
STRATEGIC PATENT LANDSCAPE ANALYSIS: ENHANCING IP MANAGEMENT AND ACCELERATING SUSTAINABLE DEVELOPMENT GOAL IN INDIA

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ABSTRACT

India's focus on an innovation-led development path and the commitment to the United Nations Sustainable Development Goals (SDGs) face a substantial gap: a lack of a structured, data-informed framework for leveraging patent data for decision making on intellectual property management and policy. This study introduces a structured framework for Patent Landscape Analysis (PLA) to address India's limited ability to leverage patent data, especially in sustainability-focused fields such as clean energy, health care, or agriculture, by linking patent applications to development outcomes. India has experienced 44 percent growth in patent grants over five years, and there were over 61,000 green technology patents granted between 2016 and 2022. Even India being a largest contributor to IP still they lack analytical systems which can translate patent use into R&D and other investments. By providing a framework that links India's current IP infrastructure with global best practice, the PLA framework provides a structured approach to chart technology pathways, locate white spaces for innovation, and create a bridge to collaborative R&D paths. This framework will be implemented by building analytical capabilities within existing institutions, deploying sophisticated data-processing and machine-learning tool, and incentivizing collaboration across sectoral and stakeholder groups. Intended outputs include greater alignment of innovation agendas with SDG priorities, faster technology transfer, and improved global competitiveness through proactive IP intelligence. Application of the PLA within the national innovation policy from sector-level analytical units to the National Patent Intelligence Initiative will facilitate a move from intuition-based decision-making to evidence-based decision-making, leading to better resource allocation within priority sector and facilitating investments that are consistent with the goals of India's Vision 2047 for development. Eventually, PLA could restart the innovation ecosystem for India by appropriate IP management and unleash the full potential of India's growing portfolio of patents for sustainable development, economic competitiveness, collaborative innovation ecosystems, and contributions toward global targets for SDGs.

Keywords: Sustainable Development Goals (SDGs), patent data, intellectual property management, Patent Landscape Analysis (PLA), Vision 2047.

INTRODUCTION:

India is at a critical moment, balancing the need for accelerated innovation-led growth and the continued commitment to the ambitious UN Sustainable Development Goals (SDGs)¹. This dual challenge is not only an economic or social responsibility but also a requirement for India's future. Achieving these intertwined objectives requires a framework that is able to harness the aspects of India's intellectual capital and align the country's strategic development programmes in those areas. The most often neglected but powerful leverage within this framework is intellectual property (IP) specifically, patents. Patents are universally considered a critical tool for advancing innovation, and also contribute to sustainability. While the role of patents is recognized, India has a significant and systemic gap in the way that patent IP can be better leveraged in the current system as a resource. There is not a systematic, data informed approach for utilizing patent information within India's current IP management framework or policy development. As a result, there is a large source of information about technology advancement, market access, and competitive landscape that is under-utilized which limits India's ability to make largely evidence-based decisions in its innovation ecosystem. The lack of a systematic approach represents a big obstacle that restricts the ability of the country to develop an organized framework that effectively focuses its research and development (R&D) efforts, supporting its vision or aspirations of sustainable development. However, there is a global opportunity to utilize a strong tool that has been confidently applied in addressing exactly this kind of knowledge gap - Patent Landscape Analysis (PLA). PLA has gained widespread reputation and acceptance across the globe, especially in its ability to map innovation trends, identify white spaces, highlight emerging technologies and to provide necessary evidence to inform R&D investment decisions². It systematically organizes patent data into actionable intelligence to enable groups to make strategic decisions based on firm knowledge of both the market and technology. For countries like India, that are complex and multi-focused development needs, PLA has potentially a lot to offer in providing evidence regarding potentials pathways toward innovation that are likely to be economically viable but

¹ IPflair. (2025, August 26). *Patent Amendment 2025*. Blogs | IPFlair. <https://ipflair.com/blog/patent-amendment-2025/>

² Gyan, I. (n.d.). *India's IPR challenges and reforms: UPSC current affairs*. IAS GYAN. <https://www.iasgyan.in/daily-current-affairs/indias-patent-landscape-status-challenges-and-way-forward>

environmentally and socially sustainable. Interestingly, however, in a paradox way, PLA remains significant underutilized in India, especially in the sectors that are most crucial for its aspiration of sustainable development. Sectors such as clean energy, healthcare, and agriculture which are critical to achieving multiple SDGs and stand to benefit from innovation have not undertaken the full application of data-informed patent landscape analysis (PLA). This underutilization of PLA represents an opportunity cost for strategically allocating investment, supporting relevant research, and informing policies that meaningfully advance these important sectors. In this context, it is clear that, we need to do things differently and in a more organized and strategic manner. This research responds directly to this urgent need for researchers, innovators, policy makers, investors and development partners to apply PLA to fill knowledge gaps in India's overall IP ecosystem. This can be achieved by use of a framework through which PLA could build on and improve India's IP management by providing not just a summary but data and intelligence, which can be translated into actionable decisions. Ultimately, this will advance India's sustainable development by supporting innovation strategies and collaborative decision-making, which also meets India's growth targets while advancing both its ambitions and commitments to global SDGs, ultimately unlocking the full potential of patent information for national advancement. The importance reaches past theoretical understanding to implications for India's economic competitiveness and global positioning. As India actively pursues its Viksit Bharat 2047 advocacy to become a developed economy, the planned use of patent intelligence could prove to be an important enablement in achieving economic objectives and sustainability commitments.³

