विज्ञान एवं प्रौद्योगिकी विभाग
DEPARTMENT OF
SCIENCE & TECHNOLOGY
सत्यमेव जयते

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

NATIONAL MANUFACTURING INNOVATION SURVEY 2021-22:

SUMMARY FOR POLICYMAKERS

Key findings and opportunities

March 2023

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March 2023, New Delhi

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Minister of State in the Department of Atomic Energy and
Minister of State in the Department of Space
Government of India

24th March 2023

MESSAGE

I am pleased to extend my warmest congratulations to the Department of Science and Technology (DST) and the United Nations Industrial Development Organization (UNIDO) on the successful completion of the National Manufacturing Innovation Survey (NMIS) 2021-22. The results of the survey provide significant insight into the state of innovation in India's manufacturing sector. The Government of India has been steadfast in its commitment in promoting the competitiveness of Indian manufacturing and increasing its contribution to the GDP. In the past decade, key policies and programmes have been implemented to stimulate innovation, entrepreneurship and the adoption of new technologies. Additionally, large-scale incentive schemes have been introduced to foster growth and innovation in the manufacturing sector, positioning India as a global manufacturing hub.

The findings of the NMIS 2021-22 can add significant value to the Make in India programme objective, and, the more recent Production Linked Incentive (PLI) scheme. These initiatives aim to enhance manufacturing in various sectors, including electronics, pharmaceuticals, and automobiles, and have already demonstrated positive outcomes. The study's recommendations will undoubtedly strengthen our efforts to address the challenges and opportunities in manufacturing that require immediate attention.

I would once again like to applaud DST and UNIDO for their fruitful collaboration in bringing out NMIS reports and offering recommendations for continued growth and success of the Indian manufacturing sector.

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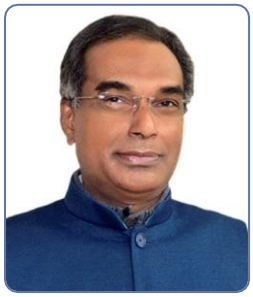

24th March 2023

FOREWORD

I am pleased to present the National Manufacturing Innovation Survey (NMIS) 2021-22 report on behalf of the Department of Science and Technology (DST), Government of India. The significance of this study lies in the government's prioritization of the manufacturing sector as a critical driver of economic growth and job creation in India, and the launch of several initiatives to catalyse innovation across the industry.

NMIS 2021-22, a follow up of first Indian innovation survey in 2011, is a focused effort to evaluate the state of innovation in India's manufacturing sector. In collaboration with the United Nations Industrial Development Organization (UNIDO), this survey provides a comprehensive understanding of the Indian manufacturing innovation landscape.

The NMIS 2021-22 findings offer valuable insights into the enabling characteristics and barriers to innovation faced by firms, and closely evaluated the performance of states and sectors in terms of producing new products and services. The detailed analysis of the survey results provides valuable insights into the innovation ecosystem in India. I anticipate this report to be of great interest to policymakers, researchers, and practitioners in the field of innovation and economic development.

Furthermore, the findings and recommendations of NMIS offer strong insights for strengthening the scope of the 5th National Science, Technology and Innovation Policy (STIP) (draft), to enable a holistic ecosystem for science, technology, and innovation that includes academia, industry, government, and civil society, with a stronger vision for manufacturing innovation to bolster the Make in India agenda.

I am confident that these reports will serve as an essential resource for all those interested in the state of innovation in India, providing valuable information that can contribute to the development of policies and initiatives that can foster a more innovative and dynamic manufacturing sector in the country.

(S. Chandrasekhar)

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Preface by Mr. Ciyong Zou, UNIDO Deputy to the Director General and Managing Director for publication of "the National Manufacturing Innovation Survey 2021-2022"

It is with great pleasure that I introduce the National Manufacturing Innovation Survey (NMIS) 2021-2022 report. Jointly conducted by the Department of Science and Technology (DST) of the Ministry of Science and Technology of India and the United Nations Industrial Development Organization (UNIDO), this report aims at comprehensively assessing the state of manufacturing innovation in India towards the achievement of the 2030 Agenda for Sustainable Development, especially Goal 9, and beyond.

As the only specialized agency of the United Nations mandated to promoting inclusive and sustainable industrial development, UNIDO recognizes the critical role that innovation plays in driving economic growth and job creation in the manufacturing sector. We are proud to partner with the DST in this endeavour to assess the state of innovation in India's manufacturing sector.

The NMIS 2021-2022 is a comprehensive study that provides a detailed understanding of the innovation landscape in India's manufacturing sector through a firm-level and systems analysis of innovation. The firm-level component of the survey examines the performance of firms across states, sectors, and firm sizes in terms of innovation processes, outputs, and barriers, and evaluates the innovation ecosystem that affects the innovation outcomes. The sectorial systems of innovation component provide insights into the collaborative processes between innovation stakeholders in specific industrial sectors, such as automotive, pharmaceutical, textiles, food and beverages, and information and communication technologies (ICT).

The findings of the NMIS 2021-2022 serve as a valuable resource to policymakers, researchers, and practitioners in the field of manufacturing, innovation, and economic development. The report highlights the enabling factors and barriers to innovation in the manufacturing sector and provides valuable insights for strengthening the ecosystem for science, technology, and innovation in India. The recommendations contained in this report will not only contribute to the development of national policies and initiatives but can also guide other countries in the region on ways to foster a more innovative and dynamic manufacturing sector.

I would like to express my sincere appreciation to the DST and the technical advisory committee for their valuable contributions to the NMIS 2021-2022. I also extend my gratitude to all the survey respondents who provided their insights and valuable information for this study serving as a public good. UNIDO is eager to continuing the long-standing collaboration with the Government of India in promoting inclusive and sustainable industrial development.

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डॉ. अखिलेश गुप्ता
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PREFACE

The National Manufacturing Innovation Survey (NMIS) 2021-22 is a significant step towards assessing manufacturing innovation in India. The objective of the survey was to evaluate the performance of states, sectors, and firm sizes in terms of innovation processes, outcomes, and barriers, as well as the innovation ecosystem that affects innovation outcomes. The NMIS 2021-22 offers a comprehensive understanding of manufacturing innovation in India from all perspectives.

The Department of Science and Technology (DST), in collaboration with the United Nations Industrial Development Organization (UNIDO), has developed the first Indian Manufacturing Innovation Index (IMII) for guiding decision-making in innovation policy with respect to manufacturing and related services. The significant difference in the IMII score captures the variations in manufacturing across the states.

The "Assessment of Firm-Level Innovation in Indian Manufacturing" report provides a comprehensive and in-depth analysis of innovation activities, outcomes, and barriers in manufacturing firms. Additionally, the NMIS 2021-22 survey produced five reports studying the sectorial systems of innovation within manufacturing sectors, namely, Automotive, Pharmaceutical, Textiles, Food & Beverages, and Information & Communication Technologies (ICT). These reports examine the collaborative processes between innovation stakeholders and the innovation systems available to specific industrial sectors.

The key findings from the study demonstrate that innovation is highly beneficial to manufacturing firms. Over a quarter of manufacturing firms in the country are innovative, and about eighty percent of these firms have used innovations successfully to increase turnover, open new market opportunities, and respond to market and cost pressures. However, the study also reveals that firms face a wide array of barriers to innovation, and innovation activities require perseverance and long-term commitment. Manufacturing firms demonstrate high risk-aversion and lack of entrepreneurial appetite to engage with innovation. Instead of competing for new products that are necessary to compete in the future, firms are still addressing the predominant and immediate demands in the market. These findings call for concerted efforts in strengthening manufacturing policies and bring attention to the need for an innovation strategy for the country, with particular attention to manufacturing.

I would like to express my sincere appreciation to all those who contributed to the creation of this report, including the UNIDO team and the technical advisory committee from DST. We sincerely hope that this report will be of great value as valuable resource and reference note.

(Akhilesh Gupta)

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Acronyms

DNH&DD	Dadra & Nagar Haveli and Daman & Diu
DST	Department of Science and Technology
EoDB	Ease of Doing Business
F&B	Food & Beverages
FI	Financial Institutions
GDP	Gross Domestic Product
GII	Global Innovation Index
GSDP	Gross State Domestic Product
IASSI	Indian Automotive Sectorial System of Innovation
ICT	Information and Communication Technology
ICTSSI	Indian Information & Communication Technology Sectorial System of Innovation
IFBSSI	Indian Food & Beverages Sectorial System of Innovation
III	India Innovation Index
IPSSI	Indian Pharmaceuticals Sectorial System of Innovation
IMII	India Manufacturing Innovation Index
INR	Indian Rupees
ISTC	Institutions Supporting Technical Change
IT	Information Technology
ITASSI	Indian Textiles & Apparels Sectorial System of Innovation
KBC	Knowledge-Based Capital
KBI	Knowledge-Based Institutions
MSME	Medium, Small and Micro Enterprises
NER	North Eastern Region
NIC	National Industrial Classification
NMIS	National Manufacturing Innovation Survey
OECD	Organization for Economic Cooperation and Development
PLI	Production Linked Incentive
R&D	Research and Development
SSI	Sectorial System of Innovation
STIP	Science Technology & Innovation Policy
TH	Triple Helix
UNIDO	United Nations Industrial Development Organization
UT	Union Territory

1 Background

The Government of India conducted the first National Innovation Survey in 2011 which found that innovations were mostly 'new to the firm'[1], indicating that manufacturing firms were responding to market forces by adopting more prevalent market practices (DST, 2014). Particularly, the survey found that the role of innovations in creating a competitive advantage for firms was rather underdeveloped. The severe disconnect observed between the production systems and the innovation support systems limited the abilities of firms to pursue innovations and other changes envisaged for driving productivity and prevailing competition (Arora & Nath, 2015). This forced the firms to rely almost exclusively on internal sources for their innovation activities. Notably, the study pointed out that the absence of demand-side dynamics was a key constraint that kept the National Innovation Systems underdeveloped. In 2019, the Department of Science and Technology (DST), Government of India decided to follow up with a second nationwide innovation survey and assigned the innovation survey to the United Nations Industrial Development Organization (UNIDO), with a view to focus on manufacturing and associated services spread across large, medium, small, and micro-enterprises.

The DST-UNIDO collaboration allowed a 360-degree approach to measuring manufacturing innovation outcomes, processes, and barriers at firm-level, mapping the contributing processes and interactions, and thereby assessing the performance of states, sectors, and firm sizes. The study also in parallel examined how the ecosystem actors and their interactions affected the innovation outcomes.

[1] Not new to the market or the world

2 National Manufacturing Innovation Survey 2021-22

The National Manufacturing Innovation Survey (NMIS) 2021-22 was conducted by UNIDO, in collaboration with the DST. The NMIS 2021-22 aimed to measure and map innovation activities, capabilities, linkages, outputs, outcomes, and barriers to assist DST in developing robust analytical frameworks for measuring **firm-level innovations** and the **sectorial systems of innovation**. This involved collecting data from manufacturing firms and actors of innovation systems, as a follow up of the first Indian innovation survey conducted by DST in 2011. Hence, the NMIS 2021-22 survey had two specific components, the firm-level survey, and the survey of sectorial systems of innovation (SSI).

FIGURE 2.1: Two components of NMIS 2021-22

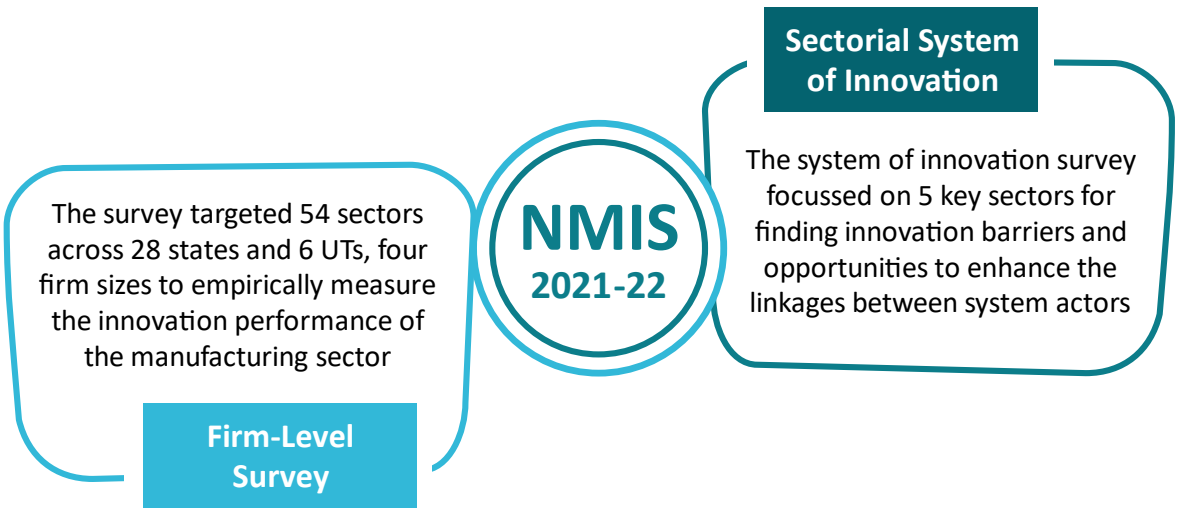


TABLE 2.1: Overview of firm-level and sectorial system of innovation survey.

Firm-Level Survey	SSI Survey

▸ Types of innovations achieved by manufacturing firms.
  ▸ Product innovation
  ▸ Business process innovations in (e.g., operation, product/business process development, marketing & sales, procurement, distribution & logistics, administration, and management)
▸ Innovation input activities
▸ Sources of information, collaborations, and resources
▸ Impacts of digitalization, infrastructure, and IP
▸ Factors hampering innovation activities, and the impact of COVID-19 pandemic
	▸ Innovation actors (firms and non-firm actors) and their networks (density, distribution, directionality, symmetry of intra- and inter-linkages)
	▸ The role and impact of actors and institutions on innovation activities in firms
	▸ Impact of policy instruments (fiscal, monetary, regulatory, standards and others)
	▸ Barriers to innovation

NMIS 2021-22 is an independent assessment of the innovation performance of manufacturing firms and sectors in India with the objective of informing and supporting policy for improving productivity and competitiveness of manufacturing firms and sectors. The study was not designed to assess the effectiveness of specific policies individually or collectively; however, it is recognised that over the past decade the Government of India launched several key policy initiatives to expand and diversify manufacturing and focus on the pivotal role of technology innovations. The NMIS 2021-22 provides observations on the status of firm-level innovations and the system of innovation in sectors, which can inform and support the implementation and modification of policy and corrections, if any, via evidence-based and targeted recommendations for improving India's innovation mechanisms and manufacturing performance.

