Digital Eye

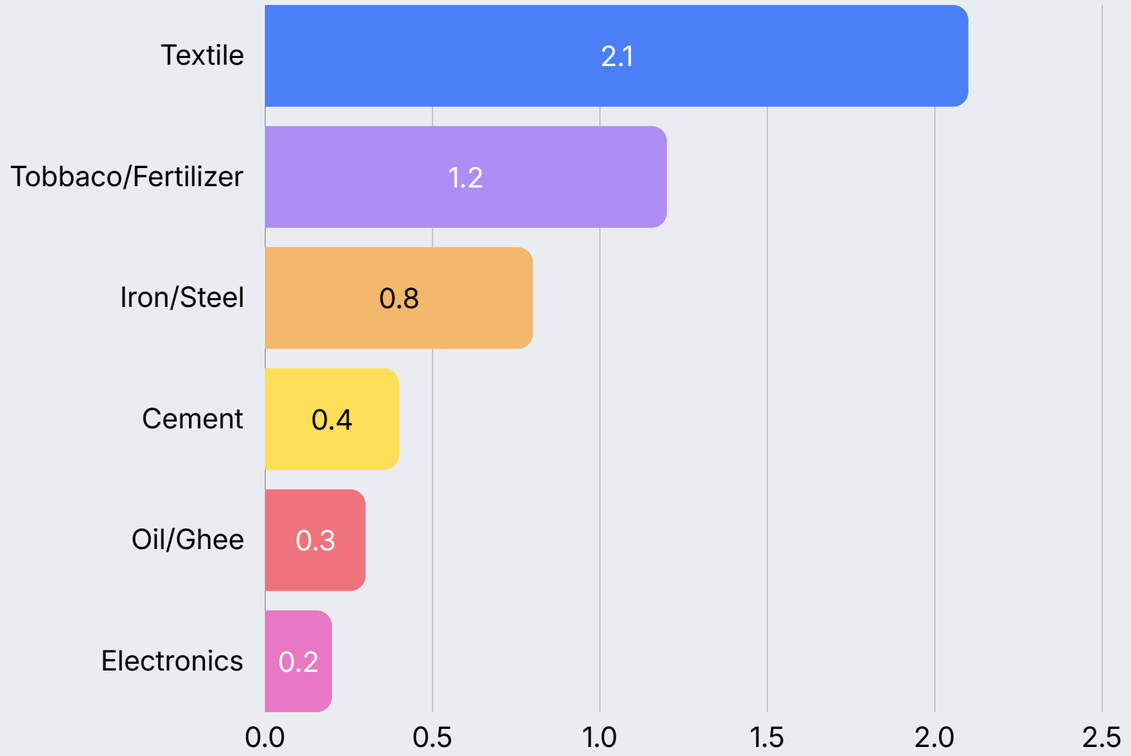
Ordinary Cameras Plus AI

Akbar Mayo | ASI | Pakistan

The core issue is underreporting of production

> “If production volume is misreported, the sales figures built on top of it cannot be trusted either.”

- **$ 90 Billion** – Manufacturing GDP
- **$ 6.1 Billion Sales Tax Gap** from Manufacturing Sectors
- Horizontal Inequity - Skewed Distribution of **Tax Burden**
- Tax Authority is Forced to Alternative Regimes
  - Final/ Fix/ WHT
  - Super Tax
  - Rate Hikes
  - Aggressive Enforcement
- Detrioration of Tax Authority’s Ops Capacity

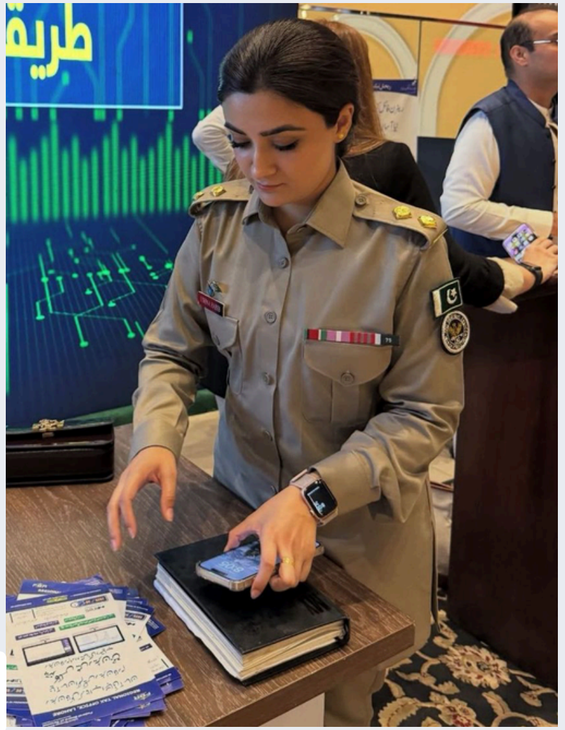


Sales Tax Gap [Source: Federal Board of Revenue]

Why physical inspection fails ?

