

Innovating Towards Growth

A Region-focused Study of India's Innovation System



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Innovation System



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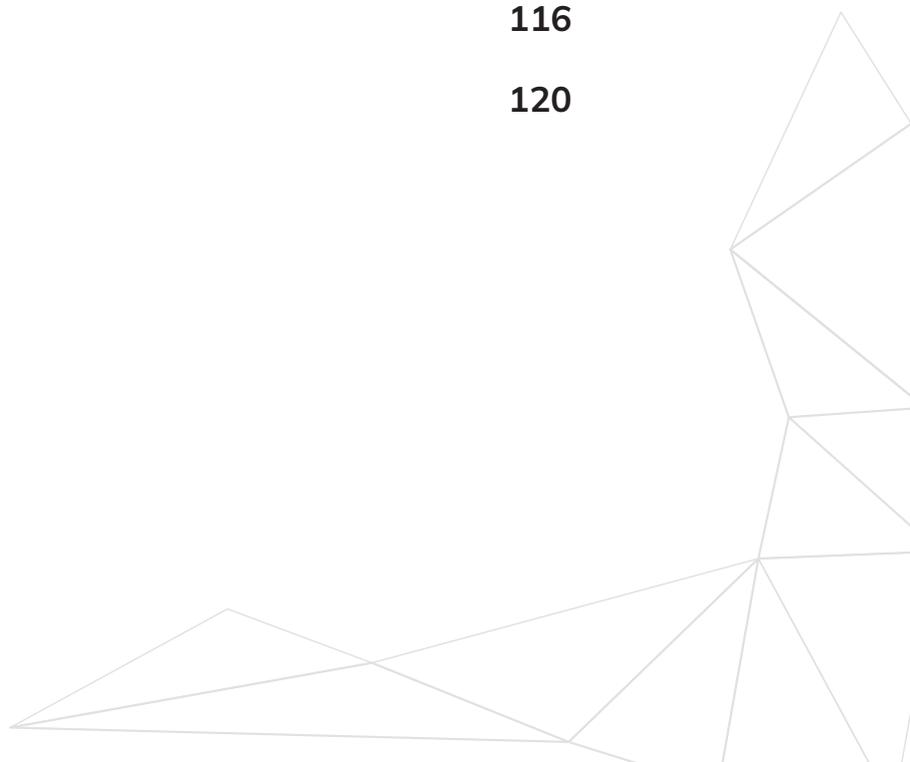
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Executive Summary

Contemplating the process of innovation as part of a system, wherein interplay between different actors (government, academia and industry) guides the course of innovation as well as the long-term growth of a country, encourages policymakers to identify and address systemic failures to synergise the efforts of these actors (OECD 1997).

The actors in India's innovation system have an interdependent relationship. For example, higher education institutions (HEIs) conduct research that the industry may commission, fund and later take to the market. Both HEIs and industries are regulated by state policies and are often provided fiscal and non-fiscal state support. Hence, the engagement of one actor is linked to the other. In this context, strengthening collaboration between HEIs, industry, government, and other organisations within an innovation system can help to bridge the gap between inventions and their commercialisation, ostensibly leading to the development of new products and services that may benefit communities and enable economic and social progress in a region. The discourse on innovation systems suggests that to build national innovation capabilities, focus should be shifted to nurturing and developing regional innovation systems in a country (Chung 2002). In light of the same, this report aims to examine India's leading regional innovation systems.

First, an overview of India's innovation system has been presented by conducting a state-wise analysis. Subsequent to this, the regional innovation systems of seven states and UTs in India (Karnataka, Telangana, Haryana, Maharashtra, Tamil Nadu, Delhi & Chandigarh) have been reviewed. Additionally, HEI-based innovation within these regions has been assessed on the basis of research output, university-industry linkages, and institutional facilities of select HEIs.

From this exercise, some common findings emerged: while most states have startup and innovation policies, they are often poorly implemented. State expenditure on research and development (R&D) is quite dismal in most states, ostensibly stymying the knowledge output of these regions. Investment in university-based research is often a low priority for industries due to weak linkages and a lack of incentives. Additionally, while some HEIs have robust infrastructure and institutional facilities to support research and innovation, the knowledge production occurring within these institutes is not adequately disseminated to benefit their surrounding region.

In cognisance of these findings, this report also proposes specific recommendations. For instance, several HEIs in India largely operate as academic spaces; they may be transformed into spaces that encourage innovation and entrepreneurship by upgrading their infrastructure, providing mentorship opportunities for students, partnering with industry for R&D and technology transfer, and seeking access to private capital and markets, so as to bolster innovation-driven activities and knowledge dissemination that may contribute to the country's overall growth. We hope this report provides valuable insights into India's innovation system that may be utilised to galvanise its socio-economic development.

Introduction

What is innovation? Put simply, it refers to “the *use* of a new idea or method”¹. Some may regard the term as coextensive to ‘invention’; however, it is erroneous to consider the two terms as synonyms. Invention is defined as “the process of *creating something* that has *never been made before*”². While both terms do involve conceiving a new idea, product or method, an invention becomes an innovation when it is put to use and implemented, often in an economically beneficial or commercial sense.

When innovation is conceptualised as the creation of something that is economically useful, an interesting hypothesis develops. One may argue that innovation is a potent tool to stimulate economic growth in a region. In this regard, the economist Joseph Schumpeter was one of the first to highlight the importance of innovation in propelling economic growth. He theorised an innovation-based growth model, in which he stated that investment in research and development (R&D) and human capital offers a competitive advantage that results in innovation, upon which long-term growth relies (Schumpeter 1975). Therefore, it is useful to undertake a study of the state of innovation in a country, to equally ascertain the positives (to replicate) and negatives (to mitigate) so as to ensure unimpeded economic growth and development.

The Global Innovation Index published by the World Intellectual Property Organisation (WIPO) maps the state of innovation in economies across the globe. In its 2022 edition, India was ranked 40th among 132 economies. While India occupied the foremost position amongst the lower-middle income economies, it still has a long path to traverse.

What approach can be taken to understand and assess the state of innovation in India? Will a mere appraisal of inputs (e.g. investment in higher education institutions) and outputs (e.g. the number of scientific publications) of innovation suffice? Or is a broader systemic approach (which observes the role played by several actors) more suitable? In this report, the latter approach was undertaken, and the following section elucidates on the same.

A Systemic Approach to Innovation

A systemic approach seeks to analyse the complex linkages and interactions between components present in a system, as opposed to analysing the components in isolation. It adopts a birds-eye view rather than a focal view, so as to cull out a comprehensive picture of the subject under study.

Traditionally, innovation was studied by mapping inputs versus outputs. While this approach provided key information regarding the evolution of an innovative endeavour, it was unable to provide a measure of the overall “innovativeness” of an economy, nor did it indicate how different actors interact in the innovation process (OECD 1997). Very few endeavours (innovative or otherwise) evolve in a linear fashion; instead, they often emanate from a set of complex interactions between different factors in a system. A systemic approach is mindful of the same.

When innovation is studied through a systemic approach, it is not regarded in isolation as an idea, product or method emanating from a set of inputs and outputs. Rather, it is regarded as a ‘system’ wherein an analysis of the linkages between different actors (government bodies, higher educational institutes, private enterprises and civil society etc.) is undertaken.

In this regard, it would be pragmatic to limit the scope of study of an innovation system in geo-spatial terms to acknowledge and appreciate the specificities of a particular context. For this purpose, innovation is often studied on a national or regional scale.

One of the earliest definitions of a ‘national innovation system’ was provided by Freeman: “the *network of institutions in the public and private sectors* whose activities and interactions initiate, import, modify and diffuse new technologies” (Freeman 1987). Another pertinent definition was provided by Lundvall: “the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ...

1. Cambridge Dictionary, s.v. “Innovation”, Accessed on December 21, 2022, <https://dictionary.cambridge.org/dictionary/english/innovation>
 2. Cambridge Dictionary, s.v. “Invention”, Accessed on December 21, 2022, <https://dictionary.cambridge.org/dictionary/english/invention>

and are *either located within or rooted inside the borders of a nation state*" (Lundvall 2010). The idea of a national innovation system is premised on studying relations among actors involved in an innovation system, which is vital for improving the technical performance of a country (OECD 1997). Furthermore, understanding this system can help policy-makers to recognise factors to leverage for boosting innovation and competitiveness in an economy to boost overall growth and development in the country.

There exists evidence to suggest that in order to build national innovation capabilities, the focus should be shifted to nurturing and developing regional innovation systems in a country (Chung 2002). Regional innovation systems refer to the "diffusion of knowledge, skills, and best practice *within a geographic area larger than a city, but smaller than a nation*" (Almeida and Sequeira 2018). Research on this subject suggests that universities play a significant role in supporting the development of regional innovation systems where large firms and enterprises are absent to enable knowledge exchange (Kindt, Geissler, and Bühling 2022). In such regions, universities act as intermediaries by coordinating regional R&D collaboration and facilitating knowledge exchange between Small- and Medium-sized Enterprises (SMEs).

In India, universities and higher educational institutes (HEIs) play a decisive role in shaping the overall innovation ecosystem. These knowledge institutions train and impart skills to students while simultaneously networking with R&D institutions and business enterprises to secure capital and commercialise inventions. Hence it may be argued that HEIs play a strategic role in galvanising India's innovation landscape, as indicated in Indian IITs' contribution to knowledge transfer through sponsored research and industrial consultancy projects (Krishna 2012). Additionally, HEIs also contribute significantly to the technology industry by supporting business enterprises with the supply of skilled human resources that generate knowledge capital.

Within HEIs, it cannot be denied that institutional facilities³ and sound infrastructure create an enabling environment for prospective innovators to invent. Often, they also provide requisite means to transform an invention into innovation; for example, incubators within HEIs provide students with a dynamic space where they are encouraged to conceive ideas and are supported with funding and mentorship so that these ideas can graduate to become economically viable in the market. Research has suggested that university-based incubators⁴ leverage talent from within the university by developing entrepreneurial talent and leadership, thereby generating

value in emerging economies (Abbott, Bathula, and Karia 2011). This holds vast implications in terms of designing policies for academia, industry and governments alike.

As India looks to accelerate its social and economic transformation, it is critical to harness the full potential of the regional innovation systems of the country to drive this transformation. In light of the same, this report analyses India's regional innovation system. Additionally, HEI-based innovation within these regions has been assessed on the basis of research output, university-industry linkages and institutional facilities. From this exercise, certain recommendations have been culled out.

3. For the purposes of this report, institutional facilities refer to the following: research parks, pre-incubation and incubation facilities, startup cells, entrepreneurship cells, IPR management cells, industry-academia cells, centres of excellence, maker spaces etc.

4. An organization that fosters the growth of new ideas or companies. An incubator generally acquires small companies and provides them with financing, management expertise, office services and possibly office space. <https://www.pcmag.com/encyclopedia/term/incubator>

Methodology

The framework of this report was conceptualised by following a five-fold process, for which data has been gathered from secondary sources. First, a macro-level analysis of India's innovation landscape was undertaken to compare different states and UTs in India. The 'CTIER Handbook: Technology and Innovation in India 2019' was referenced for the same. The 'Regional Innovation Systems' section of this publication provides an overview of the innovation systems of India's states by presenting data on key indicators relevant to R&D and innovation. These indicators were referred to conduct the macro-level analysis of India's innovation landscape and are listed in the next section. In order to collect the latest data pertaining to these indicators, publicly available reports, publications, websites and databases published by the centre and state governments of India were utilised.

Second, the top-performing regions in terms of innovation in India were identified to cull out learnings relevant to this report. A total of 7 regions were selected based on states and UTs that recurrently appeared as top performers under the indicators selected previously. Subsequent to this, the India Innovation Index 2021 was used as a cross-reference for finalising these regions: Karnataka, Telangana, Haryana, Maharashtra, Tamil Nadu, Delhi & Chandigarh.

Third, the seven selected regional innovation systems were analysed through data provided in the Startup India portal, Research and Development Statistics (2019-2020) by the Department of Science and Technology (DST), Ministry of Commerce and Industry's Reply in Lok Sabha dated 20 July 2022 and Reply in Rajya Sabha dated 12 July 2019, Ease of Living Index 2020, India Innovation Index 2021, States' Startup Ranking 2021, Invest India state profiles, media reports and government portals.

Fourth, to understand the relationship between the selected regional innovation systems and their HEIs, university-industry linkages in these regions were studied with the help of data from 'Framework of Industry-University Linkage in Research' published by PHD Chamber of Commerce and Industry and DSIR, Ministry of Science and Technology.

Finally, the research output and institutional facilities of HEIs in the selected regions were examined. A review of the existing literature indicated a paucity of data in this regard. However, one publication, i.e. 'Mapping Patents and Research Publications of Higher Education Institutes and National R&D Laboratories of India' published by Panjab University, Chandigarh presented data pertaining to research publications and patents granted to National Institutional Ranking Framework (NIRF) ranked institutions in India. As the scope of research in this report was limited to scientific and technological research and innovation, top-performing S&T and engineering HEIs were selected from this publication for review of their research output and institutional facilities. The parameters for the same were selected from the Atal Ranking of Institutions on Innovation Achievements (ARIIA) 2021. In summary, this report includes the identification of strengths and weaknesses in select regional innovation systems in India so as to enable policymakers to frame relevant measures that may foster innovation-led growth at the regional level.

Overview of India's Innovation System

Innovation is regarded as one of the main drivers of social progress. In light of the same, India has made a concerted effort to encourage scientific and technological research through several policy instruments over the years. From the Scientific Policy Research of 1958 to the recent Draft National Science, Technology and Innovation Policy of 2020, policymakers in India have consistently sought to foreground the importance of supporting R&D to enable the country's overall development.

A recent report by the National Science Foundation in the U.S. stated that India ranks third in terms of global scientific publications and scholarly output (Burke, Okrent, and Hale 2022). India was also ranked 40th in the Global Innovation Index (GII) 2022, the foremost position amongst the lower-middle income economies of the world. As per the GII report:

India continues to lead the world in the ICT services exports indicator (1st) and holds top rankings in other indicators, including Venture capital recipients' value (6th), Finance for startups and scaleups (8th), Graduates in science and engineering (11th), Labor productivity growth (12th) and Domestic industry diversification (14th) (WIPO 2022).

Moreover, India has been categorised as an 'innovation achiever' for 12 consecutive years. Though its performance across several parameters of the Index was above average in its group (upper middle-income), it scored below average under the infrastructure parameter (Ibid.).

India's rank in these global reports indicates the presence of a promising research environment in the country that may carry the potential to strengthen its innovation ecosystem and drive its growth. In this context, this report intends to add to the academic discourse on regional innovation systems. To begin the study, an overview of India's innovation system was considered beneficial; first, to understand the present status of innovation in India and second, to identify regions that outperform others in innovation.

This section of the report presents a macro-level analysis of the regional innovation systems by gathering data on different states and UTs in India. For the same, indicators from Chapter 4 of the 'CTIER Handbook: Technology and Innovation in India 2019' were selected which are as follows:

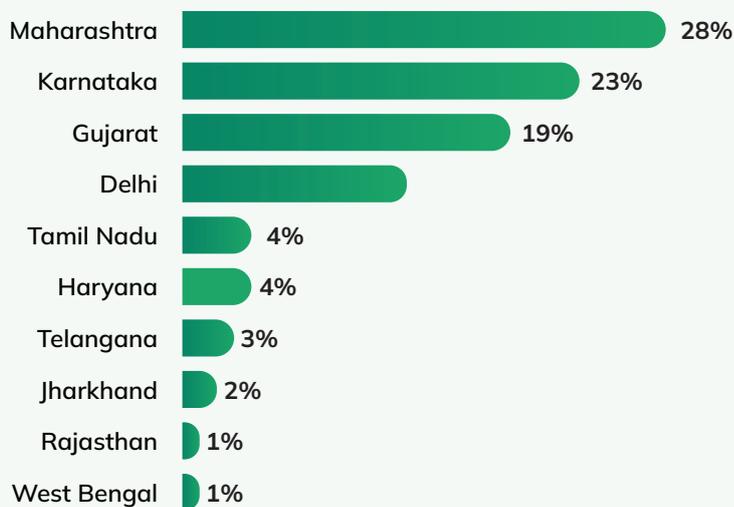
- Foreign Direct Investment into India for Select States
- State-wise Distribution of Startups
- State-wise Number of Incubation Centres
- State-wise Gross Enrolment Ratio in Higher Education
- State-wise Pupil-Teacher Ratio in Higher Education
- State-wise Number of Institutes in Top 100 under the National Institute Rankings Framework
- State-wise Number of Institutes of National Importance

Apart from these, the additional indicators were also selected which are as follows:

- State's Expenditure on R&D
- State-wise Patent Applications
- State-wise Trademarks Applications
- State-wise Industrial Design Applications

At the outset, it is important to mention that the macro-analysis conducted in this report is by no means an exhaustive list of factors affecting innovation, but aims to provide limited yet important insights into aspects of India's innovation system.

FDI Equity Inflow (October 2019 - June 2022)



% share to total FDI Inflows (in terms of US\$)

Figure 1: State-wise FDI Equity Inflows from October 2019 to June 2022 (DPIIT 2022)

Number of Startups Recognised by DPIIT

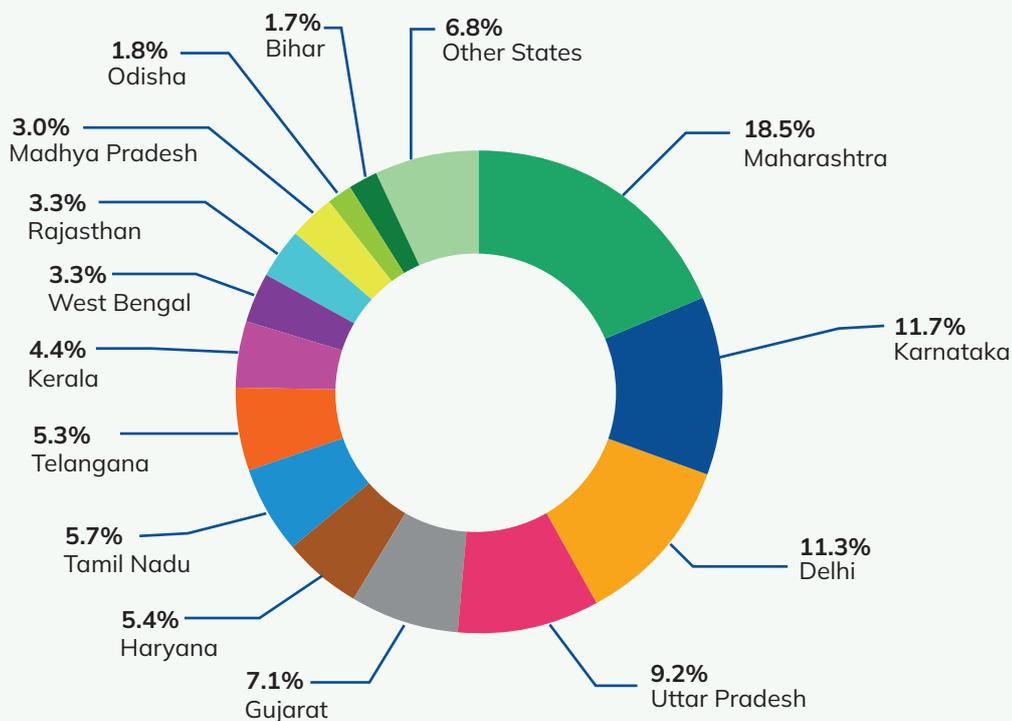


Figure 2: Number DPIIT Recognised Startups from States & UTs in India, As on 21st December 2022 ("Startup India" 2022)

Number of Incubators

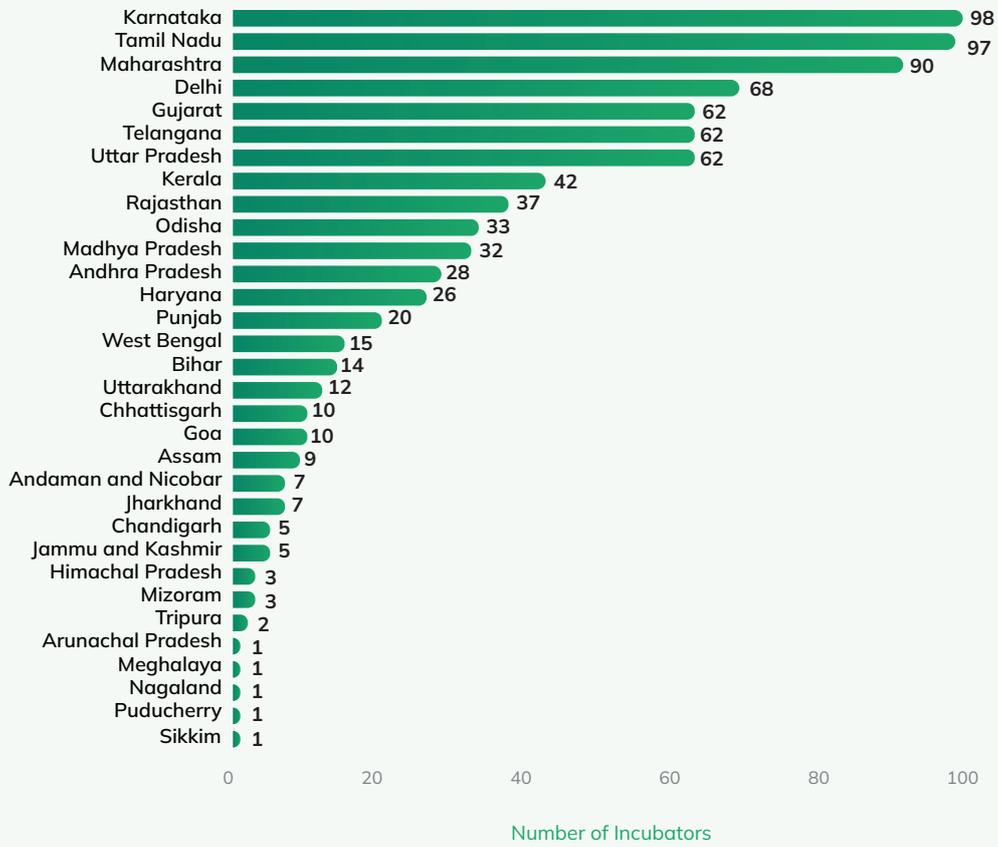


Figure 3: Number of Incubators in States & UTs in India, As on 21st December 2022 (“Startup India - Incubators”, n.d.)

Gross Enrolment Ratio (%) in Higher Education 2019-2020

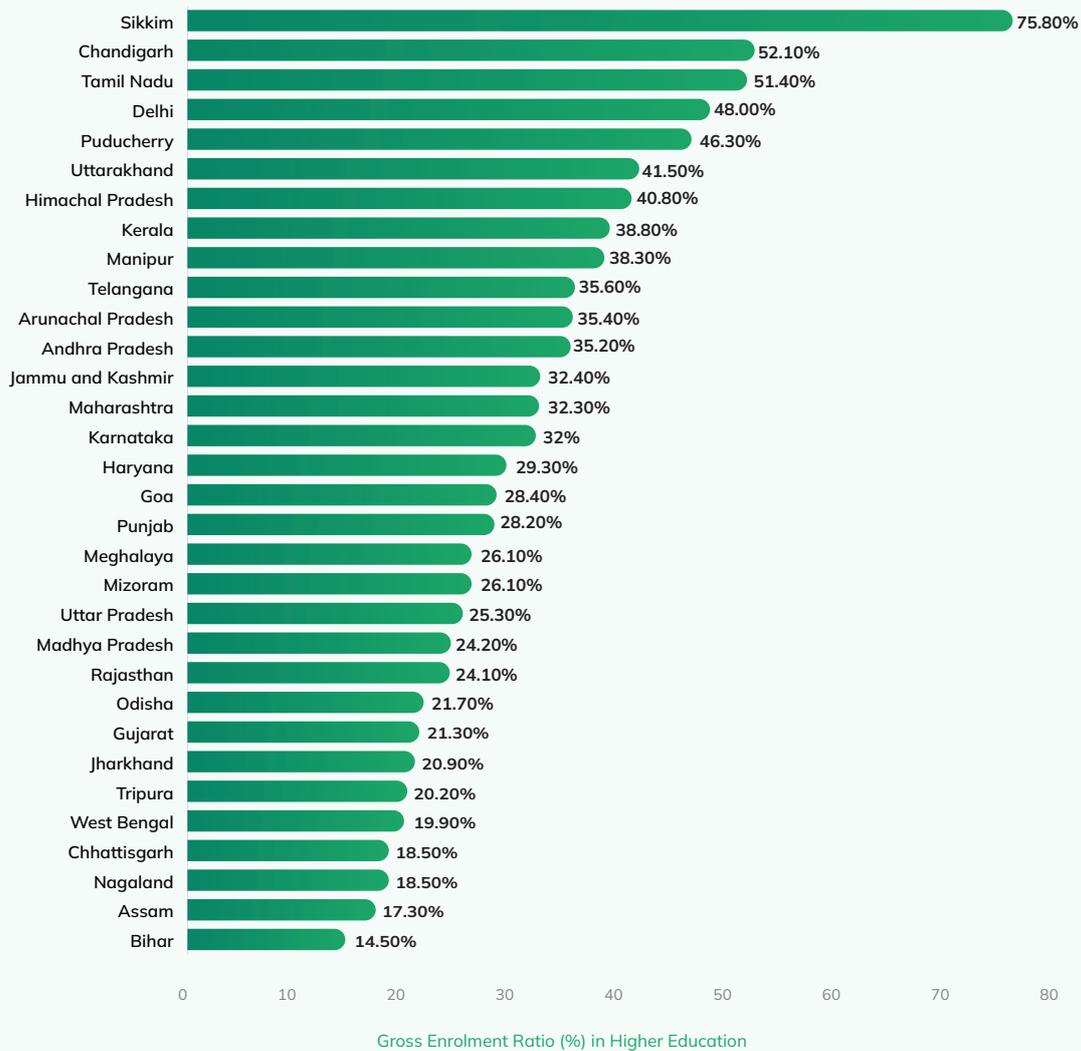


Figure 4: Gross Enrollment Ratio (%) in Higher Education, 2019-2020 (“Economic Survey” 2022)

Pupil Teacher Ratio in Higher Education (2019-2020)

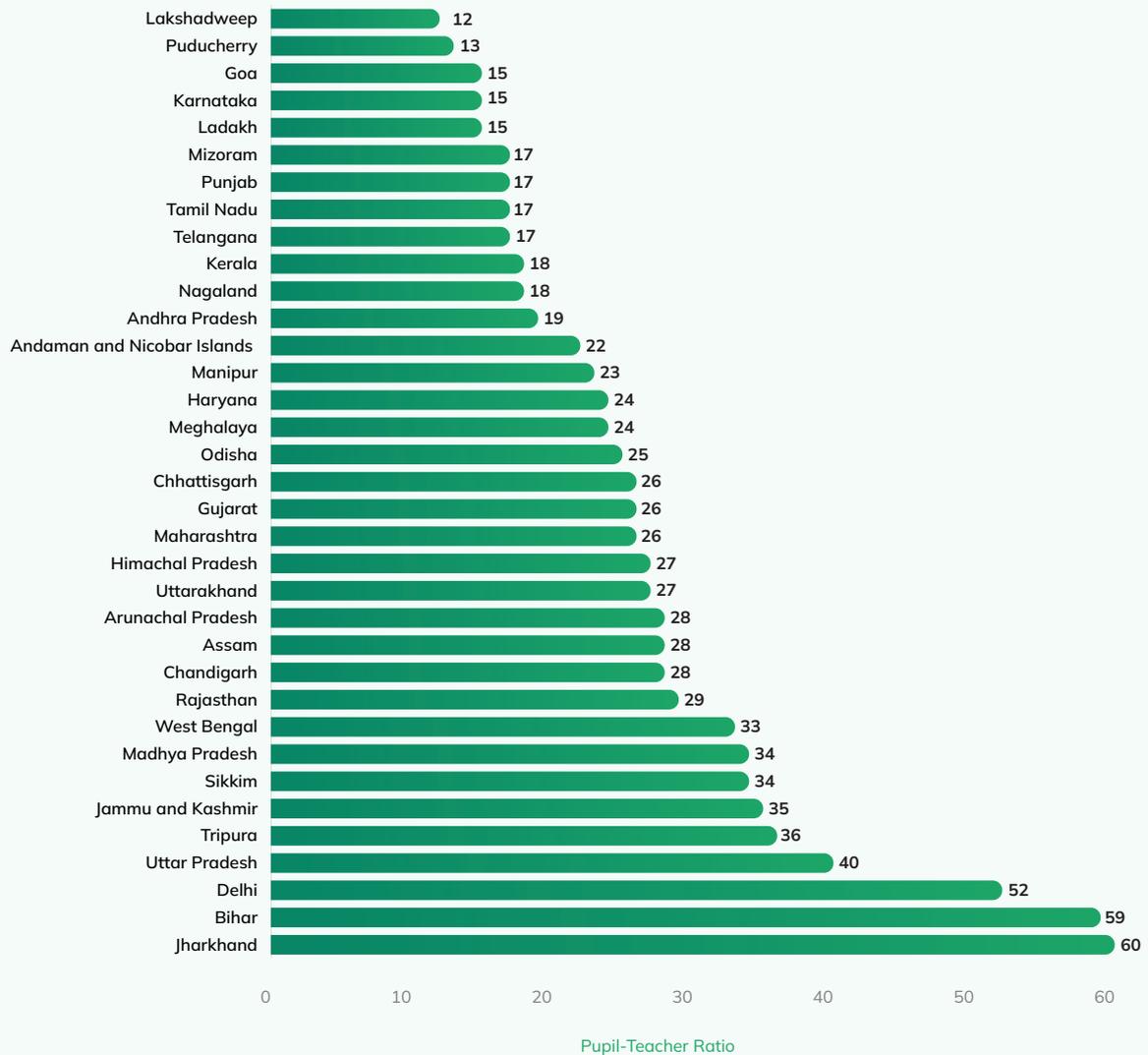


Figure 5: Pupil-Teacher Ratio in Higher Education, 2019-2020 (“All India Survey on Higher Education 2019-20” 2020)

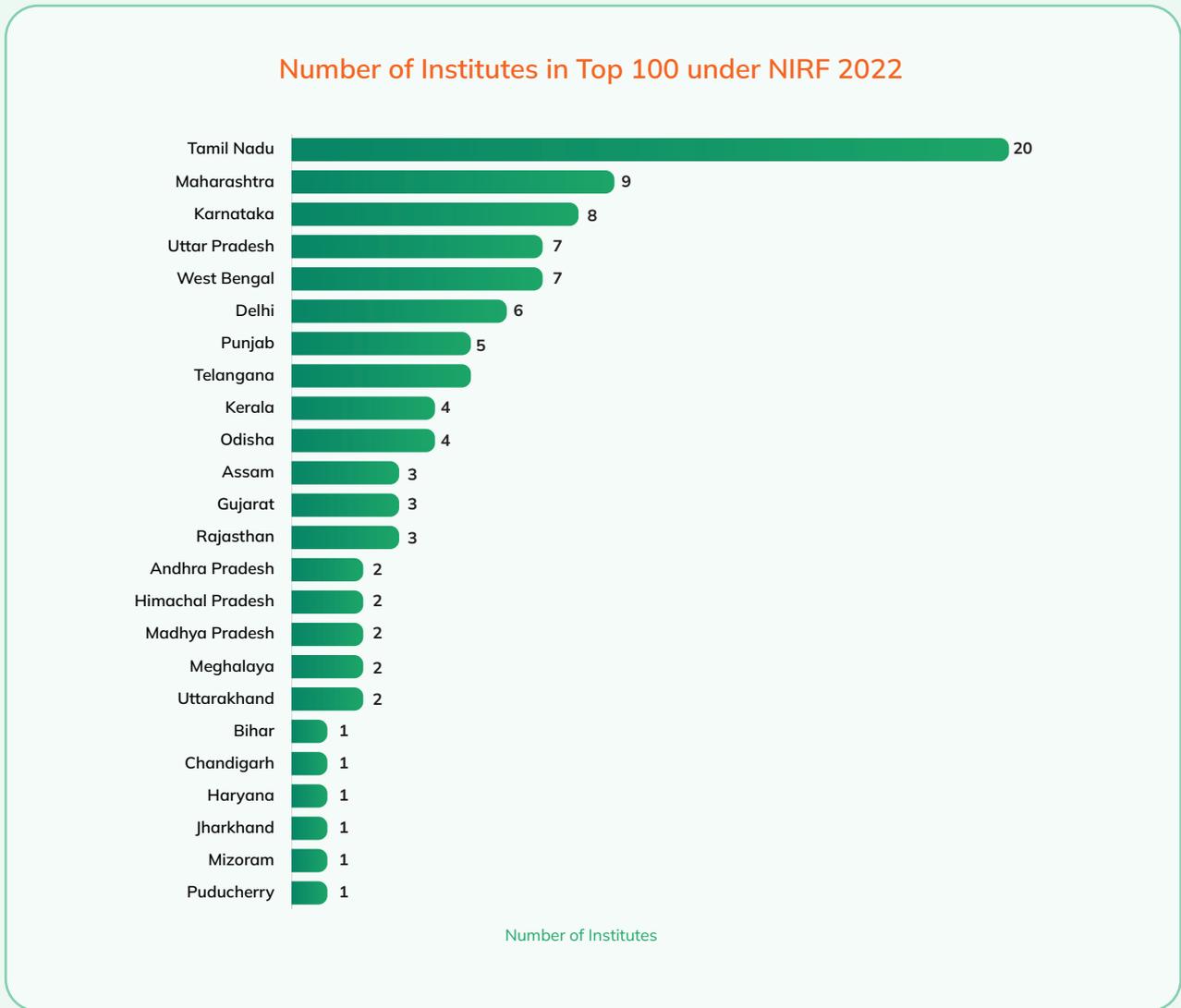
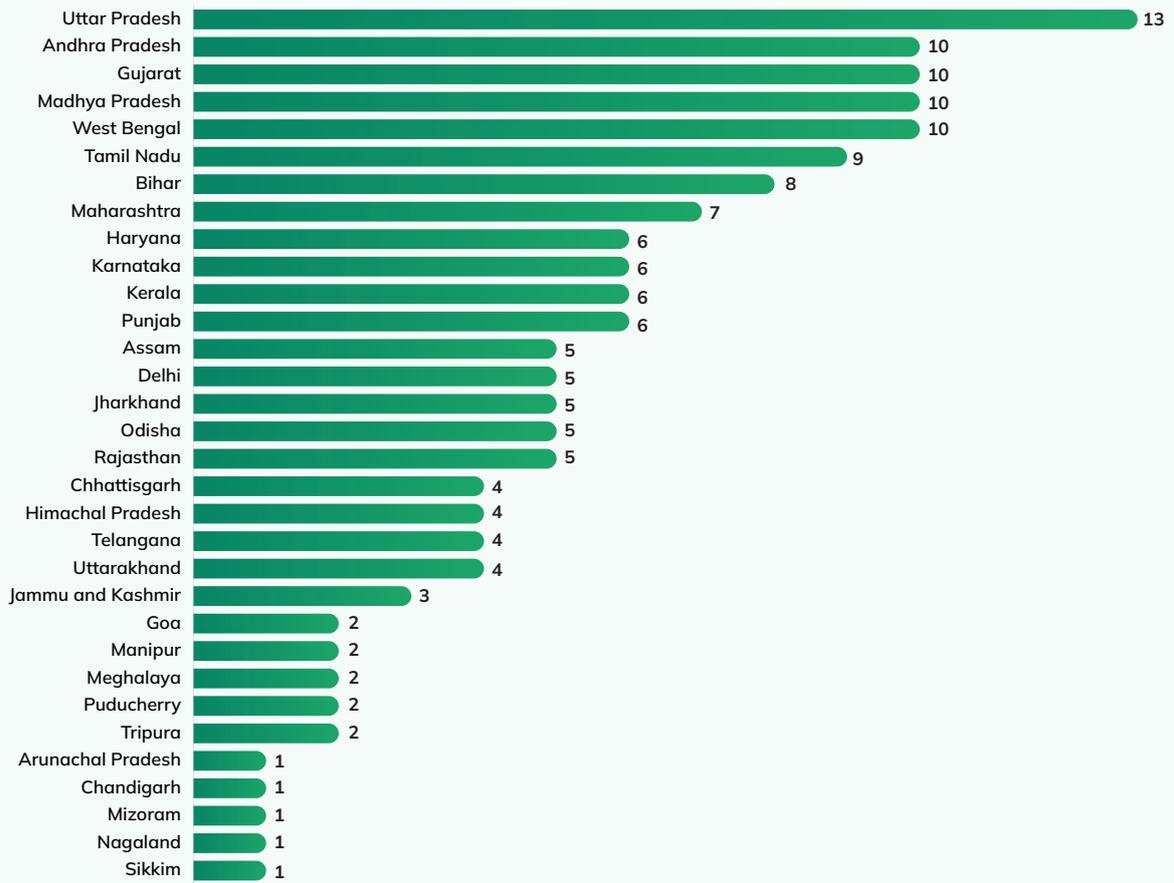


Figure 6: Number of Institutes in Top 100 under the NIRF 2022 (“National Institute Ranking Framework” 2022)

Number of Institutes of National Importance



Number of Institutes of National Importance

Figure 7: Number of Institutes of National Importance in States & UTs in India (“Department of Higher Education, Government of India” 2022)

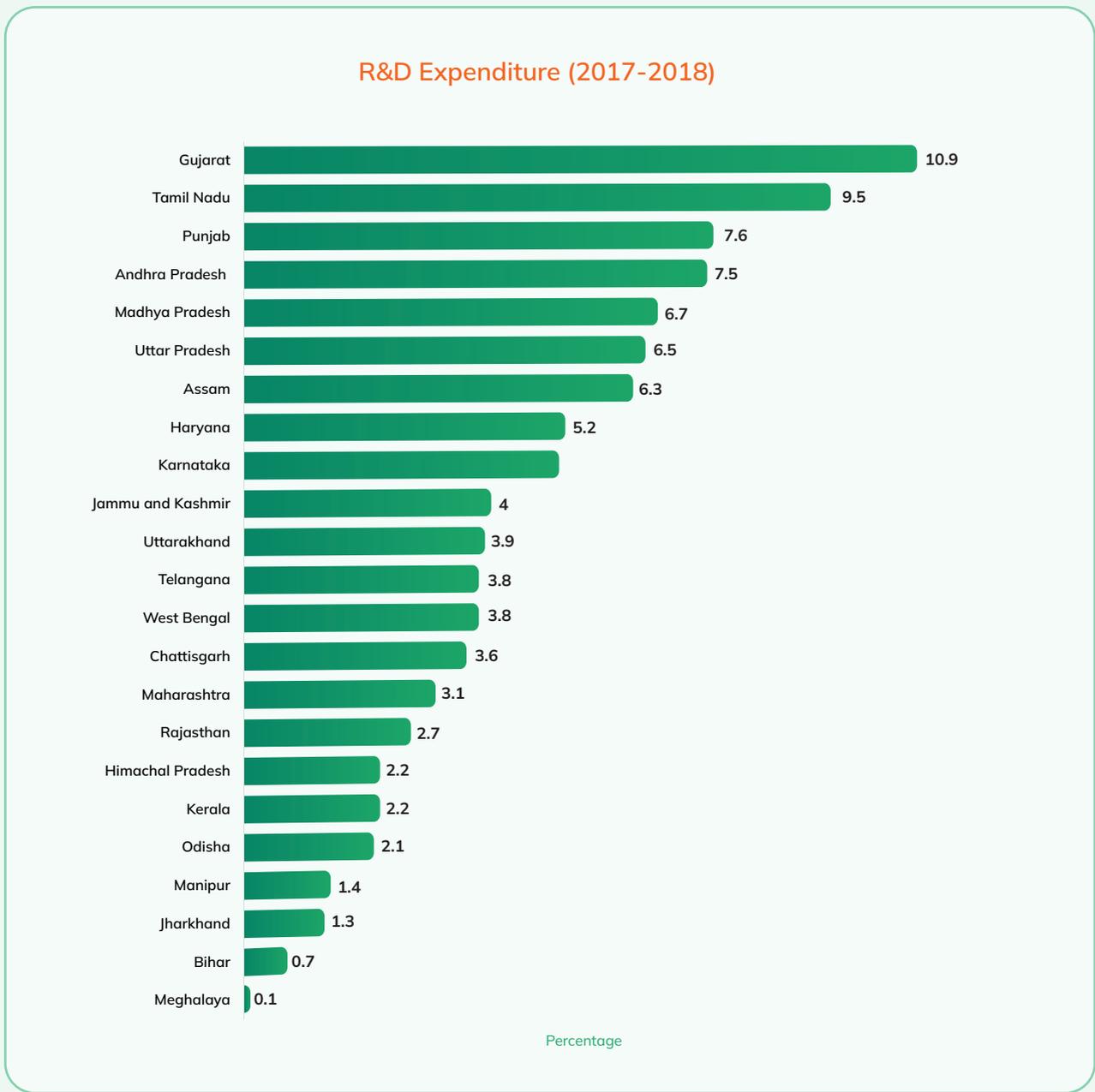


Figure 8: States' Expenditure on R&D, 2017-2018 ("Research and Development Statistics" 2020)

Number of Patent Applications (2019-2020)

