SMART BORDER MANAGEMENT

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FICCI

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FOREWORD

Border management has emerged as a crucial area in need of smart solutions for various border guarding forces such as Border Security Force, Indo-Tibetan Border Police, Assam Rifles, Sashastra Seema Bal and Indian Coast Guard. These Forces have to facilitate legitimate travel and trade while maintaining strong security at the border.

India shares 15,106.7 km of its boundary with seven nations—Pakistan, China, Nepal, Bhutan, Myanmar, Bangladesh and Afghanistan. These land borders run through different terrains. Managing a diverse land border is a complex task, which is very significant from the view of national security. In addition, India has a coastal boundary of 7,516.6 km. It includes 5,422.6 km of coastline in the mainland and 2,094 km of coastline bordering islands. The coastline touches 9 states and 04 union territories.

This report explores how Indian border guarding forces could leverage big data and predictive analytics to enhance border management and security. The report also highlights the challenges and the way ahead for capturing and collation of data, the need for infrastructure to support capturing of data, extraction of information and conduct of predictive analytics, and training of Border Guarding personnel.

I sincerely hope that this report will offer important and useful insights for policy makers, border guarding forces and all other stakeholders.

MR. DILIP CHENOY
Secretary General
FICCI

FOREWORD

India has a large and complex land border covering 15106.7 km and a long coastline of 7517 km, with difficult and varied terrain, peculiar conditions related to each terrain, varied climatic conditions, geo-political standpoints, which further complicate the border management and presents the need for the use of technology to move towards smarter ways of managing our borders. Use of technology in terms of cameras, night vision devices, radars and other sensors notwithstanding, the use of big data and predictive analytics is a solution to optimise the available data and to put it to good and intelligent use. Dovetailing of predictive analytics with the use of sensor technologies would not only optimise the use of effective force at the right time and the right place but would also help in savings to the exchequer. Big data and predictive analytics are being used world over in a number of domains to enable better decision making and commercial gains. It is also being used by developed countries like the US, China, Russia, etc in the domain of military and security to enable proactive surveillance by predicting the nature, location and time of the threat. Budgetary allocation to the Ministry of Home Affairs was spiked in 2009–10 following the Mumbai terror attacks of November 2008, since then budget allocation has steadily increased over the years. The budget allocation has gone up to INR 89,837 cr for 2018-19 from INR 79,781 cr in 2017-18, which is a hike of 12.6% with respect to the last year.

I take pleasure to present this report, on behalf of BDO India and FICCI, that brings out an overview of the Indian borders-land and coastal, border security and border management, initiatives taken by Government of India, emphasizing the need for technology for efficient border management. The report highlights the use of big data and predictive analytics and also brings out a number of use cases which can be implemented for the management of our borders in a more efficient and smarter way. I hope that, through this report, you will be able to garner a view on the concept of Smart border management and gain an insight into the world of big data and predictive analytics and its use in border management.

GAUTAM NANDA
Leader - Aerospace, Defence & Security
Associate Partner - Government Advisory
Business Advisory Services
BDO India LLP

LIST OF ABBREVIATIONS

AEG	Automatic Exploit Generation
AI	Artificial Intelligence
AIS	Automatic Identification System
AR	Assam Rifles
BADP	Border Area Development Program
BIA	Business Intelligence analytics
BSF	Border Security Force
CAM	Collision Avoidance Model
CIBMS	Comprehensive Integrated Border Management system
CIP	Community Interaction Programme
CPS	Coastal Police Station
CSN	Coastal Surveillance Network
CSS	Coastal Security Scheme
CYMBALS	Colour, Year, Make, Body, Attire, Looks, Sex
DRDO	Defence Research and Development Organisation
EEZ	Exclusive Economic zone
IBL	International Border Line
ICG	Indian Coast guard
IMD	Indian Meteorological Department
IMDB	In Memory Database
IoT	Internet of Things
ITBP	Indo-Tibetan Border Police
LoAC	Line of Actual Control
LoC	Line of Control
LRIT	Long Range Identification and Tracking
MDA	Maritime Domain Awareness
MHA	Ministry of Home Affairs
MNIC	Multi-purpose National Identity Card
MoCA	Ministry of Civil Aviation
MPP	Massive parallel-processing
RLS	Radio Local System
RTP	Registered Traveller Programme
RTS	Radio Trunk System
SED	Self-encrypting drives
SSB	Sashastra Seema Bal
UNCLOS	United Nations Convention for the Law of the Sea
VTF	Vehicle Trans ponding Framework
VTMS	Vessel Traffic Management System
DARPA	Defense Advanced Research Projects Agency

1. OVERVIEW

1.1 Border Security and Management

1.1.1 Indian Land and Coastal Borders

India has a large and complex land border, covering around 15,106.7 km, which it shares with Bangladesh, China, Pakistan, Nepal, Myanmar and Bhutan, as well as a small portion with Afghanistan, with all possible terrains—namely deserts, fertile lands, swampy marshes, snow-covered peaks and tropical evergreen jungles. The difficult and varied terrain, peculiar conditions related to each terrain, climatic conditions, relationship with certain neighbours, etc, all these factors and more make safe guarding our borders challenging and vulnerable to insurgency, illegal migration, smuggling and other anti-national activities.

India also has a coastline of 7,517 km, of which the mainland accounts for 5,422 km. The Lakshadweep coast extends for 132 km and the Andaman and Nicobar Islands have a coastline of 1,962 km. The Indian coastline is distributed among 09 coastal states and 04 UTs, and almost the entire coast of India falls within the tropics. The 09 coastal states are Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. India also has large coastal wetlands, which cover an area of over 41,401 km^2, which is 27.13% of the total area covered by wetlands in India. India's inland wetlands, on the other hand, cover 1,05,649 km^2. In case of the coastal border line, the territorial boundary is defined up to 12 nautical miles. This zone is India's sovereign territory and other countries need to take permission from India to enter this area. In continuation to this zone is the contiguous zone or the zone of hot pursuit which extends up to 24 nautical miles. Infringement of customs, sanitary, immigration and fiscal regulations in this zone can attract punishment.

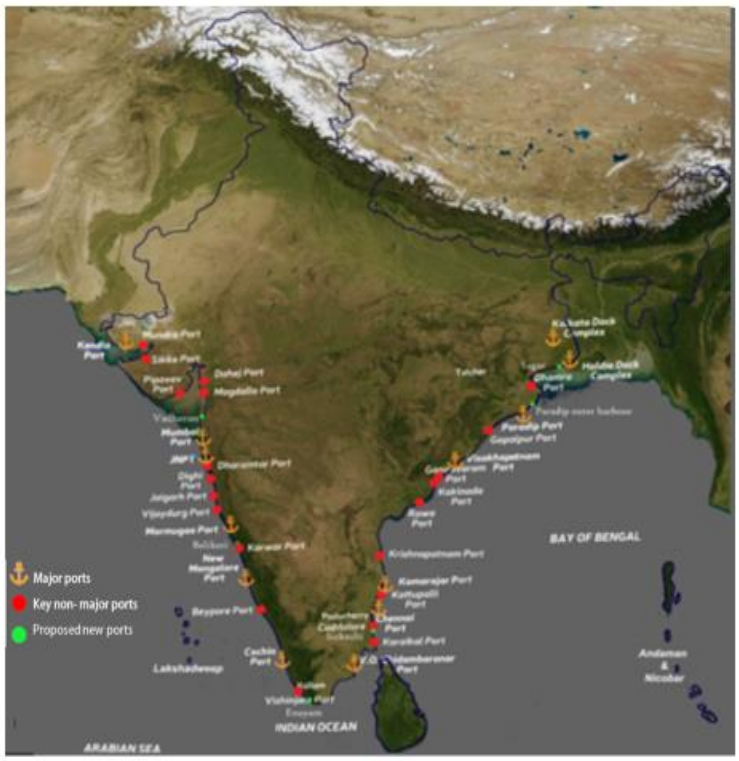


Figure 1: Indian borders and major seaports.[1]

The exclusive economic zone (EEZ) extends from the outer limit of the territorial sea up to 200 nautical miles. Coastal States hold the right to natural resources and economic resources like minerals, oil, fisheries in this zone. Ships of other countries are allowed to pass through this zone as long as they do not pose a

[1] http://www.sagarmala.gov.in/

threat to the coastal State. Rights and responsibilities of a nation with respect to their use of the world's oceans, its resources are governed by the United Nations Convention for the Law of the Sea (UNCLOS).