RESEARCH PROBLEM:

India's innovation-driven development and commitment to the UN SDGs are at a critical juncture due to an inability to leverage patent data for IP management and decision-making policy without a structured, data-driven framework. India's patent grants have grown rapidly, particularly in terms of green technologies. Despite this growth, the IP ecosystem in India continues to be largely reactive and does not have the analytical tools to translate patent information into strategic decisions based on evidence. This paper attempts to fill this gap by proposing a structured Patent Landscape Analysis (PLA) framework to connect patent data to

³ Payik, L., Sridharan, R., Thirumalai, B., Nayak, S., Nasscom, Bain & Company, Inc., Bain & Company, Inc., Bain India team, Bain Capability Network team, & editorial team. (2025). India @2047: Transforming India into a Tech-Driven Economy. In *Nasscom | Bain & Company, Inc.* [Report]. https://www.credaincr.org/iismgmt/all-images/policypdf/pdf_1753948077.pdf

development outcomes in sustainable development focused sectors, to facilitate targeted R&D investment, improve allocation of resources and amplify national development goals.

RESEARCH METHODOLOGY:

In this investigation, the research methodology is doctrinal. This involves the scrutiny and examination of pre-existing norms and principles, statutes, precedents, and guidelines available on intellectual property and the management of innovation in India. This research reviews the collection and critique of both primary and secondary sources such as statutes, precedents, government policies, and treatises. This research combines the aforementioned sources aiming to contextualize the theoretical basis that patent management is premised upon. This research is based on library-based research, emphasizing legal reasoning and doctrinal analysis of the research problem. This approach offers clarity in understanding the existing legal situation and practical gaps in the literature. It identifies recommendations on how best Patent Landscape Analysis can continue to engage practice in India's IP ecosystem and sustainable development goals.

RESEARCH QUESTIONS

1. Whether a strategic PLA framework structure is able to effectively respond to the identified gap in the data-driven use of patent data for IP in the case of India?
2. How can insights gained through Patent Landscape Analysis (PLA) be used to improve strategic management of IPs to facilitate sustainable development in important sectors with sustainability-driven goals, including clean energy, healthcare, or agriculture in the Indian context?
3. How could the use of a consistent PLA framework work to facilitate informed innovation strategy and collaborative decision-making efforts to move forward both the innovation-driven development of India and the achievement of the United Nations Sustainable Development Goals?

RESEARCH OBJECTIVES

1. To examine and evaluate the knowledge gaps and limitations presently prevailing within the existing intellectual property management and policy formulation regarding the strategic use

of patent information by India.

2. To conceptualize and develop an overall strategic Patent Landscape Analysis framework relevant to the Indian scenario that would help to create necessary data for better IP management.

3. Evaluate the applicability of the PLA framework for fast-tracking the sustainable development of India to achieve informed innovation strategies and collaborative decision-making, especially in the context of the clean energy, healthcare, and agricultural sectors

1. INTRODUCTION: THE IMPERATIVE FOR DATA-DRIVEN IP STRATEGY

India is experiencing a significant boom in its intellectual property (IP) ecosystem, evidenced by a 44% increase in patent filings over five years and reaching 92,168 applications in 2023–24⁴. Furthermore, the country ranks 6th globally with 64,510 filings in 2023. Administratively, India has made progress, with over 95% of patent and trademark applications now filed online⁵. Despite this volume and administrative efficiency, the national patent ecosystem suffers from fundamental deficiencies in leveraging patent information for strategic purposes, undermining effective IP management and policy formulation.

1.1 IDENTIFIED GAPS IN INDIA'S DATA-DRIVEN APPROACH

The core challenge lies in the current utilization landscape, where digital transformation efforts have focused primarily on procedural efficiency rather than strategic intelligence generation. Several critical gaps persist:

Insufficient Analytical Infrastructure: Contemporary patent analytics systems, such as the Patent Application and Search System (PASS), do not have advanced analytical features that would facilitate an organized search for insightful and strategic application of data about patents. Thus, proponents, who include but are not limited to policymakers, researchers, and industry, have no way to attain an actionable conclusion regarding the vault of patent data

⁴ *Revolutionizing India's Patent Ecosystem*, (Aug. 19, 2025), <https://www.drishtias.com/daily-updates/daily-news-analysis/revolutionizing-indias-patent-ecosystem>.