The NMIS adopted the taxonomy proposed by the OECD[2], in terms of categories of innovations, and measurement of innovation activity at the level of performance (innovations implemented during the observation period) and the presence of innovation enablers (input activities undertaken by firms and their stakeholders during the observation period to foster innovation) and of innovation barriers (encountered by firms in their innovation endeavours.

[2] Oslo Manual 2018 is the 4th and the latest edition of OECD guidelines for collecting, reporting and using data on innovation, https://www.oecd.org/science/oslo-manual-2018-9789264304604-en.htm

3 Scope and methodology

Data collection for the NMIS 2021-22 was undertaken between February 2021 and May 2022 covering an observation period of the financial year 2017-18 to 2019-20, i.e., three years from 1st April 2017 to 31st March 2020. The data collection was impacted due to the Covid-19 pandemic, during close-down periods and as a result of the ensuing socio-economic downturn.

The firm-level survey targeted 10,139 firms, through a stratified random sample representing firms from 28 states and 6 union territories covering 54 NIC manufacturing and related service sectors and micro, small, medium, and large-size groups[3]. The firm-level survey responses are indicated below:

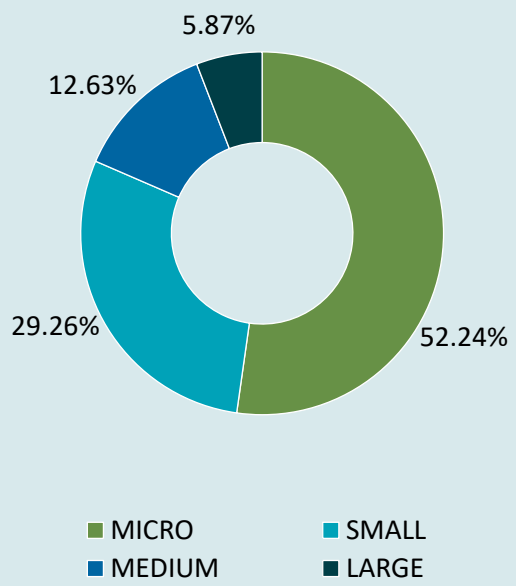
- A total of 8,087 firms[4] completed the survey, with a response rate of 79.76% (micro 97%, small 86%, medium 47% and large 56%)[5].
- While 52.24% of the firms surveyed were micro, 29.26% were small, 12.63% were medium and 5.87% were large (figure 3.1).
- The 54 NIC sectors were merged into 33 sector-groups based on similarities (in raw materials, technology, etc.) and the subsequent data analysis focused on 17 sectors-groups that achieved at least 100 responses each and accounted for 7,364 responses (i.e., 91% of the total firm respondents).

[3] Firms from Lakshadweep were absent in the survey population, while firms from Andaman and Nicobar Islands (12), and Ladakh (1) were excluded given the low number of survey responses. Moreover, seven North-Eastern states (Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura) were clubbed together as North Eastern states (excluding Assam) on account of the low number of responses received per state.

[4] Sample size and responses received across states and sectors are available in the annexure of the firm-level report.

[5] The classification of micro, small, medium and large firm sizes was verified post the data collection as per the 2020 MSME definitions issued by the Ministry of MSME https://msme.gov.in/faqs/q1-what-definition-msme

FIGURE 3.1: Share of responses across firm sizes



The SSI survey targeted 7,851 firm and 1,000 non-firm actors through a stratified random sample covering 5 selected sectors, namely: food & beverage (NIC 10 & 11), textiles and apparel (NIC 13 & 14), automotive (NIC 29), pharmaceutical (NIC 21), and information and communication technology (ICT) (NIC 60 – 63).

SSI actors were classified as manufacturing firms (industry), government, knowledge-based institutions, arbitrageurs (banks, financial institutions, venture capitalists and angel investors) and intermediary organisations (industry associations, institutions supporting technical change and incubators).

TABLE 3.1: SSI survey response

Sector	Responses from firms (response rate %)	Responses from non-firm actors (response rate %)	Total responses (overall response rate %)
Food & Beverages	2713 (64.5%)	118 (59.0%)	2831 (64.3%)
Textiles	1198 (57.5%)	121 (60.5%)	1319 (57.7%)
Automotive	375 (63.7%)	178 (89.0%)	553 (70.0%)
Pharmaceutical	379 (48.3%)	102 (51.0%)	481 (48.8%)
ICT	73 (39.0%)	231 (115.5%)	304 (78.6%)
Total Responses	**4738 (60.0%)**	**750 (75.0%)**	**5488 (62.0%)**

4

India Manufacturing Innovation Index 2022

The responses obtained from the firm level survey[6] have been converted into an index, the India Manufacturing Innovation Index (IMII) for comparison across the 28 states and 6 union territories of India. The IMII provides a holistic index score for the level of innovation across states, taking into consideration innovation output through performance, and innovation input through the presence of innovation enablers and the absence of innovation barriers. The construct of the IMII allows for comparison with other innovation assessments based on routinely collected economic and related statistics, particularly the Global Innovation Index (GII) and the India Innovation Index (III).

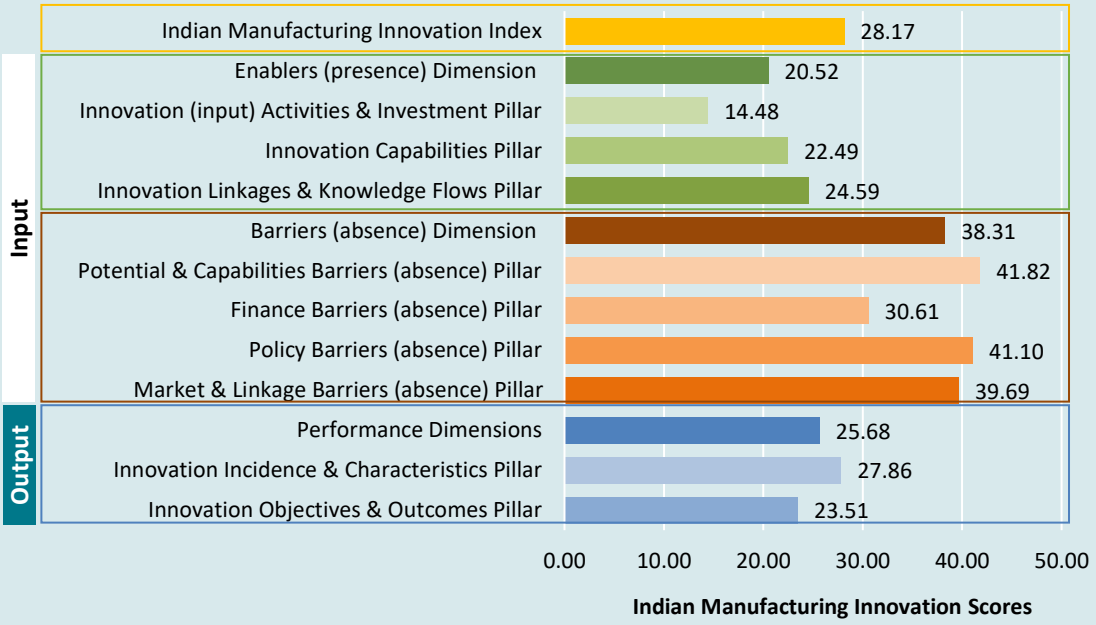
The IMII is computed using three main dimensions (which have been constructed using 9 pillars built from 80 indicators[7]):

- Innovation enablers: the presence of innovation input activities, internal firm capabilities and linkages and knowledge flows in the innovation ecosystem.
- Absence of innovation barriers related to potential and capabilities, finance, policy, and market and linkages; and
- Innovation performance measured through the innovation objectives of firms, as well as the innovation outputs and outcomes achieved during the observation period.

[6] The firm-level component of the survey has 54 questions (see questionnaire in the annexure of the firm-level report) covering innovation inputs as presence of enablers and absence of barriers, and innovation outputs and outcomes in the form of innovation performance, designed using the Oslo Manual framework (2018) in alignment with Indian manufacturing.

[7] All the indicators of the index are derived from the 54 questions to measure the internal capabilities of firms as well as the external enabling environment (innovation linkages and knowledge flows) that promote innovation. The indicator score is principally the share (%) of responding firms within the respective State, Sector or Firm size, that responded positively or negatively to the survey questions relevant to the indicator.

FIGURE 4.1: All-India scores of IMII 2022



- The Indian manufacturing sector has an overall IMII score of 28.17[8], which is the average of the scores for the three dimensions across all states and UTs.
- The enablers (presence) dimension has a national score of 20.52, the barriers (absence) dimension has a national score of 38.31, and performance was at 25.68.
- The output or the performance (i.e. actual innovations made) is lower than the inputs at 29.41 (average of enablers at 20.52 and barriers (absence) at 38.31, i.e. the endeavours and the ecosystem made available to achieve innovation during the observation period (activities, investments, capabilities, ecosystem linkages and knowledge flows, absence of barriers related to potential and capabilities, finance, policies, market and linkages) did not (yet) effectively yield results (performance) during the observation period.

Indian Manufacturing Innovation Index 2022 of states and UTs

All 28 states and 6 union territories were ranked based on their IMII scores. Category ranks were also provided to the states and UTs post their classification into three groups: major (larger) states; hill states; and UT or city states[9].

Table 4.1 shows the IMII score, ranking, and the dimensional Enablers (presence), Barriers (absence) and Performance scores across 28 states and 6 UTs. The state innovation performance is assessed based on the national average & standard deviation of the IMII score, Enablers (presence) score, Barriers (absence) score and Performance score.

[8] The indicator scores used to construct the pillar and dimension scores are in percentage, that is, between 0 and 100. The pillar and dimension scores are presented without normalization as it retains the original value and scale of the scores, allowing for a more accurate representation of the data. This approach can also help to avoid the limitations and biases that may come with normalization. Instead of converting the scores to a common scale, we use benchmarking and ranking to make meaningful comparisons between the states.

[9] This classification is also in line with the India Innovation Index (III) state categorisation by NITI Aayog.

TABLE 4.1: Indian Manufacturing Innovation Index ranking across states

STATES	IMII RANKING	IMII SCORE	ENABLERS (PRESENCE) SCORE	BARRIERS (ABSENCE) SCORE	PERFORMANCE SCORE
MAJOR STATES					
KARNATAKA	1	**33.41**	27.28	40.07	32.87
TELANGANA	3	**32.86**	28.17	37.57	32.83
TAMIL NADU	4	**32.54**	24.37	44.16	29.07
MAHARASHTRA	6	**31.38**	26.07	37.79	30.27
HARYANA	10	**30.47**	22.92	40.84	27.63
GUJARAT	11	**30.37**	25.50	38.18	27.43
KERALA	13	**29.39**	21.43	41.74	25.01
UTTAR PRADESH	14	**29.00**	18.37	43.28	25.36
MADHYA PRADESH	15	**28.47**	20.03	40.55	24.82
WEST BENGAL	16	**27.77**	17.06	39.03	27.23
PUNJAB	17	**27.48**	16.95	40.69	24.81
CHHATTISGARH	19	**27.02**	18.39	39.55	23.12
RAJASTHAN	20	**26.42**	19.78	35.57	23.92
ANDHRA PRADESH	22	**24.25**	16.92	35.35	20.48
ODISHA	23	**23.05**	12.88	34.63	21.63
JHARKHAND	24	**22.78**	14.53	30.93	22.86
BIHAR	26	**21.32**	12.47	34.40	17.10
MAJOR STATES AVERAGE		**28.12**	**20.18**	**38.49**	**25.67**
HILL STATES					
UTTARAKHAND	5	**31.72**	22.93	43.23	28.99
HIMACHAL PRADESH	8	**31.20**	22.77	43.27	27.55
ASSAM	25	**22.22**	16.64	27.82	22.18
NORTH-EASTERN STATES (EXC. ASSAM)	27	**19.69**	13.00	25.42	20.65
HILL STATES AVERAGE		**26.21**	**18.84**	**34.94**	**24.84**
UT & CITY STATES					
DADRA & NAGAR HAVELI & DAMAN & DIU	2	**32.88**	28.69	39.92	30.03
PUDUCHERRY	7	**31.29**	19.68	50.83	23.35
NEW DELHI	9	**30.55**	24.08	40.27	27.31
GOA	12	**29.77**	25.33	38.05	25.94
CHANDIGARH	18	**27.03**	22.09	32.16	26.84
JAMMU & KASHMIR	21	**26.29**	15.76	38.96	24.16
UT & CITY STATES AVERAGE		**29.64**	**22.61**	**40.03**	**26.27**
NATIONAL AVERAGE		**28.17**	**20.52**	**38.31**	**25.68**

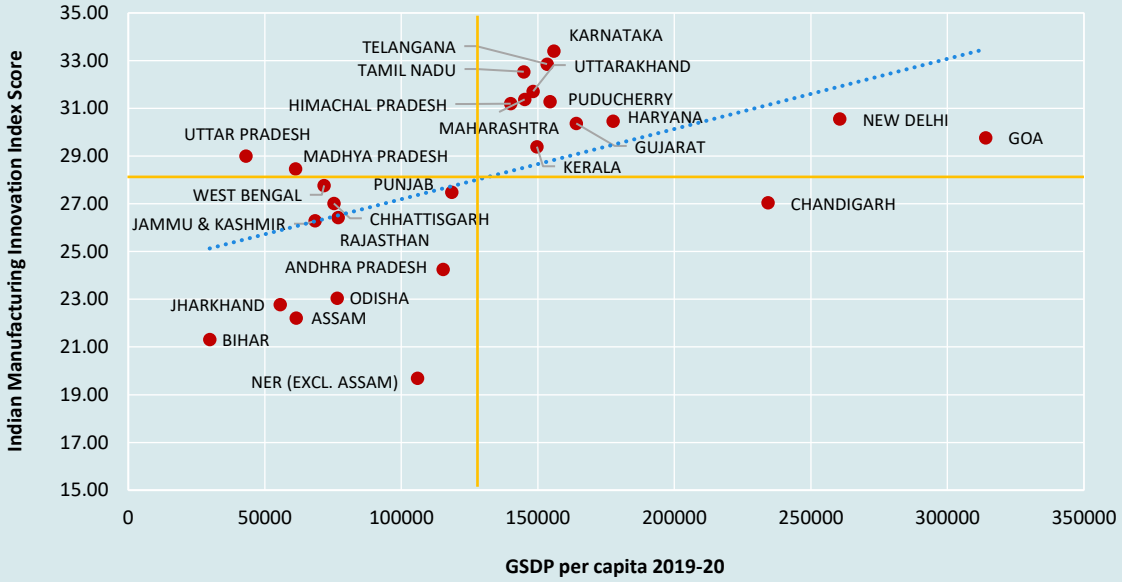
Best Performers Above national average + standard deviation	**Average Performers** Between national average + standard deviation and national average - standard deviation	**Low Performers** Below national average - standard deviation

IMII 2022 Ranking: The state of Karnataka (33.41) ranked highest on IMII 2022 and the lowest was North-eastern states (excluding Assam) (19.69). The range of the IMII 2022 scores is 13.72, representing significant differences at indicator level performance across 80 indicators.