The Traditional Enforcement Process

- Sheer Volume & Capacity Constraints
- Collusion and Corruption
- Legal Challenges Limiting Continous Presence
- Temporal Snapshots
- Humanly not possible to monitor Fast Paced Production
- Disconnect from Data Environments
- Absence of Predictive Analytics



Results: reliance on estimates, inaccuracies, and slow counting, verification, and compliance.







CTA:Physical Inspection

The missing number costs $ 6.1 Billion a year !

"If production volume is misreported, the sales figures built on top of it cannot be trusted either."

Sugar sector

about 1.1% of GDP*

Runtime Anomaly Detection

Refined sugar output grew 31.0% while the sugarcane feeding it grew only 6.2%, a 5x divergence.



Source: PBS, Pakistan Economic Survey 2025-26

Cement sector

about 0.4% of GDP*

Reconciliation gap

Roughly 40 percentage points between installed capacity (84.6M tonnes) and actual utilization (60.2%)
Source: All Pakistan Cement Manufacturers



Source: PBS, Pakistan Economic Survey 2025-26

Poultry hatcheries

about 2.3% of GDP*

Hatchery output anomaly

Day-old chick output rose 9.9% (2.19 bn to 2.40bn), nearly double the 5% growth in breeding stock



Source: Ministry of National Food Security and Research

Textile and apparel

about 2% of GDP*

Capacity reconciliation gap

29% of installed spinning capacity (13.4M spindles) sits idle against reported working spindles



Source:PBS, Cotton Textile Statistics

Iron and Steel

about 0.3% of GDP*

Output vs import divergence

Domestic output fell 6.3% while imports rose 10.5% by volume in the same period

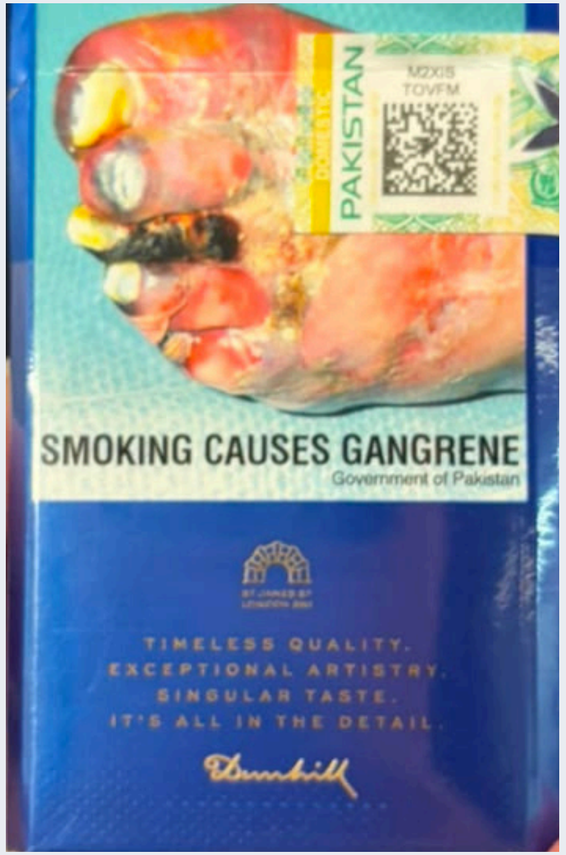


Source: PBS / Ministry of Commerce

Track & Trace:Stamping That Couldnt Stick!

Authenticity Tool Deployed to a Quantity Problem

- **Compliance depended on the evader;** where is the incentive to underreport ?
- **No independent ground truth;** the manufacturer's return the only production count
- **Registered sector was desciplined**, majority remained outsite
- **Incentives moved the wrong way**, raised costs for the compliant
- **Stamp activation ≠ stamp application,** no live view of what actually left the line
- **Downstream checks never scaled,** market inspection couldn't cover the gap
- **Humans at every loop;** every manual step was an integrity risk
- **Stamps didn't stick on cement or tiles** - dusty lines defeated adhesives
- **Applicators slowed production;** manufacturers resisted, coverage stayed partial

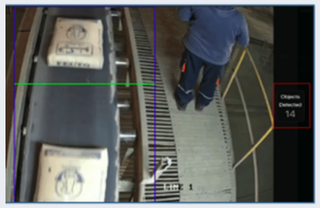


TTS QR Code

Where enforcement was feasible, cigarettes, it worked. Where the gap was biggest, bulk materials, it couldn't stick. Literally.

