



**Unique Identification Authority of India**  
Planning Commission, Government of India



Aam Aadmi Ka Adhikaar

# **ANALYTICS - EMPOWERING OPERATIONS**

## **THE UIDAI EXPERIENCE**

Unique Identification Authority of India





## Table of Contents

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Executive Summary .....	04
1. Introduction .....	06
2. What is “Analytics and Reporting”? .....	07
3. “Analytics and Reporting” should be an essential part of Government programs .....	09
3.1. Nature of Government programs is extremely demanding .....	09
3.2. Analytics and Reporting is helping meet some of these demands .....	09
3.3. Using Analytics and Reporting in government programs .....	12
4. Creating an Analytics and Reporting function .....	13
4.1. Journey cycle of data .....	14
4.2. Design principles .....	14
4.3. Business Intelligence framework .....	16
4.4. Delivery platform .....	17
4.5. Delivery team .....	18
4.6. Infrastructure .....	19
4.7. Data security and privacy .....	19
4.8. Process Requirements .....	20
5. Complexities and challenges in implementation .....	21
6. Phased approach to creating a sustainable Analytics function .....	22
7. Illustrations from UIDAI .....	23
7.1. Setting the Objectives .....	23
7.2. Business Intelligence Architecture and Infrastructure .....	23
7.3. Delivery platform .....	25
7.4. Delivery team .....	27
7.5. Software requirements .....	29
7.6. Guiding principles for design .....	30

# Executive Summary

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Government programs are characterized by complex implementation challenges on the ground, from the geographic scale to interaction with millions of residents within a multi-layered ecosystem. Further, they must straddle the multiple goals of universality, ubiquity, inclusiveness, uniformity and conformity. The Unique Identification Authority of India (UIDAI) is working to provide residents of India a Unique Identification number (called Aadhaar). The authority, in a short span, is set to become the largest biometric capture and identification project in the world. Managing these complexities in growing and maintaining large ecosystems has required UIDAI to leverage innovations across technology and operations. A strategic initiative adopted by UIDAI from the design stage has been the extensive usage of Analytics and Reporting to aid operations.

Reporting is the process of sharing data related to an organization with key stakeholders. Analytics is the structured process of analyzing this data to derive insights that help operations. UIDAI's experience, as well as emerging academic research, indicates that Analytics and Reporting delivers concrete benefits to the end-to-end operations.

These benefits span tactical, operational and strategic levels, helping move decision making from "intuition based" to "data based":

1. Creating information conduits providing End-to-End integrated visibility for management across the entire ecosystem;
2. Having a common language derived from a single source of truth (data) helps the entire ecosystem communicate and coordinate;
3. Real-time feedback loops to enable continual fine-tuning of operations;
4. Increasing transparency of the system, internally and externally;
5. Improvement in delivery of services, reducing leakages and delivering it to the right beneficiaries;

Government programs stand to further gain by the usage of Analytics and Reporting. With the move to digitization in many programs, huge amounts of data are getting generated. Having a clear Analytics and Reporting strategy in place can ensure this data is harnessed and used to improve operations and delivery of services. Further, Analytics can be used at a strategic level to shape and execute public policy priorities in resident facing applications.

At UIDAI, Analytics and Reporting has been a constituent of the UIDAI implementation strategy from inception. BI and Reporting modules have been part of the IT architecture design and a dedicated BI and Reporting team in place. A cross-functional Analytics and Continuous Improvement council was created at an early stage to suggest and oversee usage of Analytics across the organization.



**Creating an Analytics and Reporting function** involves recognizing that building IT systems is not the end point; rather it is the starting point in terms of generating data. Success of this function depends on recognizing that data is the platform from which multiple decisions are enabled and not hardware or software. A key starting point in creation of the function is to ensure Business Intelligence (BI) systems are part of the overall IT architecture design and strategy. This is because Analytics and Reporting spans not just publishing reports, but includes data capture, integration and management; as well as analysis of data using dedicated tools and experts.

The function can comprise of three broad parts:

1. **Business Intelligence framework** that captures and manages data. They provide the extensible infrastructure platform, framework and associated tools for Analytics. The long-term reporting requirements need to be separated from operational (in-process) requirements by providing different databases to handle.
2. **Delivery platforms** like Email/FTP/Portal/Mobile create the information conduits through which data is shared with the organization in various formats (Excel/PowerPoint/Charting). An online analytics delivery platform is recommended.
3. **Delivery team** would enable the function. A structure that is used in the Analytics and Reporting function is a combination of “End-user” (process owners who are the actual consumers of analytics) focused teams along with “support teams” that have been built for specific competencies. Two broad set of support teams focused around Technology and Specialized Analytics can be envisioned.

Certain design principles including a focus on stakeholder requirements, flexibility, scalability and self-service based can help ensure the outputs are relevant and useful for the organization. A core team can be built in-house that is supplemented by external vendors providing specific skill sets. The Analytics and Reporting team, core and extended, should ideally be co-located. Ensuring the right mix of technical (Warehouse, Analytics software) and business skill sets (Analysis, Insights) is important in building the team. A dedicated portal development team from the Technology vendor is required to run and maintain a web-based Analytics delivery platform.

Hardware requirements for Analytics and Reporting need to be addressed separately since it is typically among the most compute intensive sub-system. It is recommended that the Data Warehouse storage and processing hardware be created independently, rather than using live production systems for Reporting. Software requirements would include Business Intelligence tools, Visual Analytics software, advanced modelling software and Data security software. Processes and a governance structure should be put in place to ensure data privacy and security.

Implementation of a strategic initiative of this nature is likely to face challenges. Some of these challenges are technological, but the more difficult ones are behavioural. Senior leadership support is critical to the successful implementation of this transition. Implementing this requires a carefully thought out, phased transition plan that is a combination of short term and long term milestones.

# 1. Introduction

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The Unique Identification Authority of India (UIDAI), attached to the Planning Commission of the Government of India, is working to provide residents of India a Unique Identification number (called Aadhaar) linked to the resident's demographic and biometric information. The project aims to create a platform that serves as an "identification infrastructure" for the delivery of public and private services to the residents of India.

The project began issuing Aadhaar numbers in September 2009, and as of January 2012 had already issued more than 110 million Aadhaar numbers. More than 40 million additional enrolments have been completed on the field across almost all states. The project has involved taking cutting edge technology and devices to each individual resident. This has been accomplished in a short timeframe adding additional layers of operational complexity. Reaching this scale of operations has required UIDAI to create and operate a large eco-system.

The Aadhaar project is set to become the largest biometric capture and identification project in the world. In its implementation, the Aadhaar project has leveraged many innovations across technology and operations. An important strategic initiative adopted by UIDAI from the design stage has been the extensive usage of Analytics and Reporting.

Analytics based on usage of macro-economic data and government published datasets (e.g. Census) has been prevalent. However, this document particularly deals with Analytics on data generated by organizations themselves to aid their own operations and strategies. This document describes specifically how UIDAI is benefiting by leveraging Analytics and Reporting in its end to end operations.

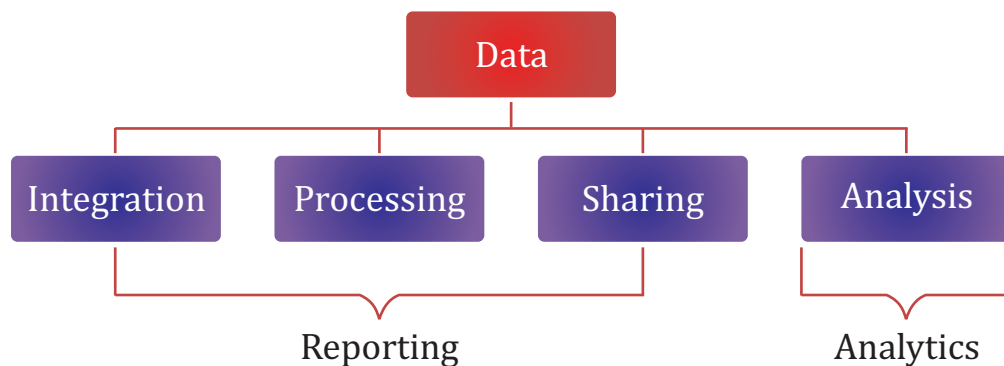
With the move to digitization, almost all government programs are generating data in each of their transaction points. For e.g., creation of a Ration card or linking the family members of a ration card leads to creation of operational data. Many public sector enterprises already have large datasets related to their operations. Having an Analytics and Reporting strategy in place ensures that this data is harnessed and used to enhance operations in an efficient manner. The document shows how it is as relevant for other Government programs and provides a basic template and guiding principles to build an Analytics and Reporting function.