- Karnataka is closely followed by Dadra & Nagar Haveli and Daman & Diu (32.88), Telangana (32.86), and Tamil Nadu (32.54).

- Low scoring states are North-eastern states (excluding Assam) (19.69) followed by Bihar (21.32), Assam (22.22), Jharkhand (22.78), Odisha (23.05) and Andhra Pradesh (24.25).
- All other states and UTs have scored average IMII 2022 scores.

FIGURE 4.2: GSDP per capita (2019-20) versus IMII 2022 scores



The horizontal yellow line shows the average of GSDP per capita across states (INR 127,007) while the vertical yellow line shows the national average of IMII scores (28.17).

- Gross State Domestic Product (GSDP) per capita 2019-20 (INR) at constant (2011-12) prices[10] against IMII scores show a positive correlation with a moderate coefficient of 0.528. The higher the GSDP per capita of a state, the higher its IMII score. Except for Chandigarh (27.03), all high GSDP per capita states have IMII scores greater than the national average.
- While correlation does not imply causation[11], it may indicate that other confounding variables not included in the model may have influenced both the GSDP per capita and IMII score. They could be factors such as the relative contribution of manufacturing to the state's economy, where more diversified manufacturing may not be innovative, but contributes to GSDP, availability of skilled labour, government policies, access to capital, and/or the level of R&D in a state.

For example, states with GSDP per capita below INR 160,000, like Karnataka (33.41), Telangana (32.86), and Tamil Nadu (32.54) have manufacturing innovation scores greater than states or UTs with GSDP per capita above INR 160,000 such as Gujarat (30.37), Haryana (30.47), Chandigarh (27.03), New Delhi (30.55) and Goa (29.77).

[10] MOSPI (2019-20) 11.xps (esopb.gov.in)

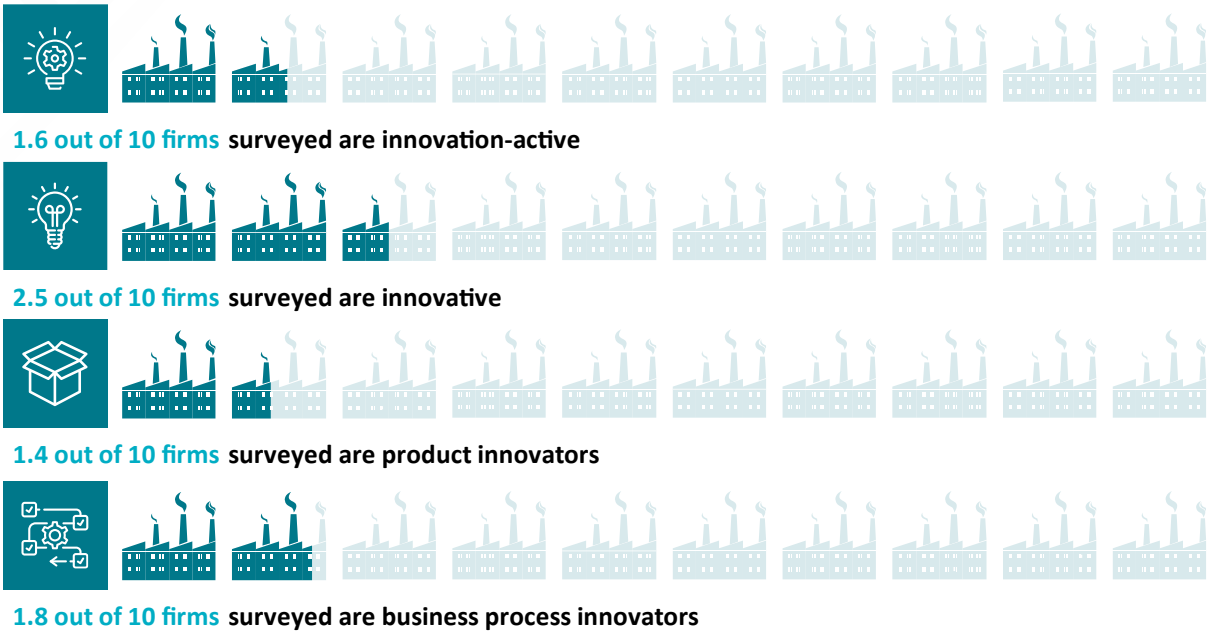
[11] The adjusted R-square value of 0.248 indicates that only 24.8% of the variation in IMII score, can be explained by the variation in GSDP per capita.

5

Firm-Level Innovation

Key findings on firm-level innovation performance, enablers and barriers

Firm-Level Innovation



1.6 out of 10 firms surveyed are innovation-active

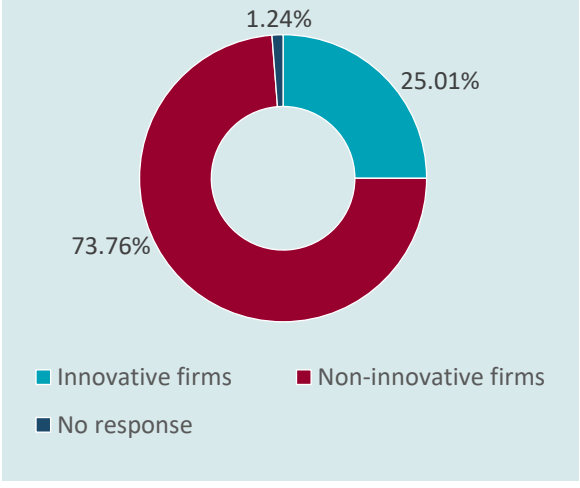
2.5 out of 10 firms surveyed are innovative

1.4 out of 10 firms surveyed are product innovators

1.8 out of 10 firms surveyed are business process innovators

25.01% of the 8,074 firms surveyed[12] were considered innovative. They have successfully implemented either new or significantly improved products or processes (marketing and sales, procurement or other organisational methods in their business practices) (Figure 5.1).

FIGURE 5.1:
Innovative versus non-innovative firms



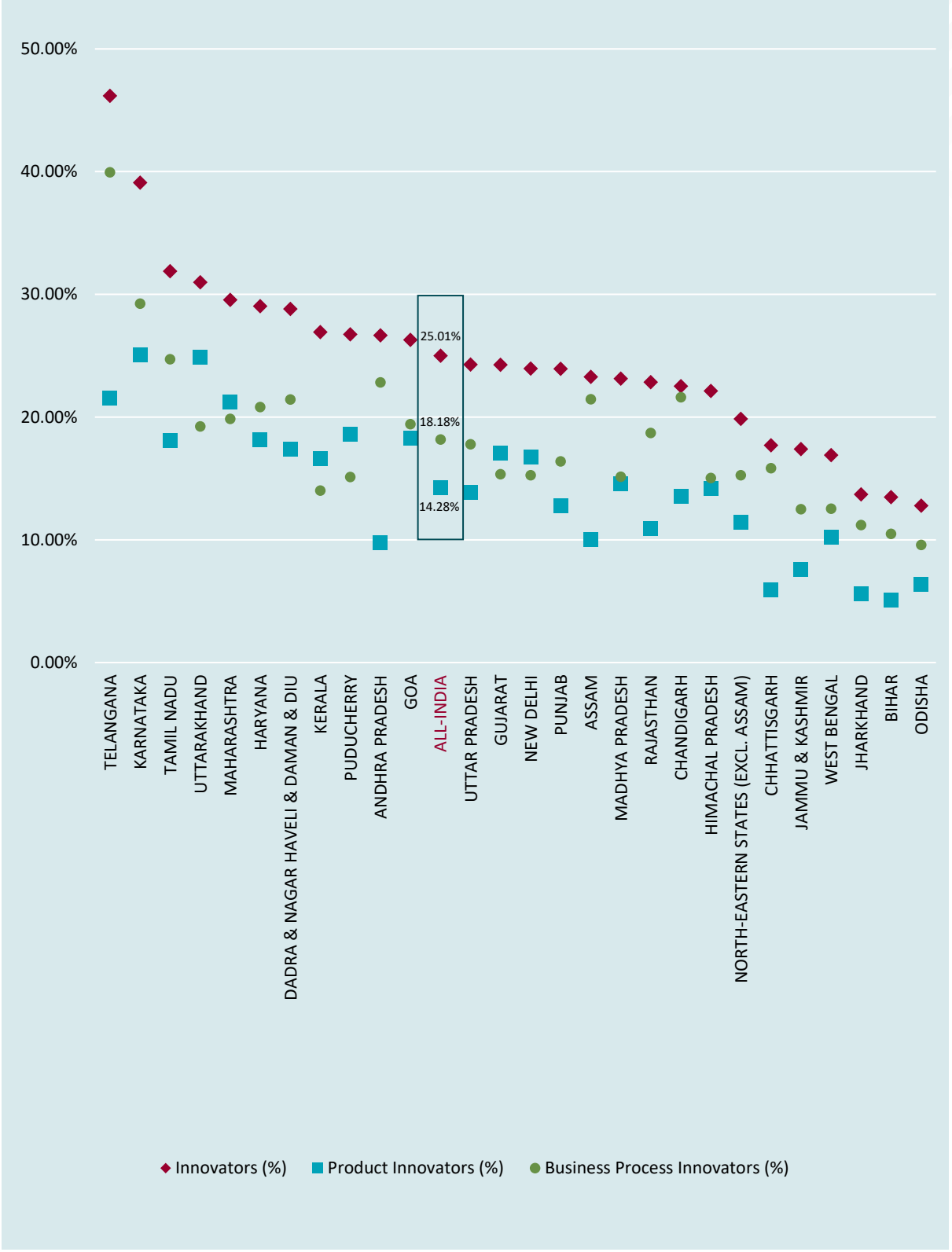
The majority of the firms, 73.76% did not introduce product or business process innovations in this period.

As seen in figure 5.2 of the total firms surveyed, 14.28% identified as **product innovators** who indicated that they introduced either one or more new or significantly improved goods or new or significantly improved services during the observation period. Also, 18.18% of the total firms that participated in the survey were identified as **business process innovators (BPI)** as they introduced either one or more innovations in their business processes across operations and product or process development, marketing and sales, procurement, logistics and distribution, or administration and management.

Share of firms across the 80 indicators at the national level is presented in Table A in the Annexure.

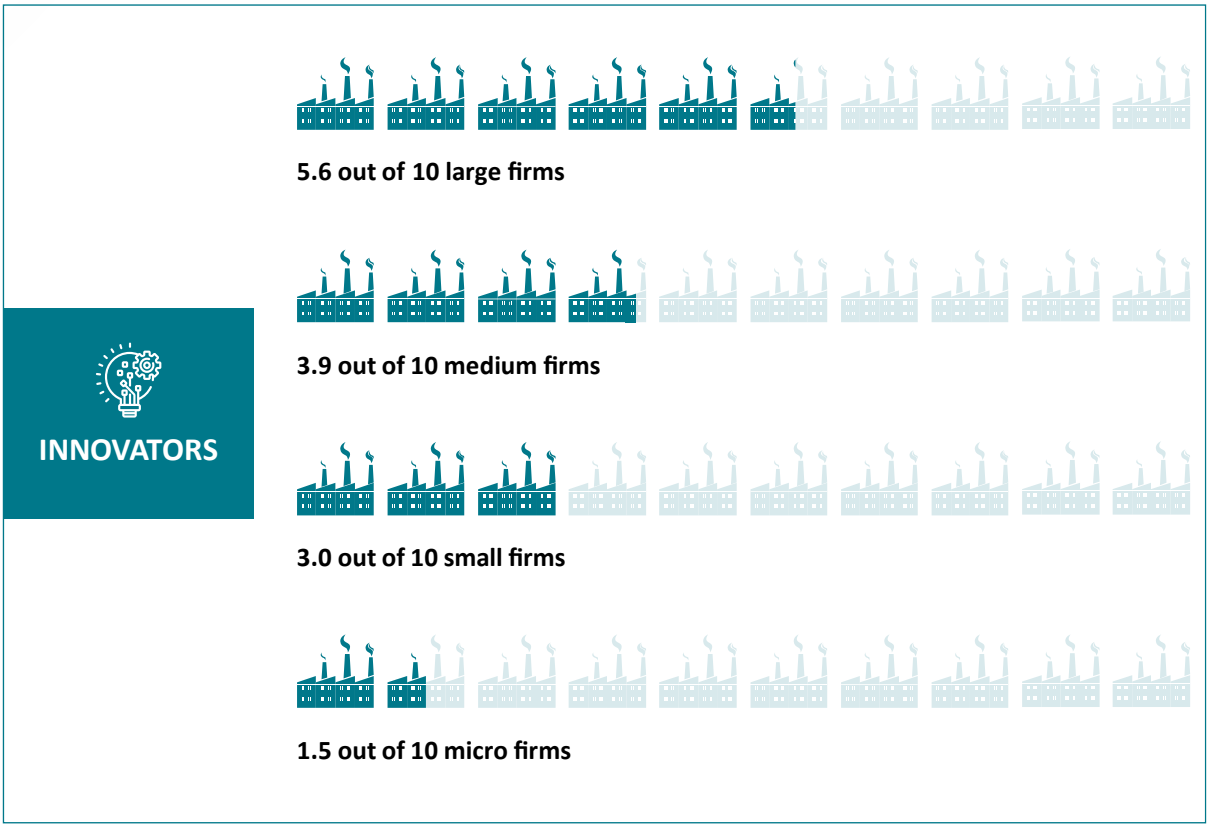
[12] During the observation period from FY 2017-18 to FY 2019-2020

FIGURE 5.2: Share of innovators and their types by state



Telangana, Karnataka, and Tamil Nadu had the highest share of innovative firms at 46.18%, 39.10% and 31.90%, respectively, among the total manufacturing firms surveyed from the respective states (Figure 5.2).

