ASSOCHAM
INDIA

Safe cities architecture for India

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Foreword

Safety and security are perhaps the most influencing factors while choosing your place of residence or place of work. However, in India, as population and gross domestic product (GDP) continue to rise as a result of urbanisation, increased population is leading to anonymity, and fighting crime is becoming more complex. Criminals are becoming more organised and sophisticated, and are operating with little regard to national and international boundaries.

The National Crime Records Bureau statistics of 2012 clearly reflect that there has been a tremendous increase (296.6% since 1953 and 2.6% over 2011) in cognisable offences such as rape, murder, kidnapping, etc. Cases of rape alone have increased nine times over the last 40 years, followed by while instances of kidnap and murder have increased by eight and 2.5 times respectively in the last 60 years. In spite of several security initiatives implemented by the government of India, there still have been events that accentuate the need for immediate security strategies such as surveillance and analytics to enable a safe city environment and safeguard key public infrastructure.

Governance, planning, technology, resources and awareness form the most important dimensions of a security strategy and it gives us immense pleasure to present this report that highlights the challenges associated with security in the Indian context. Real reduction in crime will be attained, firstly, through more effective and efficient governance and, secondly, through a greater ability to prevent crime. With this background, we have attempted to profile and analyse the current security scenario in India, with respect to its stakeholders, emerging technologies, opportunities, challenges and prospects. Our initiative is an attempt to leverage partnerships and technology to aid the community and reduce insecurities in order to create an environment conducive for growth and development.

I am grateful to the participating domain experts for their valuable time and for sharing their thoughts and strategies with us. Our ability to counter security challenges and the elements of security that create a safe and secure environment will decide the momentum of India's growth.

We hope you find this report insightful and useful and look forward to your feedback.

Neel Ratan
Leader, Government and Public Sector
PwC India

Message

It gives me immense pleasure to announce the 4th National Conference on Homeland Security. The theme for this year's conference is A Safe City: Architecture for India.

The Prime Minister's concept of smart policing has been widely appreciated by the industry as we believe that our nation's homeland security needs to be significantly improved and further modernised to face the emerging threats in the current scenario.

I am happy to inform you that the ASSOCHAM and PwC have worked in unison to bring out this background paper on the safe city concept, outlining the critical role to be played by different stakeholders to ensure a safe and conducive environment for the safety, growth and development of trade, industry and personnel engaged. ASSOCHAM's Council on Homeland Security, under the Chairmanship of Padma Shri DR Kaarthikeyan, IPS (Retd.), Former Director, CBI, with the active support from the police, defence ministry and friends from other state and private agencies and private security establishments, have contributed greatly in making this conference a great success.

 I thank our knowledge partner, PwC, along with the ASSOCHAM team for preparing this paper for the conference and convey my good wishes for the success of this conference.

D S Rawat
Secretary General
The Associated Chamber of Commerce and Industry of India

Context

Introduction

Increased security requirements and focus on public safety have necessitated designers to chalk out a comprehensive surveillance design for cities. Any city design has to ensure safety of its citizens, organisations and institutions against threats to their well-being as well as the traditional functions of law and order. With more than half the global population today living in urban areas, a safe city is increasingly being considered essential in ensuring secure living and prosperity. The basic principles of good governance must find a direct application in any urban safety strategy, aimed at reducing and preventing common problems of crime and insecurity.

The United Nations, through its Habitat Agenda on Human Settlements (Habitat II, 1996), which was adopted at the Istanbul Conference, initiated a series of approaches and strategies to effectively reduce and eradicate violence and crime within the cities. The aim of the UN-Habitat Safer Cities programme is to reinforce personal safety and reduce fear by improving safety services and accountability to the community.
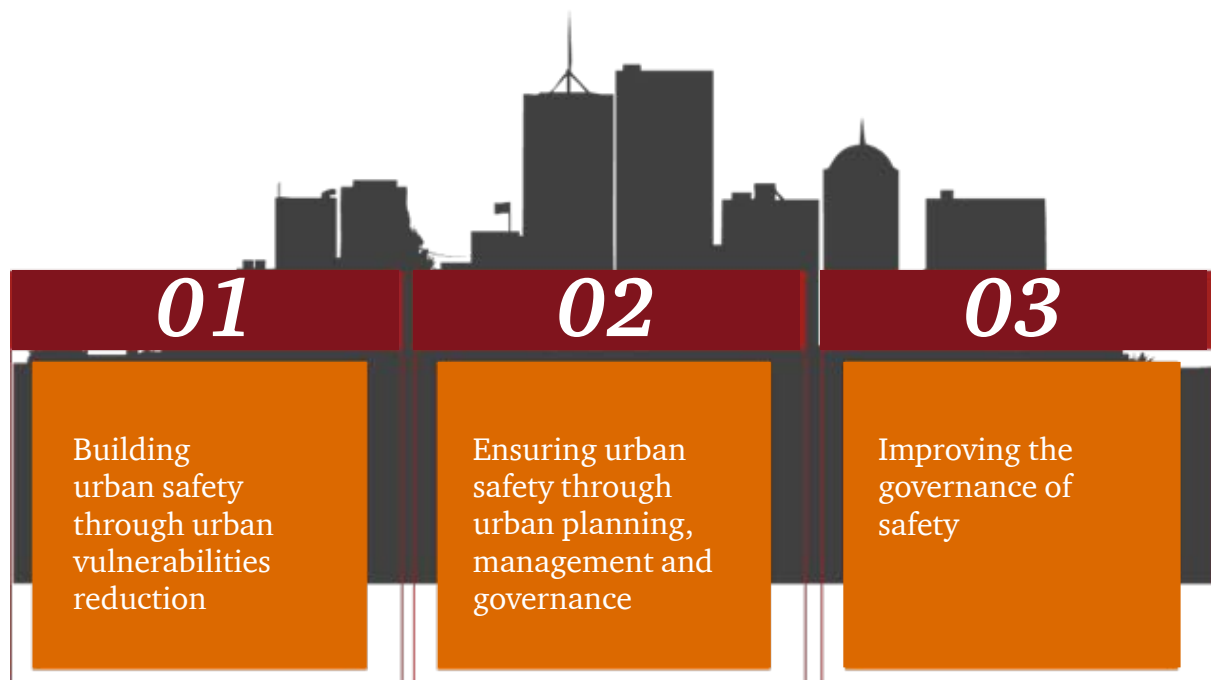
The Safer Cities programme has the following building blocks:

- **Building urban safety through urban vulnerabilities reduction**: The UN Safer Cities programme defines vulnerability as the probability of an individual, a household or a community falling below a minimum level of welfare (the poverty line) or the probability of suffering physical and socio-economic consequences (homeless or physical injury) as a result of risky events and processes (forced eviction, crime or floods). Paying special attention to urban vulnerabilities and violence shall reduce the probability of crime and ensure a secure and safe urban environment.

- **Ensuring urban safety through urban planning, management and governance**: Sustainable urbanisation by emphasising inclusive as well as participatory urban planning, and local development practices, incorporates policy making and strategy development. This, in turn, promotes institutional and organisational development, resource planning and management in order to enhance efficiency in governance.

- **Improving the governance of safety**: Enhancing urban safety and social cohesion are issues of good urban governance. They intend to create a city where safety is improved for its citizens and neighbourhoods, where there is fearless interaction among people and groups. These are prudent aspects of good governance, which create an enabling environment for the inhabitants of the city, allowing improved quality of life and fostering economic development.

01

Building urban safety through urban vulnerabilities reduction

02

Ensuring urban safety through urban planning, management and governance

03

Improving the governance of safety

Components

Safe city solutions incorporate a wide array of technology-driven sub-systems. Integration and interoperability of these sub-systems is fundamental in obtaining better intelligence from various sources and sensors. From CCTVs to crisis management centres, technology will enable law enforcement, emergency services and local decision-makers. This will help optimise their response to the expected as well as unexpected. The following are the components that form the basis of the safe city architecture:

#1

Surveillance equipment

#2

Network connectivity

#3

Data centre (servers, storage and applications)

#4

Command viewing centres

#5

Collaborative monitoring

#6

Change management, capacity-building and help desk

Surveillance system and equipment

The goal of any safe city programme is to provide officers and first responders with a shared security presence and an enhanced awareness through a system equipped with video surveillance cameras. The network of cameras collects data in the form of images or videos that are required to detect risks and respond to an emergency situation. The CCTV camera technology has evolved over time, starting out as 100% analogue systems, they have gradually started becoming digitised. Network cameras and PC servers are now used for video recording in a fully digitised system.

IP cameras

An IP camera combines a camera and image processing into one unit that includes the digitisation and compression of the video, as well as a network connector. The video is transported over an IP-based network through switches and recorded to a standard digital storage system with video management software. Some typical cameras used in surveillance systems are fixed cameras, fixed dome, PTZ, IR and thermal imaging cameras.

Video analytics

The video analytics (VA) capability of a surveillance system determines its effectiveness and efficiency. VA, also known as intelligent video surveillance, is a technology that uses software to automatically identify specific objects, behaviours or attitudes in video footage (for example, from CCTV systems). There are extensive powerful video analysis methods and tools that are deployed in a number of application domains, including surveillance and security applications. VA like motion detection, trip wires, object removal or abandonment, facial recognition, licence plate recognition, etc enables video surveillance to become a proactive monitoring tool that signals the need for immediate intervention

by guards, police, or other security personnel. A video surveillance based safe city shall include the above mentioned video analytics tools along with other equipment to support the detection of gun shots, fire alerts, unclaimed object alert and crowding alert.

Data centre

Data centres are the heart of the surveillance based safe city projects. The data centre acts as a warehouse for the data collected from the surveillance sensors. It is also responsible for providing continuous, real-time data to command viewing centres for seamless, efficient and effective operations. Generally, a primary and a secondary data centre are established in order to ensure that operations remain uninterrupted even if one is down. This centre hosts all applications that are required by agencies to operate systems such as the video management software and the analytics application (VMS, VA), automatic number plate recognition application (ANPR) and the automatic vehicle classification. Appropriate space is provided for storage as well as retrieval of the digital information captured by the system. The design of a data centre for a safe city primarily depends on the type of operations that are envisaged by the security agency in a safe city project and the type of processing required on these feeds: indexing, matching in DB, pattern analysis, GIS mapping, video analytics, facial recognition, etc.