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## 2. What is “Analytics and Reporting”?

**Reporting is the process of sharing data related to an organization with key stakeholders. Analytics is the structured process of analyzing this data to derive insights that help operations.**

While there is a general understanding of “reports”, an analogy of water source can be considered to understand the full spectrum of Analytics and Reporting within organizations. Data can be considered as the equivalent of water. There are a number of processes involved before the actual consumption of water and data. The journey begins with data, like water, being generated at multiple sources. These are then brought together into one central location. Data in this central source then needs to be cleaned, processed and brought to defined standards before it can be shared ahead. Information is then delivered to end-consumers through a series of conduits in the form of multiple delivery platforms. Analytics and Reporting does not end at just delivering data to users. Analytics involves usage of this data for further running operations.



**Figure 1:** Components of Analytics and Reporting

**Reporting can be broken down into two broad areas** - collecting / managing data within the system (processing) and sharing it with the organization (Reports). It is observed that “Reports” are strongly associated with the entire Reporting process, though they represent only the visible part of the process (output).

**Data is generated in an organization from multiple sources.** Some data is captured automatically while some is manually generated or captured by third-party sources. Core operations of organizations, typically directly linked with their IT infrastructure, tend to automatically capture data. Processes that are not directly connected with the IT infrastructure, or that were not designed to capture data, generate data that needs to be

manually input (typically field level operations data done in offline/paper mode). As an example, operations related data like number of enrolments, processing etc is captured directly by UIDAI systems. Data like number of enrolment centres (different from enrolment stations), enrolment form number are either not captured or fed manually in the system. Finally, data could also be provided by sources beyond the organization – these could be the vendors of the organization or independent sources like Census, market surveys etc. In UIDAI's case, the data provided by its certification agency (Sify) and delivery partners (India Post) is captured independently by them and shared in a defined format.

**Data integration and management** is an important part of Reporting as well. This typically involves integrating the various sources of data together and creating a platform (data warehouse) which provides easy access to this data. Data typically is stored in databases. However, as organizations, users and size of data grows larger; direct extraction from raw databases is not scalable. Tools hence need to be configured that help access this data in a convenient, fast and secure manner. These activities within Reporting are typically more technology focused and involve specialized skill sets related to Data Warehouse and Business Intelligence. UIDAI uses HDFS (Hadoop Distributed File system), an advanced data storage system from which data is extracted and managed using specialized tools (called Business Intelligence tools).

**Sharing of processed data** is the most visible part of Reporting. This is typically done through Excel, PowerPoint, Web-Portals, Dashboards (a screen with all key pieces of data at one place) etc. Depending on the organization's maturity, this sharing spans basic data dumps to interactive usage of data. In the case of UIDAI, there is a dedicated reporting portal with standardized reports, dashboards available to users when the log in.

**Analytics**, on the other hand, is the structured process of analyzing this data to help improve operational decision making. In the absence of a structured process, most users tend to use their "gut", past experiences or data analysis on an ad-hoc basis to make decisions. Analytics is the process of doing this in a structured manner, using a combination of data (science), tools, skilled resources and operational experience. The analysis could be basic analysis of trends and charts using Excel / Graphs or sophisticated statistical analysis of large amounts of data. This analysis is used to identify trends or anomalous behaviour, understand the root cause of the issues and conduct forecasting. The insights from Analytics guides decision makers to gain a deeper understanding of their operations. The Analytics team at UIDAI works closely with process teams to analyze data like productivity, biometric quality and help them improve their operations.

While organizations tend to have "reports" available in some form, Analytics and Reporting involves having a dedicated team working closely with Technology (IT) and program stakeholders to provide them data and insights on a regular basis. Data here is the "hero" – the centrepiece that anchors decision making. Hence the function needs to be treated differently, and over time decoupled, from systems and infrastructure architecture considerations.



## 3. “Analytics and Reporting” should be an essential part of Government programs

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The government runs public service programs that are huge in scale, having many moving parts and complex implementation on the ground. Further, several large scale programs have been launched in the past few years (e.g. MNREGS, SSA, NRHM etc) and more initiatives continue to be launched. Government programs are characterized by complexity and challenges on the ground; mainstreamed usage of “Analytics and Reporting” helps meet some of these.

### 3.1. Nature of Government programs is extremely demanding

Government programs at all levels are characterized by the **scale** they operate at. They must straddle the varied goals of being universal (anyone can have access), ubiquitous (anywhere access), inclusive (no bias), uniform (in line with national goals) and yet diverse (to be relevant to every region, community, geography, language, customs).

They involve interacting with millions of residents regularly. This scale translates into billions of transaction points between residents and the government in the delivery of these public services. The delivery of these public services often involves operating in a multi-layered ecosystem within the government itself. This spans multiple ministries, central-state-district-local administrations, partners across public sectors and private sector firms and vendors. Further, any implementation within the government framework requires strong compliance with government norms and processes. These include financial norms as well as process norms and Service Level Agreements (SLAs) while minimizing leakages.

The UIDAI implementation bears out all of these challenges. The UIDAI ecosystem today has more than 60 Registrars; including State governments, multiple central ministries and public sector enterprises that coordinate enrolment in the field. They in turn employ in excess of 100 private sector agencies that physically enrol residents in the field. In addition, partnership with banks for Financial Inclusion and multiple enterprises for Authentication (actual usage of the Aadhaar number on the field) is taking off.

Managing this ecosystem required the creation and operation of a distributed ecosystem. Historically, management has been vertically integrated where all the resources are owned by the implementing agencies and where they are not, they are done by dictat. UIDAI’s model is one where responsibility is distributed, but it is brought together through incentive alignment, contracts/MOUs and technical interfaces like APIs.

### 3.2. Analytics and Reporting is helping meet some of these demands

UIDAI’s experience as well as emerging academic research indicates that Analytics and Reporting delivers concrete benefits to organizations. Reporting and Analytics has been a key constituent of the UIDAI implementation strategy from inception, with the BI and Reporting

modules being part of the IT architecture design. A cross-functional Analytics and Continuous Improvement council was created at an early stage to suggest and oversee usage of Analytics across the organization. The technology partner for UIDAI was also required to provide a dedicated Business Intelligence and Reporting team to support UIDAI.

UIDAI has been able to leverage this Analytics and Reporting support at a tactical, operational and strategic level. The Analytics and Reporting function, through the council, has provided the UIDAI ecosystem with tools to help meet some of the challenges of scale and ramp-up that UIDAI has taken on.

### **1. Providing End-to-End Visibility**

UIDAI today collects a huge amount of “meta-data” at each possible juncture in the Aadhaar enrolment and processing stages. Meta-data refers to data that describes the process, and can be captured at each stage of the implementation. As an example, UIDAI captures the time spent by an operator on each screen of the enrolment process, number of attempts, transit time, packet status at each stage of processing, letter delivery status etc. This, for example, is used to identify operators whose productivity is low and give them individual feedback to help improve. This also helps identify the best operators and share best practices.

Technology helps build a complete end-to-end process using various best of breed components, technologies, organizations. “Data virtualization” and Reporting provide an integrated end to end view of the entire process, using highly granular data which provides full management visibility, exception handling etc. Web-based interaction serves as information conduits within the entire ecosystem, thus smoothening communication and coordination between departments. The organization becomes strongly inter-connected, in line with organizations that are becoming “networked”.