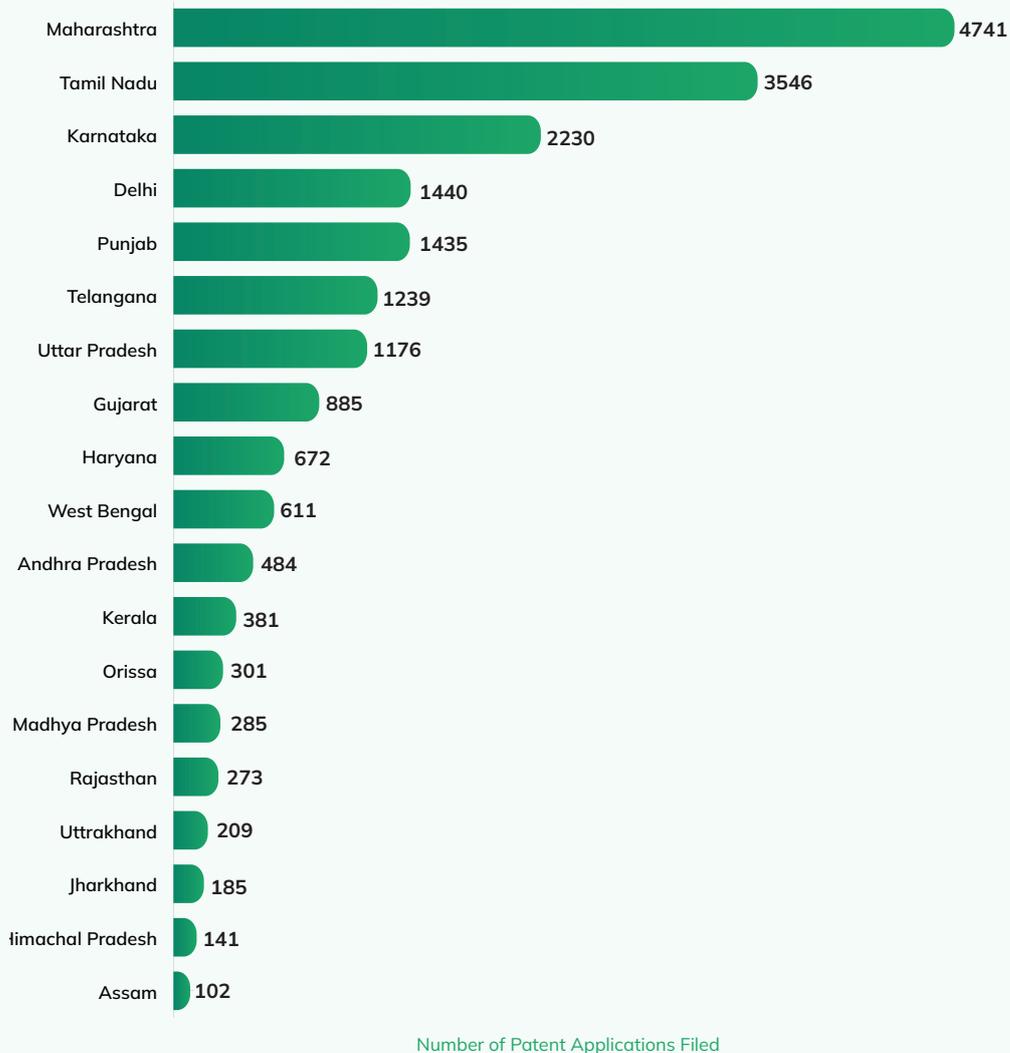


Figure 9: Number of Patent Applications from States & UTs in India, 2019-2020 (Office of the Controller General Of Patents, Designs, Trademarks And Geographical Indications 2020)

Number of Trademarks Applications (2019-2020)

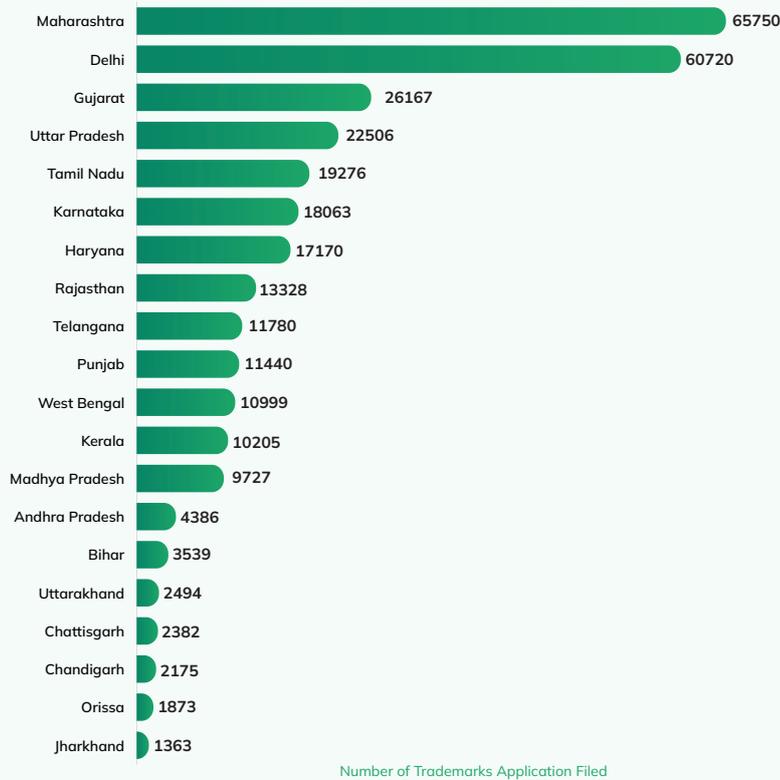


Figure 10: Number of Trademarks Applications from States & UTs in India, 2019-2020 (Office of the Controller General Of Patents, Designs, Trademarks And Geographical Indications 2020)

Number of Industrial Design Applications (2019-2020)

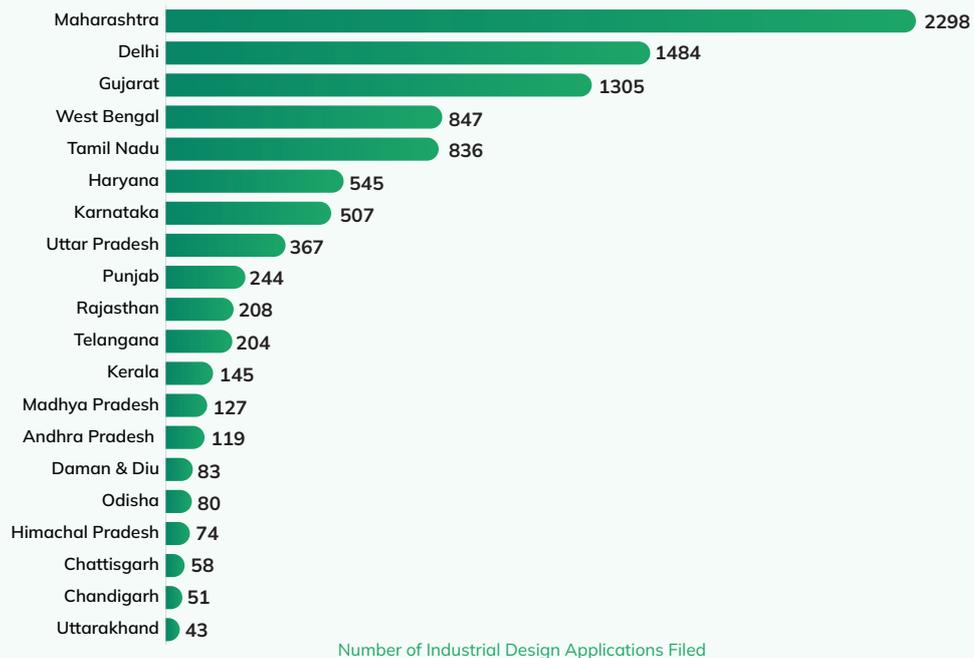


Figure 11: Number of Industrial Design Applications from States & UTs in India, 2019-2020 (Office of the Controller General Of Patents, Designs, Trademarks And Geographical Indications 2020)

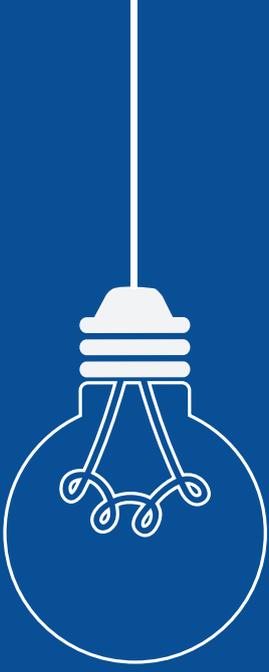
Final Tally & Selection of Regions

After conducting a macro-analysis of India's innovation landscape as presented in the preceding sub-section, certain states & UTs emerged as clear forerunners in innovation due to their recurrent appearance in top positions under the selected indicators. The recurrent states and UTs were:

Recurring UTs	Delhi, Chandigarh and Goa
Recurring States	Tamil Nadu, Gujarat, Maharashtra, Karnataka, Uttar Pradesh, Haryana, West Bengal, Andhra Pradesh, Madhya Pradesh, Punjab and Telangana

Hence, a method was required to select states and UTs to embark on a study of regional innovation systems in India. Here, the ranking of states and UTs under the India Innovation Index 2021 was utilised as a cross-reference to make this selection. The top five states (Karnataka, Telangana, Haryana, Maharashtra and Tamil Nadu) and top two UTs (Delhi & Chandigarh), as mentioned in the Index, were selected, and all other states and UTs were eliminated from the consideration of this report.

The following sections of this report contain an in-depth analysis of the innovation landscape in the selected states and UTs, in the order of their ranking under the India Innovation Index 2021. First, the regional innovation systems were studied, subsequent to which the status of university-based innovation in these regions was also assessed. This exercise was concluded with a brief discussion which put forth broad policy recommendations.



Karnataka



Karnataka has emerged as a leading centre of innovation in India. In several reports that evaluate the innovation and startup ecosystem in India (i.e. The India Innovation Index 2021 and States' Startup Ranking 2021), Karnataka has consistently been ranked first among all other states.

Bengaluru, the capital and largest city, is arguably the state's biggest asset. It is considered the 'Silicon Valley of India' and is the largest exporter of software in India. It is also regarded as a global S&T cluster as it houses several hi-tech research and educational institutions often buttressed by supportive state policies and associated with significant industry players.

The state's stellar performance, indicative of its robust regional innovation system, may be attributed to several factors. In light of this, this section covers the regional innovation ecosystem of Karnataka to cull out bright spots (to emulate) and problem areas (to circumvent) for other states

Karnataka's Startup and Innovation Environment

Policy Framework

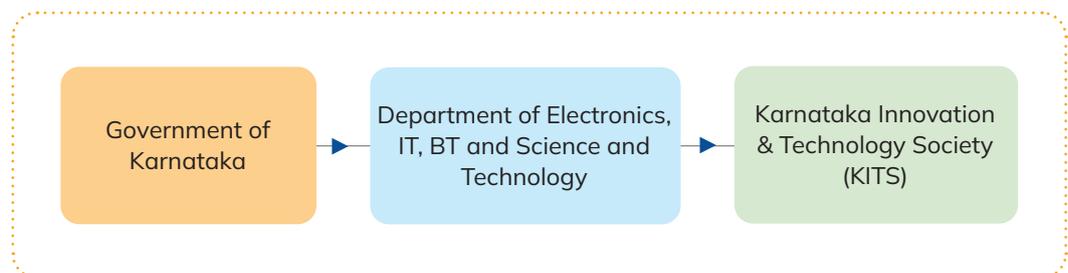


Figure 12: Key Policymaking Bodies in Karnataka ("Karnataka State Report" 2022)

(A) Key policymaking bodies & nodal agencies

In Karnataka, startup & innovation policies are made and implemented by authorised entities that form part of a threefold hierarchical structure. The apex policy-making body is the elected state government, which includes a total of 42 departments. Out of these 42, the nodal department for startups and other innovation-related endeavours is the Department of Electronics, IT, BT and S&T, and the nodal centre for implementing schemes of this department is the Karnataka Innovation & Technology Society (KITS) ("Karnataka State Report" 2022).

To understand how these entities synergise to support innovation in the state, Google's recent Memorandum of Understanding (MOU) with the Karnataka government may act as an example. In November 2022, the company signed an MOU in which it undertook to collaborate with KITS under the Department of IT, BT and S&T to nurture women entrepreneurs and local startups in the state through training and mentorship sessions (Thathoo 2022). In this manner, KITS often acts as a liaison agent between industry players and the state government to promote IT, BT and S&T endeavours in the state.

(B) Assessment of Karnataka's startup policy

A key policy launched by the state government related to innovation is the Karnataka Startup Policy (2015-2020). An ex post facto assessment of the policy reveals that the state has fallen short of achieving most of the goals set under the policy. The same has been presented in Table 1.

Table 1: Assessment of Karnataka Startup Policy, 2015-2020

GOALS	STATUS
Stimulate the growth of 20,000 technology-based startups including 6,000 product startups by 2020 in Karnataka	As of 21st December 2022, 10,098 startups in Karnataka have received recognition by the DPIIT, Government of India (“Startup India” 2022).
Achieve creation of 6 lakh direct and 12 lakh indirect new employment in the sector	As of 30th June 2022, the total number of individuals employed in Karnataka's startup sector is 1,03,541 (“Minister of State, Ministry of Commerce & Industry, Written Reply in Lok Sabha” 2022).
Mobilise Rs. 2,000 Cr funding for investment in startups through Government intervention alone, by leveraging the Fund of Funds proposed to be put in place by the State Government	As of 30th June 2022, the total amount allocated under the Fund of Funds for Startups is Rs. 1,701 crores and the total amount utilised is Rs. 666 crores (“Minister of State, Ministry of Commerce & Industry, Written Reply in Lok Sabha” 2022).
Facilitate generation of at least 25 Innovative Technology solutions with a social impact in sectors like Health care, Food Security, Clean environment, Education for all etc.	An initiative under the Start-up Policy, “Grand Challenge Karnataka” aims to channel innovations for social impact and support the establishment of start-ups. A total of 33 winners have been provided funding support for their innovations through this initiative as of 21st December 2022. (“Grand Challenge Karnataka”, n.d.).

(C) Other relevant policy measures

In the States’ Startup Ranking 2021, Karnataka scored in the 100th percentile under the ‘Institutional Support’ Reform Area, implying that it scored higher than all the other participating states (“Karnataka State Report” 2022). This suggests the presence of a robust institutional framework to support entrepreneurship and industry—which is explored in this section.

As per the India Innovation Index 2021, Karnataka is the top exporter of software and ICT when compared with the rest of the country (Niti Aayog 2022). It may be argued that behind this laurel lies a strategic policy decision. In 1997, Karnataka became the first state in India to adopt an IT policy, which significantly accelerated the growth of its IT industry. In the years that followed the adoption of this policy, Karnataka’s share in software exports steadily increased, as depicted in the figure.

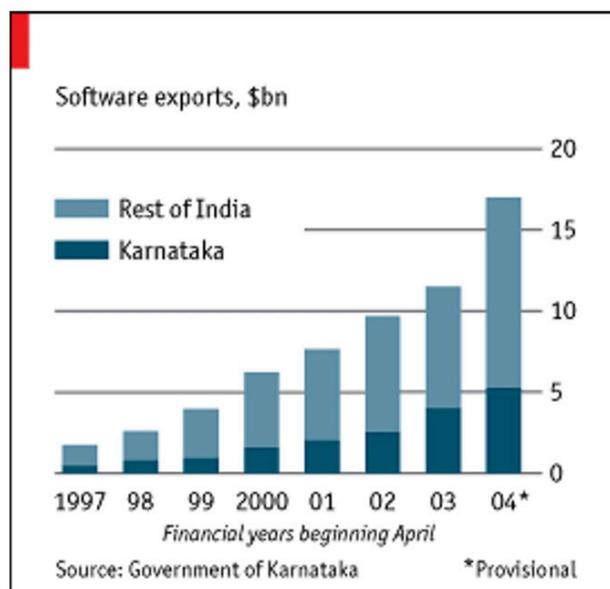


Figure 13: Growth in Software Exports from 1997 to 2004 in Karnataka (The Economist 2005).

Several other measures were also undertaken by the state to encourage innovation, ease the dissemination of technology and enable access to the market. Recently, Karnataka enacted a unique legislation titled the 'Karnataka Innovation Authority Act' in 2020. Among other provisions, it envisions the creation of 'regulatory sandboxes' in the State, where innovative technologies can be tested and offered to the public (with restrictions and for a definite time period) while being exempt from municipal and state laws. The regulatory sandbox is termed as sector agnostic and open to applications from all domains ("Karnataka Innovation Authority Act" 2020).

Additionally, the state government launched the Karnataka Digital Economy Mission (KDEM), which aims to utilise the potential of the digital economy of Karnataka, facilitate investments and act as a bridge between industry and the government. To that end, its 'Beyond Bengaluru' initiative promotes the growth of technology clusters across Karnataka. Launched in 2021, it aims to encourage industries to strengthen their footing in the emerging

startup hubs throughout the state, such as Hubballi-Dharwad, Belagavi, Mysuru and Mangalore, by offering companies incentives in Tier II cities to take industries out of Bengaluru ("Beyond Bengaluru", n.d.). Specific events are also organised by the state to connect startups with private stakeholders. Touted as one of India's flagship tech events, the Bengaluru Tech Summit has been conducted annually since 1998 by the state government of Karnataka. It aims to bring together concerned stakeholders of several fields to engage for their mutual benefit ("Bengaluru Tech Summit 2022", n.d.).

To surmise, the state government of Karnataka has made concerted efforts to improve its policies regarding information technology, industry and innovation. While these policies have enabled the development of a budding regional innovation ecosystem in the state, the proof of the robustness of these policies and the larger innovation system can only be evinced through the state's sustained growth.

Features of Karnataka's Innovation System

- | | | |
|--|--|---|
| 1 Number of Startups | 4 Knowledge Output & Diffusion | 7 Emerging Startup Hubs in the State |
| 2 Concentration of Incubators | 5 Urban Infrastructure | 8 IT, Bio-Tech & Life Science Hub |
| 3 Access to Capital & Investment | 6 Human Capital | 9 R&D Expenditure |

1. Number of Startups

With close to 10000+ startups registered with DPIIT, Karnataka has the second highest number of startups in India after Maharashtra. When examined together, both these states account for more than a third of the total startups in India, as represented in this figure:

Percentage Share of Startups

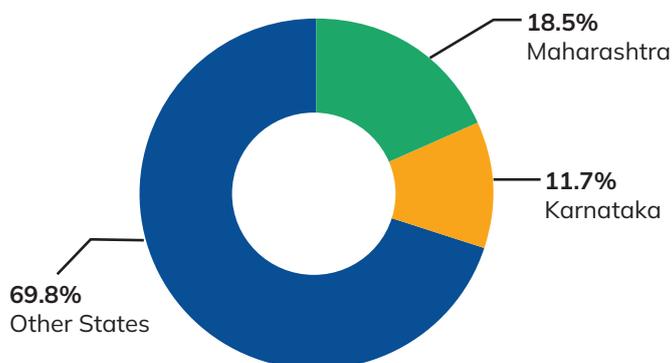


Figure 14: Percentage Share of Startups in Karnataka & Maharashtra, As on 21st December 2022 ("Startup India" 2022)

It may be contended that the number of startups present in the state of Karnataka provides tentative evidence of an environment that is conducive towards entrepreneurship.

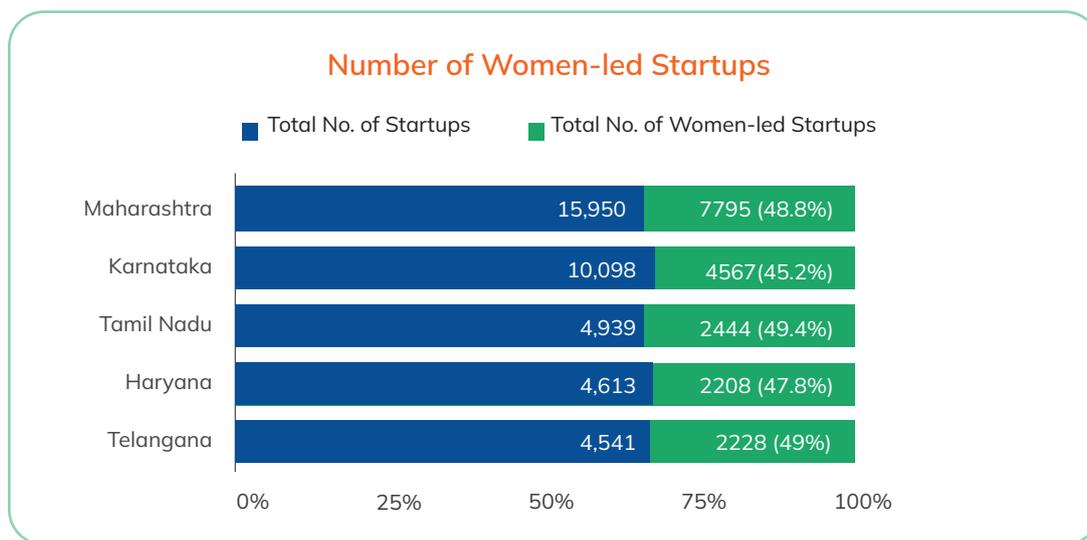


Figure 15: Percentage of Women-led Startups to Total Startups in Selected States, As on 21st December 2022 (“Startup India” 2022)

Among the states under consideration in this report, Karnataka has the second highest number of women-led startups. However, a closer look at the data reveals that its percentage share of women-led startups to the total number of startups in the state is the lowest. While Karnataka’s innovation ecosystem may be favourable towards startups, it must work towards making itself inclusive by encouraging and incentivising women entrepreneurs.

2. Concentration of Incubators

As per the Startup India portal, Karnataka has 98 registered incubators, making it the state with the highest number of incubators in India. However, under the States’ Startup Ranking 2021, Karnataka scored in the 68th percentile under the ‘Incubation Support’ reform area (“Karnataka State Report” 2022). Compared with the states under consideration of this report, Karnataka is positioned second after Telangana in this area, leaving room for improvement in terms of its support towards state-supported incubators.

Two incubation facilities in Karnataka are worth highlighting. First is the K-Tech Innovation Hub, a network of hardware product startup incubators in Karnataka set up by KITS in collaboration with

IKP Knowledge Park, Hyderabad. The central hub of this facility is a makerspace⁵ linked incubator which supports five other centres at Belagavi, Jalahalli (Bengaluru), Mangaluru, Mysuru and Shivamogga. Currently, it hosts 70+ startups and teams of students as well as working professionals through workshops, mentoring, skilling events and networking opportunities (“KTech Innovation Hub”, n.d.).

Second, the New Age Innovation Network (NAIN) was launched under the Karnataka Startup Policy as an entrepreneurship development program to support students, research scholars and alumni. It provides incubation facilities in select engineering colleges in the state that develop ideas in the proof of concept stage, so as to derive commercial value from them (“Karnataka State Report” 2022).

3. Access to Capital & Investment

Under the India Innovation Index 2021, Karnataka is the top-performing state under the investment pillar. This is largely due to its high performance on various indicators, including FDI inflow and venture capital deals. It accounted for 45% of total FDI in India for the fComparedthe fiscal year 2021–2022 and from the period of October 2019 to June 2022, Karnataka attracted the second-

5. A makerspace is a collaborative work space inside a school, library or separate public/private facility for making, learning, exploring and sharing that uses high tech to no tech tools. These spaces are open to kids, adults, and entrepreneurs and have a variety of maker equipment including 3D printers, laser cutters, cnc machines, soldering irons and even sewing machines. <https://www.makerspaces.com/what-is-a-makerspace/>

highest FDI inflow after Maharashtra (DPIIT 2022). It also recorded the highest number of venture capital deals in the country (Niti Aayog 2022).

A plausible link exists between the state’s high FDI inflow and its industrial policy and clearance committees. The State High-Level Clearance Committee (SHLCC) and State-Level Single Window Clearance Committee (SLSWCC) are

mandated to take up project proposals on priority as per the Industries Facilitation Act, 2020. Between the period of October 2021 and January 2022, the two committees cleared 345 projects worth close to Rs 21,998 crore (Sood 2022). Further evidence is presented in the following figure, which depicts the strong access to capital in the city of Bengaluru:

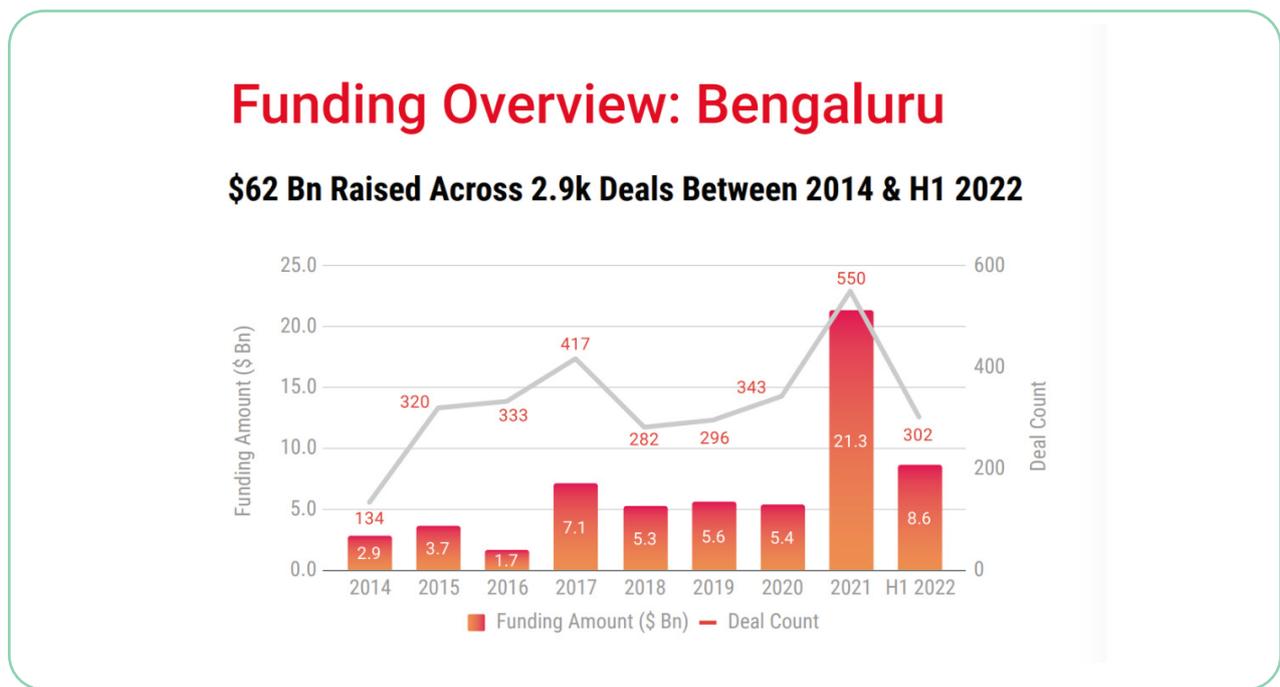


Figure 16: Access to Funds for Startups in Bengaluru 2014-2022 (Inc42 2022)

In the State’s Startup Ranking 2021, Karnataka scored in the 100th percentile under the ‘Funding Support’ reform area, making it the top performer in providing financial support for entrepreneurship and innovation-driven activities (“Karnataka State Report” 2022). The state government has floated several schemes and funds to facilitate access to funding. For example, Idea2PoC is a scheme that offers early-stage funding to startups which have not established the proof of concept of their ideas. It offers up to INR 50 lakh for a maximum of 2 years (“Idea2PoC”, n.d.). Additionally, the government of Karnataka provides three kinds of incentives that offer funding support to startups: Patent Reimbursement, Marketing Incentives, and GST Reimbursement. These schemes and incentives suggest the availability of multiple sources of capital for prospective innovators in the state.

The state government has made a concerted effort to promote business-friendly policies and schemes, which in turn has made Karnataka an attractive investment for industries. Furthermore, it may be argued that high FDI inflows, venture capital deals and financial support from the state have galvanised Karnataka’s entrepreneurship

and innovation activities.

4. Knowledge Output & Diffusion

The highest ICT exports in India (i.e. 14.83%) are reported to emanate from Karnataka. The state also holds the record for the country’s highest number of citations and registered geographical indications (Niti Aayog 2022). Due to its high performance under these indicators, Karnataka has outperformed all other states under the knowledge diffusion pillar of the India Innovation Index 2021. Evidence of the robustness of a region’s innovation system can be found in its ability to produce and diffuse knowledge skillfully; research posits that patents act as a reasonably reliable measure of innovative activity at the regional level (Acs, Anselin, and Varga 2002). This hypothesis merits a closer look at the relevant data to ascertain the state’s ability to produce knowledge, i.e. as seen in the number of patents filed and granted from Karnataka. As presented in the following figure, Maharashtra is the top performer in terms of the number of patents filed and granted, while Karnataka and Tamil Nadu are in close competition with each other for the second position.

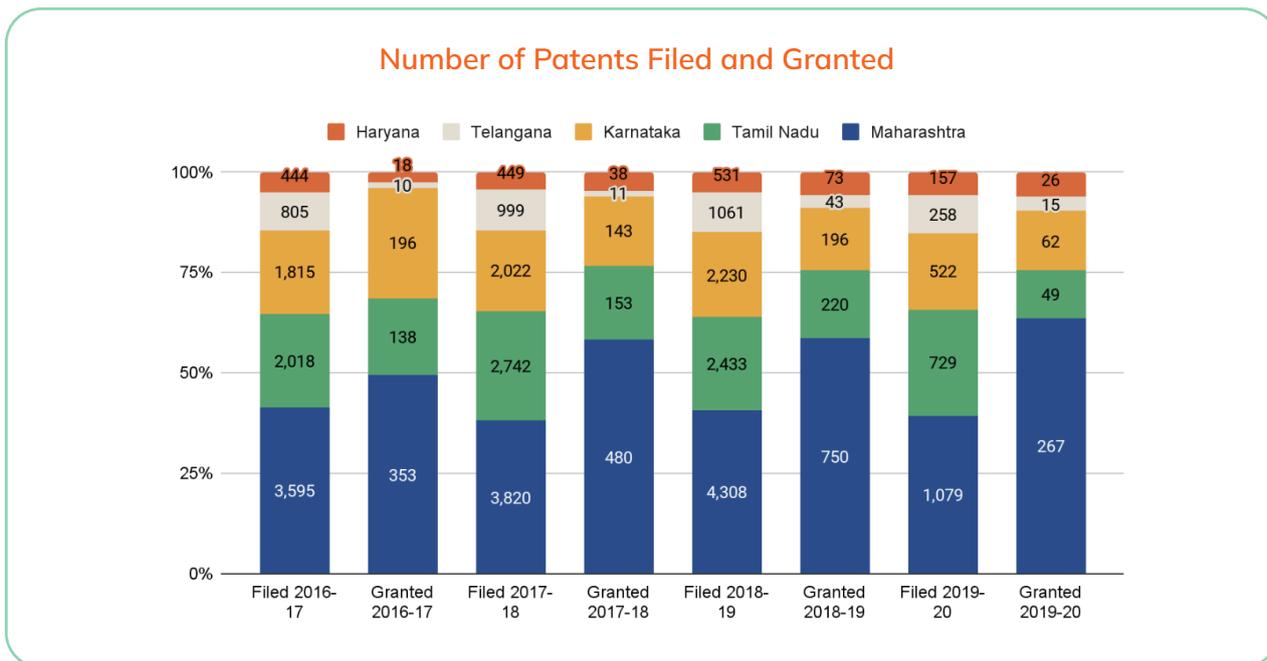


Figure 17: Comparison of the Number of Patents Filed and Granted in Different States from 2016 to 2020 (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

A comparison of patent data of Karnataka and Maharashtra shows that Maharashtra’s knowledge output is indeed significant as it accounts for nearly a quarter of patents filed and granted in India, while Karnataka’s average is around 11.35%, as depicted here:

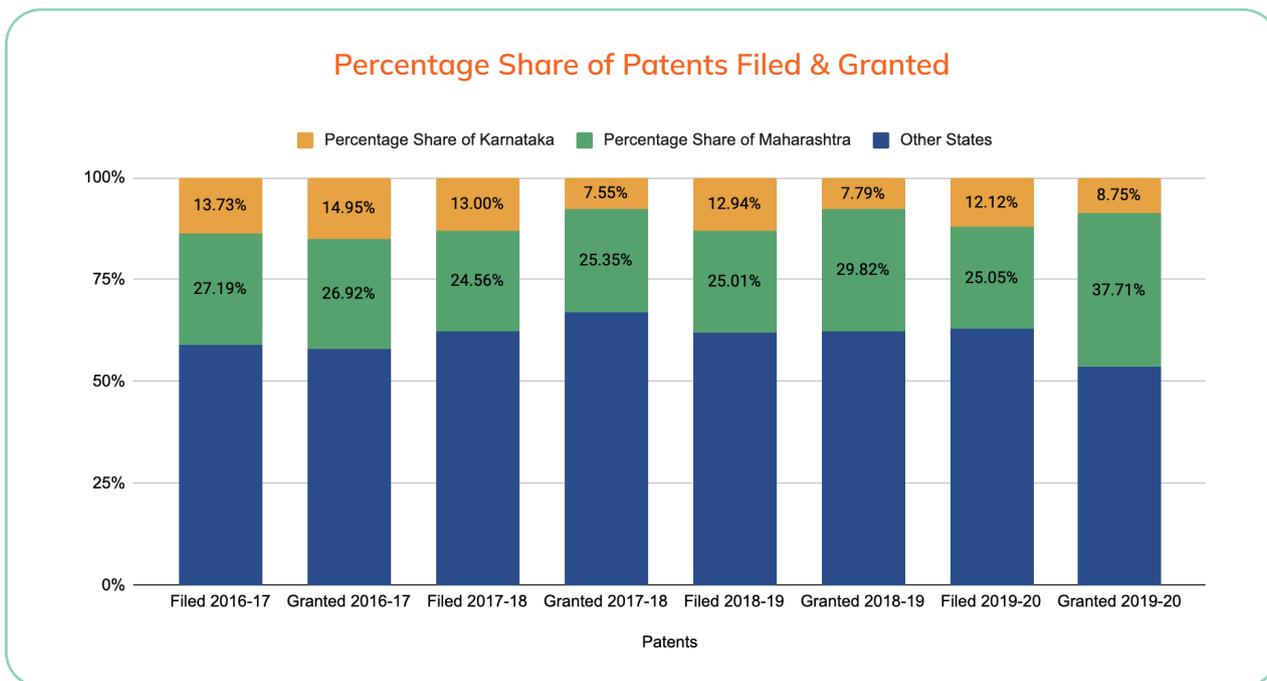


Figure 18: Percentage Share of Patents Filed and Granted in Karnataka and Maharashtra (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

While the average patents filed and granted in Karnataka is nearly half the average of Maharashtra, still, patent filings from Karnataka have seen an increase over the years. Unfortunately, increased filings have not translated into an increase in grants, which have remained dismally low, as seen in the figure below:

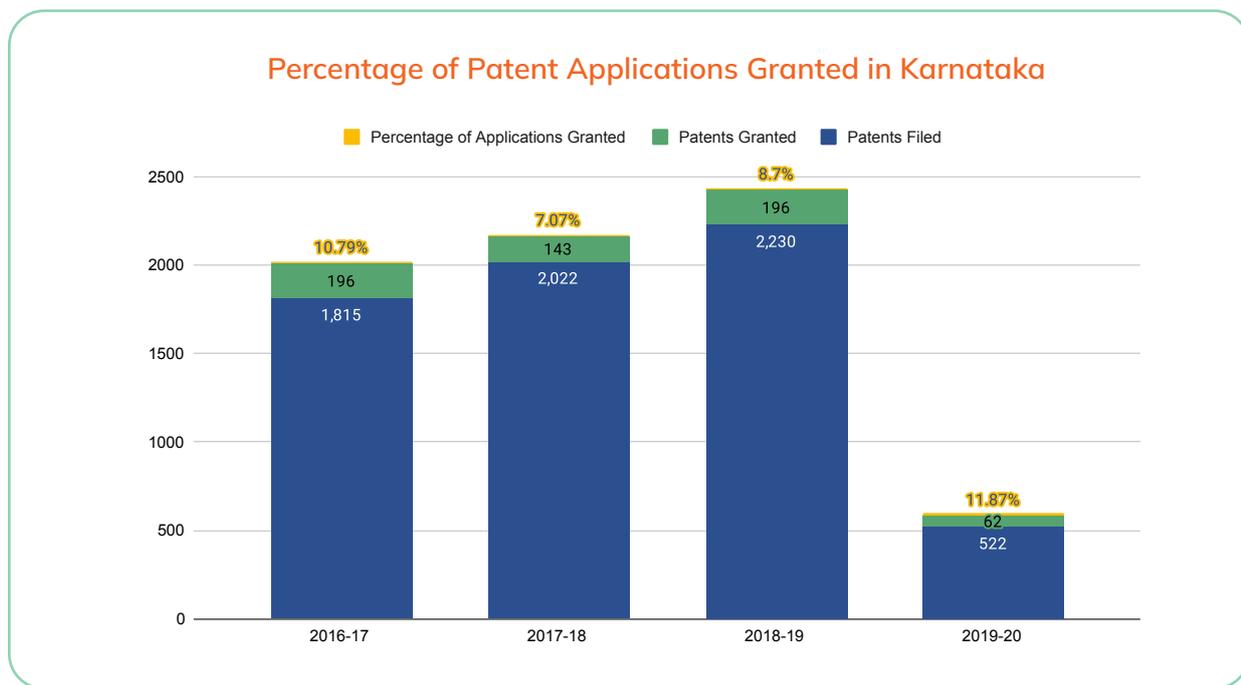


Figure 19: Percentage of Patent Applications Granted in Karnataka (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

The average patents granted in Karnataka from 2016 to 2020 is 9.63%, far lower than Maharashtra’s 16.13%, which is the highest average in India. While Karnataka may excel in the diffusion of knowledge via mainly its exports, it must also enhance its ecosystem to encourage patenting activity, which will facilitate improved knowledge production.

5. Urban Infrastructure

Among the 111 cities of India, Bengaluru was named the most liveable city under the Ease of Living Index 2020. The city scored the highest in the ‘Economic Ability’ pillar under the Index; its performance may be attributable to the conducive investment environment and thriving start-up culture in Karnataka (Ministry of Housing and Urban Affairs 2021).

However, the findings of this Index are by no means the final verdict on the ease of living offered by the city. The European Intelligence Unit (EUI), in its Global Liveability Index 2022, ranked Bengaluru as the “least liveable” city in India. The city received a score of 46.4 out of 100 for its infrastructure, which is the lowest among all Indian cities. The infrastructure score is based on the “quality of roads, public transportation system, international links, energy provision, telecommunications, water, and availability of good quality housing” (The Indian Express 2022).

Bengaluru’s low score on this parameter posits a weak city infrastructure, which may challenge its burgeoning regional innovation and startup ecosystem.

6. Human Capital

With a literacy rate of 75.36% (which is higher than the national average) Karnataka has one of the most educated populations in India. Furthermore, over 67% of Karnataka’s population is in the working age group of 15-59 years, which suggests the state’s vast potential in utilising its human resources (Invest India, n.d.).

One method of assessing the quality of human capital is mapping the learning outcomes of school students. Under the India Innovation Index 2021, Karnataka performed well in terms of student learning outcomes as it was a top performer in the metric of National Achievement Surveys (NAS) scores, which are used in assessing school students’ reading, mathematics, and science skills to report on the quality of education provided to students in schools (Niti Aayog 2022).

At the tertiary level of education, the pupil-teacher ratio in Karnataka was reported to be 15:1, the lowest among the states under consideration of this report. This indicates access to individualised attention for students in the

state. It also had good PhD enrolment numbers. The state has a high number of institutions at the tertiary level; 1 Central University, 28 State Universities, 16 Private Universities, 491 Engineering Colleges (AICTE approved), 57 Medical Colleges, 298 Polytechnic Institutes and several government research institutes in aerospace, electronics and defence which provide education and skills to significant strata of the population (Invest India, n.d.). One of the state's premier institutions is the Indian Institute of Science (IISc) in Bengaluru, which has enabled the advancement of scientific temper in not only Karnataka but also the rest of the country. The clustering of hi-tech knowledge-based research and educational spaces and institutions within the state suggests a robust educational infrastructure, which undoubtedly generates the potential for innovation in Karnataka.

7. Emerging Startup Hubs in the State

The following are the emerging hubs of Karnataka's startup ecosystem, as seen through the number of startups currently operating in these regions:

Mysuru	61+
Hubli	33+
Udupi	11+
Mangaluru	34+
Belagavi	17+

Figure 20: Emerging Startup Hubs in Karnataka (Inc42 2022)

8. IT, Bio-Tech & Life Science Hub

Karnataka has a vibrant IT/ITes, biotechnology and life sciences sector. Relevant information and statistics related to these sectors are as follows:

IT and IT-Enabled Services	Biotechnology & Life Sciences
<p>Karnataka is the largest software, electronics and computer exporter in India, totalling US\$ 81.4 billion in FY20 and US\$ 38.8 billion in FY21 (India Brand Equity Foundation 2022).</p> <p>Bengaluru is the fourth-largest technological cluster in the world after Silicon Valley, Boston and London (India Brand Equity Foundation 2022).</p>	<p>Karnataka accounts for 60% of all biotech companies in India and contributes to 1/3 of all biotech exports from India (Invest India, n.d.).</p> <p>It accounts for 26% of India's biotech revenues and is home to the largest biotech cluster in India (Pradhan, n.d.).</p>

9. R&D Expenditure

As per the Research and Development Statistics 2019-20, Karnataka's R&D expenditure (5.1%) is higher than the national average (4.3%), yet it still ranks ninth among other states of India in terms of R&D expenditure. Additionally, as indicated in the figure below, when compared with the states under consideration of this report, Karnataka has the third highest R&D expenditure.

