सत्यमेव जयते

NITI Aayog

Improving the **Culture of Research** and **Development** (R&D) in **State Universities** and **Institutes**

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I. Introduction

In the aftermath of India's independence, a myriad of higher education institutes (HEIs) sprouted across the nation, setting the stage for academic evolution. Within this landscape, certain distinguished institutions like the Indian Institute of Science (IISc), the Tata Institute of Fundamental Research (TIFR), and the Indian Institutes of Technology (IITs) emerged as stalwarts of exemplary research. However, the majority of traditional universities, whether publicly funded or privately owned, despite their extensive numbers and societal outreach, encountered challenges in producing research of notable quality. This dichotomy between elite and conventional institutions has given rise to a prevailing sentiment that the overall research output in India does not align with the country's lofty aspirations.

In response to this imperative, the Government of India has orchestrated various strategic initiatives to fortify Research and Development (R&D) in India. These endeavours encompass targeted missions such as the Startup India initiative, the implementation of schemes like FIST (Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions), PURSE (Promotion of University Research and Scientific Excellence), and the establishment of Science and Technology (S&T) clusters. While these measures have yielded certain improvements, the Global Innovation Index (GII) underscores that, despite progressing from 52 to 40 between 2019 and 2023[1], India still requires refinement in terms of institutes and infrastructure. Notably, India exhibits strength in market sophistication but lags in creating a robust research ecosystem.

The Government's proactive role extends beyond traditional expectations, encompassing a multifaceted approach to augmenting the quality of research. This approach aligns with conventional government involvement in basic research, where immediate commercial benefits may not be apparent, where costs and risks are prohibitive for private sector investment, and where the focus is on developing public goods essential for areas like public health and energy. However, a nuanced understanding of the government's responsibility acknowledges the imperative of cultivating an enabling ecosystem for research and innovation. This involves considerations such as funding, education, training, skill development, and support for knowledge creation and dissemination.

This report asserts that India harbors the potential to ascend to the strata of a global leader in research and development, surpassing mere aspirations. It underscores a discernible imbalance in the demand and supply of quality research output within India, presenting a challenge that requires redressal to realize the ambition of positioning India as a formidable center for scientific and technological innovation. Central to this argument is the imperative for the government to institute compelling incentives for the primary stakeholders – academia, research professionals, and the industry – to actively engage and invest in R&D endeavours. By fostering a harmonious collaboration among these critical elements, India can pave the way for a transformative journey towards becoming a forerunner in scientific and technological innovation on the global stage.

II. Purpose and Scope of the Report

The NITI Aayog has recognized the need to strengthen the culture of Research and Development in State Universities and Institutes to harness their full potential. This report aims to provide a comprehensive overview, analysis, and set of recommendations based on insights gathered from meetings with Vice Chancellors and Heads of such institutions across various states and union territories.

For this purpose, the NITI Aayog undertook a systematic approach, organizing a structured sequence of meetings with Vice Chancellors, Heads, and other Senior Representatives from universities and institutes spanning the length and breadth of India. These consultations were strategically divided based on geographical regions, including the National Capital Region of Delhi, the northern, eastern, northeastern, southern, and universities in the western and central regions. This comprehensive outreach covered a spectrum of stakeholders, totalling over 110 universities and institutes from all 36 States and Union Territories of India.

The scope of this report encompasses an in-depth examination of the current status of R&D in State Universities and Institutes, highlighting the challenges impeding its growth. By delineating the existing landscape, the report sets the stage for formulating strategic interventions and policy measures to invigorate the R&D ecosystem in these institutions. It serves as a roadmap for fostering a vibrant culture of research, innovation, and knowledge creation, aligning with national aspirations for excellence in the academic and scientific domains.

III. Background on the Importance of R&D in Academic Institutions

Research and Development (R&D) stands as the cornerstone of academic institutions, serving as a catalyst for innovation, knowledge advancement, and societal progress. In the dynamic landscape of education, R&D plays a pivotal role in shaping the future by fostering a culture of inquiry, experimentation, and discovery. Academic institutions, particularly State Universities and Institutes, are crucial contributors to the national research ecosystem, possessing the potential to drive groundbreaking discoveries, technological innovations, and solutions to pressing challenges.

Understanding "Research": The dictionary definition of research is, "*a careful study of a subject, especially in order to discover new facts or information about it.*"[2] Research can be broadly categorized into two main types:

Basic or fundamental research: Research that is usually driven by a scientist's curiosity to seek unchartered territories in the pursuit of truth, and

Applied research: Utility-driven research for tangible and well-defined deliverables, involving innovations in technology, creating new products, achieving improved control over systems and developing processes that are efficient and/or cost-effective.

It is important to promote both types of research in order to achieve economic growth and development from a public policy perspective. Note that the terms 'Research' and 'R&D' are used interchangeably within this report

The significance of R&D in academic institutions extends beyond the confines of traditional education. It propels institutions to the forefront of global competitiveness, positioning them as hubs for cutting-edge research, interdisciplinary collaboration, and intellectual contributions. As the world undergoes rapid transformations, the role of academic R&D becomes increasingly crucial in preparing students for the demands of a knowledge-driven society.

[2] https://www.oxfordlearnersdictionaries.com/definition/english/research_1#:~:text=%2Fr%C9%AA%CB%88s%C9%9C%CB%90rt%CA%83%2F,facts%20or%20information%20about%20it

IV. R&D Landscapes in the Global Arena

i. Germany

Gross Domestic Expenditure on R&D (GERD):

A consistent investment of around 3% of its Gross Domestic Product (GDP) is made by Germany in research and development, positioning the country among the top global spenders in R&D relative to GDP.

Sector Contributions:

- **Engineering:** Germany is known for its engineering expertise, particularly in automotive and industrial engineering, where ongoing R&D investments by companies like Volkswagen, BMW, and Siemens drive technological developments.
- **Pharmaceuticals and Biotechnology:** Significant contributions to R&D are made by the pharmaceutical and biotechnology sectors. Companies such as Bayer and Merck actively engage in healthcare research and biotechnological innovations.
- **Renewable Energy:** Germany's focus on sustainability drives R&D efforts in renewable energy technologies like solar and wind, fostering developments in energy efficiency and green technologies.
- **Information Technology:** The IT sector, represented by companies like SAP and Infineon, contributes to R&D efforts in areas such as cybersecurity, artificial intelligence, and digitalization.

Collaboration and Research Networks:

Germany's R&D landscape relies on collaborations between academia, research institutions, industries, and government bodies. Initiatives like the Fraunhofer Society, Max Planck Institutes, and Helmholtz Association facilitate collaboration for applied research and technology transfer.

International Collaboration:

Germany actively participates in international collaboration, engaging in joint research projects and collaborations with global partners through programmes like Horizon Europe, enabling collaborative research across borders.

Key policies contributing to R&D output by state and higher education institutions

- **Excellence Initiative:** Launched in 2005, the Excellence Initiative aims to enhance the research landscape at German universities. It identifies top-performing institutions and

research clusters, providing additional funding to bolster their research capabilities and international competitiveness.

- **Fraunhofer Society (FhG):** The Fraunhofer network comprises applied research institutions collaborating closely with universities and industries. This collaboration facilitates the translation of research into practical applications, fostering innovation and technology transfer.
- **Industry-Academia Collaboration:** Policies promoting partnerships between universities and industries drive R&D output. Initiatives like joint research projects, technology transfer programmes, and industry-sponsored chairs facilitate knowledge exchange, leading to applied research and innovation.
- **Strategic Research Funding:** Government-sponsored research funding programmes, such as the Federal Ministry of Education and Research (BMBF) initiatives, provide grants and support for R&D projects in various sectors, encouraging universities and institutions to pursue innovative research.
- **International Collaboration and Networks:** Policies supporting international collaborations and participation in research networks enable German institutions to engage in global research initiatives, fostering knowledge exchange and access to diverse expertise.
- **Research Clusters and Centers of Excellence:** Germany promotes the establishment of research clusters and centers of excellence, encouraging collaboration among universities, research institutions, and industries to focus on specific areas of innovation and expertise.

ii. Japan

Gross Domestic Expenditure on R&D (GERD):

Japan consistently directs a significant portion of its GDP, typically around 3.5%, towards research and development, showcasing a consistent commitment to fostering innovation and technological progress.

Sector Contributions:

- **Electronics and Automotive Technology:** Japan is recognized for its contributions to electronics and automotive technology. Ongoing R&D investments by companies such as Sony, Toyota, and Honda drive advancements in these sectors.
- **Robotics:** Japan is a key player in robotics R&D, focusing on innovations in automation and robotics technology for various industries.
- **Biotechnology and Materials Science:** R&D efforts in biotechnology and materials science contribute significantly to Japan's innovation landscape.

Policies and Initiatives:

Japan has implemented strategic R&D plans like the Science and Technology Basic Plan, outlining long-term objectives and funding priorities to drive innovation.

Policies promoting industry-academia collaboration through joint research ventures, technology transfer initiatives, and innovation hubs facilitate knowledge exchange and innovation.

International Collaboration:

Japan actively engages in international collaboration, participating in joint research projects and partnerships with global counterparts to enhance research outcomes and foster global innovation.

Key policies contributing to R&D output by state and higher education institutions

- **Science and Technology Basic Plan:** Japan's long-term strategic plan outlines objectives and funding priorities for R&D. It focuses on driving innovation, fostering collaboration between academia and industries, and addressing societal challenges through scientific advancements.
- **Industry-Academia Collaboration:** Policies promoting partnerships between universities and industries are instrumental in driving R&D output. Initiatives such as joint research projects, technology transfer programmes, and industry-academia hubs facilitate knowledge exchange and applied research.
- **Government Funding and Grants:** Japan provides substantial public funding and grants to universities and research institutions, encouraging them to pursue innovative projects and cutting-edge research in various sectors, including technology, healthcare, and environmental sciences.
- **Strategic Research Initiatives:** Japan emphasizes strategic initiatives in key sectors through programmes like the Moonshot Research and Development Program, focusing on ambitious technological goals to address societal challenges and drive innovation.
- **International Collaboration:** Policies promoting international collaborations and partnerships enable Japanese institutions to engage in joint research ventures, share expertise, and access global resources, fostering innovation through diverse perspectives.

iii. Singapore

Research and Development Expenditure:

Singapore directs a significant portion of its GDP, exceeding 2% in recent years, towards R&D investments, showcasing a commitment to fostering innovation and technological advancement.

Sector Contributions:

- **Biotechnology and Pharmaceuticals:** Singapore's R&D landscape strongly focuses on biotechnology and pharmaceuticals, with research initiatives aimed at drug discovery, biomedical sciences, and healthcare innovation.
- **Advanced Manufacturing:** R&D efforts in advanced manufacturing technologies drive Singapore's competitiveness in areas like precision engineering, materials science, and additive manufacturing.

- **Information and Communication Technology (ICT):** The ICT sector contributes to R&D endeavours focusing on digital innovation, cybersecurity, data analytics, and artificial intelligence.

Research Institutions and Innovation Hubs:

Singapore hosts renowned research institutions and innovation hubs like A*STAR (Agency for Science, Technology, and Research), Nanyang Technological University (NTU), and the National University of Singapore (NUS). These institutions drive cutting-edge research and foster innovation through collaboration with industries and international partners.

Government Initiatives:

The Research, Innovation, and Enterprise (RIE) plans outline Singapore's strategic R&D initiatives, emphasizing investment in key sectors, talent development, and fostering partnerships between academia, industries, and research institutions.

International Collaboration:

Singapore actively engages in global research collaborations, partnering with international institutions, participating in joint projects, and fostering scientific exchange programmes to leverage global expertise and address complex challenges.

Key policies contributing to R&D output by state and higher education institutions

- **Research, Innovation, and Enterprise (RIE) Plans:** The RIE plans outline Singapore's strategic vision for R&D, emphasizing investment in key sectors, fostering innovation, and supporting collaboration between academia, industries, and research institutions.
- **Industry-Academia Collaboration:** Policies promoting partnerships between universities and industries drive R&D output. Initiatives such as joint research projects, technology transfer platforms, and the establishment of innovation hubs facilitate knowledge exchange and applied research.
- **Government Funding and Grants:** Singapore provides substantial public funding and grants, channeled through agencies like the National Research Foundation (NRF), to support R&D initiatives, encourage innovation, and attract top research talent.
- **Talent Development and Retention:** Singapore focuses on talent development by attracting and retaining researchers and scientists through initiatives like scholarships, grants, and world-class research facilities, fostering a vibrant R&D ecosystem.
- **Research Institutes and Innovation Hubs:** Singapore hosts renowned research institutions and innovation hubs such as A*STAR (Agency for Science, Technology, and Research), Nanyang Technological University (NTU), and the National University of Singapore (NUS), which drive cutting-edge research and innovation through collaborations.

V. Navigating the Evolution from Core Research to Tangible Solutions

The paradigm shifts from foundational research to translational exploration, culminating in the commercialization of technology, marks a pivotal transformation in how innovation shapes both society and the economic landscape. This progression traverses a spectrum of activities, transitioning from fundamental scientific inquiry to the pragmatic application of discoveries in real-world scenarios.

i. Foundational Research as the Pillar

At the heart of knowledge creation lies India's rich heritage of foundational research, championed by prestigious institutions such as IITs and IISERs. This type of research delves into unravelling the fundamental principles of natural phenomena, often without immediate practical implications.

ii. Bridging the Divide with Translational Research

In contrast, translational research emerges as the bridge, seamlessly translating scientific knowledge into tangible solutions for real-world challenges. Recent times have witnessed a concerted push to narrow the gap between foundational and translational research. Initiatives like the National Initiative for Development and Harnessing Innovations (NIDHI) and the Biotechnology Industry Research Assistance Council (BIRAC) champion academia-industry collaborations, transforming visionary ideas into pragmatic applications.

iii. The Thriving Landscape of Technology Commercialization

The intricate process of commercialization underscores the transformative power of innovation, translating scientific breakthroughs into marketable products or services. This intricate journey involves securing patents, licensing technologies, incubating startups, raising funds, and scaling up production. India's vibrant landscape for technology commercialization thrives underpinned by a robust policy framework and forward-thinking initiatives tailored to the unique needs of diverse sectors.

iv. Policy Support for Propelling Progress

India's strategic policies are integral to shaping this trajectory. Taking the example of the initiatives of the Indian Space Research Organisation (ISRO), the commercialization of space technology by ISRO has not only propelled India's space capabilities but has also acted as a catalyst for burgeoning startups in this domain. Notable examples include Dhruva Space, which offers end-to-end satellite infrastructure solutions, and Skyroot Aerospace, which has pioneered the development of indigenous rockets.

This wave of innovation is not confined to space technology; it extends across diverse sectors such as biotechnology, renewable energy, and information technology. The landscape is marked by a surge in startups, each contributing to the nation's scientific and technological advancement. However, this transition underscores the need for a delicate equilibrium in research and innovation. While the entrepreneurial spirit is driving progress, it necessitates careful consideration to harness the full potential of scientific breakthroughs.

The dynamic continuum in research and innovation requires a harmonious interplay between policy frameworks, institutional support, and entrepreneurial endeavours. Striking this balance will be pivotal in ensuring that India not only keeps pace with global advancements but also emerges as a frontrunner in shaping the future of scientific and technological landscapes.

v. Real-World Impact

The impact of translational research and technology commercialization extends far beyond laboratory walls, finding applications in critical sectors like healthcare and agriculture. The innovation ecosystem is generating solutions addressing pressing challenges, from personalized medicine tailoring treatments to individual patients to precision agriculture optimizing resource utilization. Amidst persistent challenges, including the imperative for increased investment in research and development, bridging academia-industry gaps, and streamlining regulations, India's entrepreneurial resilience and supportive policies position it as a frontrunner for global innovation leadership.

VI. Statistics of Universities/ Institutions/Colleges in India

Universities

There are various type of degree awarding universities and university level Institutions, i.e the Institutions which are empowered to award degree under some Act of Parliament or State Legislature. They are:

- Central Universities
- State Public Universities
- State Private Universities
- Institution Deemed to be Universities
- Institute established under the state legislature
- Institutes of National Importance & Others.

For ease of reference, the State Public Universities and the State Private Universities have been jointly called the State Universities and Institutes in this report.

Universities listed by UGC under section 2(f) and 12B of the UGC act, 1956

As of 31st of March, 2022 UGC listed 54 Central Universities, 450 State Public Universities, 409 State Private Universities, 4 Institutions established under the State legislature act and 126 Institutions Deemed to be Universities[3].

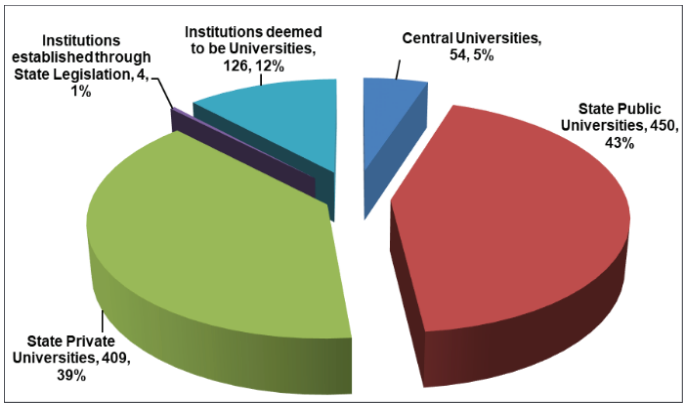

Figure 1: Type wise Number of Universities as on 31.03.2022[3]

From 01.04.2021 to 31.03.2022, 26 State Public Universities, 34 State Private Universities, and 1 Institution Deemed to be University and 1 Institute established under state legislature were included in the list of universities.

Gross Enrolment Ratio in Higher Education

During 2019-20, Gross Enrolment Ratio (GER) in Higher Education in India is 27.10% which is calculated for 18-23 Years of Age Group. GER for Male Population is 26.9% and for Females it is 27.3%. (Gross Enrolment Ratio in 2021-22 is not available).

[3] https://www.ugc.gov.in/pdfnews/5789724_UGC_AR_2021-22_FNL.pdf

VII. Revolutionizing Indian Education through National Education Policy (NEP) 2020

i. Rethinking Higher Education

The National Education Policy (NEP) 2020 unfolds as a transformative narrative, not merely as a policy document but as a catalyst for reshaping India's educational trajectory. In its essence, NEP 2020 represents a paradigm shift, steering the nation towards a future where the synergy between education and research becomes the cornerstone of progress.

NEP 2020 initiates a profound revaluation of higher education, challenging conventional norms and fostering an ecosystem where innovation is not an exception but an expectation. The 'Institutions of Eminence' initiative, a manifestation of this vision, seeks not just excellence but a redefinition of what excellence means in the context of research and innovation.

