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Review Article

From Generics to Global Leadership: State-Level Policies and India's Pharmaceutical Transformation (2010–2025)

Dr. Gunjan Lath, Dr. Raju Rhee, Dr. Vivek Jha, Samit Paul

[1]Consultant, IIM Kolkata.

[2]Head Kerala Genome Data Centre

[3]Industry Advisor IIM Bangalore

[4]Associate Professor, Indian Institute of Management Calcutta

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Abstract:

Between 2010 and 2025, India's pharmaceutical industry underwent a striking transformation. What was once seen primarily as a cost-competitive generics hub, matured into a global supplier of vaccines, complex generics, APIs, and biologics. National schemes such as the PLI program, Jan Aushadhi, and regulatory reforms provided the broad policy framework, but state governments played a decisive yet often overlooked role in shaping industrial outcomes.

This paper compares the strategies of seven reform-oriented states- Gujarat, Telangana, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Karnataka, and Kerala, alongside legacy clusters in Maharashtra, Uttarakhand, Himachal Pradesh, Sikkim, Assam, and Goa. Using a mixed qualitative framework that integrates policy review, ecosystem assessment, and outcome mapping, it evaluates how fiscal incentives, infrastructure, innovation ecosystems, and governance mechanisms translated into manufacturing scale, export strength, and regulatory credibility.

The findings suggest that states which emphasized regulatory continuity, infrastructure execution, and institutional coordination achieved more durable results than those relying mainly on fiscal incentives. By highlighting state-level diversity and execution capacity, the study proposes a framework for designing pharmaceutical strategies that are context-sensitive, outcome-oriented, and aligned with long-term sustainability. Unlike earlier work that focused narrowly on national schemes or individual clusters, this review provides a longitudinal, cross-state perspective spanning 15 years.

Keywords: Pharmaceutical policy, Innovation Ecosystems, API Manufacturing Revival, Environmental Regulation, Fiscal Incentives Pharma, Bulk Drug Parks.

1. Introduction

India's pharmaceutical industry today is valued at more than USD 50 billion, with projections suggesting it could reach USD 130 billion by 2030. (1) This growth reflects a mix of strategic policy interventions, export competitiveness, and the country's dominant role in supplying generics and vaccines worldwide. India currently accounts for nearly 20 percent of

global generics and close to 60 percent of vaccines, underscoring the sector's strategic importance in international health markets. (2) While national policies set the overall direction, the competitiveness of pharmaceutical firms is deeply shaped by state-level actions: land allocation, cluster infrastructure, fiscal incentives, regulatory enforcement, environmental management, talent availability, ease of doing business, and logistics connectivity. This study focuses on seven representative states- Gujarat, Telangana, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, and Kerala, while also referencing legacy clusters such as Maharashtra, Uttarakhand, Himachal Pradesh, Sikkim, Assam, and Goa for context.

Before 2010, most states lacked specialized pharmaceutical or biotech policies. Growth was driven largely by broader industrial promotion schemes and central incentives. (3) States such as Sikkim, Himachal Pradesh, and Uttarakhand benefitted from excise duty holidays in the early 2000s, attracting numerous small and medium manufacturers to clusters like Baddi and Rangpo. (4,5) Gujarat and Maharashtra leveraged their established industrial bases and port connectivity to expand bulk drug and formulations production, while Andhra Pradesh's Hyderabad cluster emerged as a hub for APIs and contract manufacturing. (6,7) These interventions were limited to land allotment, tax concessions, and basic infrastructure, with little emphasis on innovation, environmental governance, or regulatory specialization.

The period from 2010 to 2025 marked a decisive shift. States such as Gujarat, Telangana, Andhra Pradesh, Tamil Nadu, and later Uttar Pradesh pursued aggressive strategies with dedicated pharma and biotech parks, fiscal grants, and active investor facilitation. Others, including Kerala and Karnataka, focused more on health governance, drug quality oversight, and regulatory enforcement. Together, these diverse approaches illustrate how state-level choices have shaped India's pharmaceutical landscape in ways that extend far beyond national policy frameworks.