The land borders in India are demarcated as follows: -

International Border Line (IBL) - IBL is the demarcation that has been agreed upon and ratified by both the neighbouring countries and has been accepted by the rest of the world.

Line of Control (LoC) - LoC is the de facto border and separates Pakistan-occupied Kashmir from India's state of Jammu & Kashmir. Originally known as the Cease-fire Line, it was re-designated as the "Line of Control" following the Simla Agreement, which was signed on 03 July 1972.

Line of Actual Control (LoAC) - LoAC is the boundary line that separates Indian-held lands from Chinese-controlled territory.

The disputed and unsettled nature of our boundaries (both land and maritime) has made their security much more difficult.

1.1.2 Border Management

Border management is a security function that calls for coordination and concerted action by various government agencies within our country. The aim of border management is to secure our frontiers and safeguard our nation from the risks involved in the movement of goods and people from India to other countries and vice versa. Border management itself is a multifaceted term and may include, but is not limited to, the regulation of legal and illegal immigration, ensuring safe and secure movement of authorized people and goods, and prevention of human trafficking, infiltration and smuggling.

India being an increasingly globalised and service-oriented economy relies heavily on the movement of goods and people. However, if these movements are uncontrolled, less regulated or unsupervised then smuggling, trafficking, crime, terrorism and illegal migration can increase, which can foment trouble of various kinds in the country. Border management is an integral part of security and demands proactive intelligence, inclusion of technological advancements, and coordinated action by bureaucrats, economic agencies, security personnel and other related stakeholders of the nation to safeguard our borders from any threat. Key stakeholders involved in border management are depicted below.

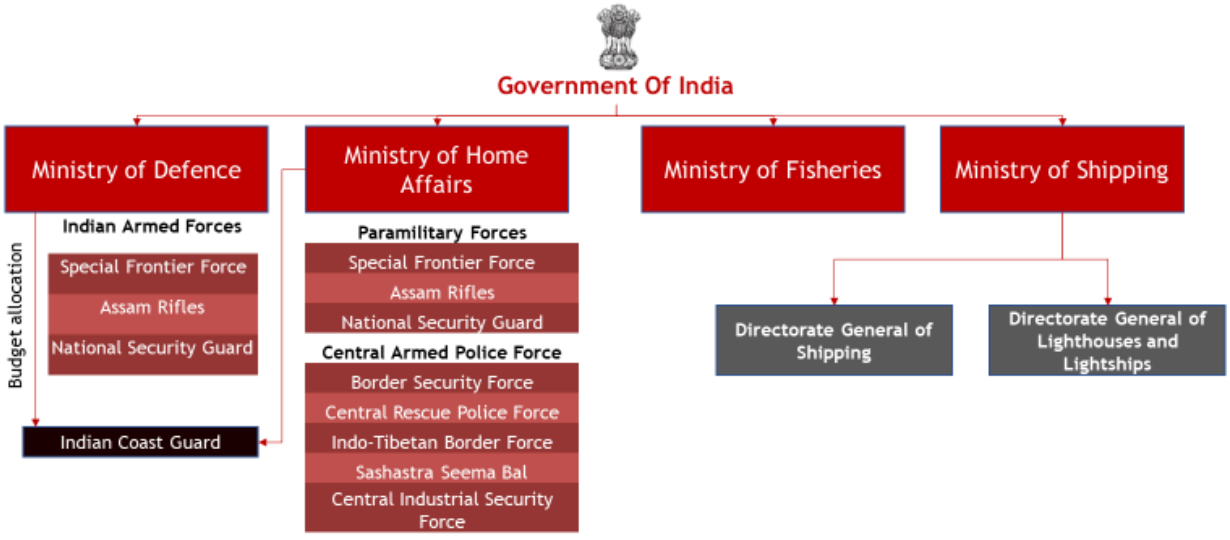


Figure 2: Key stakeholders in Security and Border management

1.2 Ministry of Home Affairs & Department of Border Management

1.2.1 Role of MHA and Department of Border Management

The Department of Border Management was formed under the Ministry of Home Affairs (MHA) in January 2004, following recommendations from the Group of Ministers on border security. This department has been entrusted with the responsibility of all matters associated with land borders and costal borders, except for LoC in the Jammu and Kashmir sector which is guarded by the Army. The department focuses on the issues

relating to the management of international land and coastal borders, strengthening of border policing and guarding, creation of infrastructure such as roads, fencing and flood lighting on the borders, and implementation of the 'Border Area Development Programme'. Border management by Government of India can be categorised into two essential processes as below: -

a) Deployment of border guarding forces
b) Development of border areas

1.2.1.1 Deployment of border guarding forces.

Guarding of the Indian borders is undertaken by the various border guarding forces which are deployed along different borders as below:

a) Border Security Force (BSF): The security of Bangladesh and Pakistan border is looked after by BSF
b) Indo-Tibetan Border Police (ITBP): The security of the China border is entrusted to ITBP.
c) Sashastra Seema Bal (SSB): The Nepal and Bhutan border are looked after by SSB.
d) Assam Rifles (AR): Assam Rifles have been deployed on the Indo-Myanmar Border.
e) Indian Coast Guard (ICG): The responsibility for security of the coastal borders lies with the ICG with the coastal State (Marine) Police acting as the second line for coastal patrol.

The LoC on the Indo-Pakistan border and the LoAC on the Indo-China border is protected by the Indian Army. The Indian Navy performs a constabulary role which includes ensuring security of EEZ, conducting low intensity maritime operations and maintaining good order at sea.[2] In addition to this, the Central board of Excise and Customs has over 8000 officials on Border Security Check.

1.2.1.2 Border Surveillance and Management

To manage the borders effectively, surveillance is carried out by conduct of regular patrols by personnel guarding the borders. In addition, electronic surveillance equipment such as night vision devices, handheld thermal imagers, surveillance radars, direction finders, unattended ground sensors and high-powered telescopes are also used by the border guarding forces as force multipliers for carrying out surveillance.

On the coastal front, the MHA is implementing supplementary Coastal Security Schemes (CSS) to strengthen the marine police of 09 coastal states and 04 UTs to enhance surveillance and patrolling in the coastal areas. Electronic surveillance is being undertaken using a radar chain, called Coastal Surveillance Network (CSN). The coastal surveillance is further augmented by Automatic Identification System (AIS), Long Range Identification and Tracking (LRIT), day / night cameras and communication systems. These measures assist in developing Maritime Domain Awareness (MDA) through interconnecting Indian Navy and ICG stations and helps in development of a 'Common Operational Picture'. Vessel Traffic Management System (VTMS) radars in ports also facilitate surveillance of port areas.[3]

Effective management of the borders involves facilitation of legitimate trade and travel and simultaneous prevention of illegal immigration, smuggling and infiltration of insurgents and terrorists. Building of barriers helps to prevent illegal ingress and egress of people and goods. Another method employed by the government to regulate the borders is the preparation of a national register and issuance of Multi-purpose National Identity Cards (MNICs). This helps identify the population of the border areas and prevents illegal migration.

The government has also undertaken the construction of Integrated Check Posts (ICPs) to provide better facilities for the legal movement of people and goods across the border. ICPs were introduced to reduce hassles in the cross-border movement of goods and people for promoting trade and commerce.

1.2.1.3 Development of border areas

Lack of economic opportunities makes the border population more susceptible to illegal activities such as drugs and smuggling. Additionally, difficult terrain and lack of proper roads and infrastructure keeps the border areas inaccessible and underdeveloped. As a solution to tackle these issues, the government initiated the 'Border Area Development Program' (BADP) in 1987, to facilitate the provision of the required socioeconomic infrastructure and adequate security, and to eliminate a sense of alienation among the population living at the border. BADP schemes include the development of community-based infrastructure

[2] https://www.indiannavy.nic.in/content/role-navy
[3] http://pib.nic.in/newsite/PrintRelease.aspx?relid=176953

such as forestry, fishery ponds, parks, community centres, markets and mobile dispensaries. BADP also takes up security-related schemes.