### **2. Providing a single source of truth**

Internal and external stakeholders across the UIDAI ecosystem have access to performance and operational data at a click of a button through a web enabled Analytics portal. UIDAI provides the common data source that becomes the single source of truth for the organization.

This has led to some significant advantages: First, decision making moves from being intuition-based to evidence-based. Second, since all decisions are being made using the single source of truth, the chance of them being conflicting is greatly reduced. Third, the same data source is available to everyone, regardless of geographical location or organizational boundaries, and hence decisions are coordinated. Finally, future decisions are well coordinated with past ones, since they are based on the temporal evolution of the same source of truth.

### **3. Managing through information**

Internal reviews, reviews of UIDAI with external partners like Registrars and Enrolment Agencies are enabled through standardized review reports delivered online every fortnight. Users also have the option to build custom datasets through a user interface for their own analysis with almost real-time data. Internally, the portal provides a unified view to the eco-system partners on the status of their operations.

In a multi-layered ecosystem, and in UIDAI's case – a distributed system; data begins to serve as the common language. The ecosystem is 'snapped together' through technical APIs, other interfaces, workflow tools, legal agreements and contracts, and other coordination mechanisms. The data 'overlay' and analytics, reporting etc, enables it to be managed as a seamless system. Analytics and Reporting thus helps manage the dispersed responsibility that is a characteristic of a distributed ecosystem. It facilitates communication and coordination; helps align incentives and track against the same goals.

#### **4. Real time Feedback**

The data centre is the nerve centre of UIDAI where each enrolment data packet is processed to generate Aadhaar numbers. The “Network Operations Centre” (NOC) of UIDAI in Bangalore is a control room with rows of wall-mounted screens showing near real time data of processing stages and hardware. Alerts are triggered to the respective process owners in case of build-ups or hardware breakdown.

Near real-time visibility of operational performance enables rapid feedback loops – a necessity to manage large and complex systems. Real time feedback also enables policy making to be 'data-based' and tactical/operational moves to be continually fine tuned. Course correction happens faster, rather than be more of a post-mortem analysis. It also helps speed up transfer of learning within the organization, which typically is a slow process and people dependent.

#### **5. Transparency:**

The UIDAI public website (<http://uidai.gov.in>) and the public portal (<http://portal.uidai.gov.in>) provide a platform to share data related to operations publicly. The public portal provides overall enrolment stats with high degree of click-through granularity. Users can track the real-time status of processing of their enrolment packet. Aggregated and anonymized datasets are available for download by external users to conduct their own analysis. Payments related information is accessed and delivered through a standardized monthly process. Many Right to Information (RTI) and parliamentary questions are answered using data pulls using the internal portal.

Analytics and Reporting greatly helps in increasing transparency within an organization by sharing real-time operational data across the system as well as providing End-to-End visibility to everyone. Many government programs are pro-actively seeking to build public facing “transparency portals” as well to share a lot more of information related to their users. The Analytics and Reporting infrastructure can help with some of these initiatives by providing the computational back-end (e.g. search capability for users) as well as some of the aggregated data.

#### **6. Improving delivery of services**

UIDAI used a team of specialists who analyzed huge amounts of data using statistical software to come up with rules for identifying potential fraud attempts by enrolment operators. Further, Online Authentication provided by UIDAI, will use a combination of biometric matching with fraud modules to identify potential fraud. State Resident Data Hubs (SRDH) will provide standards and APIs that will help public services clean their databases using the Aadhaar as the

common key, as well as deliver benefits to the right people when data across departments are combined.

The move to digitization can help improve delivery of public services by government programs. Combining this with Analytics at the back-end, offline or in real time, can improve the quality of this delivery by minimizing leakages at each of the billions of transaction points between residents and the Government.

## **7. Continuous improvement:**

Poor biometric quality enrolments by Ravi, an operator with an Enrolment Agency, came down by 75% after a training session that used analytics to help identify specific areas of improvement for him. The Analytics and Reporting function analyzes and publishes data to aid quality improvement initiatives that UIDAI is undergoing. The combined efforts have led to an almost consistent increase in the quality of Biometric data being captured for UIDAI since March, 2011. It is an unusual case of a system where quality has improved with expanding scale of operations!

The Analytics and Reporting function can support specific initiatives that various process owners in organizations undertake. The function, through a team of analysts, can provide support to help improve their operations through operational insights.

## **3.3. Using Analytics and Reporting in government programs**

The Government and public sector, with its interaction with a billion plus residents and many more times the number of transactions is a treasure trove of data. In fact, Government stands to gain among the most by using data and analysis; to not just execute programs, but also to better execute public policy priorities in resident facing applications. For example if we analyze public grievances in a city and find that biggest complaints are about water logging, appropriate resources can be directed to focus on drainage. Geographic level analysis can help pin-point pain areas and help deliver services better.

Government programs can further bolster operations by sharing relevant analysis datasets (with application of suitable aggregations, anonymization and statistical disclosure limitation procedures) with the academia, industry and the public through a data portal. This external support, in the form of “crowd sourcing” can provide insights and improvements that the programs may themselves miss. Modelling this around participative initiatives like data.gov along with an API based design can allow people to analyze and mash up data and services across a larger section of data and for new applications.

It is evident that the benefits outlined in the previous section can accrue to any government program that integrates Analytics and Reporting. The operational complexity of such ecosystems can be addressed by providing tools that enable better communication and visibility into operations. Analytics and Reporting ensures that the ecosystem as a whole speaks a common language. Information flows smoothly across the entire ecosystem thus improving communication. This flow of information can be as close to real-time as possible

enabling rapid feedback loops and continuous improvements. Friction within distributed ecosystems further reduces when all SLAs are visible and can be tracked easily by all stakeholders. Analytics and Reporting can increasingly become a “soft infrastructure” by providing a reliable decision support system delivering the right data and insights at the right time in an easy to comprehend manner.

## 4. Creating an Analytics and Reporting function

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Most government programs today have an Information Technology strategy in place. Creating an Analytics and Reporting function involves recognizing that building IT systems is not the end point; rather it is the starting point in terms of generating data. Hence, while the function can be built independently, Business Intelligence modules need to be ingrained within the overall IT strategy of the organization to be able to function.

Success of this function depends on recognizing that Data is the centrepiece here around which the function works, and not hardware or software as is the case in a system or infrastructure driven IT architecture. The design should treat data as the platform from which multiple decisions are enabled; rather than just a technology platform that enables access to data. Hence, there is a need to create an independent Analytics and Reporting platform whose functioning is eventually decoupled from the systems and infrastructure teams. Focusing on the ‘what’ of data/information becomes the purview of this team, with the infrastructure team focusing on the ‘how’ of it.

The structure and functioning of the Analytics and Reporting function would depend on the objectives and deliverables that the organization expects from it. In most cases, the Analytics and Reporting function acts as a support function to various processes within the organization.

The sections that follow lay out a generic structure and some guiding principles that can serve as a reference for government programs when setting up or enhancing their Analytics and Reporting function. These have been derived from the experience within UIDAI as well as some of the best practices observed in industry. Details of these with specific reference to UIDAI are provided in section 7.