⁵ *India's Growing Influence in Global Innovation: A Look at WIPO 2024's Intellectual Property Report*, (Nov. 16, 2024), <https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2073890>.

available⁶.

Fragmented Data Integration: Patent information exists in isolated silos across agencies and institutions that inhibit a complete landscape analysis. This siloing limits analysis across sectors and inhibits longitudinal identification of technology trends and competitive intelligence, which has a particularly negative impact on policy making that requires a comprehensive view of innovation across domains.⁷

Limited Strategic Application: The current utilization of patent data is mostly reactive in nature, typically focused on prosecution, opposition proceedings, and rudimentary prior art searches. The use of patent data in a proactive manner for strategic foresight, as indicators in planning research and development, and as signals for policy initiative development is still quite underdeveloped, particularly in the case of sustainable development initiatives in which a patent landscape analysis can be particularly helpful regarding technology gaps and policy interventions⁸.

1.2 POLICY-MAKING CHALLENGES AND LIMITATIONS

These insufficiencies represent primary barriers for policymakers and practitioners alike in conducting evidence-based research. Although presented as benchmarks, the National IPR Policy 2016 is criticized for lack of observation based on research-informed recommendations, thus not utilizing patent analytics for strategic purpose⁹. Policy decision options often rely on generalized economic indicators and stakeholder consultations as opposed to systematic analyses of patent trends, technology trajectories, and innovation patterns to form consider policy decision options¹⁰. Because of this, there are patterns in the policy framework in India such as:

Absence of Evidence-Based Framework: Insufficient integration of patent landscape

⁶ Intellepedia. (2025, June 17). Searching for Patents on Indian Patent Database (INPASS) | Intellepedia. *Intellepedia*. <https://www.bananaip.com/intellepedia/indian-patent-database-inpass-patent-search-guide/>

⁷ Importance of patent data and challenges in accessing Indian patent data by EU applicants. (2021, July 30). IP Helpdesk. https://intellectual-property-helpdesk.ec.europa.eu/news-events/news/importance-patent-data-and-challenges-accessing-indian-patent-data-eu-applicants-2021-07-30_en

⁸ Mapping Innovations: patents and the sustainable development goals. (n.d.). Patent-analytics. <https://www.wipo.int/en/web/patent-analytics/mapping-innovations-patents-sustainable-development-goals>

⁹ Kapoor, V. (2024, January 7). *National IPR Policy - IPLeaders*. iPLEaders. <https://blog.ipleaders.in/national-ipr-policy-2/>

¹⁰ www.swaniti.in. (2016). *National Intellectual Property Rights Policy 2016: An analysis*. <https://www.swaniti.com/wp-content/uploads/2022/10/National-IPR-Policy-2016-An-Analysis-.pdf>

intelligence in formulating strategic priorities.

Inadequate Technology Foresight: Insufficient mechanisms for systematic technology foresight using patent analytics, resulting in reduced government capacity to foresee emerging technology trends, define strategic intervention points, and align policy frameworks with future innovation pathways¹¹.

Recent advancements like IP Reforms 3.0 and the addition of artificial intelligence to patent examination suggest some awareness of these constraints; however, these reforms still focus on procedural efficiency as opposed to generating strategic intelligence¹².

2. STRATEGIC PATENT LANDSCAPE ANALYSIS FRAMEWORK: THEORETICAL FOUNDATION

Patent Landscape Analysis (PLA) is defined as a methodical approach for examining patents in a technology space to create strategic intelligence for action demonstrations. A strategic framework for PLA for India needs to consider the distinctive nature of its innovation ecosystem, including the high number of foreign patent filings, the context of emerging domestic innovation, and the complicated regulatory landscape.

2.1 CONCEPTUAL FRAMEWORK AND CORE COMPONENTS

Effective implementation of strategic PLA relies on two foundational components:

A. Comprehensive Data Integration Platform:

The creation of integrated platforms that compile patent data from multiple sources is required by the framework. These might include domestic patent databases, commercial databases, and international patent filing services (like national patent offices and WIPO Patent scope). The ability to map patent data to non-patent literature (such as Scopus and Web of Science), pertinent economic indicators, R&D spending trends, and/or technological commercialization

¹¹ Ho, M., Price, H. C., Evans, T. S., & O'Sullivan, E. (2025). Enhancing foresight models with network science: Measuring innovation feedbacks within the Chain-Linked Model. *Technological Forecasting and Social Change*, 213, 124010. <https://doi.org/10.1016/j.techfore.2025.124010>

¹² *AI and intellectual property rights*. (n.d.). <https://www.dentons.com/en/insights/articles/2025/january/28/ai-and-intellectual-property-rights>

metrics could be a crucial component of this integration¹³.