In coastal States, the department of border management is working for creation of infrastructure along the coastal belt. Community Interaction Programmes (CIPs) are conducted periodically by the ICG for the fishermen and coastal populace to sensitise them to security and safety issues. The ICG has been imparting regular training to marine police personnel since 2006. Regular training programs are also conducted at the Coast Guard District Headquarters corresponding to the coastal states/UTs. All this is undertaken with an aim to sensitise the border population to become the eyes and ears of the security apparatus as well as to put in place a community support system for the residents of the coastal States to respond in a cohesive manner to natural calamities, as was demonstrated during the recent floods in Kerala by the fishermen community.

1.2.2 Budgetary Allocations

Budgetary allocation to the Ministry of Home Affairs was spiked in 2009-10 following the Mumbai terror attacks of November 2008, since then budget allocation has steadily increased over the years.

Homeland security budget allocation (in '000 cr INR)

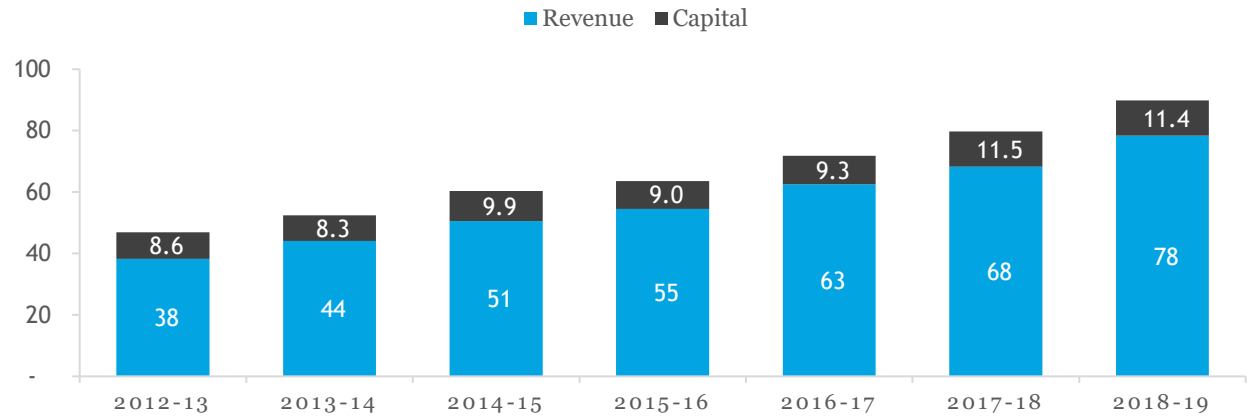


Figure 3: Homeland security budget allocation

The budget allocation has gone up to 89,837 Cr for 2018-19 from 79,781 Cr in 2017-18, which is a hike of 12.6% with respect to the last year.

Allocation of MHA budget 2018 - 19 (%)

The budget allocation to different forces is depicted as below: -

100% = INR 89,837 cr

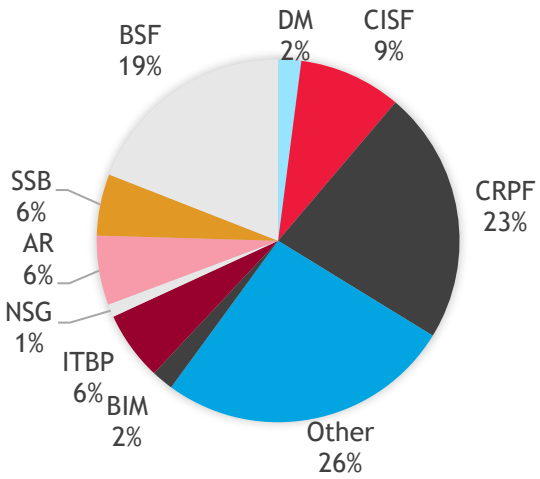


Figure 4: Allocation of MHA budget

AR: Assam Rifles, BSF: Border Security Force, CISF: Central Industrial Security Force, CRPF: Central Reserve Police Force, ITBP: Indo-Tibetan Border Police, NSG: National Security Guard, SSB: Sashastra Seema Bal, BIM: Border Infrastructure Management, DM: Disaster management
The category 'Others' includes Intelligence Bureau, Home Guards, Civil Defence, National Intelligence Grid, Special Protection Group, Central Police Organizations, Narcotics Control Bureau, Misc. Police, Union Territories Police

BSF and ITBP have the largest share of the MHA's budget for border security. For the financial year 2016-17, BSF was allocated a budget of INR 14,908.85 cr which was hiked by 8.58% for the financial year 2017-18 bringing the budget allocated to INR 16,188.74 cr. In the financial year 2018-19 the budget for BSF stands at INR 17,118.64 cr which is 5.74% more than the last year. The budget allocation for ITBP has been hiked by nearly 9% every year as compared to the previous financial year since the last 2 years. It currently stands at INR 5,521.67 cr for the financial year 2018-19.

The ICG receives its budget allocation from the Ministry of Defence. For the financial year 2018-19 ICG has been allocated a budget of INR 4,791.42 cr which is a growth of 10.17% over the last years revised budget of INR 4,348.97 cr.[4] ICG has proposed an expansion plan to have a fleet strength of 200 ships and 100 aircrafts by 2022[5] from the current numbers of 134 ships and 62 aircrafts[6]. Hence, ICG had projected a budgetary requirement of INR 7,358 cr including INR 4,950 cr under Capital head but was allocated only INR 4,791.42 cr in total including INR 2,700 Cr under Capital head.

1.2.3 Government of India Initiatives for Enhancement of Border Security

The Indian government has initiated multiple steps to ensure secure and non-porous borders for our country. The surveillance of any border area, due to its vastness, relies heavily on the Area of Interest (AoI). This AoI requires round-the-clock deployment of security personnel and equipment, which ensures a constant and effective vigil on the concerned area. Listed below are some of the key initiatives taken for enhancing border security:

a) The border areas are currently protected by fencing, floodlighting, sensors and manual patrolling. Long Range Reconnaissance and Observation Systems (LORROSs), which have been deployed at strategic areas, have proven useful in the detection, identification and recognition of infiltrators.
b) The government has set up a border management system for 24-hour vigilance along 2,900 km of the Western border to lock down any illegal intrusion. 383 border outposts (BOPs) have been constructed along the Indo-Bangladesh border and vulnerability mapping and strengthening has been done for vulnerable border outposts identified along the Indo-Bangladesh border. This has been done by deploying additional manpower, special surveillance equipment, vehicles and other infrastructure support.
c) Use of drones for surveillance and security purposes has been one of the emerging technological trends across the world for border security management system. Indian military has long operated Israeli Searcher and Heron drones for Command, Control, Communications, Computers, Information/Intelligence, Surveillance, Target Acquisition and Reconnaissance (C4ISTAR) roles and possesses anti-radiation suicide drones.
d) The Centre for Artificial Intelligence and Robotics under the Defence Research and Development Organisation (DRDO) is helping to improve the technology used in border areas for communication and surveillance. Important innovations like the Radio Trunk System (RTS) and the Radio local system (RLS) have significantly improved military communication in the border areas.
e) Department of Border management, MHA is implementing Coastal Security Scheme (CSS) in phases with the objective of strengthening infrastructures and capabilities of Coastal Police for patrolling and surveillance of coastal areas particularly shallow areas close to the coast. CSS (Phase I): Phase I was implemented from 2005 to 2011. Under this scheme, coastal states/UTs were provided with 73 Coastal Police Stations (CPS), 97 check posts, 58 outposts, 30 barracks, 204 interceptor boats, 153 jeeps and 312 motor cycles. CSS (Phase II): Phase II is under implementation till 31st Mar 2020. Under this scheme, coastal states/UTs have been sanctioned with 131 Coastal Police Stations (CPS), 60 jetties, 10 Marine Operation Centres, 225 boats, 131 four wheelers and 242 motor cycles.[7]
f) Comprehensive Integrated Border Management system (CIBMS) is a five-layer security system for border management with the objective to implement the D4R2 (Deter, Detect, Discriminate, Delay, Response, Recover) principle on the border. CIBMS uses low-light CCTV cameras, thermal imaging, NVDs,

