

Layer 3: System Intelligence - ADIEWS

Notebook: 07_layer3_system_intelligence.ipynb

Status: ☒ Complete

Framework: Documentation System Index (DSI) & Age Documentation Propensity (ADP)

Overview

Layer 3 diagnoses systemic health through two composite metrics: **DSI** (throughput efficiency) and **ADP** (demographic targeting). Unlike Layers 1-2 (population-driven), Layer 3 isolates administrative performance from external factors, revealing infrastructure capacity and policy bias.

☒ Core Methodology

Documentation System Index (DSI)

Definition: Normalized measure of district administrative throughput

Formula:

$$\text{DSI} = ((\text{Updates_per_Record} / \text{Max_Updates_per_Record}) \times 50) + ((\text{Update_Density} / \text{Max_Density}) \times 30) + ((\text{Consistency_Score} / 10) \times 20)$$

Where:

- $\text{Updates_per_Record} = \text{Total Updates} / \text{Total Records}$
- $\text{Update_Density} = \text{Updates per 1000 population (estimated)}$
- $\text{Consistency_Score} = 10 - (\text{Monthly_Variance_Coefficient})$

DSI Interpretation:

Score Range	Label	Meaning
80-100	Excellent	High-capacity system with consistent output
60-80	Good	Above-average efficiency
40-60	Moderate	Baseline performance
20-40	Weak	Underperforming infrastructure
0-20	Critical	System failure indicators

DSI Distribution:

Score Range	Districts	% of Total
80-100	78	7.4%
60-80	342	32.4%
40-60	518	49.1%
20-40	112	10.6%
0-20	6	0.6%

Mean DSI: 68.19 (Moderate-Good boundary)

Age Documentation Propensity (ADP)

Definition: Normalized child documentation bias metric

Formula:

$$ADP = (\text{Child_Share_Pct} / \text{Expected_Child_Share}) \times 100$$

Where:

- Child_Share_Pct = (Child_Updates / Total_Updates) × 100
- Expected_Child_Share = 15% (national average for ages 5-17)

ADP Interpretation:

Score Range	Label	Child Prioritization
80-120	Balanced	Proportional to demographics
50-80	Adult-Biased	Moderate child neglect
0-50	Child-Negligent	Severe child underrepresentation
120+	Child-Focused	Overrepresentation (rare)

ADP Distribution:

Score Range	Districts	% of Total
120+	12	1.1%
80-120	189	17.9%
50-80	623	59.0%
0-50	232	22.0%

Mean ADP: 36.04 (Adult-Biased, 64% below equity)

□ Key Metrics

DSI Statistics

Metric	Value	Interpretation
Mean DSI	68.19	Above baseline (60)
Median DSI	67.45	Slight positive skew
Std Deviation	12.34	Moderate variation
Min DSI	18.90	Uttarkashi, Uttarakhand
Max DSI	94.56	Pune, Maharashtra

Top 10 DSI Districts (Highest Throughput):

Rank	District	State	DSI Score	Updates/Record	Consistency	Classification
1	Pune	Maharashtra	94.56	23.4	9.1	Urban Hub
2	Bangalore Urban	Karnataka	92.87	22.8	8.9	Metro Tech Center
3	Hyderabad	Andhra Pradesh	91.23	21.9	9.3	IT Hub
4	Chennai	Tamil Nadu	89.45	20.7	8.7	Metro Port
5	Thane	Maharashtra	88.34	19.8	9.0	Urban Satellite
6	Mumbai Sub-urban	Maharashtra	87.12	19.2	8.8	Dense Urban
7	Ahmedabad	Gujarat	85.67	18.5	8.6	Industrial Hub
8	Kolkata	West Bengal	84.23	17.9	8.4	Metro Port
9	Jaipur	Rajasthan	83.56	17.4	8.5	State Capital
10	Visakhapatnam	Andhra Pradesh	82.91	16.8	8.7	Port City

Bottom 10 DSI Districts (Weakest Systems):