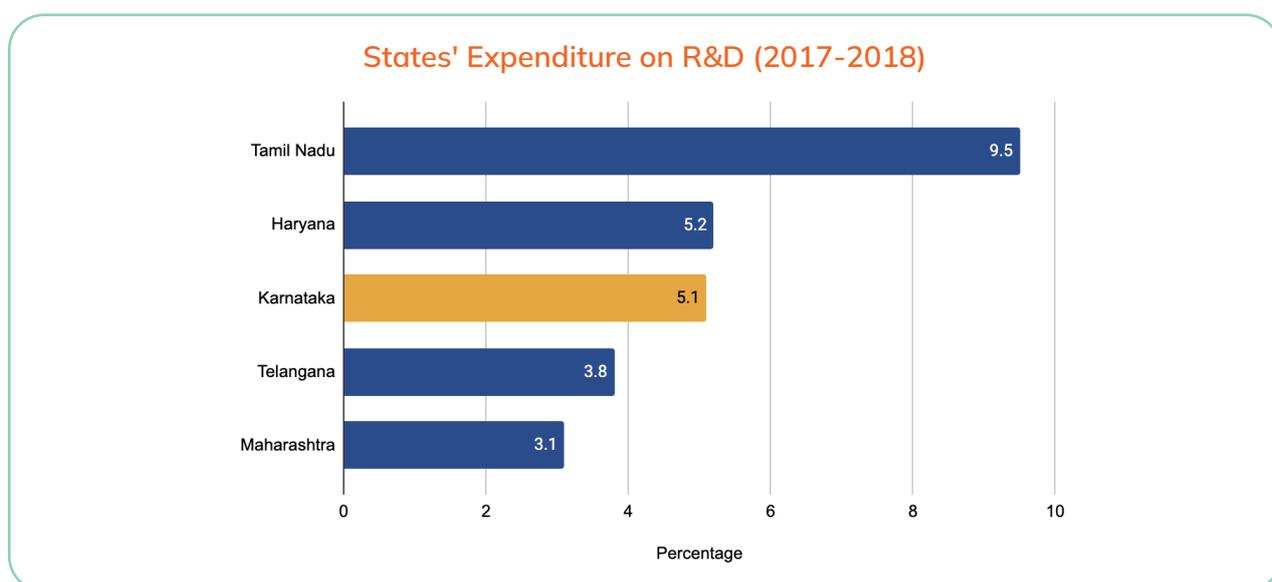


Figure 21: Karnataka's R&D Expenditure 2017-2018 ("Research and Development Statistics" 2020)

While Karnataka's existing innovation landscape is regarded as one of the best in the country, it may take measures to retain its preeminent position. Increasing investment in R&D is one means to do so. The top states in

terms of R&D expenditure in India are Gujarat (10.9%) and Tamil Nadu (9.5%); hence, Karnataka may aim to increase its current R&D expenditure two-fold to leverage its existing strengths and bolster its innovation system.

S&T, Life Sciences and Industrial Clusters

To set up a robust innovation ecosystem in a region, several players must come together to synergise and collaborate. With the acknowledgement that entrepreneurial activity cannot occur in a vacuum, the Prime Minister's Science, Technology and Innovation Advisory Council (PM-STIAC), supported by the Office of the Principal Scientific Advisor (PSA) to the Government of India, have proposed to establish S&T clusters across India. These clusters aim to create linkages between government bodies, academic institutions, research laboratories, industry players, start-ups, MSMEs, investors, and social sector organisations to leverage their strengths and galvanise innovation in these regions ("Science & Technology Clusters", n.d.).

Bengaluru is one of six cities that the Indian government has selected for establishing an S&T cluster. Named the 'BeST Cluster', it aims to synergise the efforts of several players in the innovation system to drive development in the region. It received seed funding approval in September 2022 and was formally launched on 16 November 2022 at the Bengaluru Tech Summit ("BeST Cluster", n.d.). Currently, the cluster's activities are at a nascent stage as it is setting up its administrative operations. What impact it shall have on the region's growth remains to be seen. However, the cluster has access to institutions and organisations as seen in Figure 22.

As Bengaluru is also regarded as a biotech and life sciences hub, the Bangalore Life Sciences Cluster (BLiSc) is a major player that anchors and vitalises this sector. It comprises three institutions, namely: National Centre for Biological Sciences (NCBS), the Institute for Stem Cell Science and Regenerative Medicine (inStem) and the Centre for Cellular And Molecular Platforms (C-CAMP). While the researchers at NCBS focus on basic and applied fields within the biological sciences, at inStem, researchers are focused on stem cell and regenerative biology. Both these institutions collaborate and draw upon one another's resources and expertise. This scientific expertise is merged into the entrepreneurial environment provided by C-CAMP, which provides the previous two institutions with access to resources and facilities in genomics, proteomics, next-generation sequencing and other bio-incubation technologies, as well as providing a platform for interface with the industry (Kankaria 2019). C-CAMP has been

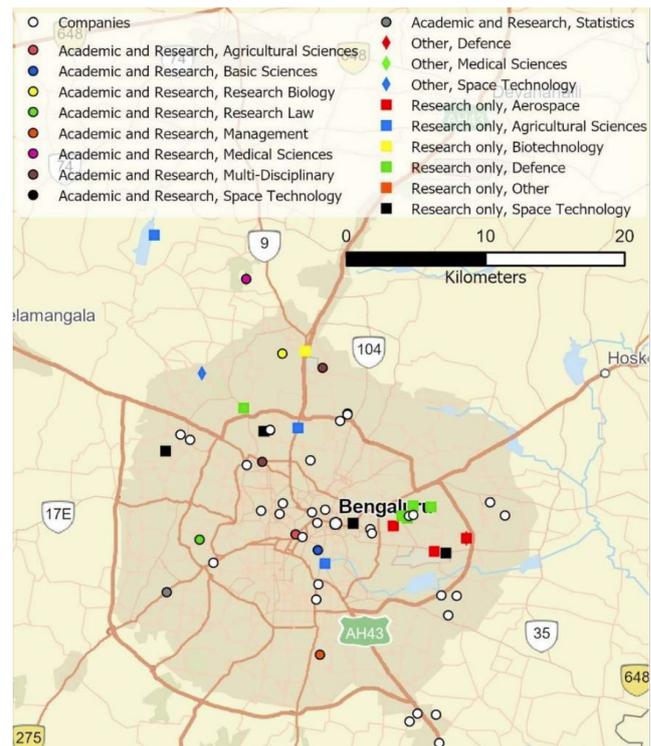


Figure 22: Mapping of Institutions and Organisations in the S&T cluster in Bengaluru ("Report of the high-level committee on developing science & technology clusters in India" 2020).

recognised as an 'Ecosystem Enabler' by Startup India and DPIIT, as part of the National Startup Awards 2022. Its function as an incubator has been significant not only for the growth of the life sciences sector in Karnataka but also for the rest of the country; it has built a portfolio of 350+ startups and innovators across 34 states and UTs in India (BioSpectrum India 2023).

Aside from the S&T and life science cluster, Karnataka has a sizable presence of industrial clusters⁶ made up of Special Economic Zones (SEZs) and Coastal Economic Zones (CEZs). Figure 23 depicts clusters of SEZs and CEZs along with their focus areas present in Karnataka. Special economic zones (SEZs) are defined areas in a country that are subject to different economic regulations

6. Geographic concentrations of interconnected companies and institutions in a particular sector or field. <https://hbr.org/1998/11/clusters-and-the-new-economics-of-competition>

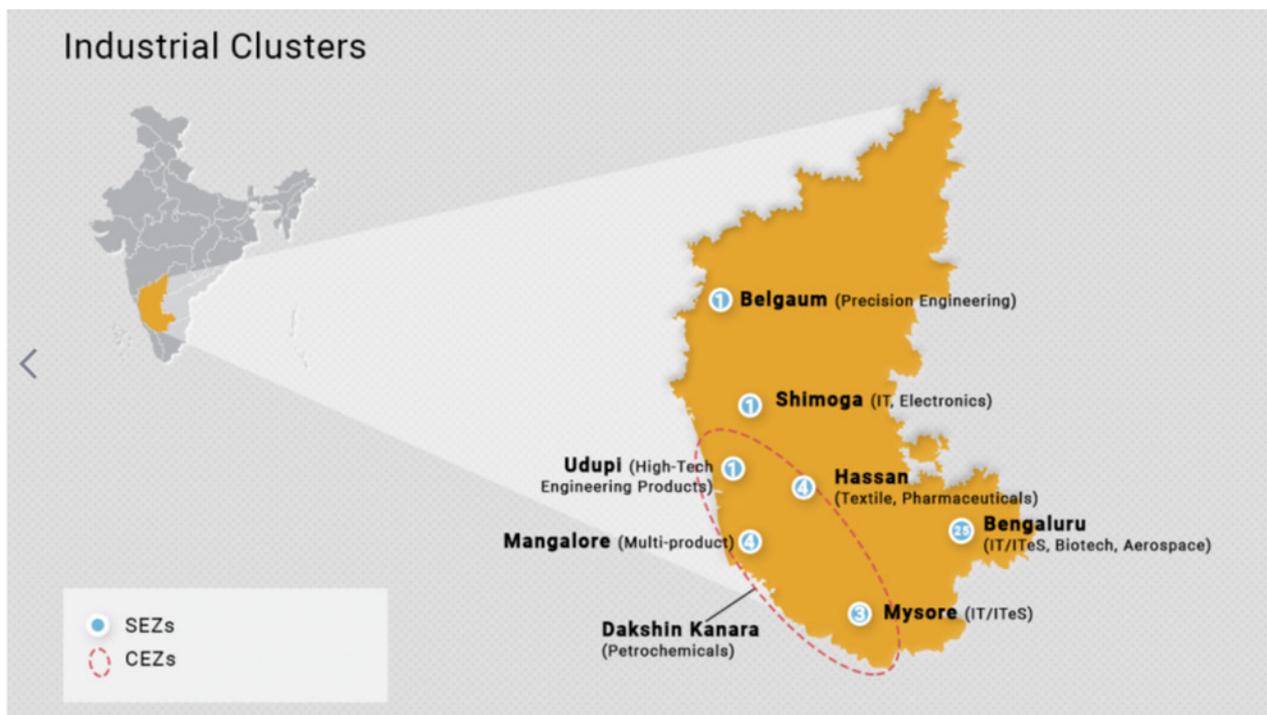


Figure 23: Industrial Clusters in Karnataka (Invest India, n.d.).

than other regions within the same country. The special economic regulations in these zones are regarded as conducive to attracting FDI (Eichler, n.d.). A study of SEZs in China found that such zones also promote innovation by providing tax credits and technological subsidies and attracting more enterprises (Wu, Liu, and Huang 2021).

In India, SEZs were introduced via a policy announced in April 2000. Subsequently, the SEZ Act of 2005 was enacted to lay down the procedure for notification of SEZs. The following table enumerates the number of notified SEZs as against the number of operational SEZs (as on 22 November 2022) present in the states under consideration of this report. It can be observed that a large gap exists between notified SEZs and operational SEZs in Karnataka.

Table 2: State-wise Distribution of SEZs

STATE	NOTIFIED SEZS	TOTAL OPERATIONAL SEZS
Maharashtra	44	37
Karnataka	51	34
Tamil Nadu	58	50
Telangana	58	36
Haryana	22	7

Source: (“Special Economic Zones in India” 2022)

A study of SEZs in Karnataka conducted for the period spanning 2006–07 to 2016–17, argued that positive growth in employment generation was seen with an increase in SEZs. However, data from this study also showed that the male-female gap was 245 per SEZ in 2006–07, which increased to 3,695 people in 2016–17, indicating that employment opportunities offered by SEZs have indeed increased, but this growth has not been inclusive as the male-female gap in employment has shown a consistent rise over the years (Shivakumar B.P. 2020).

As SEZs enable innovation and employment opportunities—both of which are vehicles for economic growth—Karnataka may aim to operationalise all of its notified SEZs and make concerted efforts to make such spaces more inclusive for prospective job seekers in the state.

Role of HEIs vis-a-vis Karnataka’s Innovation System

University-Industry Linkages

Karnataka topped the University-Industry Linkages (UILs) rankings in a study conducted by the PHD Chamber of Commerce and Industry, by scoring 7.8 on a 10 point scale.

The study noted that all key industries of the state—engineering, biotechnology, automotive and auto components, IT and IT-Enabled Services—have very strong University-Industry Linkages. The study also highlighted regular interaction between universities and industries in the state to conduct R&D activities on campuses and improve a firm’s business processes. Several industries have collaborated with the universities through agreements and MoUs to provide them with quality solutions for business purposes. Furthermore, industries in the state interact regularly with students to provide them with internship opportunities in their respective plants (PHD Chamber of Commerce and Industry 2019).

Example: Bosch Power Tools Training facility was established at the National Institute of Technology, Karnataka. This collaboration focused on giving hands-on experience in using a power tool for carpentry, metalworking and construction which shall encourage students to undertake research with this technology (PHD Chamber of Commerce and Industry 2019).

Research Output

In Karnataka, the Indian Institute of Science (IISc) is considered a prolific institution in terms of scientific research. In the QS World University Rankings 2022, IISc was ranked as the world’s top research university (Gohain 2021). In “Mapping Patents and Research Publications of Higher Education Institutes and National Research Laboratories of India”, published by Panjab University, Chandigarh, IISc was featured as one of the top institutions in terms of its research output. It had the highest number of patents granted (see figure 24) and the second-highest number of research publications (see table 3).

Table 3: Rankings of Top 5 Institutions Based on Research Publications, 2010-2016

RANKING	INSTITUTION	RESEARCH PUBLICATIONS
1	Delhi University	15052
2	IISc Bangalore	10852
3	IIT Kharagpur	8724
4	Banaras Hindu University	8140
5	Bhabha Atomic Research Centre, Mumbai	7887

Source: (Kumar 2017)

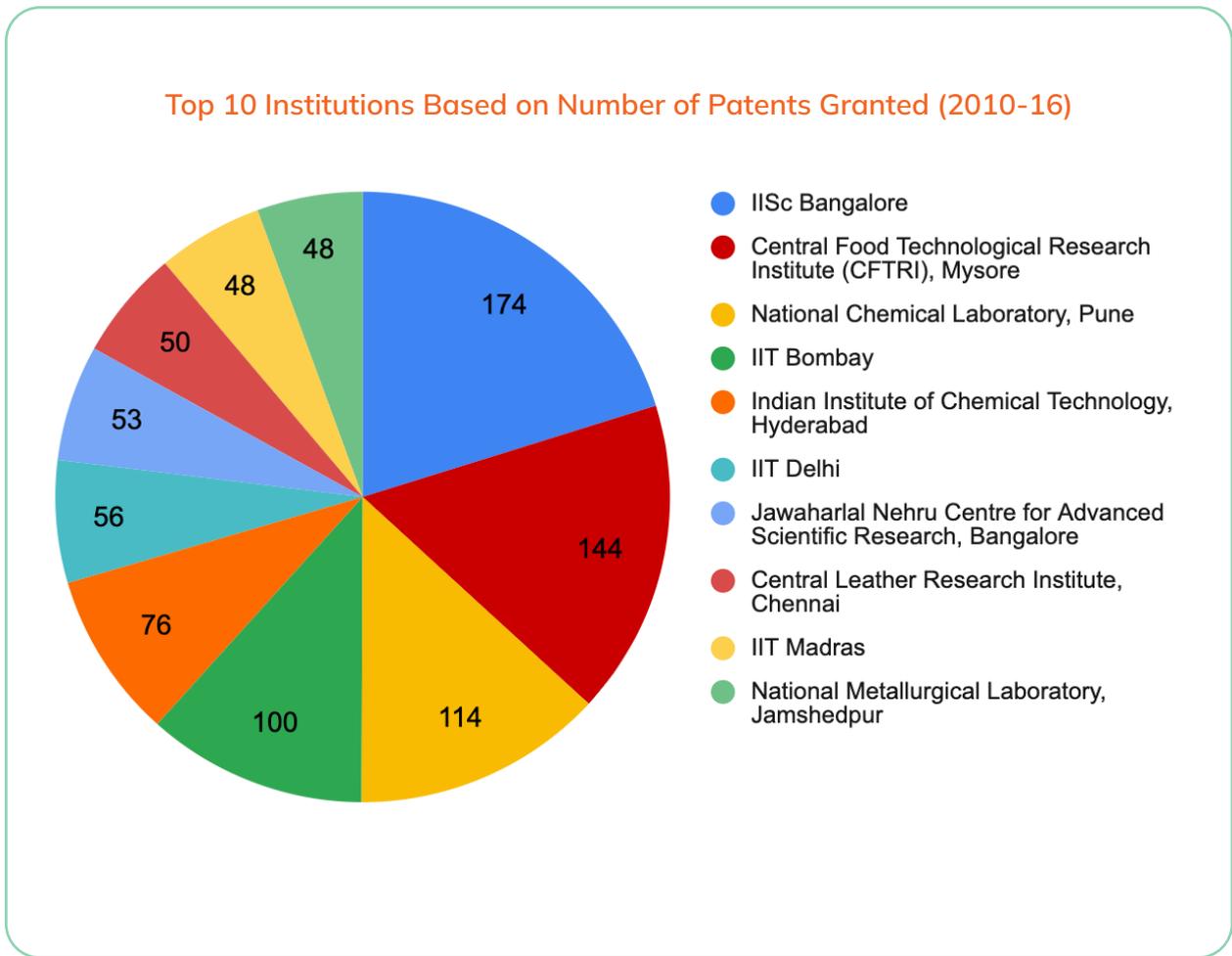


Figure 24: Top 10 NIRF Ranked Institutions in Terms of Patents Granted 2010-2016 (Kumar 2017).

The National Institutional Ranking Framework (NIRF) of 2022 ranked IISc as the top research institution in India. Its impact is evident in its significant contributions to rural and urban development, health and medicine, environment and sustainability and emerging technologies like aerospace, nanotechnology, cryptography and cyber security (Indian Institute of Science, Bangalore 2019).

Apart from IISc, an assessment of the research output of engineering HEIs in Karnataka is also relevant to the report. The following figure represents the number of research publications and patents granted from 2010 to 2016 in India's top 100 NIRF-ranked engineering institutes:

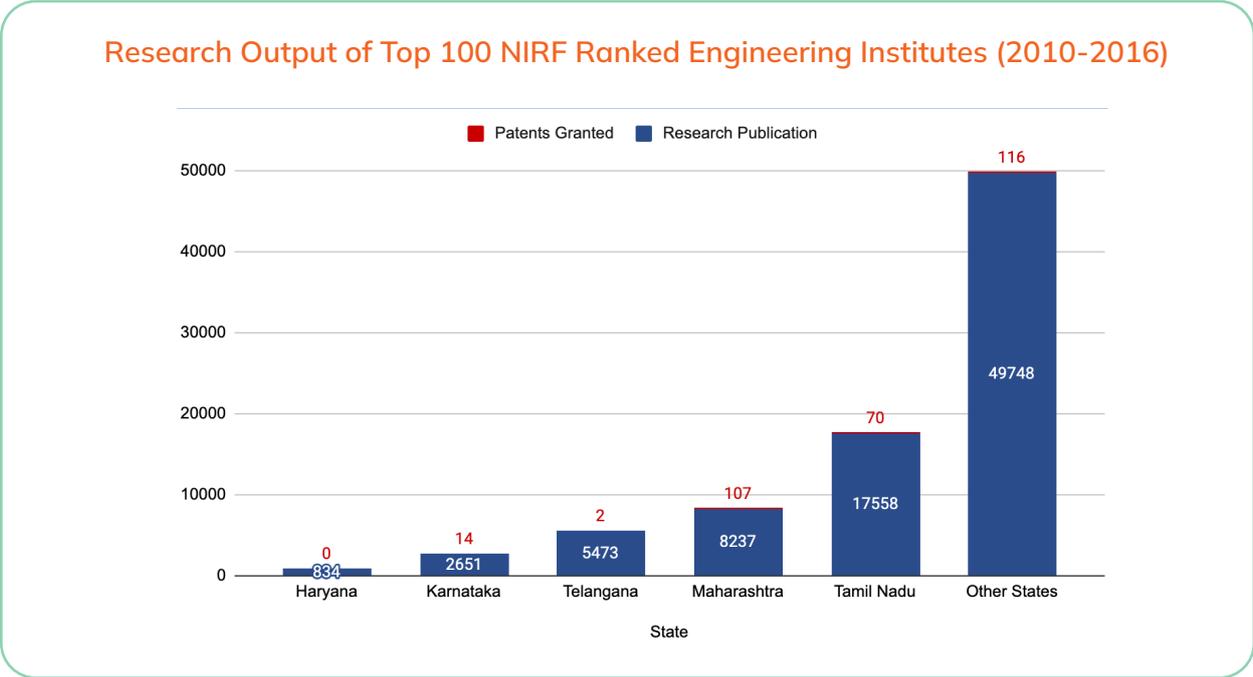


Figure 25: Research Output of Top 100 NIRF Ranked Engineering Institutes, 2010-2016 (Kumar 2017).

The research output of engineering HEIs in Karnataka, in terms of publications and patents granted, is relatively poor compared to other states of India. As seen in the figure below, Karnataka’s HEIs merely account for 2.8% of the total research publications and 4.5% of the total patents granted to HEIs in India from 2010 to 2016.

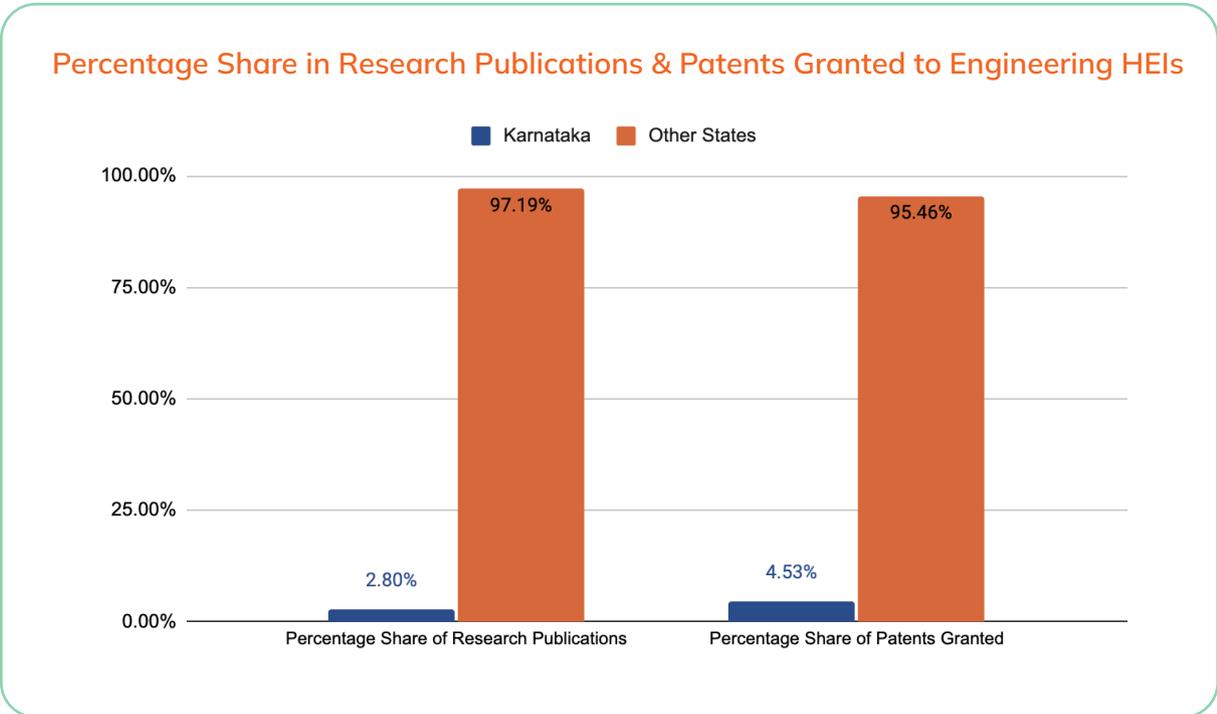


Figure 26: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs in Karnataka (Kumar 2017)

The following table presents HEIs situated in the state of Karnataka that were listed in this publication (Kumar 2017) along with the number of their research publications and patents granted.

Table 4: Research Output of Engineering Institutions in Karnataka, 2010-2016

Name of HEI	Research Publications	Patents Granted
NIT Karnataka, Mangalore	1377	0
Manipal Institute of Technology, Manipal	812	13
M. S. Ramaiah Institute of Technology, Bangalore	256	1
Siddaganga Institute of Technology, Tumkur	188	0
R.V. College of Engineering, Bengaluru	18	0
Total	2651	14

Source: (Kumar 2017)

NIT Karnataka and Manipal Institute of Technology are the top performing HEIs in Karnataka, as per the volume of their publications and patents granted. The former accounts for more than half of the total publications of all HEIs from the state and the latter accounts for close to a third of the publications and 92% of the total patents granted to HEIs from the state.

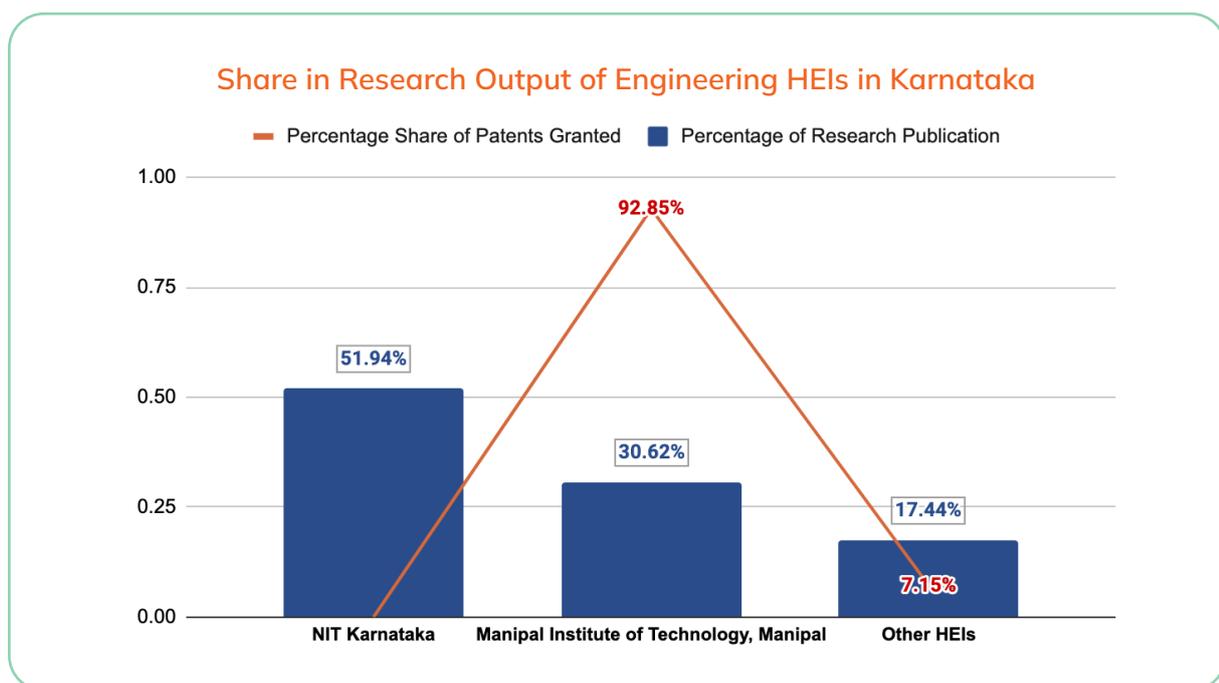


Figure 27: Share in Research Output of Engineering HEIs in Karnataka 2010-2016 (Kumar 2017)

When compared with the research output of other engineering HEIs in the state, Manipal Institute of Technology accounts for a significant number of publications and leads in terms of patents granted. The engineering college is a private constituent institution of the Manipal Academy of Higher Education, which was ranked as 'Band Excellent' in the Private/Self-Financed Technical University category in ARIIA 2021.

In light of the foregoing, it may be surmised that the top institutions in Karnataka in terms of research output and institutional rankings are IISc and Manipal Institute of Technology. Hence, examining the institutional facilities present in these institutions may yield relevant learnings for other institutes to emulate.

Institutional Facilities - Indian Institute of Science (IISc)

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/ innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Institutional Facilities - Manipal Institute of Technology, Manipal

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

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- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

Karnataka has the second highest number of startups in India after Maharashtra. However, its percentage share of women-led startups compared to the total number of startups is the lowest among states under consideration of this report. The state may work towards making its entrepreneurial climate inclusive by designing policies that provide incentives for women entrepreneurs.

Bengaluru city is considered a global S&T cluster and an IT hub, with the ability to provide access to capital for prospective entrepreneurs. Several emerging startup hubs across Karnataka may benefit from the dissemination of knowledge and capital from the city. Hence, the state may craft policies that provide tax incentives to industries in order to encourage them to set up their base in other regions of Karnataka and ensure equitable growth in the state.

Under the Global Liveability Index, Bengaluru scored poorly in terms of its city infrastructure, which may impact investor outlook towards the city and pose a challenge to its burgeoning innovation system. Hence, the state may enhance the city's infrastructure to support the growth of industries and businesses.

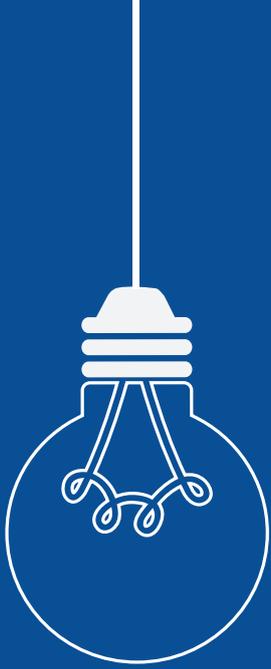
While Karnataka excels in the diffusion of knowledge mainly via its exports, it may also work towards enhancing its ecosystem to encourage knowledge production. Karnataka's share of the total patents filed and granted in India averages around 11%. To improve its performance on this front and strengthen its overall regional innovation system, it may increase its R&D expenditure and provide incentives for individuals carrying out scientific and technological research.

As biotechnology, life sciences and IT/IT-Enabled Services are the major industries in Karnataka, HEIs may leverage these strengths in the region by encouraging student-industry interaction. With this exposure, students may tailor their applied research and inventions to suit the needs of these industries. This will ensure the marketability of HEI-based innovation and facilitate knowledge creation and dissemination that will benefit the state's innovation system.

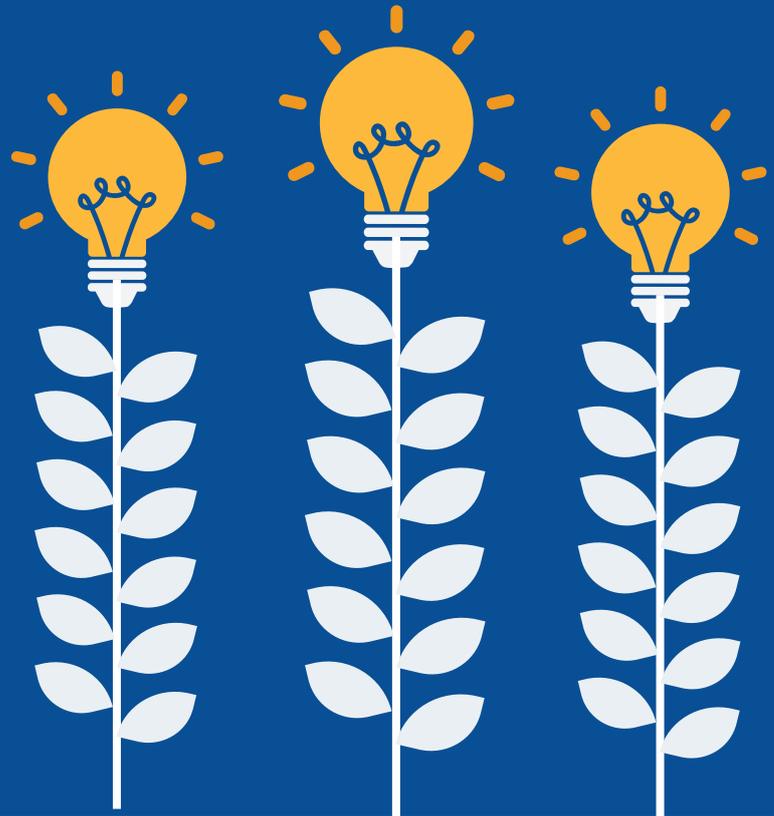
As SEZs promote innovation and the availability of employment opportunities, Karnataka may aim to operationalise all of its notified SEZs and design policies that make these zones more gender inclusive for prospective job seekers in the state.

The top HEIs in Karnataka in terms of research output and institutional rankings are IISc and Manipal Institute of Technology. Both appear to have the requisite infrastructure and facilities to enable innovation and entrepreneurship to emanate from them, as evidenced in their research output. Other academic institutions in the state may aim to build similar institutional facilities. Additionally, the state may create policies to facilitate sharing of knowledge and expertise from these HEIs to enhance Karnataka's innovation system and enable its economic growth.

It may be argued that IISc operates as a largely research-focused HEI. It may reorient its focus to also become a leading entrepreneurial HEI by partnering with the industry for mentorship opportunities, access to private capital for R&D, ease of technology transfer, and a means of entry to markets to transform its inventions into workable products and services that may be introduced to the public for their benefit.



Telangana



Telangana is considered an established life sciences and pharmaceutical hub and an emerging IT centre in India. Around one-third of the production of pharmaceutical products in India emanates from Telangana. Hyderabad is touted as the vaccine capital of the world, as it produces a third of the global vaccine output; it is also the second highest contributor to India's IT exports and is home to 10 prominent global tech companies (Rao, n.d.) Several leading MNCs and startups have their headquarters in the state of Telangana, which anchor and energises its innovation ecosystem.

In 2021, Telangana received a mention in the Global Startup Ecosystem Report on the basis of the availability of affordable talent in the state. Under the India Innovation Index 2021, Telangana's innovation ecosystem was ranked second in the major states category. In the States' Startup Ranking 2021, it was ranked as a top performer in terms of its startup ecosystem. Telangana's performance under these reports indicates that it houses a promising innovation and startup ecosystem, which is examined in this section.

Telangana's Startup and Innovation Environment

Policy Framework

(a) Key policymaking bodies & nodal agencies

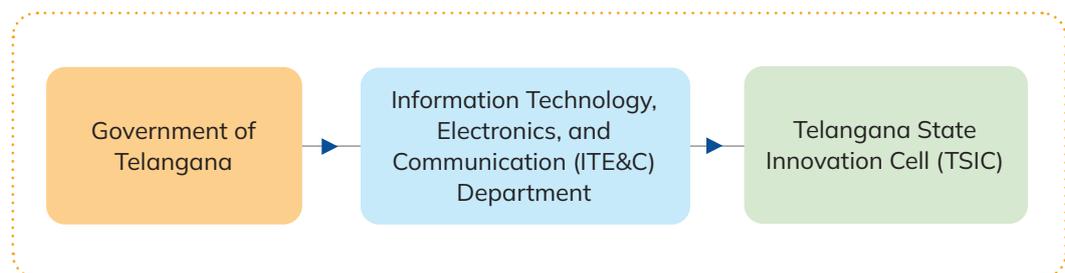


Figure 28: Key Policymaking Bodies in Telangana ("Telangana State Report" 2022).

Under the Government of Telangana, the Information Technology, Electronics, and Communication (ITE&C) Department was appointed as the nodal department for the startup ecosystem of Telangana ("Telangana State Report" 2022). The ITE&C Department set up the Telangana State Innovation Cell (TSIC) in 2017 under the state's innovation policy to nurture innovation in Telangana ("About – Telangana State Innovation Cell", n.d.). To illustrate how these entities collaborate to foster innovation in the state, the "Pitch In The Ring" may act as an example. The TSIC, ITE&C Department, and Government of Telangana jointly organised this event to provide a platform for rural innovators of Telangana to gain an audience with key innovation ecosystem stakeholders which included investors, incubators, private industry and civil society organisations, to measure their interest in supporting their innovative products and solutions (The Hindu 2022).

(b) Assessment of Telangana's startup policy

The Telangana Innovation Policy (2016–2021) proposed to create an environment conducive to innovation and entrepreneurship in the state through both fiscal and non-fiscal incentives. Telangana's startup model is based on five pillars: physical infrastructure and program management, funding models, human capital, engagement with industry and rural and social enterprises.

A report made by an expert committee of the Reserve Bank Of India that studied the condition of the MSME sector in India made a special reference to Telangana's startup model and its innovation policy while recommending other states replicate the same (Reserve Bank of India 2019). It specifically highlighted the fiscal and non-fiscal incentives offered by the Telangana state

government to incubators and startups present in the state. To incubators, it provides reimbursement of paid stamp duty and registration fees. Whereas for startups, fiscal incentives include reimbursement of SGST, cost of travel for promotion of companies, patent filing cost, recruitment assistance for idea stage companies, and grants on turnover. Non-fiscal incentives for startups in the state include permission to file self-certifications for prescribed labour acts and rules (“Telangana Innovation Policy” 2016). The expert committee noted that the key reason for the relocation of startups from India is the enabling environment offered in other countries, such as tax incentives and concessions, better infrastructure, exit policy, ease of doing business etc. (Reserve Bank of India 2019). Therefore, it recommended that providing fiscal incentives and improving infrastructure facilities be undertaken to retain Indian startups. In this context, it highlighted Telangana’s innovative model for startups and recommended its replication in other states of India.

While mapping the impact of the innovation policy of Telangana, viewing the number of startups in the state against the total number of startups in India may cull out a better picture of the status of entrepreneurship in the state. As seen in Figure 29, DPIIT registered startups in Telangana are a mere 5.3%, much lower than other states like Maharashtra (18.5%) and Karnataka (11.7%).

Percentage Share of Startups in Telangana

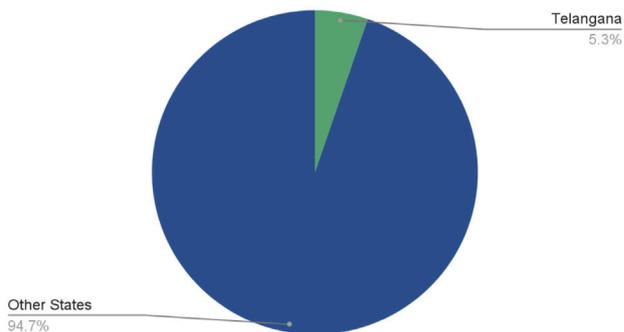


Figure 29: Percentage Share of Startups in Telangana, As on 21st December 2022 (“Startup India” 2022)

However, the share of women-led startups in the state is praiseworthy. In this regard, Telangana and Tamil Nadu (with nearly half of the startups in these states being women-led) appear to provide an inclusive entrepreneurial environment, especially when compared with the other states under consideration of this report (see figure 15). Programs, schemes and facilities provided in these states to entrepreneurs may be replicated in other states to create an inclusive entrepreneurial environment in the country.

Features of Telangana’s Innovation System

- 1 State Support for Incubation**
- 2 Life Sciences & Pharma Hub**
- 3 Human Capital**
- 4 Business Environment**
- 5 Knowledge Output & Diffusion**
- 6 R&D Expenditure**

1. State Support for Incubation

Telangana has close to 19+ state-supported incubators listed on its startup portal (“State Incubators – Startup Telangana”, n.d.). Of these, T-HUB is the leading incubator in the State. It was set up in 2015 under the state innovation policy and is offered support from various players: government, academia, investors and other ecosystem enablers. It claims to have nurtured close to 2000+ national and international startups (“T-hub”, n.d.).

Other important state-sponsored players in the innovation system of Telangana include WeHub (India’s first and only State-led incubator for women entrepreneurs), Research and Innovation Circle of Hyderabad (the state’s

S&T cluster), T-Works (which aims to provide a space for entrepreneurs to engage in prototype development) and Telangana Academy for Skill and Knowledge (which aims to skill the youth in technologies to foster industry-academia linkages). It is contended that these players synergise and leverage each other’s strengths to drive innovation in this region. The impact of these facilities can be seen in the performance of Telangana in the State’s Startup Ranking 2021, wherein it was ranked in the 100th percentile in the ‘Incubation Support’ reform area, implying that it scored higher than all the other participating States/UTs. (“Telangana State Report” 2022). While state support in terms of incubation is plentiful, the role of private industry in this space may also be encouraged. While T-HUB does involve corporations and

private players in its initiatives to nurture innovation in the state, further fiscal or non-fiscal incentives may be provided to such entities, so as to propel them to invest in startups being incubated in the state through venture or seed funding.