[4] https://www.indiabudget.gov.in/ub2018-19/eb/sbe19.pdf [Accessed 10 Sep 2018]
[5] https://www.business-standard.com/article/economy-policy/coast-guard-s-rs-32-000-cr-expansion-plan-to-see-higher-pvt-participation-117102700287_1.html [Accessed 10 Sep 2018]
[6] http://www.indiastrategic.in/2018/02/02/coast-guard-day-2018/ [Accessed 10 Sep 2018]
[7] https://mha.gov.in/sites/default/files/CostalSecurity_23042018_0.pdf

surveillance radars, laser beams and underground monitoring sensors to detect infiltration via land, underwater, air and tunnels. Two pilot projects of CIBMS of 5.5km and 5.3km, along the 200 km long International Border (IB) have already been undertaken and CIBMS is expected to be deployed on Pakistan border by December 2019.[8] CIBMS has also been implemented on the border in Assam's Dhubri area, which is a riverine region. Few areas in Rann of Kutch and riverine areas in Punjab have also been identified for implementation of CIBMS.[9]

[8] https://economictimes.indiatimes.com/news/defence/bsf-itbp-chiefs-stress-on-need-for-technology-in-border-management/articleshow/60739528.cms
[9] https://www.financialexpress.com/defence/smart-fences-modi-governments-new-project-to-protect-indias-borders-with-bangladesh-pakistan/1138248/

2. BIG DATA AND PREDICTIVE ANALYSIS

2.1 Big Data

Big Data is not a technology, but rather a phenomenon resulting from the vast amount of raw information generated across society and collected by commercial and government organisations. Further, it is

a) Management and exploitation of large or complex data sets.
b) Relationship between data and the organisational, procedural and cultural factors that make up the enterprise.
c) Ways in which data is sorted, summarised to derive meaningful information.

In order to derive meaningful information out of this overwhelming amount of data it is often broken down using five V's: -

a) Volume: Volume refers to the incredible amounts of data generated each second from social media, cell phones, cars, credit cards, photographs, videos etc. The vast amounts of data generated can no longer be stored and analysed using traditional database technology. Distributed systems are thus used to analyse data by bringing together parts of the data stored in different locations using software.
b) Variety: Variety is defined as the different types of data that is used, which may be structured and/or unstructured and is harvested, stored and used simultaneously.
c) Veracity: Veracity is the quality or trustworthiness of the data, which needs to be ensured to generate meaningful results.
d) Velocity: Vast amounts of data being generated is collected and analysed, but the speed of transmission and access to the data remains instantaneous to allow for real-time access, without ever putting it into databases.
e) Value: The most important part of embarking on a big data initiative is to understand the costs and benefits of collecting and analysing the data to ensure that ultimately the data that is reaped can be monetised.

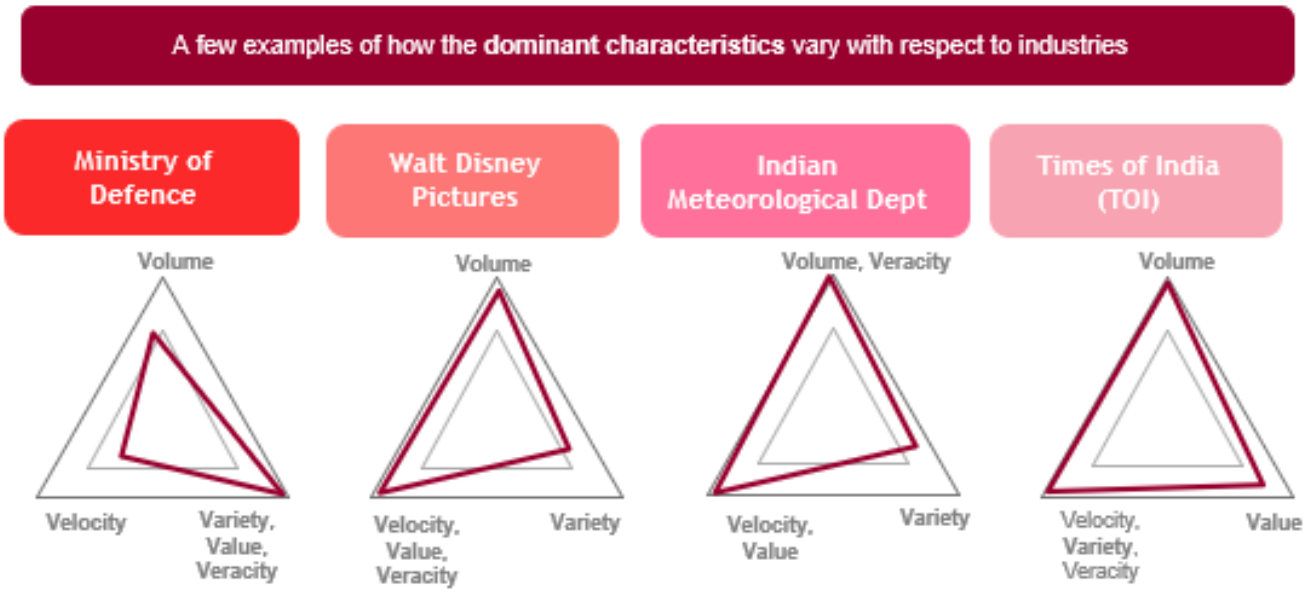


Figure 5: Dominant characteristics of Big Data for different industries

2.2 Predictive Analysis

Predictive analytics are built on the foundation of higher-level descriptive and diagnostic analytics. Raw data is sorted and made comprehendible in the form of spreadsheets, charts, reports and presentations using descriptive analytics. Descriptive analytics records happenings in the past and in the present but cannot establish a relationship between events. Diagnostic analytics looks for relationships in the data and can provide clues to causes and effects of events. Intelligence analysts use diagnostic analytics, for example, to determine whether money being moved by a terrorist group is intended to buy weapons.

Predictive analytics go far beyond the common practice of manually extrapolating from spreadsheets to make projections. These advanced analytics rely on computer models to create and think through any number of possible scenarios and assigns each one a likelihood of occurrence. They thus provide the

probability of an event, based on data about events which occurred in the past. It involves applying statistical analysis techniques, analytical queries and automated machine learning algorithms to data sets to create predictive models that place a numerical value or score on the likelihood of an event happening. There are various methodologies and techniques that are used in predictive analytics, some of them are:

a) Logistic Regression: A statistical analysis method used to predict a data value based on prior observations of a data set
b) Time Series Analysis: An illustration of data points at successive time intervals
c) Decision Trees: A graph that uses a branching method to illustrate every possible outcome of a decision.

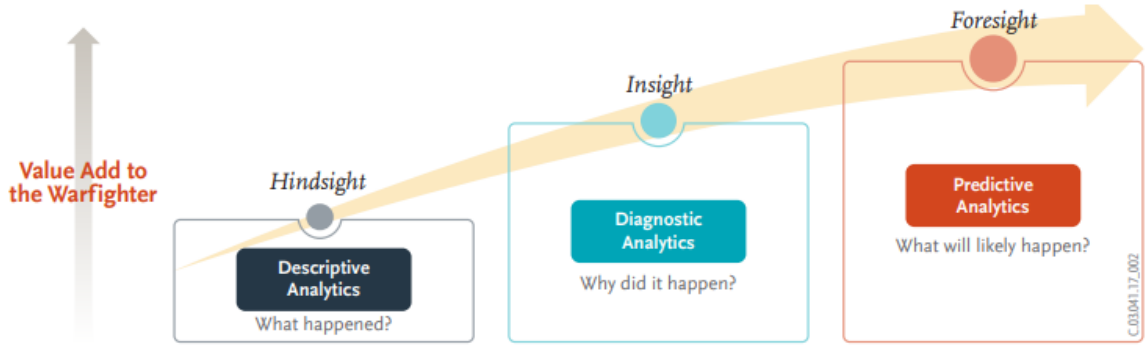


Figure 6: Descriptive to Predictive Analysis

As organisations become adept at predictive analytics, they can begin to move to the next phase i.e. Prescriptive Analytics. These analytics rate each option of the predictive, taking into consideration the organisation's goals, needs, limitations and other factors. Emerging technologies like analytics can help border agencies not only tackle their near-term challenges, but also lay the foundations for a sustainable future of continuous innovation and improvement.

