:* Engage with all stakeholders, including government bodies, private partners, community representatives, and technology experts.

4.2.2 Planning and Strategy

- *Policy Formulation and Governance Structure:* Establish a governance structure defining roles and responsibilities, building regulations
- *Technical Planning and Infrastructure Design:* Collaborate with technology partners to design and finalize the technical infrastructure required for the ICCC
- *Contract/Tendering:* Initiate the process of tendering and selection of contractors based on predefined criteria.

4.2.3 Implementation

- *Project Management Office (PMO) Setup:* Set up a dedicated PMO responsible for overseeing project execution, resource allocation, and adherence to timelines.
- *Execution and Implementation:* Begin the construction and installation of hardware, software, networking infrastructure, and operational facilities.
- *Operations and Maintenance Planning:* Develop standard operating procedures (SOPs) for the day-to-day functioning and long-term maintenance of the ICCC.

4.2.4 Execution and Management

- *Data Management and Analytics:* Establish robust protocols for collecting, storing, and analysing data from various sources within the ICCC framework
- *Community Engagement and Training:* Conduct outreach programs to educate citizens about the ICCC's functions and benefits. Provide training sessions for staff and stakeholders on utilizing ICCC tools effectively(10).

4.2.5 Monitoring and Evaluation

- *Performance Monitoring:* Implement KPIs to measure the effectiveness of the ICCC in achieving its objectives. Regularly monitor and assess the system's performance against these KPIs.
- *Feedback and Iterative Improvements:* Gather feedback from stakeholders and citizens to identify areas for improvement. Use feedback to enhance the functionalities and operations of the ICCC.

4.2.6 Project Submission and O&M

- *Project Submission to Smart City:* Compile project reports, compliance documents, and necessary certifications for submission to the Smart City governing body.
- *Operations and Maintenance (O&M):* Commence the O&M phase to ensure continuous functionality and sustainability of the ICCC as per established protocols.

In conclusion, the implementation of an Integrated Command and Control Centre (ICCC) in Indian cities requires a multifaceted approach, as outlined in the preceding steps. By meticulously following these steps, cities can effectively deploy and operate an ICCC, thereby enhancing their urban management capabilities and fostering resilience. This structured approach ensures that cities are well-equipped to address evolving urban challenges and meet the needs of their residents efficiently.

4.3 Enhancing Administrative Coordination through Integrated Command and Control Centers (ICCC)

The integration of administrative structures with Integrated Command and Control Centres (ICCC) is pivotal for ensuring efficient urban governance. Figures 1 and 2 exemplify how administrative coordination enhances management across both physical and social infrastructure through the ICCC framework. In the domain of physical infrastructure, such coordination facilitates streamlined decision-making, enabling prompt responses to infrastructure projects, maintenance needs, traffic management, and disaster mitigation efforts. By fostering synergy among administrative bodies, the ICCC ensures cohesive planning and execution of initiatives aimed at enhancing the city's built environment and infrastructure resilience.

Similarly, administrative integration plays a critical role in managing social infrastructure, including vital services like healthcare, education, and emergency response (Figure 2 & 3). Through effective coordination, cities can optimize resource allocation, improve service delivery mechanisms, and bolster emergency response capabilities within these essential sectors. By harnessing the capabilities of the ICCC to foster seamless communication, collaboration, and decision-making among administrative entities, cities can navigate complex urban challenges more effectively. This integrated approach not only enhances the overall resilience and functionality of urban systems but also fosters a more responsive and inclusive governance framework, crucial for the sustainable development of cities.

