Sustainability of integrated control and command centers

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Abstract

India's Smart Cities Mission, launched in 2015, aims to improve urban infrastructure and services to improve the quality of life of the citizens. To meet this aim, it is endeavored to optimize city management through real-time data analysis, integrating various systems for informed decision-making. Accordingly, Integrated Control and Command Centers (ICCCs) are established in Indian Smart Cities to serve as the central hub for city operations. ICCCs provide a collaborative framework where input from different departments of city municipality and other city-level authorities such as transport, water, fire, police, etc. are assimilated and analyzed on a single platform. It facilitates in developing aggregated city level information. Further this aggregated city level information is converted to actionable intelligence, which is propagated to relevant stakeholders and citizens. To sustain the operation of ICCCs, a comprehensive strategy is imperative. This requires diversified revenue streams through facility leasing, advertising, and fine-sharing, alongside attracting private investment and exploring innovative financing. An example in this context is that of Gujarat provincial government, which has approved sharing revenue collection from traffic management for sustainability of ICCCs. Cities like Rajkot and Surat are monetizing their optical fibre networks, expecting significant revenue to support their ICCCs. Besides, strong local collaboration and citizen engagement are crucial, as well as, robust cyber security, data privacy compliance, and continuous technological adaptation, leveraging artificial intelligence. Compliance with the objective for which ICCCs are established depend on the strategy for sustainability of these centers.

Keywords: smart cities mission, diversified revenue, cyber security and technological adaptation.

1. Introduction

1.1. Smart Cities Mission

On June 25, 2015, **Smart Cities Mission** was launched in India. This Mission is an initiative designed to transform urban living. Its core aim is to develop robust city infrastructure, create a pristine and sustainable environment, and provide superior quality of life for the urban inhabitants. Besides, strong emphasis is placed on fostering sustainable and inclusive development, with the creation of scalable models.

The Mission intends to achieve its goal through application of innovative "smart solutions." The Mission strives to ignite economic growth and elevate living standards by comprehensively addressing the social, economic, physical, and institutional foundations of the city. The Smart Cities Mission involves a dual strategy. First, the Area-Based Development (ABD) approach designates a specific area of the city for intensive interventions. The specific area and the required interventions are selected and prioritized through stakeholder consultations and active citizen participation. The ABD zones are meticulously developed as replicable blueprints for broader urban transformation. The second approach incorporates Pan-City Projects, which leverage technology to deliver city-wide solutions. Complementing these core strategies are vital operational elements such as establishing a Special Purpose Vehicle (SPV) for seamless program execution, diversifying project funding sources, and ensuring robust citizen involvement.

1.2 Integrated control and command center

In order to effectively manage, monitor, and secure the city infrastructure and public services, it becomes incumbent to establish robust governance processes augmented by technology. Real-time oversight of critical infrastructure, such as parking facilities, transportation networks, and street lighting, facilitate, for example, in unhindered citizen mobility and foster informed decision-making. This capability is instrumental not only in the ongoing management of existing infrastructure but also in strategic future planning. Accordingly, under the Smart Cities Mission, Integrated Control and Command Center (ICCC) are set up to provide an agile integration approach, prioritizing the following components:

- An Integrated Platform designed for real-time urban operations, comprehensive collaborative decision support, and sophisticated simulation and optimization capabilities, serving as both an operational and enterprise knowledge nexus.
- A Unified Big Data Platform engineered to manage high-volume, high-velocity structured, semi-structured, and unstructured data.
- Provision for Real-time Situational Awareness alongside pre-engineered and extensible Standard Operating Procedures (SOPs).
- Integration of 2D/3D Locational Intelligence and Analytics, complete with time series analysis, to optimize Smart City Operations planning and management.
- A Pre-built Key Performance Indicator (KPI) Manager offering role-based, configurable, and customizable dashboards tailored for Smart City Operations.

In other words, the ICCC serves as the central coordinating entity for all essential civic functions and works as the brain and nerve center of a Smart City.