2.3 Challenges

2.3.1 Capture and collation of data

To make effective use of data it is necessary to firstly capture the right data and use the best and most suitable predictive analytics tool on the data by modelling it to meet the requirement. Thus, collating data to create value would require strategies to be in place. Four 'big data' strategies to capture and create value from big data are mentioned below:

a) **Performance Management**: Performance management involves understanding the meaning of big data in large databases using pre-determined queries and multidimensional analysis.
b) **Data Exploration**: This approach leverages predictive modelling techniques to predict user behaviour based on their previous business transactions and preferences.
c) **Social Analytics**: Social analytics measure the vast amount of non-transactional data. Much of this data exists on social media platforms, such as conversations and reviews on Facebook, Twitter etc. Social analytics measure three broad categories: awareness, engagement, and word-of-mouth or reach. Awareness looks at the exposure or mentions of social content and often involves metrics such as the number of video views and the number of followers or community members; engagement measures the level of activity and interaction among platform members, such as the frequency of user-generated content; and word of mouth or reach measures the extent to which content has been spread.
d) **Decision Science**: Decision science involves experiments and analysis of non-transactional data, such as consumer-generated product ideas and product reviews, to improve the decision-making process.

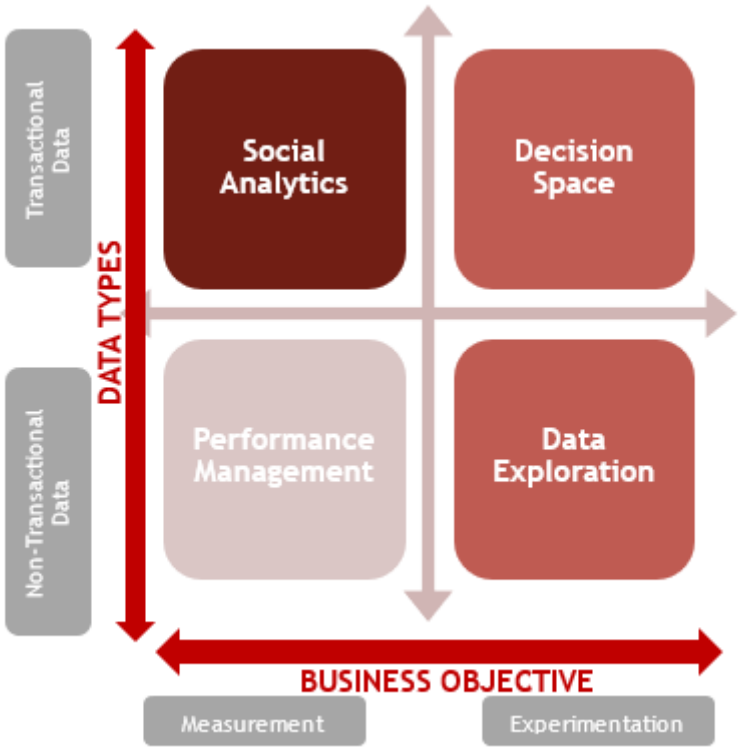


Figure 7: Big data strategies for capture and collation of data

To capture and analyse big data, companies have to deploy new storage, computing and analytic technologies and techniques. The range of technology challenges and the priorities for tackling them will differ depending on the data maturity of the organisation. However, legacy systems and incompatible standards and formats can prevent the integration of data and impede the more sophisticated analytics that create value. This means that big data also requires big technology. Several new and enhanced data management and data analysis approaches assist with the effective management of big data and the creation of analytics from that data. The actual approach used will depend on the volume of data, the variety of data, the complexity of the analytical processing workloads involved, and the responsiveness required by the organisation. Big data technologies include open-source database management systems designed to handle huge amounts of data, including Cassandra and Hadoop, as well as business intelligence software designed to report, analyse and present data.

2.3.2 Need for infrastructure to support capture of data

Big data and predictive analysis require infrastructure to support capturing of data. Details of infrastructure requirement have been provided below:

a) Massive parallel-processing (MPP) databases: These would allow data scientists and developers to take advantage of large clusters of increasingly powerful, increasingly inexpensive commodity servers, storage and ethernet switches. Key features of MPP are listed below:
   i. Allow the analytic models to be processed inside the database over vast petabyte datasets.
   ii. Reduce the need to move large datasets around and increase the performance a hundred times over non-MPP databases.
   iii. Facilitates the rapid ingestion of data. This speed affords the data scientist the ability to iterate many models and hypotheses.

b) In Memory Database Capability (IMDB): IMDBs primarily rely on main memory for computer data storage and are faster than disk-optimised databases since the internal optimisation algorithms are simpler and execute fewer CPU instructions.

When MPP databases and in-memory databases are coupled together, the concept in which fast data meets Big Data becomes a reality. This is particularly important when the real-time location of an entity is desired, or, for instance, data is flooding in from millions of sensors in the battlefield and needs to be correlated with vast quantities of historic data.

2.4 Big-Data and Predictive Analytics for Smart Borders

Security organisations collect vast amount of data. This data along with analytics can be used to make more insightful, forward-looking decisions about readiness, logistics, manpower, intelligence, and a host of other critical security concerns. Seamless integration of strategic intelligence with operational and tactical Intelligence across defence services and other agencies is needed and this can be made feasible using Big Data analytics. Agencies need a data integration layer, that can connect all the disparate databases residing across the agency, department or other central, state and local government entities - a single layer that can link a comprehensive set of data from multiple data sources into a single dashboard in real time. In other words, to successfully analyse vast amounts of granular data, this data infrastructure must be able to:

a) Process large volumes of data quickly
b) Handle the huge variety of structured and unstructured data
c) Manage the velocity of data, which is increasing rapidly

Some possible applications for big data and predictive analysis are as below:

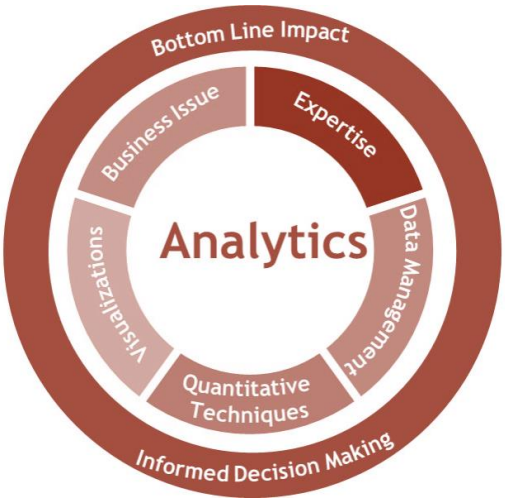
a) Signal Intelligence, cyber intelligence and intelligence from social media platforms can be integrated with operational and tactical platforms/sensors thus providing actionable intelligence to troops on ground and value inputs to decision makers to timely deploy resources and take corrective actions.
b) Better management of land borders and maritime security can be achieved by having terrain/traffic/asset analytical layer on digital/raster maps. This can act as a useful tool in formulating plans.
c) Analytics can revolutionise the supply chain management system by creating diagnostic tools for fleet / equipment management, ammunition management (manufacturing – storage – replenishment) and inventory management.
d) Cognitive analytics with behaviour prediction is an essential tool for the decision makers in the Defence Forces.