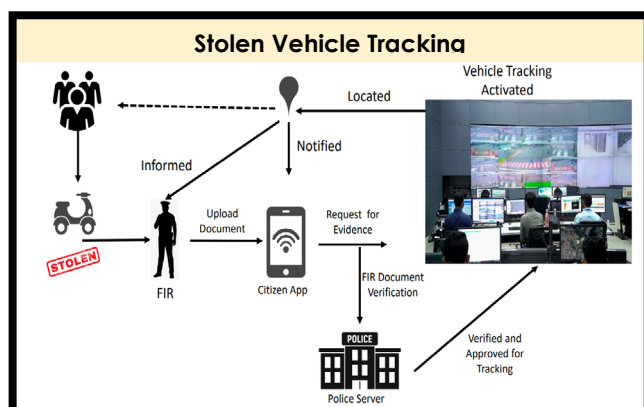


Figure 3. ICCC work structure for stolen vehicle case

Source: Integrated Control and Command Centre Bhopal , 2019

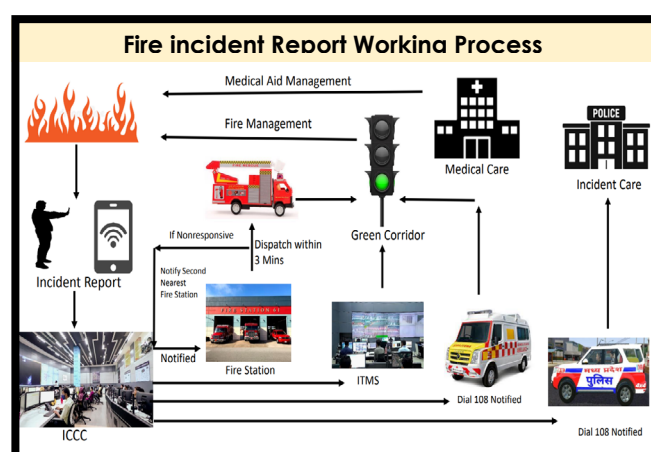


Figure 4- ICCC work structure for Fire incident Reporting

Source: Integrated Control and Command Centre Bhopal , 2019

5. Conclusion

Despite its recognized potential as a crucial tool in urban planning and city management, the ICCC faces underutilization, stemming from a lack of awareness and knowledge among stakeholders. The paper underscores the critical need for capacity building and training programs to equip staff with the requisite skills for effective ICCC utilization. Furthermore, it emphasizes the necessity of enhancing citizen awareness regarding the role of ICCC in their daily lives, advocating for the efficiency and expediency of digital workflows. The proposition extends

to educational institutions, urging them to integrate awareness programs into their curricula, emphasizing the vulnerability of cities to cyber security issues and the pivotal role of ICCC in mitigating such threats. The conclusion posits that substantial investment is imperative in fostering ICCC utilization, not only to fortify urban resilience but also to bridge the knowledge gap hindering its full potential. By advocating for increased awareness, training initiatives, and strategic investments, the paper advocates a holistic approach to unlock the true transformative power of ICCC in shaping resilient, efficient, and digitally empowered Indian cities.

Acknowledgements.

We would like to express our sincere gratitude to all the individuals and organizations who contributed to the successful completion of this study on the role of Integrated Control and Command Centres (ICCC) as a crucial tool for urban planning.

First and foremost, we extend our heartfelt appreciation to the personnel of the Smart City initiatives and the Municipal Corporations of the case study cities. Your invaluable cooperation, insights, and access to data were fundamental to our research. The dedication and expertise demonstrated by the officials in these cities have significantly enriched our understanding of the operational dynamics and strategic significance of ICCCs in urban governance.

We are also deeply grateful to the National Institute of Urban Affairs (NIUA) for their comprehensive report on the Maturity Framework. This report provided a robust analytical foundation that was instrumental in shaping the theoretical and practical dimensions of our study. The Maturity Framework offered critical benchmarks and performance indicators that guided our assessment of the ICCCs' efficacy and maturity in various urban contexts.

This study is a testament to the collaborative efforts of all these individuals and organizations, whose contributions have been indispensable. We hope our findings will contribute to the ongoing discourse on urban planning and the strategic deployment of Integrated Control and Command Centres.