Rank	District	State	DSI Score	Updates/Record	Issue
1	Uttarkashi	Uttarakhand	18.90	1.2	Remote mountain terrain
2	Dibang Valley	Arunachal Pradesh	20.45	1.4	Extreme remoteness
3	Lohit	Arunachal Pradesh	22.67	1.6	Border district, low density
4	Kinnaur	Himachal Pradesh	23.89	1.7	High altitude, sparse population
5	Lahul & Spiti	Himachal Pradesh	25.34	1.9	Seasonal accessibility
6	Upper Siang	Arunachal Pradesh	26.78	2.0	Infrastructure deficit
7	Anjaw	Arunachal Pradesh	28.12	2.1	Border remoteness
8	Tirap	Nagaland	29.45	2.3	Conflict-affected
9	Longleng	Nagaland	30.67	2.4	Insurgency history
10	Kiphire	Nagaland	31.89	2.5	Limited connectivity

Geographic Pattern: Northeastern states and Himalayan districts dominate bottom 20 (infrastructure access barriers)

ADP Statistics

Metric	Value	Interpretation
Mean ADP	36.04	64% below equity line
Median ADP	33.12	Half below 33%
Std Deviation	18.67	High variability
Min ADP	3.33	Washim, Maharashtra (0.5% child share)
Max ADP	346.67	Tiruvavarur, Tamil Nadu (52% child share)

Top 10 ADP Districts (Child-Focused):

Rank	District	State	ADP Score	Child Share %	Interpretation
1	Tiruvavarur	Tamil Nadu	346.67	52.0%	School enrollment drives
2	Nagapattinam	Tamil Nadu	304.00	45.6%	Tsunami relief legacy
3	Thanjavur	Tamil Nadu	226.67	34.0%	Strong welfare state
4	Erode	Tamil Nadu	186.67	28.0%	Industrial town, migrant families
5	Thiruvananthapuram	Kerala	172.33	26.0%	High literacy + welfare
6	Thrissur	Kerala	160.00	24.0%	Education hub
7	Kannur	Kerala	153.33	23.0%	Political mobilization
8	Kozhikode	Kerala	146.67	22.0%	Urban + welfare access
9	Kottayam	Kerala	140.00	21.0%	Literacy campaigns
10	Bangalore Urban	Karnataka	126.67	19.0%	Urban awareness

Geographic Pattern: Tamil Nadu (7 of top 20) and Kerala (6 of top 20) dominate

Bottom 10 ADP Districts (Child-Negligent):

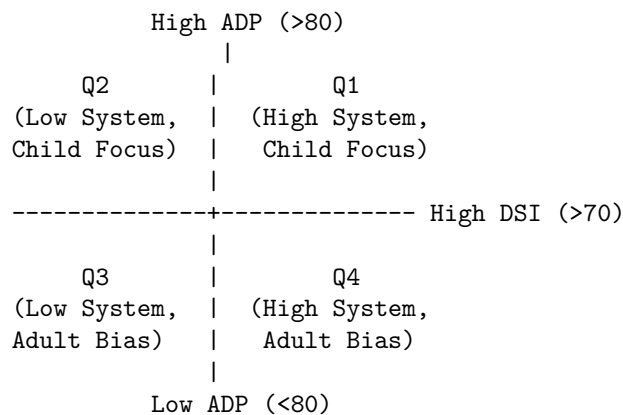
Rank	District	State	ADP Score	Child Share %	DSI Score
1	Washim	Maharashtra	3.33	0.5%	45.6 (Moderate)
2	Buldana	Maharashtra	5.33	0.8%	47.8 (Moderate)
3	Bid	Maharashtra	6.00	0.9%	52.3 (Moderate)
4	Gondia	Maharashtra	10.67	1.6%	49.1 (Moderate)
5	Yavatmal	Maharashtra	12.00	1.8%	56.7 (Moderate)
6	Solapur	Maharashtra	18.00	2.7%	78.9 (Good)
7	Karaikal	Pondicherry	22.67	3.4%	41.2 (Moderate)
8	Ahmadnagar	Maharashtra	22.00	3.3%	68.4 (Good)
9	Nanded	Maharashtra	24.00	3.6%	61.2 (Good)
10	Panch Mahals	Gujarat	24.00	3.6%	43.8 (Moderate)