3. GLOBAL TRENDS

3.1 World of Big Data and Predictive Analytics

There is a massive amount of data being collected and stored by organisations world over. The ability to access and analyse this data, is quickly becoming more and more important. Statistics given below shows the kind of market that analytics is estimated to grow to in the coming years.

a) The **Big Data technology and services market** is estimated to grow at a CAGR of 22.6% from 2015 to 2020 and reach $58.9 billion in 2020
b) Revenue for **Big Data infrastructure** is estimated to grow at a CAGR of 20.3% from 2015 to 2020 and reach $27.7 billion in 2020
c) Revenue for **Big Data software** is estimated to grow at a CAGR of 25.7% from 2015 to 2020 and reach $15.9 billion in 2020
d) Revenue for **Big Data services**, which consists of professional and support services, is estimated to grow at a CAGR of 23.9% from 2015 to 2020 and reach $15.2 billion in 2020.[10]



Big data analytics can be utilised for intelligence gathering since inputs for national and military intelligence are obtained continuously. Human analysis of this information and intelligence data is well beyond physical capability. Big data analytics-based intelligence, on the other hand, can provide the requisite output for decision-making and conduct of operations. One of the most important features of higher-level diagnostics is that it can show us anomalies in overall patterns, uncovering critical factors one may not even have considered. The outputs of predictive analytics are particularly helpful in assessing risk, such as when making a tactical decision, or in deciding investments. Predictive analytics evaluates the risk and expresses it as a mathematical probability which provides commanders with powerful information when they're balancing priorities and considering trade-offs.

Figure 8: Features of big data analytics

3.2 Implementation of Big Data Analytics in security

A few areas where big data and predictive analytics is already being implemented in the field of security are:

a) Video analytics

Video analytics applies big data to CCTV footage and deciphers trends to automatically raise the alarm. This helps to solve the shortcomings of CCTV cameras, which rely on human monitoring and are limited to forensic analysis after the fact. Video analytics is currently used at ports, where there is 24/7 activity. British Association Ports Southampton, Abu Dhabi Ports Corporation and many more are using video analytics to detect early signs of criminal activity, security threats and suspicious behaviour, allowing rapid and effective interventions

b) Advanced analytics and predictive modelling

Fast becoming the most rapid area of technological advancement in public services, advanced analytics and predictive modelling use big data to predict future trends. Taking the recent refugee crisis in Europe as an example, this form of analytics could be used to predict migrant patterns across borders, which would allow governments and organizations to better prepare their responses.

[10] Comparative Analysis of Big Data, Big Data Analytics: Challenges and Trends by Dr. Venkatesh Naganathan - https://www.irjet.net/archives/V5/i5/IRJET-V5I5373.pdf

c) Biometrics

Biometric data, such as facial recognition, is used at "smart borders" around the world to identify people and run security checks. Use of this technology is expanding rapidly in the E.U. as countries look to improve their monitoring of border crossings. Biometrics is also being used to create identities for refugees as they seek asylum. UNHCR has created an identity management system based on individuals' biological features, which enables them to access social security and open a bank account.

d) Machine learning

This is a form of artificial intelligence that makes machines more and more efficient and effective over time through repetition and acquisition of new data. Machine learning can be used in conjunction with biometrics, for example, to enable facial recognition technology at borders get better at recognizing individuals the more it is used. California-based Qylyr Intelligent Systems Inc., meanwhile, is applying machine learning to advanced analytics to develop autonomous security checking machines at airports. These machines sniff for chemicals, scan content, analyse behaviour and become "smarter" as they improve their decision-making ability over time.[11]

e) Intelligent process automation

This is the application of automated intelligence whereby entire processes can be automated by smart processing vast amounts of data. Intelligent process automation is used at many stages of borders and customs services. E-gates, for example, are widely used at airports; this technology combines intelligent process automation with biometric analytics to reduce waiting times.[12]

f) Natural language processing/generation

This technology allows machines to understand natural language and generate a response or action.
One application could be in visa application interviews where there is a language barrier between the interviewer and applicant. The technology is already being offered by leading telecommunication application software for social purposes, but it could also be applied at borders to automatically translate speech in visa applications to increase accuracy and aid mutual understanding.[13]

g) Internet of Things (IoT)

Broadly, the IoT is the concept of multiple devices being connected through the internet – allowing them to communicate and share information. Tracking solutions provided by T-Systems use the IoT to undertake smart tracking of cargo for customs. The technology uses an online portal to track not only the location of the cargo, but also the status of the goods and other information such as temperature and any complications encountered.

3.3 Use of Big Data Analytics by organisations to provide security solutions

Some examples[14] on how predictive analytics based artificial intelligence and security applications are helping some organisations meet current challenges are mentioned below:

a) Cyber Attacks (Defence Against Hackers) and Software Errors/Failures

The software that powers our computers and smart devices is subject to error in code, as well as security vulnerabilities that can be exploited by human hackers. Potential ramifications are on a grand scale and range from the safety of an individual to the level of a nation or a region. ForAllSecure, a start-up based in Pittsburgh and launched after years of research at Carnegie Mellon, created the winning security bot in Defense Advanced Research Projects Agency's (DARPA) most recent 2016 Cyber Grand Challenge. AEG (automatic exploit generation) is the "first end-to-end system for fully automatic exploit generation", according to the CMU team's own description of its AI named 'Mayhem'. Developed for off-the-shelf as well as enterprise software being used in our smart devices and appliances, AEG can find and determine whether

[11] http://www.bloomberg.com/news/articles/2013-10-22/ coming-soon-to-the-airport-self-service-security
[12] https://www.t-systems.com/de/en/references/overview/reference/container-tracking-305840
[13] https://www.skype.com/en/features/skype-translator/
[14] Artificial Intelligence and Security: Current Applications and Tomorrow's Potentials - https://www.techemergence.com/artificial-intelligence-and-security-applications/

the bug is exploitable. Bugs are errors in software that can cause unexpected results or behaviour or potentials for security breaches.

b) Security & Crime Prevention

Predictive analytics and other AI powered crime analysis tools have made significant strides since those "pioneering" times. California-based Armorway (now Avata Intelligence) has been using AI with game theory to predict when terrorists or other threats will strike a target. The United States (US) Coast Guard uses the Armorway software for port security in New York, Boston and Los Angeles, drawing on data sources that includes passenger load numbers to traffic changes, and creating a schedule that makes it difficult for a terrorist to predict when there will be increased police presence.

c) Privacy Protection

A recent National Academies study (2015) reached the conclusion that there are no (yet) technological alternatives to bulk collection and analysis of civilian metadata. Differential privacy offers a way to maintain private data on a network, while providing targeted "provable assurances" to the protected subpopulation and using algorithms to investigate the targeted population. This type of solution can be used in trying to find patterns or indications of terrorists in a civilian population, find infected citizens within a larger healthy population, amongst other scenarios.

4. THE WAY FORWARD

The section below provides use cases of big data and predictive analytics and the way forward for smart border management covering areas of coastal security management, land border security management, enhancing communication and surveillance systems for mobilising forces, customs administration and management. Areas of intervention/ key challenges faced in the above areas and possible solutions along with expected outcomes and potential benefits have been highlighted.

4.1 Big data and Predictive analytics for coastal security management

Areas for intervention	Proposed solutions	Expected outcomes and potential benefits
▪ Predictive analytics for border management forces	▪ Use predictive models to forecast requirement of equipment and systems ▪ Use data driven predictive models to track the failure of equipment and systems ▪ Use data driven intelligent systems to harness R&D potential at DRDO & 'Transfer of Technology (ToT)' with industry partners	▪ Be on the top to enunciate the need for developing various advanced systems ▪ Understand & plan requirements of relevant organisation, through predictive models ▪ Deeper insights on cost savings, import savings, etc.
▪ Predictive analytics for logistics planning	Using advanced predictive analytics to address in advance: ▪ maintenance and modernization ▪ cost, timelines, people and skill sets needed ▪ delays in supply chain ▪ plan for 'float, move and fight categories	▪ Timely/ pre-emptive action on changes in manpower affecting maintenance planning and execution ▪ Finding out hidden patterns in usage and repair data – this can be used to improve the reliability of parts of certain border patrol vehicle, tracked amphibious patrol vehicle, aircraft or ship, etc ▪ Meet schedule and budget requirements
▪ Unavailability of large pool of trained manpower for employment for coastal security duties	▪ Automation of reading CYMBALS (Colour, Year, Make, Body, Attire, Looks, Sex) information ▪ Robotic process automation, with the use of inbuilt rules and intelligence engines to enable better decision making ▪ Infrastructure support using prediction ▪ Enhance CBT for marine personnel and 'persons in position'	▪ Improvement of screening and tracking people, boats, vehicles using CYMBALS information ▪ Using Prediction models, to cut down delays in land acquisition and support infrastructure, such as barracks and staff quarters ▪ Better allocation of officers and improving productivity and skill sets
▪ Indirect threats-vulnerability of the Indian coast to illegal inflow of migrants & refugees	▪ Introduction of Big Data using Business Intelligence analytics (BIA) to monitor data from AIS, LRIT, IR camera, GPS, Inertial Navigation Unit, IPMS & other sensor equipment (radars, etc) ▪ Implementing geospatial trending algorithms	▪ Predictive models in BIA could be used to gain insights for better control on population centres along the coast, security and safety of vital installations like atomic power plants, oil platforms, naval/ military/coast guard bases and industrial centres ▪ Better control on illegal inflow of migrants & refugees ▪ Detect deviation of vessel routes and unusual voyages ▪ Enable more efficient monitoring/ surveillance of the waters