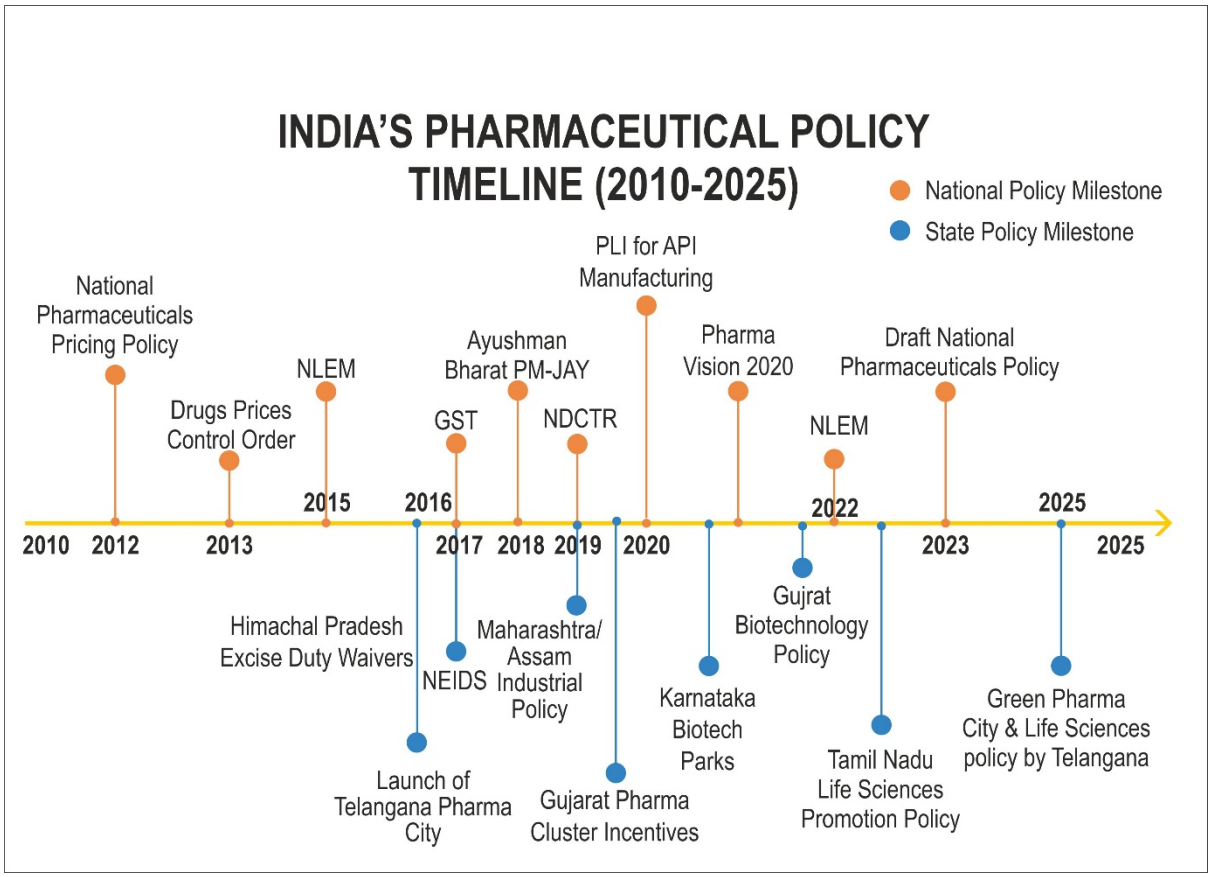

Figure 1: (Original) India's Pharmaceutical Policy Timeline from 2010-2025 (8-27)

2. Evolution of State-Level Pharmaceutical Policies (2010–2025)

The trajectory of state-level pharmaceutical policymaking in India between 2010 and 2025 reflects a decisive shift from passive facilitation to active, competitive, and differentiated strategies. Over this 15-year period, states increasingly recognized that pharmaceuticals, biotechnology, and life sciences were not simply subsets of general industrial policy but sectors with direct implications for economic growth, public health, export competitiveness, and national security. While central initiatives provided the broad framework, it was state governments that translated these priorities into operational outcomes through land allocation, infrastructure development, fiscal incentives, regulatory enforcement, and innovation support. This evolution unfolded unevenly. Some states moved early to craft specialized pharmaceutical and biotechnology policies, while others relied on legacy incentives or broader industrial schemes. Over time, these choices produced a highly differentiated landscape: a handful of globally competitive clusters alongside several that stagnated or remained narrowly specialized. To capture these dynamics, the period can be divided into three phases: the pre-2014 era of legacy clusters and limited activism; the 2014–2020 phase of heightened competition following the Make in India initiative; and the post-2020 period shaped by pandemic-induced supply chain vulnerabilities and the revival of API manufacturing.

2.1 Pre-2014: Legacy Clusters and Moderate State Activism

Before 2014, India's pharmaceutical growth was anchored in a set of legacy clusters that had emerged through historical industrial concentration, proximity to ports and urban markets, and preferential central incentives. Gujarat and Maharashtra benefitted from

long-standing industrial ecosystems in Ahmedabad, Vadodara, Mumbai, and Pune, supported by chemical industries, skilled labor, and logistics connectivity. Andhra Pradesh, particularly Hyderabad before bifurcation, became a major hub for APIs and contract manufacturing, leveraging technical talent and a relatively business-friendly administration. (6,7) Smaller states such as Himachal Pradesh, Uttarakhand, and Sikkim experienced rapid expansion driven by excise duty exemptions and tax holidays introduced in the early 2000s. Clusters like Baddi and Rangpo attracted numerous small and medium manufacturers focused on formulations and domestic markets. (4,5) While these incentives dispersed manufacturing geographically and increased capacity, they did little to foster innovation ecosystems, specialized regulatory institutions, or long-term sustainability.