Command viewing centres

A command viewing centre (CVC) is an infrastructure that accesses the integrated information available at the data centre such as incident video feeds. CVC allows the collation of information, thus helping in the analysis of data for quicker decision-making. CVCs will be equipped with intelligent operations capability so as to ensure integrated data visualisation, real-time collaboration and deep analytics that can

help agencies prepare for problems, coordinate and manage response efforts, as well as enhance the ongoing efficiency of city operations. The GUI available at the CVC will equip users to take decisions by using the real-time and unified view of operations. Cities can rapidly share information across agency lines to accelerate problem response and improve project coordination.

A CVC assists in leveraging information available with all the city agencies, thus allowing the management to make efficient and informed decisions. Furthermore, the centre helps in anticipating the challenges and minimising the impact of disruptions.

A CVC will provide a citywide GUI for visually depicting the video feeds and other sensor data. The GUI will also provide an overall status of various city operations and its functions.

The drill-down capability of such a dashboard will allow operational users and decision-makers to explore the underlying detailed status information to a depth relevant to their role. The viewing centre will have a GIS map of the city giving the status of the area of interest to the agency. Multiple map layers may depict equipment or other assets, events, weather, positions of resources available to the city operations or boundaries of designated areas. Cross-agency collaboration supports messaging between operators at the control centre, response units at the incident sites and other agencies, with the aim of reducing the response time, sharing information effectively and enabling collaborative decision making in a controlled and assured environment. It will comprise of a set of tools such as emergency call response systems and call dispatch systems so as to support immediate communication between all users and supporting agencies.

Incident management capability is achieved through tools that assist in detection and management of incidents. These tools enable commanders as well as the executive staff to actively manage all security aspects of the city since they provide real-time information of incident detection, incident correlation as well as incident response. All capabilities of the CVC put together (the user interface, the GIS maps,

the integration of application data, advanced analytics and incident management) provide the shared situational awareness required to enable the city operations staff and supporting agencies to synchronise and prioritise. The operator will be trained and provided with the standard operating procedures for responses to such incidents and emergency situations for effective crisis management. The control centre will be designed to enable all back office operations, which will be closely integrated with the command and control centre operations.

Collaborative monitoring

A key enabler for a safe city is the aspect of collaborative monitoring. In Indian cities, where every government and private establishment, has realised the necessity to secure its infrastructure and establish surveillance, monitoring and incident response systems, it is important that the data gathered by these agencies is shared among them. Government agencies such as the aviation and transport department are already deploying on-board surveillance systems by provisioning CCTV-based surveillance on public buses and bus stands, metros, railway stations and airports. These systems under collaborative monitoring can conveniently share their data in real-time with security agencies of the city. Similarly, live feeds from CCTV systems deployed by private establishments such as malls, business parks and entertainment houses can be provided to the CVC of the city where the security agency can make effective use of the information. Many cities across the world have surveillance systems deployed by multiple public and private establishments. These cities are using the collaborative framework to receive video feeds from these systems to ensure real-time responses.

Change management

It is crucial that change management and capacity building programmes form an integral part of the safe city project. These initiatives will acquaint stakeholders to the proposed system and its associated processes. Furthermore, it will motivate, train and empower security agency officials to adopt revised methods of working and appreciate the resultant benefits.

Change management will keep every stakeholder informed about the changes in the process flow and information management systems. It will empower officials with the necessary skill and attitude in order to facilitate them in performing their duties in a more effective manner.

Capacity building

It is prudent to build the capacities of the departmental officials who are involved in the operations and decision-making, by disseminating the necessary knowledge and skills for smooth implementation of the envisaged processes. It is equally important to generate an attitude that is receptive to a technology-based delivery of services. Merely developing, redefining processes and implementing technology will deliver the quality of services envisaged. The concerned officials have to learn to operate the redesigned services, and efficiently deliver the desired outputs.

Help desk

As part of facilities management for the CVC, organisations may need to have dedicated manpower to troubleshoot and solve issues. This is what is termed as a centralised help desk, which should ideally be located near the command centre. This help desk shall be the single point of contact for complaint management and resolution for all users of the surveillance system. It needs to be integrated with the enterprise management system.
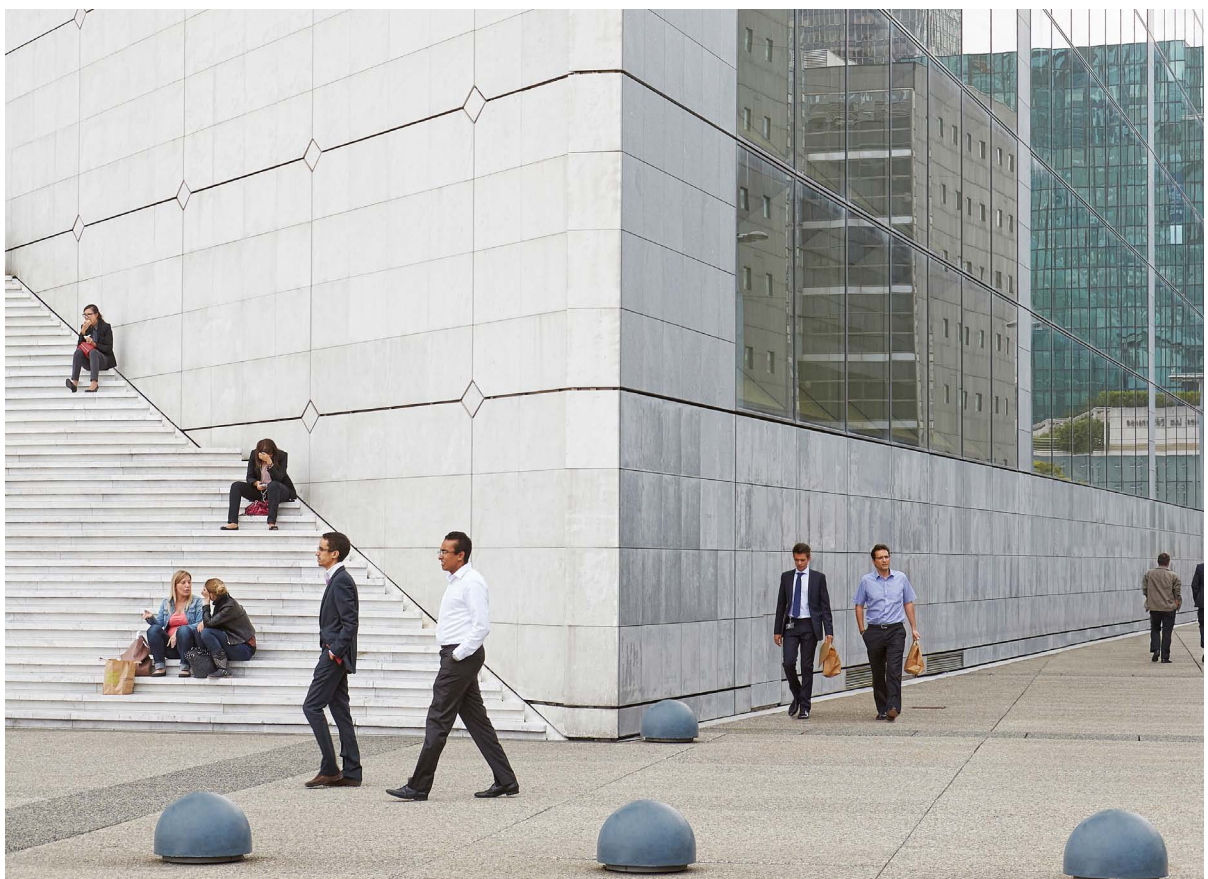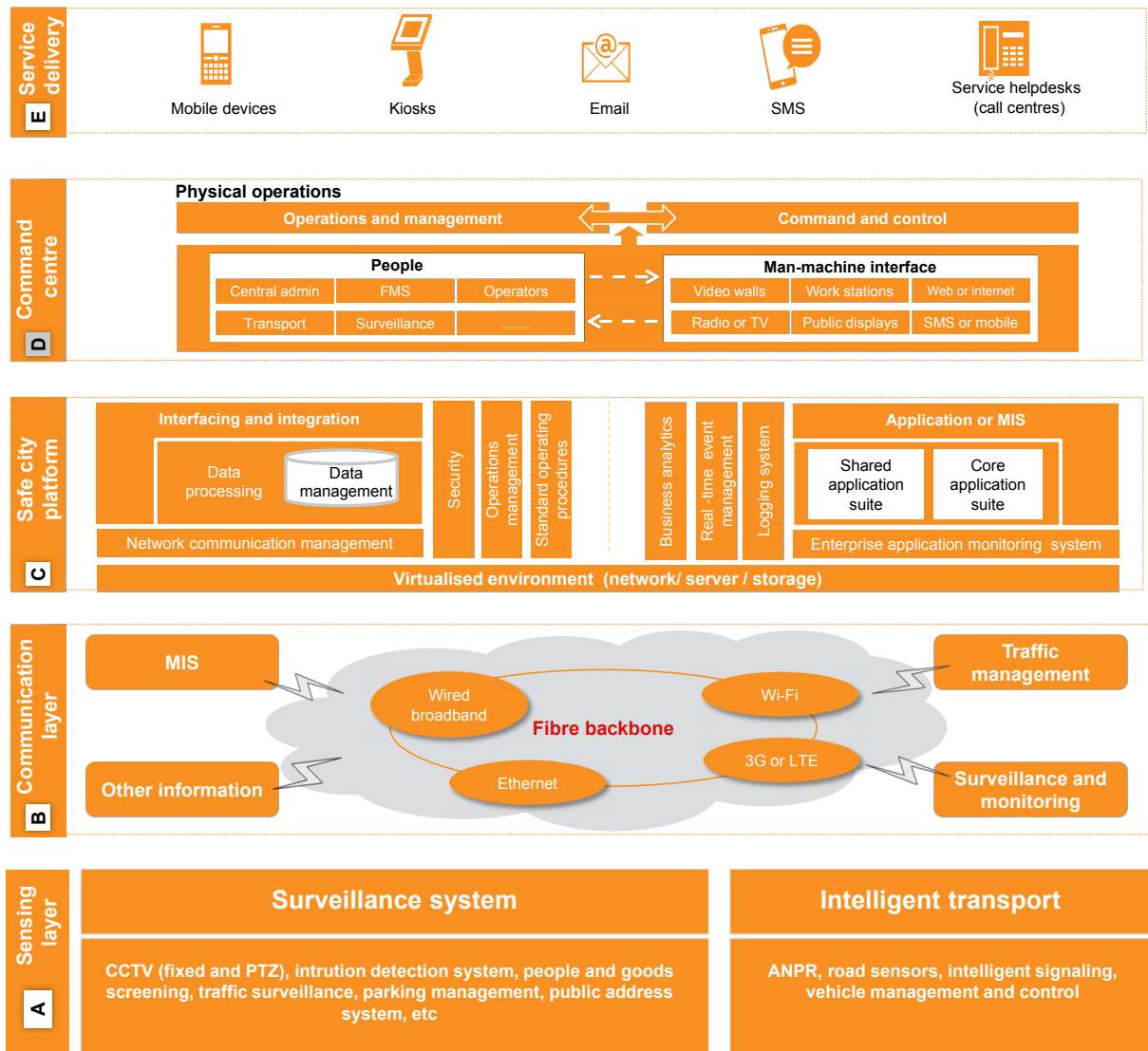
Architecture