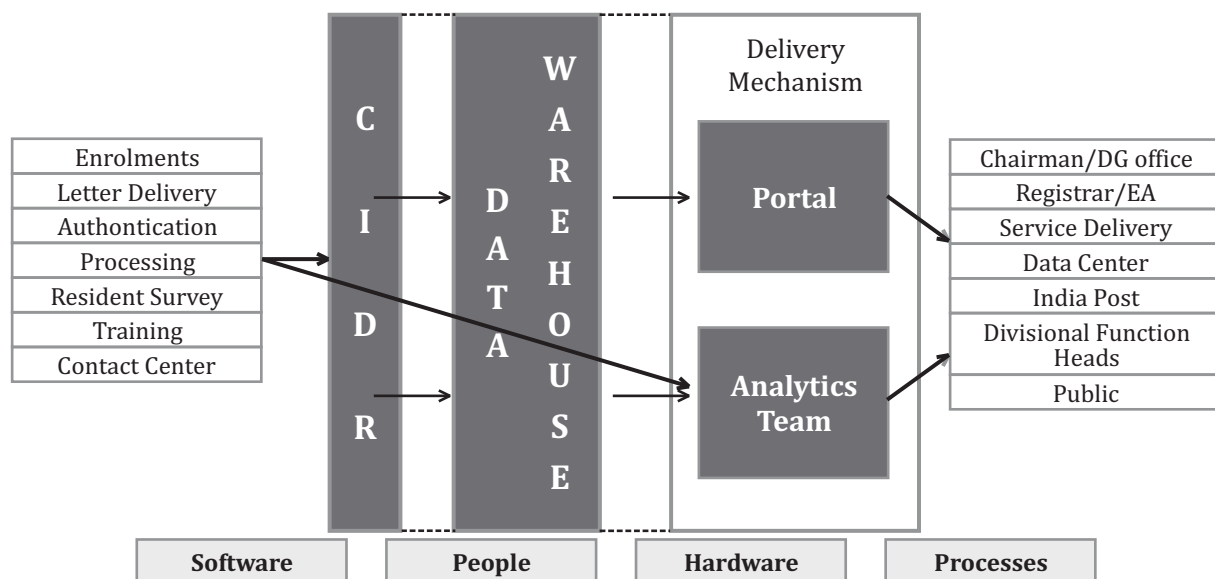
There are 3 broad components to the Analytics and Reporting function - the **Business Intelligence framework** that captures and manages data, the **Delivery platform** through which data is shared within the organization (and potentially outside as well) and the **Delivery team** that enables the function. The delivery platform, in the context of the Analytics and Reporting function, is an important component since adoption of analytics is strongly driven by accessibility of data to users and ease of analysis. BI systems often provide for a delivery platform, but one should treat the design and usage in an independent manner. Each of these components is described below, along with an illustration of how UIDAI has applied them.



## 4.1. Journey cycle of data

The Analytics and Reporting function handles data, right from the stage of capture to the end analysis and insights it generates. The structure of the function and how it is enmeshed with the organization will thus evolve from the journey-cycle of data within an organization.

The journey cycle of data within an organization can be understood by going back to the analogy of a water source referred to earlier. Creating this flow helps track each touch-point of the data, and consequently, what is required at each touch-point in the flow, who would control the flow at each stage, the delivery mechanism and security features. Figure 2 illustrates the same by laying out the basic data flow and the resulting Analytics structure for UIDAI.



**Figure 2:** Data flow and Analytics structure in UIDAI

At UIDAI, data generated at multiple sources would typically come to the CIDR (Central ID Repository), UIDAI's Data centre, through an online mechanism. There could be certain exceptional sources, like Contact centre or Resident consumer surveys; that will not feed into the Data centre directly. Data is then processed in the Data Warehouse using Business Intelligence tools and converted into forms that can be accessed and shared easily. The delivery mechanism for data in most cases is the portal. In some cases, the Analytics team will directly access the warehouse, work on the data and deliver the analysis results to end-users. Some of the End-users are shown in the diagram.

## 4.2. Design principles

The flow, structure and operations of the Analytics and Reporting function will keep evolving over time; it is thus important that some basic guiding principles are formulated against which new changes can be evaluated. Some design principles are provided below. The appendix provides examples of the same in the UIDAI context.

## 1. **Stakeholder Focused:**

- a. **Broad base data across E2E process owners** –Analytics function should have access to data across processes to be able to deliver in highly interconnected and distributed ecosystems.
- b. **Directly relevant to the operations of End-users at all times** – The Analytics function should NOT be conducting analysis that is cocooned in its OWN complexity and relevance. The analysis and insights should have laser-like focus on how they will improve operations. In this regard, having process owner specific focus and projects is helpful.
- c. **Active involvement of stakeholders in defining the scope** - Involvement of Stakeholders to define the scope of Analytics for their processes will help drive adoption.
- d. **Making analysis consumable** – Given the varied types of stakeholders with different exposure to Analytics, focus of all reporting and Analytics outputs should be to ensure ease of understanding, conciseness and ease of usage on the field.

## 2. **Facilitating Self-improvement:**

- a. **Provide Self-service ability:** Making data and basic analysis as much self-service based as possible through tools and relevant metrics will help drive self-improvement.
- b. **Awareness and Training:** Conscious effort is required to ensure stakeholders are trained on how to use data and how it can benefit them.
- c. **Feedback mechanism** – Strong feedback mechanism on Reporting, especially at the initial stages, will ensure relevance and successful implementation.

## 3. **Flexible And Scale-able:**

- a. **Handle “Big” data:** Over time, data will increase exponentially, fuelled by data coming in from residents, vendors and partners. Big data refers to data that is many orders of magnitude larger than traditional data. This size and nature of data makes the traditional database methodologies and technologies obsolete. Hence, provision should be made to ensure the system can handle this.
- b. **Automation and portal based delivery:** Manual creation of dashboards, management reports etc typically entail large teams within Analytics functions. Focus on automating these standardized Reporting along with delivering them through a portal is recommended.

c. **Consistency of data:** Ensuring consistency of data across multiple sources is necessary to maintain quality of data. The system should be able to accommodate the varied types of data getting generated across the ecosystem.

d. **Modular design:** The ability to ‘snap’ together various operating components, through technical APIs, interfaces, workflow tools etc is required to be to rapidly build scalable platforms, leveraging the best available options.

### 4.3. Business Intelligence framework

The Business Intelligence systems provide the extensible infrastructure platform, framework and associated tools to help meet goals of the Analytics and Reporting function. This is the system that captures and manages data. Consequently, the architecture would typically consist of the three broad sections of data acquisition, Data storage and Data distribution platform; all of which can be considered to be part of an over-arching Data Warehouse strategy.

- **Data acquisition** would include all source systems (apps) that feed data into the organization. It is necessary to have the BI system integrated with all the process to ensure capture and consistency of data across multiple sources. In UIDAI’s case, these include areas like Enrolment, Authentication, Training, Resident Interactions, etc.
- **Data storage** would be the repository that contains all data in its granular details. It is important to note that data storage for Reporting should be separated from the master data (data that is part of the live production systems) used by organizations. The necessity and advantage of the data storage being a replica and not the actual production systems is to ensure reporting queries do not impact live production systems. Also, the replica can have specific pieces of information only that will ensure more amounts of data and history can be stored and only required information is available in Reporting databases. At UIDAI, no information that can be personally identifiable is stored in these Data warehouses.
- **Data distribution platform** provides access to data on UIDAI and its entire constituents. This data is presented to the end users and general public, in a timely manner, while still protecting privacy, confidentiality, and security. Data access frameworks are in place that lay out the rules around which data is distributed within the organization as well as shared in the public, partner and data portals.

UIDAI employs a highly scalable, n-tier, reliable and open technology components to meet the UID-BI requirements. UID BI systems consist of an Atomic Data Warehouse consisting of granular level data, tools and applications to provide for extraction of data from source systems into the Warehouse, Data distribution platform that enables provisioning of data through various datasets/dim-sets and Analytical delivery platform delivering relevant metrics, dashboards, portals etc through subject area specific Data marts. UIDAI uses open source based Apache Hadoop File System to handle “big data” storage requirements. Further, UIDAI uses an open source BI tool – Pentaho, for managing all the data in the back-end (ETLs, Access) as well as serve this data ahead for distribution.

The BI data in UIDAI stores data for only those packets that have undergone processing. This serves as the key source of all long term reporting requirements for the organization.

However, organizations also face the need to have a reporting system to address operational requirements. Operational data refers to “in-process” information. This is typically volatile (changes continuously) and the usage is normally for tactical needs. UIDAI maintains an Operational Data Store (ODS) that provides this information on an “end of day” basis. This provides “in-process” information like number of packets at each stage of processing, and is used for Reporting as well as the Network Operations Center (NOC) that tracks status of the system real-time. This separation of the Operational and BI data helps UIDAI meet the short and long term Reporting requirements. The logical view of both of these data sources are provided in Section 7.