2. Paper objective

In the backdrop of the "Smart City Mission" that aims for comprehensive development of physical, institutional, social and economic infrastructure of cities to improve the quality of living and set in motion a virtuous cycle of growth and development, this paper explores the need for sustainability of the ICCC, which functions as the brain and nerve center of a Smart City**.** The paper underlines without sustained operation of the ICCC, the entire smart city eco-system would lose its central coordination and data-driven decision-making capabilities. A breakdown in functionality of the ICCC would directly compromise public service, citizen safety and security. The paper, hence, discusses the ways and means for sustaining the operation of the ICCC of the Smart Cities in India.

3. Study methodology

The study followed a multi-layered approach. A global literature review was carried out to identify best practices, challenges, governance models, funding mechanisms, and key technologies. The perspectives of urban bodies, technology providers, citizens, and others are captured through stakeholder interviews. Specifically, the methodology aligns sustainability of the ICCC with the Smart Cities Mission, reviewing mission objectives, implementation status, and frameworks. The methodology targeted to draw actionable insights that ensure long-term operational, financial, and technological viability of the ICCCs, enhancing their role in urban governance, service delivery, and citizen engagement.

4. Components of ICCC

ICCC is comprised of numerous essential components, which usually include:

a) Data Centre equipped with servers, storage, security, and network components.

b) Bigger Video Wall consisting of A 5 x 3 cube of 70" DLP Projection screens with related controllers for comprehensive visualization.

c) Citizen Engagement Platform featuring a chat box to facilitate citizen interaction.

d) One City One Mobile Application for a unified mobile application.

e) Smart Parking System that includes a mobile application for both departments and citizens.

f) Smart Water Management System, which comes with a mobile application for departments and citizens.

g) Intelligent Transit Management System (ITMS) along with mobile applications for transit.

h) Smart Environmental System.

i) Integrations with various third-party applications.

j) Enterprise GIS Software platform.

k) A Software Platform that incorporates an Enterprise Service (IoT and Middleware) for:

- Situational Awareness (Map-based/Video-based)
- Incident Management layer
- SOP (Standard Operating Procedure) Execution Layer
- Notification System
- Social media Integration and sentiment analysis

l) ICCC AI/Bigdata Platform that utilizes machine learning for predictive servicing.

m) Connectivity: between all integrated locations and the ICCC Data Centre.

In addition, operation & maintenance (O&M) of the ICCC generally includes a 5-year O&M period from the Go-Live date of the ICCC.

5. Working of ICCC

5.1 General

By integrating command and control, data visualization, and sensor integration technologies, it creates a Common Operating Picture that improves the capability and resiliency of agencies responsible for citizen safety, infrastructure protection, and relief activities.

5.2. An example of Thiruvanthapuram smart city

To quote an example, ICCC in Thiruvananthapuram, a city in Kerala, a province in South India, serves as the central hub for all online data and information related to various city services. This includes, but is not limited to:

- LED Street lighting
- CCTV surveillance cameras
- Air quality sensors
- Smart Parking system
- Wi-Fi
- Electricity and water SCADA and billing systems
- GIS data

- Electric and water meters
- e-hospitals
- Property tax management
- Estate management
- Engineering system
- Asset management system

The ICCC acts as a central monitoring and controlling center for city administrators. It significantly enhances the decision support system by providing various reports and analytics. These insights are generated from data collected through diverse sensors and the integration of existing software applications. The analytics highlight actionable items, enabling city officials to make informed and timely decisions.

The ICCC offers city administrators a centralized platform to manage citizen grievances, incidents, and feedback, fostering efficient and transparent interactions with residents. At its core, the solution seamlessly integrates various citizen touch points. The One-City Mobile application directly feeds citizen-raised tickets into the Citizen Engagement Platform (CEP) dashboard, ensuring immediate visibility. Additionally, the Contact Centre Solution is fully integrated with the CEP, providing citizens multiple channels, including a configured toll-free number staffed by ICCC operators, to raise tickets or provide feedback, accommodating their preferred communication methods.

The CEP features a sophisticated ticket resolution mechanism designed to address all submitted tickets within stipulated time frame. To ensure comprehensive grievance redressal, an escalation matrix is embedded within the system. This guarantees that if first-level helpdesk staff cannot resolve an issue, the grievance is systematically escalated to appropriate higher authorities.Operational support for the ICCC is generally provided by dedicated helpdesk staff from the O&M contractor, supplemented by personnel from respective city departments and ward representatives.