2. Life Sciences & Pharma Hub

As per a study of four life sciences clusters in southern India, scientists from Hyderabad had the maximum number of patents in the subject of life sciences (Ramachandran, n.d.). The study also noted the important role of Indian Drugs and Pharmaceuticals Limited (incorporated in 1961) which had a significant role in the city's growth as a prime pharma hub in India. Another important event behind the hub's emergence was the commissioning of a bio-cluster called Genome Valley in 1999 through a public-private partnership, which has enabled the state to account for a third of India's pharma production. More recently, in 2018, the government of Telangana announced that it was setting up the 'Hyderabad Pharma City', which will undoubtedly reinforce the life sciences and pharmaceutical industry in the state. Strategic policy decisions have enabled the state to create the availability of sound infrastructure for the pharmaceutical industry in India, which may have also driven private investment in this sector. These strengths may be further leveraged by the state to galvanise innovation well as investment in the state.

3. Human Capital

Under the India Innovation Index 2021, Telangana scored relatively lower than the states of Karnataka and Tamil Nadu under the 'human capital' pillar. However, in certain indicators, it performed exceedingly well. The number of enrolments in higher education witnessed an increase. Growth was also seen in the number of private R&D units and the number of women employed with advanced degrees (Niti Aayog 2022). These figures present a favourable view with regard to the state's capacity to produce skilled human capital.

Under its innovation policy, the state provides an incentive to emerging companies in their first year of operations in the form of a recruitment assistance amount of around INR10,000 per employee. Of the trained personnel, nearly 50% are recruited by the state, regarded as the highest percentage for a state-aided skilling program in India (Rao, n.d.). This endeavour may enable the creation of a high number of knowledge workers by the state. Additional measures may also be undertaken to promote the employment of such workers in the private sector, as fostering an environment in the state that is conducive to providing opportunities to knowledge workers is essential to support Telangana's bustling innovation and entrepreneurial landscape.

4. Business Environment

In the India Innovation Index 2021, Telangana scored the highest among the states under consideration of this report in the business environment pillar. It performed particularly well in the following indicators: number of microfinance institutions, villages in the state with internet connectivity, bank accounts with Aadhar seeding and share of manufacturing and services as a (% of GSDP) (Niti Aayog 2022).

Certain policy measures undertaken by the state government have also enabled ease of doing business in Telangana. In 2014, the Telangana State Industrial Project Approval and Self-certification System (TS-iPASS) Act was passed to provide clearances to large projects in 15 days and other projects in 30 days, which is the shortest period for receiving clearance in the country (Invest India, n.d.).

Despite these strengths, the state has a relatively lower percentage share of FDI inflow at 3%, especially when compared with Karnataka (23%) and Maharashtra (28%) (DPIIT 2022). It also performed poorly in some indicators under the safety and legal environment pillar under the India Innovation Index 2021, i.e. high pendency percentage of investigation of corruption cases, a low number of cyber cells and police personnel (Niti Aayog 2022). The state may aim to remedy the same, as these existing issues may impede entrepreneurial endeavours in the state.

5. Knowledge Output & Diffusion

When compared with the states under consideration of this report, Telangana scored the highest in the knowledge output pillar of the India Innovation Index 2021. Its score is credited to its performance in the following indicators: publications, startups, new businesses, GSDP per capita growth rate, and approved environment clearances of proposals. While this presents an optimistic view of Telangana's innovation system concerning knowledge creation, a closer look at a different set of data, i.e. the number of patents filed and granted from the state, may yield a more comprehensive picture. Telangana's contribution to patents filed and granted in India averages around 3.73%, far behind the leading states in India, Maharashtra (27.07%) and Tamil Nadu (12.27%).

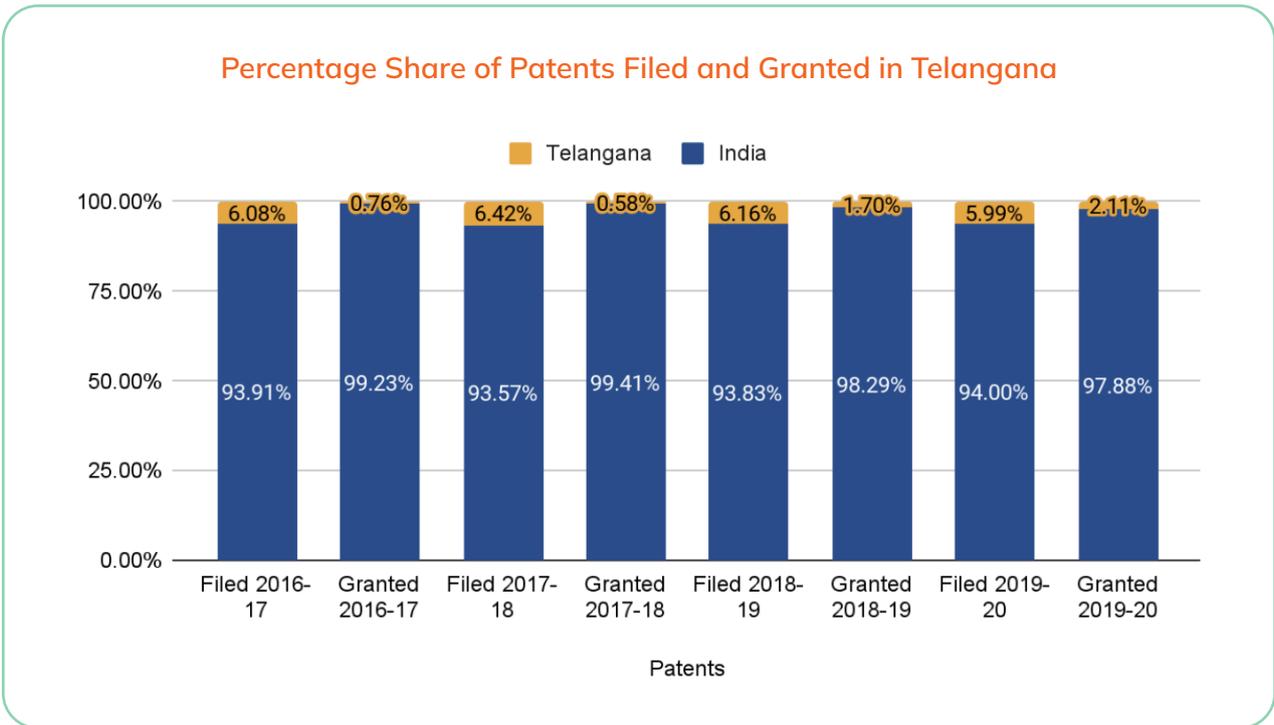


Figure 30: Percentage Share of Patents Filed and Granted in Telangana (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

As depicted in the figure below, the average patents granted from 2016–2020 in Telangana are 3.05%, much lower than Karnataka (9.63%) and Maharashtra (16.13%). In this regard, an Intellectual Property India Report published in 2017 noted that Telangana and Andhra Pradesh led in terms of filing patents. However, experts reckoned that several of these filings did not lead to patent grants, concluding that they have little or no commercial value (Vadlapatla 2017). Patent filing and grants are often regarded as measures to gauge a region’s scientific advancement and innovative capabilities. Hence, the state may aim to encourage patenting activity through targeted policy measures.

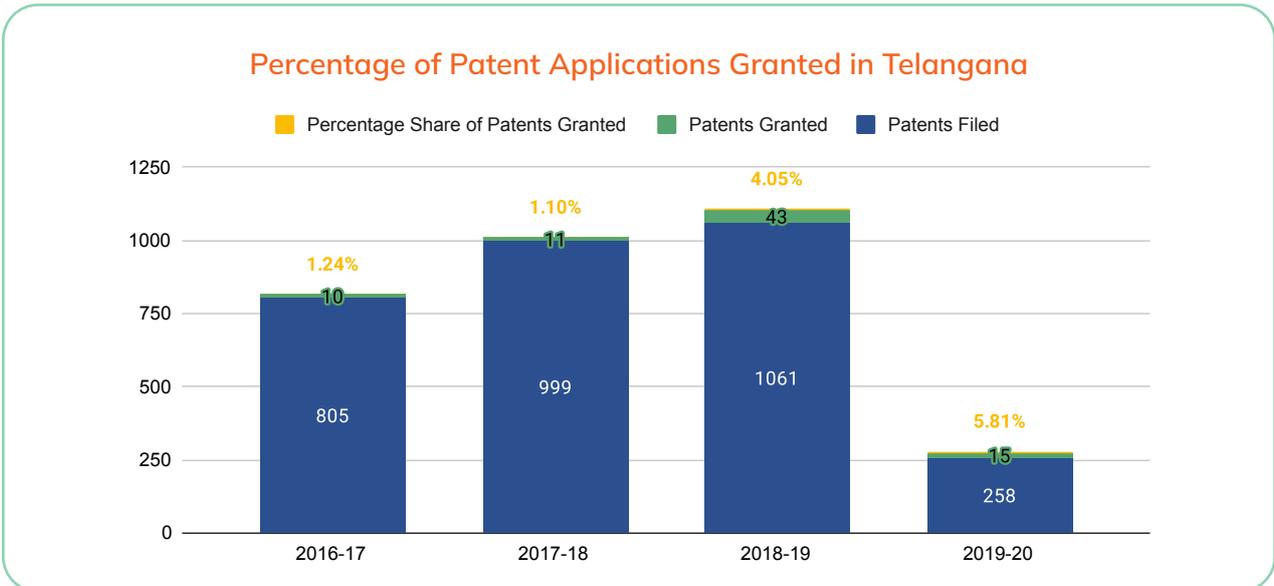


Figure 31: Percentage of Patent Applications Granted in Telangana (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

Telangana was also reported to be deficient in the knowledge diffusion pillar under the India Innovation Index 2021. While the state performed relatively better than other states under consideration of this report, it underperformed in terms of a low number of GI tags, low handlooms sales as a (% of GSDP) and low high and medium high tech manufacturing entities (Niti Aayog 2022). Therefore, the state may aim to craft suitable policy measures to enhance its knowledge creation and diffuse these creations into marketable products and services.

6. R&D Expenditure

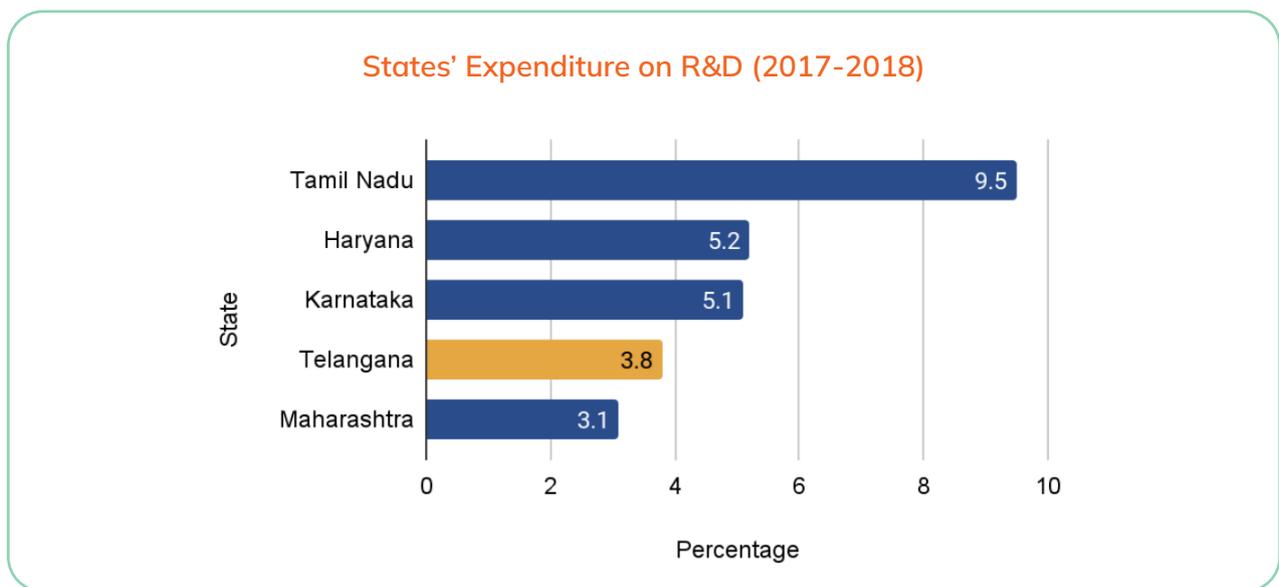


Figure 32: Telangana's R&D Expenditure 2017-2018 ("Research and Development Statistics" 2020)

As per the Research and Development Statistics 2019-20, Telangana's R&D expenditure (3.8%) is far lower than the national average (4.3%). It ranks 12th among other states of India in terms of R&D expenditure.

When compared with the states under consideration of this report, after Maharashtra, Telangana has the lowest R&D expenditure. As per the India Innovation Index 2021, Telangana's innovation landscape is one of the best in India; hence, it may be surmised that the state is making up for its lack of R&D investment through other measures, i.e. fiscal and non-fiscal incentives for key stakeholders. The state may leverage its existing strengths by amping its R&D expenditure to bolster its innovation system.

S&T and Industrial Clusters

PM-STIAC and the Office of the PSA, Government of India selected the city of Hyderabad in Telangana as one of the six S&T clusters to be established in India (“Science & Technology Clusters”, n.d.). Research and Innovation Circle of Hyderabad (RICH) was made the nodal agency for the Hyderabad S&T cluster to act as an intermediary among the government, research institutions, academia, industry, investors, and incubators situated in the state (“RICH”, n.d.). Since the cluster was launched in 2021, most of its initiatives are at a nascent stage. The nature of its impact on the region’s innovation ecosystem cannot be reliably predicted; however, the cluster has access to the following institutions and organisations:

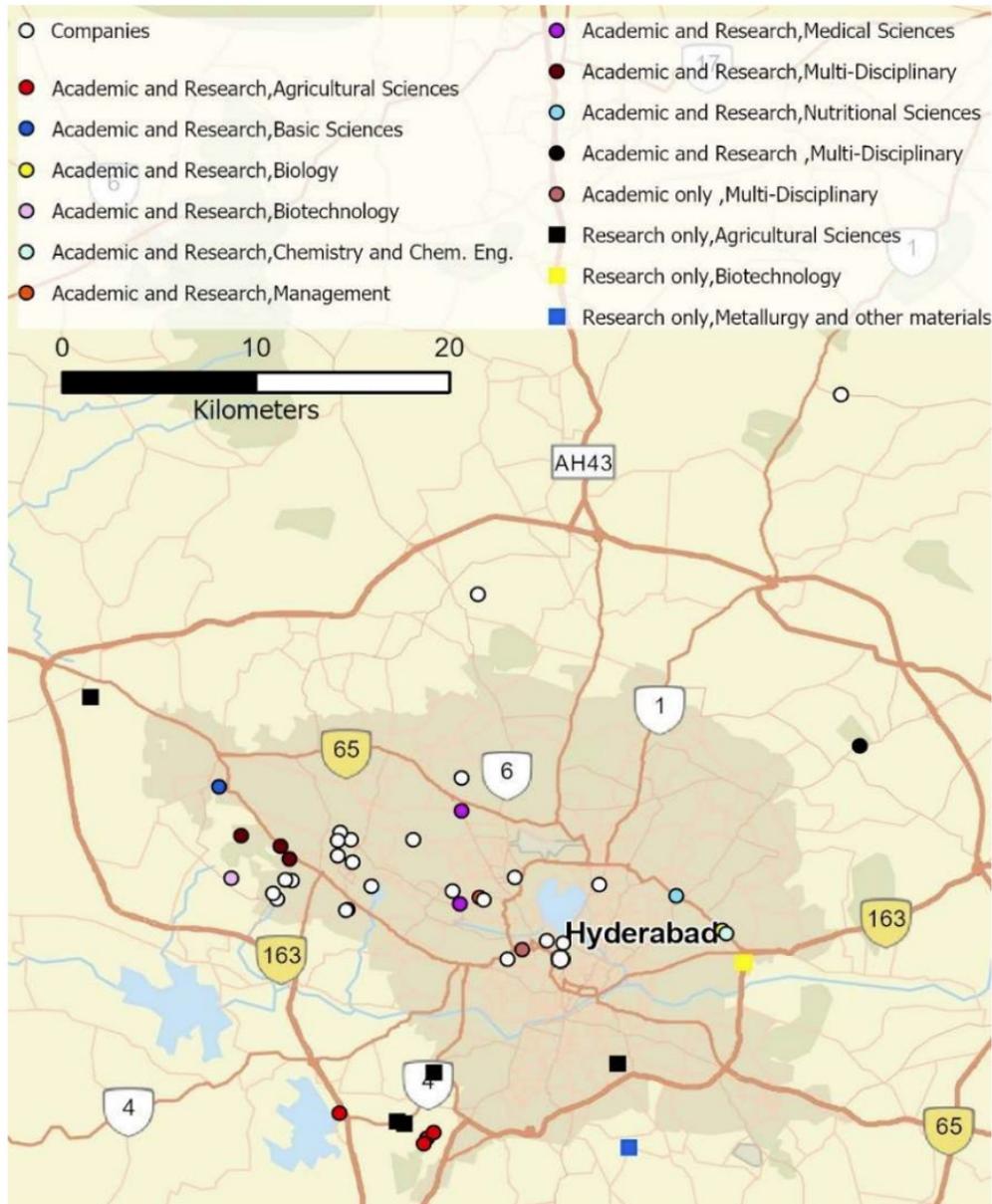


Figure 33: Mapping of Institutions and Organisations in the S&T cluster in Hyderabad (“Report of the high-level committee on developing science & technology clusters in India” 2020).

Role of HEIs vis-a-vis Telangana's Innovation System

University-Industry Linkages

Telangana, Tamil Nadu and Delhi jointly secured the sixth rank in a study on University-Industry Linkages (UILs) conducted by the PHD Chamber of Commerce and Industry. While all three were positioned at the sixth rank on the basis of their average score, their actual scores were: Tamil Nadu - 6.1, Delhi - 6.06 and Telangana - 6.05 on a 10 point scale (PHD Chamber of Commerce and Industry 2019).

As per the study, IT and IT-Enabled Services and pharmaceuticals industries have very strong UILs in Telangana, followed by strong UILs in tourism. Additionally, moderate UILs were reported in the minerals industry and weak UILs in the textiles industry of the state (PHD Chamber of Commerce and Industry 2019).

While Telangana performed well in certain indicators in the study, i.e. 'industry interaction with universities' and 'industry interaction with students', it may improve its performance in the following areas: 'continuity of research activities', 'continuity in interaction', 'frequency of interaction' and 'MoUs/collaborations/agreements with universities'.

The study noted that IT and IT-enabled Services and pharmaceuticals industries in Telangana hold quarterly interactions with the universities, primarily for creating business process solutions. The opportunity to interact with the IT and pharmaceuticals industry may be leveraged by the universities in the state, by encouraging students to benefit from these interactions and tailor their innovations to suit the needs of these industries.

Research Output

As Telangana is regarded as a significant hub of life sciences in India, assessing the research output of institutions specialising in pharmaceuticals and life sciences studies may provide valuable insights for this report.

As seen in table 5, the National Institute of Pharmaceutical Education and Research (NIPER), Hyderabad ranks first in terms of the number of research publications among the NIPERs in India. Its research output in terms of publications may have enabled it to secure the second position in the pharmacy category of the NIRF rankings of 2022.

Despite its rank under NIRF, the patenting activity from NIPER Hyderabad as well as other NIPERs in India is dismally low, with NIPER Mohali being the only exception in this category (see table 5).

Table 5: Research Output of NIPERs in India, 2010-2016

Name of HEI	Research Publications	Patents Granted
NIPER Hyderabad	284	
NIPER Mohali	222	21
NIPER Hajipur	67	
NIPER Guwahati	60	
NIPER Kolkata	54	
NIPER Raebareli	53	
NIPER Ahmedabad	47	

Source: (Kumar 2017)

Apart from NIPER Hyderabad, an assessment of the research output of engineering HEIs in Telangana is also relevant to this report. Among the states under consideration of this report, Telangana's engineering HEIs rank third in terms of their research publications and fourth in terms of patents granted (see figure 25). The following figure depicts the percentage share of publications and patents granted to engineering HEIs in Telangana in comparison to other states in India.

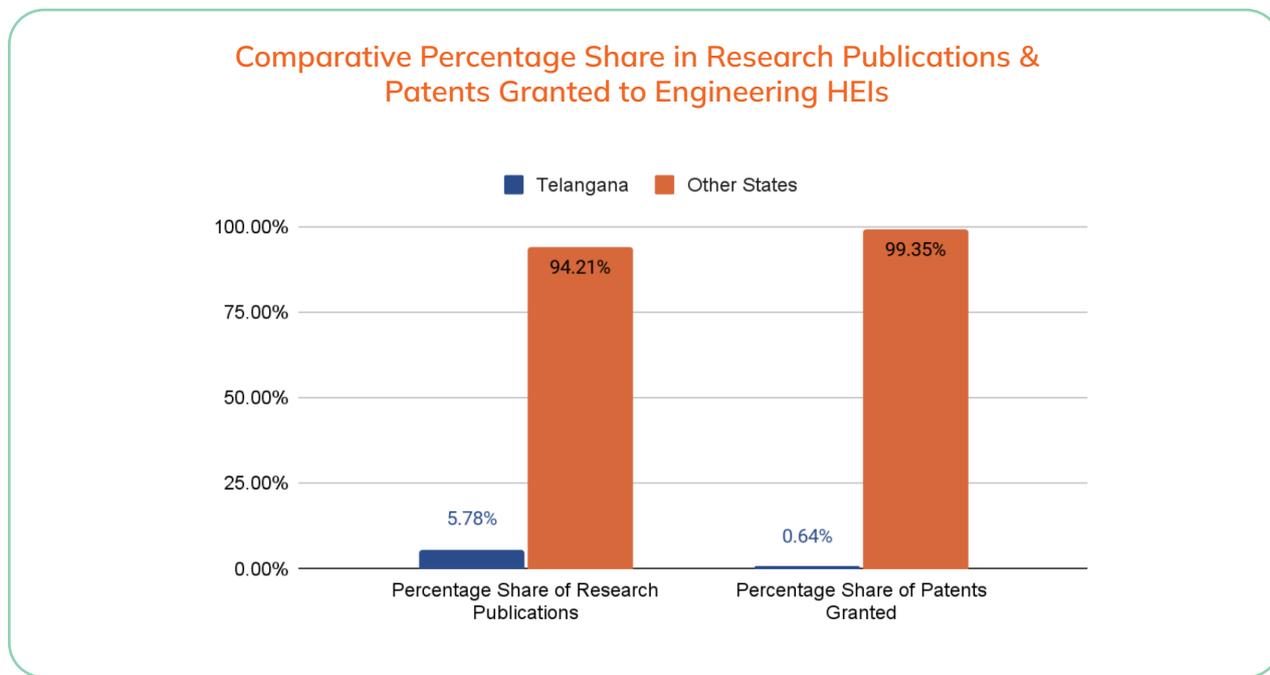


Figure 34: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs (Kumar 2017)

As seen in the figure above, the research output of engineering HEIs in Telangana appears to be dismally low in comparison to other states of India. The state's HEIs account for 5.7 % of the total research publications and a mere 0.6% of the total patents granted to engineering HEIs for the period of 2010-2016.

Only two engineering HEIs situated in the state of Telangana were listed in this publication (Kumar 2017) and the following table presents the number of research publications and patents granted to these HEIs.

Table 6: Research Output of Engineering Institutions in Telangana, 2010-2016

Name of HEI	Research Publications	Patents Granted
IIT Hyderabad	5398	2
Chaitanya Bharathi Institute of Technology	75	0
Total	5473	2

Source: (Kumar 2017)

As seen from the table above, as per the volume of its publications and patents granted, IIT Hyderabad is the top performing HEI in Telangana. At the national level, the institute was ranked seventh in India under the Atal Ranking of Institutions on Innovation Achievements 2021 ("Press Release - IIT Hyderabad" 2021).

In light of the foregoing, it may be surmised that the top institutions in Telangana in terms of research output and institutional rankings are NIPER Hyderabad and IIT Hyderabad. Hence, examining the institutional facilities present in these institutions may present relevant findings to improve the level of innovation in the state.

Institutional Facilities - NIPER Hyderabad

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Institutional Facilities - IIT Hyderabad

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
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- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

The number of DPIIT registered startups in Telangana are far lower than other states such as Maharashtra and Karnataka. While the state offers substantial support to several incubators, the role of private industry in this space may also be encouraged by removing regulatory barriers and providing additional incentives to such entities to boost private investment and increase the number of startups in Telangana.

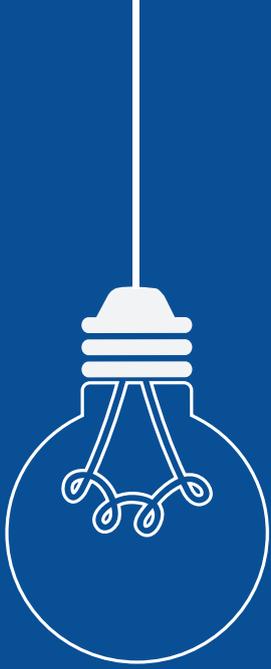
Telangana offers one of the largest state-aided skilling programs in India, which has enabled the creation of a high number of knowledge workers in the state. It may design additional policy measures to incentivise the employment of such workers in the private sector, as the availability of diverse employment opportunities will boost individual choice and enhance the state's entrepreneurial landscape.

Among the states under consideration in this report, Telangana scored the highest under the business environment pillar of the India Innovation Index 2021. However, it underperformed in terms of its FDI inflow and safety and legal environment. The state may undertake targeted measures to ameliorate the same, as they may impede entrepreneurial endeavours in the state.

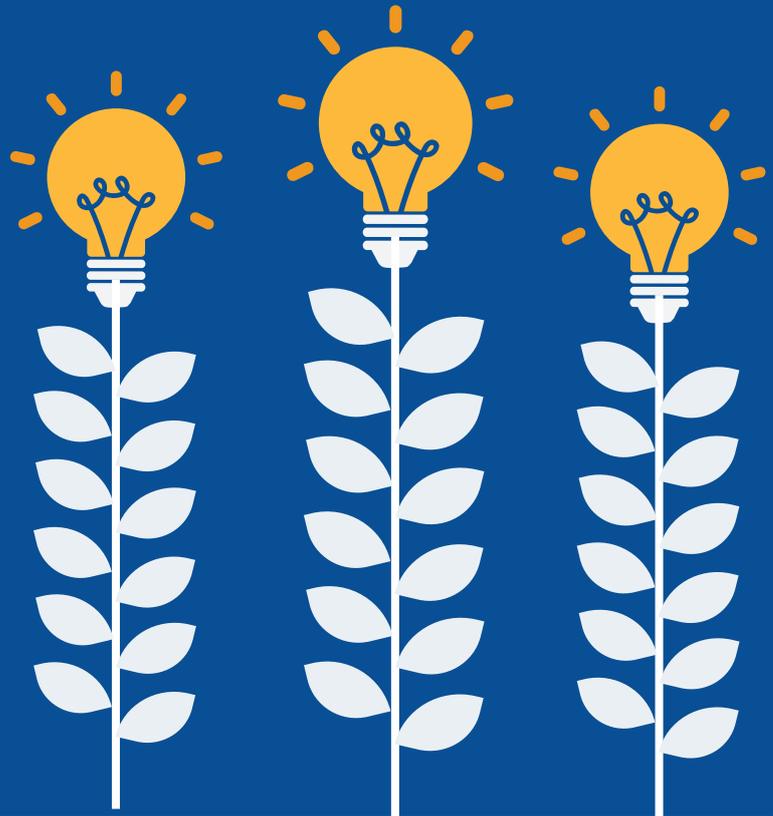
Patenting activity is often regarded as a measure to gauge the innovative capabilities of a region. In this context, Telangana's low contribution to the total number of patents granted in India indicates the lack of commercial viability and utility of inventions that emanate from the state. The state's low R&D expenditure is one of the possible reasons for its underperformance in this area. Hence, the state may aim to increase the same to support the creation and diffusion of knowledge from the state.

The research output of HEIs in Telangana is relatively low compared to the states under consideration in this report. As the life sciences and pharmaceutical industries have a significant presence in the state, HEIs may aim to increase student exposure and interaction with these industries. This may enable students to tailor their applied research and innovations according to the needs of these industries, increasing their chance of receiving early-stage funding and possibly ensuring the marketability of their inventions.

The top HEIs in Telangana in terms of research output and institutional rankings are NIPER Hyderabad and IIT Hyderabad. An assessment of the institutional facilities in both these institutions suggests a paucity in certain respects. While NIPER Hyderabad lacks critical incubation facilities and a dedicated policy to provide administrative support for researchers, IIT Hyderabad lacks a dedicated industry-academia cell or interface unit. This may impede the development of an entrepreneurial and industry-focused innovation climate in these institutes. It may be argued that this is reflected in their low patenting profile. The state may aim to equip these institutes with adequate facilities to support researchers and simultaneously bolster the region's innovation system.



Haryana



Haryana's economy is mainly agrarian in its orientation. This has allowed the state to contribute to the country's agricultural output significantly. It accounts for 60% of the total export of Basmati rice from India (Invest India, n.d.). The state is also a critical automobile and IT hub, as it manufactures 50% of the total cars in India and is the third largest exporter of software in the country (Invest India, n.d.).

In the India Innovation Index 2021, Haryana was ranked third in the major states category. As for the States' Startup Ranking 2021, it was reported to be a non-participating state under these rankings (DPIIT 2022). It did, however, participate in the States' Startup Ranking 2019, where it was ranked as an 'Aspiring Leader', i.e. the bottom third category in these rankings ("Haryana State Report" 2020). This section highlights the merits of its innovation system along with probable areas for improvement.

Haryana's Startup and Innovation Environment

Policy Framework

(a) Key policymaking bodies & nodal agencies

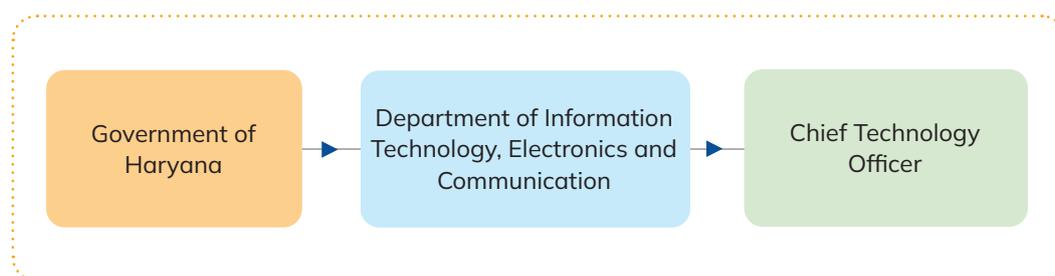


Figure 35: Key Policymaking Bodies in Haryana ("Haryana State Report" 2020)

Under the Government of Haryana, the Department of Information Technology, Electronics and Communication (DITECH) is appointed as the nodal agency for the startup ecosystem in the state, whereas the Chief Technology Officer (DITECH) has been appointed as the nodal officer ("Haryana State Report" 2020).

To illustrate how these entities collaborate to foster entrepreneurship in the state, DITECH and Startup Haryana's MoU with India Accelerator (an Indian institution with Global Accelerator Network) may act as an example. Through this public-private collaboration, India Accelerator will offer an online program to empower young entrepreneurs with knowledge, mentorship, and connections, thereby supporting the growth of the startup ecosystem in Haryana ("Press Release, Government of Haryana" 2020).

(b) Assessment of Haryana's startup policy

The Entrepreneur and Startup Policy 2017 was a key policy launched by the state that aimed to nurture the startup ecosystem in the state. Under this policy, a committee was also constituted to ensure its implementation. An ex post facto assessment of the policy proved to be difficult due to the paucity of data. The same has been presented Table 7.

Table 7: Assessment of Haryana's Startup Policy, 2017

Objectives	Status
Attract INR 1500 Crores investments into the Incubation and Startup Ecosystem in Haryana during the policy period	No data available
Establish at least 22 Technology /Business Incubators / Accelerators in each of the different sectors in every district of Haryana	Technology Business Incubators are situated in two districts: Ambala & Karnal ("Consolidated list of TBIs" 2021). Additionally, a Fisheries Business Incubation Centre has also been established in Gurugram (Press Information Bureau 2021). Aside from these, a host of university-based business incubators are situated in many districts of Haryana.
Develop 1 million sq. ft. of Incubation/ Common Office space	As per DITECH's Annual Progress 2020-21, an Innovation and Start-up Hub in Gurugram is operational (area of 1,20,000 Sft.) providing infrastructure & facilities to the Start-up Ecosystem Stakeholders including NASSCOM 'Centre of Excellence for Internet of Things (CoE-IoT)' (DITECH, Haryana 2022). In 2018, a 3,000 square feet incubation centre was launched in Government College, Panchkula, by the Department of Higher Education in collaboration with Startup Accelerator Chamber Of Commerce (SACC) for the students of four government colleges of the district located in Panchkula, Barwala and Kalka (Bishnoi 2018).
Facilitate Venture Capital funding of a minimum of INR 200 Crore	No data available
Encourage/Facilitate/Incubate at least 500 startups	As on 21st December 2022, DPIIT has recognised 4,613 startups in Haryana ("Startup India" 2022).t

In 2022, the Government of Haryana vide a government order repealed the Entrepreneur and Startup Policy 2017 and promulgated a new policy, i.e. Haryana State Startup Policy 2022. The introduction to this policy mentions that the state government undertook this step to address the feedback it received (that included areas of improvement) regarding the implementation of the previous policy from various stakeholders ("Haryana State Startup Policy" 2022). The policy is built around the following pillars: infrastructure augmentation, fiscal support, regulatory easing and entrepreneurship development. The policy also includes a provision for the establishment of a policy implementation committee. However, the proof of the robustness of the new policy, as well as the regional innovation system of Haryana, can only be evinced through the state's sustained economic growth.

Features of Haryana's Innovation System

1 Human Capital

3 Knowledge Output & Diffusion

5 Key Sectors

2 Emerging Startup Hubs in the State

4 Business Environment

6 R&D Expenditure

1. Human Capital

When compared to its performance under the India Innovation Index's previous editions, Haryana saw an improvement in the human capital pillar in the 2021 edition of the Index. This development may be credited to its improved performance under various indicators such as the number of ICT labs, pupil-teacher ratio, enrollment of PhD students and the number of private R&D units in the state (per lakh population) which all increased since the last edition of the Index (Niti Aayog 2022). Despite this positive development in terms of enrollment PhD students, Haryana still has the lowest gross enrollment ratio in higher education (calculated by dividing the number of students enrolled in higher education out of the total population in the age group of 18- 23 years) amongst states under consideration of this report ("All India Survey on Higher Education 2019-20" 2020). It may undertake policy measures to correct the same, as this could have an impact on the creation of knowledge workers as well as impede the ability of workers seeking gainful employment in the state.

As per the Centre for Monitoring Indian Economy (CMIE), Haryana has the highest unemployment rate in the country. As of December 2022, the unemployment rate in the state was 37.4 (Centre for Monitoring Indian Economy, n.d.). In this context, the state government recently passed a quota law titled 'Haryana State Employment of Local Candidates Act, 2020', which proposed to reserve 75% of jobs in private enterprises for domiciles of Haryana with a monthly gross salary or wage not more than Rs 30,000 ("The Haryana State Employment of Local Candidates Act" 2020). However, this law was challenged in the Punjab and Haryana High Court. After considering the matter, the court reserved its judgement in March 2022 (Upadhyay 2022).

NASSCOM conducted a survey which aimed to study the perceived impact of the new Haryana reservation law on start-ups operating in Haryana. Most of the respondents to the survey perceived the law negatively, as they felt it may impact their revenue, business operations, company's growth and investment plans and may also increase the compliance burden on start-up founders. Many wished to be made exempt from the law or for the law to be repealed altogether. The majority of the respondents also claimed

that they would shift their operations outside of Haryana and increase hiring in states which do not have reservation laws (NASSCOM 2021). The state may pay heed to these concerns emanating from industry players and adopt a course correction. Otherwise, it may risk losing out on employment opportunities offered by startups that might shift their base outside the state.

2. Emerging Startup Hubs in the State

While Delhi NCR is an attractive base for companies and startups alike for setting up their operations, high real estate prices and rental values, as well as shrinking availability of office spaces in the city, act as major deterrents to the growth of startups in the national capital. Another concern is the high level of pollution in New Delhi, which is one of the most polluted cities in the world. Many new startups are exploring the option of setting up their base outside of the city's limits so as to reap the benefits of being in its proximity while evading its drawbacks. In this context, two of Haryana's satellite cities, i.e. Gurugram and Faridabad, have emerged as new startup and corporate hubs (Balachandran 2019). Both are important centres of economic activity as a large number of firms are situated in these cities. It may be plausible to claim that these high-growth cities, which are situated in the vicinity of the country's capital and a major international airport, may have the ability to steer the growth of the state's future industrialisation and development.

3. Knowledge Output & Diffusion

Under the India Innovation Index 2021, Haryana scored above the national average in the knowledge output pillar. Its performance in several indicators under this pillar (number of patents, trademarks and industrial designs) was better in comparison to previous editions of the Index (Niti Aayog 2022). However, Haryana's high score may be compared with other top-performing states to gain an accurate picture of the state's ability to produce knowledge; one method to do so is by conducting an analysis of the number of patents filed and granted to the state. As seen in the following figure, Haryana's contribution to patents filed and granted in India averages around 2.8%, which is far lower than the leading states in India, i.e. Maharashtra (27.07%) and Tamil Nadu (12.27%).

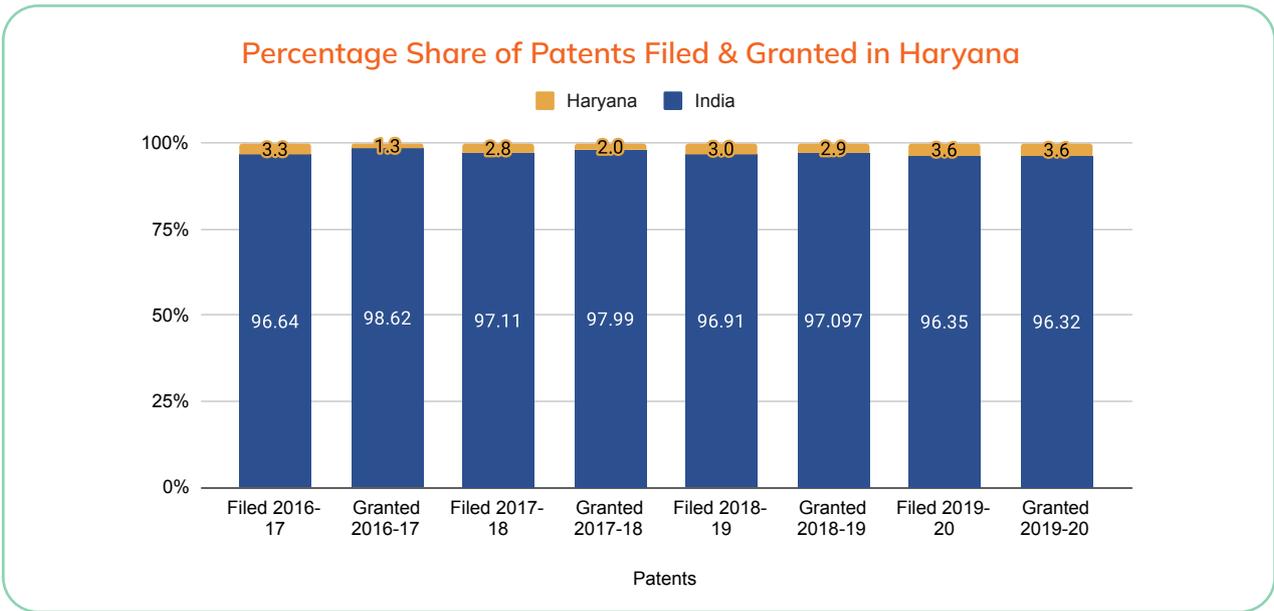


Figure 36: Percentage Share of Patents Filed and Granted in Haryana (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

However, the percentage of patents granted to those filed from 2016–2020 in Haryana averages close to 10.7%, which is the second highest among the states under consideration of this report. As patenting activity is one of the means of sharing knowledge and encouraging scientific advancement, the state may aim to create incentives to support the same.