Beyond the rhetoric, NEP 2020 breathes life into the commitment to bolstering research and development (R&D). This is not a mere quantitative surge but a qualitative leap, focusing on scientific research and the tangible impact of technology development. The crux lies in the acknowledgment that outstanding education cannot exist without a parallel commitment to groundbreaking research – a symbiotic relationship at the core of NEP 2020.

ii. Gross Domestic Expenditure on R&D, as % of GDP

The Gross Expenditure on Research and Development (GERD) in India has exhibited a consistent upward trajectory, witnessing a notable surge from Rs. 60,196.75 crore in 2010-11 to **Rs. 127,380.96 crores in 2020-21**. This substantial increase reflects a more than twofold growth over the specified timeframe, underscoring the nation's intensified commitment to fostering research and innovation.

According to the UNESCO Science Report 2021, **India's global standing in GERD is noteworthy, constituting 3.1% of the World's Gross Expenditure on Research and Development in 2018**. This recognition on the global stage signifies India's growing significance in contributing to the collective pool of scientific and innovative endeavours. The escalating GERD figures and international acknowledgment underscore India's dedication to advancing research across diverse domains, positioning itself as a key player in the global scientific landscape.

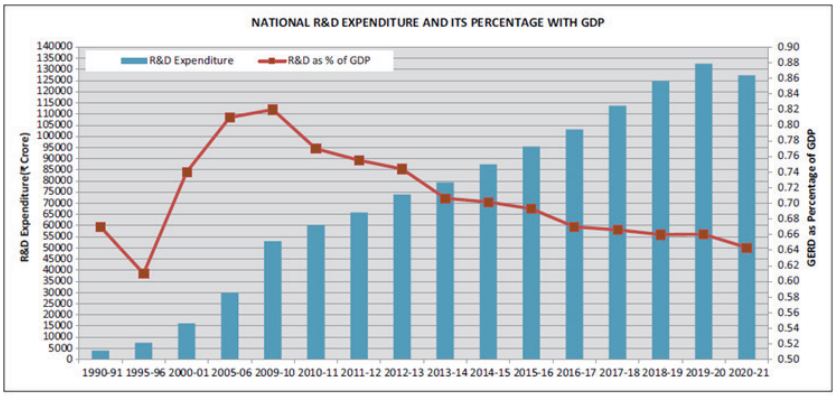

Figure 2: National R&D Expenditure and its Percentage with GDP
(Source - NSTMIS, Department of Science & Technology, Government of India)

iii. Gross Domestic Expenditure on R&D, Composition by Sector

The Science, Technology, and Innovation Policy (STIP) 2013 outlined an ambitious goal, setting the Gross Expenditure on Research and Development (GERD) target for India at 2%. However, despite witnessing annual increments in research and development expenditure, **India's GERD as a percentage of GDP hovers around 0.7%, significantly below the stipulated target**.

A key factor contributing to this shortfall is the sectoral composition of GERD, revealing that the **Government emerges as the primary contributor to R&D activities in India**. To bridge the gap and achieve the targeted GERD, there is a **critical need to augment private sector investments in research and development**. This strategic shift is essential for aligning India's research and development landscape with its aspirations outlined in the STIP 2013, fostering a more balanced and robust ecosystem that propels innovation and scientific advancement.

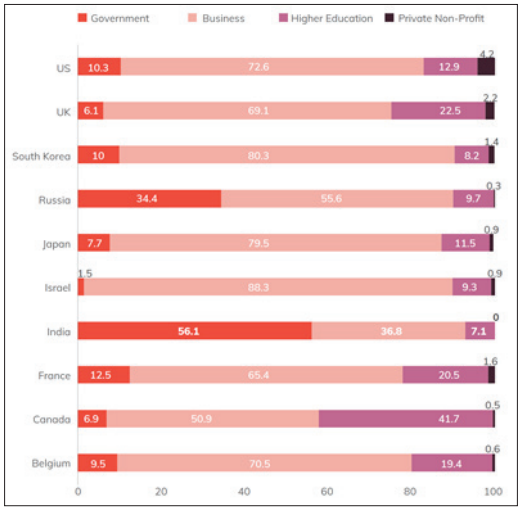

Figure 3: Composition of GERD as Percentage Contribution by Sector
(Source - India Innovation Index 2021, NITI Aayog, Government of India)

iv. Quality of Technical Education

In India, the landscape of technical education has been a focal point for policymakers and educators alike, recognizing its pivotal role in driving economic growth, innovation, and societal development. To address the challenges and harness the potential of technical education, several

initiatives have been introduced over the years, each with its unique objectives and approaches.

The cornerstone of technical education reform in India is the Technical Education Quality Improvement Programme (TEQIP), launched in 2002 under the auspices of the then Ministry of Human Resource and Development (MHRD), now the Ministry of Education. TEQIP was conceived to uplift the quality of technical education and enhance the capacities of engineering institutions across the nation. Implemented in multiple phases, TEQIP has seen significant progress in improving infrastructure, faculty development, curriculum revision, and governance mechanisms in participating institutions.

TEQIP-III, the latest phase initiated in 2017, marks a renewed commitment to bolstering engineering education quality. It places particular emphasis on addressing disparities in states with lower income levels, aiming to bridge the gap between institutions and ensure equitable access to quality technical education. Through targeted interventions such as infrastructure upgrades, faculty training programs, and curriculum modernization efforts, TEQIP-III seeks to position technical education as a catalyst for socio-economic advancement and industrial growth.

Parallel to TEQIP, the Multidisciplinary Education and Research Improvement in Technical Education (MERITE) Project has emerged as another initiative poised to enhance technical education standards in India. The MERITE Project shares similar objectives with TEQIP, aiming to elevate the quality and relevance of technical education to meet the evolving needs of industry and society. Once approved and implemented, MERITE has the potential to complement TEQIP's efforts and further strengthen the technical education ecosystem in the country.

Beyond TEQIP and MERITE, several other initiatives contribute to the comprehensive reform agenda in technical education. The Margadarshan and Margadarshak programs, spearheaded by the All India Council for Technical Education (AICTE), focus on providing mentorship and guidance to technical institutions, fostering a culture of continuous improvement and excellence. The Institutions of Eminence (IoE) Scheme, on the other hand, aims to empower select higher education institutions to achieve global standards of excellence, thereby elevating the overall quality of technical education in the country.

One of the most significant proposed reforms in technical education is the concept of Technical Education in Mother Tongue, as outlined in the National Education Policy (NEP). This visionary proposal aims to make professional courses, including engineering and medicine, accessible in regional languages, thereby democratizing access to technical education and promoting linguistic diversity. By enabling students to learn in their native language and fostering a conducive learning environment, this initiative seeks to unlock the full potential of learners and enhance their employability prospects.

Lastly, the Uchhatar Avishkar Yojana (UAY) schemes serve as a bridge between academia and industry, facilitating collaborative research and innovation projects that address real-world challenges. By incentivizing partnerships between technical institutions and industries, UAY fosters a culture of innovation, entrepreneurship, and problem-solving, thereby enhancing the relevance and impact of technical education in driving socio-economic development.

The diverse array of initiatives aimed at improving technical education in India reflects a concerted effort to transform the sector into a dynamic engine of growth, innovation, and inclusive development. By leveraging these initiatives and embracing innovation and collaboration, India is

poised to emerge as a global leader in technical education, empowering its youth with the skills, knowledge, and opportunities needed to thrive in the 21st Century.

v. Challenges and Continuous Improvement

NEP 2020 does not confine research to laboratories; it envisions a dynamic landscape where ideas traverse from incubation to real-world impact. The establishment of incubation centers is not a procedural checkbox; it's a strategic move to weave a seamless fabric between academia and industry. The call for interdisciplinary research is not a token gesture; it's a recognition that real-world challenges demand holistic solutions born from the convergence of diverse fields.

The pursuit of excellence, as envisaged by NEP 2020, is not without challenges. The National Institutional Ranking Framework (NIRF) steps in not as a mere ranking mechanism but as a relentless interrogator, pushing institutions to evolve continuously. It's a mechanism not for validation but for introspection, a tool to unearth potential amidst challenges and drive institutions toward a holistic educational experience.

vi. Guidelines for the Establishment of Research and Development Cell (RDC) in Universities and Colleges

In alignment with the visionary National Education Policy (NEP) of 2020, the imperative for quality research and innovation within Higher Education Institutions (HEIs) takes center stage. To actualize these objectives, Guidelines for the establishment of the Research and Development Cell (RDC) in universities and colleges have been issued in March 2022 by the University Grants Commission (UGC)[4]. The establishment of RDCs in HEIs emerges as a strategic imperative. Far beyond being mere administrative entities, these cells are envisioned to be catalysts, propelling a vibrant research culture within the higher education landscape. The significance of RDCs lies in their ability to act as bridges between researchers and pertinent funding agencies, facilitating seamless communication from project proposal preparation to post-sanction grant oversight, and ensuring strict adherence to timelines.

One of the key roles of RDCs is to foster multidisciplinary and transdisciplinary collaborations, aligning with the mandate of NEP 2020. By nurturing liaisons between researchers and funding bodies, these cells are positioned to become epicenters of innovation and knowledge exchange. Moreover, they are tasked with the development of Institutional Research Information Systems. Through the effective utilization of Information and Communication Technology (ICT), these systems aim to create comprehensive databases, showcasing the status of ongoing and completed research projects and programmes, as well as the available expertise and resources within the institution.

As of July 2023, around 2500 HEIs and 300 Universities have embraced this vision, establishing R&D Cells on their campuses[5]. This collective endeavour symbolizes a commitment to nurturing a research ecosystem that not only meets the standards of NEP 2020 but also propels India towards self-reliance and global eminence.

[4] https://www.ugc.gov.in/pdfnews/6347789_RDC-Guideline.pdf
[5] https://www.education.gov.in/sites/upload_files/mhrd/files/nep/Background_Notes_Thematic_Sessions.pdf

VIII. Overview and Analytical Insights of the Consultative Exercise

Composition of the Universities across India and in the Consultation

Considering the scope of the present report, which is to improve the R&D culture in India with a focus on State Universities, the consultative exercise sought to take a closer look at research-oriented programmes – typically graduate and doctoral programmes. Hence, the consultative exercise was structured as a series of five meetings, with each covering different States and Union Territories (UTs) of India, and in two parts – a survey on the status of R&D activities to be completed before the meeting and a consultative discussion in the meeting.

As briefly discussed in the previous section, there are 1043 Universities in India (as of March 2022), classified as Central Universities, State Public Universities, State Private Universities and Other Institutions, whose distribution is given in the Figure 4(a).

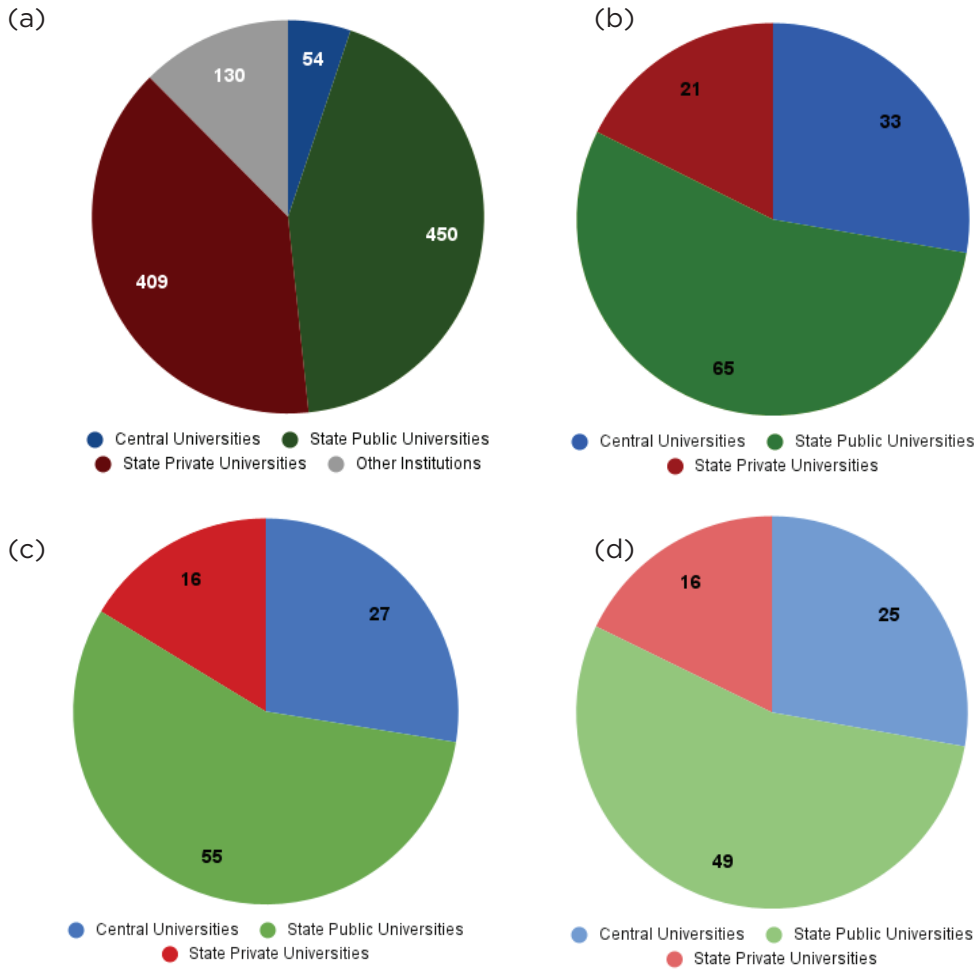

Figure 4: Distribution of Universities (a) in India (b) invited to the meetings (c) attended the meetings and (d) responded to the survey on Status of R&D activities

In an attempt to cover at least 10% of these, and considering the focus on State Universities, an invitation for the consultative exercise was sent to 119 Universities with a distribution given in Figure 4(b). Among those, 98 Universities attended the consultative meetings, with distribution as given in Figure 4(c), and 90 Universities responded to the survey on Status of R&D activities, with their distribution given in Figure 4(d).

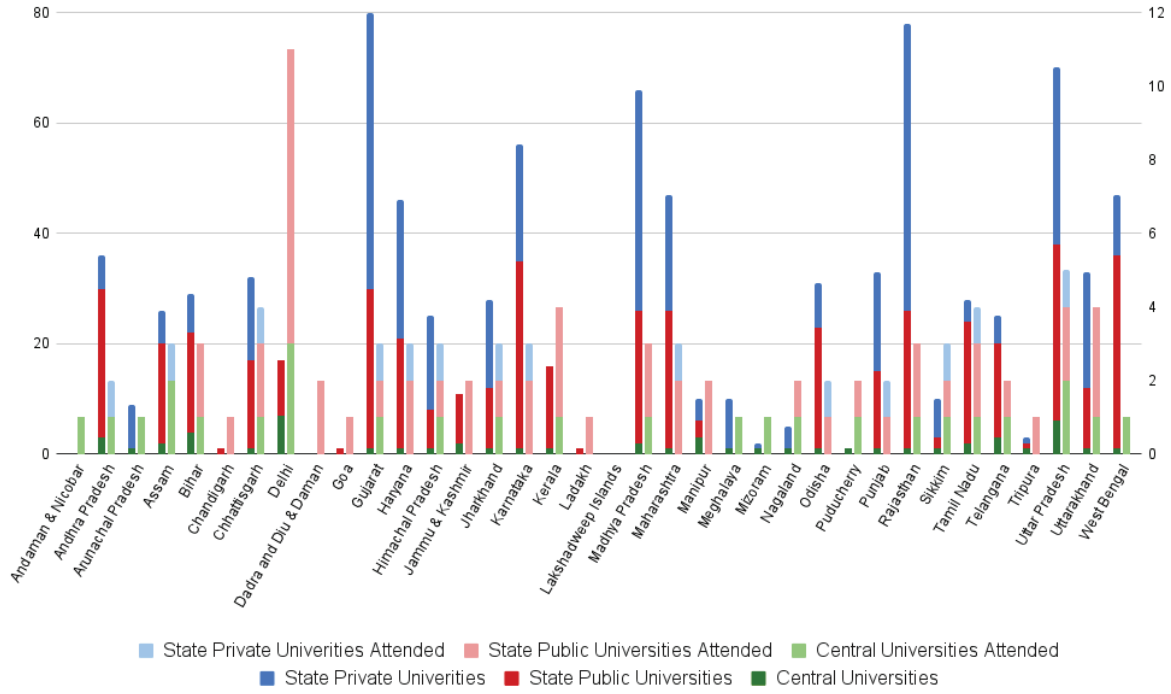

Figure 5: State-wise Distribution of Universities and Universities that Attended the meeting

Whereas such attrition is expected, the validity of the exercise and its insights rested on the final sample of 98 and 90, for the meetings and the survey respectively, being representative of the focus group – namely State Public Universities. While this is evident at the aggregate level, the same validity can also be ascertained when examined statewise. Figure 5 shows two stacked columns for each State and UT, with the left column (darker colours, read on the left axis) showing the distribution of Universities in that State/UT, and the right column (lighter colours, read on the right axis) showing the distribution of the Universities which attended that meeting from that State/UT.

There are three observations from the above.

- The UT of Delhi is over represented relative to other States and UTs. While this may skew analysis at the state level, it does not impact the analysis of data pertaining to R&D activities.
- The distribution of Universities across India's States and UTs is highly skewed, driven largely by the proliferation of State Private Universities.
- The States having such a proliferation of State Private Universities also tend to have a sizeable number of State Public Universities.

Composition of R&D units by Sector

In order to understand the impact of the latter two observations, it is necessary to also examine the number of registered R&D Units in the State as compared to the number of Universities in the State. Figure 6 provides a snapshot view of this by plotting the number of registered R&D units by their sector (as given and classified by the DST) against the number of universities in the State/UT.