Safe city architecture

Any ICT architecture, for an existing or greenfield city, needs to aim at achieving the following objectives:

- Enabling law enforcement agencies and citizens to benefit from the future of connectivity for assuring public safety
- Enabling citizens to benefit from the upcoming initiatives or digital governance and management
- Integrating the existing public security systems with the deployed elements and infrastructures and extend this implementation to citizens for creating effective awareness
- Involving key users and public authorities at the local, regional and national levels from the very beginning of the safe city design
- Overcoming regulatory and policy issues such as interoperability, openness, standards, data security and privacy

Safe city architecture needs to aim at making the public safety service infrastructure better integrated and networked for seamless sharing of data and information. This will assist public safety organisations (the police, municipal bodies, etc) in collecting, sharing and analysing data more effectively in order to make real-time decisions while planning and responding to incidents and emergencies. The model architecture for any such city will have to deal with different virtual layers that will work as an integrated system. In addition, the city service delivery channels will act as touch points for citizens to receive and exchange information. This layer will be supported on a central integrated command centre, which will carry out the activities of command and control for the city machinery. The safe city platform will enable the integration of various applications, data and the IT infrastructure required to support such a setup. This layer will thrive on a wide network and a layer of sensors distributed around the entire city for providing input data to processing units in higher levels and actuators, comprised of phones, traffic panels, CCTV cameras etc that receive commands from processing units.

E. Service delivery

| Mobile devices | Kiosks | Email | SMS | Service helpdesks (call centres) |

D. Command centre

Physical operations

| Operations and management | ⟷ | Command and control |

People

| Central admin | FMS | Operators |
| Transport | Surveillance | .... |

Man-machine interface

| Video walls | Work stations | Web or internet |
| Radio or TV | Public displays | SMS or mobile |

C. Safe city platform

Interfacing and integration

| Data processing | Data management |

Security
Operations management
Standard operating procedures

Business analytics
Real-time event management
Logging system

Application or MIS

| Shared application suite | Core application suite |

Network communication management

Enterprise application monitoring system

Virtualised environment (network/ server / storage)

B. Communication layer

MIS

Wired broadband

Wi-Fi

Fibre backbone

Ethernet

3G or LTE

Traffic management

Other information

Surveillance and monitoring

A. Sensing layer

| **Surveillance system** | **Intelligent transport** |

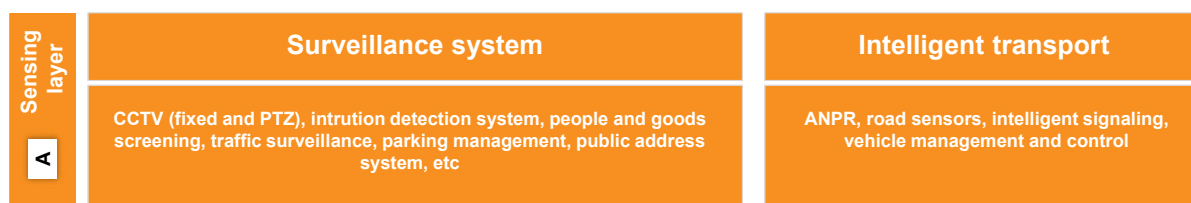| **CCTV (fixed and PTZ), intrution detection system, people and goods screening, traffic surveillance, parking management, public address system, etc** | **ANPR, road sensors, intelligent signaling, vehicle management and control** |

Sensing layer

Role

By placing various types of sensors, we can monitor the environment, collect information and upload the data. A common sensing layer can integrate and provide access to various types of sensors.

- The on-field sensor network is akin to the sensory system within a human body, which helps us with the following:
  - Visualise, sense and assess situations
  - Relay situational awareness to the control centre (brain)
  - Perform automated or informed actions based incidents
- A massive volume of information is generated from a variety of different sensors and is forwarded to the command and control centres and human operators to take necessary actions based on standard procedures or custom commands.

The sensing layer is categorised further on the basis of its functionalities as depicted in below diagram and explained further.

Sensing layer	Surveillance system	Intelligent transport
A	CCTV (fixed and PTZ), intrution detection system, people and goods screening, traffic surveillance, parking management, public address system, etc	ANPR, road sensors, intelligent signaling, vehicle management and control

Desired functionalities

• Surveillance system

The surveillance system sensors form the key component in the sensing layer of a safe city project, which enables real-time surveillance by gathering information on public assets, government buildings, traffic and assist in crime detection.

It integrates public as well as private video surveillance resources to provide live video surveillance, historical query recording and accurate intelligent analysis services. When connected to the command and dispatch system, the system enables quick incident response and helps protect public security. It monitors the growing threat from crime and terrorism and helps in ensuring public safety and manages smooth traffic operations.

The video surveillance needs to be flexible, scalable and future-proof, with the capability of easily expanding to accommodate the ever-changing urban environment of the safe city. The system supports crime investigation services, citizen assistance platform, emergency helpline and coordinated response, early warning and disaster-response simulation modelling. The system leverages centralised video management and quick video indexing to facilitate accurate video location, video association, case analysis, information sharing and collaborative response.

The centralised management solution supports video storage, video stream forwarding, image recognition, feature extraction, video diagnosis, and facial detection and recognition.

• Intelligent transport management

The intelligent transport management system provides a sophisticated system for collecting and analysing real-time transportation data in order to improve system efficiency and provide insights for generating services that cater to the requirements of the citizens, and develop a more sustainable transportation system that integrates land use, economic development and transportation planning. The system includes the following components:
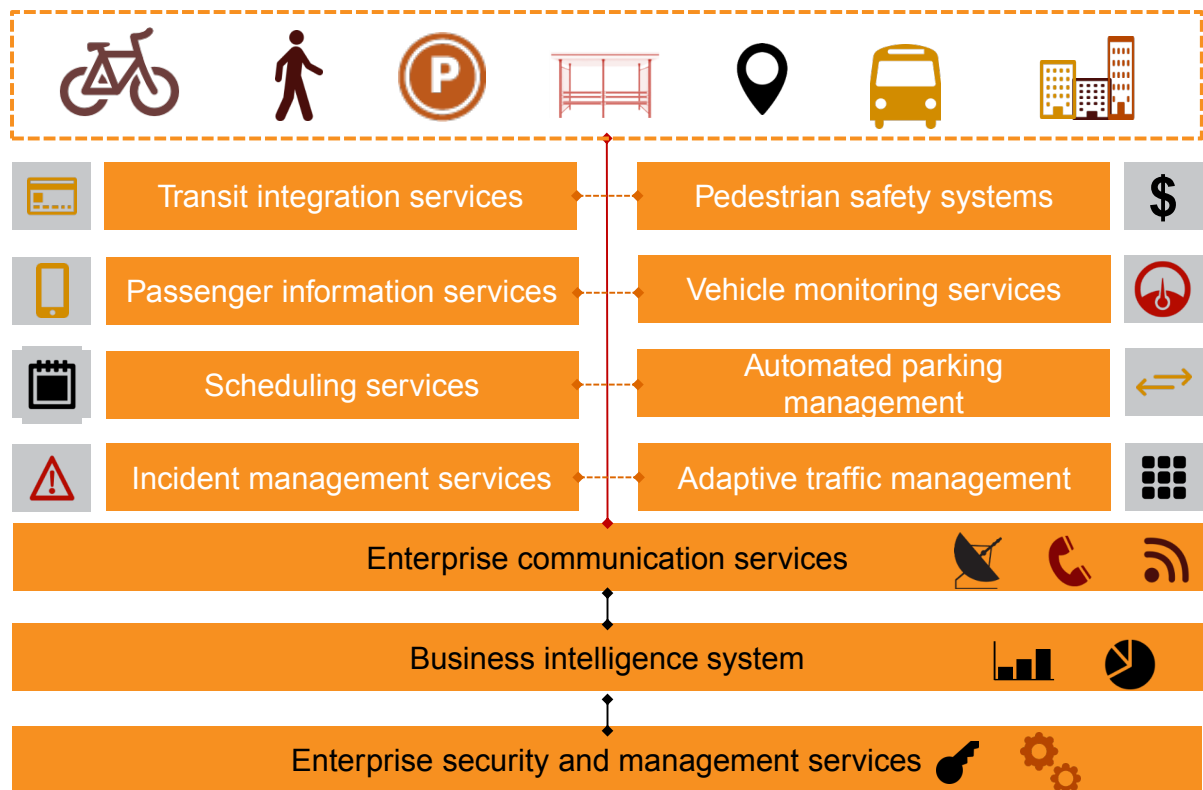
- Automatic signalling system
- Integrated signalling system for the pedestrian and non-motorised transport
- Cameras for enforcement of traffic rules
- Integration of traffic signal system of the entire city
- Integration of ITS for BRTS
- Smart travel cards

The above systems play a major role in transport management through traffic-volume detection and auto-synchronisation of traffic signalling systems, which help to manage traffic flows and provide advice regarding to traffic congestion. It helps in increasing peak capacity and smoothening traffic flows on busy roads. Further, it assists in detection of traffic-rule violation and enforcement of speed and traffic rules and laws. The ANPR system uses optical character recognition on images to read vehicle registration plates, using the existing CCTV or specific road-rule enforcement cameras or ANPR cameras (which are specifically designed for the task). This can be used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloguing the movements of traffic or individuals.