State interventions during this phase were largely subsumed under broader industrial promotion schemes. Land allotment, basic infrastructure, and tax concessions dominated, while biotechnology, biologics, environmental governance, and regulatory specialization remained peripheral. Innovation support and skill development were secondary considerations. This laid the foundation for India's emergence as a global generics supplier but also entrenched structural weaknesses: limited R&D depth, environmental externalities, and an over-reliance on cost competitiveness.

2.2 2014–2020: Make in India, Emergence of State Competition

The launch of the Make in India initiative in 2014 marked a turning point. (8) With renewed national emphasis on manufacturing competitiveness, ease of doing business, and global value chain integration, states began to compete more aggressively. Pharmaceuticals and life sciences were increasingly seen as high-value sectors capable of generating exports, skilled employment, and international visibility.

Gujarat refined its biotechnology policies, offering capital subsidies, operational incentives, and support for global quality certifications. Karnataka leveraged its innovation ecosystem to promote biotech startups, incubation centers, and university-industry collaboration, positioning itself as a research hub rather than a bulk manufacturing powerhouse. (9) Telangana, newly formed in 2014, adopted a mission-driven approach, introducing the TS-iPASS single-window clearance system and branding Hyderabad as a "Life Sciences Capital." (10) Uttar Pradesh, though slower to respond, began laying the groundwork for a more aggressive pharmaceutical strategy toward the end of this period.

This phase was defined by deliberate cluster deepening rather than simple capacity expansion. States invested in specialized parks, regulatory facilitation mechanisms, and investor outreach, seeking to differentiate themselves within India's federal landscape. There was growing recognition that state governments could actively shape India's position in global pharmaceutical value chains by influencing compliance standards, infrastructure quality, and innovation capacity. (11) Environmental governance and API self-reliance, however, remained secondary concerns, as cost efficiency and export growth dominated priorities. (12)

2.3 2020–2025: COVID-19 and the API Revival

The COVID-19 pandemic exposed India's dependence on China for APIs and key intermediates, forcing a fundamental reorientation of policy priorities. In response, the Union Government launched the Production-Linked Incentive scheme for pharmaceuticals and the Promotion of Bulk Drug Parks scheme, explicitly targeting supply chain resilience and self-reliance. While centrally designed, their success hinged on state-level implementation. (13,14)

States competed to host bulk drug parks and expand API manufacturing infrastructure. Uttar Pradesh, Andhra Pradesh, and Himachal Pradesh emerged as key beneficiaries, with projects such as the Lalitpur and Kakinada bulk drug parks. (15) At the same time, states expanded vaccine, biologics, and biotechnology

infrastructure to meet surging global demand, with Telangana and Maharashtra playing prominent roles. (16)

This period also brought environmental and regulatory concerns to the forefront. The concentration of API manufacturing heightened scrutiny over effluent discharge, pollution, and antimicrobial resistance, prompting states to strengthen governance mechanisms such as Common Effluent Treatment Plants and Zero Liquid Discharge mandates. (17,18)

By 2025, India's pharmaceutical geography had become markedly uneven, reflecting cumulative policy choices over the previous decade and a half. The pandemic acted not only as a stress test but also as an accelerant, magnifying the advantages of states with strong institutional capacity and exposing the limitations of those reliant on legacy or incentive-only models.

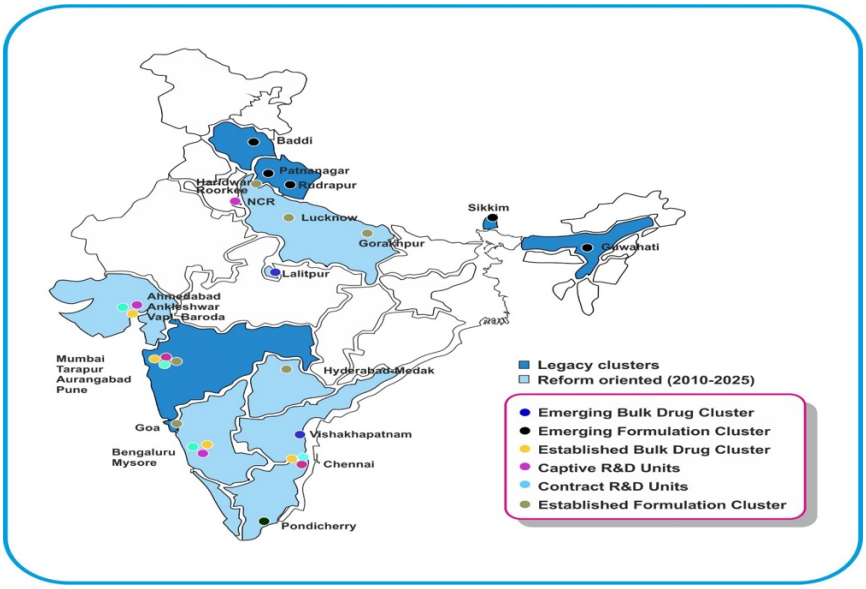

Figure 2: (Original) Map of India showing states considered in the policy framework design & pharmaceutical clusters. (39)

3. State Case Studies

India's pharmaceutical geography is best understood through the contrasting strategies of its leading states. Gujarat, Telangana, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Karnataka, and Kerala illustrate different models of industrial activism, innovation, and governance. Rather than ranking them, the case studies highlight how varied policy mixes shaped outcomes.