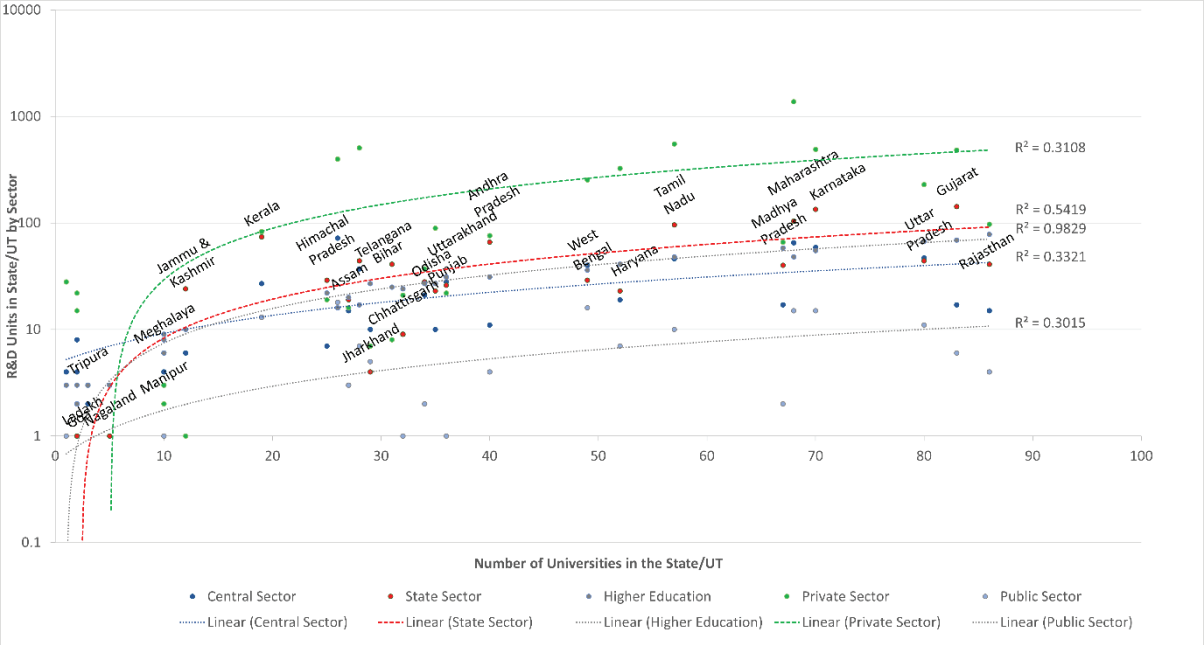

Figure 6: Number of R&D Units (log scale) vs Number of Universities in the State/UT

It is noted that there is a strong correlation between the number of universities and the number of registered R&D units in the Higher Education Sector. While this follows logically, it also lends credibility to additional inferences drawn from analysing the said graph.

Particular attention is drawn to the number of registered R&D Units in the State Sector and the Private Sector in a given state vis-a-vis the number of universities in that state. It is observed that the states which have a high number of State Sector R&D units – seen above as the red dots above the red line – also have a high number of Private Sector R&D units – seen above as the green dots above the green line. It is worth noting that the same pattern is not observed with Central Sector R&D Units.

The above observations give rise to an important inference regarding the composition of R&D activities in a given State.

> "States that invest in the Scientific Education and R&D ecosystem, whether through their Public Universities or their R&D Units, also benefit from a resultant stimulus to Private investment in the Scientific Education and R&D ecosystem in the State."

While the econometric validation of linkages in this inference falls outside the scope of the present report, the intuitive relationship between stakeholders of the R&D ecosystem that it describes aligns with the discourse in the scientific community and the industry.

Analysis Section 1: Scholars, Researchers, and Faculty

The doctoral scholars, researchers, and faculty of a university are responsible for the lion's share of the R&D activities in that university. Hence, this was a core component of the survey on the Status of R&D activities. A snapshot of the responses is given in Figure 7 (a to f) below.

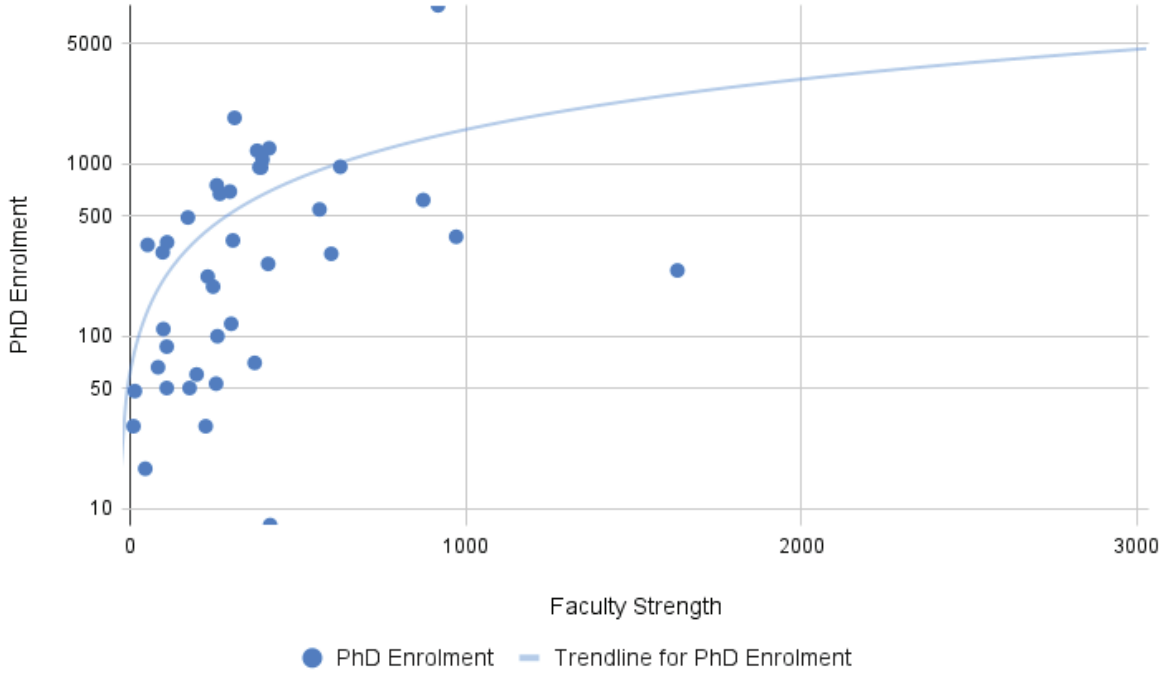

Figure 7: (a) PhD Enrolment by Faculty Strength (all Universities responses)

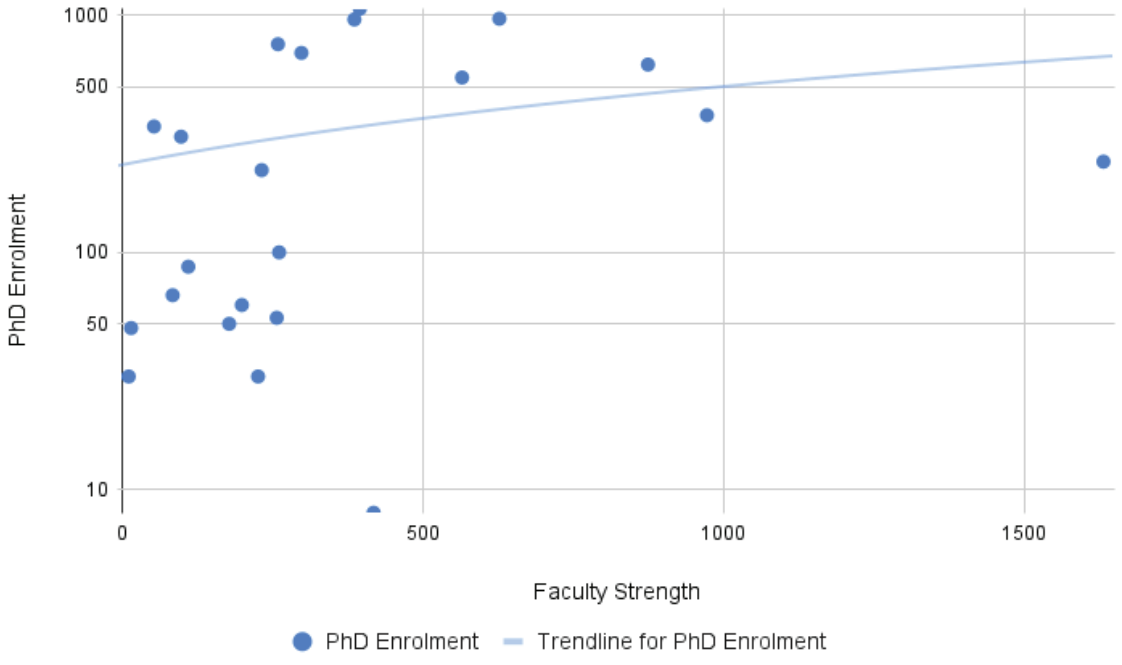

Figure 7: (b) PhD Enrolment by Faculty Strength (only State Universities responses)

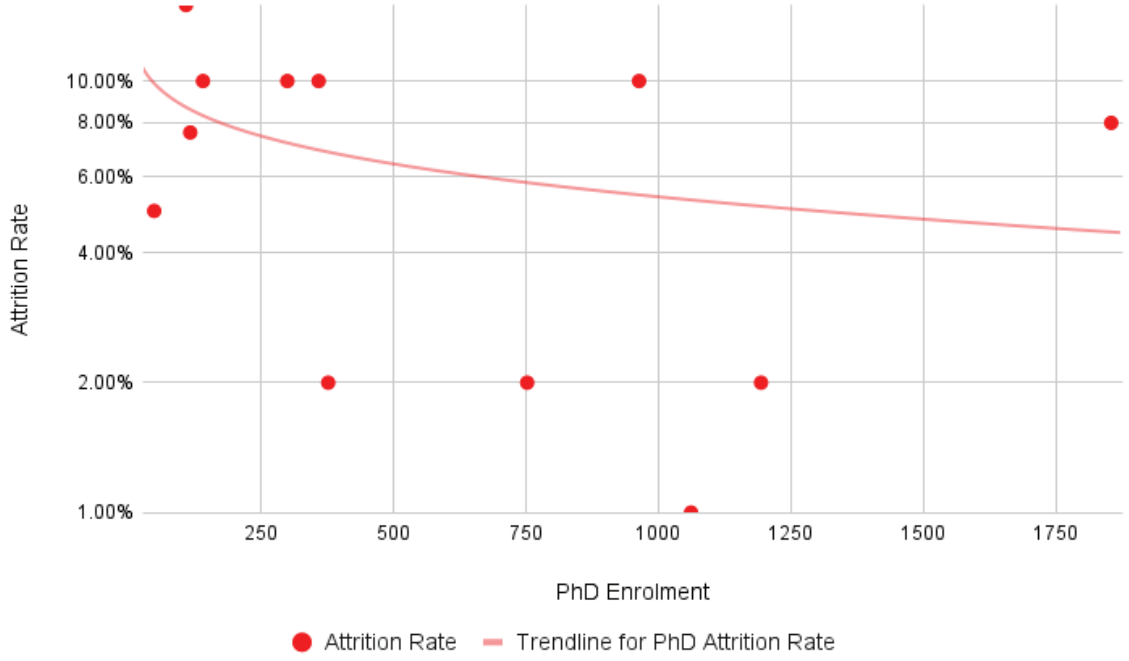

Figure 7: (c) PhD Attrition Rate by PhD Enrolment (all Universities responses)

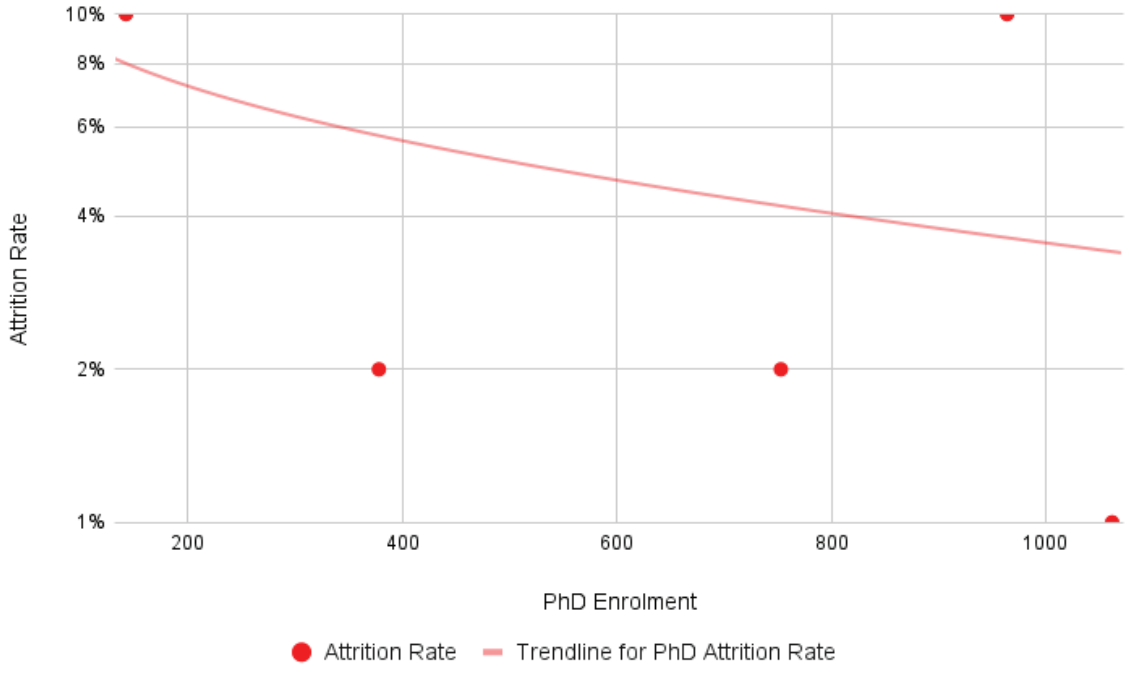

Figure 7: (d) PhD Attrition Rate by PhD Enrolment (only State Universities responses)

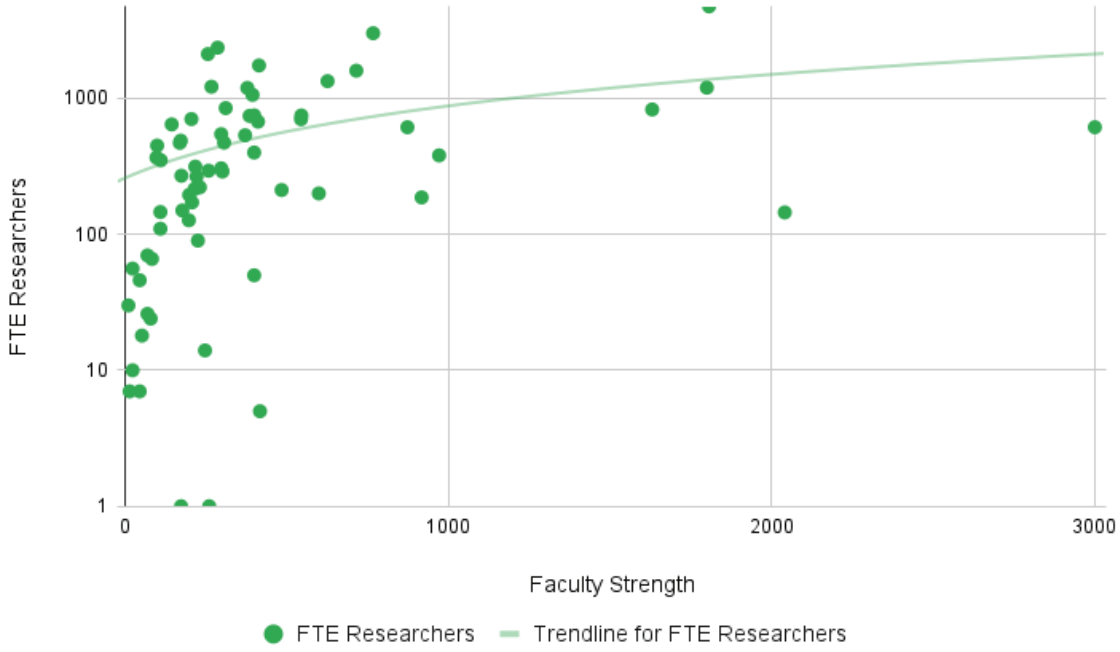

Figure 7: (e) Full Time Equivalent Researchers by Faculty Strength (all Universities responses)

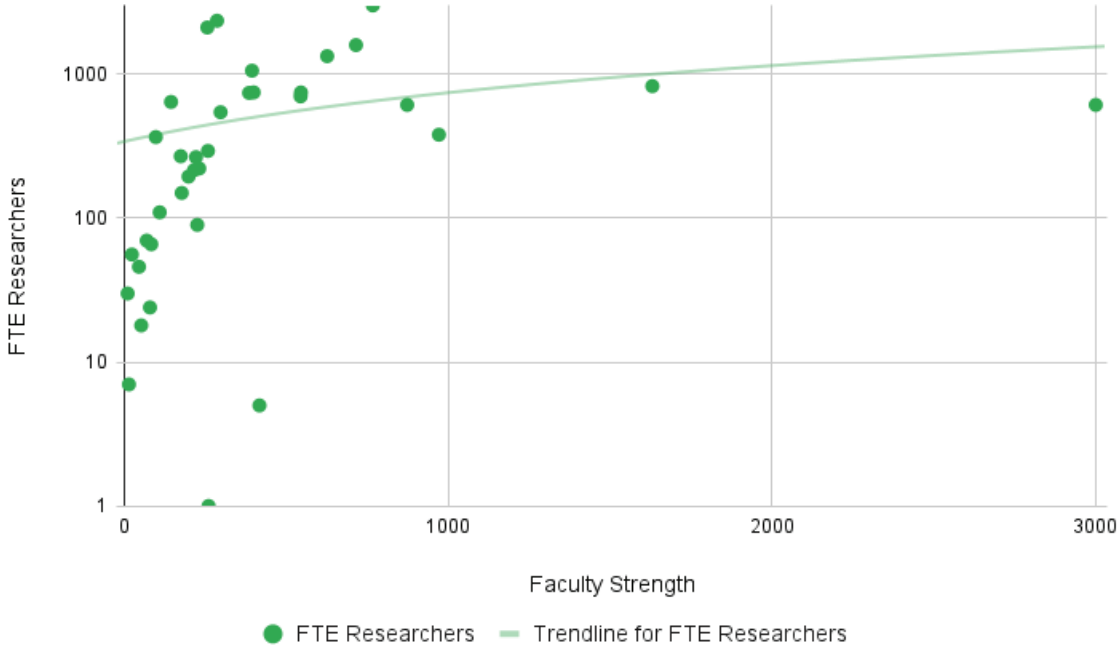

Figure 7: (f) Full Time Equivalent Researchers by Faculty Strength (only State Universities responses)

The PhD enrolment trend across all responding universities suggests that there is a strong correlation with the faculty strength until a point, after which increasing faculty strength offers diminishing returns in improving PhD enrolment. This observation also holds true from the responses of only the State Universities.

"Faculty strength positively correlates with PhD enrollment in universities, but reaches a saturation point where further increases yield diminishing returns."

However, PhD enrolment must also be seen alongside the attrition rate in doctoral programmes. There is a noteworthy observation when this is examined across all responding universities. The attrition rate appears to be high for universities with small doctoral programmes and drops rapidly as the number of doctoral students increases. While the same result appears to hold true for State Universities, the responses from the State Universities are not sufficient to make such an inference.

"Attrition rates are higher in universities with smaller doctoral programs, decreasing notably as the number of doctoral students grows."

The bulk of research activities in a university is carried out by researchers - measured in terms of Full-Time Equivalent (FTE) Researchers - engaged by the university on various R&D projects that are run by its faculty. This trend, similar to that of PhD enrolment, appears to be strongly correlated with the faculty strength of a university. Furthermore, this trend holds true across all responding universities as well as only the State Universities.

"Faculty strength correlates strongly with research activity, measured by FTE Researchers engaged in R&D projects, across all Universities."