The below diagram depicts typical functionalities of an intelligent integrated transport management system.

Transit integration services	Pedestrian safety systems
Passenger information services	Vehicle monitoring services
Scheduling services	Automated parking management
Incident management services	Adaptive traffic management

Enterprise communication services

Business intelligence system

Enterprise security and management services

The various high-level components of an intelligent transport management system are as follows:

- Surveillance cameras: For incident detection and monitoring all directions of a junction
- Enforcement cameras: Categorised into the following two broad requirements:
  - Speed detection: This is supported by magnetic or virtual loops to identify over-speeding and capture the violating vehicle details as an image using ANPR application or camera.
  - Signal jumping detection: It captures signal jumping by a vehicle and captures the details of the violating vehicle as image.
- Automated signalling system: This is used to manage signals from either a central location after viewing the feeds of cameras or data from sensors, or using a localised area traffic controller.

- Variable messaging system: Real-time information dissemination is the key to sound traffic management. VMS is a tool that helps in displaying critical messages to commuters.

Communication layer

In most critical or disaster scenarios, civilian wireless communications infrastructure collapses because of overuse, destruction or jamming. The provision of an independent and secure communications system infrastructure is essential for the success of the first-responder efforts.

Role

- This is akin to the nervous system in the human body, which acts as a medium for message carrier.
- For safe cities, the communication layer will provide a connecting medium between sensor layers, data and command centres.

- Adoption of the most appropriate communication technologies for seamless provision of a wide variety of services within a safe city.
- A plethora of network devices interact to provide safe, convenient and environmentally conscious services.
- Ad-hoc networking allows for communication to and from the sensors in cases where no communication infrastructure exists.
- The 4G network provides fast transmission of data and video between responder's teams on the move (sensing layer) and with central command centre, allowing video and data information sharing among mobile units for better monitoring of the situation on the ground and in the air.
- Identification of Wi-Fi service zones (clusters) for Wi-Fi access point
  - Public places (railway stations, airports, bus stops, markets, malls, etc)
  - Government offices
  - Any other areas

The different types of communication network for safe city application are depicted in below diagram.
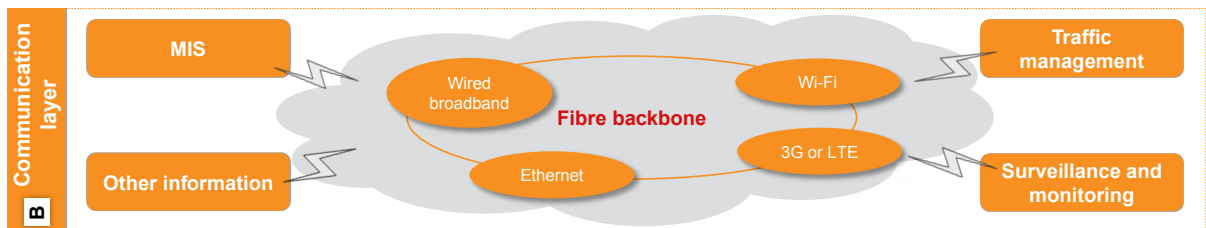
Desired functionalities

- Overlay area network (OAN) with optical fibre connectivity coupled with a 3G or 4G network to provide various connectivity options enabling ad-hoc communications between mobile responders and central command centre.
- Large-bandwidth and highly reliable network connection so as to ensure timely and efficient transmission of live video surveillance data
- Central management of Wi-Fi access point using Wi-Fi controller
- High-speed broadband access that ensures long-term smooth backhaul for HD video using LTE and microwave networking
- LTE and hybrid energy supplies that adapt to adverse environments and eliminate surveillance blind spots
- Support for point-to-multipoint (P2PM) and non-line of sight (NLOS)
  - Microwave for high bandwidth, multiple frequency spectra, and long-distance backhaul
  - User authentication, authorisation and accounting (AAA)
- Identify usage models (charged, partially free and partially charged, etc)
- Creation of wireless sensor network to automatically monitor and detect changes in the status of public infrastructure to ensure the quick and appropriate provision of services.

Safe city platform

The safe city platform provides all the necessary ingredients to establish a city network for making the cities better for their residents. Starting with the traditional city service and operations, the citizen empowerment and sustainable city capabilities of the platform are the basis of further innovation and are aimed to ignite collaborative creativity of the cities as well as the residents. It supports the notion that the governments and citizens share a joint responsibility in shaping the city of the future.
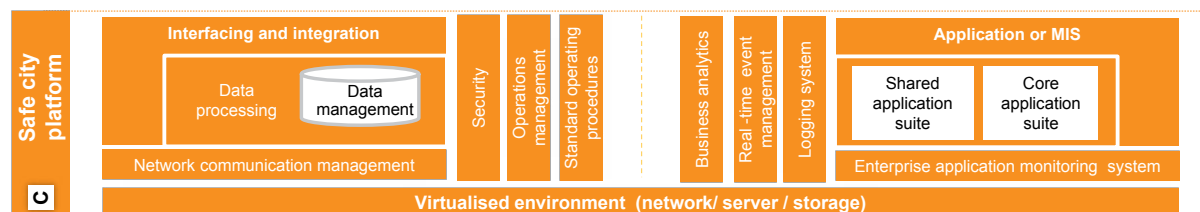
A safe city is able to:

- Benefit from state-of-the-art developments, citizens, SMEs and other actors from across the country rather than just from within a city
- Contribute to a multi-national service-oriented ecosystem by providing and sharing open business processes as services with other cities
- Leverage a service infrastructure that is capable of delivering 'one stop governance' through the integration of services, interoperability of systems and use of actionable intelligence in service delivery

This platform is built on three fundamental architecture principles:

- **Modularisation of architectural components**: Multi-purpose components that can be extended as necessary

- **Regularisation of system data**: The design derives from standardising and normalising data from participating services as well as sub-systems and provides a standard format and interface that allows administrators to define their respective ends
- **Standardisation of common functions**: Doing similar things in an integrated fashion

A typical safe city platform with various layers and blocks that enable the system to cater to various smart city functionalities has been represented in the adajacent diagram. City sensors or components can be integrated with the safe city platform and a safe city design can hence be extended to a smart city system.

Triggers

Government users/ agencies Residents Other agencies

Command and control centre

7

Domain specific integration gateway **8**

Portal layer **4**

9 Security layer

6

3 Application and integration layer

Alert or notification system Incident management system Messaging

Core business applications Enabling applications

Identity management or SSO

2 Analytical and reporting layer

e-Services Asset management Payment gateway Process management

Real-time analytics Reactive analytics

5 Enterprise service bus

Land an estate management Adaptive traffic Content management Mobile or SMS gateway

Application security

Dashboarding and reporting Forecasting

Database security

Risk modeling or simulation Text, video, geospatial analytics

ANPR Video recognition system EMS, NMS Event detection, processing

Network security

Enterprise service bus

1 Data layer

Master data (resident, service) Data from devices or sensors Transactional data Data warehouse Unstructured content (Videos, images, SM Feed,etc) Geo-spatial data

Command centre

The command centre is based on decision-making capabilities which enable the system to perform an intelligent enrichment of data from multiple concurrent and/or correlated information sources (surveillance cameras, ANPR cameras, road sensors) and provide the safety operators with efficient real-time understanding of situations. Advanced visualisation capabilities are also targeted and CCTV operators have access to regularly updated city crime and traffic incidents maps, automated 3D video tracking of suspects and the possibility to create associated metadata to the video in real-time as well as access memory repositories of past events whenever needed.

The command centre supports dynamic alarming, HD video recording, voice control, and cooperation with other systems, which enable pre-event prediction and warning, intra-event surveillance and command as well as post-event retrospective analysis and evaluation.

Role
The command centre collects data from throughout the field and turns it into actionable information by routing it to the resource best suited to handle that size and type of incident.

- The integrated command and control centre is akin to the human brain in:
  - Processing data or information coming in from multiple sensor systems
  - Guiding a sensor or control point to act in a desired manner so as to address incidents in the most optimal way
  - Collecting, collating, co-relating and analysing data to enhance experience for improving future incidental response
- It provides high-speed image processing enabling centralised management of multiple signals through digital information display (DID) and digital light processing (DLP) screen splicing technologies.
- It enables visual dispatching and real-time onsite information control, thus improving the incident response time.
- The open platform is used to integrate CAD, ECC, call centres, and alarm systems in order to handle various events.
- For a smart city, the command and control centre will help in integrated city management thus improving resource utilisation, response time and decision-making.

The various components of a command centre have been represented in the below diagram.

Command centre	Physical operations						
	Operations and management			⇄	Command and control		
	People				Man-machine interface		
	Central admin	FMS	Operators		Video walls	Work stations	Web or internet
	Transport	Surveillance	....		Radio or TV	Public displays	SMS or mobile
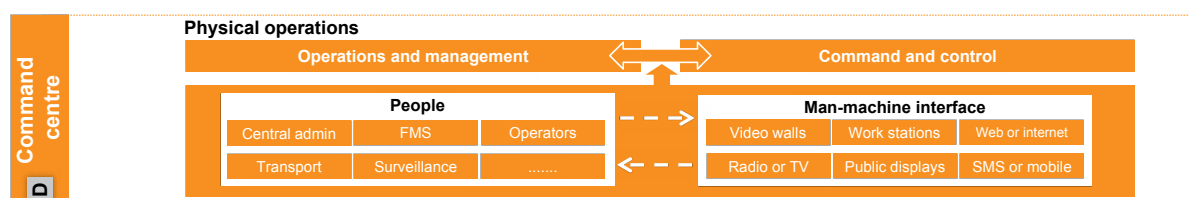
Desired functionalities

This integrated centre undertakes the following functions:

- **Command and control**: It supports dynamic alarming, HD video recording, voice control and cooperation with other systems through various public utilities, sensors and surveillance systems to achieve strategic, response centric and tactical objectives.