6. Key features of the citizen engagement platform

The key features of citizen engagement platform consist of:

a) **Web-Based Citizen Portal:** A dedicated web application for citizens to submit grievances and interact directly with city administrators on various civic matters.

b) **SLA-Driven Grievance Redressal:** A robust mechanism for addressing grievances, incidents, issues, and problems related to citizen services, all underpinned by predefined Service Level Agreements (SLAs).

c) **Multi-Channel Citizen Access:** Diverse channels for citizen engagement, including toll-free lines, landlines, specialized helpdesk tools, email, and direct walk-in facilities.

d) **Structured Call Logging System:** A comprehensive system that assigns incident/call ID numbers and categorizes severity levels in strict adherence to predefined SLAs for citizen service-related calls

e) **End-to-End Incident Tracking:** Meticulous tracking capabilities for each incident or call from initiation to final resolution.

f) **Tiered Service Provision:** Initial self-service options like chat or Interactive Voice Response (IVR), with seamless transfer to a live agent upon citizen demand.

g) **Automated Escalation Protocol:** An embedded escalation matrix to ensure calls are escalated to appropriate levels as required, based on pre-agreed protocols with authorities.
h) **Analytical Reporting:** Generation of monthly reports covering incident/call statistics, including:

- Type of incidents/calls logged
- Incidents/calls resolved
- Incidents/calls open
- Performance metrics for wards
- Ratings of all wards

i)**Knowledge Management:** Capability to upload and manage Frequently Asked Questions (FAQs) and their corresponding solutions within the platform.
j)**ICCC Integration for Data Analytics:** Seamless integration with the ICCC to generate analytical reports, identifying areas for improvement and highlighting wards needing specific attention or intervention.

To address the challenges of cleanliness and heritage preservation in case of a hypothetical "Heritage City X," a tailored Citizen Engagement Platform (CEP) would offer specific features and implementation steps to enhance the city's tourism experience and protect its historical infrastructure.

7. **Ensuring sustainability of the ICCCs**

To maintain the long-term functionality and relevance of the ICCCs, a well-rounded and strategic approach is essential. This involves addressing several key areas, outlined below.

a) Financial Sustainability

To ensure the ICCC's financial stability and growth, the following strategies are critical:

- **Diversify Funding Sources**: Move beyond reliance on government funding by attracting private sector investments, monetizing smart services (e.g., charging for data access or premium services), and forming strategic partnerships with businesses that benefit from the ICCC data.
- **Optimize Operational Costs**: Lower expenses by implementing energy-efficient technologies, phasing out redundant systems, and simplifying processes in line with the goals of the Smart Cities Mission.
- **Adopt Revenue-Sharing Models**: Create frameworks for sharing revenue with key stakeholders—such as municipal bodies or private partners—who gain value from the outputs of the ICCC.

It may be cited that cities like Rajkot, Surat, Vadodara, and Gandhinagar in Gujarat, a province in western part of India, is exploring revenue sharing from traffic fines to fund their ICCCs. Some cities are adopting models such as Public-Private Partnership, infrastructure monetization, and smart traffic systems. These efforts aim to ensure sustainability of the ICCC through diverse, innovative revenue streams.

b) Technological Advancement

Keeping the ICCC at the forefront of innovation requires continued investment in technology. Key focus areas include:

- **Infrastructure Modernization**: Regularly upgrade hardware, software, and communication systems, with an emphasis on cloud computing, advanced analytics platforms, and strong cyber security frameworks.
- **Enhanced Data Capabilities**: Equip the ICCC with advanced tools to integrate and analyze data from various city services, enabling real-time responses and predictive insights.
- **Leverage AI and Machine Learning**: Utilize AI and ML to automate processes, enhance forecasting accuracy, and allocate resources more efficiently.
- **Strengthen Cyber Security**: Implement robust cyber security protocols to protect sensitive data and infrastructure, particularly as digital operations expand.
- **Ensure Operational Continuity**: Prepare for disruptions through comprehensive disaster recovery and business continuity planning.
- **Foster Innovation through Collaboration**: Engage in partnerships with other cities and organizations to share insights, best practices, and access to emerging technologies.