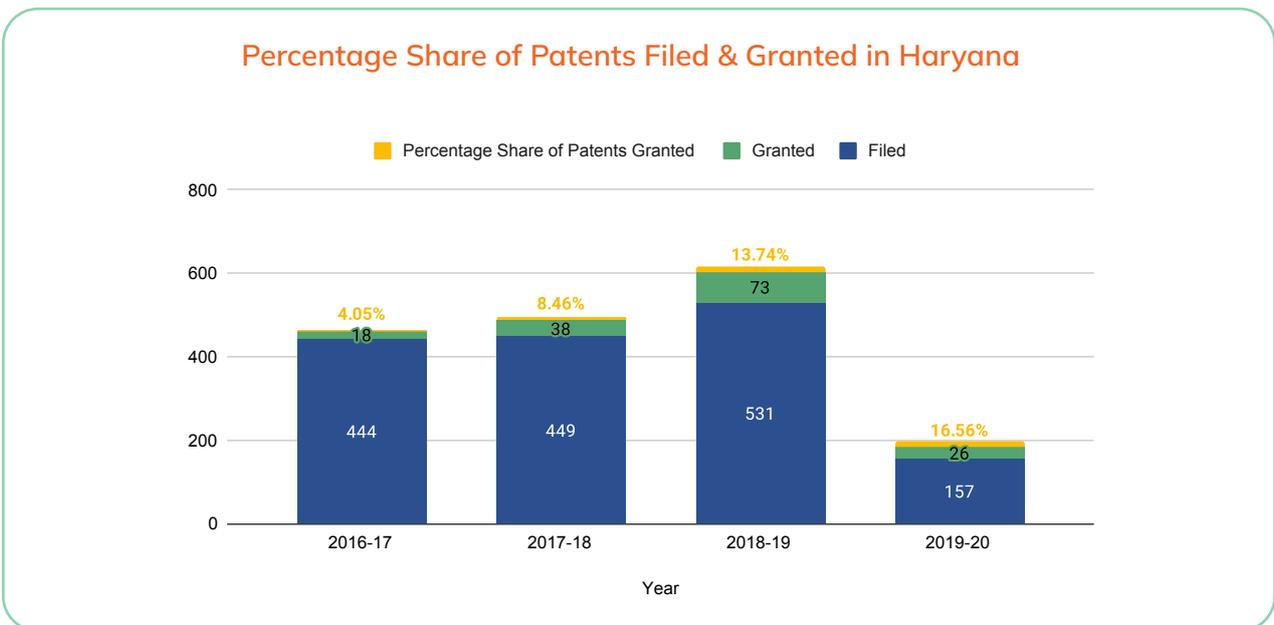


Figure 37: Percentage of Patent Applications Granted in Haryana (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

In spite of Haryana’s relatively high knowledge output, the state underperformed in the knowledge diffusion pillar under the India Innovation Index 2021. Its score in the pillar fell below the national average, as the state reported a low citation score and geographical indications registration rate, pointing towards its inefficiency in sharing the knowledge it produces (Niti Aayog 2022). The state may undertake policy measures that are geared to address the same.

4. Business Environment

Among the states under consideration of this report, Haryana scored the lowest in the business environment pillar under the India Innovation Index 2021. The state underperformed in various indicators under this pillar: ‘ease of doing business score’, ‘common facility centre’, ‘domestic credit to private sector’, ‘bank accounts’, ‘bank accounts with Aadhar seeding’, ‘online services transaction’, ‘services offered online by state government’ and ‘subsidies or benefits transferred through DBT’. Haryana also attracts a low % share of India’s total FDI inflows (4%), in comparison to other states such as Maharashtra (28%) and Karnataka (23%) (DPIIT 2022). The state may aim to craft policies that address the same, as a poor business environment negatively impacts investor outlook, thereby scuttling possible entrepreneurial endeavours.

However, in terms of safety and legal environment, Haryana was the best-performing state in the major states category under the India Innovation Index 2021. The pendency of court cases in Haryana was reported to be the lowest in the country (Niti Aayog 2022). As the effectiveness of the judicial system is one of the factors that impact the ease of doing business in a region (quick

resolution of disputes and enforcement of contracts boost the investor outlook), Haryana’s performance in this area is laud worthy.

5. Key Sectors

Agro and food processing, IT/ITeS and automobile manufacturing are the top sectors in the state of Haryana as they have a sizable impact on the state’s economy. Haryana is a major agro and food processing hub, as the state is responsible for 60% of India’s Basmati export and is the second largest contributor of food grains to India’s central pool (Invest Haryana, n.d.).

50% of all cars and 60% of all two-wheelers in India are manufactured in Haryana, which provides evidence of the state’s prowess in automobile manufacturing (Invest India, n.d.). In terms of the IT/ITeS sector, Haryana is the third largest software exporter in India. It is also home to four Software Technology Parks and over 450 companies, out of which some are global IT companies of the likes of Microsoft, Accenture, Google, IBM, TCS etc. (Invest Haryana, n.d.). Haryana’s Software Technology Park, situated in Gurugram, began operations in 2014, and FY 2020-21, it contributed Rs. 25,228.05 crores to IT/ITeS/ESDM exports (“STPI Gurugram” 2022). The automobile manufacturing edge present in the state, coupled with its promising IT/ITeS industry, demonstrates the potential of its infrastructural capacity to galvanise innovation in the state.

6. R&D Investment

As per the Research and Development Statistics 2019-20, Haryana’s R&D expenditure (5.2%) is higher than the national average (4.3%), yet it still ranks eighth among other states of India in terms of R&D expenditure.

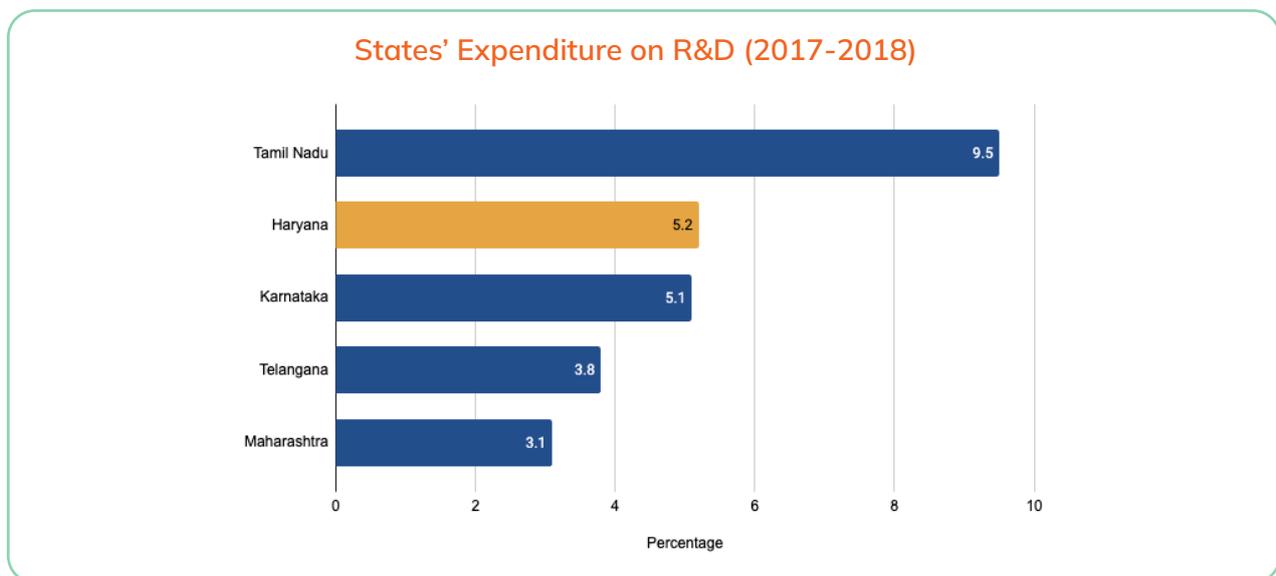


Figure 38: Haryana’s R&D Expenditure 2017-2018 (“Research and Development Statistics” 2020)

As indicated in Figure 38, when compared with the states under consideration of this report, Haryana has the second highest R&D expenditure. Karnataka's R&D expenditure is comparable to that of Haryana, yet the former's innovation ecosystem is ranked as the foremost in the country as per the India Innovation Index 2021, while Haryana has been ranked third under the same.

The top states in terms of R&D expenditure in India are Gujarat (10.9%) and Tamil Nadu (9.5%), hence, Haryana may aim to increase its current R&D expenditure by two-fold to leverage its existing strengths and support the growth of its innovation system.

S&T and Industrial Clusters

Haryana has not been included in the list of regions in India where the establishment of S&T clusters has been proposed by the Government of India. However, a biotechnology science cluster, i.e. NCR Biotech Science Cluster (NCR-BSC), has been established in Faridabad to foster biotech innovation in the region and by sharing resources between different institutions (Department of Biotechnology 2020).

Additionally, the state has close to 56 MSME clusters (Government of Haryana, n.d.). To illustrate the wide range of these clusters, here is a selected list: Decorative Lighting Cluster in Gurugram, Women Knitwear Cluster in Faridabad, Furniture Cluster in Sirsa and Kitchen Appliances Cluster in Ambala.

As per the Economic Survey of Haryana 2021-2022, 2.43 lakh MSME Industrial Units (up to March 2021) provide employment opportunities to 20.89 lakh People in the state (Government of Haryana 2022). The state may support its promising MSME sector by providing incentives to individuals in the state so that they may participate in this sector and undertake entrepreneurial activities.

Role of HEIs vis-a-vis Haryana's Innovation System

University-Industry Linkages

Haryana secured the 12th rank in a study on University-Industry Linkages (UILs) conducted by the PHD Chamber of Commerce and Industry. Haryana scored 5.5 points on a 10 point scale, which is the lowest among states under consideration of this report.

As per the study, among the major industries present in Haryana, the agro and food processing and automotive industries hold very strong UILs, followed by strong UILs in the IT and IT-enabled Services and weak UILs in the textiles and real estate industries (PHD Chamber of Commerce and Industry 2019).

While Haryana performed well in certain indicators in the study i.e. 'continuity of research activities with Universities', 'patents gained in the past 5 years', 'MoUs/Collaboration/Agreement of industries with Universities', 'frequency of interaction with University' and 'availability of University for industries', it may improve its performance in terms of 'interaction of industries with students' and 'frequency of interaction of industries with students' (PHD Chamber of Commerce and Industry 2019).

The study noted that the automotive, textile and IT industries interact with the Universities for research activities and business processes/modelling. Additionally, the automotive industry has provided the maximum number of internship opportunities to students in the state. Universities may leverage such opportunities by encouraging students to tailor their innovations to suit the needs of the industry.

Research Output

In the context of the number of research publications and patents granted from the year 2010 to 2016 in the top 100 NIRF-ranked engineering institutes in India, among the states under consideration of this report, Haryana's HEIs have the lowest number of publications and patents granted (see figure 25).

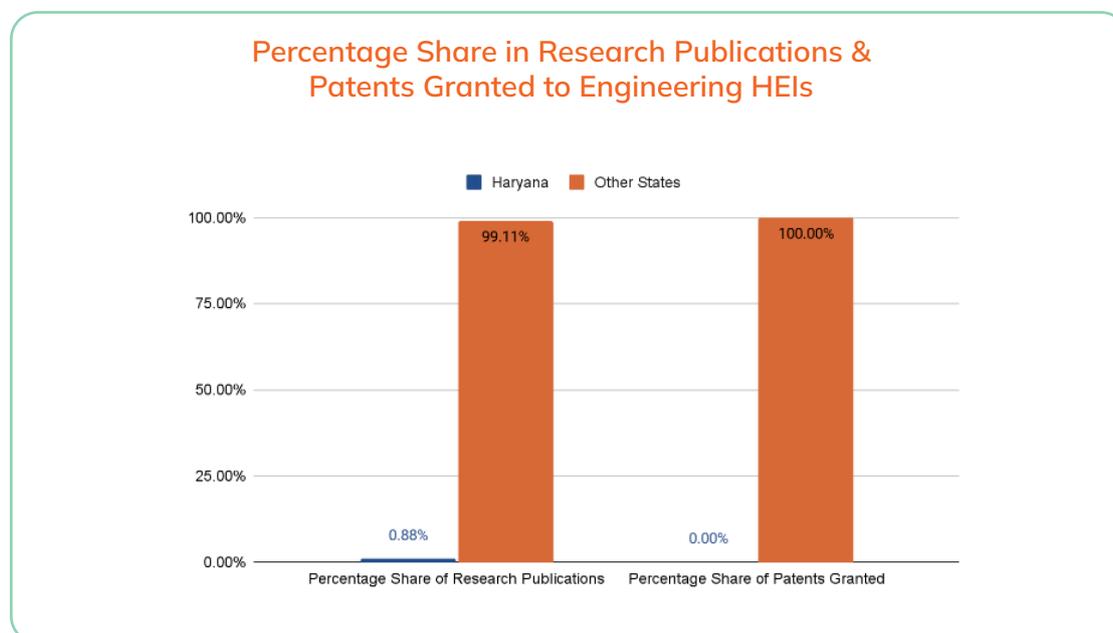


Figure 39: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs in Telangana (Kumar 2017)

As seen in the figure above, the research output of engineering HEIs in Haryana appears to be dismally low in comparison to other states of India. The state's HEIs account for 0.88% of the total research publications and 0% of the total patents granted to engineering HEIs in India.

Only one engineering HEI situated in the state of Haryana was listed in this publication (Kumar 2017). The following table presents the number of their research publications and patents granted to this HEI:

Table 8: Research Output of Engineering Institutions in Haryana, 2010-2016

Name of HEI	Research Publications	Patents Granted
NIT, Kurukshetra	834	0

Source: (Kumar 2017)

As per the volume of its publications and patents granted, NIT Kurukshetra is the top performing HEI in Haryana. At the national level, the HEI was ranked under 'Band Promising' in the Atal Ranking of Institutions on Innovation Achievements 2021 (Ministry of Education, Government of India 2021). An examination of its institutional facilities may present relevant findings to improve the level of innovation in the state.

Institutional Facilities - NIT Kurukshetra

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

Haryana has the lowest gross enrollment ratio percentage in higher education among the states under consideration of this report. As this may impact the creation of knowledge workers in the state, it may undertake policy measures to facilitate the retention of students in its HEIs.

As per data from CMIE, Haryana has the highest unemployment rate in the country. The Haryana State Employment of Local Candidates Act (which proposes 75% reservation of jobs in private enterprises for domiciles of Haryana) was ostensibly passed to address the same; however, it appears to be a controversial legislation. In a NASSCOM survey, most respondents from the industry perceived the law negatively and claimed that they would shift their operations outside of Haryana if the law came into force. If these concerns emanating from industry players remain unheeded, the state may suffer a loss of business, exacerbate its issue of unemployment and hinder its overall economic growth.

Delhi's high real estate prices, shrinking availability of office space and prevailing issue with air pollution are major deterrents to the growth of startups in the city. In this context, Gurugram and Faridabad in Haryana have emerged as alternative corporate and startup hubs. The state may create policies to bolster the growth of these cities by offering incentives and removing regulatory barriers on private entities.

The percentage of patents granted to those filed in Haryana is the second highest among the states under consideration in this report. While Haryana has a relatively high knowledge output, it underperformed in terms of knowledge diffusion, as the state reported a low citation score and geographical indications registration rate, indicative of its inefficiency in sharing the knowledge it produces. Hence, the state may undertake policy measures that are geared to address the same. One method to do so is to increase its current R&D expenditure by twofold to support the growth of its innovation system.

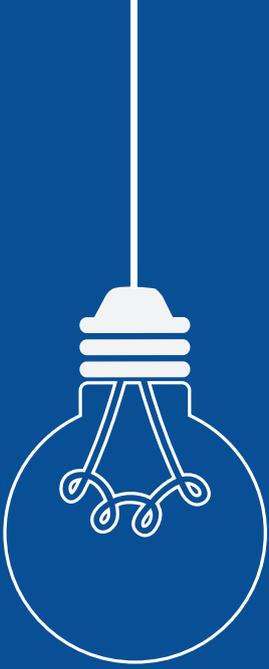
Among the states under consideration of this report, Haryana scored the lowest in the business environment pillar under the India Innovation Index 2021. The state also attracted a relatively lower % of FDI inflow. The state may aim to craft policies that address the same, as a poor business environment negatively impacts investor outlook, thereby scuttling potential entrepreneurial endeavours.

The state has a strong presence of MSME clusters, which provide substantial employment opportunities to individuals. Hence, the state may support the growth of its MSMEs by reducing regulations on such entities, providing access to credit and offering support workshops, skilling programs and initiatives that foster entrepreneurship and encourage individuals to set up businesses in the state.

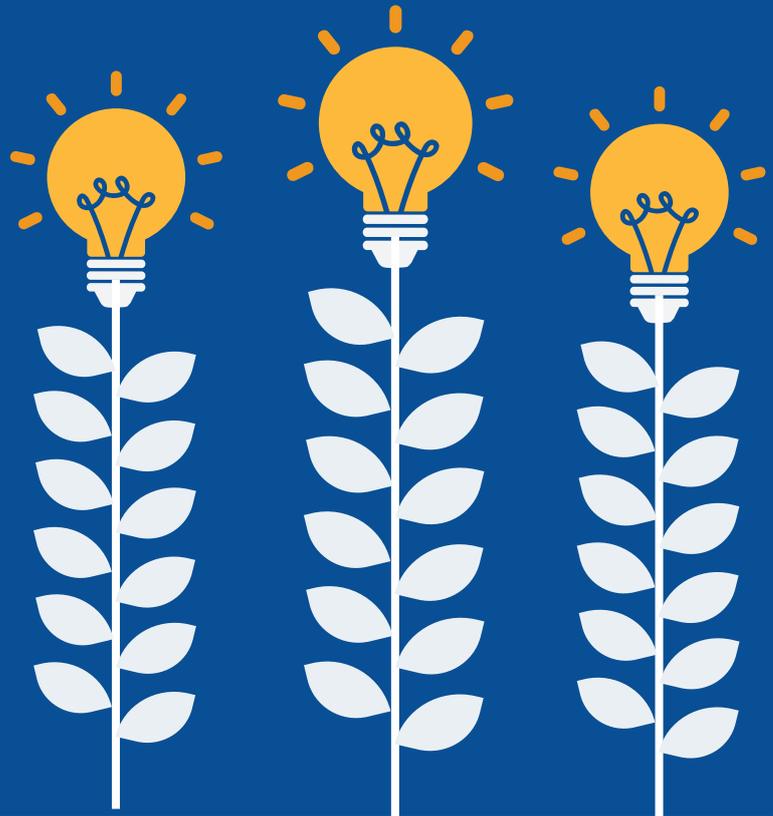
The research output of engineering HEIs in Haryana appears to be dismally low compared to other states of India. In terms of research output and institutional rankings, NIT Kurukshetra is the top engineering HEI in the state. An assessment of the institutional facilities available at NIT Kurukshetra suggests clear deficiencies in the same. While acknowledging that sound infrastructure and facilities in an institute are not the sole method to improve its research output, it cannot be denied that such facilities do support HEI-based research and innovation. Hence, the state may aim to equip NIT Kurukshetra, as well as other HEIs across the state, with adequate facilities to raise their research profile.

In comparison to other states under consideration of this report, HEIs in Haryana were reported to have relatively lower university-industry linkages. The state may undertake targeted measures such as reducing regulations and providing tax incentives to industry players. Reducing regulations may help streamline the process of technology transfer between universities and industry, making it easier for new ideas and innovations to reach the market (for, e.g. simplifying the process for universities to licence their technologies to companies). Additionally, attractive tax incentives encourage companies to invest in university research in an attempt to bring down their costs. Hence, by reducing barriers and incentivising collaboration, universities and industries can strengthen their linkages and work effectively to bring new products and services to market.

In Haryana, the top sectors with a sizable impact on the state's economy are agro and food processing, IT/ITeS and automobile manufacturing. Even in terms of University-Industry linkages, these sectors have the most interaction and knowledge sharing with academic institutions. Hence, HEIs in Haryana may aim to increase student exposure and interaction with these industry players from these sectors through dedicated cells, incubators, industry-sponsored competitions, events, courses and mentorship opportunities. This may allow students to understand the requirements and demands of these industries and tailor their innovations accordingly.



Maharashtra



Maharashtra has the highest Gross State Domestic Product (GSDP) in India (Reserve Bank of India 2021). Its capital city Mumbai is regarded as the financial and entertainment capital of India as the Bombay Stock Exchange and the Hindi film industry are situated in the city. Agriculture and crude oil have a significant role to play in bolstering the state's economy, as Maharashtra is the largest producer of offshore crude oil as well as the second largest producer of cotton in India (Invest India, n.d.).

Apart from its economic prowess, the state also boasts of a robust entrepreneurial climate. The state has the largest number of startups registered with DPIIT in India ("Startup India" 2022). In the India Innovation Index 2021, it was ranked fourth in the major states category. Under the States' Startup Ranking 2021, it was ranked as a top performer in terms of its startup ecosystem. In light of this, it may be surmised that Maharashtra houses a promising innovation and startup ecosystem, which is examined in this section.

Maharashtra's Startup and Innovation Environment

Policy Framework

(a) Key policymaking bodies & nodal agencies



Figure 40: Key Policymaking Bodies in Maharashtra ("Maharashtra State Report" 2022).

In Maharashtra, three authorised entities create and implement startup and innovation policies. The apex policy-making body is the elected state government. Under the state government, the Department of Skills, Employment, Entrepreneurship and Innovation has been selected as the nodal department for the state's startup ecosystem. The nodal agency that supports Maharashtra's startup ecosystem is the Maharashtra State Innovation Society (MSInS) (MSInS 2018). It was established under the Department of Skills, Employment, Entrepreneurship, and Innovation and aims to foster innovative approaches and create a conducive environment for innovative businesses to operate in Maharashtra ("Maharashtra State Report" 2022).

(b) Assessment of Maharashtra's startup policy

The Maharashtra State Innovative Startup Policy was launched in 2018. Over a period of five years, i.e. 2018 to 2023, the policy aimed to achieve the following:

- attract angel and seed stage investment of INR 5,000 Cr
- develop at least 15 incubators in collaboration with industry and academia
- facilitate incorporation of at least 10,000 start-ups
- create 500,000 direct and indirect employment opportunities (MSInS 2018).

At this stage, assessing each objective under the policy would be premature, as the period of the policy is still subsisting. However, one may observe the number of startups, incubators and employment generated in this sector to arrive at an understanding of the current status of entrepreneurship in Maharashtra.

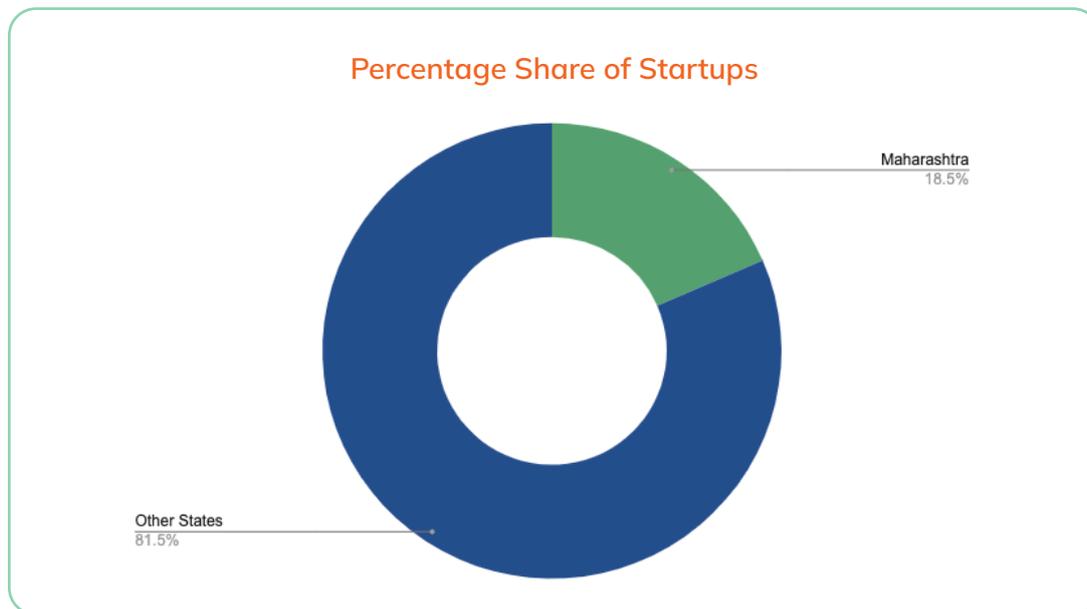


Figure 41: Percentage Share of Startups in Maharashtra, as on 21st December 2022 (“Startup India” 2022)

Maharashtra has the largest number of startups in India that are registered with DPIIT (i.e. 15,950) which accounts for close to 18% of the total startups in India (“Startup India” 2022). As for the number of incubators, Maharashtra has registered close to 90 incubation facilities with DPIIT, the third highest number in India after Tamil Nadu (97) and Karnataka (98) (“Startup India – Incubators”, n.d.).

In terms of employment generated by startups in different states of India, Maharashtra has the highest number of employees in this sector (i.e. 1,46,132 individuals) (“Minister of State, Ministry of Commerce & Industry, Written Reply in Lok Sabha” 2022). While the state’s entrepreneurial climate seems to be one of the leading ones in the country, when seen in the light of its startup policy objectives, the state has a long path to traverse if it wishes to meet the targets it has set.

(c) Other relevant policy measures

The state government of Maharashtra has introduced certain noteworthy policies and measures to bolster its innovation system. For example, it launched a FinTech

Policy in 2018, which aimed to promote the FinTech ecosystem in the state. It also established a FinTech Hub in Mumbai with a mandate to nurture the Fintech startup ecosystem (“Mumbai FinTech”, n.d.). One of the primary targets under the policy was to incubate at least 300 startups in the next three years. However, the progress made towards this goal is not very encouraging. As per the data available on the FinTech Meetup website, only 12 startups are listed as part of the Mumbai FinTech Accelerator portfolio (“Portfolio – Fintech”, n.d.).

Another noteworthy policy measure undertaken by the MSInS in January 2021 was establishing a ‘Women Entrepreneurship Cell’ to increase women’s representation in entrepreneurship (“MSInS”, n.d.). MSInS also established a dedicated incubator for women in the state in partnership with SNDT Women’s University, Mumbai. While the absolute number of women-led startups in Maharashtra is the highest in the country, the percentage share of women-led startups is 48.8% of the total startups in the state (see figure 15).

Features of Maharashtra's Innovation System

- 1** Human Capital
- 3** Knowledge Output & Diffusion
- 5** Business Environment
- 2** Emerging Startup Hubs in the State
- 4** Economic Strength
- 6** R&D Expenditure

1. Human Capital

Evidence regarding the presence of human capital in Maharashtra can be seen through its performance in the human capital pillar under the India Innovation Index 2021. Its performance in certain indicators under this pillar was reported to have improved considerably in comparison to previous editions of the Index; for instance, the percentage of schools with ICT labs rose by 27 percentage points while in higher education, enrollment in PhD programs increased from about 7 (per lakh of the population) to about 10 (Niti Aayog 2022).

The presence of multiple institutions of note, like the Indian Institute of Technology Bombay, the Indian Institute of Information Technology, Nagpur, the Indian Institute of Science Education and Research, Pune etc., suggest its emergence as a major hub of education and research. Additionally, around 68% of Maharashtra's population is employable, enabling the state to boast of the highest employable talent in India (Invest India, n.d.). However, data from AISHE 2019-2020 indicates a relatively low gross enrollment ratio in higher education in the state. Additionally, its pupil-teacher ratio in higher education is higher than all states under consideration of this report ("All India Survey on Higher Education 2019-20" 2020).

While Maharashtra did see an improvement in its performance in terms of human capital when compared with the India Innovation Index's previous editions, the state only scantily improved its performance in other pillars of the Index. In light of this, it can be argued that growth in the state (especially in terms of indicators related to innovation) is not holistic. Thus, the state may devise policy measures to grow in indicators apart from human capital to enhance its innovation ecosystem.

2. Emerging Startup Hubs in the State

The following are the emerging hubs of Maharashtra's startup ecosystem, as seen through the number of startups currently operating in these regions:

Pune	812+
Nagpur	185+
Nashik	95+
Aurangabad	41+
Kolhapur	18+

Figure 42: Emerging Startup Hubs in Maharashtra (Inc42 2022)

3. Knowledge Output & Diffusion

In the India Innovation Index 2021, the economically prosperous states of Maharashtra, Telangana, and Tamil Nadu had a comparatively higher score under the knowledge output pillar than other states in the country (Niti Aayog 2022). In terms of knowledge diffusion, Maharashtra scored above the national average of 5.81 but still ranked lower than Karnataka and Telangana. The measure of the robustness of a region's innovation system can be found in its ability to produce and diffuse knowledge skillfully. In an attempt to ascertain Maharashtra's ability to do so, the number of patents filed and granted in the state has been compared with others. As presented in the following figure, Maharashtra is the top performer in terms of knowledge output, as its contribution to patents filed and granted in India averages around 27% (more than a quarter of all patents filed and granted), which is the highest among all states in India.

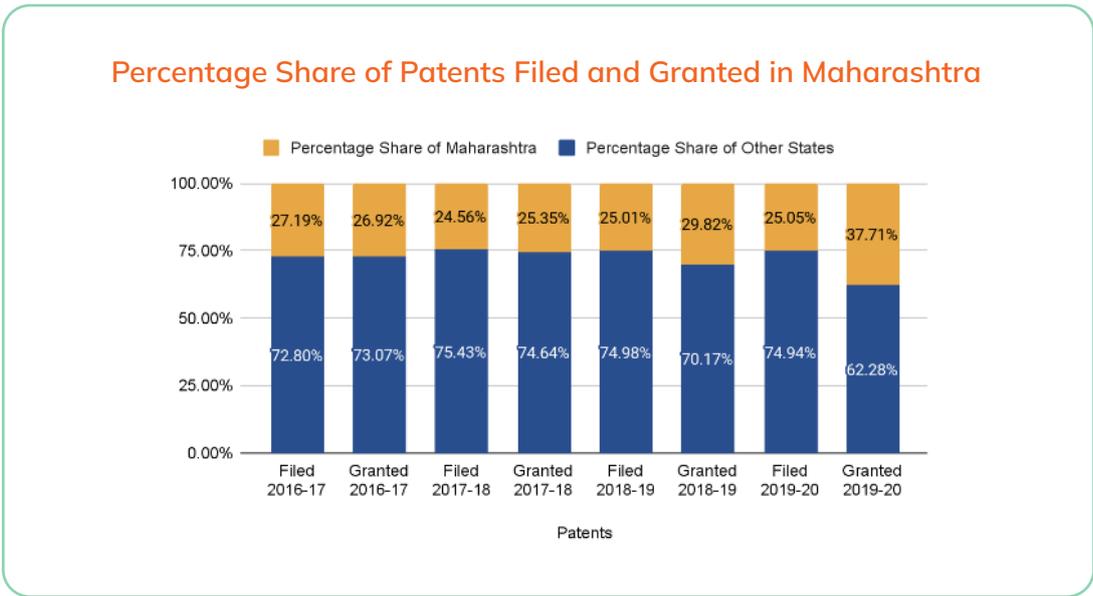


Figure 43: Percentage Share of Patents Filed and Granted in Maharashtra (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

Additionally, patent filings and grants in Maharashtra depict a primarily upward trajectory as seen in this figure:

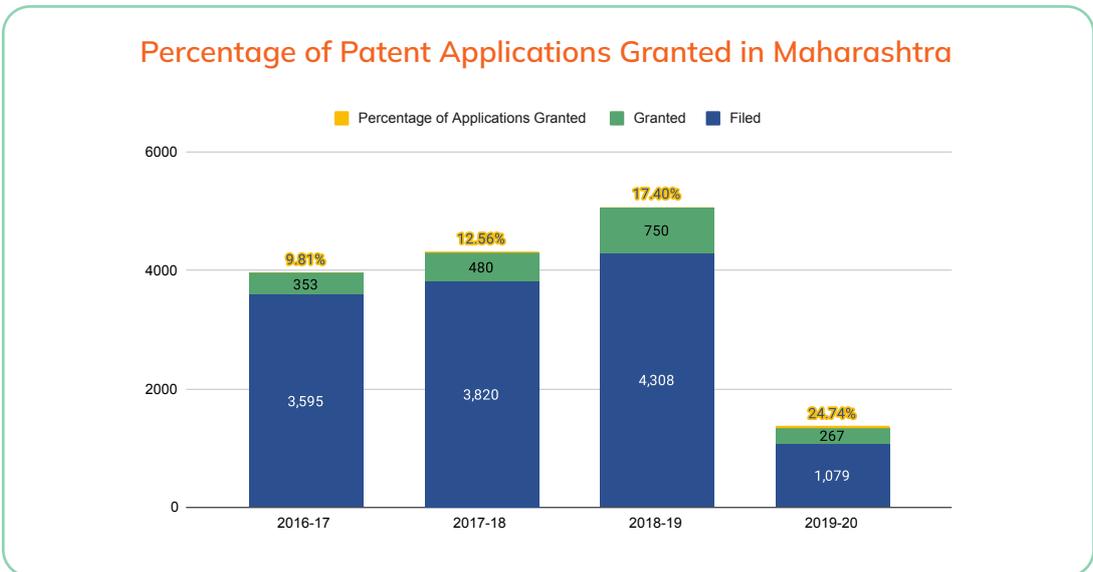


Figure 44: Percentage of Patent Applications Granted in Maharashtra (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

The percentage share of patents granted in Maharashtra averages around 16%, which is the highest among states under consideration of this report. The knowledge output of the state is indeed significant, but its performance in terms of diffusion of knowledge may be improved. The state may aim to increase knowledge diffusion

of its innovations within India through intra-state, inter-state and cross-sectoral trade and interactions.

4. Economic Strength

As per recent estimates, Maharashtra has the largest state economy in India. The average share

of the state in All-India nominal GDP is the highest (14.2 per cent) among all states (Government of Maharashtra 2022). The presence of the Bombay Stock Exchange, as well as several renowned multinational companies and global banks, has enabled Mumbai to be the country’s financial capital.

In terms of the top industries in the state, the IT/ITeS, oil & gas, pharmaceutical, and automobile industries have a sizable impact on the state’s economy. Several IT/ITeS clusters are present across Maharashtra. Software Technology Parks of India (STPI) has promoted IT exports from Maharashtra. The first such park in Maharashtra was built in 1990, i.e. STPI-Pune. Apart from Pune, STPI centres were subsequently made operational at Aurangabad, Kolhapur, Navi Mumbai, Nagpur, Nasik, and Mumbai. In FY 2020-21, STPI-Pune helped contribute to Rs. 96,861.85 of IT/ITeS/ESDM exports (“STPI Pune”, n.d.). In Bombay High (an offshore oilfield located in the Arabian Sea) the largest production of offshore crude oil takes place in India (Invest India, n.d.). Additionally, the pharmaceutical sector in Maharashtra is also robust. The state houses one of the biggest bio-pharma parks at the Serum Institute of Pune, which enabled the manufacture of the Covid-19 vaccines in India. Lastly, the state is also an emerging hub for the automobile sector in India. Pune is home to big players in

this sector, such as Bajaj Auto Ltd., Daimler Chrysler Ltd. and Tata Motors. Maharashtra’s auto sector contributes 25% to India’s total automobile exports (Invest India, n.d.). The clustering of growth-driven industries with robust infrastructure within the state generates the potential for innovation in Maharashtra.

5. Business Environment

As per the India Innovation Index 2021, the state of Maharashtra presents a promising picture with regard to its business environment. It performed well in the following indicators under the business environment pillar: ‘cluster strength’, ‘microfinance institutions (MUDRA)’, ‘bank accounts with Aadhar seeding’ and ‘villages in the state with internet connectivity’ (Niti Aayog 2022).

In terms of the availability of capital, Maharashtra attracts a high amount of FDI inflow. During FY 2021-22, Karnataka’s share of the total FDI equity inflow was 38%, followed by Maharashtra’s share of 26% (Niti Aayog 2022). According to the DPIIT, from October 2019 to June 2022, the FDI inflow in Maharashtra accounted for 28% of the total FDI inflow in India (DPIIT 2022). Further evidence is presented in the following figure, which depicts the strong access to capital in the city of Mumbai:

Funding Overview: Mumbai

\$17 Bn Raised Across 1.6k Deals Between 2014 & H1 2022

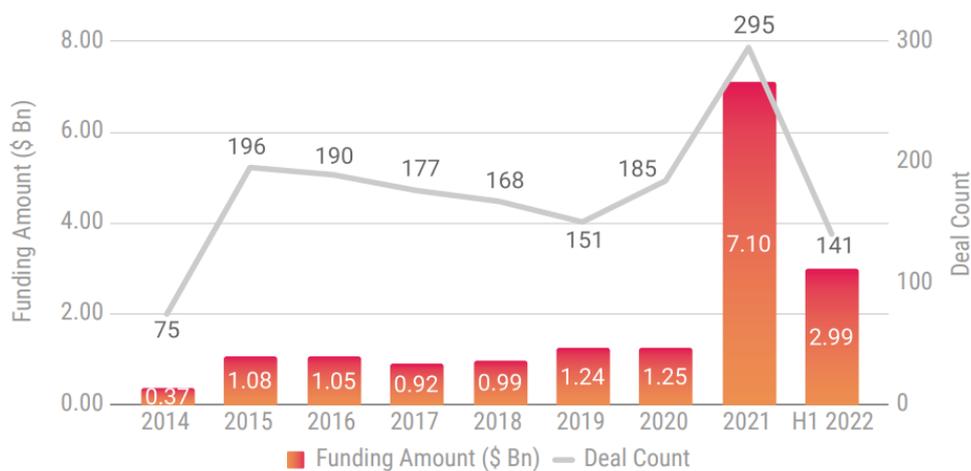


Figure 45: Access to Funds for Startups in Maharashtra 2014-2022 (Inc42 2022)

Despite these strengths, Maharashtra underperformed in the pillar of safety and legal environment in the India Innovation Index 2021. It performed particularly poorly in the indicator pertaining to the number of police personnel (per lakh of the population), as the number of such personnel in the state is below the national average (Niti Aayog 2022). Additionally, certain infrastructural issues also plague some parts of the state. As Mumbai is the financial capital of India and provides a multitude of business opportunities, it attracts several migrants from around the country who are in search of job opportunities. The growing urban population in the city poses several challenges in the form of the availability of resources, public transportation and urban infrastructure. Furthermore, real estate prices in Mumbai are relatively high in comparison to other cities in India. As a result, some startups that began their operations in Mumbai later shifted to other regions to sustain and protect their business (KPMG 2019). The state may aim to address the same, as it may influence investor perception and negatively impact the state's overall growth.

6. R&D Expenditure

As per the Research and Development Statistics 2019-20, Maharashtra's R&D expenditure (3.1%) is lower than the national average (4.3%) and ranks 15th among other states of India. Additionally, as indicated in the figure below, when compared with the states under consideration of this report, Maharashtra has the lowest R&D expenditure:

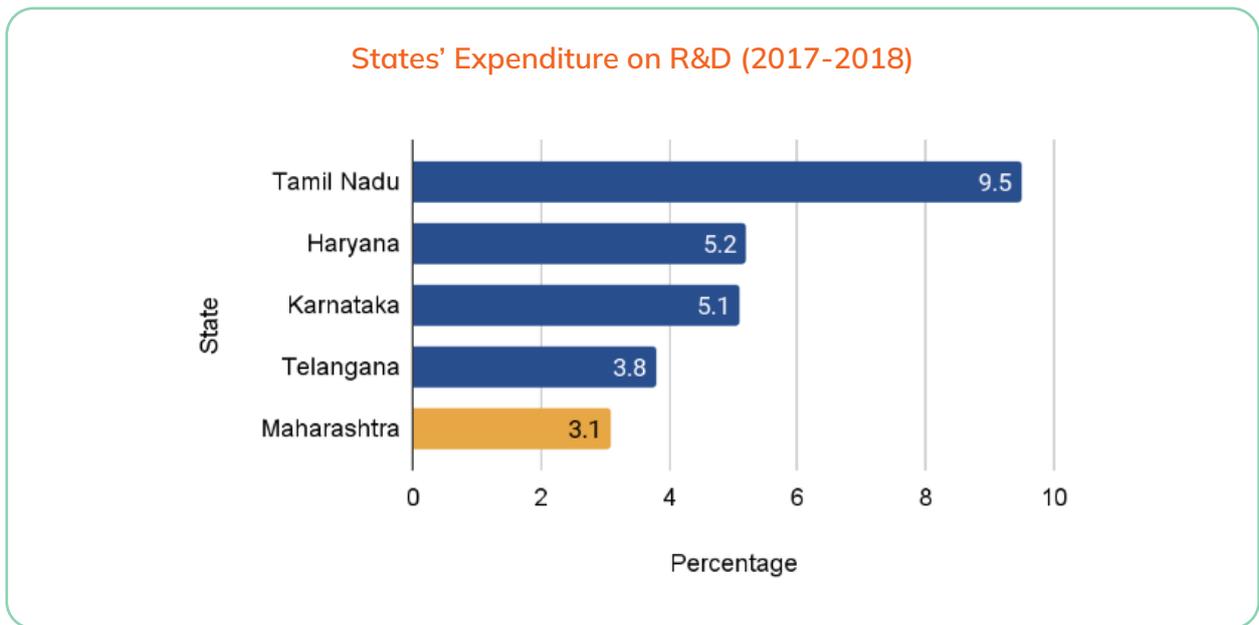


Figure 46: Maharashtra's R&D Expenditure 2017-18 ("Research and Development Statistics" 2020)

While the state's innovation landscape has been recognised as one of the top five in the country by the India Innovation Index 2021, its low R&D expenditure indicates that fostering research is not a priority for the state. As seen in one of the indicators of the investment pillar under the Index, Maharashtra performed relatively poorly in terms of expenditure on higher and technical education (Niti Aayog 2022). It may be argued that the current innovation system may be relying on other strengths present in the state, i.e. access to fiscal and human capital. The state may aim to complement these existing strengths by increasing its R&D and higher education expenditure to further encourage innovation in the region.

S&T and Industrial Clusters

The city of Pune in Maharashtra was selected by the PM-STIAC and the Office of the PSA, Government of India as one of the six S&T clusters to be established in India (“Science & Technology Clusters”, n.d.). The Pune S&T Cluster is hosted by the Inter-University for Astronomy and Astrophysics (IUCAA), an autonomous body set up by the University Grants Commission (UGC) and its focus areas are as follows: Big Data & AI, Health, Capacity Building, Sustainability & Environment, Sustainable Mobility (Principal Scientific Adviser 2022).