- **Communication**: It communicates with the various stakeholders and on-field devices to address incidents and help in decision-making.

- **Computation**: It computes real-time data in order to establish co-relations between events based on SoPs.

- **Intelligence**: It learns from past experience and enhances integrated operations and monitoring. It helps enable pre-event prediction and warning, intra-event surveillance and command, as well as post-event retrospective analysis and evaluation.

The below diagram represents various functionalities that the command and control centre caters to.
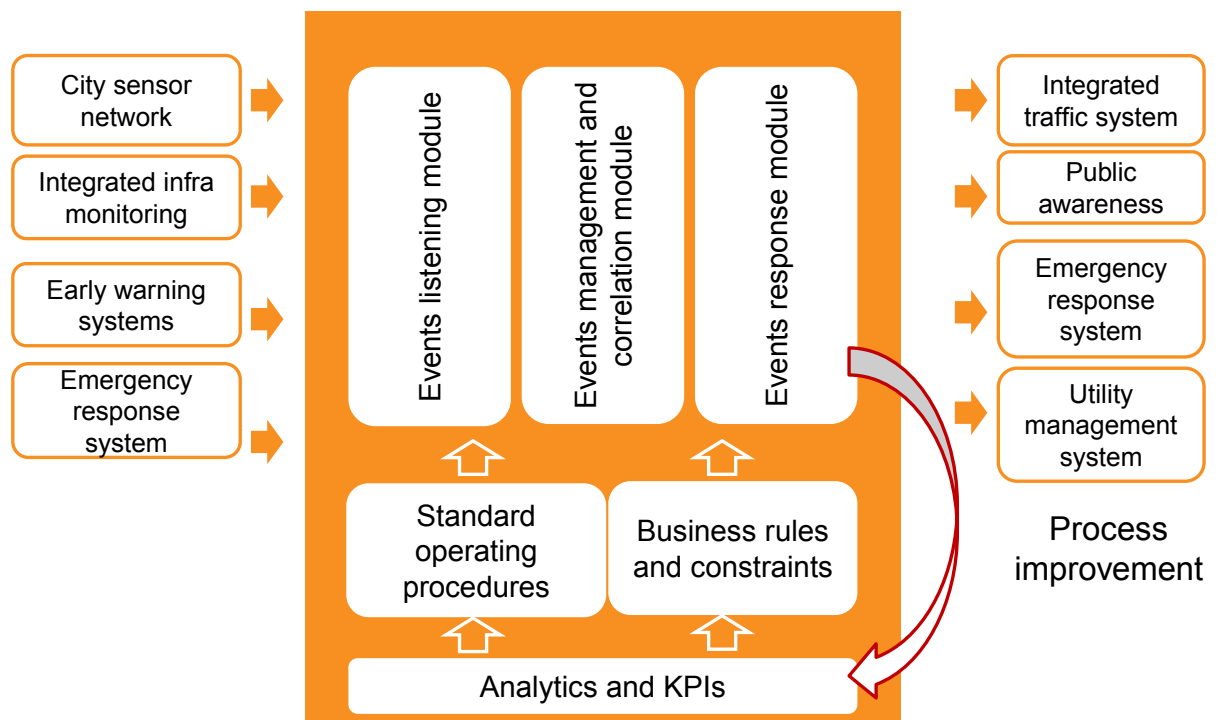
Service delivery

The service delivery layer is a knowledge-based system that supports decision-making activities and provides the public safety authorities with interaction tools along with other safe city applications. The user interfaces consist of web-services with secured access, allowing operators to note down data for real-time sensing information. It also offers access to recordings and is assisted by tools that enable the operator to anticipate future events.

This layer consists of various interactive modes of accessing the information from the safe city system and relaying alarms or alerts.

The core components used for service delivery have been represented in the diagram below.

Service delivery: Mobile devices · Kiosks · Email · SMS · Service helpdesks (call centres)
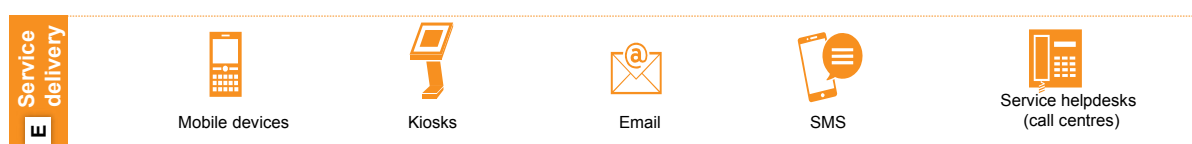
Mobile devices: Smartphones, tablets, iPads etc, can be used to view the live feeds and data generated by the sensors via command and control centres. The safe city network can be accessed through these devices by the concerned authorities having suitable user rights for the desired system functionality.

Kiosks: Information kiosks are a very good platform to display information to the citizens. They make the dissemination of dynamic information to commuters at strategic locations such as main entrance roads, market areas and public places possible and can also be employed to display traffic related information, notifications, awareness, event messages, etc.

Email: Email alerts can be sent to registered e-mail IDs through the system.

SMS: SMS alerts can similarly be sent to registered mobiles numbers through the system.

Service help-desks: Dedicated service centres (call centres) can be set up in order to provide notifications related to traffic movement as well as other events. Citizens can dial the toll-free call centre numbers to seek information.

Data flow

The mandate for the platform is to enable intelligent governance of safe city operations. Data in terms of video feeds, images, audio, alarms or alerts flows from the sensing layer and is transmitted to the safe city platform through the communication layer, for data processing and management. Various applications at the safe city platform layer process and analyse this data and respective outputs are delivered to the command and control centre. Users at the service delivery layer are the final recipients of the resultant outputs or reports, which are then further processed for necessary incident management actions.

The platform utilises an integrated framework for a wide range of emergency data exchange standards meant to support operations, logistics, planning and finance.

This framework standardises the content of alerts and notifications across all hazards, including law enforcement and public safety as well as natural hazards such as severe weather, fires, earthquakes, and tsunamis. It can be used to define and model the core concept of an alert, including key attributes such as category, status, scope, certainty, severity, urgency, onset time, expiration time, response type, instructions, etc.

The flow of data within the safe city platform can be broadly categorised into the following:

Flow of event data

An event message is sent to the system where various rules are processed and placed in the internal data store. As the reader picks-up the event message, the defined policies get triggered by the system and the message is processed as necessary. It is then placed in the database and an update is sent to the presentation layer. The data provider is simultaneously updated about the availability of this data for end users.

Flow of notification data

A notification message is sent to the system from where it enters the notification queue. Various rules are processed into the message and the data is placed in the data store. The impact notification policy then sends out the message to the presentation layer.

Flow of KPI data

The KPI data is sent to the system where various rules are processed and placed in the internal data store. As the reader picks up the event message, the defined policies get triggered by the system and the message gets processed as necessary. It is then placed in the database and an update is sent to the portal server. The KPI data provider then pulls the change and updates the GUI.

Role of the portal and GIS

Portal

It is essential to visualise the service status as well as important application information in order to make predictions and react to events and changes. The platform supports the design of the user interface for flexibility with respect to layout of information, while providing a standard look and feel.

An effective portal is governed by the following factors:

- Presenting easily consumable critical information to decision makers
- Bringing different data sources together to provide comprehensive information about service status, operations, domain business and infrastructure
- Displaying summarised data that can be expanded as required, giving access to detailed information
- Providing alerts driven by real-time information, allowing for immediate analysis and action
- Showing relevant information across dynamically linked views, for example, by selecting a point on a geospatial map, the associated views show related detailed information
- Providing a consistent look and feel to minimise the learning curve and confusion so that the user interface is simple and self-explanatory

Each type of user may require a different set of details. Following is a list of such instances:

- Executive users want high-level information (scorecards and charts) to be able to see the bigger picture.
- Detail users need the detailed in-depth information and sometimes even raw data to be used in their purpose-driven applications.
- Analytic users may need access to data so that they can run further analysis on it.

Geographic information system (GIS)

GIS is used in crime mapping facilitates to map, visualise, and analyse the crime hotspots, along with other trends and patterns. It is a key component of crime analysis and policing strategy.

It uses geographical and computer-generated maps as an interface for integrating and accessing massive amounts of location-based information.

GIS allows police personnel to plan effectively for emergency response, determine mitigation priorities, analyse historical events and predict future events. It can also be used to transfer critical information to emergency responders upon dispatch or en route to an incident to assist in tactical planning and response. GIS helps crime officers determine potential crime sites by examining complex, seemingly unrelated criteria and displaying them all in a graphical, layered as well as spatial interface or map.

The integration of GIS and video surveillance systems is very useful for security and city management. It can provide real-time spatial-temporal information and display it on an electric map. The key technology here mainly includes the mapping between videos and maps as well as the tracking of dynamic objects.

In incident processing, the command centre can obtain onsite HD snapshots that provide more detailed information to simplify decision-making. When emergency contingency plans are activated, the command centre uses the dispatching system to deploy police and medical aid resources. The trunking communication system ensures seamless communication and sends onsite information to application systems in order to enhance cross-departmental service collaboration.

The GIS is an extremely beneficial tool in safe city initiatives and helps the police departments and law enforcement agencies to:

- Identify and visualise crime hotspots, thus understanding crime patterns, trends or displacement
- More efficiently and holistically prevent crime by providing valuable information
- Distribute identified repeat location finders with different ranges of recurring crime incidents and frequencies within a defined radius
- Strategise police beats and patrolling
- Zero down on crime hotspots and determine suitable safe city measures
- Indicate interactive aoristic output with graphical representation periodically

- Analyse timelines indicating crime patterns on a monthly as well as yearly basis

The above factors, when placed on a spatial map, help in the reduction of street crimes, crimes against women and improve the efficiency of investigation by providing a fairly accurate location of the victim as well as the suspect or the offender.