In most organizations, the skill sets involved here (BI tools, Database specialists, Data Warehousing specialists) are housed within the IT function. However, they need to work closely, and often exclusively with the Analytics and Reporting function to ensure it meets the end operational requirements.

#### 4.4. Delivery platform

Delivery platform is the conduit through which data is shared with the organization. It could be shared in the form of basic offline methods like Email/FTP uploads; various formats like Excel/PowerPoint/Flash dashboards or through real time visualization and charts on a web-based portal.

The basic offline methods are typically the easiest and quickest to implement and help address many of the ad-hoc requests. However, they are also resource intensive and less visual in nature. Hence, the usage of more advanced formats is recommended. Additionally, web-based and automated delivery of data ensures consistency and security of data, as well as minimization of human errors. Combinations of these are typically used by organizations.

With increased penetration of Smartphones, integration of delivery platform with Mobile, Email and other collaboration platforms will become important. Today, there is an increasing use of devices that help capture data at the transaction point itself. Analytics delivery platform like these will further help the front-line to make **decisions to be taken on the field** rather than incurring the delay of having to come back to base location.

Enabling web-based delivery of Analytics and Reporting will require having a dedicated Analytics web portal available for users that could be integrated with the larger public portal. The web-portal would be able to provide functions like summary views, multi-dimensional analytics, highlights and reports, among other features. The delivery platform would be able to interact and incorporate new BI Tools, Charting software, security protocols and provide an easy user interface. A dedicated portal development team from the vendor will be required to run and maintain such a site. Having just a regular maintenance team only will not meet requirements.

UIDAI has a dedicated web-based Analytics portal, along the lines described above. Details of UIDAI’s delivery platform are provided in section 7. Keeping in mind the lean structure of UIDAI and the large ecosystem partners, UIDAI has chosen to have the web-based portal as the key delivery platform for all the Reporting requirements. This is a combination of standardized reports (Figure 5 – Section 7) and dashboards (Figure 3 – Section 7), as well as interfaces to enable self-service analysis (Figure 4 – Section 7).

## 4.5. Delivery team

A structure that works well for the Analytics and Reporting function is a combination of end user focused teams supported by teams that have been built for specific competencies. While different programs may choose different structure, this structure ensures a combination of specialization as well as spread within the organization.

**1. End-user teams:** The process owners across the End-2-End spectrum of operations within an organization are the actual consumers of analytics within an organization. They can be thought of as the equivalent to various vertical functions like Sales, Finance, Research, Supply Chain etc in large organizations and equivalent process functions in Government programs. Broad-basing Analytics and adoption of the Analytics and Reporting function across the organization cannot happen without focusing the deliverables around these process owner's requirements.

The End-user Analytics teams would be focused teams front-ending with their specific stakeholders. These teams would work closely with the process owners to understand data and analytics requirements and work with support teams at the back-end to ensure these requirements are implemented. They would also handhold the process owners initially and guide them on how to use data and perform basic analysis themselves. The Analytics team front-end members eventually become specialists in these Stakeholder operations over time. Section 7 provides details of the responsibilities of the team along with example of how UIDAI is creating these teams.

**2. Support Track:** These are the equivalent of the "horizontals" in large organizations. These are competency based shared services teams that would provide support across the end-user teams. Two broad set of support teams can be envisioned – a Technology focused track and a specialized Analytics and Research track. These can be differentiated on the basis of being generic support groups across stakeholders versus support groups for niche requirements.

The technology support track would be focused on working with the IT team to create and maintain the Business Intelligence and delivery platforms as mentioned in earlier sections. They would act as the bridge between the Technology function in organization and the Analytics and Reporting team. The Specialized Analytics and Research support track would consist of teams serving niche requirements - creating visual analytics, providing custom analysis, Fraud detection, Forecasting, Consumer research etc. Details with examples of these support teams are provided in section 7.

The skill sets required in such a delivery team are diverse and take time to build and mature. A **core team** could be built in-house that comprises of key members of the support team along with the end-user teams. As the Analytics function builds up, a strategic decision will need to be taken on bringing in external vendors.

The Analytics and Reporting function, core and extended, should be **co-located**. This team would be one of the few who can view the entire system simultaneously and also understand their interactions. Having them together will help create collaborations across processes;



as well as ensure learning is managed and shared quickly across the organization.

Performance of the Analytics team will largely depend on the type of talent chosen. Getting skilled resources who know the usage of Analytics tools, Excel, PowerPoint etc is important. However, getting the right people who understand the operations and environment context, provide insights based on them, and can work with senior leaders and process owners, are just as important and often harder.

#### **4.6. Infrastructure**

Hardware and Software required for setting and running the Analytics and Reporting function is strongly dependent on the existing infrastructure, budgets and Analytics structure of the organization.

Analytics and Reporting is typically among the most compute intensive sub-system in the IT architecture spanning memory, storage space, computing power etc. The Hardware requirements need to grow to be capable of handling increase in size of data over time. Keeping this in mind, care needs to be taken to ensure that the hardware procurement process budgets for future requirements. For e.g., at UIDAI, the Business Intelligence Hadoop cluster is the main repository of reporting and Analytics data. This will keep expanding exponentially as more data comes in from Enrolment, followed by Authentication and update of information.

Analytics software in the form of licenses would require to be procured. These include Business Intelligence tools to manage the data warehouse, Visual Analytics software to present data in an intuitive fashion, advanced modelling software to run statistical modelling and Data security software to ensure security of data being analyzed. Consideration should be made to keep in mind usage of Cloud based technologies where feasible. A strategic decision would need to be made on the usage of open source software, keeping in mind the considerations of support, cost and flexibility. Section 7 lists out in detail these software requirements.

Specifications for Hardware and Software requirements for the program can be arrived at by a group of experts that will ensure customization as per the needs of the organization.

#### **4.7. Data security and privacy**

Data security and data privacy are BOTH important requirements in any organization and processes should be put in place that ensure full compliance with the organization's guidelines at all times. There should be a governance structure to oversee the way data is stored, used and shared across the organization. Physical as well as Virtual security measures should be in place at each touch point for Data security.

At UIDAI, the Analytics and Reporting council also oversees the data sharing and usage policy for the function. The UID Business Intelligence system is a "Zero Knowledge of Individual Resident" data warehouse. The Analytics and reporting system does not hold or extract any data relating to resident demographics, and biometrics. No Personal Identification Information (PII) of any resident is available from the UID BI System to any user. Anonymization of data is a key strategy in the UIDAI data design. This implies that all individual IDs are only accessed through a "Reference ID" and not

their actual Enrolment ID or UID. Just like a roll number would represent an examination paper (with all details of a student masked out), the Reference ID would represent the record. Sub-systems within UIDAI processing communicate with each other using Reference IDs. This ensures complete anonymization and privacy of data. Similarly, the BI databases also do not contain any individual ID details but only contain the Reference ID information. This ensures that there is no way in which individual's data can be compromised.

There are multiple layers of security within the UIDAI system. These include physical security at the Data centres to data being encrypted (2048-bit encryption) at the source and no decryption at any intermediary point. In fact, data is always encrypted when "at rest". Adequate firewalls across each sub-system and audited data access further add to the security features.

#### **4.8. Process Requirements**

As much as setting in place the organization structure, Hardware and Software is important; it is just as necessary to set in place various processes to ensure smooth functioning within the framework of the organization. These processes should span requesting data, accessing data, creating datasets, getting requirements, incorporating requirements, SLAs etc.

## 5. Complexities and challenges in implementation

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Incorporating a strategic initiative of this nature is likely to face challenges during implementation. Recognizing these upfront will help ensure that the phased transition is more likely to be successful in the organization. Some of these challenges are technological, but the more difficult ones are inevitably behavioural.