B. Advanced Analytical Methodologies:

The strategic Patent Landscape Analysis (PLA) framework must embed advanced analytical methods tailored for India's unique innovation ecosystem, such as Technology Trend Mapping and White Space identification that strategically focused on areas of scarce patent activity, which suggest high opportunities for innovation by delineating "white space" for innovation. Another essential element is Citation Analysis and Competitive Intelligence Generation, which has been used for disclosing knowledge spillover patterns and technology relationships; more specifically, patent citation networks that disclose knowledge spillover patterns, providing the means to identify technology hubs and opportunities for collaboration. Finally, AI and Machine Learning (ML) Techniques represent modern approaches that leverage AI/ML for patent classification and trend identification, with the addition of these more credible forms bolstering the ability to identify patterns, identify trends, and undertake predictive analytics. More specifically, Natural Language Processing (NLP) models can translate patent texts into numerical formats that assist in semantic similarity analysis and allow for automated classification according to constructs such as the UN SDGs¹⁴.

2.2 EVIDENCE FOR FRAMEWORK EFFECTIVENESS

The international experience supports strategic Patent Landscape Analysis (PLA) in data utilization gap issues; WIPO's patent landscape reports provide evidence-based analysis for policymaking worldwide. India's expertise in particular receptive sectors adds value to the potential of patent intelligence; India's title as the "pharmacy of the world" has led to strategic exploits using patent intelligence regarding generic drug development and patent challenge strategies. The renewable energy sector's receptivity to patent strategies is substantiated by 61,000 green patents granted between 2016 and 2022. Finally, the recent WIPO reports support India's increasing capacity for innovation in strategic areas: India ranks 5th in the world for generative artificial intelligence (1,350 patent families and a 56% annual rate of growth) and

¹³ Tamtam, S., Laguidi, A., & Elkalay, A. (2024). Global Trends in Data Integration Systems: A Bibliometric and Patent Analysis for 2013–2023. *International Journal of Electronics and Communication Engineering*, 11(9), 135–148. <https://doi.org/10.14445/23488549/ijeece-v11i9p113>

¹⁴ Alvi, S., Ahmad, I., Nawaz, S. N., Cornell, W., Anser, M. K., & Hassan, M. U. (2025). The role of green finance, energy transition, and digitalization in OECD green house gas emissions. *Journal of Cleaner Production*, 145865. <https://doi.org/10.1016/j.jclepro.2025.145865>

7th in agrifood innovations (5,182 international patent families and a 11.2% yearly growth).

3. SECTOR-SPECIFIC STRATEGIC INSIGHTS FOR SUSTAINABLE DEVELOPMENT

Strategic patent landscape analysis provides transformative insights for sustainable development across key sectors by identifying technology gaps, competitive advantages, and areas for targeted R&D investment.

3.1 CLEAN ENERGY AND RENEWABLE TECHNOLOGIES

The clean energy sector is essential to advance sustainability principles, as more than 61,000 green patents were filed in India between 2016 and 2022. During this period, environmental patents accounted for approximately 67% of all issued patents in India, demonstrating the evident strategic importance of the clean energy sector. In both the clean energy innovation framework and from a strategic framework, the solar photovoltaic technology dominates patenting activity, with 63% classified as waste management and 26% as alternative energy generation. Additionally, Strategic Patent Landscape Analysis (PLA) identifies significant white spaces and gaps around areas that must be addressed to increase the effectiveness of renewable energy, such as energy storage technologies, grid integration, and hybrid renewable systems. From an international context, India sat in the 9th position in hydrogen fuel cells for transportation between 2000 and 2019, with 188 filings. This demonstrates significant strategic potential and opportunity through bolstered strategic focus and investment¹⁵.

3.2 HEALTHCARE AND MEDICAL TECHNOLOGY INNOVATION

Patent landscape analysis (PLA) applied in the healthcare sector can support sustainable development through better health outcomes and indigenous innovation. In line with Medical Device Innovation, PLA uncovers significant opportunities to innovate domestically and achieve import substitution in a country that imports an estimated 80% of its required medical devices. Strategic analysis can assist in identifying high-volume, high-value categories of devices with minimal domestic patent presence. Regarding the Pharmaceutical Sector Strength, India enjoys a respectable global ranking of 4th, with 195 distinct patent families for therapeutics related to COVID-19 diseases. Additionally, the area of Digital Health has

¹⁵ En. (n.d.). Patent Landscape Report on Solar Cooking. *www.wipo.int*. <https://doi.org/10.34667/tind.28193>

increased patent activity in telemedicine, digital diagnostics, and health monitoring. Analysis of this area uncovered 'white spaces' in critical emerging areas such as AI-powered diagnostics, blockchain-based health records, and IoT-empowered remote monitoring systems, indicating some opportunities in addressing accessibility issues in marginalized areas of healthcare. The Medical Innovations Patent Mitra initiative demonstrates one use of patent intelligence in accelerating technology transfer from research-based institutions to commercialization¹⁶.