3.1 Gujarat: India's Pharmaceutical and Biotech Powerhouse

Gujarat stands out for its consistent, long-term commitment to pharmaceuticals and biotechnology. Successive policies offered capital subsidies, tariff incentives, and support for global quality certifications such as WHO-GMP, USFDA, and EU-GMP audits, directly linking state aid to export readiness. Infrastructure investments in pharma parks and SEZs near ports lowered logistics costs and deepened cluster strength. As a result, Gujarat now accounts for roughly one-third of India's pharmaceutical production and a quarter of exports. Its success lies less in isolated incentives than in stable policies, strong institutions, and integrated ecosystems. (19-21)

3.2 Andhra Pradesh: API Powerhouse and Infrastructure-Driven Expansion

Andhra Pradesh's pharmaceutical identity is defined by its API manufacturing corridor around Visakhapatnam and Kakinada. With port-linked infrastructure, SEZs, and fiscal incentives, the state secured a central role in India's API revival strategy. Governance capacity has improved with single-window clearance systems and effluent treatment facilities, yet enforcement challenges persist. While innovation ecosystems remain modest compared to Karnataka or Telangana, Andhra Pradesh's strength lies in scale, logistics, and its

ability to anchor upstream manufacturing capacity critical for supply chain resilience. (22)

3.3 Telangana: Cluster Deepening & Life Sciences Branding

Telangana adopted a mission-driven model soon after its formation in 2014, branding Hyderabad as a "Life Sciences Capital." The TS-iPASS clearance system streamlined approvals, while projects like Pharma City and Genome Valley expanded both manufacturing and innovation capacity. The state also became a global vaccine hub during the Covid-19 pandemic. Environmental challenges including effluent discharge and antimicrobial resistance prompted stricter governance measures, though enforcement remains uneven. Telangana's trajectory shows how branding, institutional facilitation, and cluster deepening can rapidly elevate global visibility. (23,24)

3.4 Tamil Nadu: Late Policy Reformer with Emerging Life Sciences Ambition

Historically focused on formulations, nutraceuticals and medical devices, supported by port connectivity through Chennai and Tuticorin, Tamil Nadu shifted gears with its 2022 Life Sciences Promotion Policy. Leveraging strong academic institutions, the state introduced fiscal incentives, incubation support, and life sciences parks. Its API revival is still nascent, but emphasis on innovation and certification signals intent to integrate into global value chains. The challenge ahead lies in strengthening regulatory specialization and environmental governance to match its infrastructural base. (25)

3.5 Uttar Pradesh: Late but Rapid Entrant

A late entrant, Uttar Pradesh repositioned itself with the 2018 Pharmaceutical Industrial Policy, offering generous subsidies and SGST reimbursements. Post-COVID, the Lalitpur Bulk Drug Park aligned the state with national API revival priorities. New pharma and biotech parks in Noida, Lucknow, and Gorakhpur aim to attract investment and generate employment, especially in Tier-2 regions. While outcomes are still emerging, UP demonstrates how political commitment and fiscal incentives can accelerate catch-up, though sustainability will depend on regulatory and innovation depth. (26, 27)

3.6 Kerala & Karnataka: Regulatory Quality and Health Governance

Kerala emphasizes regulatory rigor and public health orientation over industrial scale. Strong drug control enforcement and antimicrobial resistance programs have built credibility, even if manufacturing remains limited.

Karnataka, by contrast, leverages Bengaluru's innovation ecosystem- universities, startups, and venture capital to position itself as a hub for biotech, diagnostics, and advanced therapeutics. Both states illustrate alternative models: governance-centric and innovation-driven approaches that complement manufacturing-heavy strategies elsewhere. (28-30)

4. Research Design and Methods

4.1 Methods & Methodology

This study adopts a comparative policy analysis design to examine how Indian states shaped pharmaceutical development between 2010 and 2025. The approach is qualitative but structured, combining systematic document review, thematic coding, and comparative outcome mapping. The goal was to capture both policy intent (what governments announced) and policy execution (what outcomes materialized), recognizing that state-level diversity produces differentiated industrial trajectories.