While the initiatives of this cluster are at a nascent stage, one of its initial ventures seemed promising. The Pune cluster carried out a city-focused COVID-19 serosurvey to identify the prevalence of the disease in different areas of the city. The cluster collected, analysed and provided trends and projections regarding the disease to the Pune Municipal Corporation (Principal Scientific Adviser 2022). At this stage, the level of impact this cluster will have on the future advancement of the region cannot be ascertained; however, it does have access to the following institutions and organisations for bringing the same to fruition:

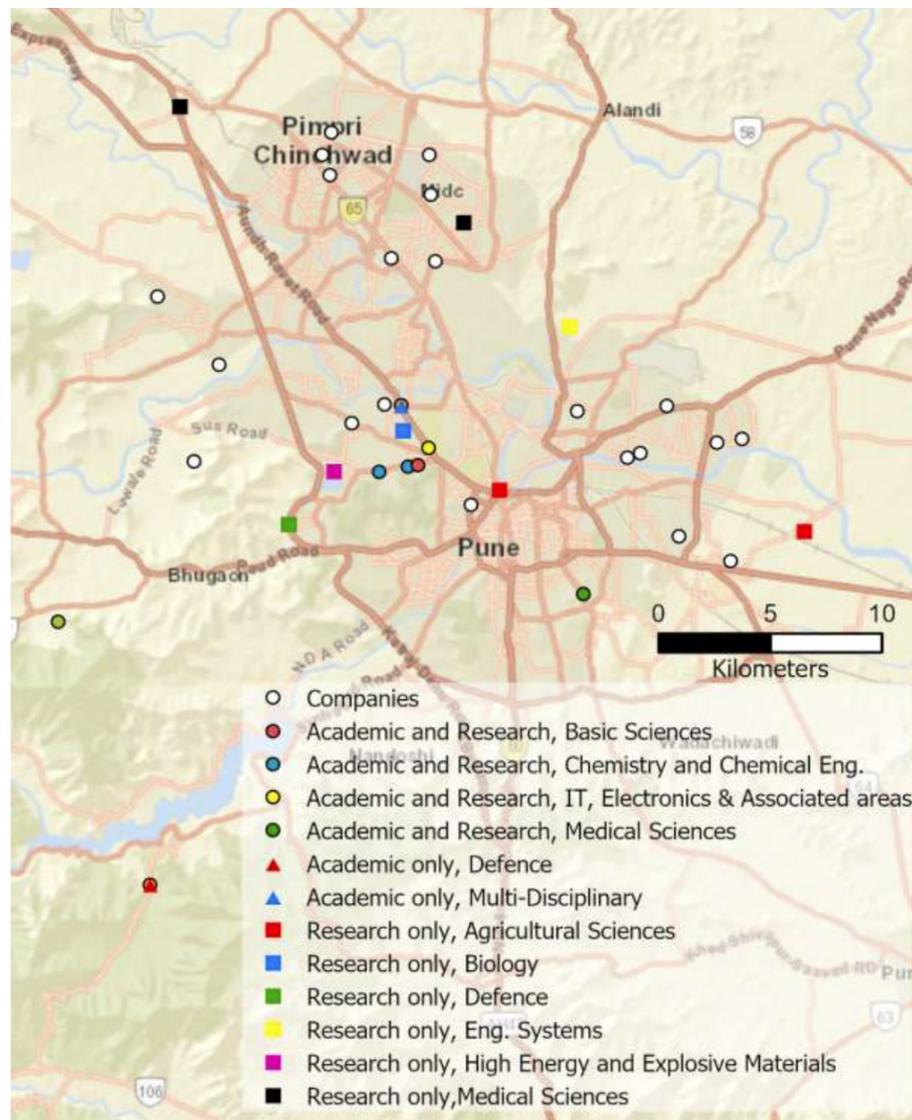


Figure 47: Mapping of Institutions and Organisations in the S&T cluster in Pune (“Report of the high-level committee on developing science & technology clusters in India” 2020).

Maharashtra has a sizable presence of industrial clusters related to the chemical, textile, food processing, automobile and IT & ITeS sectors (Invest India, n.d.).

In terms of Special Economic Zones (SEZs), the total number of notified SEZs in Maharashtra is 44, whereas the total number of operational SEZs is 37 (“Special Economic Zones in India” 2022). As mentioned in one of the previous subsections, a study conducted on SEZs in Karnataka spanning from 2006–07 to 2016–17 argued that positive growth in employment generation was seen with an increase in SEZs. As SEZs are a means of providing gainful employment opportunities, Maharashtra may aim to operationalise all of its notified SEZs.

Role of HEIs vis-a-vis Maharashtra’s Innovation System

University-Industry Linkages

Maharashtra secured the fourth rank in a study on University-Industry Linkages (UILs) conducted by the PHD Chamber of Commerce and Industry. The state scored 6.4 on a 10 point scale, indicating the presence of strong UILs in the state (PHD Chamber of Commerce and Industry 2019).

As per the study, both the pharmaceutical and textile industries were reported to have very strong UILs in Maharashtra. Additionally, oil and gas, automotive and finance industries were also reported to have significant UILs (PHD Chamber of Commerce and Industry 2019).

Maharashtra performed well under some indicators, such as the ‘availability of universities for industry’, ‘industry interaction with universities’ and ‘industry interaction with students’. However, it may improve its performance in the following areas: ‘patents gained in the last 5 years’ and ‘continuity of research activities’.

The study also noted that Maharashtra’s pharmaceutical, oil and gas, textile, automotive, and finance industries have access to universities for conducting R&D activities. These linkages may be further encouraged by creating research centres and centres of excellence that research the focus areas of these industries. This may facilitate increased industry-student interaction, providing the latter with exposure to the needs of the market, thereby encouraging entrepreneurial and patenting activity.

Research Output

The research output of the top 100 NIRF engineering HEIs in Maharashtra, both in terms of publications as well as patents granted, appear to be relatively high in comparison to other states of India (see figure 25).

As seen in the following figure, Maharashtra’s engineering HEIs account for 8.71% of the total research publications and 34.62% of the total patents (highest in India) granted to engineering HEIs for the period of 2010–2016.

Percentage Share in Research Publications & Patents Granted to Engineering HEIs

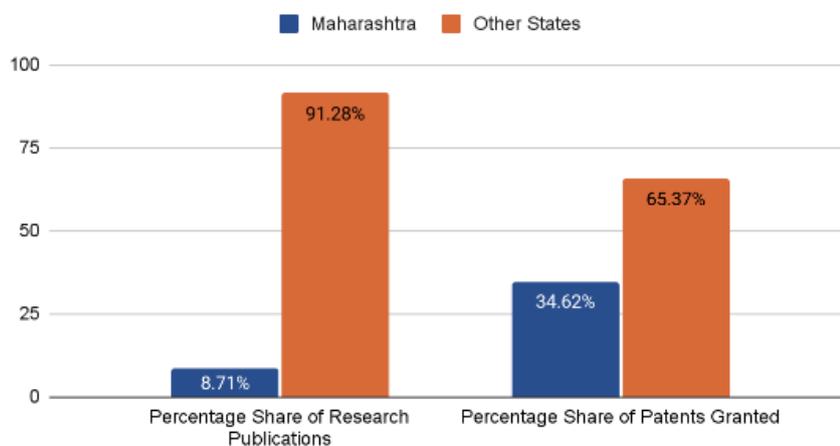


Figure 48: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs in Maharashtra (Kumar 2017)

The following table presents HEIs situated in the state of Maharashtra that were listed in this publication (Kumar 2017) along with the number of their research publications and patents granted.

Table 9: Research Output of Engineering Institutions in Maharashtra, 2010-2016

Name of HEI	Research Publications	Patents Granted
IIT Bombay	6300	100
Visvesvaraya National Institute of Technology, Nagpur	685	1
College of Engineering, Pune	671	
Vishwakarma Institute of Technology, Pune	134	
University Institute of Chemical Technology, North Maharashtra University, Jalgaon	94	4
Government College of Engineering, Aurangabad	72	
Veer mata Jijabai Technological Institute, Mumbai	62	
Bharati Vidyapeeth, Pune	60	

Name of HEI	Research Publications	Patents Granted
Yeshwantrao Chavan College of Engineering, Nagpur	41	
Shri Guru Gobind Singhji Institute of Engineering & Technology, Nanded	38	
Shri Ramdeobaba College of Engineering & Management, Nagpur	33	2
Maharashtra Academy of Engineering & Educational Research, Pune	24	
K. K. Wagh Institute of Engineering Education & Research, Nashik	23	

Source: (Kumar 2017)

As seen in the table above, IIT Bombay is the top performing engineering HEI in Maharashtra on account of the large volume of research publications and patents granted to the institute.

IIT Bombay accounts for close to 93.45% of the total patents granted and 76.48% of the total research publications of engineering HEIs in Maharashtra, as seen in this figure:

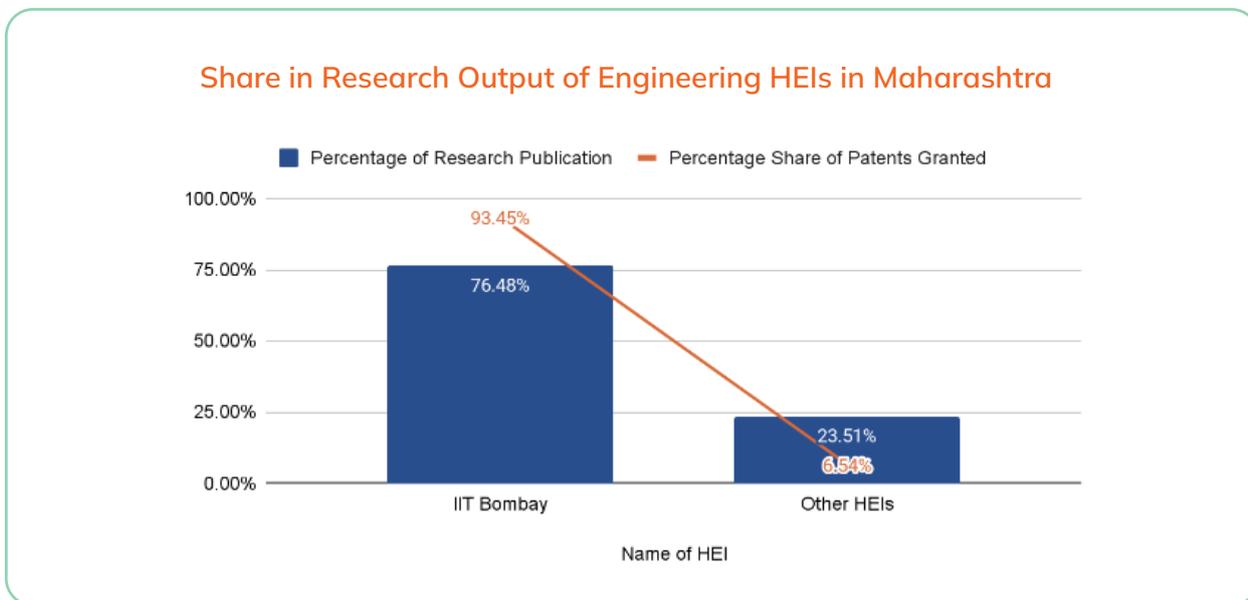


Figure 49: Share in Research Output of Engineering HEIs in Maharashtra 2010-2016 (Kumar 2017)

When compared with the research output of other HEIs in the state, IIT Bombay accounts for a significant number of publications and leads in terms of patents granted to HEIs in Maharashtra. It may be argued that its research output has also enabled it to score well under several institutional rankings. IIT Bombay was ranked second after IIT Madras in the 'Institute of National Importance & Central Universities/CFTIs (Technical)' category under the Atal Ranking of Institutions on Innovation Achievements 2021 (Ministry of Education, Government of India 2021). In NIRF rankings for the year 2022, IIT Bombay was ranked third in the overall category ("National Institute Ranking Framework" 2022).

Apart from IIT Bombay, IISER Pune is another HEI situated in Maharashtra which has performed well under institutional rankings. Under the NIRF rankings of 2022, it was ranked 26th in the overall category and 17th in the research category. In terms of research output, it has the highest number of research publications and patents granted to IISERs in India (see table 10).

Table 10: Research Publications and Patent Profile of IISERs in India (2010–2016)

Name of HEI	Research Publications	Patents Granted
IISER, Pune	1234	1
IISER, Kolkata	1194	
IISER, Bhopal	635	
IISER, Thiruvananthapuram	360	
IISER, Mohali	268	
IISER, Tirupati	17	

Source: (Kumar 2017)

In light of this, examining the institutional facilities present in both IIT Bombay and IISER Pune may present relevant findings for this report and provide possible models for other institutes to emulate.

Institutional Facilities - IIT Bombay

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Institutional Facilities - IISER Pune

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

As per data from the India Innovation Index 2021, Maharashtra's growth in indicators related to innovation is not holistic. While it significantly improved its performance in terms of human capital, its improvement in other indicators of innovation was limited. Additionally, it scored relatively poorly in terms of its gross enrollment and pupil-teacher ratios in higher education compared to other states under consideration of this report, which may thwart the creation of knowledge workers in the state. Hence, Maharashtra may undertake policy measures to address the same to support its innovation ecosystem's growth.

The capital city of Maharashtra, Mumbai, is regarded as the financial capital of India. In this context, the state may undertake policy measures to support entrepreneurship in the finance sector. While its FinTech policy is a step in the right direction, additional measures such as removing barriers to entry, easing regulations, increasing fiscal and non-fiscal incentives, and creating opportunities to secure private capital may be extended to prospective entrepreneurs in this sector.

From 2016 to 2020, Maharashtra's percentage share of patents filed and granted in India averaged around 27%, the highest among all states in India. While the state's knowledge output is indeed significant, its performance in terms of knowledge diffusion may be improved. It may aim to increase knowledge diffusion of its innovations within India through intra-state, inter-state and cross-sectoral trade and interactions.

While Maharashtra performed well in terms of its business environment and access to capital, it underperformed with regard to its safety and legal environment, as the number of police personnel in the state is below the national average. Additionally, the growing urban population in Mumbai impacts the availability of resources, public transportation and urban infrastructure. The state may aim to address this through targeted measures, as the abeyance of the same may negatively influence investor perception, thereby impacting the overall growth of the state.

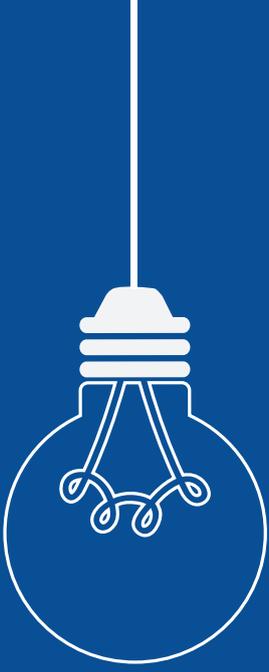
In terms of R&D expenditure, Maharashtra's figures were reported to be lower than the national average. Additionally, under the India Innovation Index 2021, Maharashtra's expenditure on higher and technical education was reported to be relatively lower than other states in the country. While Maharashtra's fiscal and human capital are its existing strengths, the state may aim to complement the same by increasing its R&D and higher education expenditure to encourage HEI-based research and innovation.

As the pharmaceutical, oil & gas, textile, automotive and finance industries in Maharashtra frequently engage with HEIs in the state, such engagements may be further encouraged by creating research centres and centres of excellence sponsored or supported by players from these industries. Apart from being a common space for interaction, these centres may also provide a space for both industry and academia to share facilities, expertise and knowledge for their mutual benefit while also stimulating research and innovation in the state.

In terms of research output of engineering HEIs in India, Maharashtra's engineering HEIs lead in the number of patents granted. One institute in particular, i.e. IIT Bombay, accounted for most of the patents granted in the state. An assessment of its institutional facilities suggests the presence of requisite infrastructure within the HEI for undertaking research and entrepreneurial activities. While such facilities may not be the sole cause behind its stellar research output, the presence of the same presents a persuasive case for emulation by other HEIs in the surrounding region as well as in other parts of the country.



Another top-performing HEI in terms of research output and institutional rankings is IISER Pune. An assessment of its institutional facilities revealed that the HEI lacks a dedicated policy and office for providing researchers with support for the management of their research. Additionally, the institute does not have targeted courses pertaining to innovation, IPR and entrepreneurship development. As this may scuttle the creation of an environment conducive to research, innovation and entrepreneurship within the HEI, the institution may aim to address the same.



Tamil Nadu



Tamil Nadu’s economy is the second largest in India after Maharashtra, enabling it to contribute significantly to India’s GDP. It is particularly known for its flourishing manufacturing and automobile sectors. It also has the largest number of operational SEZs in the country. Chennai, the capital city of Tamil Nadu, is regarded as the SaaS¹ capital of India (Micro, Small and Medium Enterprises Department, Tamil Nadu, n.d.).

In spite of its many strengths, it was ranked as a ‘Leader’ (the third position in a total of five categories) under the State’s Startup Ranking 2021. In the India Innovation Index 2021, it was ranked fifth in terms of innovation in the major states category. This section highlights the merits of its innovation system along with probable areas to be improved.

Tamil Nadu’s Startup and Innovation Environment

Policy Framework

(a) Key policymaking bodies & nodal agencies

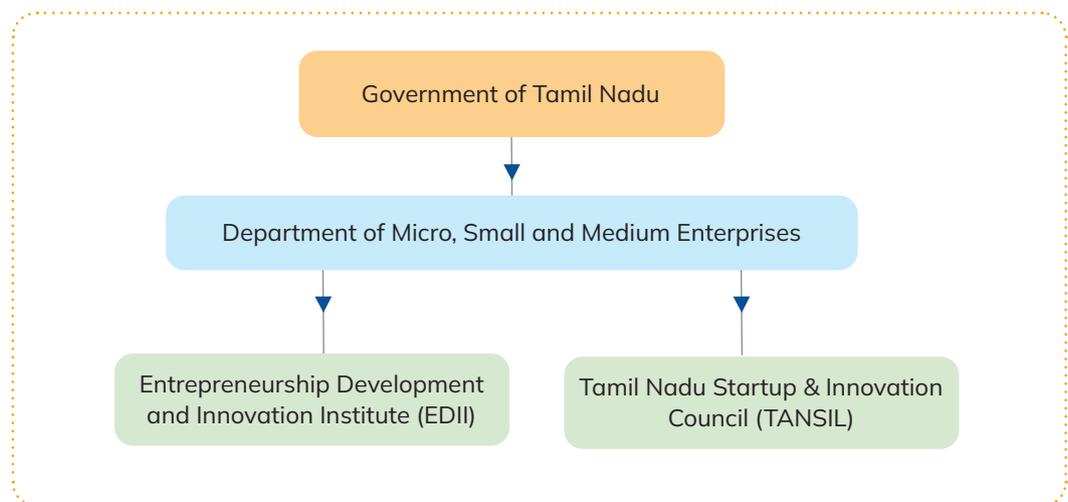


Figure 50: Key Policymaking Bodies in Tamil Nadu (“Tamil Nadu State Report” 2022).

Under the Government of Tamil Nadu, the Department of Micro, Small and Medium Enterprises is the nodal department for the development of the state’s startup ecosystem. Under this department, the Entrepreneurship Development and Innovation Institute (EDII) acts as a nodal agency to promote innovation in the State. Additionally, the Tamil Nadu Startup & Innovation Council (TANSIL) was constituted to review the Tamil Nadu Startup and InnoVaTN Mission (TANSIM) (“Tamil Nadu Startup and Innovation Policy” 2018). TANSIM aims to nurture innovation and promote R&D investment in the state.

(b) Assessment of Tamil Nadu’s startup policy

Tamil Nadu Startup & Innovation Policy (2018–2023) aimed to make Tamil Nadu a ‘Global Innovation Hub’ and the most preferred destination for startups by 2023 (“Tamil Nadu Startup and Innovation Policy” 2018). An individual assessment of each objective under the policy would

1. Software as a service (or SaaS) is a way of delivering applications over the Internet—as a service. Instead of installing and maintaining software, you simply access it via the Internet, freeing yourself from complex software and hardware management <https://www.salesforce.com/in/saas/>

be premature at this stage, as the period of the policy is still subsisting. However, the number of startups in the state can be viewed against the total number of startups in India to arrive at an understanding of the current status of entrepreneurship in Tamil Nadu.

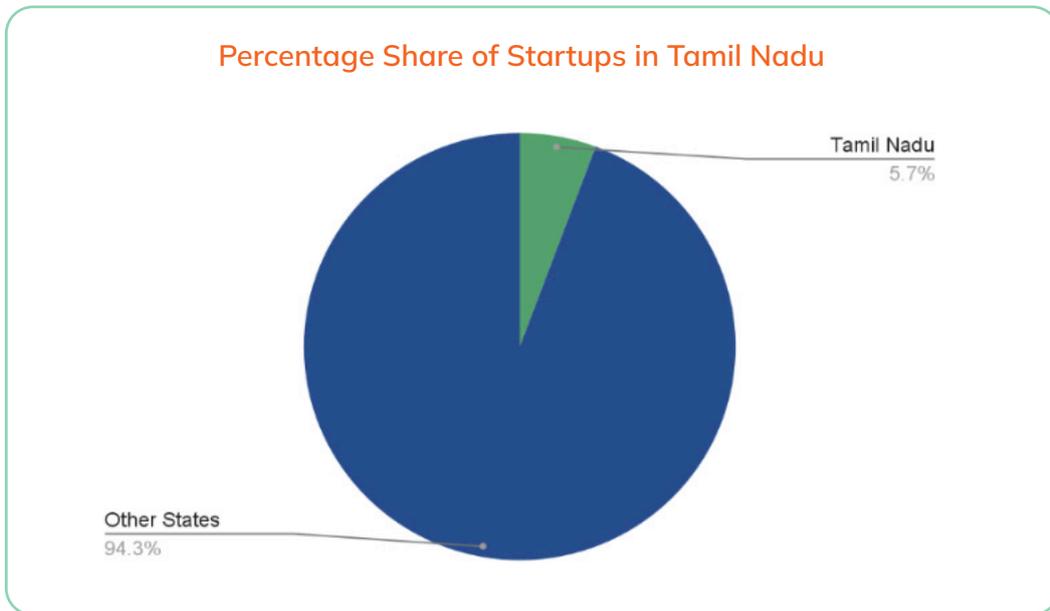


Figure 51: Percentage Share of Startups in Tamil Nadu, As on 21st December 2022 ("Startup India" 2022)

As per the number of startups registered with the DPIIT, Tamil Nadu's share of startups is a mere 5.7%, far behind states like Maharashtra (18.5%) and Karnataka (11.7%) which cumulatively account for a third of all DPIIT registered startups in India. As seen in the figure below, Tamil Nadu has a long path to traverse to match its tally with the aforementioned leading states.

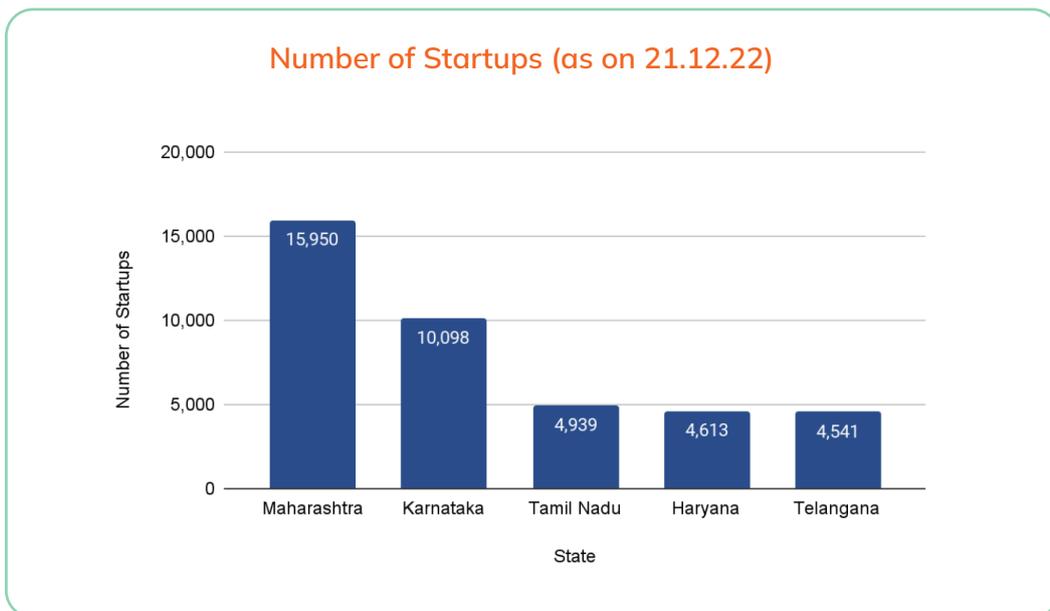


Figure 52: State-wise Comparison of Number of Startups, As on 21st December 2022 ("Startup India" 2022)

The relatively smaller number of startups in Tamil Nadu is curious, as the total number of registered incubators in the state is 97, the second highest figure after Karnataka which has 98. It may be concluded that the presence of adequate incubation facilities may not always facilitate growth in startups and entrepreneurial activity.

However, the percentage share of women-led startups versus the total number of startups in the state is impressive. In this regard, Tamil Nadu appears to be the most equitable state when compared with others under consideration of this report (see figure 15). The number of women-led startups is almost half the total startups in the state, which is a credit to its innovation system.

(c) Other relevant policy measures

Targeted policies have been advanced by the state government of Tamil Nadu to increase the number of women and other underrepresented groups in the field of entrepreneurship. Tamil Nadu's MSME Policy (2021) aims to encourage entrepreneurship among SC/ST,

transgender and women entrepreneurs. Additionally, the state promotes industrial estates for women entrepreneurs by giving priority to differential incentives and concessions for women-led startups ("Tamil Nadu State Report" 2022). The impact of these policy measures can be seen in the impressive percentage share of women-led startups in the state.

Another policy measure undertaken by the state is its annual showcase opportunity for SaaS entrepreneurs called "SaaS Stock", which was created to exhibit its SaaS ecosystem at an international level. In 2019, it was held in Dublin, Ireland and saw more than 4,000 attendees from around 50 countries. TANSIM and EDII sponsored a delegation of 8 SaaS entrepreneurs from Tamil Nadu, which helped their startups to receive insights from leading experts ("Tamil Nadu State Report" 2022). This endeavour along with several others has enabled Chennai to be considered the SaaS capital of India. 2,000+ SAAS-based start-ups have been set up in India since 2015 and close to a fourth of them are based in Chennai (Sejpal 2022).

Features of Tamil Nadu's Innovation System

1 Public Security & Legal Environment

3 Automobile & Manufacturing Hub

5 Business Environment

2 Human Capital

4 Economic Strength

6 R&D Expenditure

1. Public Security & Legal Environment

In the Good Governance Index 2021, Tamil Nadu was reported as the best state in terms of 'Judicial & Public Security', which studied five indicators, namely: conviction rate, availability of police personnel, the proportion of women police personnel, disposal of court cases and disposal of cases by consumer courts. However, the findings of this Index are by no means the final verdict on the subject, as the India Innovation Index 2021 reported Tamil Nadu's performance in the 'Safety and Legal Environment' pillar as poor, which mapped the indicators such as cyber cells, social media monitoring cells, pendency percentage of corruption case investigations and the rate of cognizable crime, among others.

While Tamil Nadu has a sizable presence of police personnel and a relatively lower pendency of civil and consumer cases, it may work towards improving the number of social media and cyber cells in its police stations along with decreasing the pendency of corruption case

investigations, as the abeyance of the same may impede or even discourage entrepreneurial and innovative endeavours in the state.

2. Human Capital

Under the India Innovation Index 2021, Tamil Nadu scored the highest in the human capital pillar amongst all other major states. Its rank is credited to an increase in the percentage of schools with ICT labs and enrollment in PhD programs (Niti Aayog 2022). Additionally, there is a high number of quality engineering colleges and other institutes in the state, reflected in 20 of these institutes being ranked under the NIRF 2022—which is the highest in India. Furthermore, Tamil Nadu has the second highest gross enrollment ratio in the country as well as a remarkably low pupil-teacher ratio at 17:1 ("All India Survey on Higher Education 2019-20" 2020).

Tamil Nadu's laudable performance under this pillar is also mirrored in its metrics pertaining to literacy and sex

ratio. As per the 2011 census, its literacy rate (80.09%) is far higher than the national average in 2011 (74.04%). Additionally, after Kerala and Puducherry, Tamil Nadu state has the third-highest sex ratio amongst all states in India (Invest India, n.d.).

However, it is curious to observe how the presence of human capital has not translated into the availability of knowledge workers in the state. In fact, Tamil Nadu has scored the lowest under the knowledge workers pillar among the states under consideration of this report. This is due to its underperformance in the indicators of 'Knowledge-intensive employment', 'Females employed with advanced degrees', 'NGOs involved in knowledge-intensive areas' and 'Skill development training' (Niti Aayog 2022). The state may aim to boost its innovation ecosystem in a manner conducive to nurturing the same, as the availability of a greater number of knowledge workers may propel innovation in the state.

3. Automobile & Manufacturing Hub

Tamil Nadu is considered one of the top 10 automobile hubs in the world and contributes to over 70% of India's passenger vehicle exports (Invest India, n.d.). As it has the ability to produce one commercial vehicle every 90 seconds, enabling the state to be regarded as the 'Automobile Capital of India' (Invest India, n.d.).

Tamil Nadu is also regarded as the manufacturing hub of India as it has the highest number of factories in the country—over 37,220 units—accounting for more than 15% of all factories in India (Invest India, n.d.). The manufacturing edge present in the state, coupled with its prowess in the automobile industry, demonstrates the potential of its infrastructural capacity to galvanise innovation in the state.

4. Business Environment

In the business environment pillar under the India Innovation Index 2021, the states of Tamil Nadu and Telangana were top performers. Tamil Nadu performed particularly well in the following indicators under this pillar: villages with internet connectivity, online services by the state government, microfinance institutions (MUDRA), bank accounts with Aadhar seeding and share of manufacturing and services as a (% of GSDP) (Niti Aayog 2022).

Tamil Nadu was also one among seven states in India that were categorised as top achievers in the Business Reforms Action Plan 2020, which assessed the implementation of business reforms to foster an investor-friendly climate in India (Press Information Bureau 2022). It can be argued that Tamil Nadu's robust business environment can be credited to its manufacturing prowess, which is aided by the state having the highest number of operational SEZs (50) in India. Additionally, the state's single-window clearance system for investments and portal for government-business collaboration may have also improved the ease of doing business in the state.

5. Knowledge Output & Diffusion

Under the India Innovation Index 2021, Tamil Nadu scored above the national average in the pillars of knowledge output and knowledge diffusion. However, its relatively high score must be seen in comparison with other top-performing states; one method to do so is by conducting an analysis of the number of patents filed and granted from the state. Similar to Karnataka, Tamil Nadu's contribution to patents filed and granted in India averages around 12.27%, as depicted here:

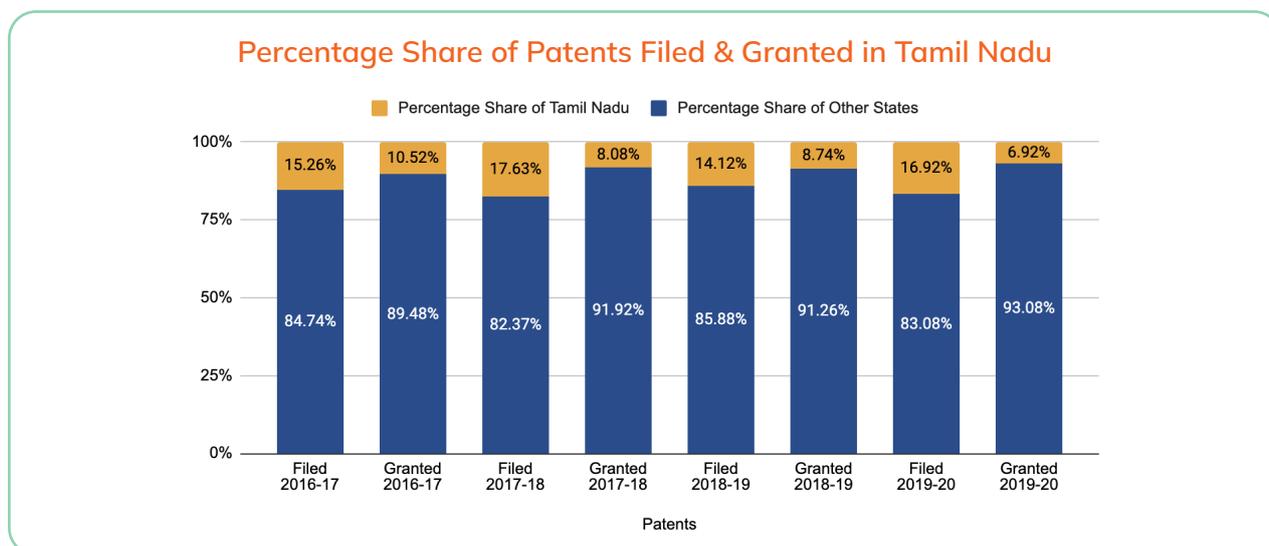


Figure 53: Percentage Share of Patents Filed and Granted in Tamil Nadu ("Minister of Commerce & Industry, Written Reply in Rajya Sabha" 2019)

Tamil Nadu's average percentage share is far behind that of Maharashtra, which accounts for a quarter of patents filed and granted in India. Additionally, patent filings in Tamil Nadu do not depict an upward trajectory; instead, the growth pattern is rather inconsistent. Furthermore, patent grants have also remained low, as seen in this figure:

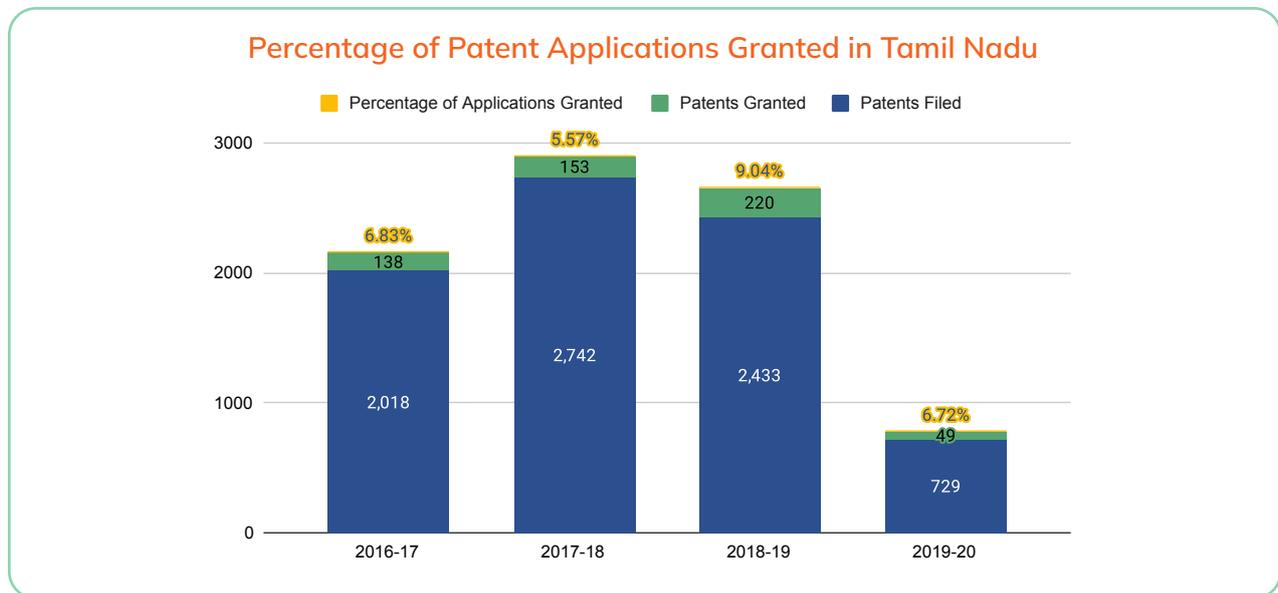


Figure 54: Percentage of Patent Applications Granted in Tamil Nadu ("Minister of Commerce & Industry, Written Reply in Rajya Sabha" 2019)

The percentage of patents granted from 2016–2020 in Tamil Nadu averages around 7.04%, far lower than Karnataka (9.63%) and Maharashtra (16.13%). As patenting activity is crucial for facilitating access to improved knowledge and scientific advancement, the state may aim to create incentives to encourage the same.

6. R&D Expenditure

As per the Research and Development Statistics 2019–20, Gujarat has the highest R&D expenditure, while Tamil Nadu's expenditure is the second highest in the country. When compared with the states under consideration of this report, the state has the highest R&D expenditure, as indicated in the figure below:

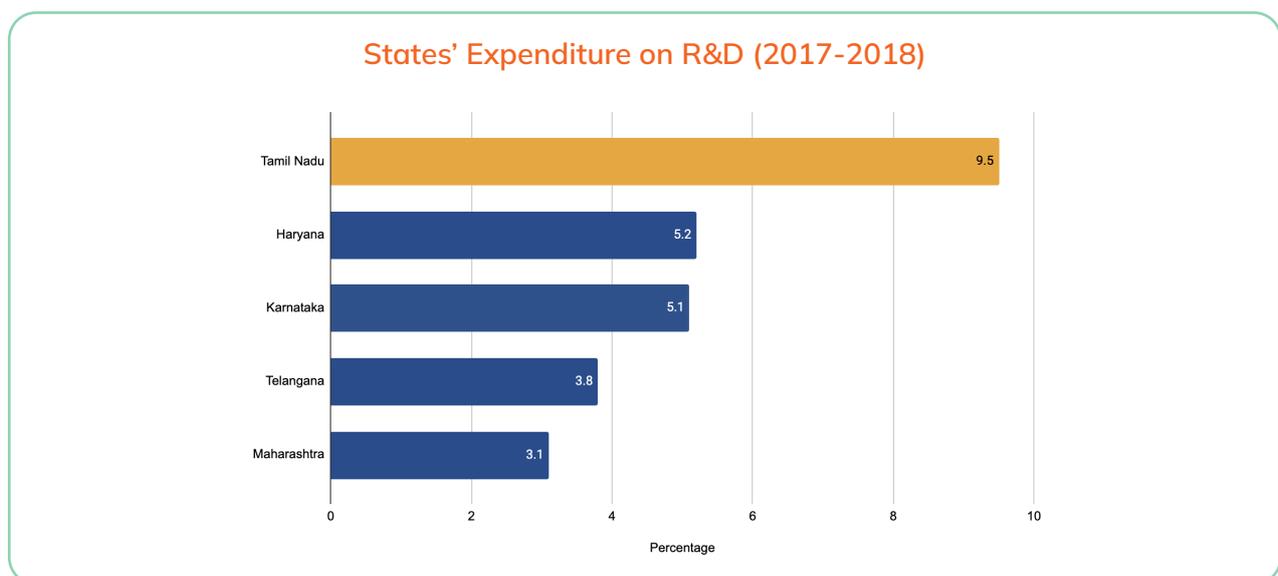


Figure 55: Tamil Nadu's R&D Expenditure 2017-18 ("Research and Development Statistics" 2020)

While Tamil Nadu's R&D expenditure is indeed laudable, it is curious to note how this input has not translated into an increase in innovation and entrepreneurial activities in the state, especially when compared with states that have less R&D expenditure yet have performed better in these areas.

The reason behind this disparity may lie in the state's meagre overall investment in science and technology. As per the India Innovation Index 2021, Tamil Nadu's

expenditure on Science, Technology and Environment (as a % of GSDP) was a dismal 0.3. This grim figure offers an explanation for Tamil Nadu's relatively low innovation score in comparison to other states that have similar socioeconomic and geographic characteristics to it. The state may aim to specifically allocate a certain sum of its R&D expenditure into science and technology to ameliorate the current state of its innovation system.

S&T and Industrial Clusters

Tamil Nadu has not been included in the list of regions in India where the establishment of S&T clusters has been proposed by the Government of India. However, small-scale collaborations between S&T players do exist in the state, primarily focused on higher educational institutions such as IIT Madras, which frequently engages with the government and industry for mutually beneficial collaborations. For example, IIT Madras Alumni Association (IITMAA) collaborated with the Strategic Alliances Division of the Office of the PSA for multiple initiatives: capacity building of researchers, academia and students; promotion of game-based learning in schools and colleges; and aiding special interest groups on working on Sustainable Development Goals (SDGs) and emerging technology (Principal Scientific Adviser 2021). In this manner, the HEI supports the creation of informal knowledge clusters in the state.

In terms of industrial clusters, Tamil Nadu houses the largest number of industrial parks and SEZs in India. Furthermore, the state is touted to be the only one in India to have all of its districts connected to an industrial corridor. Currently, the state has four industrial corridors, namely: Tamil Nadu Defence Industrial Corridor, Chennai-Bengaluru Industrial Corridor, Chennai-Kanyakumari Industrial Corridor and Kochi-Coimbatore-Bengaluru Industrial Corridor ("Investing in Tamil Nadu" 2023). The state also has the highest number of factories in the country. In this context, it is hardly surprising that Tamil Nadu is considered one of the most industrialised states in India. The state may leverage these strengths by creating incentives for prospective entrepreneurs to utilise the same for innovation-specific activities.