User management

In a system as complex as a safe city, that has large numbers of sensors and multiple layers of network and equipment, a secure user management system is of paramount importance. There can be numerous users who need to access the system for various actions. This platform provides regulated user management policies to keep a proper tab on authorised and prioritised access as well as stabilise system processes and maintain confidentiality of information and data while ensuring proper upkeep of the system.

There is a provision for role-based access to individuals through a single or multiple sign in for different roles such as administrators, supervisors, officers, operators, etc. Apart from role-based access, the system can also be defined to provide access based on location.

Following are some key features of a user management system:

- The management module can capture basic details (mobile number and email id) of the police and other personnel requiring viewing or administrative rights to the system. The interface allows changing these details after proper authentication.
- Administrators have a right to create new groups and users and assign them to each other. This includes an intuitive interface that can manage group memberships and allows for delegated administration, thus enabling each service provider to manage their respective community and permissions set.
- Rights to different modules, sub-modules and functionalities are role-based, and proper log reports are maintained by the system for such access.
- Biometric standardisation coupled with login names and passwords is provisioned to ensure that only the authorised personnel login.

- The surveillance system has the capability to map cameras to police personnel across different police stations.
- For PTZ cameras, there are provisions to specify the hierarchy of operators or officers for control of the cameras from various locations.

Safe city platform extensions

Collaborative monitoring is a key enabler. In Indian cities where every establishment, government or private, has realised the necessity to secure its infrastructure and establish surveillance as well as monitoring and incident response systems, it is important that the data gathered by these agencies is shared among them. Government agencies such as the aviation and transport departments are already deploying on-board surveillance systems by provisioning CCTV-based surveillance in public buses and bus stands, metros, railway stations as well as airports. These systems under collaborative monitoring can conveniently share their data in real-time with the security agencies. Similarly, live feeds from CCTV systems deployed by private establishments such as malls, business parks and entertainment houses can be provided to the command and control centre in the city, where the security agency can make effective use of the information. Many cities across the world have surveillance systems deployed by multiple public and private establishments. These cities are using a collaborative framework to receive video feeds from across systems in order to ensure real-time responses.

Along with components of CCTV surveillance, the safe city platform is strong enough to integrate many other services to build an infrastructure for a smart city system. Few have been listed below:

Land and estate management: A surveillance system can be integrated with the safe city platform for land and estate management. This can assist in real-time monitoring of estate development by the owner, management, constructing agency, government or municipal agency as well as the end customers.

Parking lot availability automation: Integration of the parking lot management system at railway stations, airports, bus depots, markets and tourist spots with the safe city platform can be done by utilising the existing safe city infrastructure. This will make information regarding the availability of parking space easily accessible to people through SMS, VMS, kiosks, etc.

Emergency call box system: A high quality digital transceiver, placed at certain locations across the city can be made accessible to the public, connecting them with the police department through the existing safe city network infrastructure set-up. At some locations, this can be also be used to broadcast and publicly address.

Public address system: A public address system at select public locations and junctions can be integrated with the safe city platform to allow for utilisation during crisis situation. Access control can be employed for regulated usage.

Variable messaging signs: These can be used to provide dynamic information to commuters at various strategic locations on roads.

Other sensors: Temperature sensors, air quality sensors, flood water sensors, fire or smoke sensors, GPS devices in public and private vehicles, and other green city initiatives can also be looked at for prospective integration with the safe city platform.
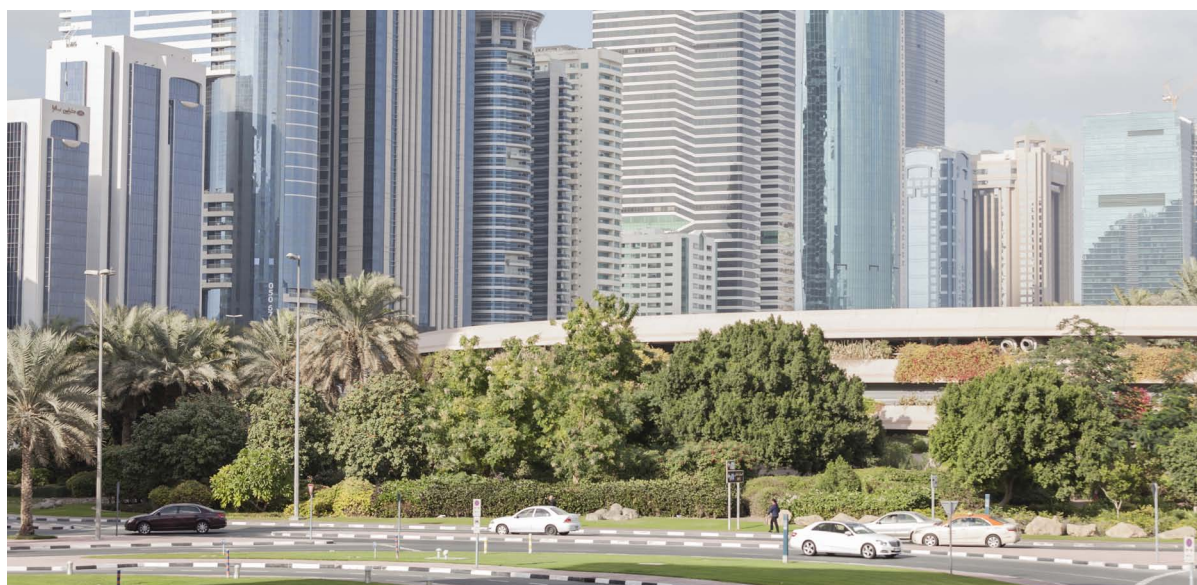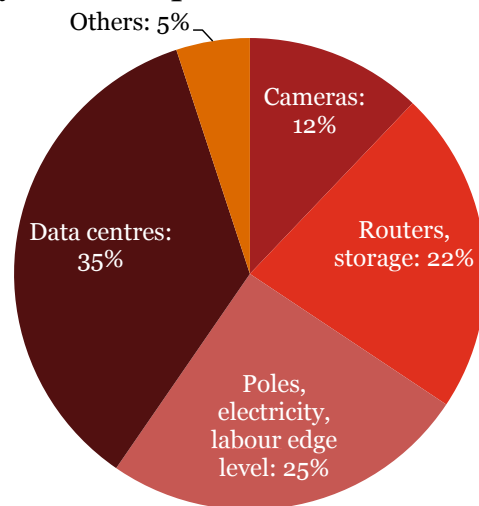
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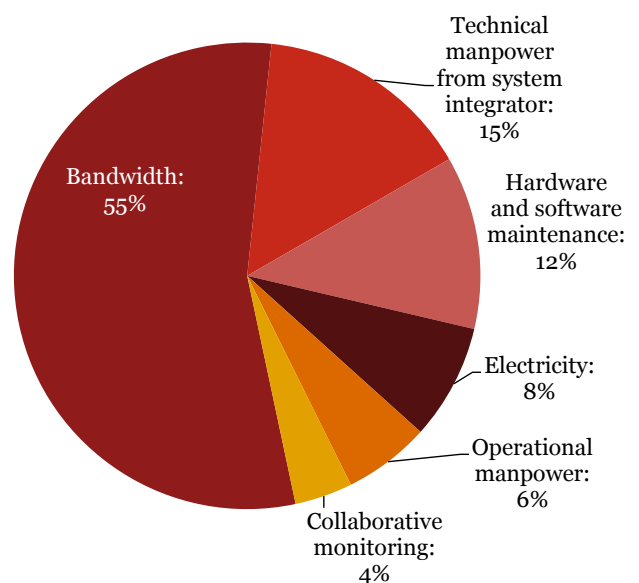
Implementation models

The safe city project requires vast experience, expertise as well as technical and financial capability in a system integrator for the successful implementation of the project as well as subsequent management, operation and maintenance. Apart from the technical strength, financial capability too plays a major role and needs due diligence for a seamless project implementation process.

The diagrams depicted here highlight the capital and operational cost break-up of a typical CCTV camera based surveillance system. The IP camera equipment, including network peripherals such as routers, switches and storage, contribute to approximately 40 to 50% of the cost, with data centres and command centres contributing around 30 to 40%. The expense incurred on the labour for installation and commissioning of civil infrastructure constitutes another 20 to 30%. Most of the operations cost is spent on bandwidth followed by hardware, software maintenance and provisioning technical manpower which is typically around 10 to 15% each. It is, thus, imperative to select a suitable funding model to ensure that the safe cities project is sustainable and remains effective throughout its operations and maintenance.

Capex: Relative cost of surveillance systems components for 6000 cameras

- Others: 5%
- Cameras: 12%
- Routers, storage: 22%
- Poles, electricity, labour edge level: 25%
- Data centres: 35%

Opex: Relative cost of surveillance systems components for 6000 cameras

- Bandwidth: 55%
- Technical manpower from system integrator: 15%
- Hardware and software maintenance: 12%
- Electricity: 8%
- Operational manpower: 6%
- Collaborative monitoring: 4%

A safe city project may adopt any of the following two philosophies to fund their implementation, operations and maintenance:

• Government or self-funded

In this project implementation model, the funds for project implementation, management, maintenance, upkeep and operations are provided by the government. The project is divided into two parts, ie, capex and opex. capex is the portion of the contract which includes supply, installation, testing and commissioning of the system. Full payment for the capex portion is released after implementation, when the project goes live. The opex portion includes all operational and maintenance expenses as well as post project implementation and is periodically released during the contract.

• Public private partnership (PPP)

PPP is a government service funded and operated through a partnership between the government and one or more private sector companies.