3.3 AGRICULTURE AND FOOD SECURITY INNOVATIONS

Patent Landscape Analysis (PLA) provides important insights into sustainable agriculture, food security, and environmentally sustainable farming practices. In reference to Precision Agriculture Trends, it was evaluated that agriculture's Internet of Things (IoT) applications have shown significant growth; 128 relevant patents were examined specific to this trend. India has growth potential in AI-enabled agricultural solutions based on ranking 6th in the world with predictive model patents for crop management (38 patents and a 35.1% CAGR). In addition, regarding sustainable biotechnology, India shows strategic strengths corresponding to SDG 2 (Zero Hunger) and its environmental sustainability ethos. However, India's optimal performance can be viewed through its global rankings, ranking 5th in the world in non-pesticide pest and disease management (243 patents and a 24.6% CAGR) and 6th in alternative nutrient sources (70 patents). Overall, India ranks 7th in the world in agrifood innovations. Applying the Patent Landscape Analysis (PLA) within this sector helps reach SDG 2 and SDG 15 (Life on Land)¹⁷.

3.4 CROSS-SECTORAL INNOVATION SYNERGIES

Strategic patent analysis is revealing opportunities at the juncture of traditional sectors, resulting in integrated solutions to speed up several SDGs simultaneously. One major example is the Energy-Agriculture Nexus, in which innovations like solar-powered irrigation, biogas

¹⁶ World Intellectual Property Organization (WIPO), Harrison, C., Dieumegard, X., Arbaoui, H., Tiga, A., Margaron, Y., Çakay, E., Kan, H., Supriya, L., Piredeir, P., Sanchez, B. N., Ghandour, G., Nikolakopoulou, M., Frelek, R., & Beauchamp, C. (2025). *Patent Landscape Report: Occupational Health and Safety*. WIPO. https://www.wipo.int/web-publications/patent-landscape-report-occupational-health-and-safety-ohs/assets/74214/2012%20PLR%20OHS_WEB2.pdf

¹⁷ World Intellectual Property Organization (WIPO), Alemán, M., Roca Campaña, A., Czajkowski, A., Harrison, C., Margaron, Y., Berekelya, L., Agrawal, P., Wissuwa, J., Kan, H., Supriya, L., Çakay, E., Piredeir, P., Belianov, A., Cruvinel, A., De Carvalho, M. C. D. O. E., Ruschel, N. S., Banasiak, V. C., Phanraksa, O., . . . Beauchamp, C. (2024). *Agri-food Patent Landscape Report*. In *WIPO [Patent Landscape Report]*. WIPO. <https://doi.org/10.34667/tind.49840>

production from agricultural wastes, and integrated agri-voltaic systems contribute towards energy access, food security, and climate action goals simultaneously.

4. COLLABORATIVE DECISION-MAKING AND INNOVATION STRATEGIES

Application of the strategic framework for the PLA in order to inform innovative strategies based on the effective transformation of unrefined patent information to strategic intelligence.

4.1 FRAMEWORK FOR INFORMED INNOVATION STRATEGIES

The framework suggests structured methods and approaches to convert unstructured data into usable intelligence. In India's IP ecosystem, this intelligence addresses the current gap between data availability and strategy.

Strategic Foresight: This tool enables the identification of trending trajectories of new technologies even before they are adopted and create a first-mover advantage for innovators in India. Patent citation networks can be analyzed for knowledge spillovers, which helps trace the regional hubs of technologies and joint working opportunities.

Evidence-Based Policy Support: Contrary to current policy frameworks that rely upon common economic factors, it provides empirically supported knowledge regarding technological trends and competitiveness, thus directly facilitating evidence-based policy formulation.

4.2 COLLABORATIVE DECISION-MAKING MECHANISMS

For successful execution, there has to be organized support for multi-stakeholder collaboration to ensure that the insights generated for the patent landscape are acted upon.

Multi-Stakeholder Engagement Platforms: The engagement platform should be made up of representatives of diverse stakeholder groups, such as governmental, scientific, industry, as well as civil society representatives.

Innovation Ecosystem Mapping: A key aspect of the PLA framework is its mapping of the innovation ecosystem, which illustrates the relationships between actors, identify patterns of technology flows among actors, and identifies capabilities that are distributed within the ecosystem. Mapping the ecosystem also informs integration development by revealing gaps in

capabilities, temporary redundancies within capabilities, and possibilities for optimizing available capabilities¹⁸.

Knowledge Transfer Facilitation: PLA will provide insight into how knowledge transfer is happening in the ecosystem, informing the design of targeted programs for technology transfer that identify successful models for transfer and the factors that facilitate effective absorption of technology.