- 1. Technology:** Typical challenges faced in implementation arise due to BI/Reporting not being part of the original design; or being improperly designed into the architecture of the IT systems. This leads to issues at the data capture stage (systems / formats not standardized), data managing stage (Data Warehouse not designed for size of data / poor BI Tools) or the data reporting stage (web/offline based sharing of data).
- 2. Silos:** Information hoarding within processes is a frequently encountered challenge in organizations. Even if data is captured and generated, they often get amassed and remain in departmental “silos”.
- 3. Data inconsistencies:** One key issue with a poorly designed BI system is that individual functions tend to generate and rely on their own data. This can lead to a lot of confusion and undermine the credibility of decisions that are made.
- 4. Data Integration:** Data integration across multiple sources, as also across vendors and partners is an issue that frequently takes a long time to address as organizations scale.
- 5. Mindset change:** The key challenge is not to adopt systems that can handle data, but to adopt the mindset of making decisions using data. The piece that takes the most amount of time is the culture change of having data as a backdrop in reviews / discussions and decisions.
- 6. Lack of senior level push:** Such dramatic changes in mindset and culture need to be driven right from the top management consistently. Very often, Analytics ends up being a one-off activity / niche support function and tends to get lost in many operational priorities.
- 7. Lack of adoption by stakeholders:** This typically arises due to a number of reasons including lack of awareness on what information is available, lack of accessibility of data and lack of data relevant for them; making sponsors lose interest.
- 8. Lack of Analytics talent:** It is important to view Analytics and Reporting as different from an IT setup. Not having the right kind of talent could lead to the work being very technology heavy or too niche to be relevant to actual on-ground operations.

## 6. **Phased approach to creating a sustainable Analytics function**

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Creation of the Analytics and Reporting function requires a large change; not just in terms of creating a new function and staffing the same, but also how it is integrated with the existing government program. This requires a carefully thought out, phased transition plan that ensures complete integration and smooth functioning as the change progresses. The phased transition should be set against a combination of short term and long term milestones.

The phases would be structured to gain detailed user requirements understanding, setting in place the right team and infrastructure, delivering on the requirements as per above and conducting awareness and training for continued usage.

Since this is a transition phase, continuous feedback should be taken to ensure relevance is maintained and adoption of Analytics is driven across stakeholders. A combination of qualitative and quantitative feedback can be used for the same.

Senior leadership support is critical to the successful implementation of this transition. A consistent push from the leadership, accompanied by usage by them on a regular basis, will lead to the percolation of the analytics mind-set, and usage of the system across the organization.

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## 7. ■ Illustrations from UIDAI

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The section lays out in detail how UIDAI has implemented the Analytics function, in the context of the data flow, structure and principles that have been laid out in the document. This should help the reader understand the main document better by looking at it through the lens of an actual example.

### 7.1. Setting the Objectives

The objectives for UIDAI are as below, and have been created keeping in mind the large ecosystem, comprising primarily of external partners and a very lean UIDAI structure.

- 1. Drive data based decision making:** The delivery of the Analytics function should be such that stakeholders can easily include data and insights in their operations on a regular basis. The function should be able to drive a feedback loop to the overall organization and specific processes to help them improve continuously.
- 2. Empowers self-improvement:** The analytics function should be such that it helps stakeholders to improve by themselves. Tools, data and platform should be created to be able to help each stakeholder analyze their own performance and operational metrics themselves.
- 3. Be scaleable and flexible:** Given the breakthrough nature of the project, UIDAI requirements will continuously evolve in ways that are difficult to predict. The analytics solution (people, technology, infrastructure etc) must be designed to be able to scale up alongside and handle new technologies and diverse data sources of huge size.

### 7.2. Business Intelligence Architecture and Infrastructure

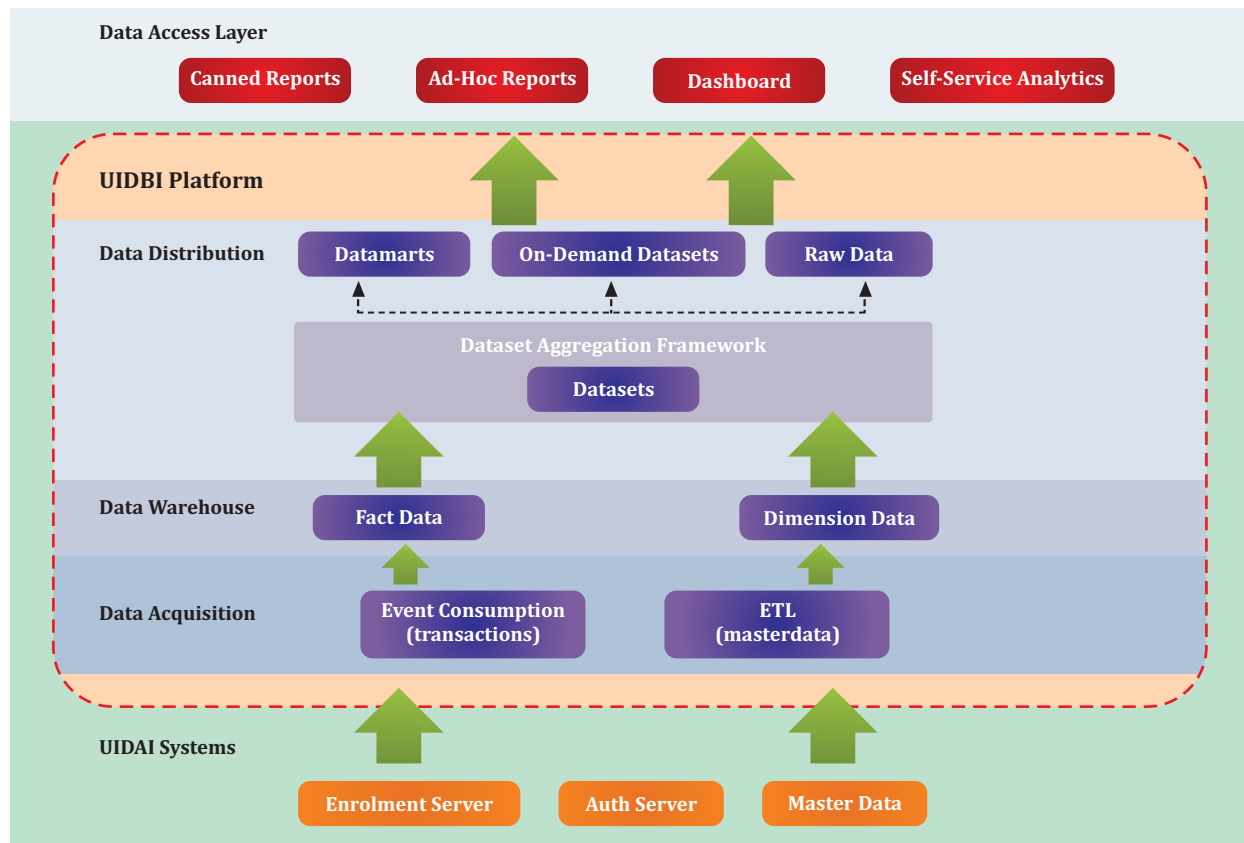
Enrolment, Processing, Authentication, Updation etc generates large amounts of data. The architecture consists of:

1. Atomic Data Warehouse consisting of atomic data obtained synchronous or asynchronously, stored in a custom designed data model for the UID BI Atomic Data Warehouse. This is time-variant, consolidated, aggregated minimally to provide such information for downstream needs, such as data marts, Charting, sandbox etc.
2. UID BI EAI consisting of tools and applications to provide for extraction of data from source systems into the UID BI Data Warehouse.
3. UID BI Data distribution platform to enable provisioning of data (through various datasets, dim-sets) for all external and internal consumption inclusive of the Public portal of UIDAI.
4. UID BI Analytical and reporting delivery platform consisting of tools and platform to deliver all relevant metrics, dashboards, portals, reports, action-response work-flows etc.