Policies were classified into four analytical lenses:

1. Fiscal Incentives & Industrial Capacity – subsidies, tax concessions, SGST reimbursements, excise duty holidays.
2. Infrastructure Development & API Revival – pharma parks, SEZs, bulk drug parks, logistics connectivity.
3. Innovation & Talent Ecosystem & Export Competitiveness – incubation centers, university–industry linkages, certification support (WHO-GMP, USFDA, EU-GMP).
4. Governance & Compliance – drug quality enforcement, environmental safeguards (CETPs, Zero Liquid Discharge), SME upgrading.

Each state's policies were coded against these lenses, with strength assessed as strong, moderate, or weak based on the depth, continuity, and execution capacity evident in the reviewed materials.

4.2 Data Sources

Literature search was done online using following keywords- Pharmaceutical policy, Innovation Ecosystems, API Manufacturing Revival, Environmental Regulation, Fiscal Incentives Pharma, Bulk Drug Parks. The following documents relevant to time period of 2010-2025 were screened. Each was coded for instruments, priorities, and implementation signals.

- Collection of primary policy documents: state industrial policies, biotechnology/pharma promotion schemes, life sciences strategies, and central notifications (PLI, bulk drug parks, excise duty concessions).
- Regulatory and audit materials: Comptroller and Auditor General (CAG) reports, state drug control enforcement data, and environmental compliance notifications.
- Secondary analyses: industry reports (FICCI, CII), think-tank studies (ORF, Brookings India), and peer-reviewed academic work.
- Media and trade coverage: longitudinal reporting on cluster development, investment inflows, and governance challenges.

4.3 Comparative Matrix Construction

- Coding aggregation – For each state, coded instruments were tallied under the four lenses.
- Strength assignment – States were rated strong, moderate, or weak using explicit criteria (e.g., Gujarat's repeated certification subsidies = strong in export competitiveness; Kerala's antimicrobial resistance programs = strong in governance but weak in industrial capacity).
- Heatmap visualization – Ratings were plotted into a comparative matrix, producing a color-coded heatmap that allowed quick identification of balanced versus narrow policy portfolios.

4.4 Outcome Mapping

Qualitative outcome mapping was done based on observable signals reported in secondary sources such as cluster depth, export visibility, innovation activity, and governance reputation. These signals were used to check whether the coded policy strengths aligned with the outcomes described in case studies. For example, Gujarat's repeated emphasis on certification support was reflected in its strong export profile, while Kerala's governance orientation was visible in its antimicrobial resistance programs.

5. Cross-State Comparison

5.1 Comparative Policy Mix Analysis

Table 1 and 2 show visual comparative matrix - a heatmap that instantly shows which states are strong (green), moderate (yellow), or weak (red) across the four integrated lenses. (31-38)

Table1-Heatmap of Comparative Policy Mix Analysis from 2010-2025 in Reform Oriented Indian States

Integrated Lens	Gujarat	Telangana	Tamil Nadu	Andhra Pradesh	Uttar Pradesh	Karnataka	Kerala

Fiscal Incentives & Industrial Capacity	Strong, consistent subsidies and SGST reimbursements; large manufacturing footprint	Moderate–Strong; incentives tied to cluster branding; expanding biologics	Strong incentives, Industrial capacity moderate, anchored in formulations, nutraceuticals & medical devices.	Strong fiscal incentives, alignment with central schemes, approval for the Kakinada Bulk Drug Park.	Strong; aggressive subsidies post-2018; rapid API capacity expansion	Moderate; startup-oriented support, less bulk manufacturing	Low; limited fiscal push, focus on governance
Infrastructure Development & API Revival	Multiple pharma/biotech parks, SEZs, bulk drug corridors; API revival strong	Hyderabad Pharma City, Genome Valley; cluster depth, API revival moderate	Strong port connectivity, bulk drug & medical device mfg, API Revival at early stage.	Strong. The Visakhapatnam–Kakinada corridor, bulk drug park initiative reinforces its role in the national API revival strategy.	Bulk Drug Park (Lalitpur) + pharma parks; API revival aligned with national schemes	Biotech parks in Bengaluru; limited API revival	Limited pharma parks; focus on CETPs and governance
Innovation & Talent Ecosystem & Export Competitiveness	Strong R&D support; high export share (~28%); certifications widely adopted	Strong innovation ecosystem; vaccines/biologics exports rising	Growing biotech startup ecosystem. University–industry linkages and incubation centers, moderate pharma exports.	Moderate strength, The focus remains on manufacturing scale.	Emerging; export competitiveness growing, certification uptake ongoing	Very strong innovation ecosystem; Bengaluru startups, biotech R&D	Modest; Ayurveda innovatio, strong governance, limited exports
Governance & Compliance with Environmental/Public Health & SME Upgrading	Moderate enforcement; support for certifications; CETPs in place	High governance focus post-effluent controversies; ZLD mandates, CETPs expanded	Moderate, emphasized ease of doing business; Environmental governance emerging	Moderate. Introduced single-window clearance systems & effluent treatment facilities, but enforcement remains uneven.	Moderate enforcement; governance emerging; SME inclusion growing	Strong regulatory enforcement; biotech quality focus	Very strong enforcement; AMR mitigation, ethical pharmacy practices