Analysis Section 2: Researchers, Projects, Funding and Publications

Following the human resources required for conducting the R&D activities, the survey sought to understand key indicators of the R&D activities themselves. The vast majority of such R&D activities takes place in the form of research projects, funded by the central or state government, that are run by the faculty of the university and are typically designed to produce research outputs in the form of reports and journal publications. The responses to this portions of the survey are given in the form of scatterplots under Figure 8 (a to e).

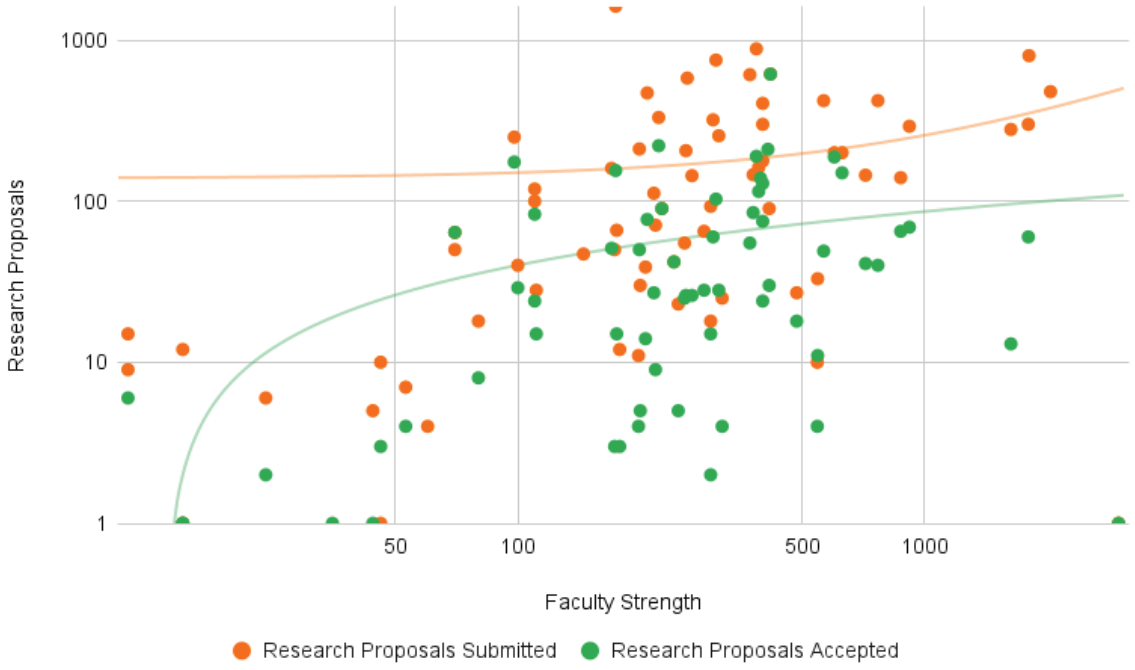

Figure 8: (a) Research Proposals Submitted and Accepted by Faculty Strength (all Universities responses)

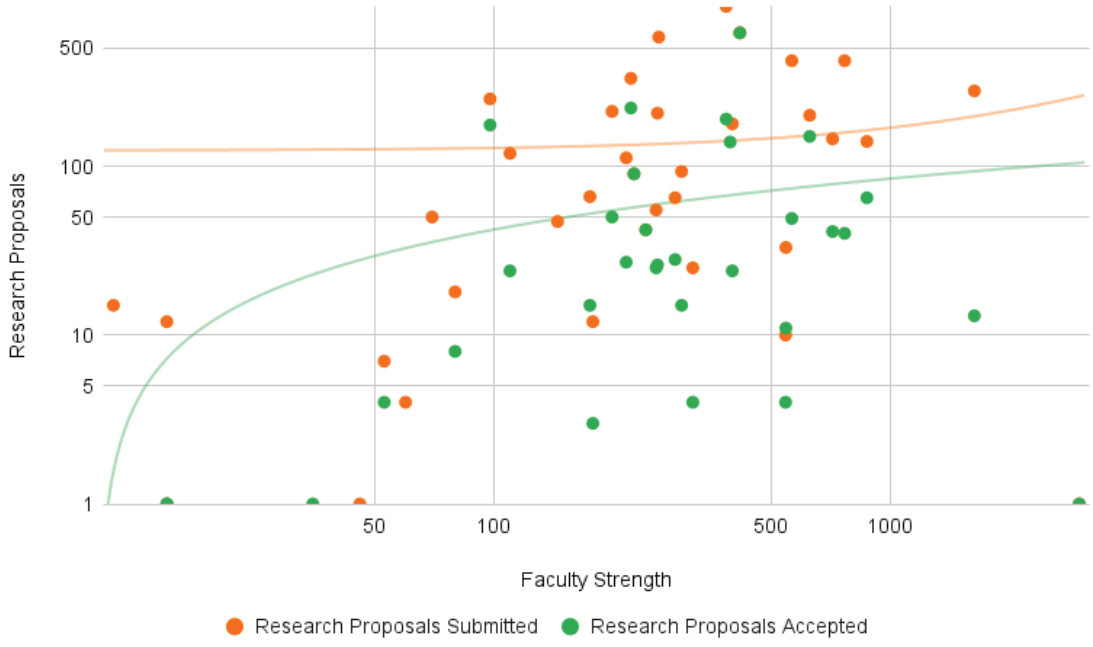

Figure 8: (b) Research Proposals Submitted and Accepted by Faculty Strength (only State Universities responses)

Figure 8: (c) Average Annual Research Funding and Research Funded by State Government by Research Proposals Accepted (all Universities responses)

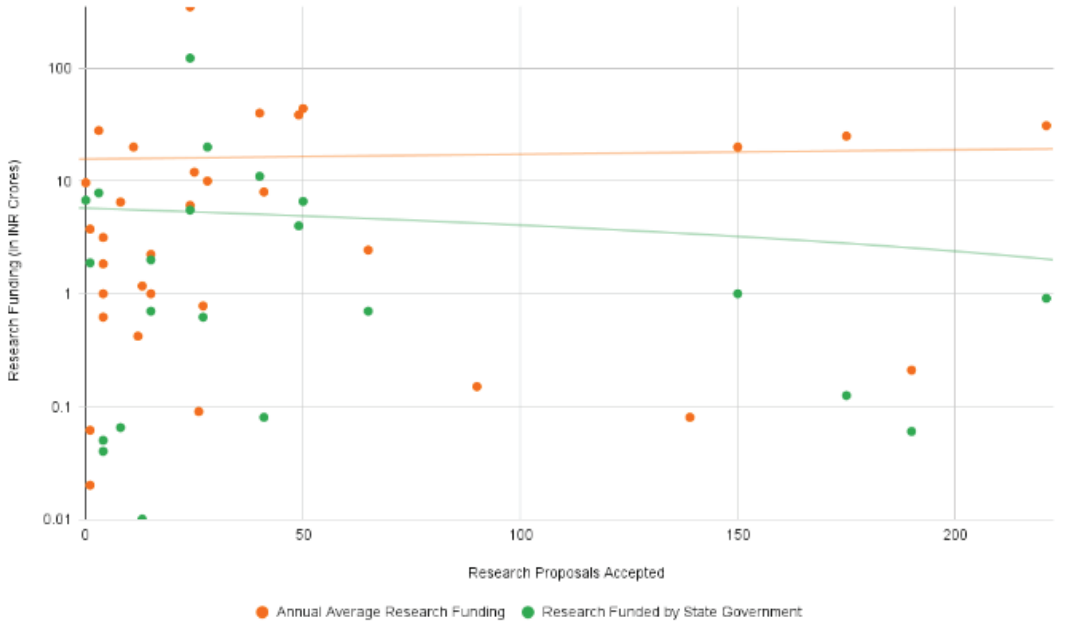

Figure 8: (d) Average Annual Research Funding and Research Funded by State Government by Research Proposals Accepted (only State Universities responses)

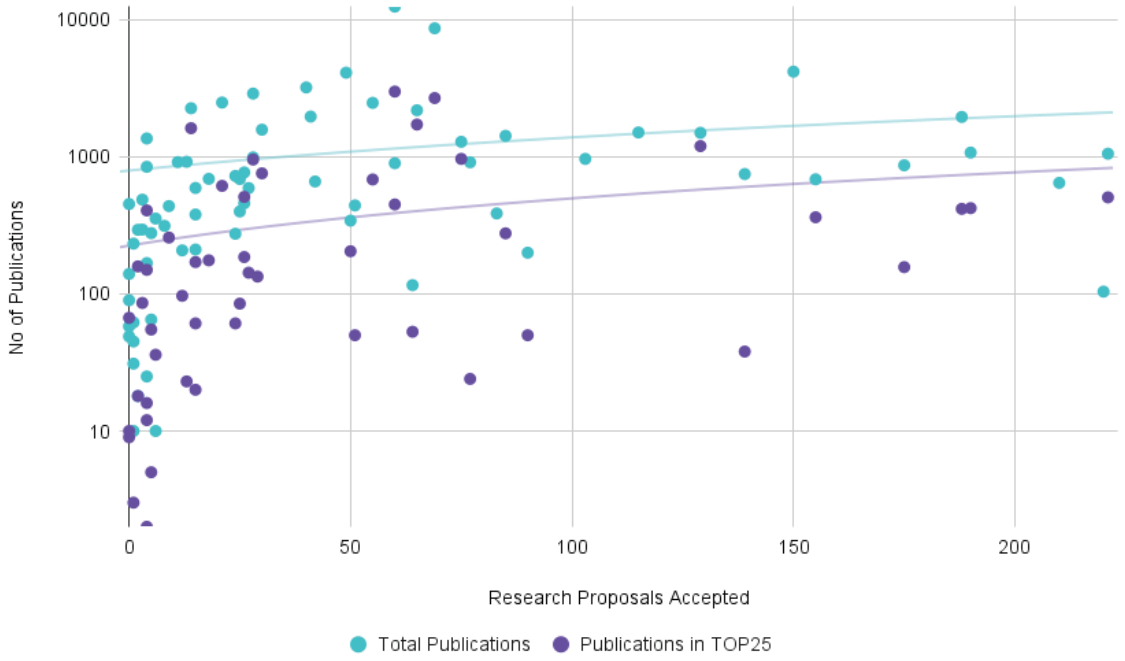

Figure 8: (e) Total Publications and Publications in TOP25 by Research Proposals Accepted (all Universities responses)

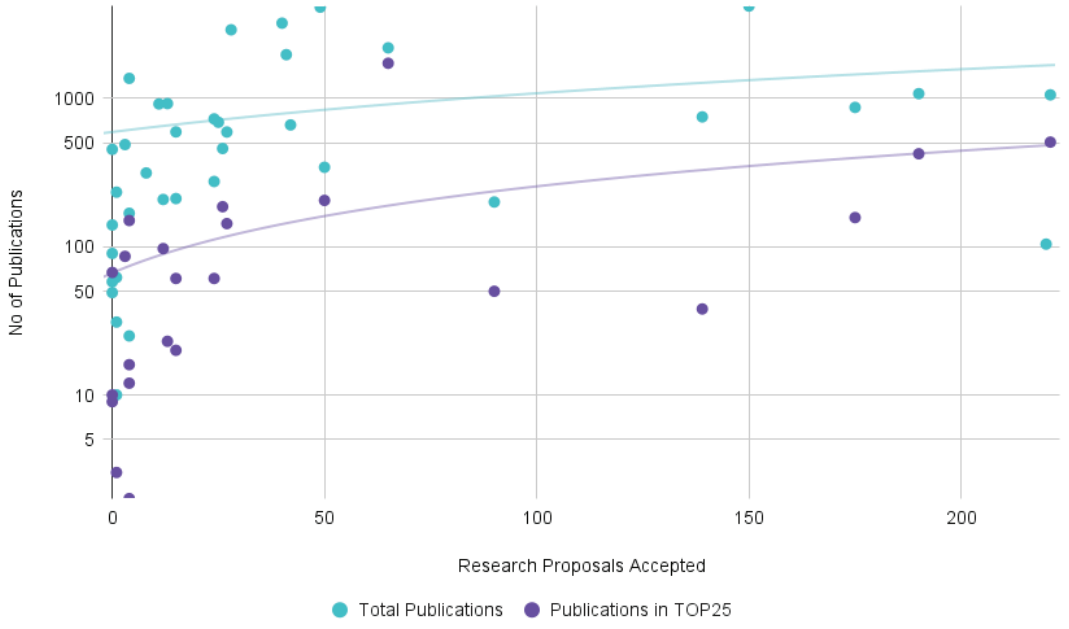

Figure 8: (f) Total Publications and Publications in TOP25 by Research Proposals Accepted (only State Universities responses)

The number of research proposal submitted is strongly correlated with the faculty strength in all responding universities as well as in State Universities. However, the same does not appear to hold true for research proposals accepted, which tend to plateau after the initial corresponding increase with the faculty strength. This suggests that while there is a need to encourage smaller universities to submit more proposals, the real challenge lies in improving the quality of research proposals submitted by the faculty.

"Research proposal submissions strongly correlate with faculty strength in all universities." The correlation weakens for accepted proposals, which plateau after an initial increase with faculty strength."

Another interesting observation is that the average annual research funding does not appear to vary significantly with the increase in number of research proposals accepted. The trend holds for all responding universities as well as the responding State Universities. Furthermore, the research funding from State Governments appears to decline with the number of research proposals accepted. This suggests that the State Governments fund very few, if any, research proposals.

"Average annual research funding from State Governments decreases with accepted proposals, indicating limited governmental support for research endeavours."

Considering the publications produced through research for all responding universities, it is found that the number of total publications increases with the number of research proposals accepted. Similarly, the number of publications in TOP25 (the top quartile of indexed journals) also increases with the number of research proposals accepted. Moreover, the gap between the two also decreases with the increase in number of research proposals accepted. These trends also hold true for responding State Universities, but the gap between the total publications and those in TOP 25 does not reduce as much.

"Accepted research proposals lead to increased publications, particularly in TOP25 journals, across all universities. Yet, in State Universities, the gap between total publications and those in top-tier journals doesn't decrease as significantly."

Analysis Section 3: Patents and Commercialization

The data presented in Figure 9 (a and b) suggests a widespread adoption of Intellectual Property Rights (IPR) cells across universities, with a particularly high prevalence in both overall university settings and State Public Universities.

According to the pie chart, 90% of universities, regardless of their classification, have established an IPR cell within their campuses. This indicates a strong recognition among educational institutions of the importance of managing and protecting intellectual property.

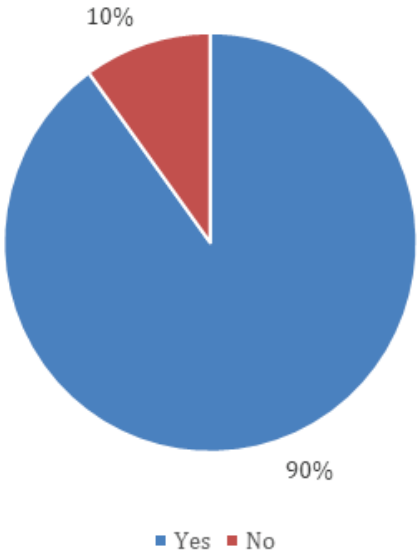

Figure 9: (a) Status of IPR Cell (all Universities responses)

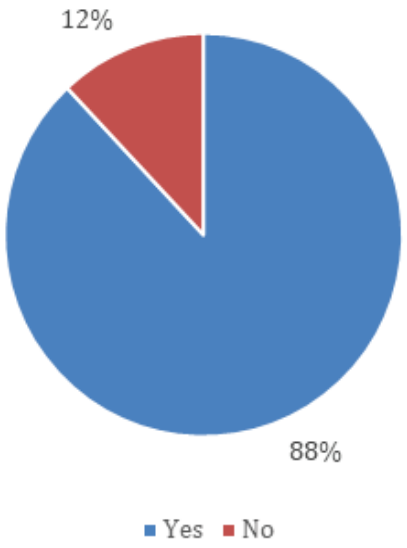

Figure 9: (b) Status of IPR Cell (only State Universities responses)

Delving deeper into the breakdown of State Public Universities, the data reveals that 88% of the State Universities have implemented an IPR cell. While this percentage is slightly lower than the overall university average, it still underscores a significant level of commitment among State Universities towards fostering innovation and safeguarding intellectual property.

The presence of IPR cells within universities is crucial for several reasons. Firstly, it serves as a platform for promoting research and innovation by providing resources and guidance on intellectual property issues to faculty, researchers, and students. Secondly, it facilitates the process of patenting and commercializing innovative ideas, thereby fostering entrepreneurship and contributing to economic growth. Additionally, IPR cells play a vital role in raising awareness about intellectual property rights and ensuring compliance with relevant laws and regulations.

"The widespread establishment of IPR cells in universities reflects a strong commitment to managing and safeguarding intellectual property, with State Universities also showing significant dedication to innovation and IP protection."

Next, the scatterplots in Figure 10 (a to d), depicting patents filed versus patents published and patents filed versus patents granted offers valuable insights into the innovation landscape within both the overall university ecosystem and the State Public University group. The upward trend observed in both scenarios is a positive indicator of increasing innovation activity and the effectiveness of intellectual property management within these institutions.