“STAMPS TRIED TO MAKE EVASION TRACEABLE. DIGITAL EYE MAKES PRODUCTION VISIBLE.”

Factory Line/
Conveyor Belt



Normal IP/ CCTV
Camera



H.264
enveloped in
RTPS

Network Swith



H.264
enveloped
in RTPS



Network Video
Recorder

H.264 enveloped
in WebRTC



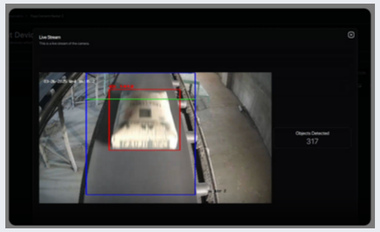
Graphical
Processing Unit



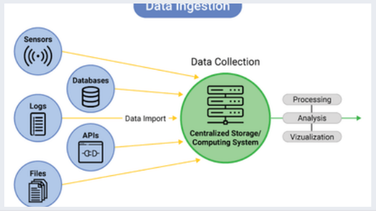
FBR HQ
Dashboard

Understanding the Tool: Four-layer architecture for national-scale production intelligence.

01- Industry Deployment
Cameras and IoT sensors at the factory level, across cement, sugar, and other sectors — real-time data capture from production environments.



02- Data Ingestion & Processing
Cleaning, aggregation at factory sites

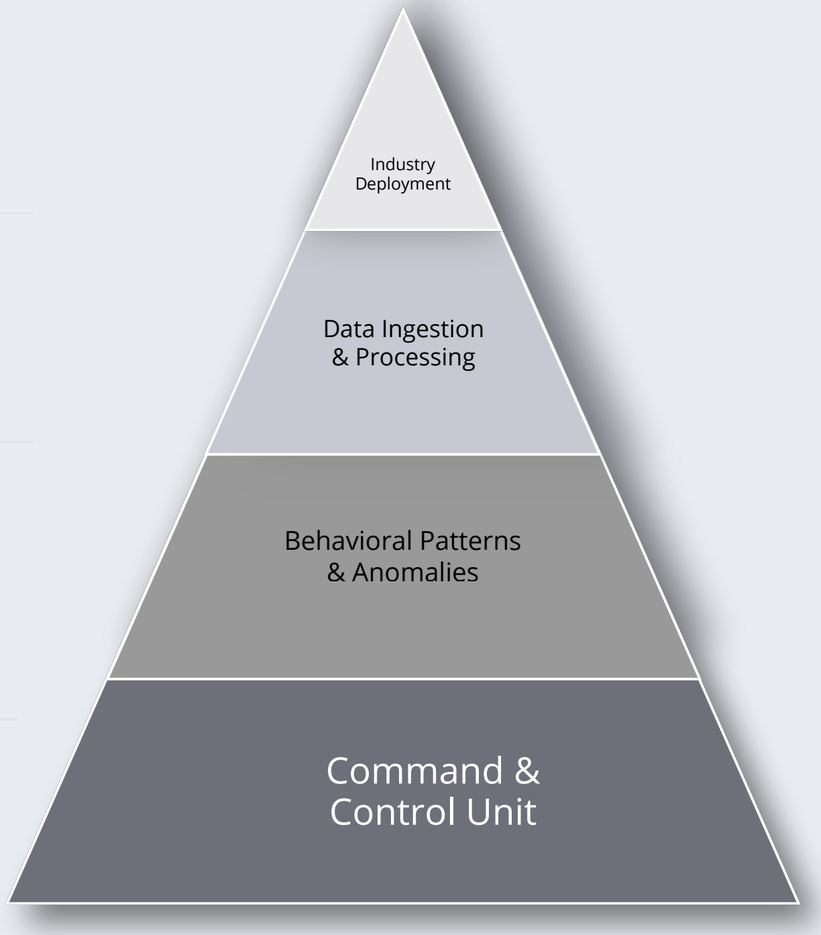


03- Behavioral Patterns & Anomalies
AI and LLM models deployed at FBR HQ predict and explain irregularities.