Text boxes in figure:

- In time project completion
- Mitigation of project delays
- Easy adoption of technology
- Avoidance of cost overruns

- Competent operators
- Better performance
- Easy maintenance, upkeep and uptime

- Latest technology adoption
- Optimum solutions design and usage
- Easy transfer of technology
- Regular upgrades

Triangle labels:

Mitigation of business risk

ITMS

Mitigation of operational risk

Mitigation of technological risk

A PPP model, if adopted effectively, ensures the following:

- Business risk mitigation
- Technological risk mitigation
- Operational risk mitigation

The above mentioned risks are also responsible for the safe city project being capital intensive. If a government is willing to pick up the cost for above mentioned mitigation, the government funding model can be brought into effect. In all other circumstances, a PPP model based on revenue sharing and collection is more attractive.

The following table describes the three variants of a PPP model that can be explored while funding the safe city project:

Type of model	Capital expenditure	Operations	Maintenance	Description
Annuity based	Private	Government	Private	This is an annuity based model in which the policing operations (transactions) are controlled and managed by the government.
Transaction based	Private	Private	Private	All investments made by the implementing agency, with revenue earnings based on each transaction done through the system, as well as management of operations and maintenance based on strict SLAs. The private agency earns a transaction fee based on a fixed percentage of the revenue.
Collection based	Government	Private	Private	Initial capital investment is made by the government and the revenue earned by the implementing agency on each transaction through the system is used for O&M. The private agency earns a trnsaction fee based on a fixed percentage of the revenue.
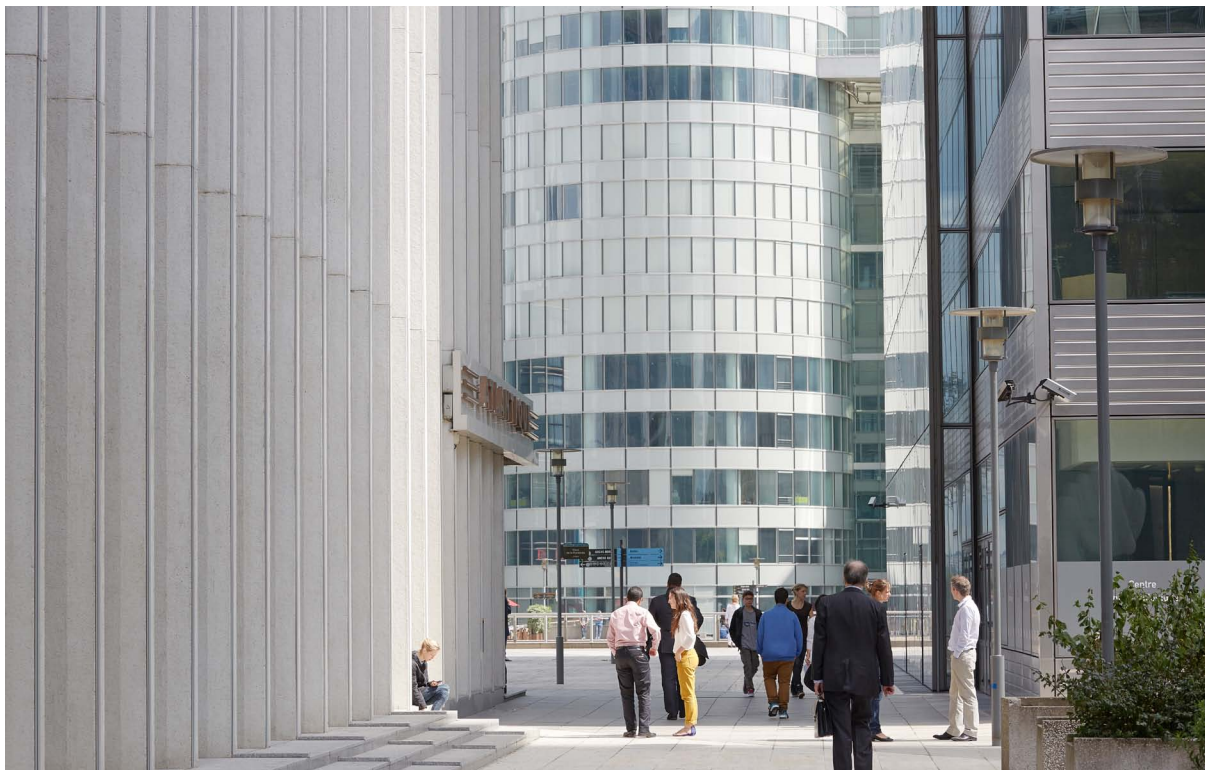
A PPP model is more suited to environments where service delivery by the system can be monetised. While adopting a PPP model, it is required to identify the transactional activities that can be revenue generating streams, thus helping sustain both the revenue as well as the non-revenue generating operations.

Model	Model description	Pre-requisites	Opportunity
Annuity based	The implementation agency implements and maintains all solutions and the government controls the transactions. The agency earns on an annuity basis.	Areas for coverage are learly identified by the department Annuity calculations are determined. Operating SLA and the penalty for non-compliance is agreed upon.	Compliance to SLA is ensured to maintain the monthly revenues and no deductions from annuity payments are made.
Transaction based	The implementation agency owns, operates and maintains all solutions. The agency earns per transaction (infringement detection and execution).	Transactions as well as the maximum percentage of sharing on any transaction are defined. Operating SLA and the penalty for non-compliance is agreed upon.	The implementation partner has an interest in optimising the transactions, and will hence invest in wider coverage and maintenance. Since the transaction is pre-defined, the opportunity is not perceived as a risk by the agencies.
Collection based	The implementation agency implements, operates and maintains all solutions and the government funds the capital expenditure. The agency is also responsible for owning the back office operations and collection and earns a fixed percentage of the revenue collected.	The percentage of sharing is agreed upon. Areas for coverage are clearly identified by the department. Operating SLA and the penalty for non-compliance is agreed upon.	The implementation agency ensures that maximum challans get delivered and follow-ups are done for their realisation. The agency looks for innovative ways to map and update the vehicle registration numbers to the challan delivery addresses.

A typical example of such a revenue generating operation in a safe city project can be the traffic law enforcement challaning system. These models are followed in countries such as USA, Ireland, Saudi Arabia, Malaysia, Australia; where a private agency works along with the traffic police enforcement agency to set up traffic violation detection systems (red light violations system, speed enforcement system and illegal parking management system). The same private agency also undertakes operations and transactions for the police based on a fixed revenue sharing, transaction fee annuity model. Similar models can be adopted in India to make private agencies work closely with the government law enforcement agencies. However, there is major skepticism about their feasibility and sustainability before streamlining the RTO database and standardisation of the number plate.

The following example depicts the applicability of a PPP model for a full intelligent traffic management project that includes traffic signal management, red light violation detection system (RLVD), speed violation detection system (SDS), variable message signs (VMS) etc, to be implemented in a Tier 1 Indian city for a period of 10 years, despite major challenges such as non-standardised number plates and an erroneous RTO database.

Infringements	Detection	Filtering	Issue of notice	Collection
• A large number of infringements take place every day on streets • Not all get detected	• Owing to the non-standardisation of number plates, electronic detection rates range from only 50-60%	• Of the successful detections, filtering of valid vehicles (minus other states) results in a further 20% decrease	• After filtering, only 60-80% registered vehicles have an updated and valid address for delivery	• Only a percentage of challan notices issued, get realised
1000	500	400	320	256

Numbers detected per system per day

Keeping in mind the challenges in India and assuming that only 1,000 challans are captured by a camera system per day, the actual collection can be realised from just 256 challans.

It is also understood that once the traffic violation detection system is in place, the number of challans reduces at around 15% in first two quarters, and then slows down but never reaches **zero**.
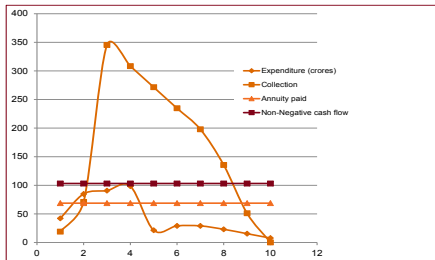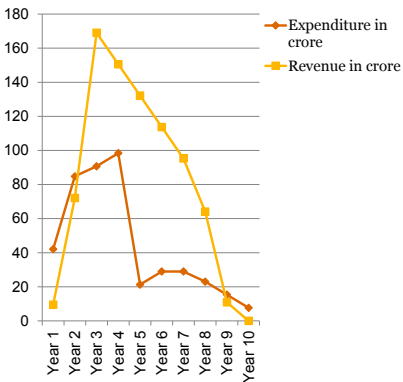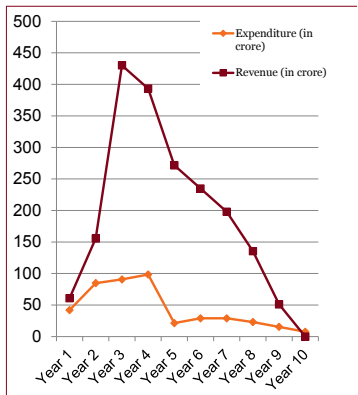
With **100 INR per challan** (based on the MV Act in India) and the capital outlay based on a phased implementation for the project, the models for PPP as described in the adjacent graph depicts the trend line for revenue generation.
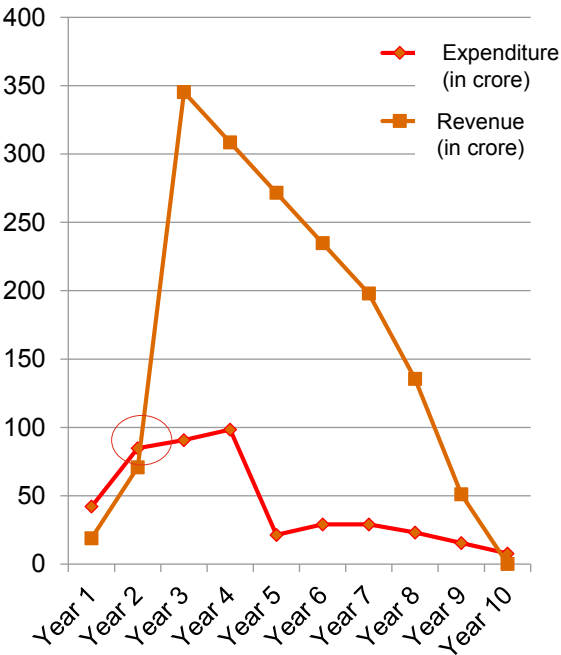
It should however be noted that the amount of revenue generated is dependent on the number of challans being captured. This essentially means that the revenue is directly proportional to the number of traffic enforcement systems installed and in operational condition. Based on the number of systems, the break-even point for the model gets shifted. The depiction in this report is basis the following assumptions:

- The implementation is phased (including capex and opex).