Odisha, Bihar, and Jharkhand reported the least share of innovative firms at 12.78%, 13.47% and 13.71%, respectively (Figure 5.2). Telangana indicated the highest share of BPIs (39.94%), while Karnataka had the highest share of Product Innovators (25.07%), closely followed by Uttarakhand (24.88%). In addition, most states/UTs showed a higher share of BPIs than product innovators, except for Uttarakhand, Maharashtra, Kerala, Puducherry, Gujarat and New Delhi.



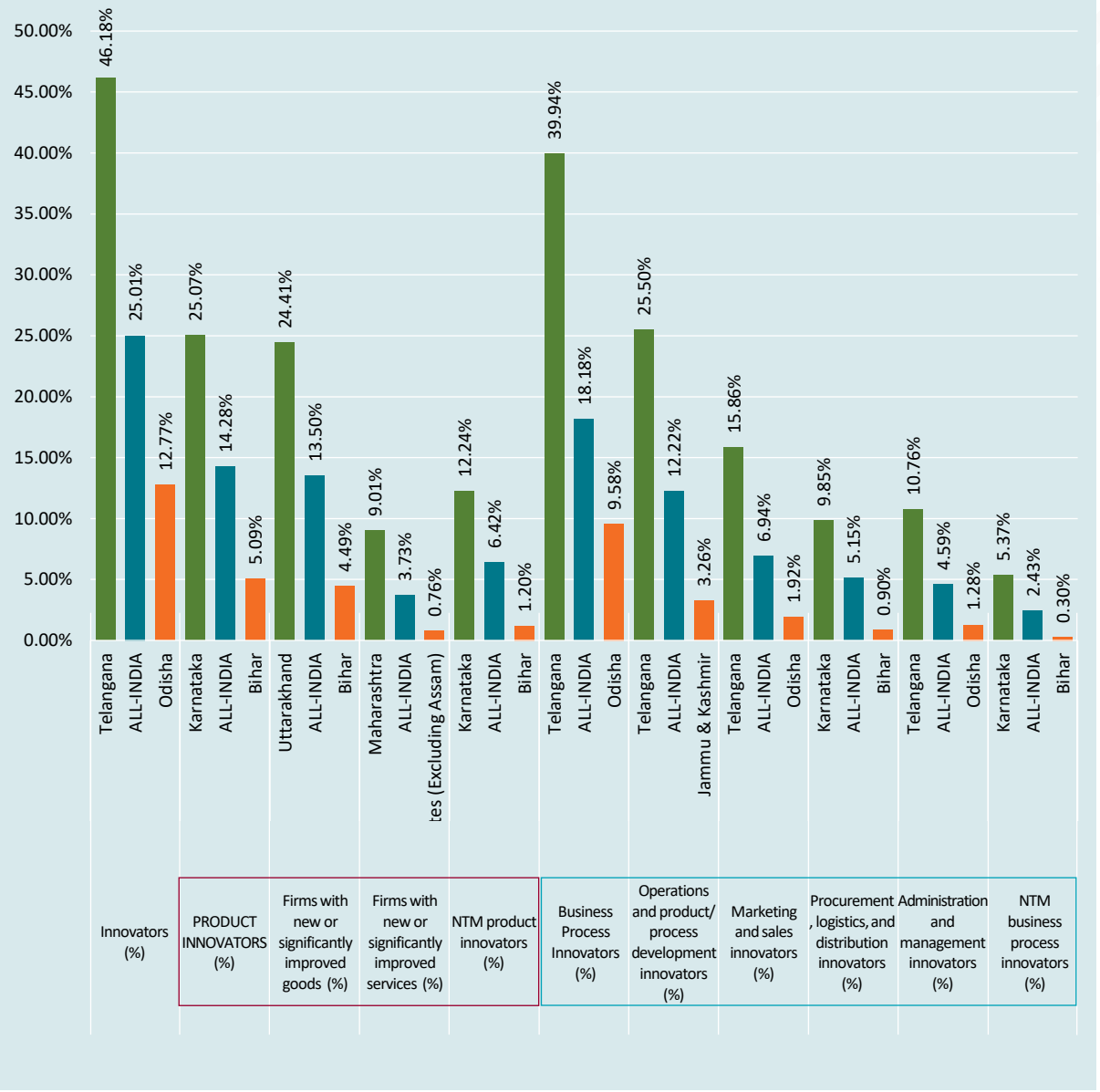
5.1 INNOVATION PERFORMANCE

A. Incidence & Characteristics - *What product and business process innovations were introduced by firms?*

Product innovators constitute firms that indicated the introduction of new or significantly improved goods (13.50%) or new or significantly improved services (3.73%), out of the total firms surveyed. The business process innovators (BPI) constitute firms that indicated innovations in either operations and product/process development (12.22%), marketing and sales (6.94%), procurements, logistics and distribution (5.15%), or in administration and management (4.59%). Of the total firms, only 6.42% reported new-to-market[13] product innovations and 2.43% reported new-to-market business process innovations. Karnataka had the highest share of product innovators (25.07%), NTM product innovators (12.24%) and NTM-BPI (5.37%).

[13] New-to-market innovations have a higher threshold for innovation than new-to-firm, indicating a first-time use or implementation by firm (OECD Manual, 2018)

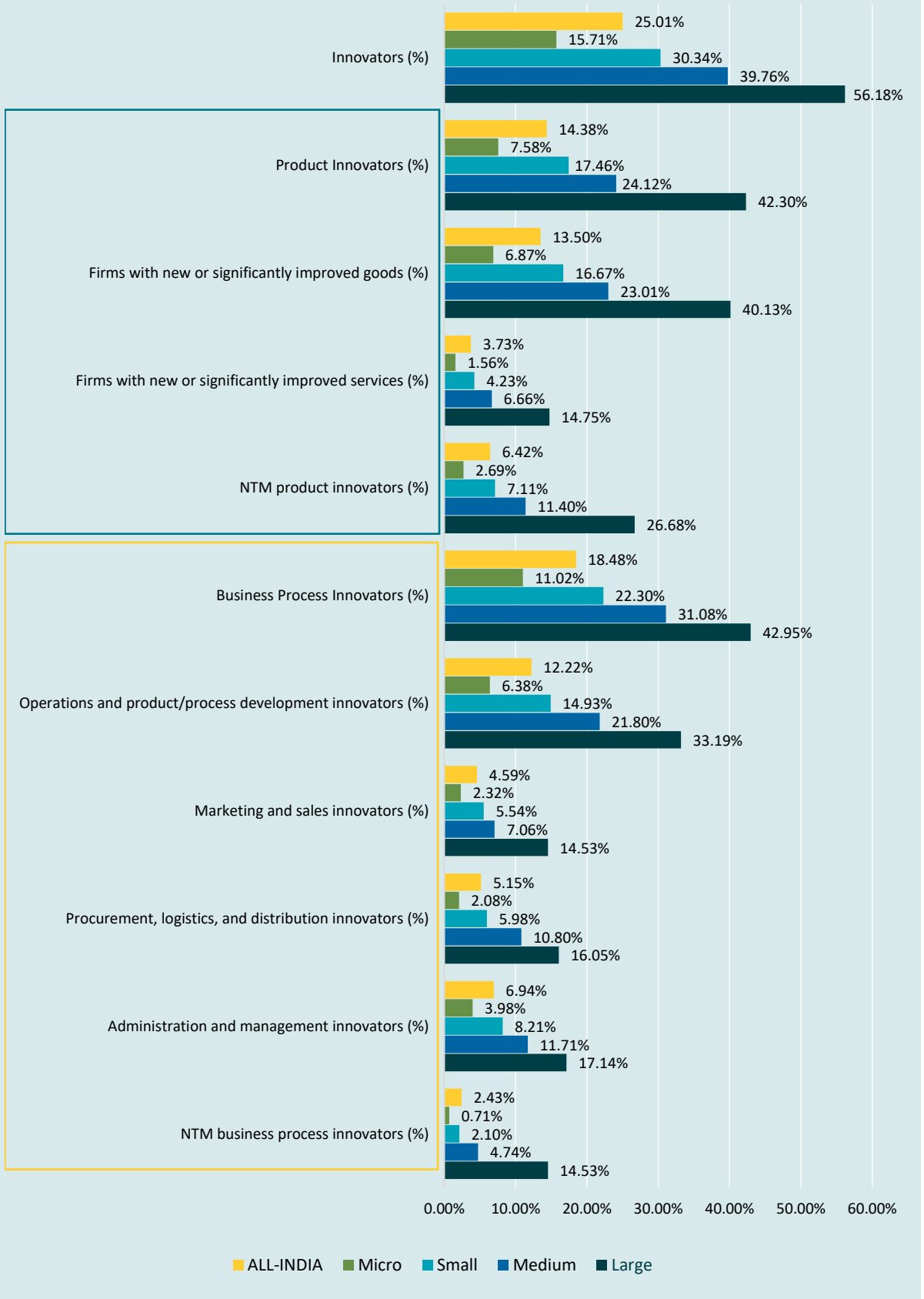
FIGURE 5.3: Innovation incidence and characteristics



The green bar represents the state with the highest share of firms for each variable, amber bar shows the state with the lowest incidence and the blue bar depicts the India average of that variable.

Figure 5.4 shows innovation incidence and characteristics by firm size. The share of innovative firms is highest among large firms, followed by medium, small and micro enterprises. Even though this is evident across all types and characteristics of innovations, it is found to be most prominent for % share of firms having product innovators and business process innovators, and least prominent in terms of % share of NTM BPI and NTM product innovators – which signifies that micro and small enterprises, including start-ups, do indeed succeed to deliver NTM innovations, responding to their immediate markets.

FIGURE 5.4: Innovation incidence and characteristics by firm size



B. Innovation objectives of firms

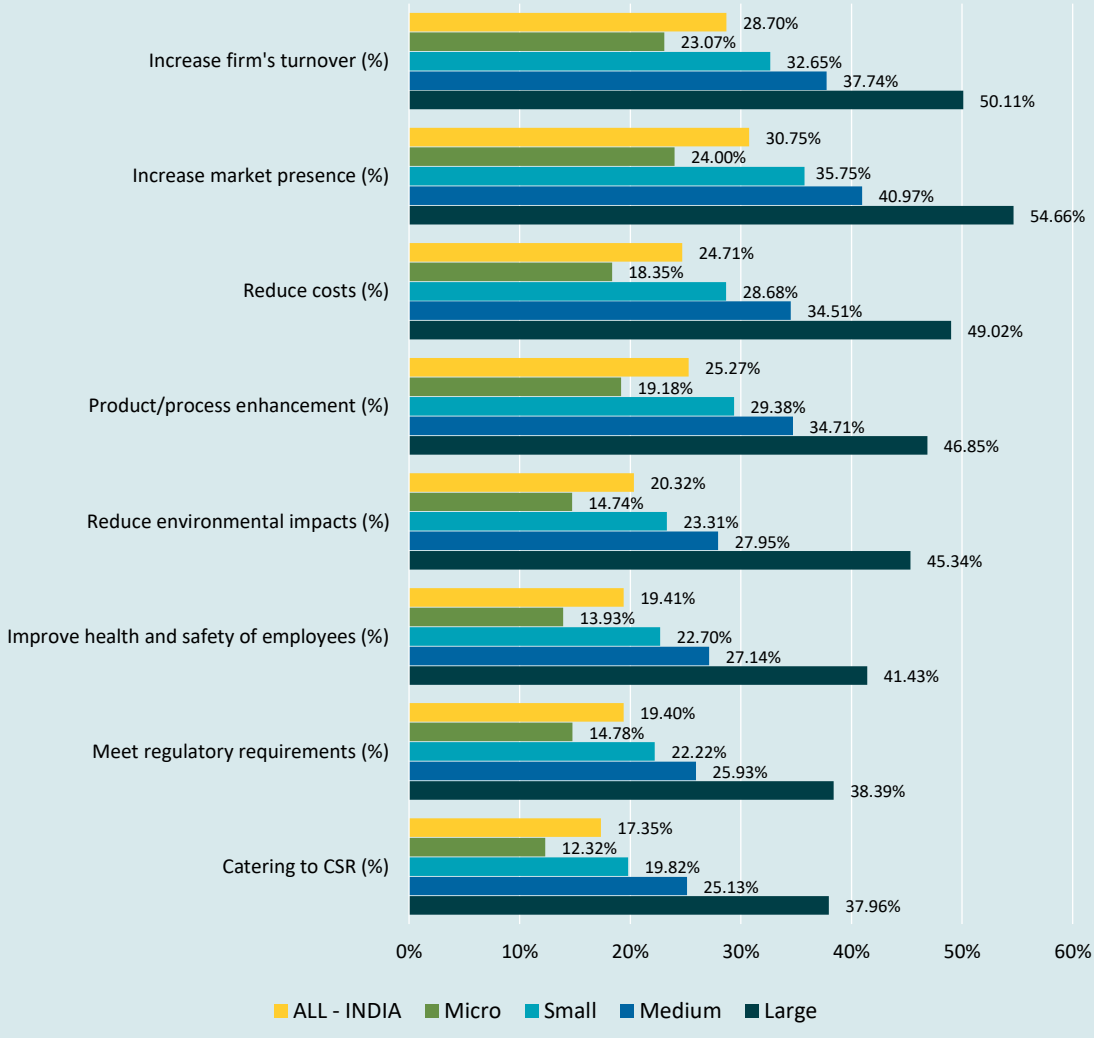
Innovation objectives of firms were measured by examining goals identified by firms to be met through innovations in the observation period (Figure 5.5).

Business-oriented innovation objectives: Close to one-third of the surveyed firms reported business-oriented innovation objectives such as increasing firm's turnover (28.70%), increasing market presence (30.75%), reducing costs (27.70%), and improved product/process enhancement in terms of quality and quantity (27.36%).

Social, regulatory, and environmental compliance objectives: One-fifth of the firms undertook innovations to meet social, environmental and regulatory requirements, particularly to minimise environmental impacts (20.32%), improve health and safety of the firm's employees (19.41%), and meet regulatory requirements (19.41%).

Fewer firms indicated innovative efforts to improve Corporate Social Responsibility (17.35%).