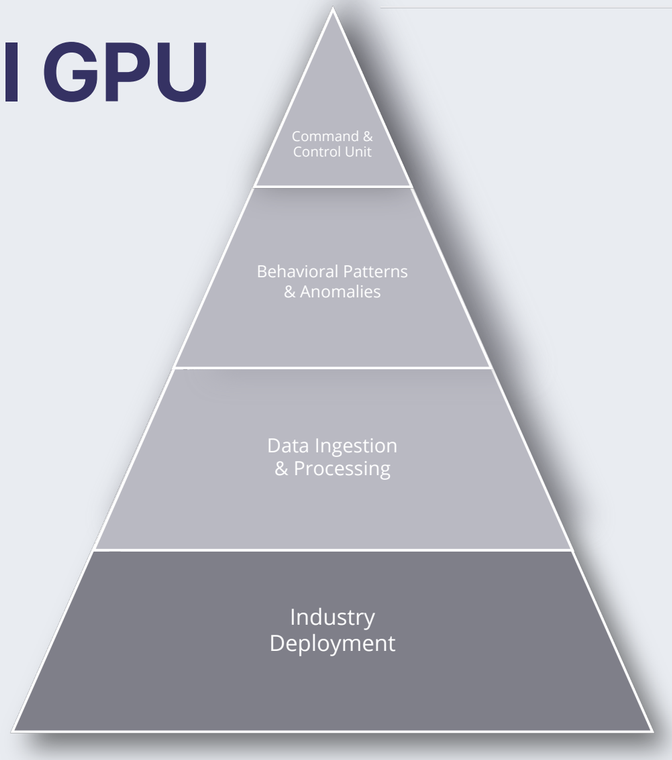
04- Command & Control Unit (CCU)
Single-window platform for FBR policy recommendations.





Standard IP camera deployment with local GPU processing.

- Standard IP /CCTV cameras are installed on the production conveyor line to capture the ongoing production activity in realtime.
- Video Feed passed through Swith to GPU for ML process and also stored in local NVR
- The production data is counted on local GPU while sending count data on online cloud based portal simultaneously the video feeds remian recorded for any verification or events detected.
- The same deployment architecture has been deployed across manufacturing sectors; including cement, sugar, textiles and tiles, without the need for redesigning the hardware.



Picture Exhibits: 4 layer Architecture For National Scale Production Intelligence


Cement


Sugar


Tiles


Beverages


Textiles


Iron and Steel

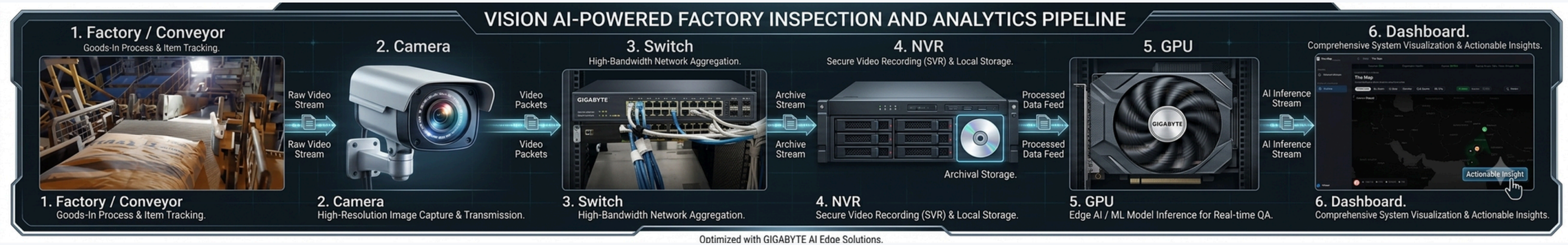

Tyres


Hatcheries


Bottled Milk

The hardware chain: edge to insight.