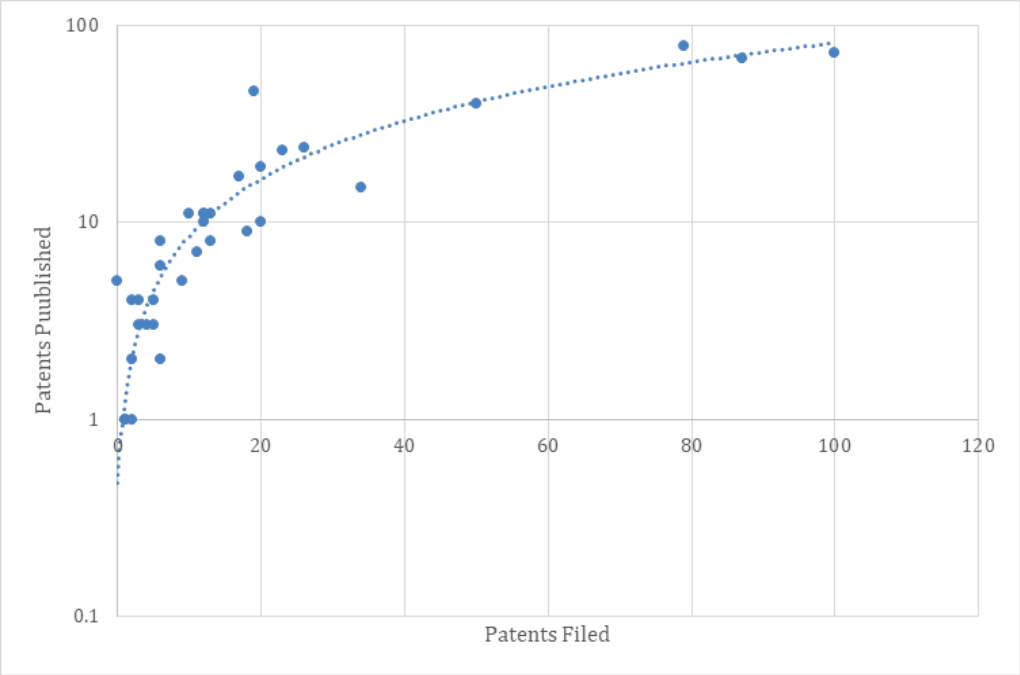

Figure 10: (a) Patents Published by Patents Filed (all Universities responses)

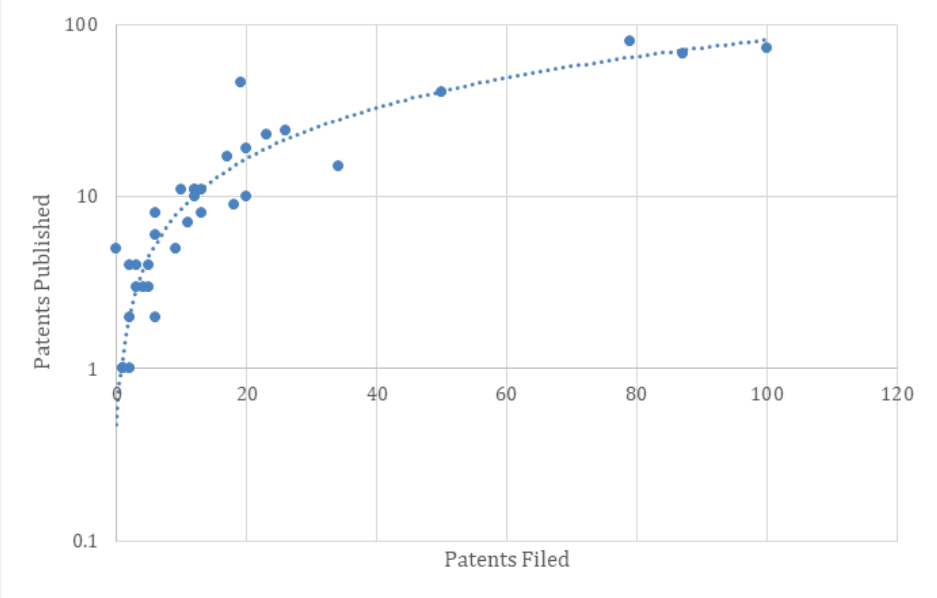

Figure 10: (b) Patents Published by Patents Filed (only State Universities responses)

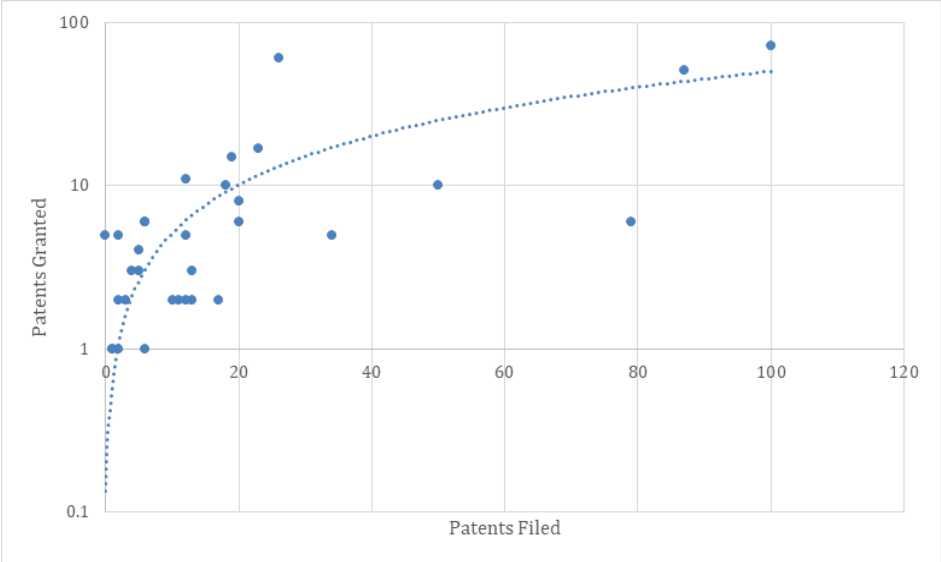

Figure 10: (c) Patents Granted by Patents Filed (all Universities responses)

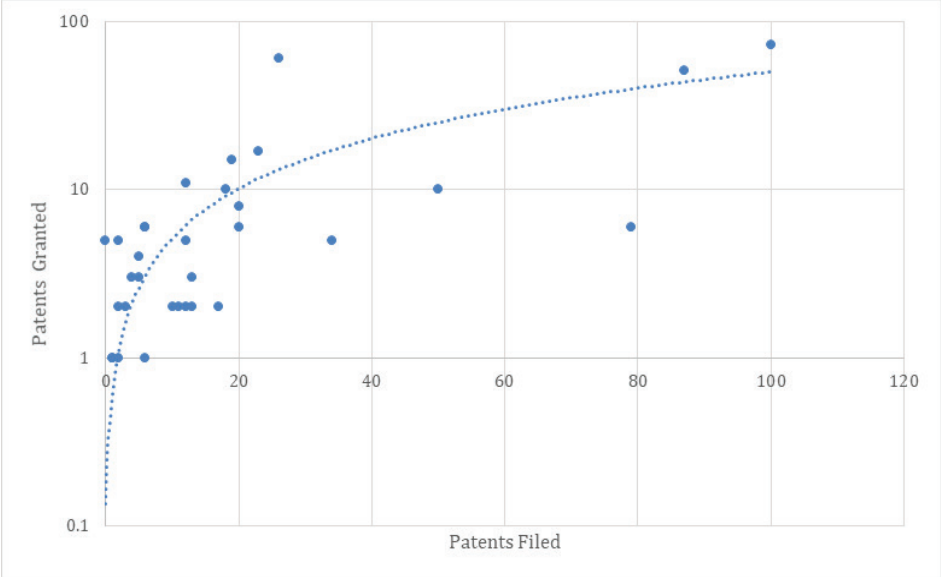

Figure 10: (d) Patents Granted by Patents Filed (only State Universities responses)

In the overall university ecosystem, the trend of more patents being filed correlating with more patents being published and granted signifies a proactive approach towards converting research and innovation into tangible outcomes. As universities engage in more patent filing activities, it suggests a higher level of research output and potential commercialization opportunities. The subsequent increase in patents published and granted indicates a successful transition from ideation to formal recognition and protection of intellectual property rights.

Similarly, within the State University group, the positive trend observed between patents filed and patents published, as well as patents filed and patents granted, underscores the commitment of these institutions toward innovation and intellectual property management. Despite potential differences in resources or research focus compared to other universities, the state universities are evidently making significant strides in contributing to the intellectual property landscape.

"Overall, the positive outcomes depicted in the scatter plots underscore the importance of fostering a supportive environment for innovation within universities, regardless of their classification."

The statistics concerning the commercialization or transfer of technologies within the university ecosystem (Figure 11) paint an interesting picture, highlighting disparities between different types of institutions. According to the data reported by universities and institutes for the consultative exercise, State Universities appear to be lagging in terms of technologies commercialized or transferred, with Central Universities demonstrating better performance and Private Universities/ Institutes boasting the highest numbers in this regard.

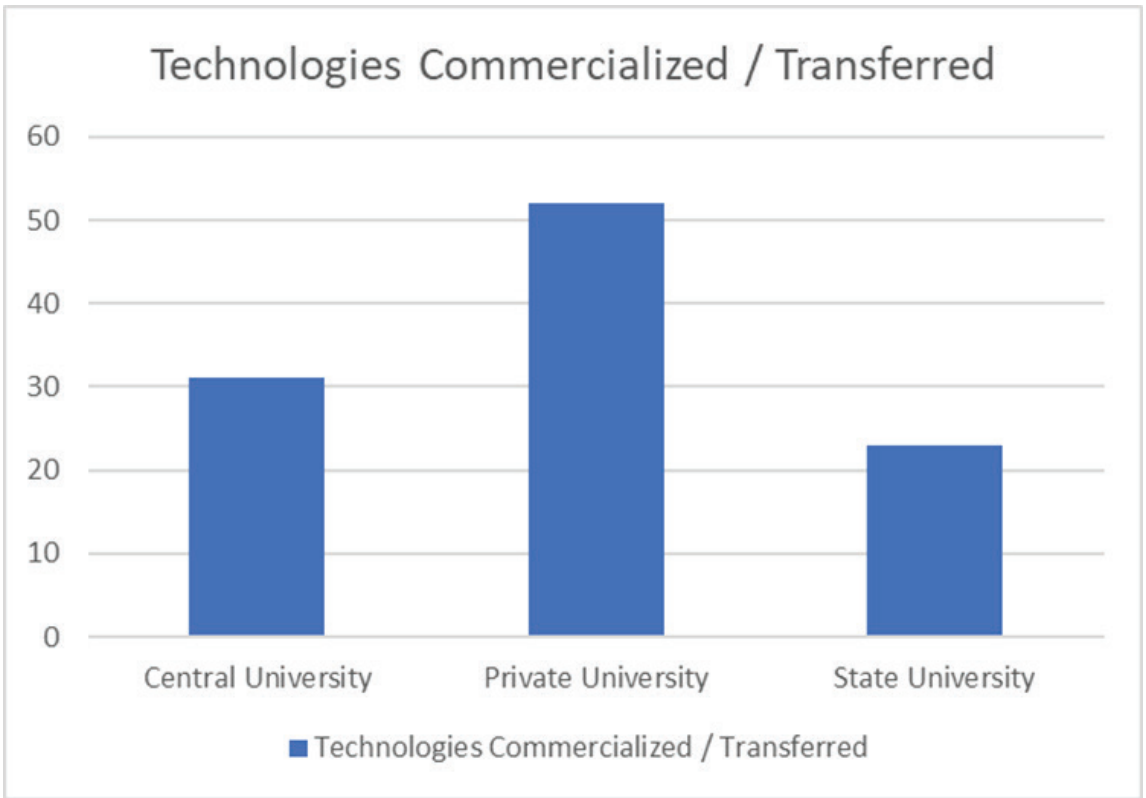

Figure 11: Technology commercialization and transfers

This discrepancy may stem from various factors. Private universities often have greater access to funding and resources, allowing them to invest more extensively in research and development initiatives, as well as in the infrastructure necessary for technology commercialization.

Central universities, on the other hand, typically benefit from substantial government funding and support, which can bolster their research capabilities and facilitate technology transfer activities. Furthermore, central universities may have established networks and partnerships with industries and government agencies, providing them with additional avenues for technology commercialization.

"State Universities lag in technology commercialization or transfer compared to Central Universities, while Private Universities/Institutes lead in this aspect."

In contrast, State Universities may face challenges such as limited funding, infrastructure constraints, and bureaucratic hurdles, which could hinder their ability to effectively commercialize or transfer technologies developed within their institutions. Additionally, State Universities may lack the same level of industry connections and resources as their private and central counterparts, further impacting their technology transfer efforts.

The data in Figure 12 (a and b), represent the average per institute of the Innovation/ Prototypes supported and the Copyrights/ Designs by the University type. It suggests that Private Universities are leading in terms of innovation and prototype development, as well as copyrights and designs. This is closely followed by Central Universities, while State universities demonstrate less impressive trends, and suggest a nuanced landscape of innovation and intellectual property management within the university ecosystem.

The Private Universities' success in copyrights and designs likely stems from their proactive approach to intellectual property management and protection. These institutions may have established robust mechanisms for identifying, documenting, and registering copyrights and designs related to their research outputs and creative works. However, despite the majority of State Universities having established IPR cells, as indicated by the analysis in Figure 9, their impact is not reflected in the results, given that state universities are lagging the most.

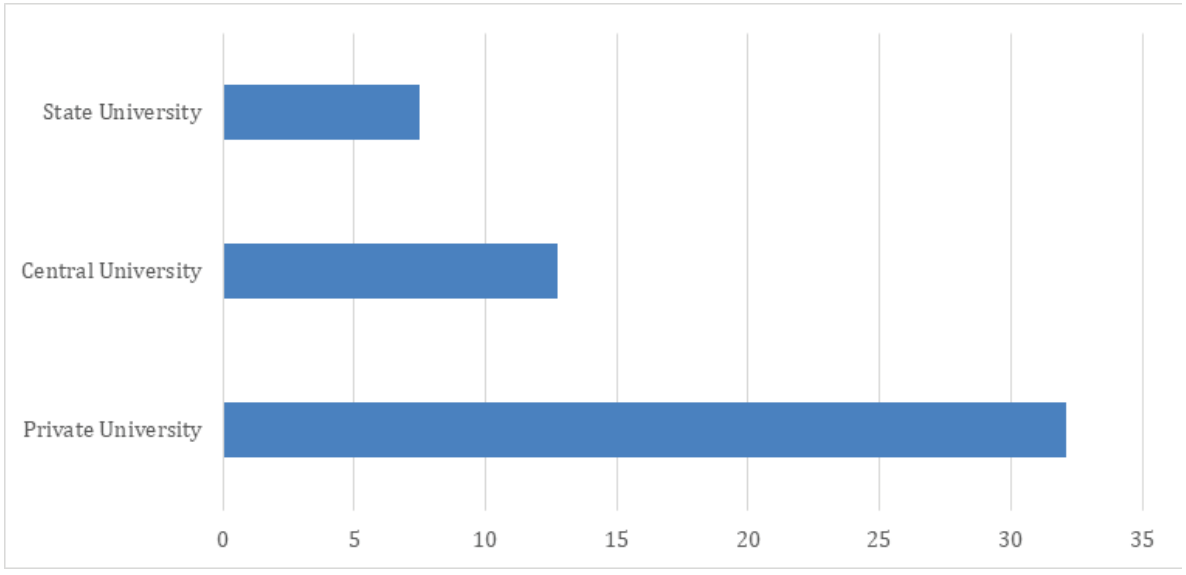

Figure 12: (a) Innovation / Prototypes supported by the University type

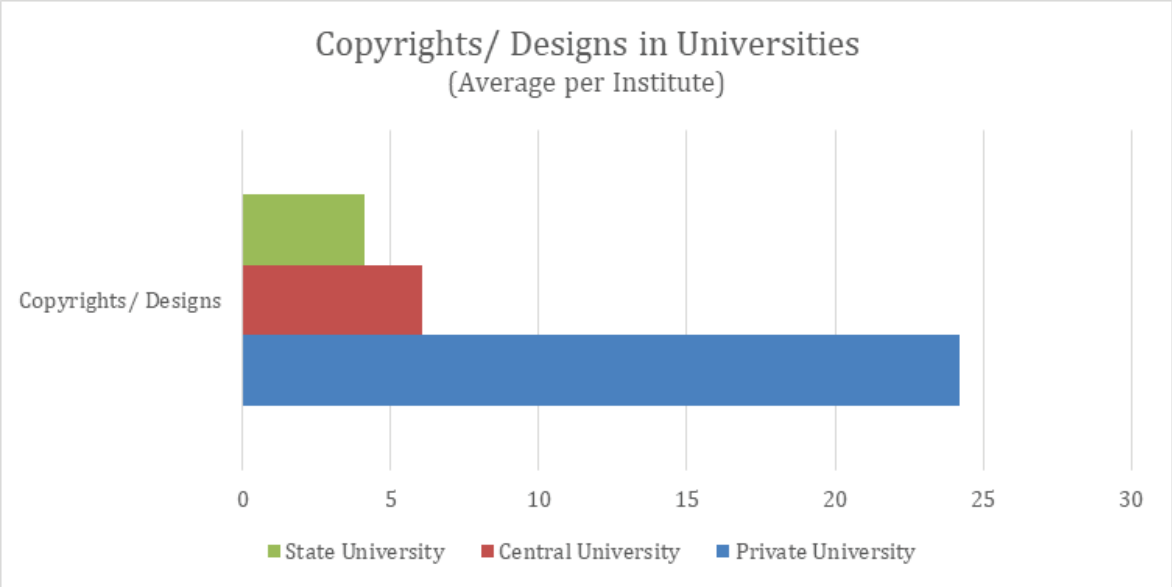

Figure 12: (b) Copyrights and Designs by University Type

"Private Universities lead in innovation, prototype development, copyrights, and designs, followed closely by Central Universities."

"State universities exhibit less impressive trends."

Analysis Section 4: Institutional and Industrial Linkages

The statistics on formal collaborations for research and development (R&D) among universities (Figure 13) reveal a positive trend across all types of institutions. Over 85% of universities and close to 90% of central universities report engaging in some form of collaboration for R&D, indicating a widespread recognition of the importance of collaborative research efforts within the academic community.

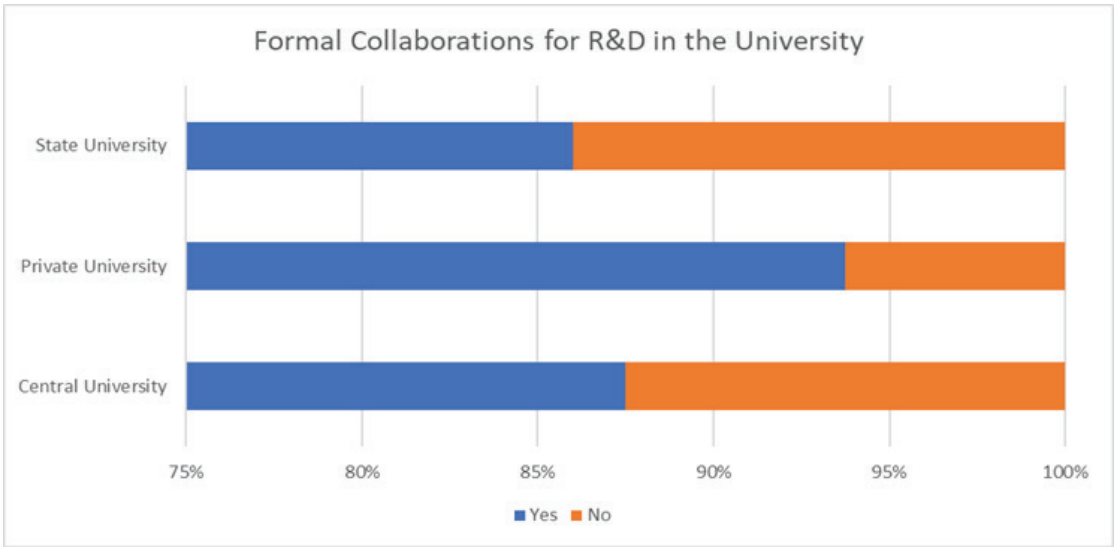

Figure 13: Formal Collaborations for R&D by University Type

Private universities, in particular, demonstrate even higher levels of engagement, with 94% falling under this criterion. This suggests a strong inclination towards fostering partnerships and collaborative initiatives to drive innovation and advance knowledge.