Role of HEIs vis-a-vis Tamil Nadu's Innovation System

University-Industry Linkages

Tamil Nadu, Telangana and Delhi jointly secured the sixth rank in a study on University-Industry Linkages (UILs) conducted by the PHD Chamber of Commerce and Industry. While all three were positioned at the sixth rank on the basis of their average score, their actual scores were: Tamil Nadu - 6.1, Delhi - 6.06 and Telangana - 6.05 on a 10 point scale (PHD Chamber of Commerce and Industry 2019).

As per the study, among the major industries present in Tamil Nadu, the automotive industry has very strong UILs, followed by engineering, textiles industries and IT and IT-enabled services. Additionally, moderate UILs were reported from the cement industry (PHD Chamber of Commerce and Industry 2019).

While Tamil Nadu performed well in certain indicators in the study, i.e. 'industry interaction with universities' and 'industry interaction with students', it may improve its performance in the following areas: 'continuity in interaction', 'frequency of interaction', 'MoUs/collaborations/agreements with universities', 'patents gained in the past 5 years' and 'continuity of research activities in universities'.

The study noted that the automotive, textiles, engineering and IT industries interact with the universities in the state once/twice/thrice in the year, depending upon their requirements. Such interactions may be leveraged by tailoring university-based innovation to suit the needs of the industry.

Research Output

Tamil Nadu's HEIs outperform all other states in terms of publications, while Maharashtra's HEIs lead in terms of the number of patents granted to the top NIRF-ranked HEIs from 2010 to 2016 (Kumar 2017).

The research output of engineering HEIs in Tamil Nadu appears to be relatively high compared to other states of India (see figure 25).

As seen in the figure below, Tamil Nadu's HEIs account for 18.57% of the total research publications (highest in India) and 22.65% of the total patents granted (second highest in India) to engineering HEIs between 2010 and 2016.

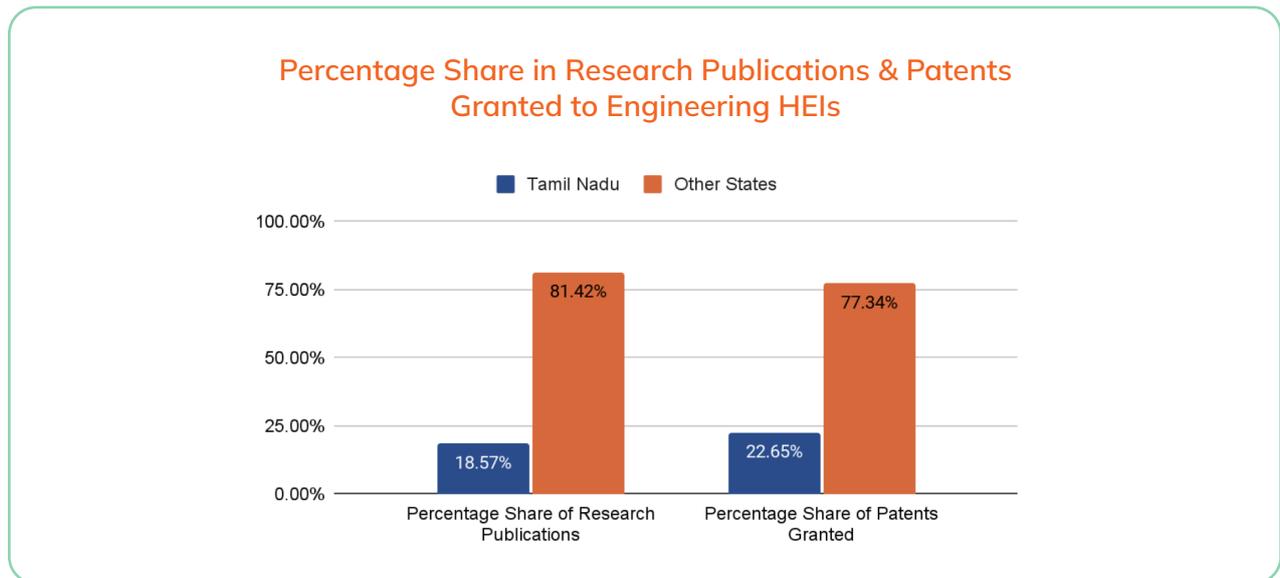


Figure 56: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs (Kumar 2017)

The following table presents HEIs situated in the state of Tamil Nadu that were listed in this publication (Kumar 2017) along with the number of their research publications and patents granted.

Table 11: Research Output of Engineering Institutions in Tamil Nadu, 2010-2016

Name of HEI	Research Publications	Patents Granted
IIT Madras	6440	48
Coimbatore Institute of Technology	1854	
Amrita Viswa Vidyapeetham, Coimbatore	1588	9
PSG College of Technology	1381	2
Vellore Institute of Technology, Vellore	988	3
Thiagarajar College of Engineering, Madurai	882	5
NIT, Tiruchirapalli	620	

Name of HEI	Research Publications	Patents Granted
Bannari Amman Institute of Technology, Sathyamangalam	546	
National Institute of Engineering, Mysuru	537	
Kongu Engineering College, Coimbatore	501	
Sona College of Technology, Salem	470	2
Kumaraguru College of Technology, Coimbatore	446	
B.S. Abdur Rahman Institute of Science and Technology	430	
Sri Ramakrishna Engineering College, Coimbatore	368	
Adhiyamaan College of Engineering, Hosur	242	
Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram	87	
Anand Institute of Higher Technology, Chennai	63	
Shanmugha Arts Science Technology & Research Academy	52	1
Noorul Islam Centre for Higher Education, Kanyakumari	45	
Karunya Institute of Technology & Sciences, Coimbatore	18	
Total	17558	70

IIT Madras is the top performing HEI in Tamil Nadu, due to the sheer volume of its publications and patents granted. The institute accounts for close to 36% of the total publications and 68% of the total patents granted to HEIs in Tamil Nadu, as seen in this figure:

Share in Research Output of HEIs in Tamil Nadu

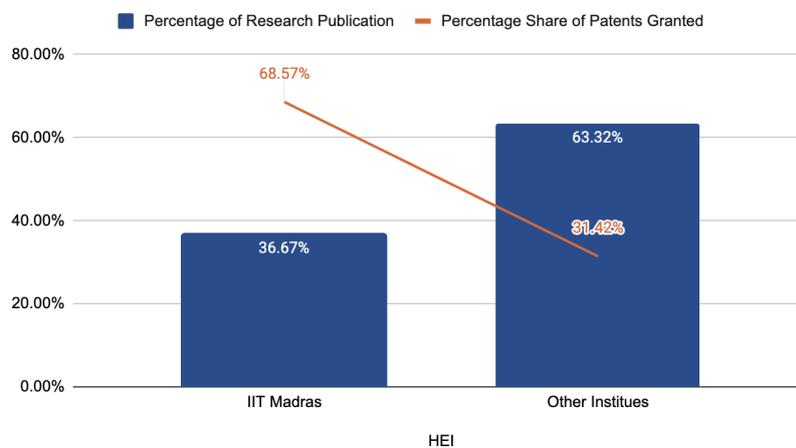


Figure 57: Share in Research Output of Engineering HEIs in Tamil Nadu, 2010-2016 (Kumar 2017)

The high research output of IIT Madras may have enabled it to top several institutional rankings. In NIRF rankings for the year 2022, IIT Madras was ranked first in the overall category. Additionally, the institute has been ranked first for three consecutive years, i.e. 2019, 2020 and 2021, in the Atal Ranking of Institutions on Innovation Achievements. While several reasons may have led to its emergence as a leading institute in terms of research output in the country, examining the institutional facilities present within it may yield relevant learnings for other institutes to emulate.

Institutional Facilities - IIT Madras

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

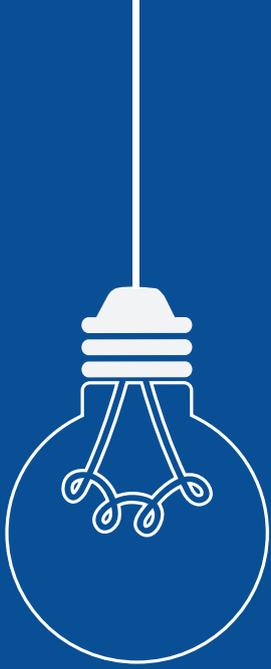
Tamil Nadu has a high number of DPIIT-registered incubators but a relatively low number of startups. This indicates that simply having such facilities is not enough to foster entrepreneurship, as the lack of access to funding, limited mentorship support, and an absence of entrepreneurial culture in the state must also be addressed through targeted policy measures.

Tamil Nadu boasts of a strong business environment, ostensibly galvanised by its automobile manufacturing prowess, several SEZs, and a single-window clearance system for private investment. Despite this, there is room for improvement in areas such as increasing the number of social media and cyber cells in police stations, as well as reducing the pendency of corruption case investigations in the state to boost the confidence of prospective investors in the safety and legal environment of the state. Additionally, the manufacturing edge present in Tamil Nadu, coupled with its prowess in the automobile industry, demonstrates the potential of its infrastructural capacity, which may be leveraged to drive innovation in the state.

Under the India Innovation Index 2021, Tamil Nadu scored the highest in the human capital pillar amongst all other major states. However, the presence of human capital has not translated into the availability of knowledge workers in the state. Policy measures (such as increasing skill development and vocational training programs at HEIs) may be undertaken by the state to address this gap.

Data from the Index also indicates that Tamil Nadu scored above the national average in the pillars of knowledge output and knowledge diffusion. However, its relatively high score must be seen in comparison with other states in India. The average number of patents granted from 2016-2020 in Tamil Nadu is 7.04%, far lower than in Karnataka and Maharashtra. To improve its performance on this front, encouraging an environment that fosters research and patenting activity in higher educational institutes present in the state is vital. Additionally, while the state's expenditure on R&D is quite high, it may aim to allocate a portion of its expenditure to scientific and technological research to support patenting activity and the overall development of its innovation system.

When compared with the other states under consideration of this report, Tamil Nadu's engineering colleges have a relatively higher research output. This may be credited to the high number of engineering institutes in the state. One institute in particular, i.e. IIT Madras, accounts for most of the publications and patents granted to HEIs in Tamil Nadu. An assessment of the institute's facilities reveals them to be requisite for facilitating knowledge production, as demonstrated through its research output. However, it may be argued that the knowledge production occurring within the institute is not adequately disseminated to benefit the rest of the region, as Tamil Nadu ranks fifth (lowest among the states under consideration of this report) in terms of innovation under the India Innovation Index 2021. While IIT Madras excels at innovation, policy measures may be undertaken to reorient its focus to facilitate the dissemination of knowledge and expertise from the institute across the state of Tamil Nadu.



Delhi



Delhi is India's capital city. It is regarded as a significant social, political, cultural and commercial centre of not only India but also the world. It is a well-connected city that houses one of the busiest international airports in the world, an extensive road network and the largest metro rail network in India (Invest India, n.d.). By offering myriad avenues of employment, especially the tertiary sector, it attracts diverse human capital from across the country in search of better living conditions and new opportunities.

Delhi's innovation system has been featured in several national rankings and reports. Recently, Delhi overtook Bangalore in terms of the number of registration of new startups, as per data from the Economic Survey 2022. In the States' Startup Ranking 2021, Delhi was categorised as an 'Aspiring Leader', i.e. the 4th category in these rankings. In the India Innovation Index 2021, it was ranked second in the UTs and city-states category. In light of this, it may be surmised that Delhi exhibits a promising innovation and startup landscape, which is examined in this section.

Delhi's Startup and Innovation Environment

Policy Framework

(a) Key policymaking bodies & nodal agencies

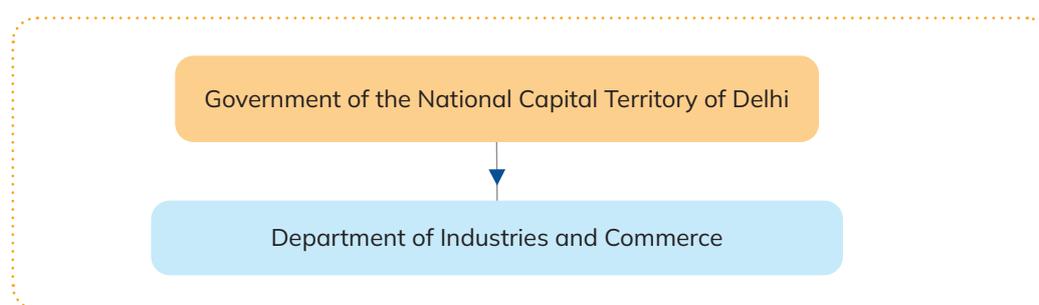


Figure 58: Key Policymaking Bodies in Delhi ("Delhi UT Report" 2022).

The startup and innovation policies applicable to the Union Territory (UT) of Delhi are made by the Government of the National Capital Territory (NCT) of Delhi. The Department of Industries and Commerce under the Government of NCT of Delhi is the nodal department mandated to support startups and entrepreneurship in the UT ("Delhi UT Report" 2022).

As of 21st December 2022, no centralised portal or dashboard has been created by the UT to provide information regarding policies, schemes and initiatives relevant to the startup ecosystem. However, the website of the Department of Industries and Commerce provides information to startups regarding the rules, regulations, and acts related to the startup ecosystem.

(b) Assessment of Delhi's startup policy

The Delhi Startup Policy was approved by the Delhi government on 5th May 2022, with the following mission:

- Encouraging, facilitating and supporting 15,000 Startups by 2030;
- Encouraging entrepreneurship;
- Generating new avenues of employment;
- Creating a conducive environment for learning from early education;
- Facilitating convenient access to funding;
- Fostering innovative ideas in S&T among youth;
- Proactive engagement of academia and industry;
- Establishing state-of-the-art incubation infrastructure;
- Nurturing Startups to become unicorns (Government of NCT Delhi 2022)

The policy also mentioned that the government would form a committee to monitor the implementation of the startup policy. The committee will be headed by Delhi’s Finance Minister, comprising 85% representatives from the private sector, 10% from educational institutions and 5% from the government. Additionally, the policy includes fiscal as well as non-fiscal incentives to promote entrepreneurial activities in the UT (Ibid).

An individual assessment of each goal under the policy would be premature at this stage, as the policy was launched recently. However, the number of startups in Delhi can be viewed against the total number of startups in India to arrive at an understanding of the status of entrepreneurship in the region.

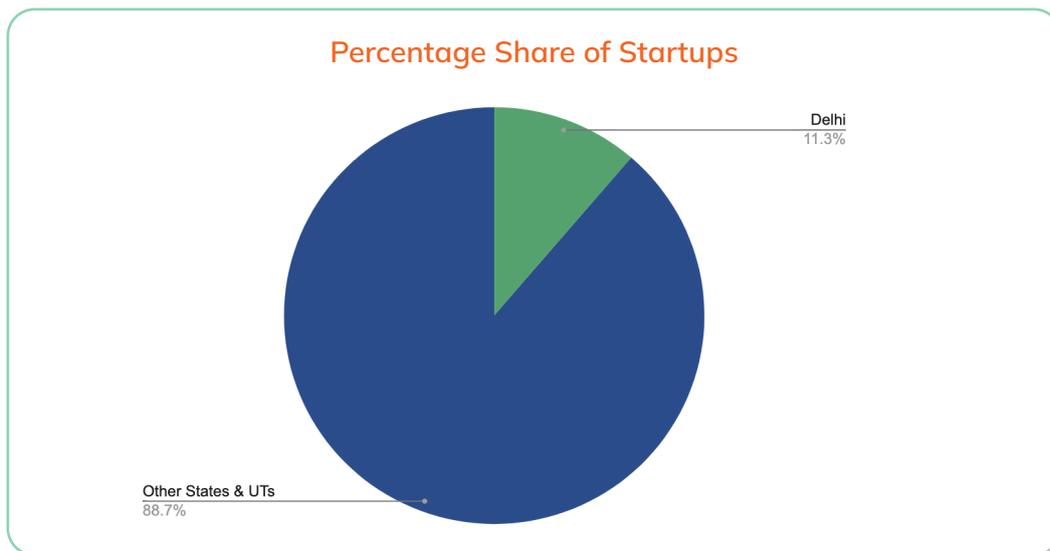


Figure 59: Percentage Share of Startups in Delhi, As on 21st December 2022 (“Startup India” 2022)

As per the number of startups registered with the DPIIT, Delhi’s share of startups is 11.3% similar to that of Karnataka (11.7%). The following table lists the top five regions in India in terms of the number of startups registered with DPIIT. As seen from the table below, Delhi has the third highest number of startups among all states and UTs in India.

Table 12: State-wise Comparison of Number of Startups, as on 21st Dec 2022

State/ UT	Number of Startups
Maharashtra	15,950
Karnataka	10,098
Delhi	9,751
Uttar Pradesh	7,916
Gujarat	6,121

Source: (“Startup India” 2022)

The India Innovation Index 2022, reported that Delhi registered high growth in startups from the previous editions of the Index (Niti Aayog 2022). This indicates an evolving innovation system in Delhi, which effectively facilitates entrepreneurial activity within the city.

(c) Other relevant policy measures

It may be surmised that this policy supported the growth of university-based incubation facilities in Delhi. As of December 2022, Delhi has the fourth-highest number of incubators among all states and UTs in India (see table 13)

Netaji Subhash Institute of Technology	Acharya Narendra Dev College
Delhi Technological University	Delhi Pharmaceutical Science and Research University
Bhai Parmanand Institute of Business Studies	Ambedkar Institute of Advanced Communication Tech and Research
Indira Gandhi Technical University for Women	College of Art
Ambedkar University Delhi	Indraprastha Institute of IT
Shaheed Sukhdev Singh College of Business	

Source: Delhi UT Report, 2022

Table 13: State-wise Comparison of Number of Incubators, as on 21st Dec 2022

State/UT	Number of Incubators
Karnataka	98
Tamil Nadu	97
Maharashtra	90
Delhi	68
Gujarat	62

Source: ("Startup India - Incubators", n.d.).

In the States' Startup Ranking 2021, under the 'Incubation Support' reform area (which maps financial and infrastructural support to startups and state-supported incubators) Delhi scored in the 26th percentile, a relatively lower score than other top states and UTs in the country. Additionally, the report recommended that fiscal support may be provided to incubators in the UT to strengthen its overall innovation ecosystem. In this regard, the

Delhi Startup Policy 2022 announced fiscal incentives in the form of grants for expenditure incurred in the establishment, expansion and operation of incubation centres (Government of NCT Delhi 2022). It remains to be seen whether the release and utilisation of these fiscal incentives occur and what impact they have on the innovation landscape of Delhi.

Features of Delhi's Innovation System

1 Human Capital

2 Hub of Education

3 Business Environment

4 Knowledge Output & Diffusion

5 Urban Infrastructure

6 Dominant Service Sector

1. Human Capital

In the India Innovation Index 2021, Delhi scored above the national average in the 'human capital' pillar. It scored exceedingly well in the following indicators under this pillar: 'percentage of schools having Atal Tinkering Labs', 'NER (Net enrollment ratio) in school education' and 'higher education institutions - NAAC grade A and above' (Niti Aayog 2022). The number of PhD enrolments (per lakh population) in Delhi was the highest in the country. Furthermore, data from AISHE 2019-2020 indicates that Delhi has the highest gross enrollment ratio at the higher education level among all UTs in India ("All India Survey on Higher Education 2019-20" 2020).

These figures suggest the availability of highly educated talent in Delhi with the potential to use its knowledge capital to boost the innovation ecosystem of the region. This is validated through data presented in the NSS 75th round survey on "Household Social Consumption: Education", which stated that after Kerala, Delhi had the highest literacy rate in the country.

According to the findings of the India Innovation Index 2021, Delhi also has the potential to effectively employ and skill its human capital, which can be seen in its performance under the 'knowledge worker' pillar. This pillar consists of indicators such as 'knowledge-intensive employment', 'females employed with advanced degrees' and 'skill development training' among others. Delhi scored above the national average under this pillar and was reported to have the highest number of private R&D units in the state (per lakh population) in the country (Niti Aayog 2022). In light of the same, it may be argued that Delhi has consistently invested in improving the quality of its education and skilling ecosystem.

It cannot be denied that the availability of educated and skilled talent is one of the most critical factors in promoting entrepreneurial activity and innovation in a region. Earlier, much of this activity was centred around Bengaluru, as the city provided access to high-quality tech talent. However, Delhi has recently emerged as a contender to it. As per the Economic Survey 2022, over 5,000 startups were registered in Delhi, while 4,514 startups were registered in Bangalore between April 2019 to December 2021 ("Economic Survey" 2022). On this basis, it may be argued that investing in the education and skill attainment of human capital enables entrepreneurship in a region, as evidenced in Delhi.

2. Hub of Education

There are five central universities, eight state universities and close to 17 engineering colleges located in Delhi (Invest India, n.d.). Among these institutions, Delhi University and Jawaharlal Nehru University are one of the top universities in India. Several S&T-based institutions are also present in the UT, notably the Indian Institute of Technology, Delhi, All India Institute of Medical Sciences and Delhi Technological University. This cluster of colleges and institutions in the capital gives a significant portion of the population access to quality education, ostensibly enhancing its human capital and increasing the availability of knowledge workers in the region.

As per the State Budget Analysis Report of RBI, Delhi has the highest budget allocation for the education sector among all states. While the national average for the same was 14.7% in 2020-21, Delhi earmarked close to 23% of its budget towards the education sector ("Economic Survey of Delhi 2020-21" 2022). This indicates that investing in education is a priority for the government, which has allowed Delhi to emerge as a significant hub of education in

the country.

However, there appears to be a lack of investment in scientific innovation and R&D activities. Illustrating the same, Delhi was reported to be underperforming in the indicators pertaining to ‘expenditure on r&d’ and ‘expenditure on Sci, Tech and Env as a (% of GSDP)’ respectively, under the India Innovation Index 2021. It may be argued that this may hinder the innovation system in Delhi from realising its potential in producing knowledge and translating the same into workable products and services for the industry.

Furthermore, while acknowledging that high-quality academic institutions and a skilled workforce are vital in galvanising entrepreneurial activity in a region, other factors like investment in R&D and incubators, engagement with industry players, and availability of mentorship opportunities for innovators are equally important. Hence, Delhi may undertake policy measures to address the absence of the same in its innovation system.

3. Business Environment

Delhi scored the highest in the ‘business environment’ pillar among all states and UTs under the India Innovation Index 2021. It performed well under indicators such as: ‘incubators (per lakh population)’, ‘share of manufacturing and services (as a % of GSDP)’, ‘cluster strength’, ‘bank accounts (per lakh population)’ etc. (Niti Aayog 2022).

In the context of creating a robust business environment in a region, one crucial aspect that helps startups to flourish is access to investment and funding. Evidence of such an environment can be seen in Delhi. In the India Innovation Index 2021, Delhi ranked first in the ‘investment pillar’ in the UTs and city-states category. It performed particularly

well in indicators pertaining to ‘NIRF ranking of top 5 universities’, ‘FDI inflow as a % of state GDP’ and ‘venture capital deals’. This is also validated by the data reported by the DPIIT, according to which the FDI inflow in Delhi accounted for 13% of the total FDI inflow in India from October 2019 to June 2022 (DPIIT 2022). After Maharashtra, Karnataka and Gujarat, Delhi attracted the fourth-highest FDI inflow in the country.

It may be argued that to create a startup-friendly city, the government must create policies that enable the flow of capital towards startups. Ensuring the same equips the growth of entrepreneurship in the region, evidence of which can be gleaned in Delhi. After Maharashtra and Karnataka, Delhi has the third largest number of DPIIT-registered startups in India (“Startup India” 2022). Hence, it may be claimed that the existing environment in the UT is startup-friendly and measures may be undertaken to safeguard the same.

4. Knowledge Output & Diffusion

When compared to the previous editions of the India Innovation Index, Delhi witnessed an improvement in both the ‘knowledge output’ and ‘knowledge diffusion’ pillars in the 2021 edition of the Index, scoring well on multiple indicators pertaining to patents, trademarks, software exports, number of high and medium-high-tech manufacturing entities (Niti Aayog 2022).

Delhi was specifically highlighted in the Index for its substantial knowledge production as compared to the rest of the country, as it outperformed all other states and UTs in the number of trademarks and patents filed (Niti Aayog 2022). This is also validated through the number of patents filed and granted in the UT as reported in a reply in the parliament of India. As presented in the figure below, Delhi’s contribution to patents filed and granted in India

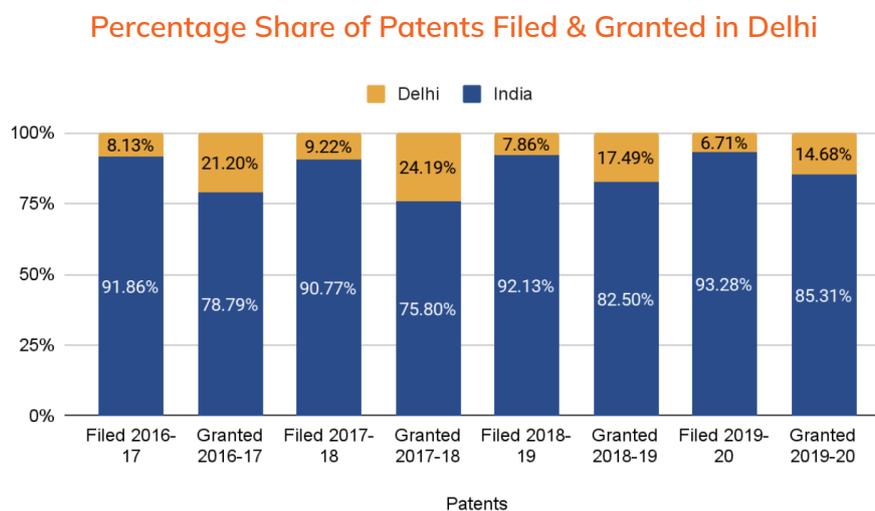


Figure 60: Percentage Share of Patents Filed and Granted in Delhi (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

averages around 13%, which is higher than most major states under the Index (i.e. Karnataka, Tamil Nadu, Telangana and Haryana) with the exception of Maharashtra.

Additionally, the percentage share of patents granted in Delhi averages around 31%, which exceeds Maharashtra as well as all the other states and UTs under consideration of this report.

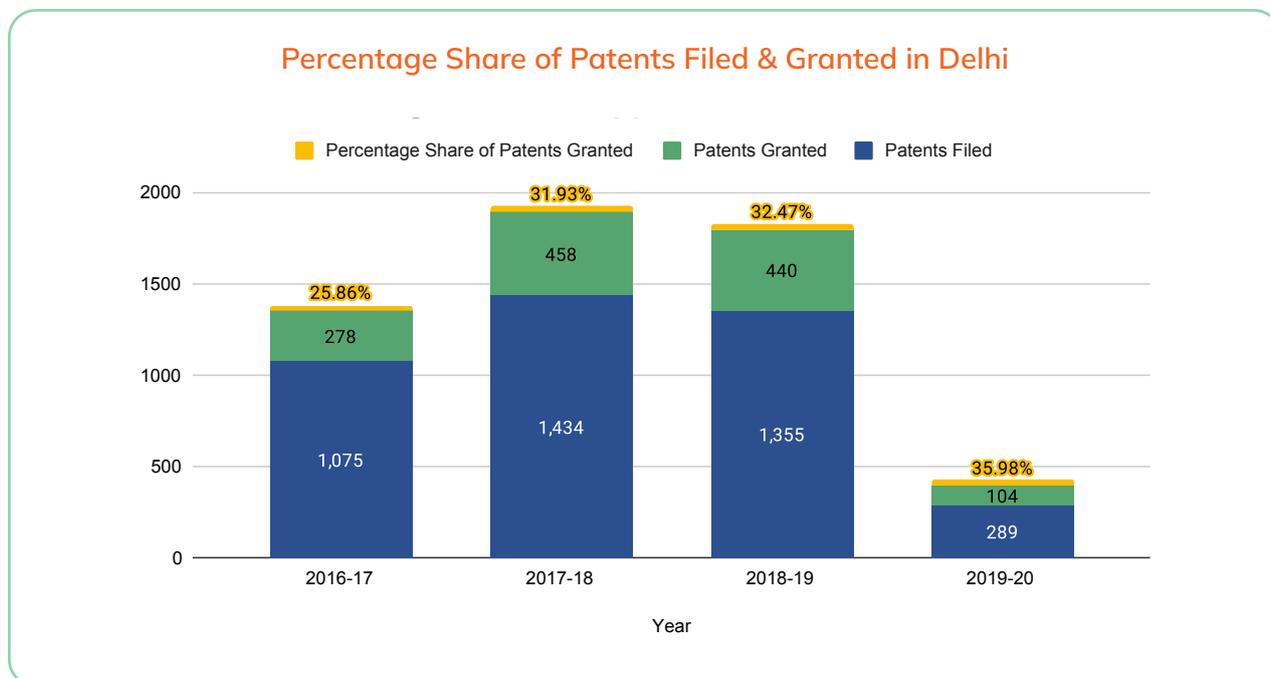


Figure 61: Percentage of Patent Applications Granted in Delhi (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

Hence, the knowledge output of Delhi is indeed significant. In terms of knowledge diffusion, it achieved a perfect score in the indicator pertaining to the number of newspapers and their circulation (Niti Aayog 2022). Therefore, the creation and dissemination of knowledge from the capital is robust.

5. Urban Infrastructure

Delhi is regarded as a well-connected city. It houses one of the busiest international airports in the world and the largest metro rail network in India (Invest India, n.d.). Additionally, Delhi is well connected to many satellite cities like Gurugram, Noida and Faridabad through expressways and flyovers. The inter-state connectivity it offers enables the migration of human capital from multiple regions in India. The opportunity to achieve better living conditions and access new employment opportunities often attracts many individuals from across the country to Delhi.

However, the level of air pollution in the city is a matter of grave concern. Delhi has often been termed as one of the most polluted cities in the world, which carries the potential to negatively impact not only the health of people but also the overall economic well-being of the city.

In the Ease of Living Index 2020, Delhi was ranked 13th among other cities in India. As per the findings of this Index, it may be argued that Delhi has many improvements to make in terms of its urban infrastructure. It was ranked 35th out of 49 cities under the ‘quality of life’ pillar of this ranking. In the WASH and solid waste management category, Delhi scored poorly in terms of stormwater drainage networks. In the mobility category, it scored low in the availability of public transport, which suggests two things: first, the insufficiency of its public transport system to support the population in the city and second, an increased use of private vehicles for the purposes of mobility (Ministry of Housing and Urban Affairs 2021).

Hence, Delhi may undertake measures to tackle issues of air pollution, inadequate drainage system and public transportation system, as they may disrupt the growth of business and entrepreneurship in the city.

6. Dominant Service Sector

The service sector in Delhi occupies a dominant role in the region’s economy. This sector covers varied activities ranging from highly specialised fields like Information and Communication Technology (ICT) to services offered by

the informal sector workers i.e. domestic workers, street vendors, vegetable sellers, rickshaws and auto drivers etc.

As per the latest Economic Survey of Delhi, the service sector in the UT occupies a predominant role in its economy, which is illustrated in the sector's share in contribution to Gross State Value Added (at current prices) during 2020-21, which was 84.59%. In comparison, the secondary sector's share is 13.56% and the primary sector's share is 1.85%. Additionally, the service sector also plays a pivotal role in terms of the generation of employment opportunities in Delhi ("Economic Survey of Delhi 2020-21" 2022).

Under the 'economic ability pillar' of the Ease of Living Index 2020, Delhi was ranked second after the city of Bengaluru. However, Delhi's performance under this pillar was disparate. In the category of 'level of economic development', Delhi scored the lowest, indicative of its poor industrial development due to low per capita factories. However, in terms of 'economic opportunities' Delhi achieved the distinction of a perfect score suggesting myriad avenues of employment (especially in the tertiary and informal sectors) in the UT. Hence, it may be claimed that supporting the growth of the service sector is one method to ensure the economic development of the capital city.

S&T Cluster

PM-STIAC and the Office of the PSA, Government of India selected the city of Delhi as one of the six S&T clusters to be established in India ("Science & Technology Clusters", n.d.). Titled as 'City Knowledge Innovation Cluster, Delhi Research Implementation and Innovation' (CKIC-DRIIV) it includes several partners such as academic and R&D institutions, industry players, corporations, think tanks, startups, NGOs, government ministries and other agencies ("CKIC-DRIIV", n.d.). Since the cluster was launched in 2021, most of its initiatives are at a nascent stage. The nature of its impact on the region's innovation ecosystem cannot be foreseen at present; however, the cluster has access to the following institutions and organisations:

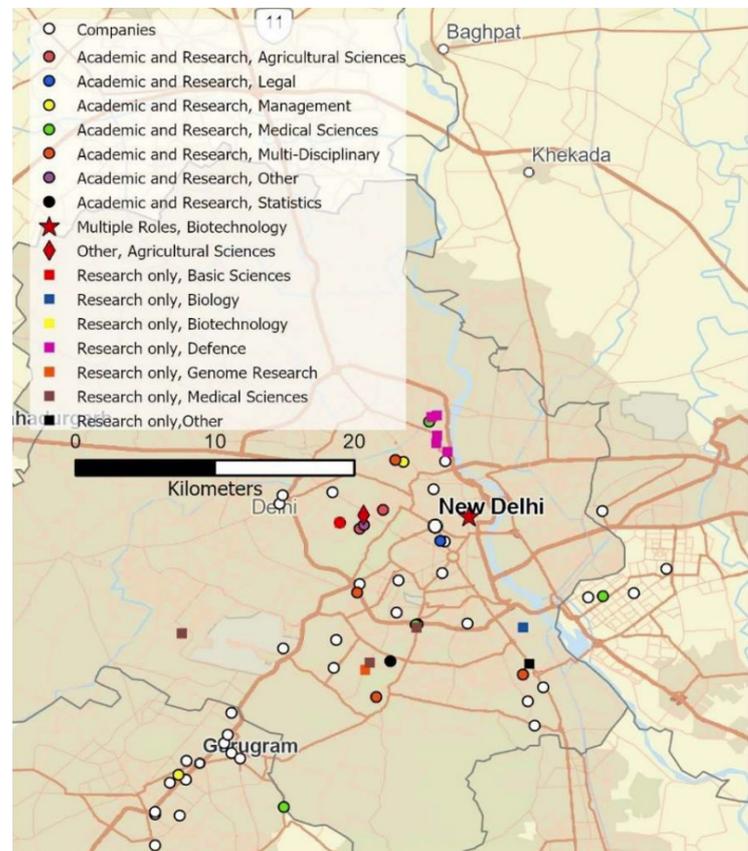


Figure 62: Mapping of Institutions and Organisations in the S&T cluster in Delhi ("Report of the high-level committee on developing science & technology clusters in India" 2020).

Role of HEIs vis-a-vis Delhi's Innovation System

University-Industry Linkages

Delhi, Telangana and Tamil Nadu jointly secured the sixth rank in a study on University-Industry Linkages (UILs) conducted by the PHD Chamber of Commerce and Industry. While all three were positioned at the sixth rank on the basis of their average score, their actual scores were: Tamil Nadu - 6.1, Telangana - 6.05 and Delhi - 6.06 and on a 10 point scale (PHD Chamber of Commerce and Industry 2019).

Among the major industries, the finance industry in Delhi has very strong UILs followed by strong UILs in the IT and IT-enabled Services and real estate industries and moderate UILs in tourism and agro and food processing industries (PHD Chamber of Commerce and Industry 2019). Delhi performed well in the following indicators: 'availability of University(s) for industries', 'interaction of industries with University(s)', 'frequency of interaction with University(s)', 'interaction of industries with students' and 'frequency of interaction of industries with students'. However, it may improve its performance with regard to the following indicators: 'continuity in interaction', 'patents gained in the past 5 years', 'support in providing quality solutions to industries from University(s)' and 'MoUs/Collaboration/Agreement of industries with Universities'.

The study noted that firms related to finance, IT and IT-enabled Services, real estate, agro and food processing and tourism interact with the Universities in Delhi for various purposes, such as business processes and research activities. Additionally, these industries also interact with students to provide them with internship opportunities in their plants. These interactions may be leveraged by universities in the UT, by encouraging students to gain practical experience and tailor their innovations to suit the needs of these industries.

Research Output

Among the top 100 NIRF-ranked engineering institutes in UTs of India, the research output from Delhi-based engineering HEI for the years 2010-2016 is significant, as seen in the figure below:

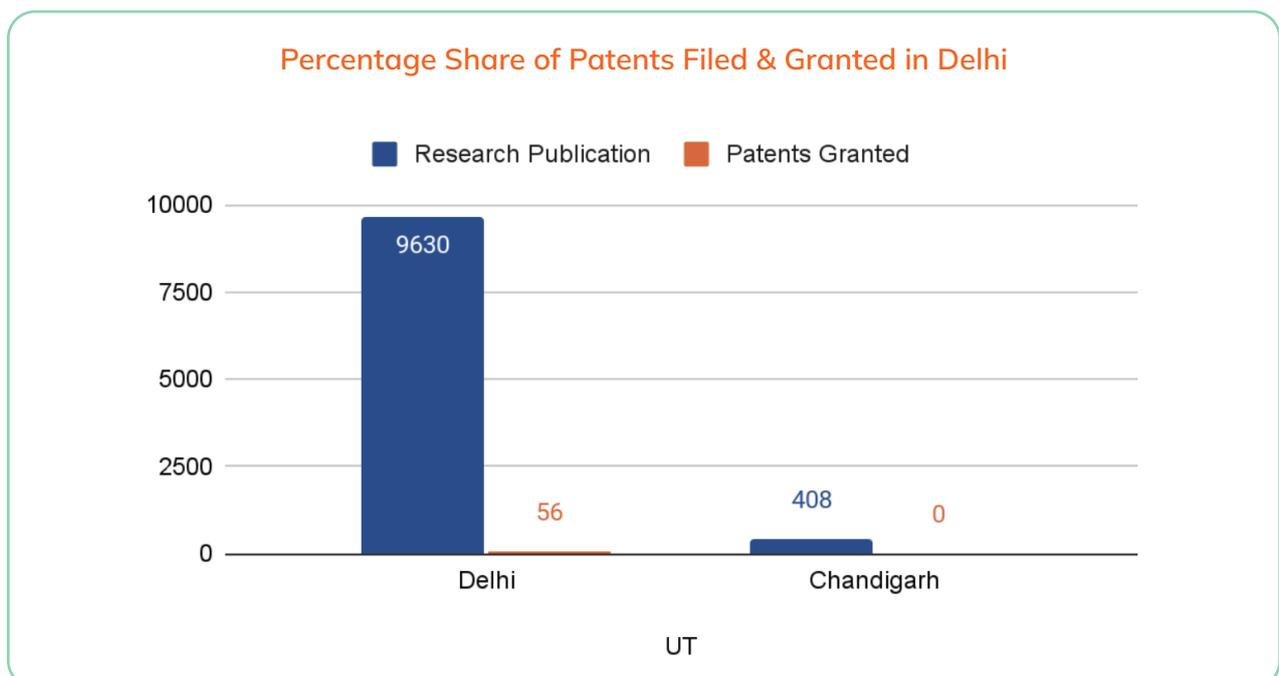


Figure 63: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs in Delhi & Chandigarh (Kumar 2017)

Delhi's engineering HEIs account for 10.18% of the total research publications and 18.12% of the total patents granted to engineering HEIs in India from 2010 to 2016, indicating the presence of significant university-based innovation and research by the engineering institutions in the UT. Only three engineering HEIs situated in Delhi were listed in this publication (Kumar 2017).

Table 14: Research Output of Engineering Institutions in Delhi, 2010-2016

Name of HEI	Research Publications	Patents Granted
IIT Delhi	7148	56
Faculty of Engineering and Technology, Jamia Millia Islamia	2320	0
NIT, Delhi	162	0

Source: (Kumar 2017)

As seen from the table above, as per the volume of its publications and patents granted, IIT Delhi is the top performing engineering HEI in Delhi. At the national level, the institute was ranked third in India under the Central University/ Institute of National Importance category of the Atal Ranking of Institutions on Innovation Achievements 2021 (Ministry of Education, Government of India 2021). An examination of its institutional facilities may present relevant findings to improve the level of innovation in the UT.

Institutional Facilities - IIT Delhi

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

Delhi may work towards enhancing its digital infrastructure by creating an e-portal that presents information regarding incentives, possible sources of capital, support and mentorship, and provides a grievance redressal mechanism for players in the startup ecosystem of the UT. This may reduce the asymmetry of information between the state and prospective innovators and provide the latter with the means to strengthen the overall innovation ecosystem of Delhi.

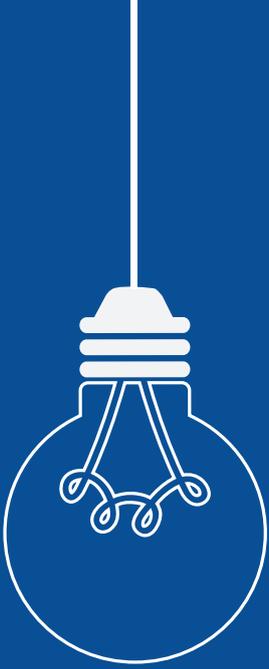
The Delhi Startup Policy, 2022 provides for establishing a policy implementation committee, which is slated to have 85% of its representatives from the private sector. While this is a progressive measure, specifications as to the granular distribution of these representatives may ensure inclusive participation from MNCs, startups and Indian corporates alike. Additionally, the sectoral distribution of these representatives may ensure views are aired from varied industries.