How a physical event becomes a structured record



STAGE	DATA TYPE	PRIMARY FUNCTION	BANDWIDTH
CAMERA	1080p video	Capture reality	10–50 Mbps, local
POE SWITCH	Organized packets	Route	40 Gbps, local
NVR	Video files	Store	2-4 TB, local
GPU	Tensor arrays / inferences	Infer meaning (AI)	10,000 CUDA cores
DASHBOARD	UI/UX, Analytics, metadata	Display insights	

Built for dust, glare, vibration - 30 Bags/ Minute

The edge & the core

COMPONENT	KEY SPECIFICATIONS
Factory / conveyor	≈30 bags/min; dynamic lighting, continuous movement, high dust & humid environments
Camera	30 FPS capture (average) 60 FPS Capture (highspeed); 12-15W Power - 24 Cameras
Network switch	10 Gbps local; 24+ Gigabit PoE ports
NVR	2 TB; upto 60-day retention

The brain & the dashboard

COMPONENT	KEY SPECIFICATIONS
GPU	56 TFLOPS; under 15 ms per inference
Data center / cloud	Nominal compute; 10 s for structured data to reach FBR
Dashboard	10 s refresh; live topology + factory-level metrics

Trained for the floor

- Dust in the air and on lenses; conditions vary line to plant
- Sun angle and glare shifting through the day
- Lighting changes across shifts and weather
- Vibration and inconsistent bag orientation on the belt
- Conveyor motion itself — blur and foreshortening

The frame-rate math: 1 bag/second at 30 fps ≈ 30 frames per bag — enough to count each one reliably.

Anti-tampering

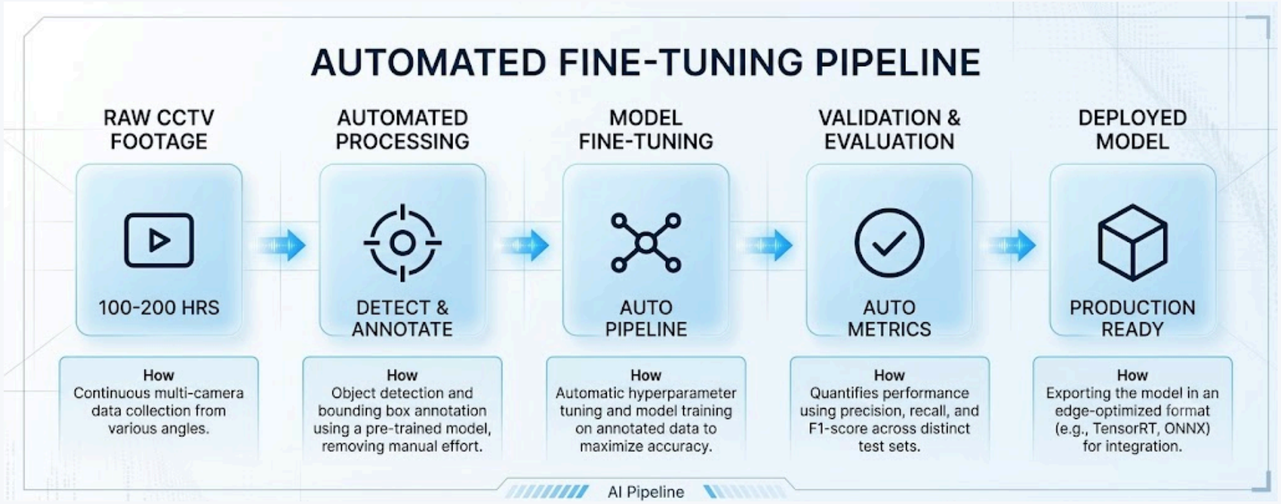
- Counts are cross-checked against energy use and camera-uptime patterns.
- Auto altering for camera off
- Video Recording for Internet Off

INSIDE DIGITAL EYE

Model Fine-tuning, Rapid rollout & Field Conditions

How the same platform reaches a new factory in days.