FIGURE 5.5: Innovation objectives of firms by firm sizes

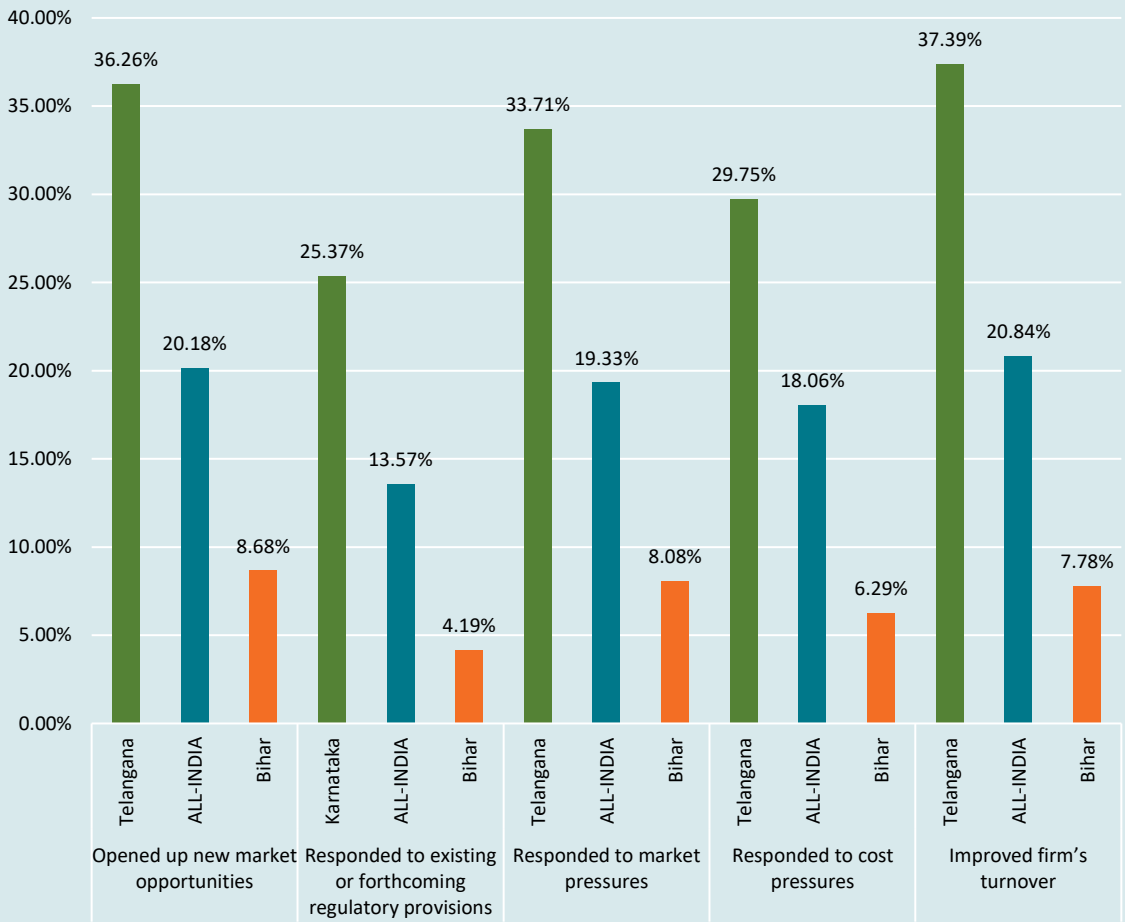


C. Innovation outcomes

Innovation outcomes achieved by firms were measured using five key indicators, namely, opened new market opportunities, responded to existing or upcoming regulatory provisions, responded to market pressures, responded to cost pressures, and enhanced the firm's turnover through innovations.

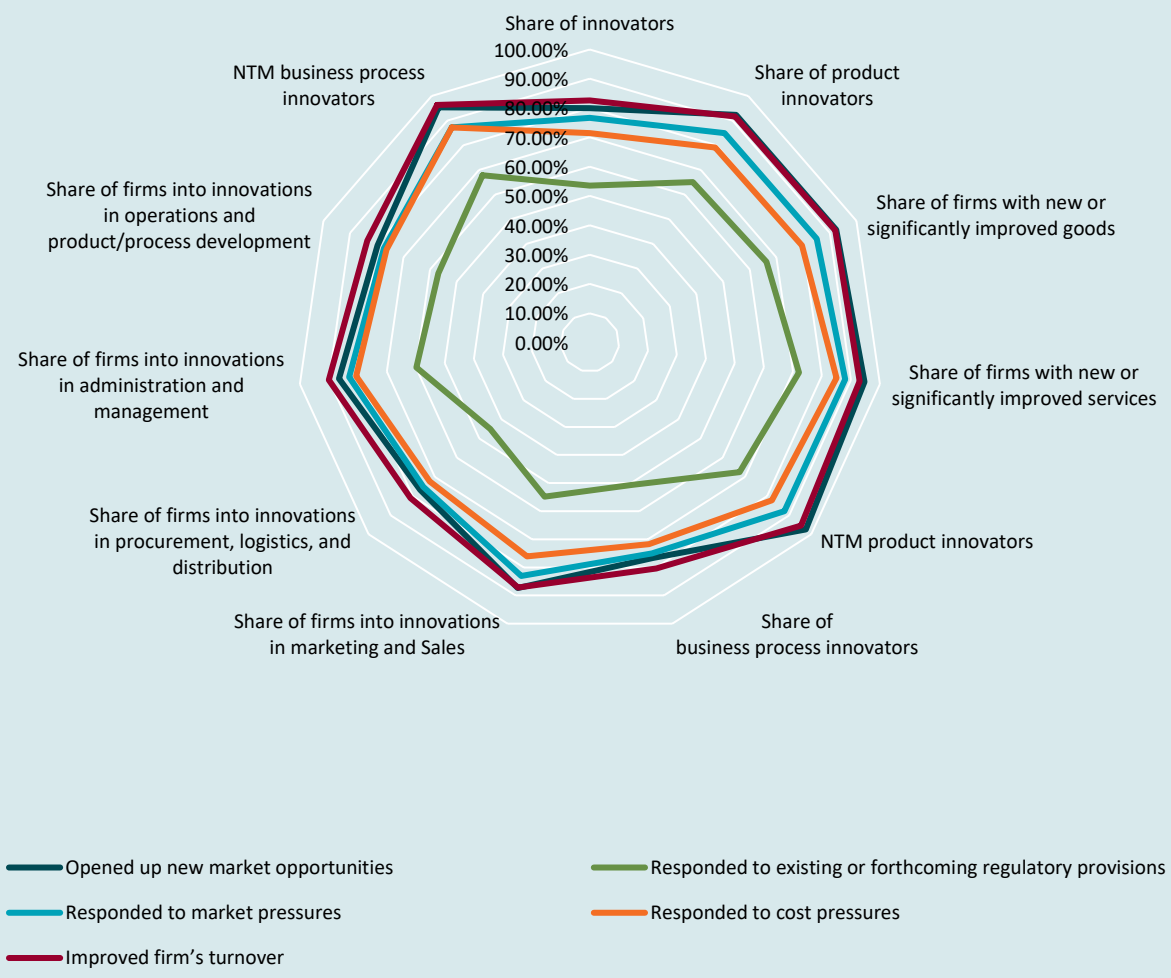
About **one-fifth of the firms surveyed indicated positive innovation outcomes** with 20.84% of firms in the country that reported improved firm turnover, 20.18% opened new market opportunities, 19.33% successfully responded to market pressures and 18.0% responded to cost pressures. Fewer firms succeeded to respond to regulatory provisions through their innovations (13.57%) (Figure 5.6).

FIGURE 5.6: Innovation outcomes achieved by firms



As shown in Figure 5.7, close to 80% of innovators were able to improve firm's turnover (82.62%), open up new market opportunities (79.94%), respond to market pressures (76.67%) and respond to cost pressures (71.47%) whereas **only 53.59% of innovators were able to respond to existing or forthcoming regulatory provisions through their innovations.**

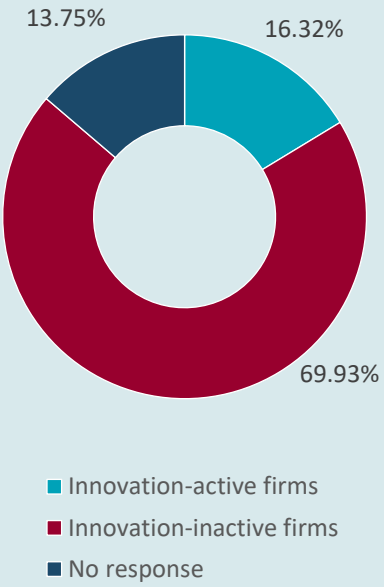
FIGURE 5.7: Share of firms that introduced different innovations and were able to achieve innovation outcomes



5.2 INNOVATION ENABLERS

Innovation enablers concern the input activities that firms undertake to prepare for and facilitate innovation. Three pillars are used to assess innovation enablers, i.e., firm's investment in innovation input activities and related investments, the internal capabilities of the firm, and the enabling ecosystem, as well as the linkages and knowledge flows, in the environment in which the firm operates. These elements work together to drive innovation within a firm. Innovation-active firms had engaged in innovation input activities with the purpose of introducing innovations. Some succeeded in implementing innovations during the observation period, and hence are innovative firms. Whereas others did not succeed and hence are non-innovative firms.

FIGURE 5.8: Share of innovation-active and innovation-inactive firms



As seen in figure 5.8, about **1/6th of the total firms surveyed (16.32%) were innovation-active**, i.e., they engaged in one or more activities with the specific focus of developing or implementing new or improved products or business processes during the observation period. However, **69.93% of the firms were innovation-inactive**, i.e., either they were engaged in innovation activities regardless of its purpose (without an innovation intent) or did not engage in innovation activities.

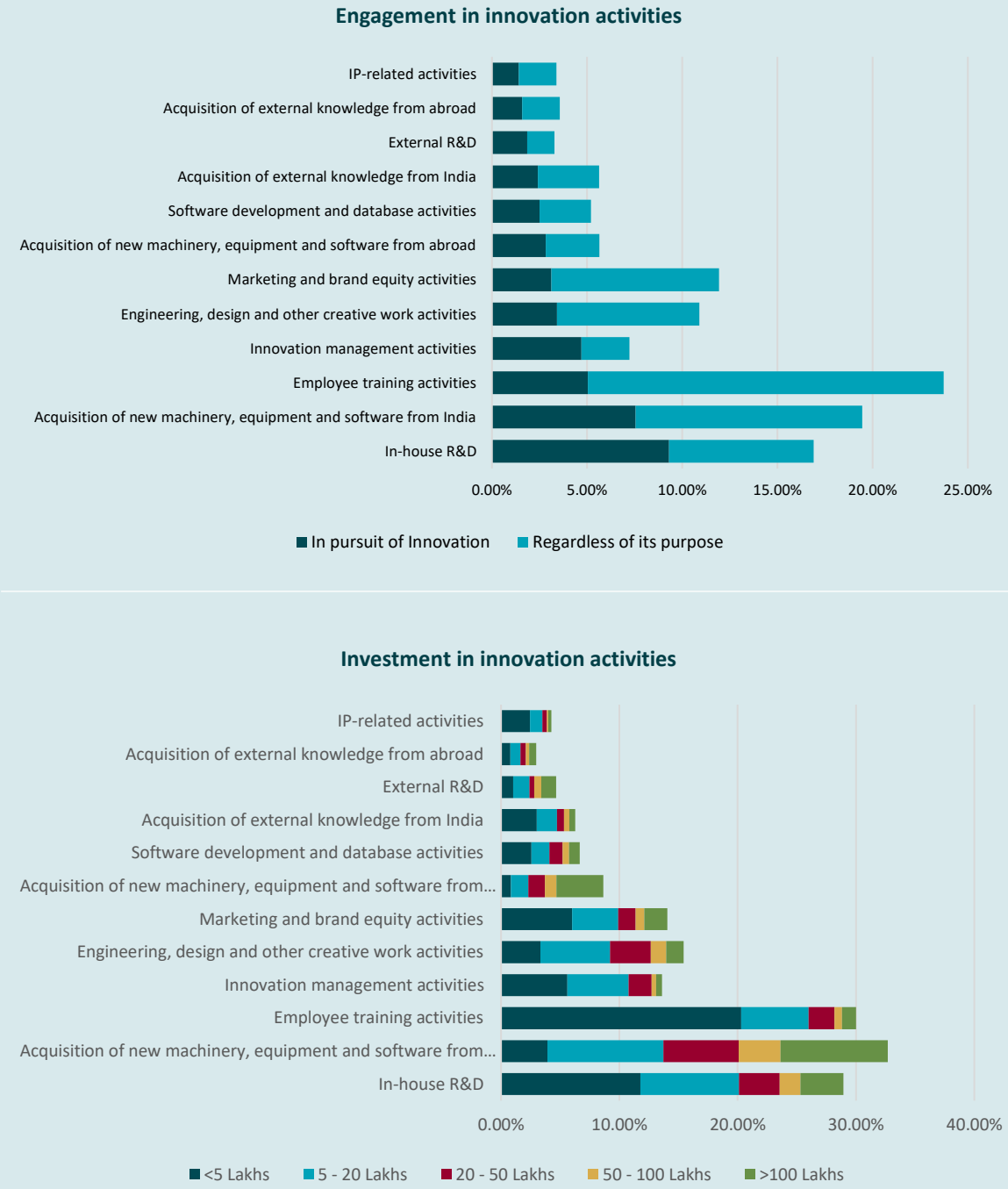
The survey results also found that only **54.40% of innovation-active firms were able to complete their innovation input activities during the observation period**, that is, they did not report incomplete, abandoned, or seriously delayed activities. On the other hand, 44.31% of innovation-active firms were not able to complete their innovation activities during the observation period. Some of these activities would have been logically continuing given innovation lead times, whereas others might have been abandoned for lack of results.

A. Innovation input activities and investments by firms

As seen in figure 5.9, fewer firms were engaged in innovation activities, also reflected in the level of investments in these activities. Firms were most frequently engaged in employee training (24% of firms surveyed), acquisition of new machinery from India (20%), in-house R&D (17%), marketing and brand equity (12%) and engineering and design (10%). Except for in-house R&D, **all firms engaging in any of the innovation activities, do this more frequently from a general business perspective or regardless of its purpose rather than for a specific innovation purpose**.