Table2- Heatmap of Comparative Policy Mix Analysis from 2010-2025 in Indian States with legacy clusters

Integrated Lens	Maharashtra	Uttarakhand	Himachal Pradesh	Sikkim	Goa	Assam
Fiscal Incentives & Industrial Capacity	Moderate; incentives for formulations/logistics, less aggressive than Gujarat	Moderate; excise duty waivers historically, modest new incentives	Moderate; excise-driven growth in formulations, now plateaued	Strong during 2002–2017 excise duty exemption; cluster built in Rangpo	Moderate; excise-driven growth in formulations, now plateaued	Moderate; new pharma park in Kamrup district; incentives for R&D and startups
Infrastructure Development & API Revival	Pharma hubs in Pune/Mumbai; logistics advantage; API revival modest	Bulk drug cluster in Haridwar; limited new infrastructure	Moderate, Infrastructure in Baddi supported large-scale formulations manufacturing, but API revival projects were limited	Rangpo Pharma Cluster; SEZ-driven infrastructure; small scale	Baddi-like cluster in Verna; formulations focus, limited API	Pharmaceutical Park in Kamrup; focus on herbal medicine R&D; emerging API initiatives
Innovation & Talent Ecosystem & Export Competitiveness	Strong in formulations/logistics exports; innovation moderate	Limited innovation ecosystem; exports modest	Weak, cluster dominated by SMEs with limited R&D capacity. Few innovation ecosystems, Export competitiveness constrained by compliance lapses	Limited innovation, but cluster exports significant during excise era	Moderate; formulations exports, limited innovation	Rich biodiversity supporting herbal medicine innovation; growing startup ecosystem; export potential rising
Governance & Compliance with Environmental/Public Health & SME Upgrading	Moderate enforcement, governance improving; SME inclusion modest	Moderate enforcement; governance modest	Weak, Baddi faced recurring concerns over GMP compliance, environmental violations, and quality lapses	Governance modest; cluster compliance issues noted	Moderate enforcement; SME inclusion limited	Active government support; innovation & startup policies; environmental compliance improving

5.2 Outcome Analysis

Each state's profile in the heatmap reflects the aggregation of coded policy instruments across the four analytical lenses- fiscal incentives and industrial capacity, infrastructure and API revival, innovation and export competitiveness, and governance and compliance. Ratings of strong, moderate, or weak were assigned based on the depth, continuity, and execution capacity evident in the reviewed documents, and then cross-checked against observable outcomes.

- Gujarat and Telangana emerged as consistently strong performers across all lenses. Their policies combined fiscal incentives with deep infrastructure, proactive support for global certifications, and institutional mechanisms such as single-window clearances. These strengths translated into measurable outcomes: high export shares, strong cluster depth, and resilience during the API revival phase.
- Tamil Nadu, Andhra Pradesh, and Uttar Pradesh showed rapid catch-up trajectories. Coding revealed strong fiscal and infrastructure interventions, but only moderate progress in innovation ecosystems and regulatory enforcement. Outcome signals such as early-stage cluster development and rising investment interest, confirm these transitional profiles.
- Karnataka was coded as very strong in innovation and talent ecosystems, reflecting its university–industry linkages and biotech startup culture. However, its industrial capacity lens was rated moderate, consistent with outcome signals showing limited large-scale manufacturing compared to Gujarat or Andhra Pradesh.
- Kerala scored weak on fiscal and infrastructure lenses but strong on governance and compliance. This coding aligns with observed outcomes: modest manufacturing presence but high credibility in drug regulation and antimicrobial resistance programs.
- Maharashtra maintained moderate scores across most lenses, leveraging logistics and formulations but without aggressive cluster expansion.
- Legacy clusters such as Uttarakhand, Assam, Sikkim, and Goa were coded as moderate or weak, reflecting excise-driven growth models. Outcome mapping confirmed that once central incentives phased out, these clusters plateaued, lacking innovation depth or governance strength.

6. Discussion

6.1 Emerging Patterns

The comparative analysis across 13 states reveals several recurring patterns in India's pharmaceutical policy landscape between 2010 and 2025:

- **Policy Mix Matters**
  States that combined fiscal incentives, infrastructure development, and innovation ecosystems (e.g., Gujarat, Telangana) consistently outperformed those relying on a single lever. Balanced policy portfolios translated into stronger industrial capacity, export competitiveness, and resilience during the API revival phase.
- **Late Entrants Can Catch Up Quickly**
  Uttar Pradesh demonstrates how aggressive fiscal incentives and alignment with national schemes (PLI, Bulk Drug Parks) can enable rapid catch-up. Despite entering late, UP's Lalitpur Bulk Drug Park and pharma clusters show how political prioritization can accelerate industrial outcomes.
- **Innovation vs. Manufacturing Divide**
  Karnataka and Telangana exemplify innovation-heavy models anchored in biotechnology research, startups, academic linkages, and venture ecosystems, particularly in Bengaluru and Genome Valley. In contrast, Gujarat and Uttar Pradesh dominate in terms of production volumes, bulk drugs, and formulations manufacturing. This divergence highlights the need for complementary national strategies that integrate innovation hubs with large-scale manufacturing clusters rather than treating them as competing models.
- **Governance-Oriented Models**
  Rather than prioritizing industrial scale, Kerala invested in drug control enforcement, antimicrobial resistance mitigation, ethical pharmacy practices, and public health-oriented regulation. While this approach has resulted in modest industrial output, it underscores the importance of regulatory quality and public health safeguards as outcomes in their own

right, rather than mere constraints on growth.

- **Excise-Driven Clusters Plateau**
  States like Sikkim, Goa, and Uttarakhand benefited from excise duty exemptions in the 2000s, creating clusters such as Rangpo, Verna and Baddi. However, once incentives phased out, growth plateaued. These clusters remain relevant but lack the innovation and infrastructure depth of Gujarat or Telangana.
- **Environmental Governance as a Differentiator**
  Telangana's Zero Liquid Discharge mandates and CETP expansion highlight how environmental safeguards are becoming central to cluster competitiveness. Export markets increasingly demand compliance with sustainability standards, making governance a competitive advantage rather than a constraint.
- **Regional Equity Challenges**
  Pharma growth remains concentrated in advanced districts (Ahmedabad, Hyderabad, Bengaluru), raising concerns about uneven regional development. Emerging models in UP (Gorakhpur, Lalitpur) and Sikkim show attempts to decentralize growth, but disparities persist.

6.2 What Drives State-Level Success?

- **Predictability of Policy Frameworks**
  States that maintain continuity in their industrial policies—such as Gujarat's successive biotechnology policies and Telangana's TS-iPASS (Telangana State Industrial Project Approval and Self-Certification System) regime create a stable environment for investors. Predictability reduces uncertainty, encourages long-term capital commitments, and signals seriousness to global partners. Frequent policy reversals or ad-hoc incentives, by contrast, erode trust and slow cluster development.
- **Institutional Strength**
  Dedicated institutions like Gujarat's Food and Drug Control Administration (FDCA) or Telangana's Life Sciences division provide credibility and efficiency. Strong institutions ensure that approvals, certifications, and compliance processes are streamlined, reducing transaction costs for firms. Institutional depth also allows states to enforce quality standards while facilitating industrial growth, striking a balance between regulation and competitiveness.
- **Cluster Depth and Supply Chain Linkages**
  Success is amplified when states build dense clusters with integrated supply chains. Gujarat's pharma SEZs and Telangana's Genome Valley exemplify how proximity to suppliers, testing labs, logistics hubs, and effluent treatment facilities creates economies of scale. Cluster depth not only lowers costs but also fosters collaboration, knowledge spillovers, and resilience against global supply chain shocks.
- **Availability of Skilled Workforce**
  States with strong educational ecosystems such as Karnataka with its universities and Bengaluru's biotech talent pool attract high-value R&D and innovation investments. Telangana's focus on life sciences training programs similarly enhances its appeal. Workforce availability ensures that firms can scale quickly, adapt to new technologies, and meet global compliance standards without relying excessively on imported expertise.
- **Global-Facing Regulatory Support**
  Export competitiveness depends on meeting stringent international standards. States that actively support firms in obtaining certifications (USFDA, EU GMP, WHO GMP) and facilitate audits strengthen their global positioning. Gujarat's subsidies for certification costs and Telangana's facilitation of regulatory approvals demonstrate how proactive support can translate into higher export volumes and reputational gains.

6.3 Key Trade-offs

6.3.1 Industrial Growth vs. Environmental Externalities

The tension between rapid industrial expansion and environmental sustainability is most clearly illustrated by the experience of Hyderabad's pharmaceutical clusters in Telangana. Following aggressive post-2014 industrial policies, the development of Hyderabad Pharma City and the expansion of Genome Valley attracted significant global investment and positioned the state as a major hub for vaccines and biologics. However, this rapid growth also generated substantial environmental externalities, including effluent discharge into local water bodies, heightened risks of antimicrobial resistance linked to pharmaceutical waste, and health concerns among surrounding communities.

In response to rising public scrutiny and regulatory pressure, Telangana introduced Zero Liquid Discharge mandates and expanded Common Effluent Treatment Plants at the cluster level. While these measures represent a meaningful shift toward sustainability, enforcement has remained uneven, reflecting the institutional and infrastructural challenges of regulating large-scale industrial ecosystems. The Telangana case illustrates that industrial acceleration without parallel investments in environmental governance can erode public trust, invite international scrutiny, and potentially threaten export certifications tied to sustainability compliance.