4.3 INNOVATION STRATEGY DEVELOPMENT

Strategic patent landscape analysis contributes to a robust process of developing targeted innovation strategies¹⁹. As a process, White Space analysis enables us to identify technology areas where we can find little overall patent activity and innovation potential. In India, we have already worked with White Space analysis to identify opportunities in areas like energy storage technologies, low-cost healthcare devices, and climate-resilient agricultural systems. Results from PLA can also guide our possible areas for R&D funding or targeted missions for innovation. Additionally, it can aid in forming strategic partnerships based on complementary capabilities using PLA in patent network analysis for co-authorship or citation.

5. ADDRESSING UN SUSTAINABLE DEVELOPMENT GOALS THROUGH PATENT ANALYTICS

The UN Sustainable Development Goals (SDGs) and patent landscape analysis together mark a paradigm shift in how innovation contributions to global sustainability are measured and maximized²⁰.

5.1 SDG-PATENT MAPPING METHODOLOGY

Recent developments in patent-SDG mapping provide systematic frameworks for alignment.

Mapping the Technologies Field: Patent analytics platforms have created comprehensive mappings of the patent classifications with each of the SDG targets, resulting in 17 distinct

¹⁸ Janet Freilich, Patents' New Salience, 109 VA. L. REV. 595 (May 2023).

¹⁹ Donald J. Featherstone, Raymond J. Werner, Christian A. Camarce & Susan E. Cullen, Flexible Display Patent Landscape and Implications from the America Invents Act, 11 NANOTECH. L. & BUS. 181 (Fall 2014).

²⁰ Cheshmehzangi, A., & Zou, T. (2024). Literary Analysis of the Connection between Urban Innovations and Sustainable Development Goals (SDGs). *Sustainability*, 16(15), 6405. <https://doi.org/10.3390/su16156405>

technology fields corresponding to each UN SDG. This combines technologies classifications and keywords²¹.

Granular Indicators: The methodology includes 231 unique indicators from the 2030 Agenda for Sustainable Development, ensuring that the analysis can capture a complete innovation contributions spectrum.

Dynamic Monitoring: The modern analytics are capable of real-time monitoring of innovation activities related to the SDGs through executing automated search queries and updates every week, thus allowing policymakers to track progress and identify early trends.

5.2 INDIA'S SDG-INNOVATION PERFORMANCE

An analysis of the patents in India suggests engagement with various Sustainable Development Goals. For instance, Sustainable Development Goal 3, “Good Health and Well-being,” shows up as India’s #4 ranking regarding the use of therapeutics for the treatment of COVID in the worldwide index of patents. There were about 61,000 patents awarded for “green” patents from 2016 to 2022, which helped with Sustainable Development Goal 7, “Affordable and Clean Energy,” in demonstrating that about 67% of the patents awarded over the six years were “green” patents. Moreover, patents in the use of agriculture were more prevalent, but particular patents for “clean energy” show up as follows: agriculture waste management patents with 63% of “all green patents” and “alternative energy” with 26% of “all green patents” as important²². Moreover, the agricultural patents in the country show that innovation relevant to SDG 2 and SDG 15 is also being done in the country. The ranking of the country as the #7 agrifood innovation globally in the agrifood innovation list becomes an important figure to strengthen the relevant SDGs mentioned above. Last, the SDGs innovation engagement strategy and plan can and should be expanded to highlight the innovation synergies that traverse SDGs in their strategy and innovation plans and deliverables. Innovation in the solar-powered watering system may be an important innovation in meeting SDG 7 and SDG 2 in the agricultural innovation landscape today.

²¹ Stuart J. Smyth, Sara McPhee-Knowles, Andrew Baker & Peter W. B. Phillips, Developing a Patent Landscape Methodology, 3 QUEEN MARY J. INTELL. PROP. 251 (July 2013).

²² Van Der Waal, J. W., Thijssens, T., & Maas, K. (2020). The innovative contribution of multinational enterprises to the Sustainable Development Goals. *Journal of Cleaner Production*, 285, 125319. <https://doi.org/10.1016/j.jclepro.2020.125319>

5.3 STRATEGIC OPPORTUNITIES FOR ADVANCEMENT

The PLA framework allows for the systematic identification of technology gaps within specific SDG areas, revealing white spaces where India can achieve leadership or where targeted intervention is required.²³ Furthermore, the framework aids in innovation network development by analyzing collaboration patterns in SDG-related patents, identifying successful partnership models and optimal conditions for technology transfer.²⁴

6. IMPLEMENTATION CHALLENGES AND STRATEGIC SOLUTIONS

Successful deployment of the strategic PLA framework requires overcoming significant technical, methodological, and institutional barriers.