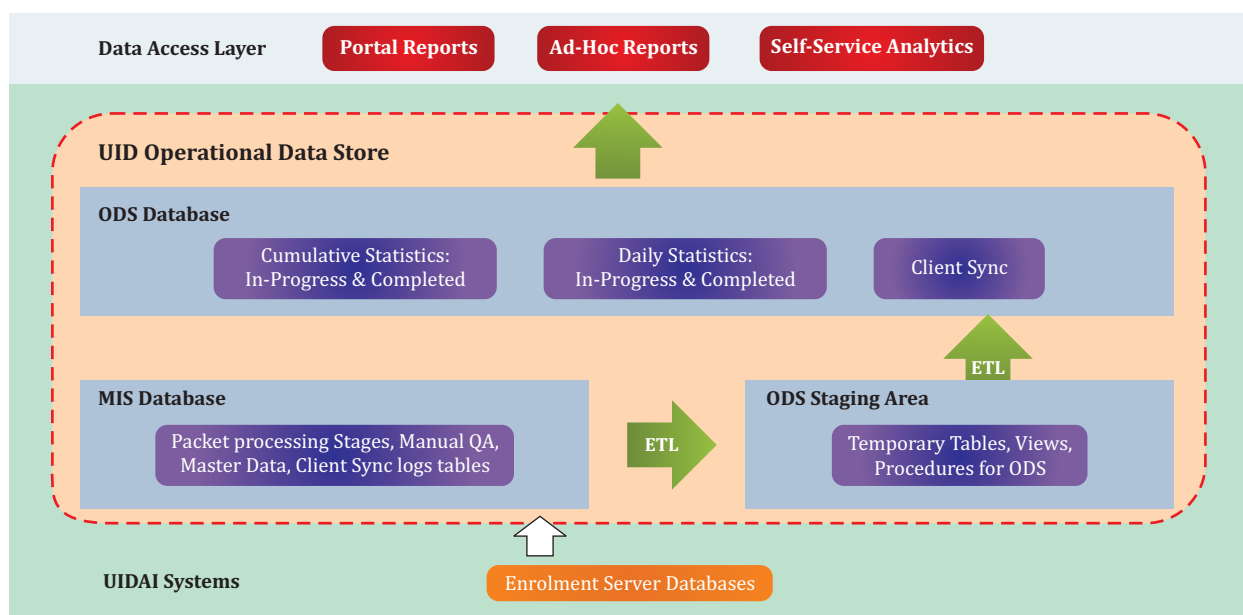


5. UID BI Data marts consisting of subject area specific or other subsets specific data derived from the UID BI data warehouse through a process of aggregation, along with relevant dimensionality.

UIDAI uses an open source tool called Pentaho to extract data and present it ahead through an internal analytics portal. The logical view below (Figure 6) gives a snapshot of the same:



**Figure 6:** Logical view of the BI Architecture



**Figure 7:** Logical view of the ODS Architecture

### 7.3. Delivery platform

At UIDAI, a dedicated Analytics Portal delivers most of the data and analysis to Stakeholders.

1. An exclusive Analytics page serves as the landing page for users. The landing page consists of dashboards providing All India figures on key Aadhaar processing; with an ability to drill down at a geography / Registrar level.
2. This is a combination of standardized reports and dashboards, as well as interfaces to enable self-service analysis.
3. The portal is able to handle multiple user types and provides customized data accordingly.
4. The portal provides a separate interface that enables self-service analytics capability for users. Users have the option to choose specific dimensions, like Time, Geography and Registrars; and create custom data sets with a wide range of metrics provided.

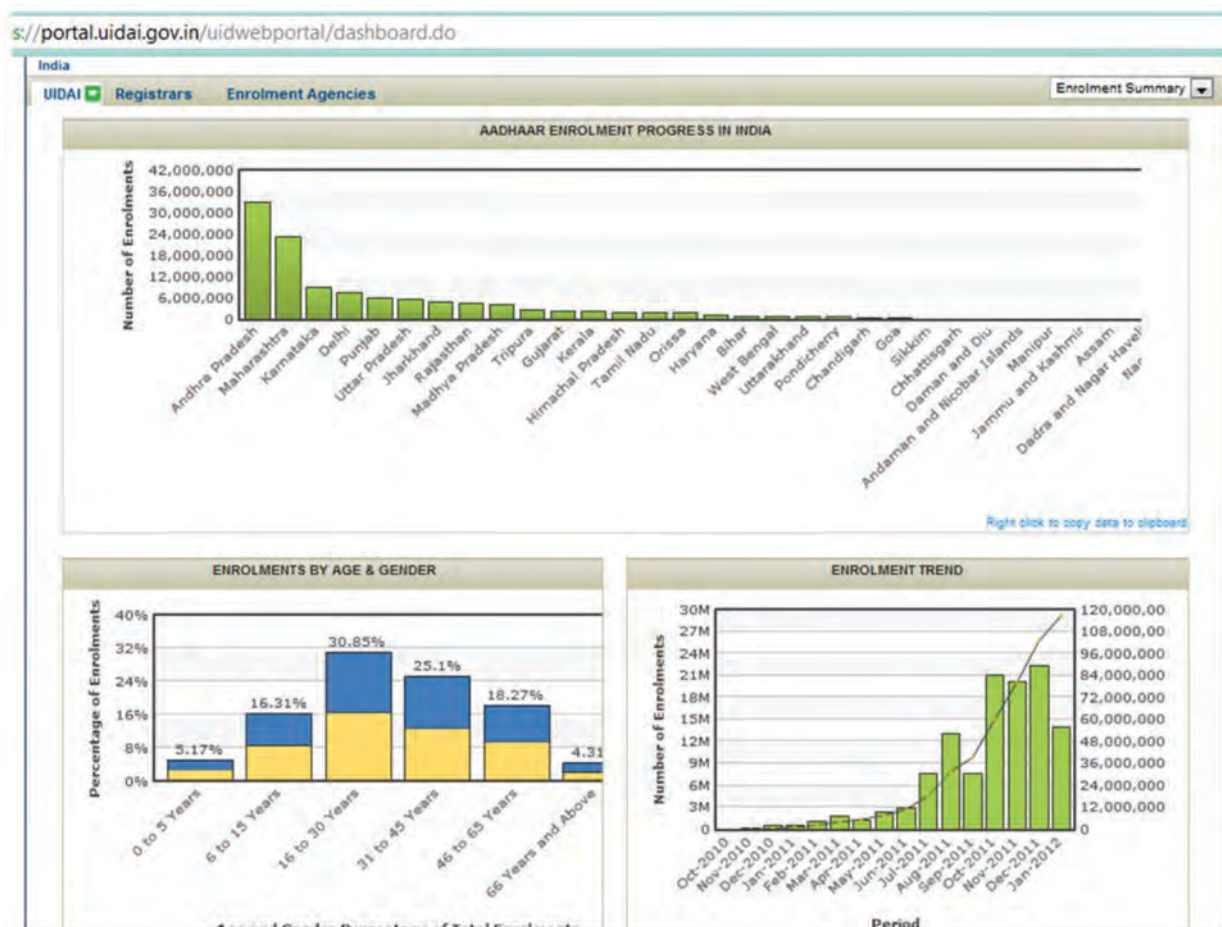





Figure 3: Dashboard for Internal Analytics portal






Unique Identification Authority of India



**ANALYSIS REPORT**



**Measures**

- ☒ No. of Enrolments
- ☐ Total time to generate Aadhaar
- ☐ Aadhaars Generated
- ☐ Total Auth Risk Enrolments
- ☐ Total Biometric Exception
- ☐ Total Dedup Risk Enrolments
- ☐ Enrolments with Email
- ☐ Total Enrolment Duration
- ☐ Total Enrolment Processing Duration
- ☐ Packets Rejected
- ☐ Enrolment to Upload Duration
- ☐ Good Quality Enrolments
- ☐ Enrolments by Head of the Family
- ☐ Enrolments with Information Sharing Consent
- ☐ Enrolments by Introducer
- ☐ Enrolments with Linked Bank Account request
- ☐ Enrolments with Mobile Number
- ☐ Enrolments with New Bank Account request
- ☐ Enrolments with Proof of Address document
- ☐ Enrolments with Proof of Identity document
- ☐ Upload to Process duration