"Central universities prioritize collaborative R&D efforts, while Private universities exhibit even stronger engagement in partnerships for research.
State Universities can further enhance their engagement in collaborative endeavours."

The prevalence of formal collaborations for R&D underscores the value that universities place on collaborative research endeavours. By pooling resources, expertise, and networks, universities can leverage collective strengths to tackle complex challenges, accelerate discovery, and maximize the impact of their research efforts.

IX. Current Status of R&D in State Universities and Institutes

i. Overview of the Existing R&D Culture

The R&D landscape within State Universities and Institutes is characterized by its multifaceted nature, encompassing a broad spectrum of academic disciplines, varied research methodologies, and distinctive institutional capacities. Despite making commendable strides in the generation and dissemination of knowledge, these academic institutions face a complex set of challenges that act as impediments to realizing their full potential in the realm of research and development.

Within this diversified landscape, pockets of excellence stand out, showcasing instances where researchers have achieved noteworthy advancements in their respective fields. Collaborative initiatives with industries, government bodies, and international partners have yielded impactful research outcomes, underlining the potential for transformative contributions emanating from these institutions.

However, against the backdrop of these successes, systemic challenges emerge as critical hurdles, impeding the seamless integration of R&D into the institutional fabric. These challenges range from structural and infrastructural limitations to issues related to funding constraints and bureaucratic complexities. Addressing these challenges is crucial for unlocking the full potential of State Universities and Institutes, allowing them to further elevate their contributions to research and development on both the national and global stages.

ii. Challenges Faced by Universities/Institutes in Promoting R&D

1. Insufficient Funding and Resources:

The persistent challenge of insufficient funding and resources poses a formidable barrier to the robust development of research initiatives within State Universities and Institutes. This overarching issue manifests in multifaceted ways, each presenting a unique set of obstacles to the institution's pursuit of academic and research excellence.

At the forefront of this challenge is the limitation it imposes on **acquiring cutting-edge equipment**. The Universities and Institutes, grappling with financial constraints, find themselves hampered in their ability to invest in state-of-the-art research tools and technologies. This impediment, in turn, directly affects the quality and depth of research outcomes, limiting the institutions' competitiveness on a national and global scale.

Furthermore, the constrained financial environment poses challenges to the **recruitment of skilled researchers**. The ability to attract and retain top-tier talent is crucial for fostering an environment of intellectual vibrancy and ensuring sustained progress in diverse research domains. However, the shortage of funds restricts the institutions' capacity to offer **competitive remuneration packages and research grants**, making it challenging to attract and retain skilled researchers.

The broader impact of insufficient funding reverberates across the overall expansion of research infrastructure. Modern research demands collaborative spaces, interdisciplinary facilities, and advanced laboratories. Inadequate financial resources hinder the **development and maintenance of such crucial infrastructure**, limiting the scope and scale of research pursuits within these academic institutions.

2. Teaching-Research Imbalance:

The challenge of teaching-research imbalance within State Universities and Institutes underscores a systemic issue that impacts the overall academic landscape. This imbalance, characterized by a disproportionate emphasis on teaching over research activities, engenders a host of challenges that permeate the core functions of these institutions.

At the heart of this challenge is the overshadowing of research pursuits by the predominant focus on teaching responsibilities. In an environment where **teaching often takes precedence**, the allocation of time for research endeavours becomes a scarce commodity. This temporal constraint directly translates into limitations on the depth and breadth of research activities undertaken by faculty members and researchers within these institutions.

In addition to time constraints, the teaching-research imbalance manifests in the **unequal distribution of resources**. State Universities and Institutes, grappling with competing demands, may allocate a larger share of resources to teaching-related initiatives, inadvertently neglecting the essential components required to foster a robust research ecosystem. This resource asymmetry can hinder the acquisition of research-specific tools, funding for projects, and support for scholarly publications.

Recognition and incentives within the academic framework also contribute to this imbalance. Teaching-related achievements often receive more visibility and acknowledgment, leaving research pursuits in the shadows. This **disparity in recognition** can impact the morale of researchers and create a culture where the value of research is undervalued compared to teaching, further perpetuating the imbalance. Fostering a culture that values and prioritizes research alongside teaching is essential for nurturing a dynamic academic environment that excels in both realms.

3. Faculty Mindset and Quality:

The challenge of faculty mindset and quality in State Universities and Institutes is multifaceted, reflecting the complexities inherent in fostering a research-oriented culture. One of the central issues is the divergence in priorities among faculty members, where some may prior-

itize teaching responsibilities or administrative duties over active engagement in substantive research activities.

This mindset challenge can be attributed to various factors, including institutional norms that may inadvertently emphasize administrative duties over research. The need to meet administrative obligations or the lack of sufficient incentives for research, contribute to this mindset disparity. Faculty members, faced with these pressures, may find it challenging to dedicate significant time and energy to research pursuits.

Moreover, the quality of research output is intricately linked to the mindset of faculty members. A culture that prioritizes teaching or administrative tasks at the expense of research can impact the depth and rigor of scholarly contributions. To address this challenge, targeted interventions are necessary, including professional development programmes, mentorship initiatives, and institutional policies that incentivize and recognize high-quality research outputs.

4. Administrative Processes:

Administrative processes within the State Universities and Institutes present a significant challenge to the seamless execution of research initiatives. The bureaucratic hurdles and cumbersome procedures inherent in the administrative framework often contribute to delays and inefficiencies in the research ecosystem.

One aspect of this challenge is the time-consuming nature of obtaining approvals and permissions for research projects. **The complex layers of administrative clearance, ranging from project proposals to budgetary allocations, can introduce significant bottlenecks.** Researchers may find themselves entangled in red tape, diverting valuable time and energy away from the actual research process.

Moreover, the allocation and disbursement of funds for research projects can be marred by administrative delays. **Delays in financial approvals, procurement processes, and disbursement mechanisms can hinder the timely execution of research activities.** This not only affects project timelines but also poses challenges in attracting and retaining skilled researchers who may seek more streamlined environments.

Addressing this challenge requires a comprehensive review and streamlining of administrative processes. Promoting a culture of administrative responsiveness and support for research endeavours is essential for overcoming this obstacle.

5. Low Enrollment in Advanced Programmes:

The challenge of low enrollment in advanced degree programmes, particularly MTech and PhD, poses a multifaceted obstacle to the research landscape within the State Universities and Institutes. This issue can be attributed to several interrelated factors that collectively contribute to the shortage of funds for research activities.

Firstly, there is a **perception gap among students** regarding the value and prospects of pursuing advanced research-oriented programmes. This can be influenced by a **lack of awareness about the opportunities and benefits associated with advanced degrees** in terms of research involvement and career development.

Secondly**, inadequate promotional and outreach activities** to showcase the significance of research-focused programmes contribute to the low enrollment numbers. Institutions may face challenges in effectively communicating the unique research opportunities, mentorship, and infrastructure available for students pursuing advanced degrees.

Moreover, financial constraints on the part of prospective students can deter enrollment in these programmes. **Limited availability of scholarships, research stipends, or financial aid for advanced research degrees** can make such programmes economically burdensome for students, further exacerbating the enrollment challenge.

Creating a conducive environment that emphasizes the benefits and opportunities associated with advanced research degrees is crucial for overcoming the enrollment challenge and, subsequently, boosting funds for research activities.

6. Interdisciplinary Collaboration:

The challenge of limited interdisciplinary collaboration within State Universities and Institutes significantly curtails the potential for holistic research outcomes. This issue arises from a combination of institutional, cultural, and logistical factors that impede the seamless integration of diverse disciplines.

Institutional barriers often manifest in **rigid departmental structures and administrative silos** that discourage interdisciplinary interaction. Faculty members may find it challenging to navigate bureaucratic processes and obtain approvals for cross-disciplinary collaborations, leading to a compartmentalized research environment.

Cultural factors contribute to the challenge as **academic traditions and expectations may prioritize disciplinary expertise over collaborative efforts**. Recognition and reward systems within institutions might not **adequately acknowledge interdisciplinary contributions**, dissuading researchers from actively engaging in collaborative ventures.

Logistical challenges, such as **limited shared spaces and resources for interdisciplinary activities**, further hinder collaboration. **Lack of designated forums or platforms for researchers from different disciplines** to converge and exchange ideas impedes the organic growth of interdisciplinary initiatives.

Addressing this challenge requires a comprehensive approach and interdisciplinary dialogue to break down existing barriers and unlock the full potential of holistic research outcomes is absolutely essential.

7. Lack of lack of Efficient Mechanisms for Swift Approvals and Clearances:

The challenge posed by the lack of streamlined "single-window" clearances for medical and engineering research facilities significantly complicates administrative processes of State Universities and Institutes. This issue is characterized by a **lack of efficient mechanisms that can facilitate swift approvals and clearances** for research projects in these specialized domains.

Administrative delays often arise from the need to navigate multiple approval channels, each with its set of protocols and documentation requirements. The **absence of a unified system or a centralized authority for granting clearances** results in a protracted and convoluted process, hindering the timely commencement of research projects.

In the context of medical and engineering research, where adherence to regulatory standards is paramount, the absence of a "single-window" clearance system exacerbates the administrative burden. Researchers and administrators must engage with various regulatory bodies, each responsible for specific aspects of project approval, leading to a fragmented and time-consuming process.

8. Publication Prioritization Over Substantial Research:

The challenge of prioritizing paper publications over substantive research underscores a complex dynamic influencing faculty member. This phenomenon often manifests as a result of external pressures and institutional **expectations that place a premium on the quantity of publications rather than the depth and impact of the research**.

In an environment where academic success is frequently measured by metrics such as the number of published papers, faculty members may be incentivized to prioritize quantity over quality. This pressure can lead to a **focus on achieving a high volume of publications**, potentially at the expense of engaging in more comprehensive and impactful research endeavours.

Moreover, the prevailing academic culture, which places a significant emphasis on publication counts for career progression and recognition, can inadvertently encourage this prioritization. Faculty members may find themselves compelled to **publish frequently to meet institutional benchmarks and criteria for professional advancement**.

To address this challenge, there is a need for a paradigm shift in evaluating academic success. Emphasizing the significance and impact of research outcomes, rather than solely relying on publication metrics, can encourage faculty members to delve into more substantive and meaningful research. Institutions could consider adopting comprehensive evaluation frameworks that recognize the quality, depth, and societal impact of research contributions, fostering a research culture that goes beyond the pursuit of sheer publication numbers.

9. Brain Drain in University R&D:

The issue of brain drain, particularly concerning R&D in Indian universities, remains a significant challenge that warrants careful consideration. Brain drain refers to the emigration of

highly skilled and talented individuals, including researchers, scientists, and academics, from their home country to other nations seeking better opportunities. In the context of R&D, this phenomenon has implications for the intellectual capital and research capabilities of Indian universities.

One of the primary drivers of brain drain from Indian Universities is the lure of superior infrastructure, research facilities, and funding available in developed countries. Many researchers are enticed by the prospect of working in well-established laboratories with cutting-edge equipment, extensive research grants, and a conducive research environment. The perception of greater career advancement and recognition abroad, often accompanied by more competitive salaries, acts as a magnet for Indian scholars.

The consequences of brain drain are manifold. It deprives Indian universities of experienced and skilled researchers, leading to a potential loss of expertise in critical areas of study. Additionally, the outflow of talent contributes to a diminished research ecosystem, hindering the overall progress of academic institutions in India. This drain not only impacts the quantity but also the quality of research outputs, as the absence of seasoned researchers can impede the development of groundbreaking ideas and collaborative projects.

These challenges underscore the need for targeted interventions and strategic reforms to enhance the R&D culture in State-funded Universities and Institutes. The subsequent sections of this report delve into recommendations and actionable strategies aimed at overcoming these hurdles and fostering a vibrant research ecosystem.

10. Other Issues:

The above are some critical issues that need immediate attention and have been identified after detailed analysis and conversations with the state universities and institutes. Other relevant and important issues can be listed as follows:

- **Grant Proposal Expertise:** The faculty lacks experience and training in crafting effective research grant proposals, causing delays in project approvals. There is a need to introduce institute specialized training programmes to enhance faculty skills in grant proposal writing.

- **Faculty Recruitment Complexity:** Recruitment processes for both regular and contractual faculty are cumbersome and intricate, requiring simplification and increased autonomy. It is important to streamline recruitment procedures, granting universities greater autonomy in faculty selection, while ensuring transparency.

- **Prioritizing Societal R&D:** Research activities lack alignment with national priorities and local needs, undermining their impact on societal issues. Developing a strategic framework guiding universities to prioritize R&D addressing societal challenges and coordinating efforts through a centralized mechanism, is required.

X. Recommendations

i. Addressing University/ Institute-level Challenges

a) Establishment of R&D Committee/ Cell:

The establishment of Research and Development (R&D) cells in higher education institutions (HEIs) is a strategic initiative aligned with the vision of the National Education Policy 2020 (NEP 2020) and guided by comprehensive guidelines developed by the University Grants Commission (UGC). This initiative aims to cultivate a robust research ecosystem within HEIs, fostering reliable, impactful, and sustained research outputs with direct relevance to industrial and societal needs.

UGC actively promotes collaboration and knowledge-sharing among these cells, organizing conferences and lectures for coordinators to disseminate best practices and commendable work done by these units.

Some of the activities carried out by these cells in the past year are summarised as follows:

i. Formulation of research policies for the University.

ii. Constitution of IPR cells and centres for Innovation, Incubation and Entrepreneurship.

iii. Preparation of legal instruments necessary to realize technology transfer and providing legal and administrative support for the same.

iv. Identification of potentially patentable or copyrightable inventions. Filing for Patents and copyright applications.

v. Assisting with research projects.

vi. Resource sharing with other HEIs.

vii. Identification of potential collaborators and sponsors and finalization of research collaborations.

viii. Providing Start-up grants for the entrepreneurial endeavour of young researchers and faculties.

ix. Organizing seminars/ conferences and workshops.

The collaborative approach fostered by UGC ensures that these cells not only operate effectively within their respective institutions but also benefit from shared knowledge and experiences across the higher education landscape.

b) Improve Infrastructure and Instrumentation Facilities:

The initial step involves conducting a **comprehensive assessment of the existing research facilities** within the institution. This assessment aims to identify gaps, obsolete equipment, and areas requiring enhancement. Prioritization strategies are then employed, aligning upgrades with the specific research needs and focus areas of the institution.

Recognizing the pivotal role of interdisciplinary collaboration in fostering innovative research, the **creation of dedicated collaborative spaces** becomes imperative. These spaces serve as hubs for researchers from diverse disciplines to converge, exchange ideas, and embark on joint ventures. The design and functionality of these spaces are tailored to promote a seamless flow of ideas, encouraging interdisciplinary exploration.

Acknowledging the financial complexities of funding new research infrastructure, a proactive approach involves **exploring public-private partnerships (PPPs)**. By engaging with private entities, institutions can secure the necessary funding for constructing state-of-the-art research facilities. These partnerships not only alleviate the burden on public funds but also bring in external expertise, fostering a symbiotic relationship between academia and industry.

Investing in infrastructure and facilities, forms the bedrock of a thriving research ecosystem. It lays the foundation for future breakthroughs by creating an environment that fosters collaboration, innovation, and sustained academic growth.

c) Encouraging Faculty Engagement:

Recognizing the pivotal role of faculty in driving research excellence, a multifaceted approach is to be adopted to incentivize their active engagement. This includes provisions for research leave, subscription of journals, **making scholarly content more accessible** and cost-effective and allowing faculty members dedicated time for intensive research pursuits. Sabbaticals are encouraged, providing more extended periods for in-depth projects and collaborations. Additional research-oriented allowances are introduced to acknowledge and reward sustained contributions to the research ecosystem. These **incentives collectively create a supportive environment**, motivating faculty members to prioritize and excel in their research endeavours.

To fortify the research capabilities of faculty members, a structured framework of **workshops and training programmes must be implemented**. These initiatives cover diverse aspects such as advanced research methodologies, equipping faculty with the latest tools and techniques. Specialized sessions on grant writing should be conducted, providing insights into securing funding for research projects. Project management workshops ensure that faculty members are adept at efficiently overseeing and executing research initiatives. These programmes, conducted regularly, act as knowledge accelerators, empowering faculty with the skills essential for impactful research contributions.

d) Incentives for Student Participation:

Incorporating students into the research ecosystem is deemed integral to fostering a culture of inquiry and innovation. **Incentivizing student participation** is achieved through various means, including the allocation of course credits or certificates for active involvement in research projects. This not only enriches the academic experience for students but also contributes significantly to ongoing research initiatives. The synergy between faculty and students becomes a catalyst for groundbreaking discoveries, as students bring fresh perspectives and enthusiasm to research endeavours. Creating an environment where students are valued contributors to the research community enhances the overall vibrancy and productivity of the academic institution.

e) Strengthening Industry Partnerships:

In pursuit of a dynamic research landscape, an emphasis is placed on fostering robust collaborations between academic institutions and industries. Establishing a **streamlined mechanism for technology transfer** becomes paramount. This involves creating frameworks and platforms that expedite the transition of research outcomes into practical applications within industries.

To further integrate academia with industry, the establishment of **industry-sponsored research positions is advocated**. These positions, funded by industrial partners, serve as conduits for direct collaboration. Faculty members and students assume roles in these positions, engaging in research that aligns with industrial objectives. This symbiotic relationship ensures that research remains aligned with real-world needs and challenges.

The collaboration extends to **joint projects and internship opportunities**, providing students with hands-on experience in industrial settings. Collaborative projects allow for the cross-pollination of ideas and skills, enriching the academic curriculum with practical insights.

The intertwining of academia and industry creates a vibrant tapestry of innovation, where research findings seamlessly translate into tangible benefits for industries and society at large.

f) Support Intellectual Property Creation and Technology Transfer:

In the realm of research and development, the journey from ideation to practical application is guided by the principles of intellectual property (IP) and seamless technology transfer. Central to safeguarding intellectual capital is the expedient filing of patents. A proactive stance is to be adopted to **streamline and expedite patent filing processes**. This involves establishing dedicated units or cells tasked with comprehensively assessing the novelty and applicability of research outcomes, ensuring timely and effective patent submissions.

Beyond mere technology transfer, the focus extends to the commercialization of research outcomes. Robust strategies must be devised to **identify market opportunities, assess commercial viability, and navigate the intricacies of bringing innovations to market**. This includes collaborations with industry partners, licensing agreements, and the establishment of spin-off ventures to ensure the effective monetization of intellectual property.