Innovation investments by firms prioritised the acquisition of new plant, machinery, or equipment from India (31.6%), followed by employee training (31.5%) and in-house R&D (29.9%). While one-fifth of firms invested up to INR 20 lakh for in-house R&D (21%), about 9% of firms indicated investments greater than INR 20 lakh. Employee training most frequently attracted investments where 27% of firms invested up to INR 20 lakh and about 4% of total firms invested more than INR 20 lakh. The least invested activities were the acquisition of external knowledge from abroad (3%) and IP-related activities (4%).

FIGURE 5.9: Engagement and investment in innovation activities by firms



Most **firms engaged in innovation activities in specific pursuit of innovations saw higher innovation successes** (Figure 5.10, demonstrating success rates between 83% and 96%), compared to those engaged in innovation activities regardless of their purpose, where success rates were found to be lower (Figure 5.11 with success rates between 41% and 88%). The top 3 innovation input activities demonstrated an increase of 40% in their success rate (innovation incidence) when conducted in pursuit of innovation.

FIGURE 5.10: Success rates of innovation activities conducted in pursuit of innovation

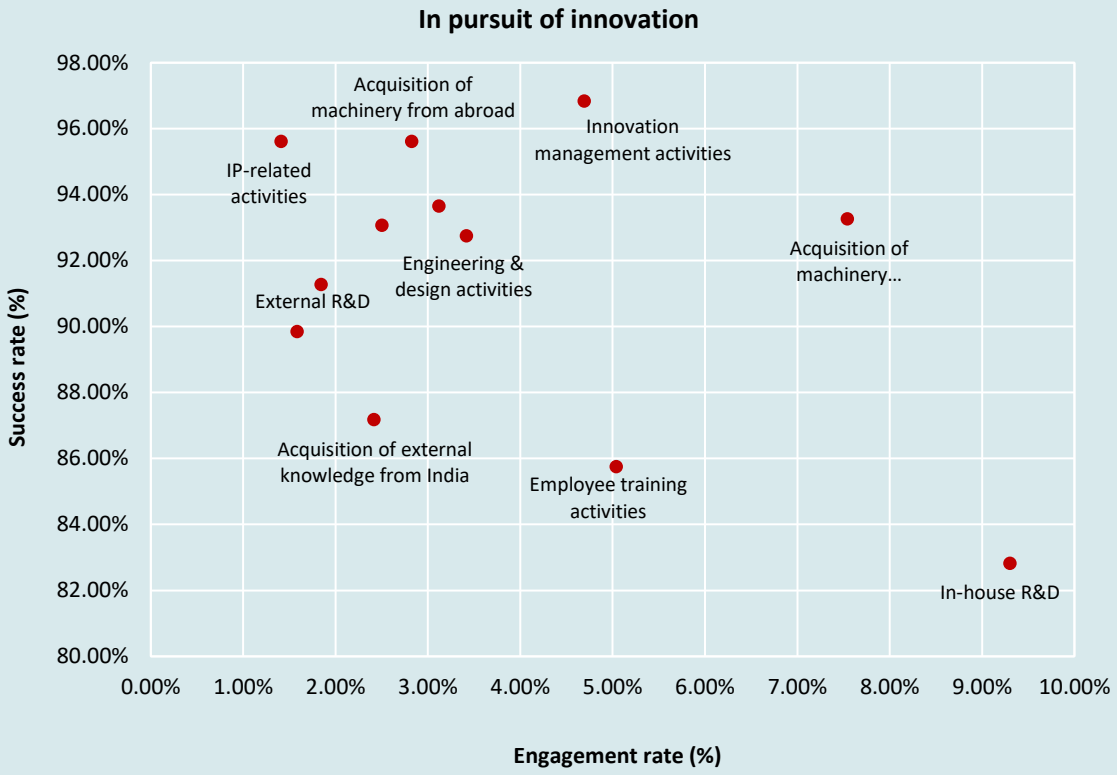
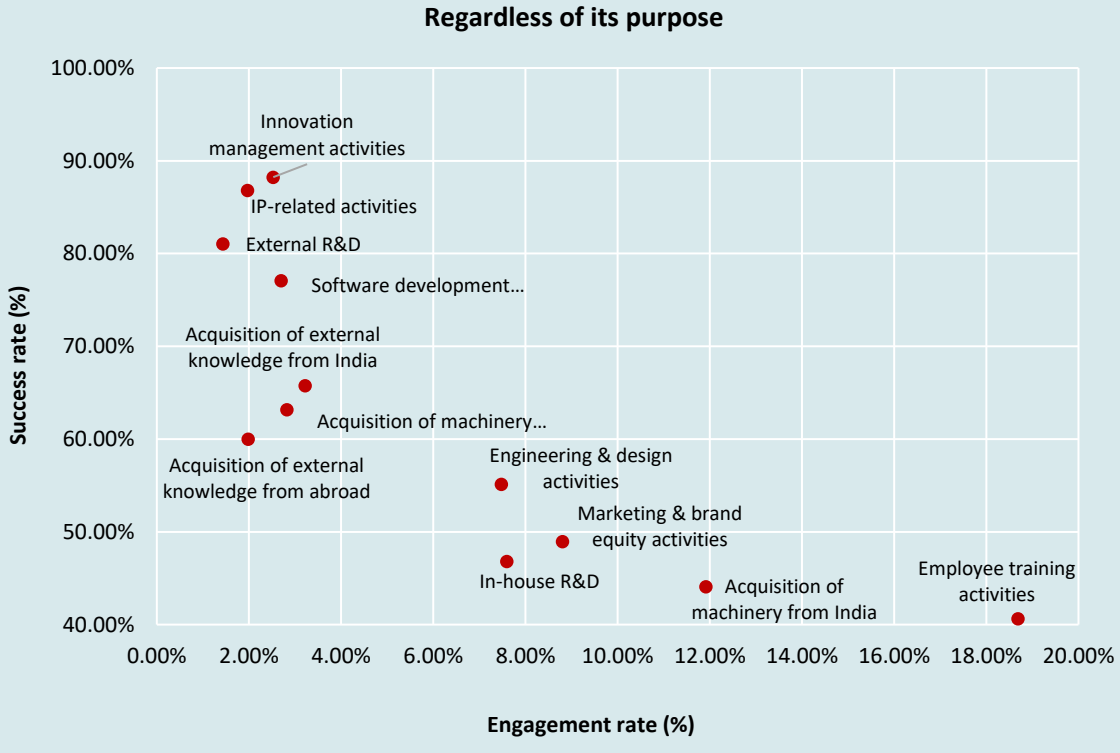


FIGURE 5.11: Success rates of innovation activities conducted regardless-of-purpose



B. Firm capabilities resulting in innovation

The success of **innovation capabilities of firms** was assessed by comparing the share of firms that were successful in producing innovations (product or business process) while possessing each of the 11 innovation capability indicators as shown in figure 5.12.

More than 50% of the firms surveyed reported being highly satisfied[14] with the innovation capabilities of their employees, but the success rate of the capability (ability to introduce innovations) was relatively low (38.40%). On the other hand, the most successful innovation activity among firms was staff using innovative tools though only 13.62% of firms reported this capability.

FIGURE 5.12: Success rates of innovation capabilities of firms

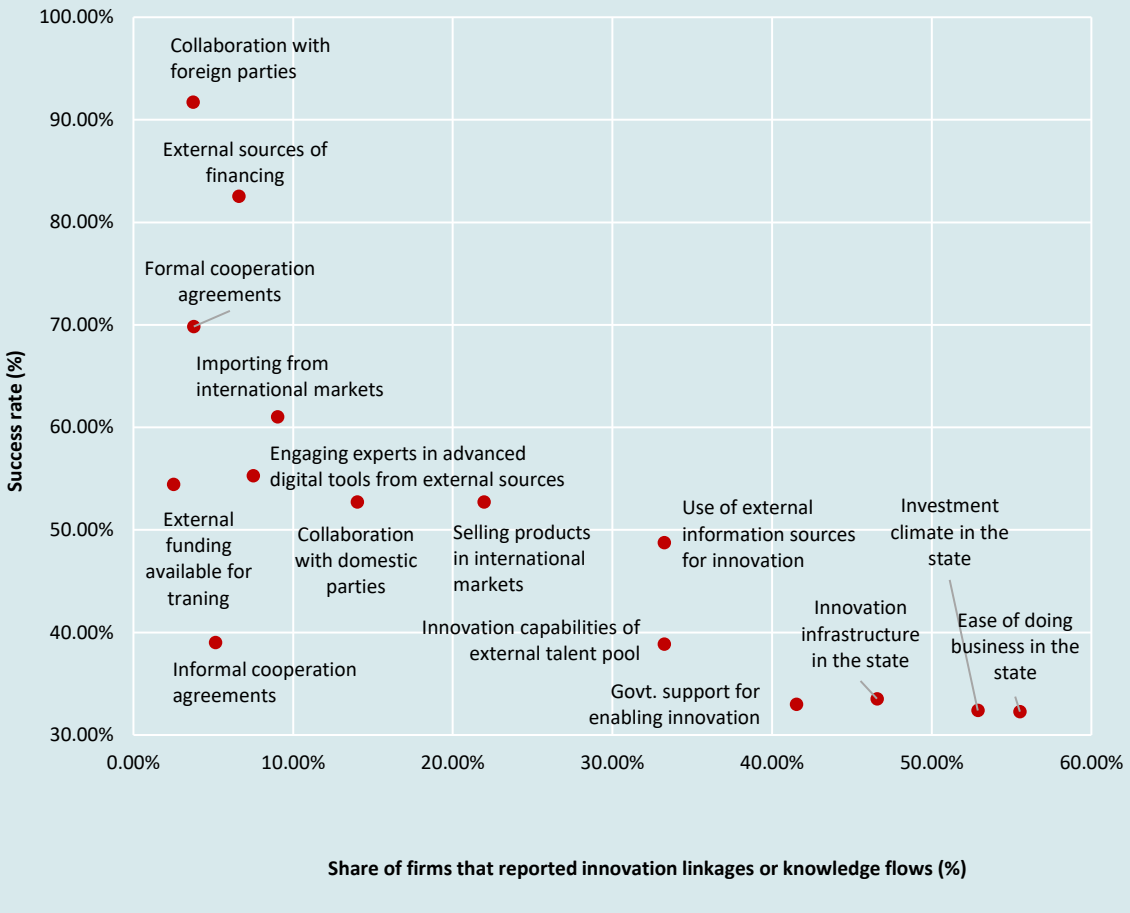
C. What innovation ecosystem is available to manufacturing firms?

The innovation ecosystem was assessed by measuring the success of **innovation linkages and knowledge flows** (see figure 5.13). The share of firms that reported each innovation linkage or knowledge flow (x-axis) is depicted against the success of that indicator. Success is defined by the share of firms that reported each indicator under

[14] Self-reported satisfaction rate

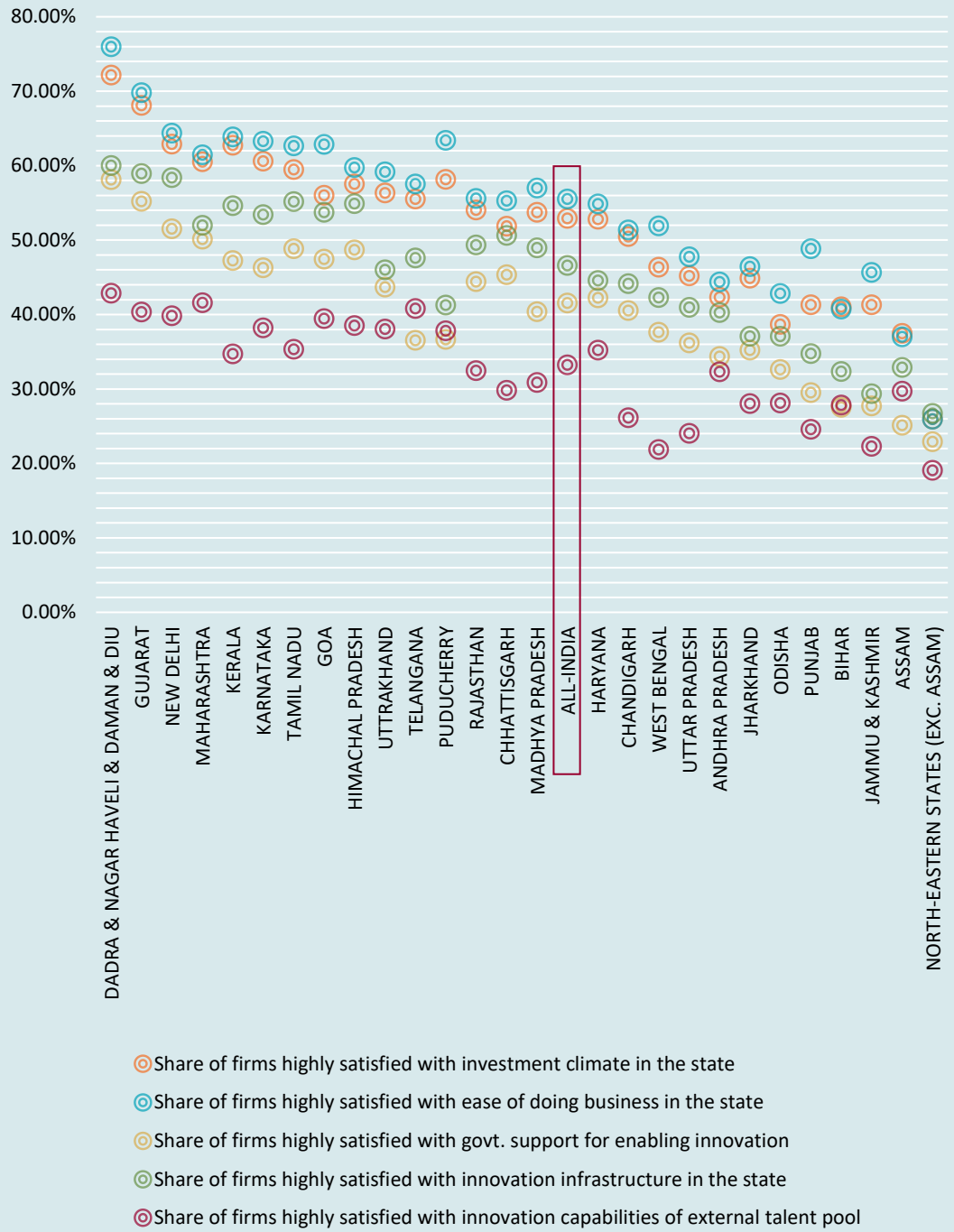
linkages and knowledge flows and were able to introduce innovations. Thus, while a higher share of firms reported high satisfaction with the ease of doing business, investment, and infrastructure climate, the most successful linkages or knowledge flows were collaboration with foreign parties, external sources of financing, and formal cooperation agreements.