An example in this context are Smart Cities like Pune and Surat, which are using IoT sensors, AI, and predictive analytics to revolutionize water management. This technology monitors flow, pressure, and detects leaks in real-time, optimizing pumping schedules and conserving water. The ICCCs unify data from various city services, enhancing efficiency, reducing energy consumption, and ensuring equitable water distribution, thus significantly contributing to urban sustainability and a lower carbon footprint.

c) Operational Efficiency

For smooth and effective operations, the ICCC must focus on:

- **Process Optimization**: Identify and eliminate inefficiencies such as duplicate data entry or delayed responses, with an emphasis on automation where feasible.
- **Capacity Building**: Continuously up-skill the ICCC personnel to ensure they are equipped to manage evolving technologies and complex urban challenges.
- **Inter-departmental Collaboration**: Encourage seamless communication and data sharing between the ICCC and other municipal departments to enhance coordination and resource utilization.

The ICCC of Bhopal Smart City has boosted operational efficiency through smart lighting. By integrating IoT-enabled LED streetlights, the ICCC remotely dims and optimizes lighting based on traffic and activity, especially during off-peak hours. This initiative has led to a 30-40% reduction in energy consumption and a lower carbon footprint. Real-time data analytics improves maintenance and minimizes downtime, generating cost savings that are reinvested into further sustainability projects.

d) Public Engagement

- **Involve Citizens**: Actively engage residents in the planning and operation of the ICCC. This not only builds trust but also ensures the solutions developed are responsive to community needs.

The ICCC of Bhopal Smart City enhanced citizen engagement through several initiatives. A public dashboard offered real-time data on urban services, fostering transparency and

trust. The "Bhopal Plus" mobile app enabled citizens to report issues, ensuring prompt resolution. Hackathons and outreach programs engaged youth in developing innovative, sustainable solutions. Finally, the ICCC data facilitated citizen participation in urban planning, making decisions more inclusive and responsive to public concerns.

8. Conclusion

While the ICCCs are designed to enhance urban management, disaster response, and citizen services, their long-term effectiveness and success in achieving their intended goals hinges critically on a robust sustainability strategy. In other words, long-term impact of the ICCCs relies on their ability to stay functional, current, and responsive to changing needs. Without a solid framework for financial sustainability, capacity enhancement, and adaptability, the ICCCs run risk of becoming underused assets—falling short of the vision for smart governance and efficient service delivery.

Smart city infrastructure, including ICCCs, involves significant initial investment. Ensuring their sustainable functioning is crucial to realize the long-term benefits and achieve a positive return on this investment. Without proper operational and maintenance plans, these expensive systems can become "white elephants. The challenges that still daunt the long-term functionality of the ICCCs are:

- **Financial Sustainability:** A primary challenge is securing adequate and consistent funding for ICCCs, as they currently lack direct revenue streams.
- **Over-reliance on Original Equipment Manufacturers (OEMs):** There is a challenge in reducing dependence on external vendors for technical expertise. This leads to a lack of in-house capacity.
- **Lack of Inter-Departmental Coordination:** Overcoming departmental silos is a major hurdle, as it hinders seamless collaboration and data sharing.
- **Data Localization & Security:** Ensuring that the ICCC data practices comply with data protection laws and safeguarding citizen privacy presents a significant challenge.
- **Hardware Security:** Protecting field hardware from vandalism and theft is an ongoing challenge, requiring robust installation and response mechanisms.
- **Scalability:** Adapting successful ICCC models to smaller cities with limited resources poses a substantial challenge for broader implementation.

Sustainability, therefore, must be seen not as a secondary concern but as a core element of successful deployment of the ICCCs. This requires not just initial investment but ongoing resource allocation for maintenance, technological upgrades, and personnel training. In essence, the sustainable functioning of the ICCC is about safeguarding the core functionalities, services, and vision of a smart city, ensuring it remains liveable, efficient, resilient, and responsive to the needs of its citizens in the long run.

This paper provides a platform for researchers for a robust study to identify actionable strategies for the long-term sustainability of the ICCCs of India's Smart Cities.