Recognizing the complexity of **navigating legal and business landscapes**, dedicated support mechanisms are to be instituted. Researchers engaged in the patenting and commercialization process should receive legal counsel and business guidance to navigate intricacies, ensuring a seamless transition from research to market-ready products or services.

g) Create a Culture of Innovation and Entrepreneurship:

In the dynamic landscape of research and development, the integration of innovation and entrepreneurship emerges as a potent catalyst for transformative change. Initiatives must be devised to **cultivate an entrepreneurial mindset among students and faculty members**. Workshops, seminars, and awareness campaigns to be conducted to instill an understanding of the entrepreneurial journey, emphasizing risk-taking, creativity, and resourcefulness.

Recognizing the need for dedicated spaces that nurture fledgling ideas into robust enterprises, institutions should prioritize the **establishment of incubators and accelerators on campus**. These innovation hubs provide a conducive environment for ideation, prototyping, and mentorship, fostering the growth of startups. Further, to equip aspiring entrepreneurs with the essential skills and knowledge, comprehensive training programmes have to be instituted. These cover various facets of business development, including market analysis, financial planning, and strategic management. The aim is to empower individuals to navigate the complexities of entrepreneurship confidently.

h) Strengthen Evaluation and Recognition:

The current evaluation and recognition system for research contributions in India, influenced by accrediting bodies like the National Assessment and Accreditation Council (NAAC) and rankings like the National Institutional Ranking Framework (NIRF), exhibits certain limitations. These limitations include a predominant focus on quantitative metrics, potential biases in citation-based assessments, and a gap in capturing the societal impact of research comprehensively.

- **Qualitative Metrics Integration:** The current system relies heavily on quantitative metrics, potentially overlooking the qualitative aspects of research. Integration of qualitative metrics, such as the novelty of research, societal impact, and interdisciplinary collaborations, into the evaluation criteria is required.
- **Diverse Research Impact Assessment:** Citations are a primary measure, but they may not capture the diverse impact of research on society. Hence, expanding the impact assessment criteria to include real-world applications, policy influences, and contributions to community development is recommended.
- **Recognition of Interdisciplinary Research:** The current system might not adequately recognize the complexity and impact of interdisciplinary research. Developing specific criteria and evaluation mechanisms that appreciate and reward interdisciplinary collaboration is proposed, encouraging a holistic approach.
- **Stakeholder Consultation:** Engage stakeholders, including researchers, academicians, and industry experts, in the process of refining and updating the evaluation criteria, ensuring a collective and inclusive approach.

i) Encourage International Collaboration:

International collaboration in research is a key driver of academic excellence, fostering cross-cultural perspectives and enriching the global research landscape. While India actively engages in international collaborations, there is room for further enhancement and strategic development.

Strategies for Strengthening Collaboration:

- **Strategic Partner Selection:** Existing collaborations are diverse but may lack a strategic focus. Prioritizing collaborations with institutions known for excellence in specific research domains such as IITs, IISc, NITs, IIITs, etc., ensuring synergy and mutual benefit is necessary.

- **Faculty Exchange Programmes:** Some collaborations include faculty exchange, but the scale and impact can be expanded. Establishing a structured and scalable faculty exchange programmes, encouraging knowledge transfer, and collaborative research, and fostering long-term partnerships.

- **Research Conferences and Symposia:** Participation in international conferences occurs, but there may be opportunities for hosting joint events. Facilitate and incentivize the organization of joint research conferences and symposia, offering platforms for knowledge exchange and networking.

- **Promotion of Interdisciplinary Collaboration:** Collaboration is often discipline-specific; interdisciplinary collaboration could be enhanced. Encourage collaborations that transcend disciplinary boundaries, fostering innovation and addressing complex global challenges.

- **Resource Allocation:** Limited resources may constrain the scale of collaborations. Explore public-private partnerships and leverage government funding to support international collaborations, ensuring sustained financial support.

j) Improve Public Outreach:

Public outreach serves as a pivotal component in magnifying the impact of research conducted within universities and institutes. To effectively showcase achievements, there is a pressing need to adopt a multifaceted communication strategy. The current approach, while existing, may lack cohesion, prompting a recommendation to develop a comprehensive strategy. This includes **utilizing diverse channels such as press releases, social media campaigns, and interactive platforms** to ensure that research milestones are communicated effectively.

Engagement with mainstream media is another area for enhancement. The current level of interaction may be limited, and forging collaborations with media outlets can significantly contribute to translating complex research findings into accessible narratives for the general public. Additionally, there should be a deliberate effort to **present success stories and impactful case studies regularly**. This will not only provide a human touch to research but also **underscore its practical applications and societal benefits**.

In the realm of highlighting research achievements through various media channels, **strategic partnerships with media organizations are recommended** for consistent coverage. Digital platforms and social media should be harnessed to their full potential, incorporating interactive elements, podcasts, and live sessions. Moreover, **organizing science communication workshops** can equip researchers with the skills needed to effectively convey the significance of their work.

k) Regular Assessment and Feedback:

In fostering a dynamic research ecosystem, the establishment of a robust system for regular assessment and feedback stands as a cornerstone. This involves a two-fold approach: creating a **structured feedback mechanism for faculty and students and conducting periodic reviews of research centers and departments**.

The feedback mechanism should be designed to be inclusive, allowing faculty and students to actively participate in shaping the research environment. This can be achieved through surveys, focus group discussions, and dedicated feedback sessions. Anonymity and confidentiality should be prioritized to encourage honest and constructive input. Additionally, the feedback process should not be a one-time occurrence but rather an iterative system, fostering continuous improvement.

Periodic reviews of research centers and departments are instrumental in assessing their impact, identifying areas of improvement, and ensuring alignment with institutional goals. These reviews should be comprehensive, considering aspects such as research output, faculty engagement, collaboration initiatives, and infrastructure utilization. The process should involve both internal and external experts to bring diverse perspectives. Furthermore, a transparent and participatory approach to the review process can instill a sense of ownership among stakeholders, motivating them to actively contribute to the enhancement of the research ecosystem.

i) Identify and Pursue Long-term Vision:

To fortify the research landscape, it is imperative to articulate a comprehensive long-term vision that goes beyond immediate challenges, encompassing strategic planning and development. **Effective strategic planning is pivotal** in aligning research initiatives with the overarching goals of the institution. This process necessitates a collaborative approach, involving key stakeholders such as faculty, administrators, industry partners, and research scholars. A thorough environmental analysis, encompassing technological trends, funding landscapes, and global research priorities, should precede the formulation of the strategic plan. Strategic planning should not be a static document but an adaptive framework that can evolve in response to emerging opportunities and challenges.

A **robust R&D strategy** serves as the guiding framework for shaping the trajectory of research activities over an extended period. This strategy should be anchored in a shared vision, with clearly articulated objectives that resonate with the institution's mission. These objectives should be SMART (Specific, Measurable, Achievable, Relevant, Time-bound) and aligned with the institution's long-term goals. Key performance indicators (KPIs) should be identified to quantitatively measure progress and success.

Timelines play a pivotal role in providing a structured roadmap for the implementation of the strategy. **Breaking down long-term goals into phased milestones** enables better monitoring and evaluation. Regular reviews and updates of the strategy ensure its adaptability to changing circumstances and emerging opportunities. It should reflect a forward-looking vision that not only addresses current challenges but anticipates future research trends and societal needs.

ii. Addressing State-level Challenges

a) Autonomy and Funding:

Advocating for greater autonomy and control over resources and decision-making is a pivotal step towards empowering universities and institutes. This multifaceted approach involves

redefining the relationship between these institutions and the governing bodies, thereby enhancing their financial independence and self-governance.

- **Financial Autonomy:** Granting financial autonomy to universities and institutes is the basis for catalyzing research initiatives. This involves providing institutions with the flexibility to manage their finances independently, allocating funds based on their unique research priorities and strategic goals. Financial autonomy liberates these entities from bureaucratic red tape, enabling swift decision-making on resource allocation, research infrastructure upgrades, and faculty incentives.
- **Decision-Making Autonomy:** Empowering universities and institutes with decision-making autonomy involves decentralizing administrative processes. This includes streamlining approval mechanisms for research projects, faculty recruitment, and infrastructure development. Decisions regarding research focus areas, collaborations, and international partnerships can be made locally, aligning with the institution's vision and strengths.
- **Strategic Allocation for Research and Development:** Meticulous distribution of funds within the specified 5-7% budget allocation to cater specifically to Research & Development (R&D) endeavours. The funding should be strategically managed to address the diverse needs of different disciplines, encouraging a well-rounded approach to knowledge creation and technological advancements.

b) Thrust Areas for Research:

Encouraging each university to identify specific thrust areas for need-based research is a strategic imperative in fostering specialized expertise and addressing societal challenges. This approach aligns with the ethos of the NEP 2020, emphasizing the role of universities in becoming engines of innovation and problem-solving.

Universities are urged to embark on a strategic identification process to **pinpoint thrust areas aligned with local communities, regional needs, national priorities, and global challenges**. This involves a comprehensive assessment of the university's existing strengths, faculty expertise, and the unique socio-economic context in which it operates. Consultations with stakeholders, including industries, local communities, and government bodies, can provide valuable insights into pressing challenges that need scholarly attention.

Concentrating efforts on specific thrust areas ensures a more profound and sustained impact on the identified challenges. By concentrating resources on a select set of research themes, universities can optimize their infrastructure, faculty training, and collaboration networks.

c) Faculty Recruitment and Autonomy:

Recognizing the critical intersection of faculty recruitment and institutional autonomy is paramount for ensuring academic excellence and fostering a vibrant research environment. The current landscape reflects challenges that, when addressed strategically, can pave the way for a more robust faculty recruitment process and increased institutional autonomy.

- **Bureaucratic Hurdles:** Cumbersome administrative processes often impede the swift recruitment of faculty, leading to delays in filling crucial academic positions. Streamlining these processes is crucial for attracting and retaining top-tier talent.

- **Autonomy Constraints:** The rigid approval processes from state governments or central bodies, such as UPSC, for each faculty recruitment pose a challenge to the autonomy of educational institutions. This bureaucratic oversight can hinder the timely appointment of qualified faculty members.

- **Autonomous Departmental Committees:** Empower individual departments with more autonomy in faculty recruitment. Establish department-level recruitment committees comprising faculty members, alumni, and industry experts.

- **Recruitment Task Forces:** Create task forces dedicated to faculty recruitment, comprising experienced academicians and administrators. Develop a repository of potential candidates for various disciplines to expedite the hiring process.

d) Equitable Distribution of Funds:

Ensuring the equitable distribution of funds, irrespective of Principal Investigator (PI) affiliation, is essential for fostering a collaborative and inclusive research ecosystem. To achieve this goal, a systematic approach is needed, encompassing policy changes, transparent mechanisms, and stakeholder engagement.

- **Transparent Evaluation Criteria:** Establishing clear and transparent criteria for evaluating research proposals, emphasizing the project's scientific merit and potential impact. The standardized set of evaluation parameters should be accessible to all stakeholders.

- **Peer Review Oversight Committees:** Create oversight committees comprising diverse experts to monitor the peer review process and ensure fairness. Conduct periodic reviews of the peer review process, addressing any biases or discrepancies.

- **Collaboration with Funding Agencies:** Collaborate with funding agencies to encourage a shift towards fair allocation practices. Exploring the possibility of pilot programmes to test and refine equitable distribution mechanisms.

- **State-sponsored Research Programmes:** Establish state-funded research initiatives aligned with the specific developmental needs and growth priorities of the region, fostering targeted contributions to local progress and advancement.

e) Scaling Up Projects:

Scaling up research projects from Technology Readiness Level (TRL) 3 to 6 and facilitating their commercialization is a critical step towards translating academic endeavours into real-world impact.

- **Establishment of a Dedicated Fund:** Creation of an Institute-level dedicated fund specifically earmarked for scaling up projects from TRL 3 to 6. Propose a detailed framework outlining the criteria for project eligibility, fund allocation, and expected outcomes.

- **Collaboration with Industry for Scaling Projects:** Encourage collaboration with industries to provide expertise, mentorship, and financial support for scaling research projects.

- **Technology Transfer Acceleration Programmes:** Developing acceleration programmes specifically focused on expediting the technology transfer process from academia to industry. Additionally, collaborating with technology transfer offices to identify bottlenecks and streamline procedures.
- **Specialized Grants for Commercialization:** Introduction of specialized grants dedicated to supporting the commercialization phase of research projects. State funding agencies can create grant categories that focus explicitly on transitioning projects from TRL 3 to 6. Ensure that these grants cover expenses related to market validation, prototype development, and initial commercialization efforts.
- **Establishing Translational Research Hubs:** Establishment of translational research hubs that serve as centralized facilities for scaling and commercializing projects. Ensure that these hubs offer shared resources, expertise, and mentoring for researchers involved in scaling projects.

The NITI Aayog, has also released, under the NITI Working Paper series, the Techno-Commercial Readiness and Market Maturity Matrix (TCRM Matrix) framework, a pioneering assessment tool designed to revolutionize technology evaluation, foster innovation, and fuel entrepreneurship in India. A copy of that framework can be accessed at https://niti.gov.in/sites/default/files/2023-07/TCRM-Matrix-Framework-FAD3.pdf. The TCRM Matrix framework presents an integrated assessment model that offers in-depth insights and actionable intelligence to stakeholders at every stage of the technology development cycle.

f) Modern Research Instruments:

Recognizing the pivotal role that modern research instruments play in advancing scientific discovery and innovation, the following actionable recommendations are proposed to address the pressing need for additional research instruments:

- **Comprehensive Instrumentation Needs Assessment:** Conduct a thorough assessment of the current research infrastructure to identify gaps and prioritize the acquisition of modern instruments. Form a dedicated committee involving researchers, faculty, and industry experts to assess instrumentation needs. Utilize the findings to create a roadmap for systematically acquiring essential instruments.
- **Establishing Centralized Research Instrument Facilities:** The establishment of centralized facilities housing state-of-the-art research instruments. Ensure accessibility to these facilities by researchers from various disciplines and institutions.
- **Public-Private Partnerships for Instrument Acquisition:** Explore public-private partnerships to fund the acquisition of modern research instruments. Engage with industry partners willing to contribute financially to procure instruments relevant to their sectors. Establish transparent agreements outlining the terms of collaboration and shared benefits.
- **Funding Allocation for Instrument Upgradation:** State Governments should allocate a specific portion of research funds for the regular upgradation of existing instruments

and procurement of new ones. Integrate a dedicated budget for instrument upgradation into the overall research funding structure. Establish an Overarching Committee responsible for periodic reviews and recommendations on upgrade priorities.

- **Collaborative Research Projects for Instrument Sharing:** Encourage collaborative research projects that involve the sharing of expensive instruments among participating institutions. Develop frameworks for collaborative projects, emphasizing the efficient utilization of shared instruments. Foster a culture of collaboration by recognizing and incentivizing joint research initiatives.

- **Grant Programmes for Instrument Acquisition:** Propose the introduction of grant programmes specifically aimed at supporting institutions in acquiring modern research instruments. Ensure that the grants cover the entire lifecycle of instruments, including maintenance and training.

g) Enhancing Fellowship:

In the pursuit of fostering a vibrant research ecosystem, State Governments and Authorities play a pivotal role in addressing the financial challenges faced by non-NET Ph.D. students.

- **Specialized Funding Allocation:** State Governments can allocate a specific portion of their research and education budget to create a dedicated fund for non-NET Ph.D. fellowships. This targeted funding approach will ensure that financial support reaches the intended recipients, addressing the existing gap.
- **Industry-State Collaboration:** States can facilitate partnerships wherein industries sponsor fellowships aligned with their research needs, providing students with financial support while fostering industry-academia synergy.
- **Recognition of State-Level Research:** State governments can institute policies that recognize and reward outstanding state-level research contributions. This recognition can take the form of additional financial incentives or awards, motivating non-NET Ph.D. students to excel in their research pursuits.
- **Collaboration with Philanthropic Organizations:** Facilitating partnerships with philanthropic organizations can enhance financial support for non-NET Ph.D. students. Exploring avenues for collaboration and encouraging philanthropic entities to contribute to fellowship programmes.

iii. Addressing Central-level Challenges

a) Accelerating NEP 2020 Implementation:

The imperative to fortify R&D initiatives in HEIs is embedded in the National Education Policy (NEP) 2020. To accelerate the NEP's vision in this domain, there are key actionable steps that require urgent attention:

- **Alignment of Curricula with Research Goals:** Urgent restructuring of academic curricula to align with NEP's emphasis on research-driven education. Inculcating a research-oriented mindset early in academic pursuits can significantly bolster the R&D culture.

- **Infrastructure Augmentation:** Swift augmentation of research infrastructure is paramount. This includes updating laboratories, acquiring modern equipment, and ensuring the availability of cutting-edge technology. Addressing these infrastructural needs directly impacts the quality of research outputs.

- **Incentivizing Faculty Engagement:** Urgent introduction of incentives to encourage faculty participation in R&D activities. Recognition through rewards, research leaves, and additional allowances can motivate educators to actively engage in impactful research.

- **Collaborative Ventures:** Facilitating collaborative ventures with industries and other research institutions. Immediate efforts should be directed towards creating a conducive environment for multidisciplinary collaborations, fostering a synergistic approach to problem-solving.

b) Special Status for Unique Requirements:

In the endeavour to enhance R&D capabilities within HEIs, a compelling case is made for granting special status to universities and institutes in distinctive geographical regions. This proposal specifically targets North Eastern regions, Island states such as Andaman & Nicobar Islands, hilly states, and other geographically unique areas, recognizing and addressing their unique developmental needs.

- **Tailoring Policies for Specific Challenges:** The call for special status is rooted in the understanding that these regions face specific challenges that necessitate tailor-made policies. Recognizing and addressing these challenges will be instrumental in fostering an environment conducive to impactful research.

- **Infrastructure and Resource Augmentation:** Special status entails a dedicated focus on the augmentation of research infrastructure and resources in these regions. This includes the provision of cutting-edge laboratories, research facilities, and the necessary technological support required for advanced research pursuits.

- **Equitable Research Funding Allocation:** A key aspect of special status is ensuring equitable allocation of research funding, acknowledging the unique obstacles faced by these regions. This approach aims to bridge existing gaps and provide the necessary financial support for research initiatives.

- **Talent Development and Retention:** Special recognition seeks to create incentives for attracting and retaining talented researchers and faculty members in these regions. Fellowship programmes, research grants, and recognition schemes can be implemented to nurture and retain research talent.

- **Promoting Interdisciplinary Research:** The proposal emphasizes the encouragement of interdisciplinary research to leverage the unique strengths of these regions. Collaborations across diverse disciplines can be facilitated, fostering comprehensive and impactful research outcomes.

- **Community Engagement and Societal Impact:** Special status also involves a focus on community engagement and ensuring that research outcomes have a positive impact on the local society. This includes initiatives that address community-specific challenges and contribute to the overall development of these regions.

c) Maintenance of Research Equipment:

Maintaining high-end research equipment is a critical challenge that demands strategic approaches for ensuring prolonged functionality and optimal performance. Firstly, there is a need for the **establishment of a dedicated fund earmarked for the maintenance of research equipment**. This fund can be allocated to HEIs based on their research infrastructure needs, ensuring equitable distribution.