FIGURE 5.13: Success rates of innovation linkages & knowledge flows measured by share of innovative firms



As reported by the firms, the success of the **innovation ecosystem available in the states** is captured in figure 5.14. More than 70% of firms in Dadra & Nagar Haveli & Daman & Diu (DNH&DD) reported high satisfaction with the environment for doing business and the investment climate, closely followed by Gujarat and New Delhi. These states also reported high satisfaction with innovation infrastructure and government support for innovation. The North-eastern states reported the least share of firms satisfied with the innovation ecosystem in their states.

FIGURE 5.14: Satisfaction rate of innovation ecosystem available to firms by state



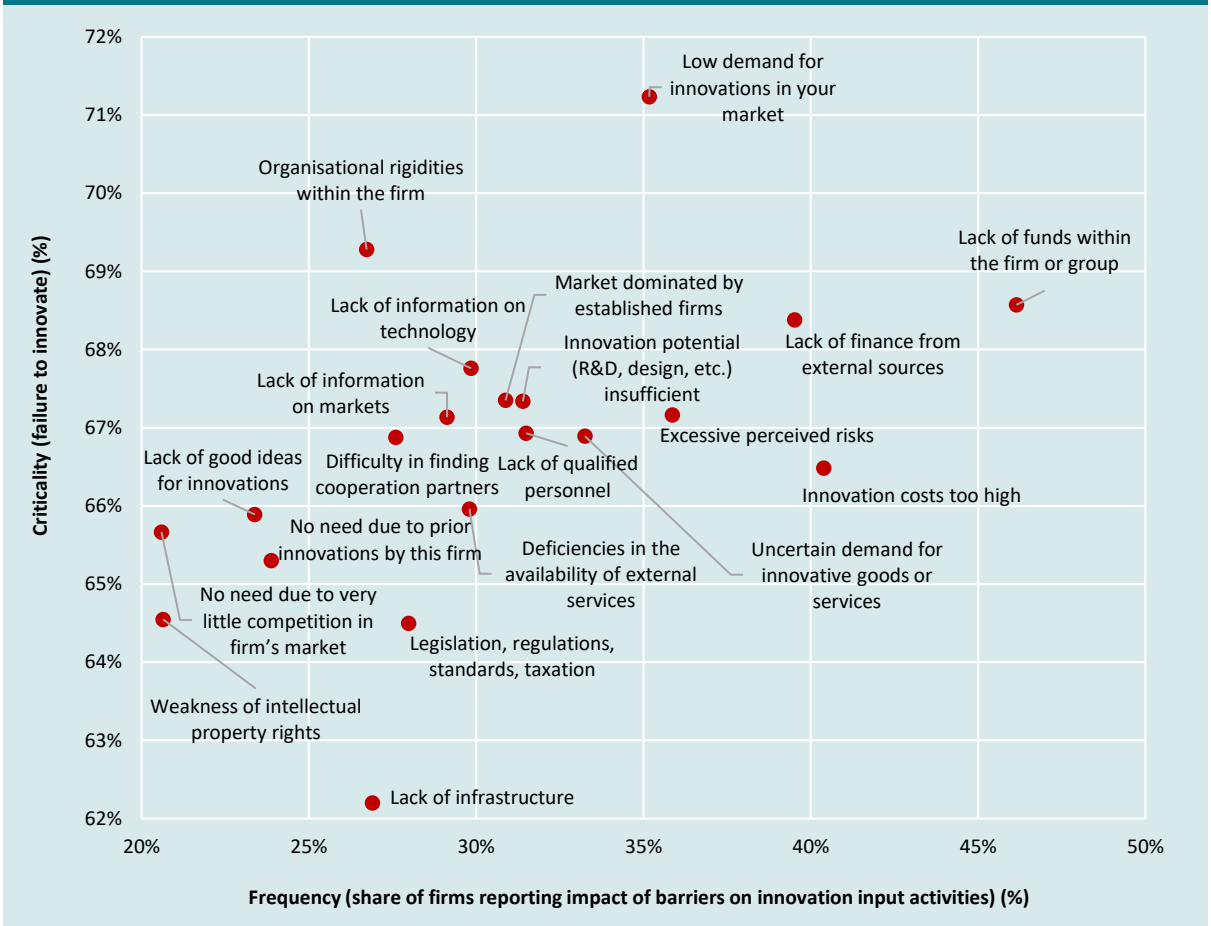
The state of Telangana which had consistently demonstrated a higher incidence of innovation capabilities in firms, however, was not in the top-most category of states having an innovation ecosystem to the high satisfaction of firms. But Telangana besides DNH&DD was successful in making use of external information resources for innovation and was highly satisfied with the innovation capabilities of the external talent pool.

5.3 INNOVATION BARRIERS

The **impact of barriers on innovation input activities** measured in the survey is presented in figure 5.15 where the share of firms reporting low to severe impact of each barrier (Frequency) is examined against the share of firms that reported each barrier and failed to innovate (Criticality).

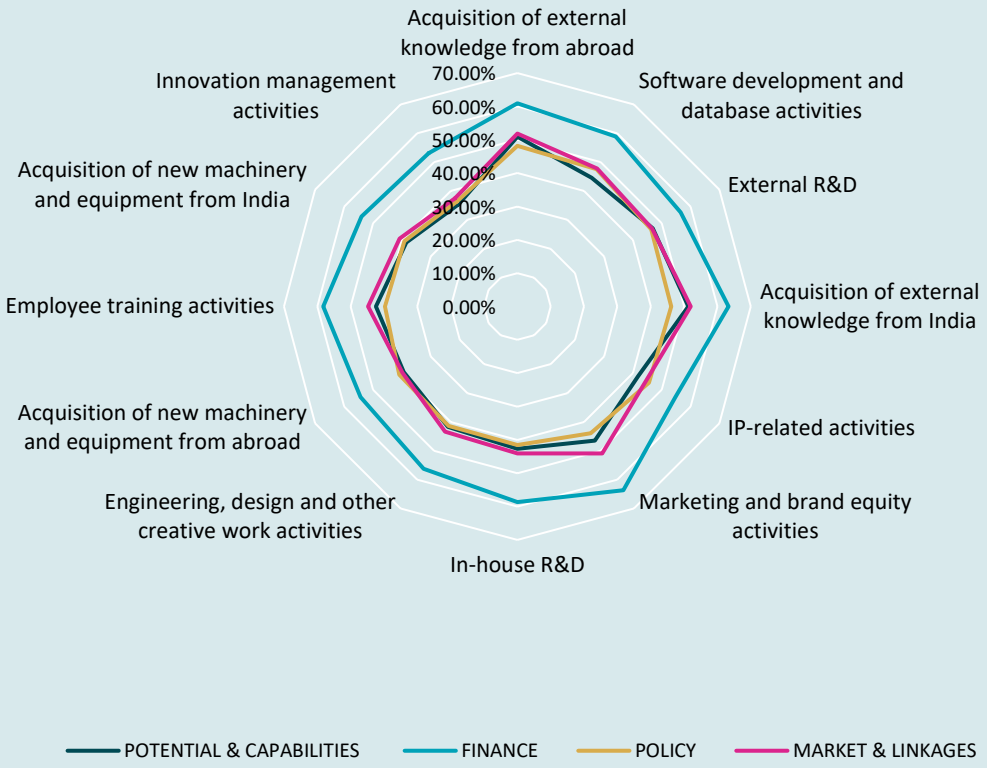
The frequency of a barrier indicates the share of firms that reported low to severe impact of a particular barrier to innovation (input) activities. Criticality is a subset of such firms, that is, it provides the share of firms that were non-innovative (not successful in introducing innovations) out of the firms that reported the impact of a barrier (frequency). As seen in figure 5.15, more than 45% of firms reported that the most frequent barrier was the lack of funds within the firm or group, followed by high innovation costs (40.30%) and the lack of finance from external sources (39.52%). On the other hand, the most critical barriers were low demand for innovations in the market (71.23%) and organisational rigidities within the firms, lack of funds within the firm or group (69.28%), and lack of finance from external sources (68.38%).

FIGURE 5.15: Criticality versus frequency of barriers to innovation in manufacturing



Further, while mapping each innovation input activity and the types of barriers firms faced while implementing these activities, as shown in figure 5.16, finance was found as the key barrier to firms across all activities. The second highest barrier was related to market and linkages to all innovation activities except external R&D, IP-related activities, and the acquisition of new machinery and equipment from abroad. For those firms that engaged in external R&D activities, the second highest barrier was related to potential and capabilities.

FIGURE 5.16: Share of firms reporting innovation input activities and barriers faced by them

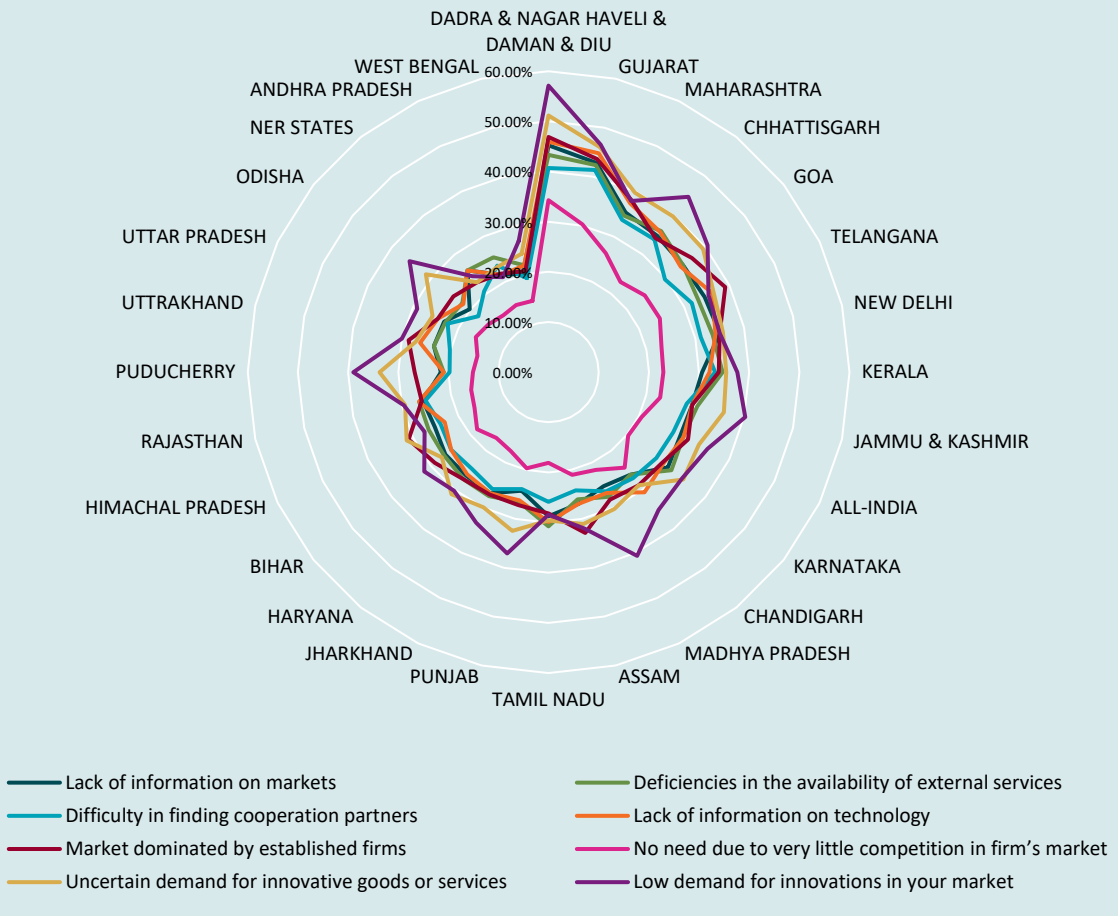


A higher share of firms that undertook marketing and brand equity activities (63.59%) and acquisition of external knowledge from India (63.33%) or abroad (60.94%) faced finance barriers. This is in contrast to the share of firms that faced market and linkage-related barriers while engaging in the acquisition of external knowledge from India (51.99%) or abroad (51.86%) and marketing and brand equity activities (50.89%). The share of firms that faced potential and capabilities barriers while engaging in acquisition of external knowledge from India or abroad and external R&D were at 51.28%, 50.91%, and 46.87%, respectively. 48.18% of firms engaged in the acquisition of external knowledge from abroad, 47.52% of

firms engaged in software development and database activities and 46.31% of firms engaged in external R&D faced policy related barriers.

Firms in the states of Dadra & Nagar Haveli & Daman & Diu, Gujarat, Goa, Maharashtra and New Delhi have reported highest market linkage barriers (see figure 5.17), besides also reporting highest barriers in policy and potential and capabilities. These firms have reported remarkably high hurdles arising from low and uncertain demand for their innovative goods and services, while they face challenges with markets dominated by established firms. However, as seen earlier in figure 5.14, firms in these states have reported to benefit from the most favourable innovation ecosystem made available by the states. On the other hand, as seen in figure 5.13, stronger linkages and knowledge flows within and beyond the immediate ecosystems appear to play a pivotal role in the success rate of innovations, which might need state-level priority.

FIGURE 5.17: Market and Linkage barriers faced by firms by state



5.4 KEY TAKEAWAYS FROM FIRM-LEVEL INNOVATION SURVEY

Innovation performance (output) lags behind presence of enablers and absence of barriers (input)

The frequency of reported innovations is lower than the frequencies of reported presence of enablers and reported absence of barriers. The external enabling environment (linkages and knowledge flows) and the firms' internal capabilities would be expected to translate into innovation activities and investments made by firms, for better innovation outputs and outcomes, i.e., performance. For the enablers and absence of barriers to translating to actual innovations (performance), more efforts (in terms of innovation activities and investments, as well as the efficient utilization of the internal firm capabilities and the enabler ecosystem) are needed in the Indian manufacturing context[15]. In addition, firms with investments in both tangible innovation activities (capital assets) and intangible (knowledge-based capital), tend to be successful innovators and these activities are also concentrated in the states that are high on the innovation index.