6.1 TECHNICAL AND METHODOLOGICAL BARRIERS

1. **Data Quality and Accessibility:** Barriers to the execution of the patenting process are issues concerning the quality of patent data, including the absence of uniform formats of the data, and incomplete data available in Indian patent systems.
2. **Foreign Filing Dominance:** This is even more complex due to the fact that more than 74% of patents approved are of foreign filers, making it complex to distinguish between the import of foreign technologies and indigenous innovation capabilities.
3. **Analytical Capacity Gap:** In the given context, the absence of experts in overlapping areas of patent analysis, technology assessment, and policy analysis or strategy development is significant. In fact, the analytical capacity gap is more of a constraint for implementation in terms of frameworks or structures.

6.2 STRATEGIC IMPLEMENTATION SOLUTIONS

1. **Phased Implementation Strategy:** To build capabilities incrementally with value demonstrated through specific use cases, implementation must utilize a staged approach.

²³ Gilmedia. (2019b, December 10). *What is White-Space Analysis in the Patent World?* | Levin Consulting Group. Levin Consulting Group. <https://www.levinconsultinggroup.com/white-space-analysis-for-patents/>

²⁴ Uche, E., Ngepah, N., Onwe, J. C., Zaman, U., & Odhiambo, N. M. (2024b). A question for sustainable development goal 10: How relevant is innovation patenting receipts to income distributions? *Technological Forecasting and Social Change*, 206, 123506. <https://doi.org/10.1016/j.techfore.2024.123506>

Phase 1: Lay groundwork for basic data integration and analytical capability by developing pilot studies in 2-3 high-value technology areas (e.g., clean energy, pharmaceuticals, IT).

Phase 2: Expand beyond the sector to additional technology areas while developing advanced analytical capability including AI-derived trend analysis.

Phase 3: Implement a comprehensive framework and deploy across all key sectors, with the policy process completely integrated with the system.

2. **Capacity Building and Infrastructure:** In order to bridge the gap of analytical expertise, it is necessary to focus on building comprehensive capacity within institutions that can target not only current professionals in the area of IP, but also new entrants. It is also critical to work towards building comprehensive infrastructure related to technology that includes database platforms, analytical tools, as well as data management.

7. ECONOMIC IMPACT AND STRATEGIC VALUE ASSESSMENT

Implementation of the strategic PLA framework promises substantial direct economic benefits and strategic competitive advantages.

7.1 DIRECT ECONOMIC BENEFITS

1. **Improving the Efficiency of Innovation:** An overall PLA should enable the reduction of R&D costs by 15%-25%, whereas the chances for success in innovation would improve by 20%-30%. Taking into account the current level of R&D investments in India, which are approximately 0.67% of its GDP, we would expect the savings to be in the order of billions of dollars per annum.
2. **Accelerating Technology Transfer and Commercialization:** PLA offers an understanding of the intellectual property landscape that enables the identification of possible licensors & position in the market to aid the transfer of technologies at a significantly faster pace as seen in Medical Innovations Patent Mitra.
3. **Attracting Investment and Reducing Risks:** Patent intelligence will help eliminate information asymmetry and help investors gain a clearer view of the risk implications of freedom of operation, market sufficiency, and IP risks. This will increase private and foreign investments.

7.2 STRATEGIC COMPETITIVE ADVANTAGES

The Strategic Patent Landscape Analysis (PLA) framework provides substantial strategic and competitive advantages, especially by helping secure Global Innovation Positioning and Technology Sovereignty for India. In terms of global positioning, the framework allows India to take advantage of its existing competitive (or comparative) advantages, like being ranked 5th globally on generative artificial intelligence (with a whopping 56% annual growth rate) and 7th globally on agrifood innovations (with a still impressive 11.2% annual growth), so that the country can position itself within global innovation networks or global value chains concerning technologies. Supporting the realization of Technology Sovereignty and strategic autonomy is another value-added aspect of strategic PLA. A value-added component of the analysis is that comprehensive patent landscape analyses are key for securing Technology Sovereignty as part of an overarching nation's economy because they provide the identification of critical technologies and dependencies, potential domestic opportunities to provide domestic capabilities, and provide opportunities for strategic investments in technologies that are supported for reasons of national security and economic independence.

7.3 COST-BENEFIT ANALYSIS AND ROI PROJECTIONS

Implementing a comprehensive PLA framework requires initial investments, estimated conservatively at \$50–100 million over 3–5 years for infrastructure, human resources, and institutional capacity building. However, the quantified benefits, including efficiency gains and enhanced policy effectiveness, are estimated to generate annual returns of \$500 million to \$1 billion. The Return on Investment (ROI) analysis suggests a payback period of 3–5 years for direct economic benefits, with early implementation phases in high-value sectors demonstrating positive ROI within 2–3 years.

8. POLICY RECOMMENDATIONS AND STRATEGIC IMPLEMENTATION ROADMAP

To achieve the strategic value articulated, decisive policy action and institutional development are required.