		▪ Use of matching algorithms on vessel-related information to quickly sieve out known threat ▪ Use business rules to detect vessels which do not conform to the norm of their vessel type and generate patterns that may contribute to a threat scenario when occurring concurrently ▪ Ability to determine formation of networks pivoted against owners, crew, etc to curb corruption and fraudulent practices
▪ Lack of integration, coordination and exchange of information between various agencies and access to human and technical intelligence sources	▪ Uncover relationships using network analysis techniques ▪ Generating insights on fraudulent activities by officials and track corrupt officials via models based on prediction ▪ Detect outliers across multiple vectors in the data using machine learning techniques ▪ Introduction of Big Data analytics to collate data from agencies such as CSN, ICG, IALA, CRPF, DPSUs, AMTS, CCTNS, NATGRID etc. & using this data to create predictive models	▪ Matching algorithms to help match varying events across different realms and draw usable information ▪ Use business rules to detect anomalies and generate patterns that may contribute to a threat scenario when occurring concurrently ▪ Ability to determine formation of networks pivoted against national security and to curb corruption and fraudulent practices
▪ State of pollution control in Indian waters	▪ Analyse data from satellites, UUVs and UAV surveillance to build diagnostic models ▪ Build predictive patterns of oil spills using database information	▪ Analyse extent of damage, and creation of alert frameworks in case of oil spillage ▪ Enhance response time by predicting near future oil spills

4.2 Innovation and technology infrastructure to enhance border management services

Areas for intervention	Proposed solutions	Expected outcomes and potential benefits
▪ Predicting immigrants' risk profiles through data analysis for immigration fraud control	▪ Immigrant risk analysis using social media insights and Biometrics/Identity Analytics (BIA) ▪ Tackle immigration fraud by highlighting groups of people that pose higher risk in terms of key metrics ▪ Entry/Exit System (EES) and Registered Traveller Programme (RTP)	▪ Predictive models in BIA suggest the eligibility of an immigrant to enter, by analysing risk of over-staying, failing to pay taxes or committing crimes once inside the country ▪ Speed up, facilitate and reinforce border-check procedures for third-country nationals (TCNs) ▪ Allow pre-vetted and frequent travellers from third countries to enter (and exit) the country/area with minimal border checks
▪ Achieving operational excellence at reduced costs	▪ Automation and robotic cargo handling ▪ Robotic process automation, with the use of inbuilt rules and intelligence engines to enable better decision making ▪ Leveraging IoT	▪ Faster online processes for visa applications ▪ Improvement of screening and tracking of goods using the IoT

▪ Optimisation and better allocation of workforce and identification of fraudulent activities within the workforce	▪ Predictive analytics to assist staff to be more productive through better workforce planning ▪ Workforce capacity planning and modelling using predictive analytics ▪ Generating insights on fraudulent activities by officials and track corrupt officials via models based on prediction	▪ Reduction in man-power leading to significant reduction in costs ▪ Allocate officers based not only on expected immigrant arrivals and likely footfall but also on the risk profiles of those immigrants ▪ Ability to determine resource requirements and conduct scenario-planning capabilities ▪ Ability to curb corruption and fraudulent practices

4.3 Big data and predictive analysis for enhancing communication & surveillance systems at border areas

Areas for intervention	Proposed solutions	Expected outcomes and potential benefits
▪ Smart Inspection System (SIS) at Border areas to allow only legitimate people to engage in cross border activities	▪ Full cycle Installation and Maintenance System for advance scanning technologies ▪ Enabling Vehicle Trans ponder Framework (VTF)	▪ Save time and manpower to detect concealed weapons, drugs, illicit radiological material etc. Using non-invasive inspection techniques such as explosive vapor detectors, full-body scanners, metal detectors and handheld substance detectors, etc. ▪ Install a pre-screening application and inspection process to make the transponder installed vehicles driven by personnel with proper background verification and compliant with laws and regulations
▪ Surveillance drones not being used to their full capacities due to restricted flight space	▪ Developing a Collision Avoidance Model (CAM) in collaboration with the Ministry of Civil Aviation (MoCA) for optimal airspace and flight trajectories using deep learning techniques	▪ Drones equipped with a high-accuracy Satellite-Based Augmentation System (SBAS), will provide a pin point solution to track illegal migration and cross-border crimes
▪ Leveraging surveillance radar or sensor information and data generated through suitcase SATCOM terminals, Long-range reconnaissance and observation systems (LORROSs)	▪ Developing models to analyse rise and fall in illegal activities and movement of trespassers across border using predictive analytics and machine learning ▪ Reduce Turn Around Time (TAT) for threats/incident responses	▪ Identify key pain points of repetitive intrusion and act on forecasting based incident pattern analysis ▪ Descriptive analytic models for threat classifications, friend/foe segmentation, availability of time and resources for incident response ▪ Data visualisation tools for presenting inferences
▪ Better ways to encrypt data during communication from command centre to border posts or vice versa	▪ Using Roots of Trust (RoT) technology, in the Internet of Things (IoT) devices to make secure data accessible in a wider number of self-encrypting drives (SEDs) ▪ Capitalising on Big-Data analytics and cloud computing to secure the confidentiality of data through high-end cryptographical techniques such as Fully Homomorphic Encryption (FHE), Verifiable Computation (VC)	▪ RoTs provide a Trusted Execution Environment (TEE) to perform one or more proven cryptographic functions and are easy to interact with a simple UI ▪ FHE is considered the “holy grail” of confidential outsourced computation because it allows any computation to be performed over multiple encryptions without decryption ▪ VC can guarantee the integrity of the data and the computations without incurring the performance

		costs associated with achieving confidentiality
▪ Extreme weather conditions at the locations make surveillance a challenging task for the border forces	▪ Develop Weather forecasting models in collaboration with Indian Meteorological Department (IMD) ▪ Establish demand and supply plan to manage inventory using predicted weather data	▪ Understanding the weather in advance would help the security forces to prepare for the effects of the weather ▪ Assist security forces to be prepared with the inventory for the predicted weather

4.4 Big data and predictive analysis for mobilizing security forces

Areas for intervention	Proposed solutions	Expected outcomes and potential benefits
▪ State-of-the art high-end technology weapons	▪ Using Big-Data capabilities to generate insights on the various advancements in the field of weaponry all over the world ▪ Predictive analytics based models to detect demand of weapons during peacetime and wartime ▪ Generating insights from current state of affairs & global socio-economic trends to build predictive models anticipating attacks & threats ▪ Providing budget vs forecast models on revenue allocations and expenses made on weapons and equipment	▪ Reduce costs and time on strategizing weapon inventory ▪ Knowledge to help in decision making for investment in robotics machinery thereby leading to reduced man-power ▪ Ability to take preventive action before any threat is out in the open
▪ Using Big data capabilities to track and neutralise criminals before they cause any harm	▪ Using Big Data and Predictive Analytics capabilities, to generate potential threat insights and such similar terrorist activities, out of email, social data, XML data, videos, audio files, photos, GPS, satellite images, sensor data, spreadsheets, web log data, mobile data, RFID tags and PDF docs	▪ Improved decision-making support for the planning and conduct of operational activities ▪ Acquisition, development and fielding of new or enhanced military capabilities ▪ Development of in-service doctrine, analysis to identify training gaps, retention issues, alternative training methods and live, virtual or constructive military training
▪ Infrastructure for training border security personnel	▪ Computer Based Trainings (CBT) for new recruited border security personnel	▪ Have better insights into preparation of training packages using big data analytics ▪ Decrease the training costs and enable sharing of knowledgeable, best practices and learnings across various security forces