References

- [1] Coleman J. India's urbanisation challenge [Internet]. Oxford policy Management. 2018 [cited 2025 Sept 10]. Available from: <https://www.opml.co.uk/insights/indias-urbanisation-challenge>
- [2] Linnea García K. Understanding India's urban future [Internet]. Penn Today. 2023 [cited 2025 Sept 10]. Available from:

- <https://penntoday.upenn.edu/news/understanding-indias-urban-future>
- [3] Nandi S, Gamkhar S. Urban challenges in India: A review of recent policy measures. *Habitat Int* [Internet]. 2013 July [cited 2025 Sept 10]; Available from: https://www.researchgate.net/publication/257053237_Urban_challenges_in_India_A_review_of_recent_policy_measures
 - [4] World Bank Group. India's Urban Challenges [Internet]. World Bank Group - Who we are. 2014 [cited 2025 Sept 10]. Available from: <https://www.worldbank.org/en/news/feature/2011/07/04/indias-urban-challenges>
 - [5] Nijman J. India's Urban Challenge. *Eurasian Geogr Econ*. 2012 Jan;15.
 - [6] Dwivedi G. Smart cities Mission in India - Footprints of International Financial Institutions [Internet]. [cited 2025 Oct 14]. Available from: <https://www.cenfa.org/wp-content/uploads/2019/07/Smart-Cities-booklet-Final.pdf>
 - [7] MoRTH. Integrated Command and Control Centers operationalized in all 100 smart cities for better monitoring and coordination [Internet]. PIB, Delhi; 2023. Available from: <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1907135>
 - [8] Uchoi E, Debbarma K. Smart Cities Survey: Based on Integrated Command and Control Center. *Int J Sci Dev Res IJSDR*. 2023 June 15;7(9):4.
 - [9] Mao Peng, Li Xiaolu, Zhou You, Qin Hong, Xiong Qixin. Study On architecture of automation system in extra-high integrated control center. In: 2010 International Conference on Power System Technology [Internet]. Zhejiang, China: IEEE; 2010 [cited 2025 Oct 23]. p. 1–4. Available from: <http://ieeexplore.ieee.org/document/5666105/>
 - [10] McKnight W. Enterprise Data Integration: Now More than Ever [Internet]. *Information Week*. 2025. Available from: <https://www.informationweek.com/data-management/enterprise-data-integration-now-more-than-ever->
 - [11] Schenk B. Data, Information, and Content Management. In: *Advanced Management Information Systems* [Internet]. Cham: Springer Nature Switzerland; 2025 [cited 2025 Oct 23]. p. 169–96. (Progress in IS). Available from: https://link.springer.com/10.1007/978-3-031-87904-3_4
 - [12] Prakash BR, Dattasmita HV. A Case Study of Command-and-Control Center—A DSS Perspective. In: Gaur L, Agarwal V, Chatterjee P, editors. *Decision Support Systems for Smart City Applications* [Internet]. 1st ed. Wiley; 2022 [cited 2025 Oct 23]. p. 17–33. Available from: <https://onlinelibrary.wiley.com/doi/10.1002/9781119896951.ch2>
 - [13] MoHUA. INTEGRATED COMMAND AND CONTROL CENTRES [Internet]. PIB Delhi; 2023. Available from: <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1947455>
 - [14] MoHUA. Integrated Command and Control Center Maturity Assessment Framework and Toolkit Draft version 1.0 [Internet]. MoHUA; 2018. Available from: https://smartnet.niua.org/sites/default/files/resources/iccc_maturity_assessment_framework_toolkit_vf211218.pdf
 - [15] KPMG, Belgium. From smartto smarter cities Leveraging integration, data and enablement for sustainable and resilient urban transformations. [Internet]. KPMG; 2024. Available from: <https://assets.kpmg.com/content/dam/kpmg/be/pdf/PS-from-smart-to-smarter-report.pdf>
 - [16] K A. Smart city command and control centre: Leveraging geospatial data [Internet]. IET (The Institution of Engineering and Technology); 2024. Available from: <https://india.theiet.org/innovation-and-knowledge/iet-future-tech-panel-knowledge-outputs/whitepapers/smart-city-command-and-control-centre-leveraging-geospatial-data/>
 - [17] Smart City Bhopal. Workshop on Integrated Control and Command Centre [Internet]. Smart City Bhopal; 2020; Bhopal. Available from: http://164.100.161.224/upload/uploadfiles/files/BSCDCL-%2022%20Sep-v2_o_bhopal.pdf