6.3.2 Incentives vs. Sustainable Governance

The trade-off between generous fiscal incentives and sustainable governance is evident in both Uttar Pradesh's recent pharmaceutical push and the earlier excise-led growth of Himachal Pradesh's Baddi cluster. UP's 2018 pharmaceutical policy and Baddi's earlier tax-holiday regime relied heavily on capital subsidies, SGST reimbursements, and tax exemptions to attract manufacturers. While these incentives succeeded in drawing investment, they also created risks of short-termism, where firms prioritize cost advantages over long-term quality systems and compliance investments.

Baddi's experience is particularly instructive. Despite becoming India's largest SME pharmaceutical cluster, it has faced recurring concerns related to GMP compliance, environmental violations, and quality lapses. These challenges highlight the danger of decoupling incentives from governance outcomes. The key lesson is that fiscal incentives must be explicitly linked to performance metrics such as quality certifications, regulatory audit outcomes, and environmental sustainability benchmarks. Without such guardrails, incentive-driven growth risks reputational damage in export markets and regulatory backlash at home.

6.3.3 Cluster Centralisation vs. Regional Equity

Pharmaceutical cluster development in India has largely favoured industrially advanced districts such as Ahmedabad, Hyderabad, Vishakapatnam and Bengaluru, where infrastructure, logistics, and talent are already concentrated. While this clustering enhances efficiency and global competitiveness, it also raises significant regional equity concerns. Peripheral districts often remain excluded from the employment, skill development, and infrastructure benefits generated by pharma growth, reinforcing spatial inequalities within states.

Emerging models in Uttar Pradesh such as pharma parks in Gorakhpur and Lalitpur and Sikkim's targeted SEZ-driven strategy demonstrate attempts to decentralize pharmaceutical manufacturing. These initiatives suggest that smaller or less industrialized regions can attract investment with focused policy design and central alignment. However, without sustained investment in skills, logistics, and local governance capacity, cluster centralization is likely to persist. The trade-off for states, therefore, lies in balancing efficiency-driven agglomeration with inclusive regional development strategies that broaden the spatial distribution of industrial gains.

6.4 Implications for National Strategy

The comparative evidence suggests that India's pharmaceutical future cannot rely solely on

central schemes like the PLI or Bulk Drug Parks. Their effectiveness depends on how states integrate fiscal incentives, infrastructure, innovation ecosystems, and governance safeguards. National strategy must therefore evolve from a one-size-fits-all approach to a coordinated federal model that recognizes differentiated state strengths. Gujarat, Andhra and Telangana demonstrate how industrial depth and branding can anchor global competitiveness, while Kerala shows the importance of regulatory quality, and Uttar Pradesh illustrates the potential of late entrants aligning tightly with central priorities. To sustain global leadership, the centre must:

- Encourage policy convergence by setting baseline standards for quality, sustainability, and certification.
- Provide flexible support that allows states to tailor schemes to their industrial maturity.
- Strengthen coordination mechanisms between central regulators and state drug control authorities.
- Invest in national-level skill and innovation platforms that complement state ecosystems.

In short, India's national pharmaceutical strategy must act as a scaffold ensuring equity, quality, and resilience while allowing states to innovate within their own comparative advantages.

Limitations

Several limitations should be considered when interpreting the findings of this study. First, state-level pharmaceutical outcomes reflect long-term path dependence, making it difficult to isolate the effects of recent policy interventions from historical industrial advantages. Second, data availability and reporting standards vary across states, limiting the comparability of certain quantitative indicators, particularly for environmental outcomes and MSME-level activity.

Third, many large infrastructure projects such as bulk drug parks and integrated clusters remain at different stages of implementation, requiring reliance on proxy indicators rather than realized production data. Fourth, the analysis adopts a state-centric perspective and does not fully capture firm-level heterogeneity, including differential responses by multinational corporations, domestic majors, and small manufacturers.

Finally, the study emphasizes policy design and governance structures rather than econometric causal inference. Future research could strengthen attribution by incorporating firm-level datasets, longitudinal investment tracking, and quasi-experimental designs to assess the impact of specific policy instruments.

7. Conclusion

Between 2010 and 2025, India's pharmaceutical sector has been decisively shaped by state-level industrial activism layered onto central schemes. Leaders like Gujarat, Andhra and Telangana built globally competitive clusters, Uttar Pradesh demonstrated rapid catch-up, and Kerala and Karnataka highlighted alternative models rooted in governance and innovation. Smaller excise-driven states contributed niche clusters but plateaued once incentives phased out.

Going forward, India's challenge is not simply to expand production but to balance industrial growth with environmental sustainability, regulatory credibility, and inclusive regional development. The next phase will require stronger centre-state coordination, deeper investment in R&D and skills, and governance frameworks that align industrial ambition with public health imperatives. If these elements converge, India can consolidate its role as the "Pharmacy of the World" while setting new benchmarks in sustainable and innovation-driven pharmaceutical policy.

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