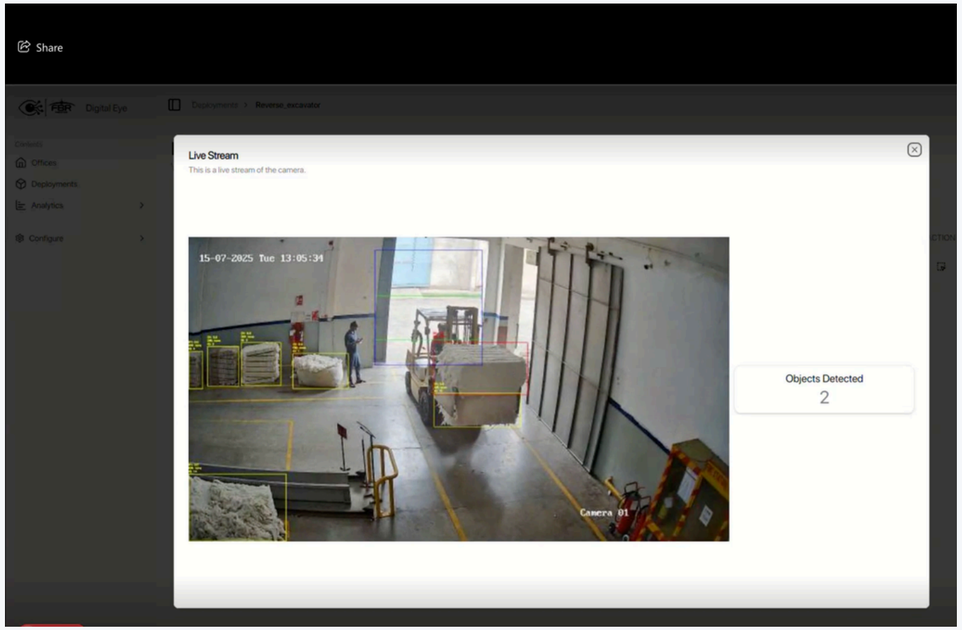
- Open-source computer-vision models are fine-tuned through an automated pipeline.
- Rapid deployment: operational in 1 day, model trained in 1 day, and a full site PoC completed within 48 hours.
- The pipeline adapts automatically to new product types and factory environments; which is what makes a 7-day proof-of-concept possible.



What makes factory-floor vision harder than a controlled environment.

- Dust in the air and on lenses, environment varies from plant to plant.
- Vibration and inconsistent bag orientation on the line.
- Changing sun angle and glare over the course of the day.
- General lighting changes across shifts and weather.

  Conveyor movement itself, which blurs or foreshortens what the camera sees.



03 INSIDE DIGITAL EYE

Deployment process & hardware.

Deployment process

- Hardware installation: cameras, switches, NVR, GPU.
- Digital Eye software installed on-premise.
- Deployment of the FBR cloud connection.
- Fine-tuning of the ML models for the site.
- Production goes live.



Hardware components

- Consumer IP cameras
- PoE / network switch and connectivity
- Network Video Recorder (NVR)
- GPU-based edge processing server
- Local monitoring display + UPS backup
- Secure cabinet, mounting, cable & site accessories



SOTA Software stack.

What runs on top of the hardware at each site and in the cloud.

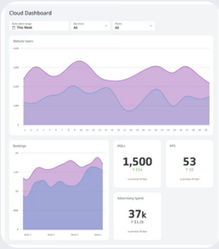
At the site

- Digital Eye AI visual-analytics engine
- Product/ Unit detection & counting model
- Local dashboard for factory-level monitoring
- Production count & reporting module



Cloud & controls

- FBR cloud dashboard for centralized oversight
- Alerts & anomaly-detection module
- User access control and audit logs
- Data-sync / API integration & model-calibration layer



DATA FLOWS

Data Ingestion & Processing Inside Digital Eye

Turning raw video into a verified, structured record.

- Specific ROI for each camera feed to detect, monitor and count as per the production lines conditions.
- Detected events trigger configurable alert workflows; results are stored in a local database before syncing to the FBR cloud on a roughly 10-second refresh.
- Data moves from camera → switch → NVR → GPU → dashboard, converting raw video into structured counts, metadata, and JSON at each stage.
- To guard against tampering, the system cross-checks camera counts against independent signals; presence detection in the GPU room and external sensors such as heat and electricity use; and flags any mismatch.



DATA FLOWS

Data segregation & monitoring outputs.

Data is segregated by

- Production line
- Factory
- Unit
- Time
- Operations shift

Key monitoring outputs

- Real-time bag/ Product Unit count
- Factory-wise and line-wise production visibility
- Current output and historical production trends
- Production verification using visual evidence
- Alerts for downtime, camera issues, abnormal activity
- Local & cloud dashboards; audit-ready records

This segregation is what enables reconciliation and comparisons across factories and shifts.

DPI Linkages : Verifiable Count Useable Across Govt

4

Macroeconomic infrastructure

PBS · LSM index · GDP nowcasting

Objective, real-time industrial output replaces delayed, self-reported surveys - an instant pulse on the economy.

3

Transactional Reconcialiation rails

e-incoving · Customs · Single Window

Physical production reconciled against digital sales and export clearances - undocumented sales and export diversion squeezed out.

2

Predictive & analytical

SECP audited financials × Digital Eye video analytics · FBR predictive models

Financial-to-physical modeling: energy and input costs vs counted output - mismatches flag camera tampering or bypass lines.