8.1 INSTITUTIONAL FRAMEWORK DEVELOPMENT

The implementation of the strategic Patent Landscape Analysis (PLA) framework should be

anchored in the creation of a National Patent Analytics Center (NPAC) as a formal institution within the existing intellectual property (IP) ecosystem to serve as the coordinating body for all strategic patent landscape analysis activities. The NPAC mandate is that the NPAC should assume the central role for patent analytics capacity, by providing a standardized methodology, training capacity, and analytic service capacity to all government departments, industry partners, and researchers. Also, regarding implementation, there needs to be Integration with Existing Institutions: the NPAC should integrate its efforts with institutions like the Rajiv Gandhi National Institute of Intellectual Property Management and leading IITs. These alliances are required to leverage existing capacity, develop specialized patent analytic capability, and develop an India-specific patented analytics methodology responsive to the innovation ecosystem's unique characteristics (like the prevalence of foreign filings). This institutional development is necessary to mitigate the gap in analytical capability currently limiting strategic PLA implementation's quality and effectiveness.

8.2 POLICY INTEGRATION MECHANISMS

Creating Formal Mechanisms is necessary for systematically embedding Strategic Patent Landscape Analysis (PLA) analytical outputs into the policy development process and, therefore, establishing the successful integration of levels of patent landscape intelligence into policy development processes. This entails creating a Formal Integration process, in which institutionalized mechanisms must be established to make patent analytics input required for policy development and strategic planning processes. This formally addresses the limitations of current approaches to policy, which primarily rely on only general economic indicators. Systems should also be developed to use Evidence-Based Policy Evaluation, in which patent analytics use data on an ongoing basis to evaluate and refine the policy based on experience to create an adaptive policy approach. More specifically, these systems should define mechanisms to measure the efficacy of the response to a particular policy intervention and provide a timely response loop necessary to ensure ongoing policy improvement. This progress provides empirical reinforcing evidence of technology trends, innovation, and competitive dynamics in a more general sense, beyond the limited marginal relevance of providing patent information solely in the context of India's existing approach to IP.

8.3 TECHNOLOGY INFRASTRUCTURE AND DIGITAL INTEGRATION

A solid and state-of-the-art technological framework is essential for practical strategic Patent

Landscape Analysis (PLA), which requires a systematic effort to develop analytical infrastructure. A primary infrastructure will be the establishment of a Comprehensive Database Integration Platform, which is necessary to integrate appropriate patent information from domestic and globally sourced patent sources and to ensure the quality of data and its analytical integrity. This platform should use India's digital infrastructure capacity, but also needs advanced analytics and visualization, including merging data from various sources, such as national patent databases, international intellectual property filings, and surrounding scholarly literature. In addition, AI and Machine Learning Integration are necessary for high-level strategic intelligence. Integrating these advanced capabilities would enhance the ability to recognize patterns, identify trends, and conduct predictive analytics while automating recurrent analytical tasks and delivering more advanced insight that is entirely beyond the level of analysis possible by more traditional means. The systematic development of the infrastructure level needed is essential to meet today's technical challenges and gaps in technical expertise in analyzing large datasets and intelligence gathering.

9. CONCLUSION: STRATEGIC TRANSFORMATION AND SUSTAINABLE LEADERSHIP

The analysis clearly indicates the need for an effective PLA framework for addressing the gaps in India's data-informed management of IP, besides promoting fast-track, sustainable, and meaningful development in the identified sectors. The overall significant increase in the aggregate number of IP filings made by India, coupled with an increase of 44% in the last five years, provides a robust, data-informed starting point for the analysis of the IP landscape. The framework should, therefore, remove the root constraints of segregated data, infrastructure, and strategic utilization. A pivot then occurs, shifting India from being managed reactively to having a strategy for innovation development. Strategic PLA can inform transformational insights. For example, it may help identify white space opportunities in clean energy (for example, energy storage); illustrate a substantial chance of import substitution with medical devices (more than 80% is imported); and demonstrate India's comparative advantage in sustainable agriculture. By implementing coherent PLA frameworks, India enables multi-stakeholder engagement through a role to collaborate on evidence-based intelligence-generation transparently. From the patent network, analyses, and collaborative potential can be revealed to pursue strategic partnerships to address complex sustainable development goal challenges. Although achieving better data will be a challenge, as will overcoming the volume of foreign filings (over 74%)

and the analysis and strategy development knowledge gap, all will be achievable when an emphasis is placed initially on high-value sectors, with a phased and more systematic process that gradually extends to all industries. The strategic PLA mechanism of International Development Assistance is a transformational shift towards ensuring alignment of innovation policy with the Viksit Bharat 2047 vision and hastening India's evolution from a technology consumer to a technology leader. The anticipated flip-side advantages: returns on R&D of 15–25%, as well as substantial shortening of commercial return postponements, warrant the investment of capital, generating tangible evidence in favor of strategic PLA to release strategic value creation, act sustainable development, and promote global sustainability objectives.