4.5 Big data and predictive analysis for customs administrations and management excellence

Areas for intervention	Proposed solutions	Expected outcomes and potential benefits
▪ Duty unpaid offences ▪ Fuel and liquor offences ▪ Gold smuggling	▪ Less than Container Load (LCL) Framework ▪ Analyse historical data, scan informative data from local intelligence sources via international collaborative efforts ▪ Risk based targeting using Anomaly-Detection BI system (ADB) ▪ Non-Eluding Inspection (NEI) using X-ray or gamma-ray imaging equipment	▪ ADS aiding in real time anomalies identification of permit declarations based on a set of pre-defined criteria and historical data, and assigning risk scores ▪ Importer profiling and segmentation to find inconsistencies using importer's past business activities and analysing risk profile of previous cases involving similar modus operandi ▪ Identify evolving trends and patterns, through analysis of multivariate data and assess their impact and respond to threats and opportunities posed ▪ Declaring agent, importing the consignment on behalf of the importer can exercise due diligence to conduct checks on the importer
▪ Civil GST evasion causing stresses on the budget	▪ Ensure tracking framework to keep a close track on civil GST evasions ▪ Enable compliance and regulatory framework on importers	▪ Routine and surprise compliance checks to keep the licensees on their toes ▪ Ensuring compliance of licensees with customs' laws and regulations
▪ Tracking of unusual shipments ▪ Under-declaring the import value of goods	▪ Tracking unusual shipments using permit declarations analytics, by using machine learning and predictive capabilities ▪ Framework to assign risk scores to goods or family of goods based on their high value and relative ease of being moved around, using predictive analytic models	▪ Identification of goods or family of goods that are more prone to money laundering and terrorism financing risks ▪ Highlighting rampancy of incorrect declarations by zeroing on permit declarations that exhibit extreme similarities ▪ Identification of fictitious commercial invoices with suppressed values
▪ Trader's satisfaction is not considered - leading them to opt for illicit and illegal means	▪ Enhance traders' experiences by implementing a Short & Simple Trader's Checklist (SSTC) ▪ Enabling trader's satisfaction scorecard	▪ Understand the experiences, needs and expectations of the trading community in a better way & enhance transparency between government teams & trading community ▪ Introduction of trader's satisfaction scorecard using key metrics such as F2F interactions with customs' officers, manufacturer's registration and SLAs, trading schemes ▪ Risk analysis of traders by segmentation and profiling techniques and in-depth analysis of supporting documents
▪ Assumption that IoT is over-hyped	▪ Using IoT to detect fraud and other crimes by using digitally-enabled supply chain ▪ Collect information that can be used to drive targeted interventions	▪ Track cargo movement using data from sensors embedded in vehicles across the supply chain ▪ Detect potential tampering by tracking unexpected temperature changes in containers ▪ Collate real-time data on factors like temperature, humidity and location

FICCI has many specialised committees where key concerns of the industry are debated and discussed with the specific aim of presenting the recommendations to the Government for favourable decisions.
Considering internal security is the backbone of growth and overall development of the nation, FICCI has constituted a Committee on Homeland Security (HLS), which is working towards bridging the gap between policing and technology.

Some of the focus areas:

SMART Policing: FICCI has instituted the first ever SMART Policing Awards in India for best practices in SMART Policing, with the objective to promote initiatives taken by the Police for safety and security of Indian citizens. This can change public perception and build positive and progressive image of the police among people. FICCI SMART Policing Awards provide a platform to police officials across India to learn from the experiences of other states and also for possible adoption of the best practices to further enhance policing in their respective states.

Police Modernisation: FICCI is working towards bridging the gap between policing and technology. We engage with various enforcement agencies and provide them a platform to interact with industry, to articulate their requirements and to understand new technologies for security. This initiative is under our umbrella theme of "*Modernisation of India's Internal Security Mechanism*".

Smart Border Management: FICCI is working towards addressing the emerging challenges faced by India in smart border management, by bringing stakeholders together to discuss how India can create smart borders that, on the one hand, allow enhanced trans-border movement of peoples, goods and ideas, and on the other, minimise potential for cross-border security challenges.

Indian Unmanned Aerial Vehicle (UAV) Policy & Regulations: FICCI has set-up Working Groups in areas of: (a) enabling regulations for developmental use of UAVs, and prevention of rouge UAVs; (b) framework for permission and licencing for manufacturing of UAVs; and (c) technological structure for detection and neutralisation of unidentified UAVs. FICCI has recently submitted its preliminary suggestions and recommendation for Indian UAV Policy & Regulations to the NITI Aayog, Ministry of Home Affairs and Directorate General of Civil Aviation.

Policy for Public Procurement in Internal Security: FICCI is working towards advocacy for bringing well-defined procedures for fair and transparent procurement of security products and solutions, so as to provide level playing field to the industry. Although the Central Armed Police Forces (CAPFs) and State Police Forces are guided by the same policies and guidelines for public procurement as other government organizations, the nature and requirements of public procurement process for police forces is different from that of the general government departments. FICCI has provided policy inputs to the Government of India for numerous challenges in regard to procurement by Internal Security forces, in the areas of policies and regulations, processes, technological advancements and capacity-building.

Cyber Crime Management: FICCI has initiated working towards promoting development and implementation, of systems and concepts to combat cyber-crime as well as improve cyber security.

Road Safety: United Nations has proclaimed 2011-20 as the Decade of Action on Road Safety. FICCI feels that the Indian Industry can play a significant role in addressing the issue of road safety.

Contact

Mr. Sumeet Gupta
Senior Director
sumeet.gupta@ficci.com

Mr. Ankit Gupta
Senior Assistant Director – Homeland Security
ankit.gupta@ficci.com
+91-99900 89493

Mr. Gaurav Gaur
Senior Assistant Director
gaurav.gaur@ficci.com
+91-98731 11690

Ms. Sonali Hansda
Research Associate – Homeland Security
sonali.hansda@ficci.com
+91-96543 87211

FICCI
Federation House, Tansen Marg
New Delhi 110 001
T: +91-11- 23487212, 23487474
www.ficci.in

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Contacts at BDO in India

MR. KAUSIK SAHA
Partner - Virtual Analytics
Business Advisory Services
kausiksaha@bdo.in

CDR GAUTAM NANDA
Leader - Aerospace, Defence & Security
Associate Partner - Government Advisory
Business Advisory Services
gautamnanda@bdo.in

CDR KARTIK VIG
Director - Aerospace, Defence & Security
Government Advisory
Business Advisory Services
kartikvig@bdo.in

MR. NIPUN AGGARWAL
Senior Manager - Aerospace, Defence & Security
Government Advisory
Business Advisory Services
nipunaggarwal@bdo.in

Federation of Indian Chambers of Commerce & Industry

Established in 1927, FICCI is the largest and oldest apex business organisation in India. Its history is closely interwoven with India's struggle for independence, its industrialisation, and its emergence as one of the most rapidly growing global economies.
A non-government, not-for-profit organisation, FICCI is the voice of India's business and industry. From influencing policy to encouraging debate, engaging with policy makers and civil society, FICCI articulates the views and concerns of industry. It serves its members from the Indian private and public corporate sectors and multinational companies, drawing its strength from diverse regional chambers of commerce and industry across states, reaching out to over 2,50,000 companies.
FICCI provides a platform for networking and consensus building within and across sectors and is the first port of call for Indian industry, policy makers and the international business community.

Contacts at FICCI

MR. SUMEET GUPTA
Senior Director
Sumeet.gupta@ficci.com

MR. ANKIT GUPTA
Senior Assistant Director – Homeland Security
ankit.gupta@ficci.com