As per data from the India Innovation Index, 2021, the business environment in Delhi is fairly robust. Presently, the service sector in the UT plays a predominant role in its economy. It also is a major source of employment. Hence, it may be claimed that supporting the growth of the service sector is one method to facilitate the economic development of the UT. Removal of barriers to entry, easing of regulations, provision of fiscal and non-fiscal incentives and easy access to credit may be offered to the players in this sector to enable them to scale up their businesses and partake in entrepreneurship, thereby strengthening the innovation system of Delhi.

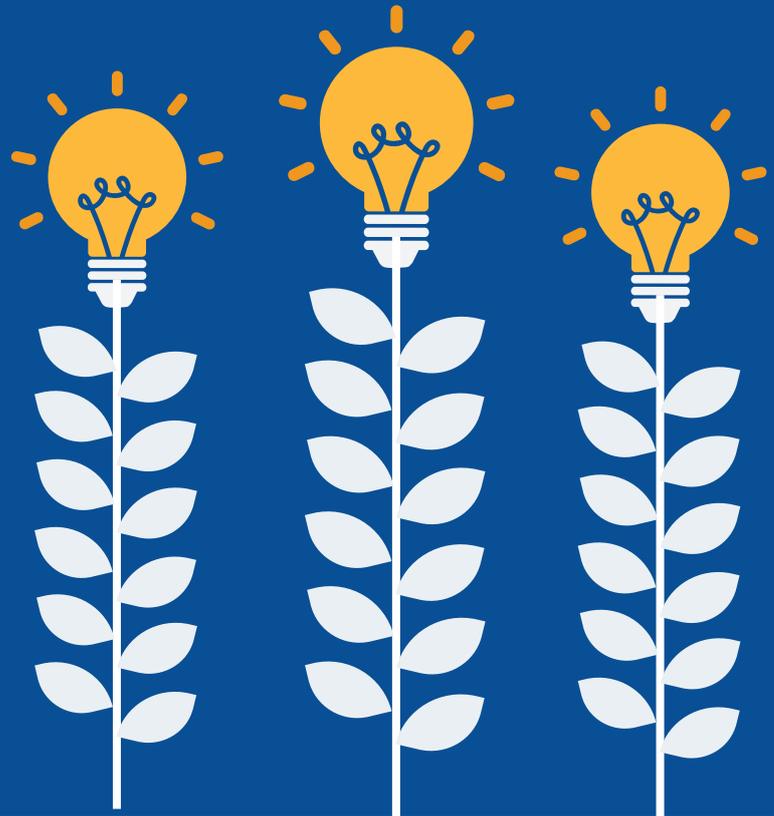
As per the Ease of Living Index, 2020 Delhi's urban infrastructure suffers from insufficiencies pertaining to inadequate drainage facilities and low availability of public transport. Additionally, the city's woes regarding air pollution are well documented. As these prevailing issues may have the effect of impeding business and entrepreneurial activities in Delhi, it may address the same through targeted policy measures so as to ensure the unhindered growth of its innovation system.

Delhi has consistently invested in improving the quality of its education and skilling ecosystem, which can be seen in its large budget allocation towards the same. Additionally, it also launched an incubation policy in 2016, which supported the growth of university-based incubators in the city. These measures indicate that investing in education is a priority for the UT, which has allowed it to emerge as a significant hub of education in the country. However, there appears to be a lack of investment in scientific innovation and R&D activities, which may hinder the innovation system in Delhi from realising its full potential in terms of producing knowledge and translating the same into workable products and services for the industry. Hence, the UT may aim to increase its focus on investment in this regard.

In terms of research output of the top 100 NIRF-ranked engineering institutes in India for 2010-2016, Delhi's engineering HEIs have a high research output. As Delhi is regarded as a hub of education, its high concentration of premier universities and institutions may have aided the promotion of university-based research in the region. One institute in particular, i.e. IIT Delhi, accounts for most of the publications and patents granted to engineering HEIs in the UT. A review of its institutional facilities indicates the presence of robust infrastructure within the HEI for undertaking research and entrepreneurial activities, which may be emulated by other HEIs in the city and other parts of the country.



Chandigarh



Chandigarh was one of India's first planned cities, designed by the Swiss-born architect Le Corbusier. The city was constituted into union territory in 1966. It presently acts as the shared capital of the two states, Haryana and Punjab, and the union territory itself (Bhardwaj 2022).

Under the India Innovation Index, the UT was ranked first in the UT and city-states category. As for the States' Startup Ranking 2021, Chandigarh was placed into the category of 'Aspiring Leader', i.e. the 4th category in these rankings. This section covers the merits of its innovation system and highlights potential areas for improvement.

Chandigarh's Startup and Innovation Environment

Policy Framework

(a) Key policy-making bodies & nodal agencies

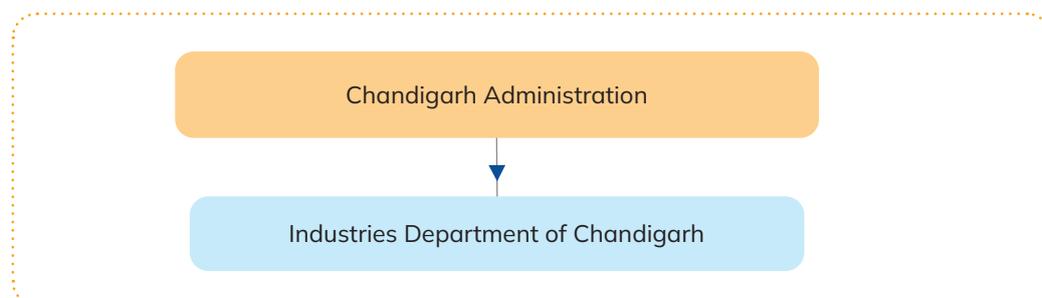


Figure 64: Key Policymaking Bodies in Chandigarh ("Chandigarh UT Report" 2022).

The Chandigarh Administration is the apex policymaking body in the UT. The Chandigarh Administration has appointed the Industries Department of Chandigarh as the nodal agency for developing the UT's startup and innovation ecosystem.

Acting as the nodal agency, the Industries Department of Chandigarh developed the Rajiv Gandhi Chandigarh Technology Park (RGCTP) to strengthen the UT's startup ecosystem. The top IT companies situated in the IT Park are Infosys, Tech Mahindra, Wipro and IDS Infotech ("IT Park Chandigarh" 2018).

(b) Assessment of Chandigarh's startup policy

In 2022, Chandigarh floated a draft startup policy to invite comments from the public as well as stakeholders. This draft policy mentions the following as its objectives:

- To make Chandigarh an aspirational geographical and human resources base for high-value startups
- To invite the best entrepreneurial minds to make Chandigarh their professional base, and thereby build a robust startup ecosystem in Chandigarh
- To foster collaboration among research and education institutes, Government and corporates
- To galvanise the startup ecosystem and to provide national and international visibility to the startup ecosystem of India
- To foster a culture of innovation in the field of Science and Technology amongst students
- To reduce the regulatory burden on startups thereby allowing them to focus on their core business and keep compliance cost low ("Draft: Chandigarh Startup Policy" 2022).

The startup policy includes provisions for fiscal support, non-fiscal support, ecosystem mobilisation activities, market access, mentorship, academic interventions, support for women-led startups, as well as provisions for the governance of the policy (Ibid).

While the draft of the policy has been published, its provisions are subject to revision. Hence, undertaking an assessment at this stage would be premature. Instead, comparing the number of startups and incubators in Chandigarh with those in other UTs may provide relevant insights pertaining to the innovation landscape of Chandigarh.

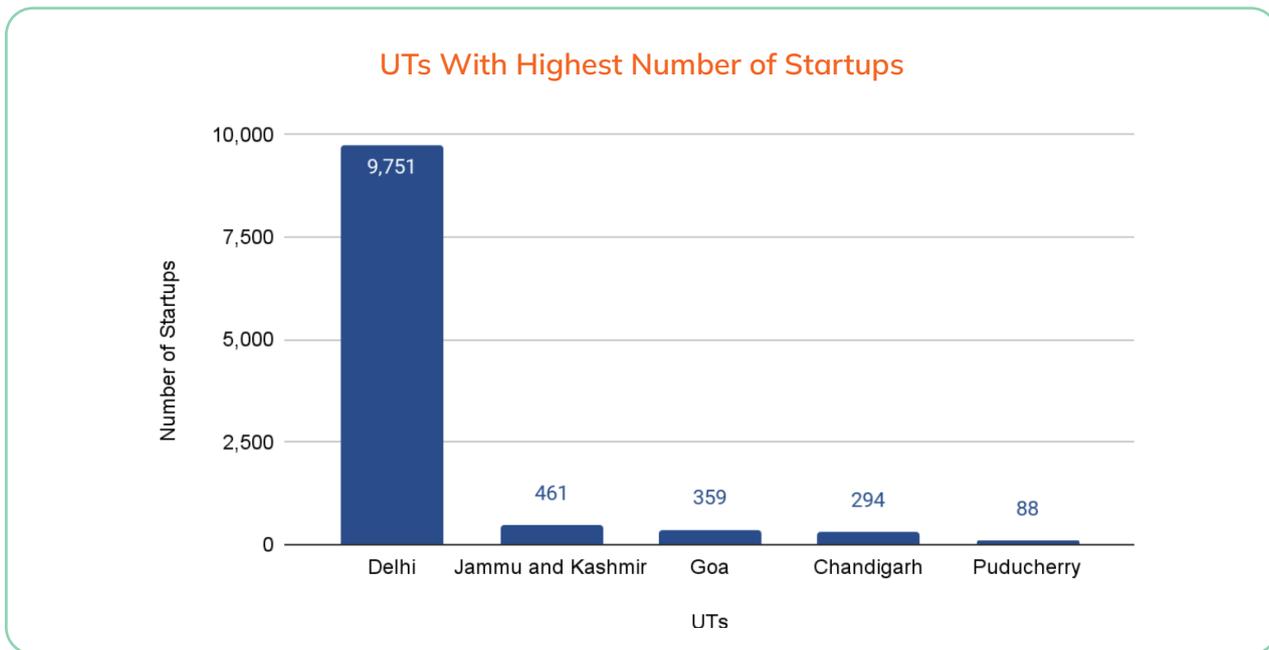


Figure 65: UT-wise Comparison of Number of Startups, As on 21st December 2022 ("Startup India" 2022).

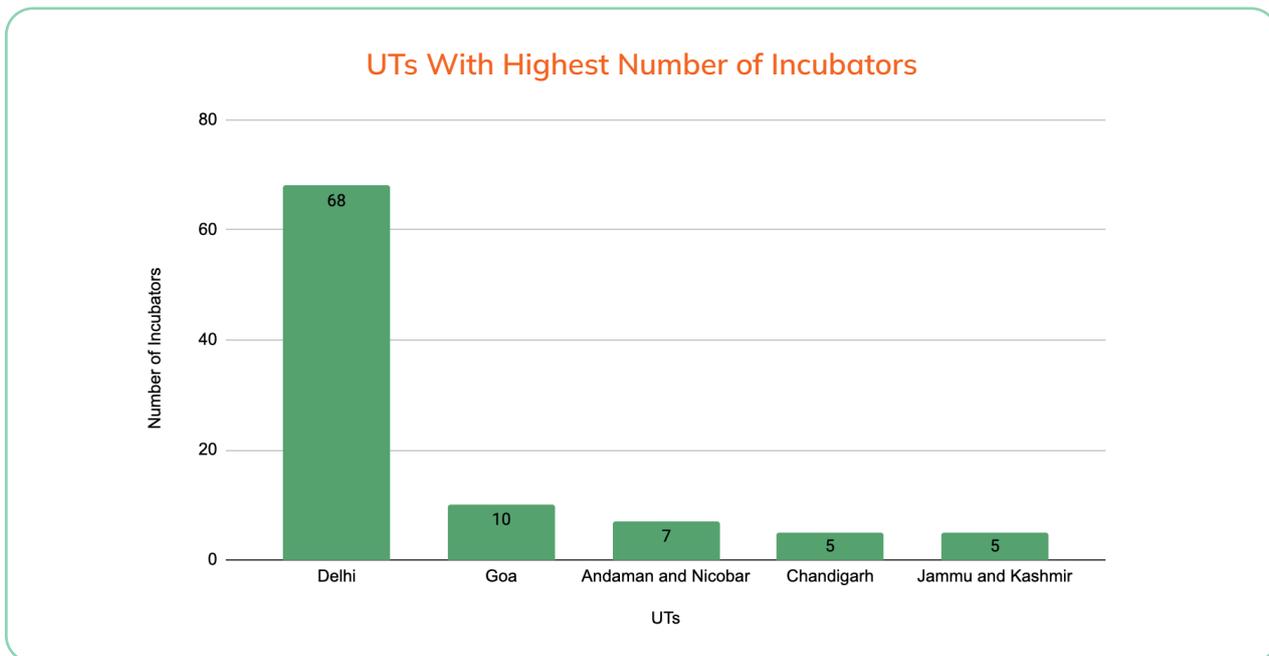


Figure 66: UT-wise Comparison of Number of Incubators, As on 21st December 2022 ("Startup India - Incubators", n.d.).

As seen in figures 65 and 66, Chandigarh has a comparatively lower number of startups as well as incubators than other UTs in India. It may craft suitable policy measures to bridge this gap.

Presently, there is a government-supported incubator in Chandigarh that focuses on promoting IT/ITeS industries and startups. The Society for Promotion of IT in Chandigarh (SPIC) under the Chandigarh Administration

set up this incubation centre which promotes IT/ITeS startups and small companies through a 7-step selection process. It has incubated several startups, including two women-led startups (“Chandigarh UT Report” 2022). The UT may develop more incubation units in collaboration with industry players or provide incentives to encourage the setting up of independent incubators that can boost entrepreneurial activity in the region.

Features of Chandigarh’s Innovation System

1 Human Capital

3 Knowledge Output & Diffusion

2 Business Environment

4 R&D Expenditure

1. Human Capital

Chandigarh was reported as the best performer in the UT and city-states category in the human capital pillar of the India Innovation Index 2021. Data from the Index suggests that the UT has invested in improving the standard of its educational environment, thereby enhancing the quality of its human capital. For example, in terms of education facilities at the school level, it recorded the highest percentage of schools with computer facilities and Atal Tinkering Labs. Additionally, compared with the previous editions of the Index, Chandigarh reported a substantial increase in the percentage of schools with ICT labs from about 59% to almost 100% and also reported an improvement in the pupil-teacher at the tertiary level (Niti Aayog 2022). In the case of higher education, while Delhi reported the highest number of PhD enrolments, Chandigarh came close behind it in this parameter. The UT also reported housing many higher education institutions with NAAC A and above grade (Niti Aayog 2022).

Furthermore, as per data from the Index, Chandigarh also has the potential to effectively skill and provide employment avenues to its human capital, which can be seen in its performance under the knowledge worker pillar under the Index. It outperformed all other states and UTs under consideration of this report. It performed considerably well on several indicators under this pillar, including creating knowledge-intensive employment, the number of private R&D units in the state and the percentage of females employed with advanced degrees out of the total employed (Niti Aayog 2022). On this basis, it may be argued that the UT has substantially invested in improving its human capital’s education and skill attainment.

Despite these concerted efforts, Chandigarh’s Export Promotion Plan 2020-21 noted that a skilled workforce is unavailable in Chandigarh. While the UT has a few multinational and tech companies, most corporate offices operate out of tier 1 cities like Gurgaon or Bengaluru. Therefore, many skilled professionals shifted out of Chandigarh for employment opportunities. Additionally, there is a noticeable lack of engineering colleges in Chandigarh, as a result of which professionals have to be outsourced from other cities (“Chandigarh Export Promotion Plan” 2021). Hence the UT may craft policies and incentives to attract and retain multinational and tech companies to set up their base in Chandigarh. This may provide employment opportunities for professionals and drive IT and software exports from the UT.

2. Business Environment

Chandigarh scored lower than Delhi in the business environment pillar under the India Innovation Index 2021. However, compared to its performance under the previous edition of the Index, Chandigarh improved its performance under this pillar. It witnessed an increase in its score on the ‘cluster strength’ indicator and was reported to have overperformed in the indicator pertaining to ‘villages in the state with internet connectivity’ (Niti Aayog 2022).

In terms of the safety and legal environment pillar under the India Innovation Index 2021, Chandigarh secured the highest score among all states and UTs under consideration of this report. The UT was reported to be overperforming in the indicator pertaining to ‘pendency of court cases’. As the quick resolution of disputes boosts investor outlook, Chandigarh’s performance in this area is a favourable sign for ease of doing business in the UT.

However, the UT underperformed in the investment pillar under the India Innovation Index 2021. It received a low FDI inflow of ₹2,558 (in lakhs), far lower than the national average of ₹4,69,955 (in lakhs) and below the UTs average of ₹3,21,953; it also scored low in the indicator related to the number of venture capital deals (Niti Aayog 2022).

The Chandigarh Export Promotion Plan 2020-21 noted that there are only two venture capital-funded companies in Chandigarh, while in Bengaluru, there are close to 700. Additionally, it reported that there is no presence of private equity players in the IT sector in Chandigarh. Further, it observed that too much regulation in Chandigarh limited the establishment of IT companies in the city, as a result of which Dell shifted to Gurgaon and Emerson moved to Noida (“Chandigarh Export Promotion Plan” 2021). To facilitate entrepreneurship in a region, it may be argued that the government must create policies that enable the flow of capital towards startups as well as limit regulation in this sector. Hence, Chandigarh may design suitable policies and incentives along these lines to strengthen its startup ecosystem.

3. Knowledge Output & Diffusion

Among the states and UTs under consideration of this report, Chandigarh scored the highest in the knowledge output pillar under the India Innovation Index 2021. Additionally, Chandigarh improved its performance in terms of filings of patents, trademarks, and industrial designs from the previous edition of the Index (Niti Aayog 2022). While this may provide tentative evidence of Chandigarh’s ability to produce knowledge, a closer look at relevant data may reveal more insights. In this regard, patents are considered as a reasonably reliable measure of innovative activity at the regional level (Acs, Anselin, and Varga 2002). Hence, the number of patents filed and granted from Chandigarh may be used as a proxy to ascertain the UT’s capacity in terms of knowledge production and innovation. As seen in the figure below, Chandigarh’s contribution to patents filed and granted in India averages around 0.42%, which is dismal compared to the other UT under consideration of this report, i.e. Delhi (its contribution to patents filed and granted in India averages around 13%).

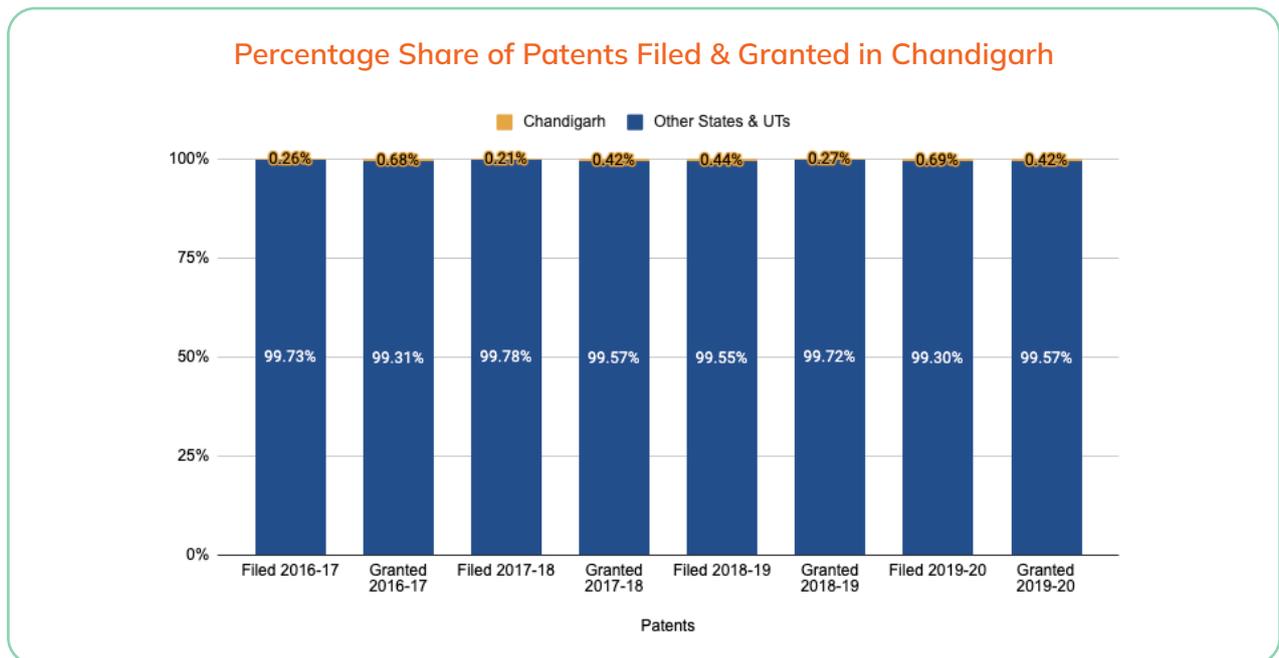


Figure 67: Percentage Share of Patents Filed and Granted in Chandigarh (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

Percentage of Patent Applications Granted in Chandigarh

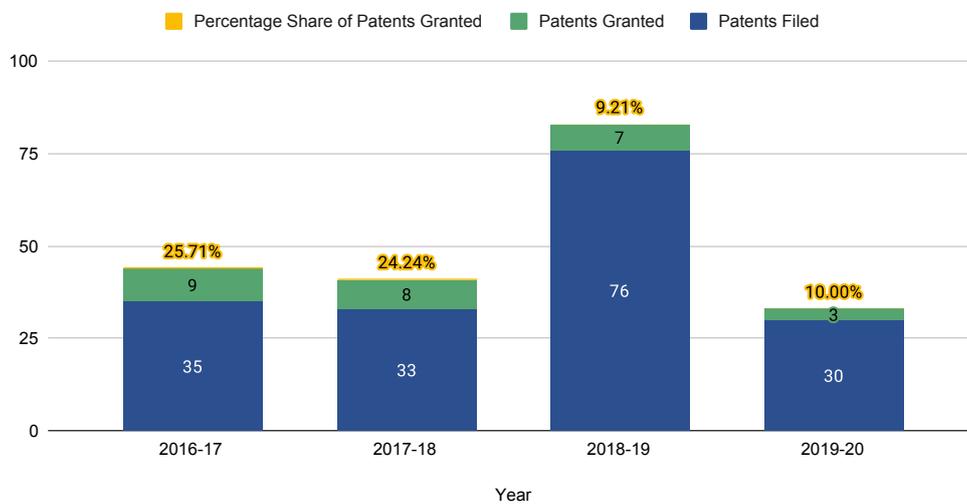


Figure 68: Percentage of Patent Applications Granted in (“Minister of Commerce & Industry, Written Reply in Rajya Sabha” 2019)

However, the percentage share of patents granted in Chandigarh averages around 17.39%. While this figure is lower than Delhi’s average (31%), it still exceeds Maharashtra and all the other states under consideration of this report. Hence, while the overall knowledge output of Chandigarh in terms of contribution to patents filed and granted in India may be low, its percentage share of patents granted is significantly high, indicating the commercial viability and utility of inventions emanating from the UT.

In terms of the knowledge diffusion pillar of the India Innovation Index 2021, Chandigarh performed comparatively well among states and UTs under consideration of this report but scored lower than Delhi. It also saw a drop in its software exports (as a percentage of GSDP) from the previous edition of the Index (Niti Aayog 2022). In this context, the UT may design suitable policy measures to supplement its level of knowledge creation as well as its diffusion of the same.

4. R&D Expenditure

The Research and Development Statistics 2019–20 do not provide any statistics related to Chandigarh’s R&D expenditure. As for data from the India Innovation Index 2021, Chandigarh underperformed in the ‘investment’ pillar. Under this pillar, Chandigarh scored 0 in two indicators, namely ‘expenditure on R&D’ and ‘expenditure on Sci, Tech and Env as a (% of GSDP)’. Additionally, data from a report titled “R&D Expenditure Ecosystem” indicated that the Department of Science & Technology (DST) did not receive a proposal for releasing grants to Chandigarh’s S&T council (Economic Advisory Council to the Prime Minister 2019). The apparent lack of investment in scientific research and R&D in the UT may negatively impact its innovation system and future economic progress. Hence, the UT may seek to receive central government grants and allocate a certain sum of its budget towards R&D activities to augment its innovation system and overall growth.

S&T and Industrial Clusters

Chandigarh has not been included in the list of regions in India where the establishment of S&T clusters has been proposed by the Government of India. However, other types of knowledge clusters do exist in the UT. The Chandigarh Region Innovation and Knowledge Centre (CRIKC) is a knowledge cluster/hub headquartered at Panjab University. It includes institutions of higher education and research in and around Chandigarh and aims

to facilitate efficient interaction and alliances among them to encourage knowledge sharing and innovation (“CRIKC”, n.d.). As the Chandigarh region has a high density of educational institutions, this knowledge cluster/hub draws upon the expertise of these institutions to augment innovation in the region; 29 HEIs are listed as participating institutions in this cluster/hub (“CRIKC”, n.d.). Apart from facilitating knowledge sharing, this cluster also provides

avenues for researchers to commercialise their inventions. In November 2022, an exhibition was conducted by Panjab University in collaboration with the Confederation of Indian Industries (CII), Punjab and Chandigarh Administration, that invited researchers from CRIKC member institutes to showcase their technologies and enable the possibility to transfer them to the industries for commercialisation (The Indian Express 2022).

Aside from this knowledge cluster, a technology park is also situated in Chandigarh called the Rajiv Gandhi Chandigarh Technology Park (RGCTP). Additionally, the UT has industrial clusters made up of two Special Economic Zones (SEZs). Both are focused on the IT/ITeS sector, and the following map depicts the same:

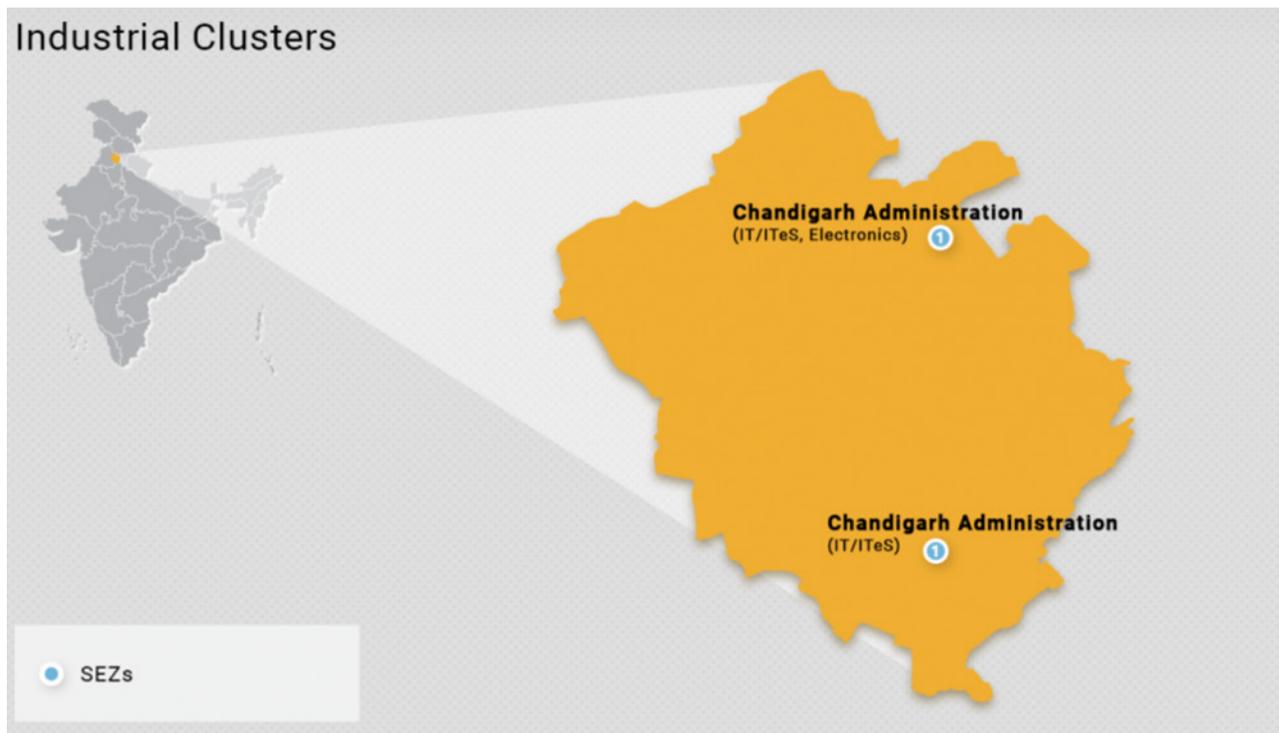


Figure 69: Industrial Clusters in Chandigarh (Invest India, n.d.).

With an increase in input costs and saturation of urban infrastructure in tier 1 cities in India, there is a possibility that IT & ITeS companies may shift their base to other cities in India. In this context, Chandigarh may emerge as a viable alternative base for such companies. Hence, the existing IT parks and SEZs in Chandigarh may be leveraged by designing policies that align their focus and output with the requirements of the industry. Additionally, incentives must also be offered to industry players so as to encourage them to invest their capital in Chandigarh's emerging IT sector.

Role of HEIs vis-a-vis Chandigarh's Innovation System

University-Industry Linkages

Chandigarh was not included in a study that assessed University-Industry Linkages (UILs) conducted by the PHD Chamber of Commerce and Industry. Hence, data to indicate the strength of UILs in Chandigarh is not available for drawing inferences and making recommendations.

Research Output

Under the NIRF ranking of 2022, Panjab University was ranked as the top university in Chandigarh and positioned 25th in the university category (“National Institute Ranking Framework” 2022). In light of the same, an assessment of the research output of this university may provide valuable insights for this report.

As per a study that mapped the research output of HEIs in India, Panjab University emerged as the top university in Chandigarh in terms of its research output (Kumar 2017). It was ranked 9th in terms of the number of publications (see figure 70) and 7th in terms of the number of patents granted (see figure 71) to the NIRF-ranked top universities in India for the years 2010–2016.

Top NIRF Ranked Universities in Terms of Research Publications 2010-2016

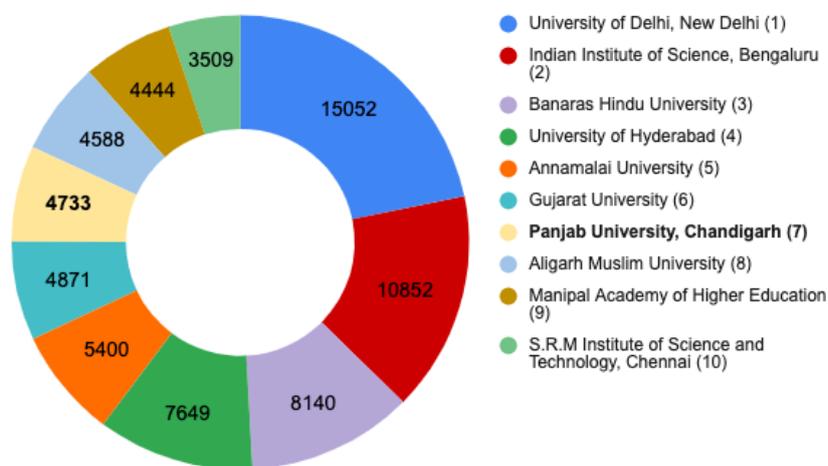


Figure 70: NIRF Ranked Universities in Terms of Research Publications 2010-2016 (Kumar 2017)

Note: The parenthesis next to the legends in this figure represent the ranking of these universities in terms of the number of their research publications.

Top NIRF Ranked Universities in Terms of Number of Patents Granted 2010-2016

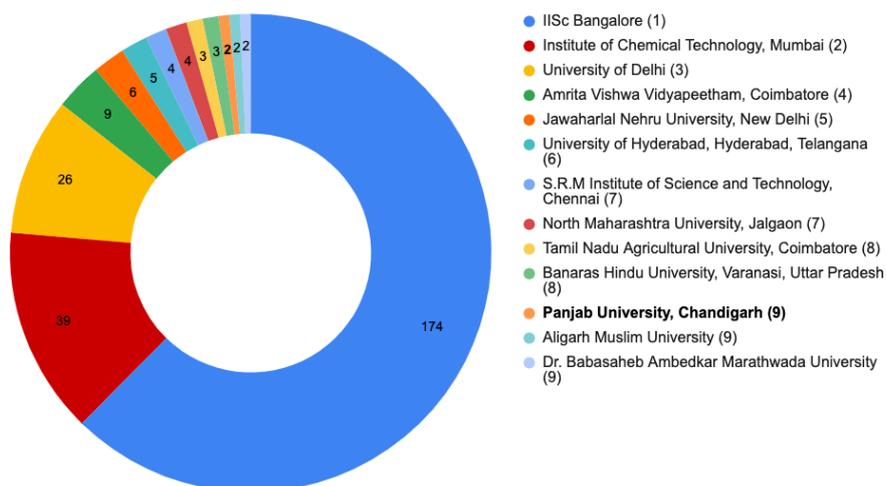


Figure 71: NIRF Ranked Universities in Terms of Patents Granted 2010-2016 (Kumar 2017)

Note: The parenthesis next to the legends in this figure represent the ranking of these universities in terms of the number of patents granted.

Apart from Panjab University, an assessment of the research output of engineering HEIs in Chandigarh is also relevant to this report. Among the top 100 NIRF-ranked engineering institutes in UTs of India, the research output from Chandigarh-based engineering HEI for the years 2010-2016 is quite low, especially when compared to Delhi, as seen in the chart below:

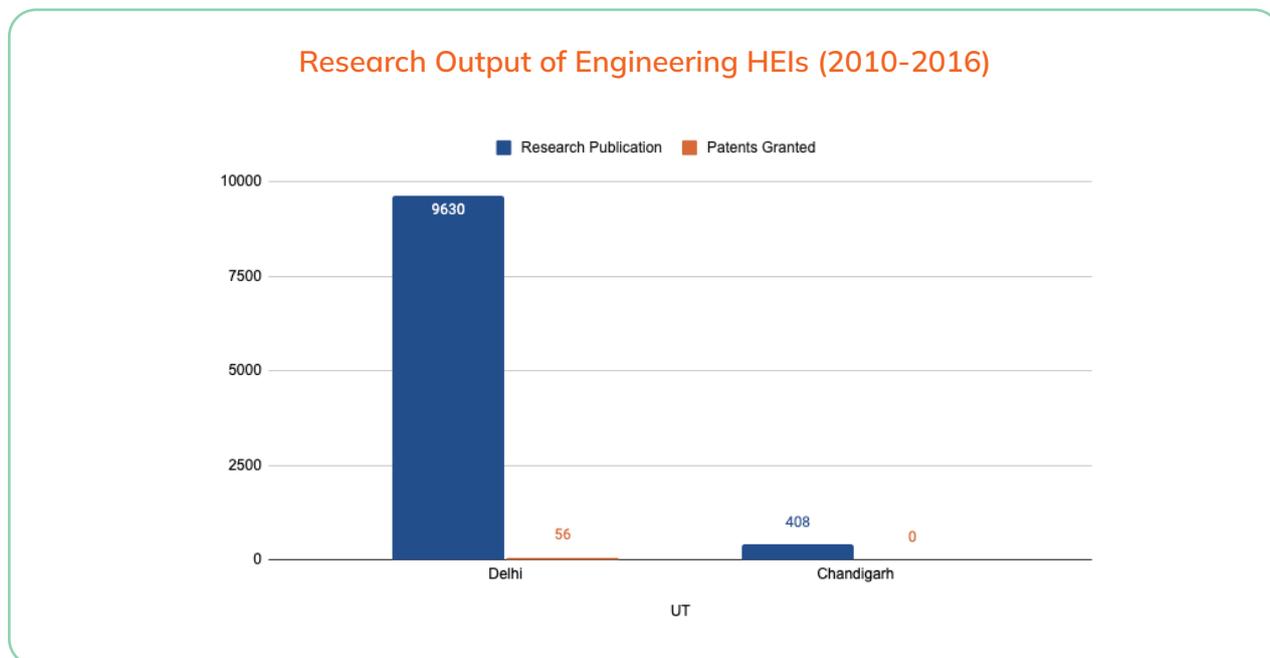


Figure 72: Comparative Percentage Share in Research Publications & Patents Granted to Engineering HEIs in Delhi & Chandigarh (Kumar 2017).

Chandigarh’s engineering HEIs account for 0.43% of the total research publications and 0% of the total patents granted to engineering HEIs in India from 2010 to 2016, indicating a dismal picture for university-based innovation and research in the UT. Only three engineering HEIs situated in Chandigarh were listed in this publication (Kumar 2017). The following table presents the number of their research publications and patents granted to these HEIs.

Table 15: Research Output of Engineering Institutions in Chandigarh, 2010-2016

Name of HEI	Research Publications	Patents Granted
Punjab Engineering College, Chandigarh	256	0
Chemical Engineering & Technology, Panjab University, Chandigarh	152	0

Source: (Kumar 2017)

In light of the foregoing, it may be surmised that the research output of academic institutions (universities and engineering HEIs) in Chandigarh is comparatively low to other UTs and states in India. However, Panjab University and Punjab Engineering College are the top-performing institutions in terms of their research profile. Hence, examining the institutional facilities present in these institutions may present relevant findings to improve Chandigarh’s innovation system.

Institutional Facilities - Panjab University, Chandigarh

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

Parameter 2: In-house Pre-Incubation & Incubation Infrastructure

Whether the following facilities are available on campus:

- Research Park
- Pre-Incubation Centre/Facility
- Incubation Centre/Facility
- Startup Club/Cell
- Entrepreneurship Club or Cell
- IPR Management/Patent Facilitation Unit/Technology Transfer Cell
- Industry-Academia Cell or Industry-Institute Interface Unit
- Centre of Excellence
- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Institutional Facilities - Punjab Engineering College, Chandigarh

Parameter 1: Activities and Collaborations Pertaining to Innovation & Entrepreneurship

- Whether seminars/conferences/conclaves have been conducted by the HEI related to IPR/entrepreneurship/start-ups/innovation
- Whether programs/certifications such as Management Development Programs (MDP) & Faculty Development Programs (FDP), Enterprise Development Programs, (EDP), Employment Generation Skill Development Programs have been conducted by the HEI
- Whether full-time credit courses on innovation, IPR and entrepreneurship development are offered by the HEI
- Whether the HEI has conducted collaborations with the government/start-ups/industry to promote innovation or entrepreneurship activities and/or provide internship or mentorship opportunities in the HEI

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- Maker Space

Parameter 3: Administrative Measures for Research & Innovation

- Whether the HEI has a policy with regard to research management and providing administrative support to researchers
- Whether an appointed faculty member or research office has been allotted for handling administrative support for research work

Policy Recommendations

Under the India Innovation Index 2021, Chandigarh was ranked first in the UT and city-states category. However, it accounts for a low number of startups and incubators compared with other UTs in India. It may craft suitable policy measures to develop incubation units in collaboration with industry players to encourage regional entrepreneurial activity.

While the UT has concerted in improving the quality of its human capital, a skilled workforce is not available in Chandigarh as most corporate offices operate out of tier 1 cities in India, resulting in the migration of skilled professionals from Chandigarh to other cities for employment opportunities. Hence, the UT may offer tax incentives to encourage IT companies to set up their base in Chandigarh, thereby increasing employment opportunities.

While Chandigarh ranks high in terms of its safety and legal environment, it underperformed under the Index's investment and business environment pillars. The paucity of venture capital and private equity for startups and excessive regulations have limited the establishment of companies in the UT. To address this, policies may be designed to limit regulation on industry players and encourage them to invest their capital in the UT's startup ecosystem.

In terms of knowledge output, Chandigarh's contribution to patents filed and granted in India is dismal when compared to other regions in India. However, Chandigarh's comparative share of patents granted to those filed is significantly high, indicating the commercial viability of inventions emanating from the UT. As for knowledge diffusion, Chandigarh witnessed a dip in software exports from the previous edition of the Index. In this context, industry players may be provided tax incentives to utilise and invest in the existing IT park, SEZs and knowledge cluster in the city to drive up the software and IT exports from Chandigarh.

The research output of HEIs in Chandigarh is comparatively lower than other UTs and states in India. Panjab University and Punjab Engineering College are the top-performing HEIs of the UT in terms of their research output. An assessment of the former's institutional facilities suggests that it is comprehensively equipped to encourage research and innovation. As for the latter, facilities such as a research park, pre-incubation centre and maker space are not present within the institute; their addition has the potential to provide much-needed impetus to the endeavours of prospective innovators. Furthermore, as the Chandigarh Export Promotion Plan 2020-21 aims to increase IT/ITeS exports to enable the UT's economic growth, HEIs may take cognisance of the same and tailor their research, facilities and infrastructure accordingly.



Conclusion

Factors that thwart the development of India's innovation system include poor policy implementation, the concentration of industries and capital in cities, low knowledge diffusion within regions, and poor urban infrastructure and legal environment that impacts investor confidence. The university innovation ecosystem, in particular, is plagued with insufficient state expenditure on scientific research & development, limited private investment due to weak linkages with the industry, and inadequate institutional facilities. This report has made broad recommendations to overcome these challenges and enhance the country's innovative capacity. It is hoped that these recommendations inform policymakers and enable them to craft policies conducive to innovation, thereby giving impetus to India's economic and social progress.

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