State-District	Registrar	Enrolment Agency	Operator	Calendar	Gender	Age Band	Measures
<input type="checkbox"/> All States	<input type="checkbox"/> All Registrars	<input type="checkbox"/> All Agencies	<input type="checkbox"/> All Operators	<input type="checkbox"/> All Time.Calendars	<input type="checkbox"/> All Genders	<input type="checkbox"/> All Age Bands	• No. of Enrolments 108,178,876

Slicer:

**Figure 4:** Internal self-service portal  
(ability to choose metrics, time periods etc to create custom datasets)

Registrar Name	IA Name	Aadhaars Generated	Registered enrolment stations	Demo error %	Good Biometric Enrolments %	Bad Biometric Enrolments %	Avg Enrolments /op/day	Turn around Time - In Transit (Days)	Turn around Time - Aadhaar processing (Days)	Rejects %	Packets on hold	Number of IS synced
A		11,55,09,031.	58,259.	0.0	68	3.1	32.7	40.6	55.7	0.0	1,70,94,354.	12947
B		77,29,726.	3,793.	0.0	65	3.9	21.2	36.4	48.9	0.0	10,32,482.	1602
B	R	20,02,862.	69.	0.0	64	4.3	25.8	47.1	85.3	0.0	1,56,337.	3
B	S	21,31,784.	1,738.	0.0	66	4.2	17.7	35.7	17.6	0.0	4,29,091.	891
B	T	3,58,782.		0.0	74	3.5	18.6			0.0		

**Figure 5:** Sample of an actual downloadable (Excel) performance report

## 7.4. Delivery team

### 1. Stakeholder Track:

The responsibility of this dedicated Stakeholder Track team will be to:

1. Collect detailed data and analytics requirements from each of the stakeholders;
2. Work with the back-end and front-end to ensure these requirements are implemented;
3. Handhold these functions initially and guide them on how to use data and perform basic level of analysis themselves;
4. Provide advanced analysis support using tools and software, which the end-stakeholder by themselves will not be able to do;
5. Provide data where possible through the self-service options;
6. Train the Stakeholder resource on data pulls and analysis

Within UIDAI, an initial list of stakeholders has been created. These have been grouped into 5 different buckets as shown in Table 1 below. This grouping would be a feature even in other programs that are beginning Analytics functions since work has not matured for individual stakeholders. The grouping has been done so that the Analytics function representatives can serve these individual groups of stakeholders together.

The initial grouping can be done based on:

1. Similarity of information requirements among the stakeholders within the Group;
2. Ensuring the data and Analytics load balances across groups,
3. Easy sequencing in phase-wise implementation of the Analytics.

Stakeholder Tracks				
Group 1	Group 2	Group 3	Group 4	Group 5
RO	Chairman / DG office	Authentication	Data Centre	Resident satisfaction
Registrar/EA	RoB / Processes	Quality	Letter Delivery	IEC
Processes	Finance			Call centre
Public	Training			Integration

**Table 1:** Grouping for Stakeholder tracks for UIDAI

## 2. Support Track

The support tracks will consist of 2 broad set of sub-tracks.

### 1. Technology Support Tracks

This is the Support Track that would provide support that spans most of the processes.

#### i. Data design

There is significant work involved before a metric is ready to be published to stakeholders, especially when the metric is being generated for the first time. This involves extracting samples of data, working with many of the back-end Technology teams and end-stakeholders to ensure that the data is being recorded correctly at the data centre, extracted correctly by the queries and defined in line with requirements in the back-end. In addition, this team would work with the BI, Database, and Application team in the technology function to define / refine back-end data structures, datamarts and data models.

#### ii. Delivery platform

This will be a dedicated team to drive the development and maintenance of the full fledged analytics delivery platform. It will help drive automation of reporting and data pulls.



## **2. Specialized analytics and research Support Tracks:**

- i. *Visual Analytics and Custom Analytics* – A large part of Analytics currently and for some time in the future as well will involve reporting; providing basic level information on what is happening in operations. Most of the action steps that stakeholders derive on a regular basis will be from this reporting. The focus of this team would be to bring data to life, handle ad-hoc data requests and custom analysis requests, creating management dashboards etc.
- ii. *Fraud Detection, Risk Modelling, and Audit support* - Identifying areas where fraud is happening, modelling to identify which residents / areas are most at risk for fraud. These could be related to Enrolment and Authentication fraud related.
- iii. *Forecasting / Statistical modelling* - Predictive modelling, optimization, scenario building towards forecasting.
- iv. *Resident and Media Research* - Resident survey and research and Media Analytics. Integrating call centre data and feedback will be a key role they play.

## **7.5. Software requirements**

### **1. Business Intelligence tools**

- a. To access back-end data and provide all kinds of basic data slice and dice capability. They could be operating on the File systems at the back-end as also be linked to the front-end where they can enable self service.
- b. The basic slice and dice would include multidimensional analysis: drill-down, drill-through, roll-up, sort, group, filter and calculation

### **2. Visualization Analytics software**

- a. This is included in what is today termed as BI 3.0. This includes charting software that can bring data to life in real time to help make data intuitive to understand.
- b. The Analytics market today contains many open-source and paid software that can take large amounts of raw data and convert them into appealing and intuitive charts. These charting software go beyond the standard charting capabilities provided by traditional software; and can also incorporate intelligence within their charting thus enabling exception reporting etc.
- c. These could include abilities in Data animation and Mobile compatibility

### **3. Analytics software**

- a. This is the software that will be used for all the advanced modelling like forecasting, segmentation etc. These include commercial packages as well as open source based ones.
- b. These will typically be used by the Data Analysts and Managers and will require prior knowledge of their usage.

#### 4. Data security software

A key principle as stated before is to enable a secure environment where data can be accessed, analyzed and shared. Apart from creating a secure VPN connection, appropriate software that can help transfer data, secure data so that it is not shared ahead, provide access restrictions etc should be procured. These have to be in line with the organization's Data security policy.

### 7.6. Guiding principles for design

Some principles are laid out as below, with relevant examples from UIDAI shared where applicable.

- 1. Broadbase data across E2E process owners** – Today, a private sector Enrolment agency on the field can directly view the status of each of their packets in the UIDAI data centre and the delivery status with India Post in one single portal. This helps stakeholders and process owners to talk to each other in the same terms and help co-ordinate decision making across functions.
- 2. Directly relevant to the operations of End-users at all times** – Today, there are separate reports individually customized for Enrolment agency, Registrar, UIDAI, Financial Inclusion team etc within the same.
- 3. Active involvement of stakeholders in defining the scope:** The customized reports for EA, Registrars, Financial Inclusion team etc have been made after detailed inputs and trials with the stakeholders.
- 4. Provide Self-service ability:** UIDAI provides a “self-service” portal to its users that help users to click through a variety of metrics and create custom reports.
- 5. Ease of understanding and usage** – The reports presented by UIDAI are in formatted PDFs for ease of printing on the field as well as downloadable in Excel to aid analysis. Charts are provided at many places with ability to download data quickly from them.
- 6. Awareness and Training:** New additions in terms of reports or functionalities are communicated to field and partners regularly, and presentations/training sessions.
- 7. Feedback mechanism** – The standardized reports that have been created have been done so after multiple iterations with stakeholders and ensuring they are relevant.
- 8. Ability to handle “Big” data:** UIDAI has used the most cutting edge data storage protocols as well as hardware. The architecture and the datamarts / databases like ODS have been designed keeping in mind the huge amounts of data they will eventually store.
- 9. Automation and portal based delivery:** UIDAI reporting team ensures that once a data requirement is standardized, the data pull for that is automated and uploaded automatically on the portal.
- 10. Consistency of data:** There has been a conscious standardization to ensure all data, right from upload to delivery is fed into the central UIDAI data store and shared through that.





**Unique Identification Authority of India**  
Planning Commission, Government of India