1

Foundational identity

FBR Taxpayer Registry - SECP corporate registry · NADRA national ID)

Every counted unit is traceable to a legal entity and its directors - artificial and natural persons linked.

DE

DIGITAL EYE — THE GROUND-TRUTH NODE

Standard CCTV + edge AI on the production line → an independent, timestamped production count (97%+ accuracy, live to FBR in ~10 seconds)

CCU: A single-window national platform for policy recommendations.

How fast a factory-floor event becomes an actionable alert on the FBR dashboard.

The architecture is physically distributed, from remote factories to FBR HQ; but operates as a single, unified system: the journey from a physical event on the belt to an actionable alert happens in well under a second.

10 ms
Capture & Route

15 ms
IInfer & Process

20 ms
RENDER INSIGHT

45 ms
Total Sytem Latency

Inputs

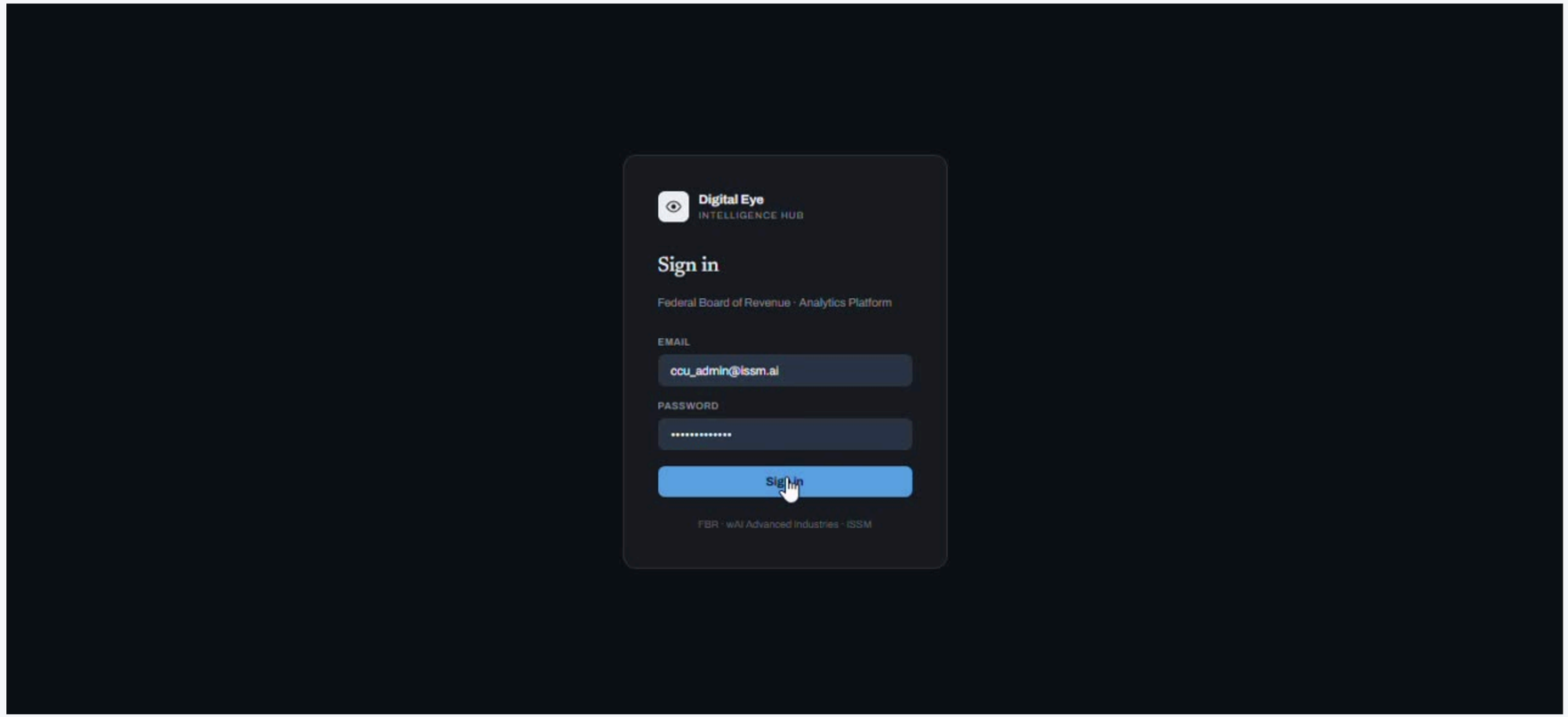
- Factory production data
- Anomaly-detection signals
- Forecasting models
- Sector & market data
- Trade & customs data
- Tax & duty data

Outputs & integration

- Policy recommendations & research papers
- Fiscal-policy decisions; tax & duty strategy
- Sector-specific insights on duty, incentives & relief
- APIs for Customs, WeBOC, digital invoicing & POS systems

Demonstration of Command & Control Unit for HQ.