Additionally, the centre can facilitate the **creation of a centralized technical support network consisting of experts in various domains**. These specialists can offer guidance and assistance to multiple institutions, sharing their expertise to address maintenance challenges efficiently. Collaborative initiatives, such as **national-level training programmes and workshops**, can be organized to enhance the skills of technical staff involved in equipment maintenance.

Moreover, public-private collaborations can bring in specialized knowledge, resources, and technologies, contributing to effective maintenance practices. Introducing **tax incentives for private companies investing in research equipment maintenance** could further incentivize such partnerships.

d) Delineation for Contract Teachers:

There is a provision in the UGC Regulations on Minimum Qualifications for the Appointment of Teachers and other Academic Staff in Universities and Colleges and Measures for the Maintenance of Standards in Higher Education, 2018[6]. Clause no. 13 of the Regulations stipulates that:

- Teachers should be appointed on a contract basis only when it is absolutely necessary and when the student-teacher ratio does not satisfy the laid-down norms.
- In any case, the number of such appointments should not exceed 10% of the total number of faculty positions in a College/University.
- The qualifications and selection procedure for appointing them should be the same as those applicable to a regularly appointed teacher.
- The fixed emoluments paid to such contract teachers should not be less than the monthly gross salary of a regularly appointed Assistant Professor.
- Such appointments should not be made initially for more than one academic session, and the performance of any such entrant teacher should be reviewed for academic performance before reappointing him/her on a contract basis for another session.

[6] https://www.ugc.gov.in/pdfnews/4033931_UGC-Regulation_min_Qualification_Jul2018.pdf

- Such appointments on a contract basis may also be resorted to when absolutely necessary to fill vacancies arising due to maternity leave, child-care leave, etc.

In addition, UGC has also published the UGC revised guidelines for enhancement of rates of honorarium for guest faculty on the 28th of January 2019. Accordingly:

1. The honorarium is Rs. 1500 per lecture, subject to a maximum of Rs. 50,000 per month.
2. Guest faculty are appointed only against sanctioned posts.
3. Qualifications for guest faculty shall be the same as prescribed for the post of assistant professor.
4. The selection procedure for guest faculty is the same as an assistant professor.
5. The composition of the selection committee is as follows:
    a. The Vice-Chancellor or his/her Nominee
    b. One subject expert to be nominated by the vice-chancellor
    c. Dean of the concerned faculty
    d. Head of the Department
    e. An Academician representing SC/ST/OBC/Minority/Women/ Differently abled categories to be nominated by the vice-chancellor
6. The guest faculty will not get benefits of allowances, pension, gratuity leave etc.

It is strongly recommended that all the state universities and institutes should follow, scrupulously, the above guidelines of the UGC while hiring contract teachers.

e) Stringency in University Establishment:

Adopting a more stringent approach to the establishment of new universities is imperative to ensure the quality, sustainability, and overall effectiveness of higher education institutions. The process of setting up universities should involve a comprehensive evaluation of factors such as academic infrastructure, faculty qualifications, financial viability, and a clear vision for educational outcomes.

Enforcing stricter criteria for approving new university establishments may include rigorous scrutiny of the proposed curriculum, faculty-to-student ratios, infrastructure plans, and long-term sustainability models. By emphasizing stringent standards, the government aims to prevent the proliferation of substandard institutions that may compromise the quality of education and research.

UGC and AICTE should jointly disseminate **clear and detailed information regarding the approval process for new universities**. This information should be easily accessible to prospective institutions, guiding them through the application and evaluation procedures.

f) Autonomy for External Ph.D. Registrations

In a dynamic academic landscape, the proposal to allow external Ph.D. registrations stands as a strategic move towards fostering a balanced teacher-student ratio and promoting a more inclusive research environment.

- Allowing external PhD registrations facilitates the infusion of diverse perspectives and experiences into research endeavours.
- Institutions can optimize resources by tapping into the expertise of scholars beyond their immediate campuses. This leads to a more efficient utilization of intellectual capital, promoting collaborative research initiatives that transcend geographical boundaries.
- External PhD registrations enable universities to forge national and international collaborations seamlessly. Scholars from different regions or even countries can engage in joint research projects, fostering global academic integration and enhancing the global standing of Indian universities.
- A balanced teacher-student ratio, facilitated by external PhD registrations, paves the way for increased research productivity. Faculty members can guide a broader spectrum of research scholars, fostering a culture of innovation and knowledge creation.
- Working professionals seeking to pursue doctoral studies can benefit from the flexibility offered by external registrations. This inclusivity caters to individuals with diverse career trajectories, promoting lifelong learning and academic growth.

g) Exempting State Universities from GST and Income Tax

To implement the recommendation of exempting State universities and institutes from the Goods and Services Tax (GST) and Income Tax, the Central Government and the University Grants Commission (UGC) can take several strategic steps:

- State universities often operate on limited budgets allocated by state governments. Exempting them from GST ensures that essential goods and services they procure for academic and research purposes are not subjected to additional tax burdens. This **financial relief allows universities to allocate resources more efficiently** to core activities like teaching, research, and infrastructure development.
- Explore financial support mechanisms to compensate for the potential revenue loss due to tax exemptions. This may involve the **creation of special funds or grants** dedicated to supporting state universities in their academic and research endeavours.
- Introduce **incentive structures that reward state universities for their contributions to research, innovation, and academic excellence**. This could include additional grants, recognition, or other benefits for universities that actively engage in high-quality research and development activities.

XI. Conclusion

In conclusion, this comprehensive report serves as a repository of the multifaceted challenges and well-considered recommendations for fostering a vibrant R&D culture within State Universities and Institutes, with the overarching goal of propelling India into a position of global leadership in innovation and technological advancement.

The report systematically unpacks the diverse challenges faced by these institutions, ranging from funding constraints and teaching-research imbalances to faculty mindset and administrative hurdles. It delineates the intricate landscape where pockets of excellence coexist with systemic impediments, offering a nuanced understanding of the current state of R&D in State Universities.

On the foundation of these insights, the report articulates a roadmap for transformative change. It puts forth actionable recommendations, spanning from the establishment of R&D committees and infrastructure development to faculty incentives, industry partnerships, and international collaborations. Each recommendation is crafted with a pragmatic lens, considering the practicalities of implementation and the potential for impactful outcomes.

The urgency of these recommendations is underscored by their collective potential to propel India into a global hub of innovation. The conclusion is not just a mere summary; it is a compelling plea for the Government of India to recognize the transformative power embedded in these recommendations. It calls for strategic planning and policy formulation that aligns with the aspirations of positioning India at the forefront of groundbreaking research and technological advancements. The report, therefore, serves as a clarion call for concerted efforts and visionary actions to shape the future trajectory of R&D in Indian higher education.

XII. Way Forward

At a time when countries across the world are taking specific measures to either nurture talent or attract such talent from the rest of the world, this report provides an assessment of the Indian ecosystem, identifies the drivers of the present system along with specific areas of friction and gaps, and finally recommends some specific cross-cutting actions that various stakeholders may take to build a robust talent ecosystem in the country.

While the intention is not to provide a panacea for all the shortcomings of the R&D ecosystem in the state universities and institutes, efforts have been made to identify major challenges that India faces to reap its demographic dividend and transform into a global hub for talent. The report hopes to initiate a frank and open discussion around current Indian challenges at the institute-level, state-level and the central-level, which will inevitably include some suggestions to revamp the existing Indian systems and processes. These constructive suggestions should be taken in the spirit of guiding improvement. Similarly, the abstraction of themes from successful S&T powers is being done to identify ideas useful for India. This abstraction does not imply an endorsement or criticism of any country's systems or policy choices.

The educational landscape in India is characterized by a collaborative governance structure, where both the central and state governments play pivotal roles. While centrally funded institutions often showcase exemplary performance, there is room for enhancement in institutions managed at the state level. This variation in educational quality can be attributed to different policy approaches and governance practices at the state level. The implications of this variation demand continuous education and skill development to keep pace with rapid innovation. There is a noticeable gap between the evolving requirements of the industry and the current direction of education and skill development.

To address this complex issue, a unified and strategic approach is necessary. Such an approach would involve aligning educational policies across different levels of government, improving infrastructure at state-managed institutions, promoting closer cooperation between academia and industry, and updating curricula to reflect the latest developments. Through these measures, India aims to cultivate a more inclusive and dynamic pool of next-gen professionals, ensuring readiness for the challenges and opportunities of the contemporary landscape.

India as a career destination has a long way to go to become an aspiration for young students, with limited career options in the Indian job market and unattractive remunerations. At the same time, talent needs to be nurtured for the market within the limits of the current educational quality. To attract talent to India, or to get back Indian talent from other countries, we require addressing specific issues related to retaining talent such as ease of doing research, reduction of bureaucratic processes for recruitment, competitive salaries and incentives along with specific actions for easing restrictions for foreign scientists to work and teach in India. Each of these are discussed, in detail, in the report.

A summary of the recommendations at the level of institute, state governments and the central government has been provided in the **Table 1**. Implementation of these recommendations would require close coordination across various stakeholders. A core group of senior level officers from these stakeholder organisations can be considered to be set-up to examine these recommendations and chalk-out a way forward for implementation, which will, in turn, help build the industries of the future, enhance the country's strategic capabilities and build a strong and prosperous Viksit Bharat.

Table 1: Summary of Recommendations

S.N.	Recommendation	Implementation By	Timeline	Implementation Modalities
University/Institute Level				
1	Establishment of R&D Committee / Cell	Vice-Chancellor + Dean (R&D) / Director (R&D)	Short Term (1 – 2 years)	• Formulation of research policies for the University and identification of research strategy. • Design and implement a model for performance evaluation of professors based on research. • Periodic review of university level research priorities, status of ongoing research projects, and assessment of research needs.
2	Improve Infrastructure and Instrumentation Facilities	Dean (R&D) / Director (R&D)	Short Term (1 – 2 years)	• Comprehensive assessment of the existing research facilities including identifying capacity gaps, obsolete equipment, and areas requiring enhancement. • Creation of a dedicated collaborative space for research promotion (aka Research Park) with a Centralised Instrumentation Facility • Explore Public-Private Partnerships for funding new research infrastructure.
3	Encouraging Faculty Engagement	Dean (R&D) / Director (R&D)	Short Term (1 – 2 years)	• Make scholarly content more accessible and cost-effective by enabling subscription to scientific and technical journals. • Allow faculty members dedicated time for intensive research pursuits, with provisions for research-oriented allowances. • Fortify the research capabilities of faculty members with workshops on writing research proposals and advanced research methodologies.
4	Incentives for Student Participation	R&D Cell	Short Term (1 – 2 years)	• Fostering a culture of inquiry and innovation by allocation of course credits or certificates for active involvement in research projects.

S.N.	Recommendation	Implementation By	Timeline	Implementation Modalities
5	Support Intellectual Property Creation and Technology Transfer	R&D Cell + Entrepreneurship Cell	Short Term (1 – 2 years)	• Establishing dedicated units tasked with supporting researchers in assessing the novelty and applicability of their research outcomes, and ensuring timely and effective patent submissions. • Provide administrative support, legal counsel and business guidance to researchers for identifying market opportunities, assess commercial viability, and navigate the intricacies of bringing innovations to market.
6	Strengthen Industry Partnerships	R&D Cell	Medium Term (2 – 5 years)	• Create frameworks and platforms that expedite the transition of research outcomes into practical applications within industries. • Establish industry-sponsored research positions for faculty members or doctoral students to engage in research that aligns with industrial objectives. • Enable joint projects and internship opportunities, providing students with hands-on experience in industrial settings.
7	Regular Assessment and Feedback	Vice-Chancellor	Medium Term (2 – 5 years)	• Create a structured feedback mechanism for faculty and students to actively participate in shaping the research environment through surveys and focus group discussions. • Facilitate periodic reviews of research centers and departments considering aspects such as research output, faculty engagement, collaboration initiatives, and infrastructure utilization.
8	Create a Culture of Innovation and Entrepreneurship	R&D Cell + Entrepreneurship Cell	Medium Term (2 – 5 years)	• Integrate research and innovation with professor evaluations and academic programmes. Emphasize research-oriented courses. • Establishment of incubators and accelerators on campus to provide mentorship and support, for fostering the growth of startups. • Organize workshops, seminars, and awareness campaigns to instil an understanding of the entrepreneurial journey.

S.N.	Recommendation	Implementation By	Timeline	Implementation Modalities
9	Strengthen Evaluation and Recognition	Vice-Chancellor	Long Term (> 5 Years)	• Engage stakeholders, including researchers, academicians, and industry experts, in the process of refining and updating the evaluation criteria. • Design new evaluation criteria for faculty by integration of qualitative metrics, such as the novelty of research, societal impact, and interdisciplinary collaborations. • Diversify impact assessment criteria to include real-world applications, policy influences, and contributions to community development.
10	Encourage International Collaboration	Vice-Chancellor + R&D Cell	Long Term (> 5 Years)	• Prioritize collaborations with institutions and industries known for excellence in specific research domains that align with the university's research priorities. • Establishing structured and scalable faculty exchange programmes, encouraging knowledge transfer, and collaborative research. • Facilitate and incentivize the organization of joint research conferences and symposia, offering platforms for knowledge exchange and networking.
11	Improve Public Outreach	Public Relations (PR) Cell	Long Term (> 5 Years)	• Adopt a multifaceted communication strategy that includes diverse channels to ensure that research milestones are communicated effectively. • Engage with mainstream media to translate complex research findings into accessible narratives for the general public using success stories and impactful case studies.
12	Identify and Pursue Long-term Vision	Vice-Chancellor	Long Term (> 5 Years)	• Analyse technological trends, funding landscapes, national research priorities, and industry interest areas to formulate an R&D strategy for the university. • Develop a structured roadmap, anchored in a shared vision, with specific, measurable, and time-bound Key Performance Indicators.
State Level				
1	Thrust Areas for Research	Department of Education, State Government	Short Term (1 - 2 years)	• Pinpoint thrust areas aligned with local communities, regional needs, national priorities, and global challenges. • Comprehensive assessment of the university's existing strengths, faculty expertise, and the unique socio-economic context in which it operates. • Each university to identify specific thrust areas for need-based research.

S.N.	Recommendation	Implementation By	Timeline	Implementation Modalities
2	Equitable Distribution of Funds	State S&T Council / Department of Science and Technology, State Government + Department of Education, State Government	Short Term (1 - 2 years)	• Initiate state-sponsored research programmes to support the state's development and growth needs. • Establishing clear and transparent criteria for evaluating research proposals, emphasizing the project's scientific merit and potential impact. • Create oversight committees comprising diverse experts to monitor the peer review process and ensure fairness.
3	Scaling Up Projects	Department of Planning, State Government + Department of Industries, State Government	Medium Term (2 – 5 years)	• Creation of an Institute-level dedicated fund specifically earmarked for scaling up projects from TRL 3 to 6. • Acceleration programmes specifically focused on expediting the technology transfer process from academia to industry. • Specialized grants dedicated to supporting the commercialization phase of research projects. • Establishment of translational research hubs that serve as centralized facilities for scaling and commercializing projects.
4	Modern Research Instruments	State S&T Council / Department of Science and Technology, State Government	Medium Term (2 – 5 years)	• Assessment of the current research infrastructure to identify gaps and prioritize the acquisition of modern instruments. • Establishment of centralized facilities housing state-of-the-art research instruments. • Collaborative Research Projects for Instrument Sharing. • Grant Programmes for Instrument Acquisition.
5	Enhancing Fellowship	Department of Education, State Government	Medium Term (2 – 5 years)	• Research and Education budget to include a dedicated fund for non-NET Ph.D. fellowships. • Introducing Industry-sponsored/ philanthropic organizations-funded fellowships. • Recognize and reward outstanding state-level research contributions in the form of additional financial incentives or awards.

S.N.	Recommendation	Implementation By	Timeline	Implementation Modalities
6	Autonomy and Funding	Department of Education, State Government	Long Term (> 5 Years)	• Allocating universities funds based on their unique research priorities and strategic goals. • Streamlining approval mechanisms for research projects, faculty recruitment, and infrastructure development. • Meticulous distribution of funds within the specified 5 – 7% budget allocation to cater specifically to Research & Development (R&D) endeavours.
7	Faculty Recruitment and Autonomy	Department of Education, State Government + Vice-Chancellors	Long Term (> 5 Years)	• Establish department-level recruitment committees. • Create task forces dedicated to faculty recruitment, comprising experienced academicians and administrators. • Develop a repository of potential candidates for various disciplines to expedite the hiring process.
National Level				
1	Accelerating NEP 2020 Implementation	Department of Higher Education, Government of India	Short Term (1 - 2 years)	• Urgent restructuring of academic curricula to align with NEP's emphasis on research-driven education. • Updating laboratories, acquiring modern equipment, and ensuring the availability of cutting-edge technology. • Introduction of incentives to encourage faculty participation in R&D activities.
2	Maintenance of Research Equipment	Department of Science and Technology (DST), Government of India + All India Council for Technical Education (AICTE)	Short Term (1 - 2 years)	• Establishment of a dedicated fund earmarked for the maintenance of research equipment. • Creation of a centralized technical support network consisting of experts in various domains. • Introducing tax incentives for private companies investing in research equipment maintenance.

S.N.	Recommendation	Implementation By	Timeline	Implementation Modalities
3	Delineation for Contract Teachers	University Grants Commission (UGC)	Medium Term (2 – 5 years)	• Contract teachers should be appointed only when the student-teacher ratio falls below norms, limited to 10% of total faculty positions. • Qualifications, selection, and emoluments for contract teachers should mirror regular appointments, ensuring a minimum monthly salary equivalent to an Assistant Professor. • Initial contracts should be limited to one academic session, subject to performance review.
4	Autonomy for External Ph.D. Registrations	University Grants Commission (UGC)	Medium Term (2 – 5 years)	• Enables scholars from different regions or countries to engage in joint research projects. • Flexibility for working professionals for pursuing doctoral studies. • External PhD registrations foster seamless national and international collaborations.
5	Special Status for Unique Requirements	Department of Higher Education, Government of India	Long Term (> 5 Years)	• Granting special status to universities and institutes in distinctive geographical regions. (North Eastern regions, Island states such as Andaman & Nicobar Islands, hilly states, and other geographically unique areas). • Dedicated focus on the augmentation of research infrastructure and resources including equitable allocation of research funding. • Create incentives for attracting and retaining talented researchers and faculty members.
6	Stringency in University Establishment	University Grants Commission (UGC) + All India Council for Technical Education (AICTE)	Long Term (> 5 Years)	• Enforcing stricter criteria for approving new university establishments. • Clear and detailed information regarding the approval process for new universities.

Notes

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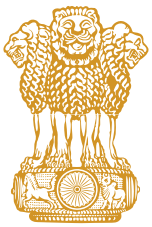
Designed by:



सत्यमेव जयते

NITI Aayog