- Approximately 200 systems have been considered for this case study.
- All challans have been assumed to be 100 INR.
- Higher challan values for repeat offenders have not been included.
- Trends may be similar for Tier 1 cities, but may differ elsewhere.

Model	Trend line	Description
Annuity based The policing operations (transactions) are controlled and managed by the government.		The government may decide to offer a base annuity which might realise negative cash flows and break even after a specific duration. The government may offer a non-negative cash flow annuity.
Transaction based All investments made by the implementing agency, with revenue earnings based on each transaction done through system, as well as management of operations and maintenance based on strict SLAs. The private agency earns a transaction fee based on a fixed percentage of the revenue.		The government can provide a fixed percentage of transaction fee to the private agency. The ratio shall determine the break-even realisation.
Collection based Initial capital investment is made by the government and the revenue earned by the implementing agency on each transaction through the system is used for O&M. The private agency earns a transaction fee based on a fixed percentage of the revenue.		The government can provide a fixed percentage of transaction fee to the private agency. The percentage shall determine the break-even realisation. However, this percentage shall be lower than the previous model, since the initial outlay of capital has been made by the government.

Making surveillance sustainable

In the 21st century, cities that are safe, lively as well as healthy can be categorised as sustainable. Safety and livability are important aspects for any city to prosper in terms of economy as well as population density. The safer a city is, the greater is the utility of public spaces well as public transport; thereby considerably reducing traffic congestion as well as pollution levels. Increased reliance on public transport will also reduce the use of fossil fuels as well as minimise energy consumption. A robust public transportation infrastructure is a future imperative in order to minimise dependence on private cars as well as making cities people-friendly.

Several cities across the globe are charting out strategies to increase the use of public transport and instil a culture of walking, bicycling and using other eco-friendly modes of commute. With rapid growth and urbanisation, city administrators must not overlook the importance of sustainability.

Challenges

Crime and violence are serious threats to social cohesion and economic stability in cities around the world. The damage and fear they create threatens quality of life, human rights, social and economic stability, sustainable development; particularly affecting the poor.

Safer cities approach

Crime and violence do not happen spontaneously. Urban environments that unequally exclude some communities and disempower them create an environment ripe for crime.

Reducing crime is everybody's responsibility

Police, courts and prisons alone cannot stop the escalation of urban crime and violence. Public safety must be considered a right of all citizens. Institutions and civil society must build safer cities together by creating inclusive and equal urban environments.

The role of local authorities

The city leadership needs to take the initiative to coordinate community-wide prevention strategies to reduce crime and violence. Success depends on partnerships between local governments, citizens, and the civil society.

Safety as a good governance issues

Good urban governance values citizenship and involves all citizens, including the most marginalised and poor, in local decision-making and planning.

Opportunities

- Local crime prevention strategies must be incorporated in urban planning.
- Prevention policies can be incorporated into slum and neighbourhood improvement policies.
- Public spaces are the sites that enhance urban safety by nurturing the values of social cohesion and co-existence.

- Youth are the agents of change and women the advocates of safety in the city. They must be fully engaged as resources, not problems, in the design and delivery of any sustainable violence and crime prevention strategies.

Safe streets and public spaces

Thriving businesss

24 hour walking cities

1

2

3
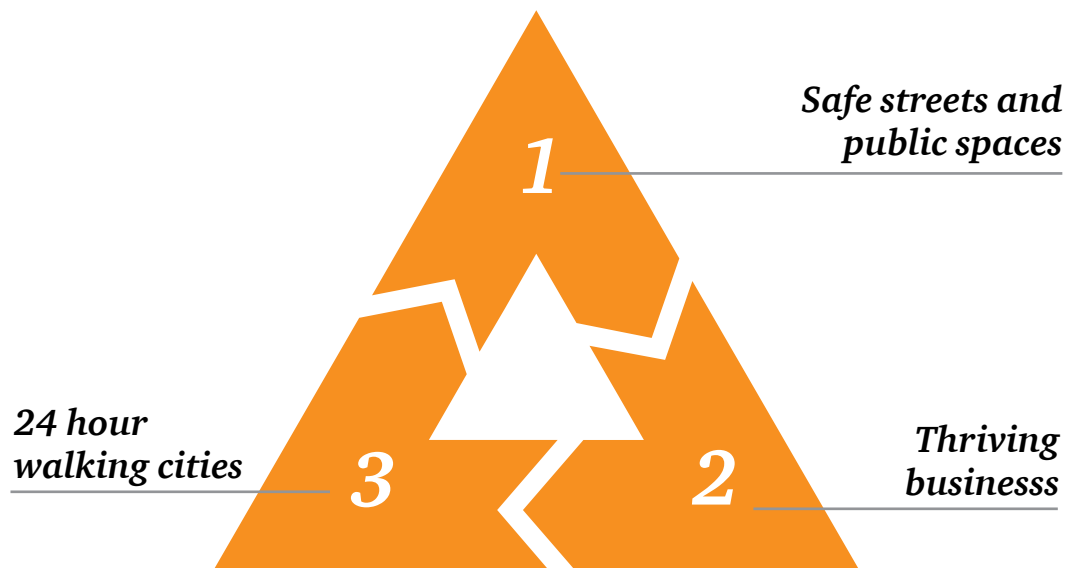
Safe cities: Future trends

Making city surveillance green

Safe and healthy

The government today is aiming at sustainable urban development to ensure progressiveness. Meticulous planning, management and good governance can ensure a well-planned, safe and sustainable city.

Green

Our current planning and design will determine the future resilience of our cities. A healthy environment can be created through the promotion of sustainable development and by aiming for increased carbon efficiency.

Inclusive

A socially equitable city promotes growth and development for everyone. In order to enhance infrastructure and sustain it for a better tomorrow, processes that are pro-poor, pro-gender and pro-youth need to be adopted.

An equitable, prosperous, sustainable safe city

Resilient

Cities must have controlled urbanisation, high-quality infrastructure, regulated expansion and strong governance. Only then will they be in a position to confront challenges in the form of natural or man-made disasters, and recover speedily.

Lively

To ensure a better standard of living and enhance productivity, a city needs to generate job opportunities through improved educational facilities, adequate investments in urban infrastructure and skills development.

Well-planned

A well-planned city needs to ensure a resilient, green, inclusive, productive, safe, as well as healthy urban development. Sustainable planning requires designing the urban space keeping in mind business development as well improvement in the quality of life of the citizens.

How to use this report

The central purpose of this report is to drive action. We hope that the frameworks, analyses, and ideas for action laid out in this document will help catalyse corporate leaders, entrepreneurs, investors, and government officials to take actions aimed at contributing India to make a safer place.

About ASSOCHAM

Vision: Empowering Indian enterprises by inculcating knowledge that will be the catalyst of growth in the barrier-less technology driven global market and help them upscale, align and emerge as formidable players in their respective business segments.

Mission: As a representative organ of corporate India, ASSOCHAM articulates the genuine, legitimate needs and interests of its members. Its mission is to impact the policy and legislative environment so as to foster balanced economic, industrial and social development. We believe education, IT, BT, health, corporate social responsibility and environment to be the critical success factors.

The knowledge architect of corporate India

Evolution of value creation: ASSOCHAM initiated its endeavour of value creation for the Indian industry in 1920. Having in its fold more than 400 chambers and trade associations, and serving more than 4,00,000 members from all over India, it has witnessed upswings as well as upheavals in the Indian economy, and has contributed significantly by playing a catalytic role in shaping the trade, commerce and industrial environment of the country. Today, ASSOCHAM has emerged as the fountainhead of knowledge for the Indian industry, which is all set to redefine the dynamics of growth and development in the technology driven cyber age of a 'knowledge based economy'.

ASSOCHAM is seen as a forceful, proactive, forward looking institution equipped to meet the aspirations of corporate India in the new world of business. ASSOCHAM is working towards creating a conducive environment for Indian businesses to compete globally.

It derives strength from its promoter chambers and other industry or regional chambers or associations spread all over the country.

Members: Our strength

ASSOCHAM represents the interests of more than 4,00,000 direct and indirect members from across the country. Through its heterogeneous membership, ASSOCHAM combines the entrepreneurial spirit and business acumen of owners with management skills and expertise of professionals to set itself apart as a chamber with a difference.

Currently, ASSOCHAM has more than 100 national councils covering the entire gamut of economic activities in India. It has been especially acknowledged as a significant voice of the Indian industry in the field of corporate social responsibility, environment and safety, corporate governance, information technology, biotechnology, telecom, banking and finance, company law, corporate finance, economic and international affairs, tourism, civil aviation, infrastructure, energy and power, education, legal reforms, real estate and rural development.

Insight into 'new business models'

ASSOCHAM has been a significant contributing factor in the emergence of new-age Indian corporates, characterised by a new mindset and global ambition for dominating the international business. The chamber has addressed key areas such as India as investment destination, achieving international competitiveness, promoting international trade, corporate strategies for enhancing stakeholders' value, government policies in sustaining India's development, infrastructure development for enhancing India's competitiveness, building indian MNCs, role of financial Sector the catalyst for India's transformation.

ASSOCHAM derives its strengths from the following promoter chambers:

Bombay Chamber of Commerce and Industry, Mumbai; Cochin Chambers of Commerce and Industry, Cochin; Indian Merchant's Chamber,

Mumbai; The Madras Chamber of Commerce and Industry, Chennai; PHD Chamber of Commerce and Industry, New Delhi.

Together, we can make a significant difference to the burden that our nation carries and bring in a bright, new tomorrow.

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