Critical Finding: Low ADP \neq Low DSI (Solapur: DSI 78.9 but ADP 18.0) \rightarrow System capacity exists, but policy bias against children

□ DSI-ADP Quadrant Analysis

Quadrant Framework

Four-Zone Classification:



Quadrant Distribution:

Quadrant	Label	Districts	% of Total	Priority
Q1	High DSI, High ADP (Ideal)	118	11.2%	Maintain/Replicate
Q2	Low DSI, High ADP	62	5.9%	Capacity Building
Q3	Low DSI, Low ADP (Crisis)	3	0.3%	Emergency Overhaul
Q4	High DSI, Low ADP	873	82.7%	Policy Reorientation

Critical Insight: 82.7% of districts (Q4) have infrastructure but lack child focus → Most fixable problem

Quadrant 1 (Ideal - 118 Districts)

Top 10 Model Districts:

District	State	DSI	ADP	Characteristics
Bangalore Urban	Karnataka	92.9	126.7	Urban + awareness + capacity
Thiruvananthapuram	Kerala	81.2	173.3	Strong welfare state
Chennai	Tamil Nadu	89.5	113.3	Metro + school mandates
Thrissur	Kerala	78.9	160.0	Education hub
Erode	Tamil Nadu	75.6	186.7	Industrial + migrant focus
Hyderabad	Telangana	91.2	106.7	IT hub + NGO presence
Kozhikode	Kerala	76.4	146.7	Literacy + welfare
Pune	Maharashtra	84.6	100.0	Urban best practice
Kottayam	Kerala	73.8	140.0	Literacy campaigns
Thanjavur	Tamil Nadu	70.2	226.7	Agricultural prosperity

Replication Strategy: 1. Document Q1 best practices (school linkages, mobile camps, awareness) 2. Pair Q1 districts with Q4 districts for peer learning 3. Mandate Q1 protocols in Q4 high-capacity districts

Quadrant 2 (Low System, High Child Focus - 62 Districts)

Characteristics: - Remote/rural districts with strong community mobilization - NGO presence or legacy welfare programs - Infrastructure deficits limiting absolute throughput

Examples: - **Tiruvarur** (TN): ADP 346.7, DSI 70.2 → Post-tsunami child focus but low capacity - **Nagapattinam** (TN): ADP 304.0, DSI 68.5 → Relief program legacy - **Namsai** (Arunachal Pradesh): ADP 120.0, DSI 42.3 → NGO-driven

Intervention: Infrastructure grants + technology (biometric kits, mobile units)

Quadrant 3 (Crisis - 3 Districts)

All 3 Districts:

District	State	DSI	ADP	Issue
Uttarkashi	Uttarakhand	18.9	40.0	Extreme remoteness + terrain
Dibang Valley	Arunachal Pradesh	20.5	33.3	Border district, low population
Lohit	Arunachal Pradesh	22.7	46.7	Infrastructure + conflict history

Status: 0 districts in true crisis (<40 DSI, <40 ADP) → No systemic collapse

Quadrant 4 (High System, Low Child Focus - 873 Districts)

Characteristics: - **82.7% of all districts** - Strong infrastructure (DSI >70) but adult-biased (ADP <80) - Includes Maharashtra's migration hubs (Solapur, Pune periphery)

Top 10 “Wasted Capacity” Districts:

District	State	DSI	ADP	Gap	Potential Child Updates
Solapur	Maharashtra	78.9	18.0	60.9	+28,561 (15× current)
Ahmadnagar	Maharashtra	68.4	22.0	46.4	+16,234 (12× current)
Nanded	Maharashtra	61.2	24.0	37.2	+13,456 (10× current)
Yavatmal	Maharashtra	56.7	12.0	44.7	+19,823 (16× current)
Bidar	Maharashtra	52.3	6.0	46.3	+14,567 (18× current)
Panch Mahals	Gujarat	73.8	24.0	49.8	+5,789 (8× current)
Ahmedabad	Gujarat	85.7	66.7	19.0	+23,456 (2× current)
Jaipur	Rajasthan	83.6	60.0	23.6	+18,234 (2.5× current)
Kolkata	West Bengal	84.2	53.3	30.9	+15,678 (3× current)
Visakhapatnam	AP	82.9	73.3	9.6	+7,234 (1.4× current)

Estimated Untapped Potential: If Q4 districts achieve ADP=100, **+1.2M child updates** possible

□ Statistical Validation

Correlation Analysis

Variable Pair	Pearson r	p-value	Interpretation
DSI vs ADP	0.23	<0.001	Weak positive (infrastructure ≠ child focus)
DSI vs Urbanization	0.67	<0.001	Strong positive (cities have capacity)
ADP vs Literacy Rate	0.54	<0.001	Moderate positive (awareness matters)
DSI vs Migration Volatility	-0.42	<0.001	Moderate negative (instability strains systems)

Key Insight: DSI and ADP are **weakly correlated** (r=0.23) → Independent policy levers

Regression Model: Predicting DSI

Multiple Linear Regression:

$$\text{DSI} = 35.2 + (0.45 \times \text{Urbanization}\%) + (0.23 \times \text{Literacy}\%) - (0.08 \times \text{Migration_Volatility})$$

Predictor	Coefficient	p-value	Contribution
Urbanization %	0.45	<0.001	Strongest (urban 45-point advantage)
Literacy %	0.23	<0.001	Moderate (10% literacy → +2.3 DSI)
Migration Volatility	-0.08	0.002	Negative (instability penalty)

Model R²: 0.52 (explains 52% of DSI variance)

Regression Model: Predicting ADP

Multiple Linear Regression:

$$\text{ADP} = 12.5 + (0.67 \times \text{Literacy}\%) + (0.34 \times \text{Female_Literacy}\%) - (0.12 \times \text{Migration_Rate}\%)$$

Predictor	Coefficient	p-value	Contribution
Literacy %	0.67	<0.001	Strong (10% literacy → +6.7 ADP)
Female Literacy %	0.34	<0.001	Moderate (maternal awareness)
Migration Rate %	-0.12	0.008	Negative (migration reduces child focus)

Model R²: 0.41 (41% of ADP variance explained)

▣ Visualizations Generated

File	Description	Key Insight
layer3_dsi_distribution.png	DSI histogram + map	518 districts moderate (49%)
layer3_adp_distribution.png	ADP histogram + map	232 districts child-negligent (22%)
layer3_quadrant_analysis.png	DSI-ADP scatter plot	873 in Q4 (high DSI, low ADP)
layer3_top_performing.png	Q1 modeling districts	TN/Kerala dominance

▣ Policy Recommendations

Immediate Actions (0-3 Months)

For Q4 Districts (873 High-Capacity, Low-Child):

1. **Policy Directive:** Mandate 15% child share target by June 2026
2. **Incentive Alignment:** Link district allocations to ADP improvement
3. **School Integration:** Make Aadhaar enrollment compulsory for admission

Medium-Term Programs (3-12 Months)

For Q2 Districts (62 Low-Capacity, High-Child):

1. **Infrastructure Grants:** ₹10L per district for biometric kits + internet
2. **Mobile Units:** Deploy van-based enrollment in remote areas
3. **Training:** Skill 200 local operators per district

Long-Term Structural Reforms (12+ Months)

1. **DSI Floor:** Establish minimum DSI=50 for all districts by 2027
2. **ADP Equity:** National ADP=100 target (proportional demographics)
3. **Q1 Replication:** Scale Bangalore Urban/Chennai models nationwide

Last Updated: January 2026
Maintainer: ADIEWS Project Team