A live walkthrough of a real factory data feed; showcasing live events, alerts, and graph coverage end to end.



Lessons are so many and still learning ! [Cont.]

Strategic

- Proof beat the persuation
- Procurement rules cannot buy an idea
- Grant money (FCDO) de-risked experimentation government budgets couldn't
- Understanding local industry economics and evasion behavior
- Continous Political Buy is essential
- Multi-vendor per sector
- Priority Target LSM - Revenue Spinners

Technical

- Every line is different: process understanding and site topology before design
- Special use cases: dust, light, blur, packaging
- Camera tampering is the biggest challenge
- GPU supply chain: high-demand item, port delays
- Rapid update cycles
- Object should be countable, AI is not a challenge.

Operations

- Field presence : both vendor, HQ team and regional office
- Power / Connectivity : necessitated NVR
- Factory cooperation is case by case struggle
- Immediate Data Matching for Building Credibility

Lessons are so many and still learning !

Legal & Regulatory

- Legal framework and notifications/STGOs had to move before deployment
- Litigation — textile sector
- Refund/clearance conditionality as the enforcement lever
- Tax Credits for Hardware Procurement

People & Institutional

- Dashboards for field officers, not data scientists
- Structured skill development: 50+ officers, ~500 hours
- Focused Litigation Team
- Multi-stakeholder management: FBR, PRAL, vendors, associations

Financial

- Accuracy is an opex; taxpayer continously test blind spots
- Budget for Litigation
- Burden on Businesses translates into resistance / decision is yours.
- Businesses donot like recurrent costs.

Results, Expectations and Journey so far!

Documented

- **~ $ 215 (m)** revenue increase in Sugar/Cement in the outgoing FY 2026. [Pakistan Economic Survey]
- **~ $775 (m)** revenue increase forecast in for FY 2027
- We started in **two**, FBR has scaled up in **four** more and **11** further in the pipeline
- **97%** counting accuracy / 99% at POC
- Timestamped records/ can be checked manually or by parralle system
- Footage verifiable against any instance of count
- Access controled data
- Runtime autonomy

Source: PBS, Pakistan Economic Survey 2025-26

Awaited

- Third party evaluation of the accuracy
- Bias & Error Analysis (for each site/sector)
- Live streaming of video
- Privacy and Data Protection Assessment
- Data Protection Law
- CCU Deployment
- Automatinc Data Matching with Declarations
- Auto Reporting / Predictive Analytics
- Dispute Settlement - Court stance

Risks & Gaps

What the public record does not cover ?

DIMENSION	Gaps/ Risk
Effects	ROI of $ 215 M gain is GoP-acknowledged but bundles Digital Eye with other interventions including price monitoring and officer presence, so isolated attribution, counterfactual, persistence beyond first monitored season remain untested.
User Experience	No published taxpayer or field officer feedback; compliance burden (hardware/vendor costs borne by mills) undocumented; dispute experience unknown.
Privacy	Data Protection Impact Assessment - Data Protection Law
Operational Value	Shift from stationed officers to exception-based enforcement (alerts + Digital Eye/T&T/IoT reconciliation) is demonstrated, but officer-time savings and false alert workload not yet measured.
Accuracy	99% live / 99.9% FOC is self-reported; third-party evaluation awaited.
Explainability	Count disputes has yet to face independent court scrutiny; timestamped, footage-backed records are the defense, but not yet tested in litigation.
Integration	Integration of Digital Eye feed into broader FBR data systems has yet to happen.
Transparency	Every count is verifiable against live footage (strength), but methodology and sector-wise results not publicly published
Bias	Site/sector-level bias is currently managed through model drift assessment instead of explicit fairness testing (lighting, dust, packaging variation).
Auditability	Immutable NVR records, access-controlled data, but no external audit standard applied
Evidence base	Multi-tier verification exists (staff, AI, BOI), but no independent impact evaluation or published baseline.

Every unit **counted.**
Every count **verified.**
Every verification **reusable.**

Journey Towards 3.0

Akbar Mayo | ASI | Pakistan
https://www.linkedin.com/in/akbarmayo/