Presence of enablers has greater impact on performance than the absence of barriers

The presence of enablers (such as innovation input activities[16], government support and access to market information) is statistically positively correlated[17] with both lower frequencies of reported barriers (such as lack of access to financing), and higher frequencies of reported performance (innovation outputs and outcomes). This means that a one-unit increase in the presence of enablers did correlate with an increase of 0.6780 in the presence of innovations, and one-unit increase in the absence of barriers did correlate with an increase of 0.0249 in the presence of innovations. It is the higher presence of enablers that sets the leaders (best-performing states on the IMII separate from the rest. Such top performers, Karnataka and Telangana – are doing markedly better on the two pillars contributing to enablers, particularly innovation activities and investment. Telangana scored the highest on innovation activities and investment resulting in innovation performance, which is also reflected in the share of innovative firms. DNH&DD also fares high on enabler scores and is one of the best performers in terms of innovation performance.

[15] Overall, the IMII value is 28.17 as seen in Figure 4.1. In the IMII, presence of enablers and absence of barriers, in other words inputs, contribute to the performance, in other words outputs and outcomes. The performance dimension at 25.68, is less than the inputs at 29.41 (average of enablers at 20.52 and barriers (absence) at 38.31). In other words, the innovation output is not commensurate with the inputs. Among enablers, innovation activity and investment pillar has the lowest score at 14.48.

[16] Tangible and intangible (knowledge-based capital) innovation activities such as acquisition of plant, machinery and equipment, internal and external R&D, engineering, design and creative work activities, marketing and brand equity, employee training, IP related activities and innovation management activities.

[17] The correlation coefficient for presence of enablers with performance is 0.6780, and the correlation coefficient for absence of barriers with performance is 0.0249.

Innovation is beneficial to business success in manufacturing

Of the 25% firms reporting innovations in the survey, 83% had increased turnover, 80% opened new market opportunities, 77% responded to market pressures and 71% responded to cost pressures. Even though just a quarter of respondent manufacturing firms reported innovations, and with the challenges encountered, there is a good business rationale for innovation in manufacturing.

At least 70 percent of the firms are innovation-inactive

16.32% of the firms surveyed were identified as innovation-active, meaning they engaged during the observation period of the survey in any innovation input activity with an intention to produce either a product or business process innovation. Out of innovation-active firms, only 54.40% reported innovation activities that were not abandoned, incomplete or seriously delayed during the observation period. On the other hand, 69.93% of the firms surveyed were innovation-inactive with no innovation-input activity.

Aspiration for topline growth drives innovation, but it could also be at odds with innovation

Most firms are driven to innovate by the objectives of increasing market presence and increasing turnover. Enhancing product quality and quantity and reducing costs are other key objectives. In other words, firms will pursue innovations provided they see topline returns. Topline-driven innovation objective combined with the inherent risky nature of innovation and limited entrepreneurial competence to take calculated business risks, may keep firms away from pursuing innovations. The immediate focus on topline growth and long-term determination to achieve innovation success could be at odds. Increasing the risk appetite of firms through appropriate measures and improved competencies could address this concern.

Activities exclusively focused on innovation correlate to higher innovation success

Activities specifically aimed at innovation appear to correlate with higher innovation performance, which saw more than 80% success rate (see figure 5.10). However, less than 10% of firms engaged in each of the innovation input activities exclusively "in pursuit of innovation" [18]. Less than 20% of firms engaged in each of the innovation input activities "regardless of their purpose"[19] that may or may not impact their innovation outputs. On the other hand, while a higher proportion of firms engaged in innovation activities regardless of their purpose, success rates for these activities were found to be lower. In other words, innovation intent in undertaking enabling activities is critical for success.

Firms with more than basic innovation capabilities demonstrate higher success in innovation

Firms with staff using innovative tools, an Industry 4.0 strategy, an R&D strategy, internal sources of financing and advanced and enabling technologies

[18] varying between 1% to 9% for each activity
[19] varying between 1% to 19% for each activity

have better innovation performance, although these capabilities are reportedly scarce as compared to other capabilities such as employing highly qualified personnel and internal information sources (see Figure 5.12).

Basic ecosystem enablers are essential but insufficient on their own to help firms increase their ability to innovate

Firms collaborating with foreign partners, accessing external sources of financing, and entering into formal cooperation agreements demonstrate higher innovation success as compared to those that don't. Other indicators such as satisfaction rate of firms with respect to EODB, investment climate, innovation infrastructure and government support for enabling innovation in the state, although high in frequency were low in success to achieve innovation outcomes. In other words, those basic ecosystem enablers are essential but insufficient on their own to help firms increase their innovation performance. For instance, among the major states, Gujarat had the highest satisfaction rate with the innovation ecosystem (innovation linkages and knowledge flows). Karnataka, Kerala, and Maharashtra also scored well, yet, Karnataka topped the IMII, primarily because its firms most frequently undertake innovation activities.

Finance is the most cited barrier to innovation in Indian manufacturing.

The most frequent barriers were the lack of funds within the firm or group, high innovation costs and lack of financing from external sources, reported by 46.15%, 40.30% and 39.52% of firms, respectively. Whereas the most critical barriers, i.e., the frequency of firms that were not successful in introducing innovations out of the firms that reported the impact of a barrier, were low demand for innovations in the market, organisational rigidities within the firm, lack of funds within the firm or group and lack of finance from external sources, reported by 71.23%, 69.28%, 68.57% and 68.38% of firms, respectively.

Small firms reported the highest frequencies of all barriers across firm sizes, even more than micro enterprises. Finance was most frequently reported as a barrier by firms of all sizes.

Frequencies of innovation barriers differ by region in India

Gujarat and DNH&DD reported the highest frequencies of barriers to innovation. They are among the more industrialized states/UTs in India and have a higher concentration of established businesses and industries such as chemicals, textiles, plastics, pharmaceuticals and electronics. These factors can contribute to higher barriers to innovation as existing firms may be less willing to take risks on new technologies and processes and may have more entrenched organisational structures and cultures. Highly innovative states such as Telangana, Karnataka, Maharashtra, Tamil Nadu, also reported average to high (higher than national average) frequencies of barriers. Highly innovative states such as Telangana, Karnataka, Maharashtra, and Tamil Nadu have invested heavily in creating supportive innovation ecosystems, such as technology parks, incubators, and accelerators. While these initiatives have spurred innovation, they have

also led to higher expectations and standards for innovation, in which may have contributed to higher frequencies of barriers. Interestingly, some of the low innovative states also reported low frequencies in barriers, such as Uttar Pradesh, West Bengal, North-eastern states (excluding Assam), Odisha and Andhra Pradesh. Insufficient innovation potential and lack of qualified personnel were the most frequent barriers related to potential and capability nation-wide as well as in most states, irrespective of their innovation rank. This suggests that there may be a shortage of skilled professionals with the necessary training and experience to drive innovation forward. This shortage could be due to a variety of factors, including inadequate education and training programs, brain drain to other countries, and competition for talent among industries.

6

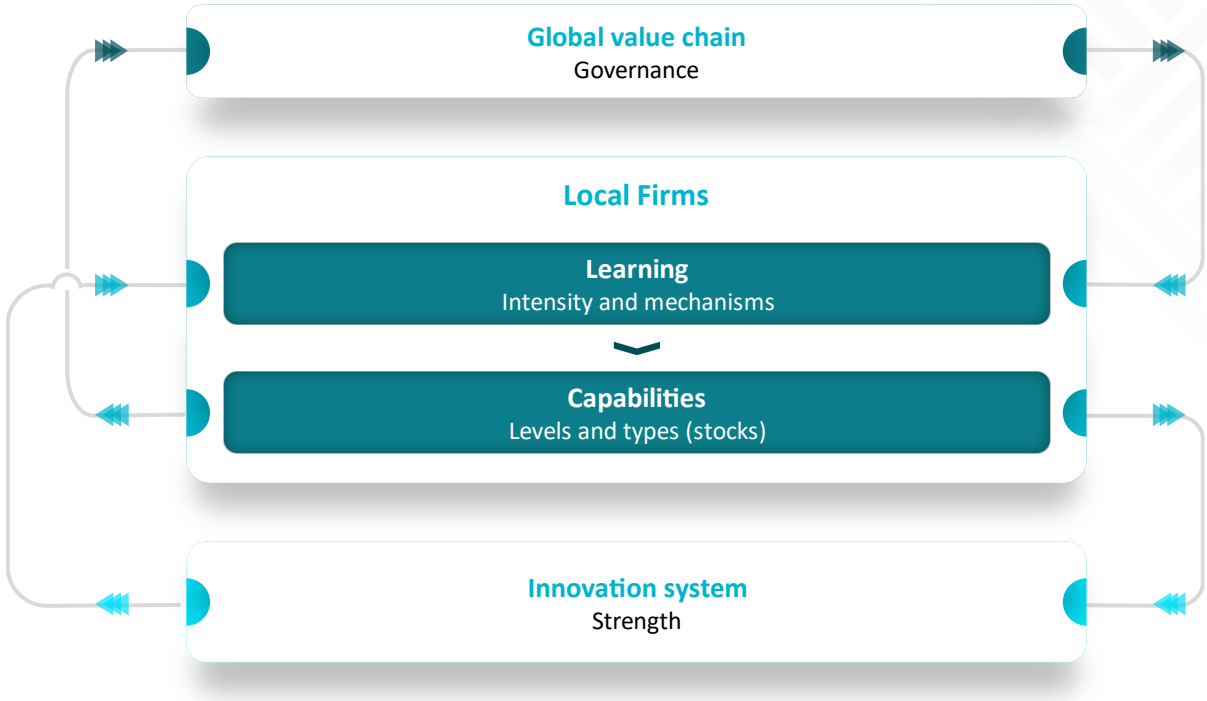
Sectorial System of Innovation (SSI) Survey

Sectorial System of Innovation (SSI) Survey

A sectorial system of innovation (SSI) refers to the set of institutions, organisations, and actors within a specific sector that facilitate innovation and the transfer of knowledge. This includes universities, research institutions, government agencies, and private companies. When these institutions and actors are well-coordinated and working together effectively, they can create a supportive environment for innovation. With respect to the NMIS 2021-22, there are two aspects of SSI that need to be considered; firstly, the role of SSI from a global perspective; and secondly, how a robust SSI promotes innovation at the level of the firm.

In today's globalised economy, participation in global value chains (GVCs) has become increasingly important for countries looking to grow and compete in the international market. This underscores the view of the Government of India in promoting 'local to global'. A robust innovation system facilitates a firm's migration from production of low-tech products to higher-tech products and services, thereby increasing its value-added and competitiveness in GVCs, ultimately leading to a more diversified economy and increased economic growth. It includes factors such as a favourable business environment, a well-educated workforce, access to financing, and supportive government policies, which can help companies bring their products to market, improve their processes, and stay ahead of the competition. However, a strong innovation system is not just about providing resources and support to companies. It also involves creating a culture that values and supports innovation. This can include encouraging entrepreneurship, promoting collaboration between academia and industry, and supporting research and development. By creating a culture that values and supports innovation, countries can encourage their businesses to take risks, try new things, and push the boundaries of what is possible.

The second aspect is that a well-functioning sectorial system of innovation can greatly boost firm-level innovation and competitiveness by helping firms access the resources and knowledge they need to innovate, including funding, expertise, and technological infrastructure. It can also help firms to commercialise their innovations and bring new products and services to market. This can include support in navigating complex regulatory processes and connecting with customers and suppliers. Another important benefit of a well-functioning sectorial system of innovation is the facilitation of collaboration and knowledge transfer between firms. This can help firms to overcome the challenges of developing new technologies in isolation and bring their innovations to market faster.



Source: Global value chains and innovation systems co-evolve[20]

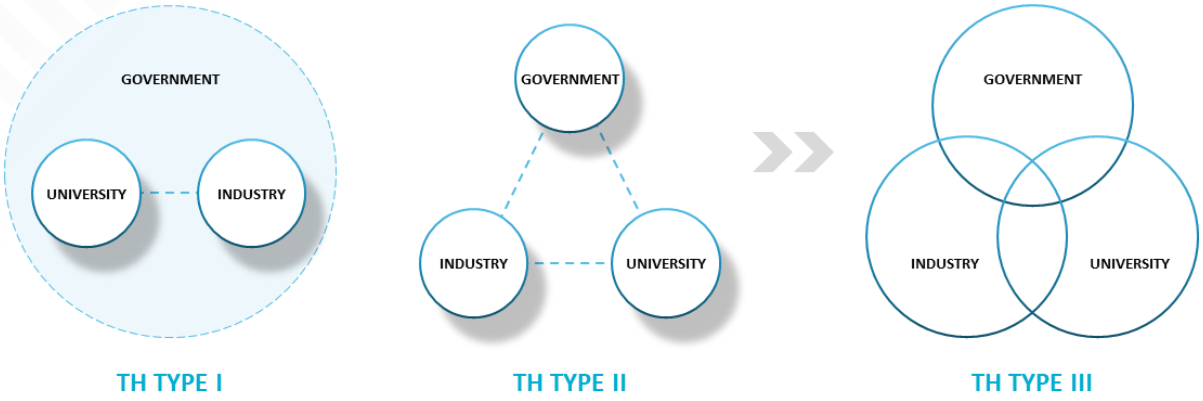
In order for a sectorial system of innovation to be effective, it must also be adaptive and responsive to the changing needs of firms in the wake of emerging technologies and market trends. Finally, a well-functioning sectorial system of innovation can help firms to share best practices and stay ahead of the curve in terms of innovation and competitiveness. This outlook is reflected in several key government policies, namely, Draft 5th National Science, Technology and Innovation Policy (STIP) 2020 (DST); National IPR policy 2016 (DPIIT); and Atal Innovation Mission 2016 (NITI Aayog). However, the Make in India initiative amongst others identifies 5 sectors of importance namely, automotive, pharmaceuticals, food and beverages, textiles and apparel, and information and communication technologies (ICT). These sectors align with the 5 sectors selected for SSI mapping as per the NIC classification.

The Triple-Helix model to assess the sectorial systems of innovation.

The SSI deployed the Triple Helix (TH) Model that focuses on the relationships between universities and knowledge-based institutions (KBIs), firms, governments, and hybrid organisations at the intersection of these three helices. Depending on the level of connectivity between system actors and the types of interaction a SSI can be classified into Type I, II or III, addressed below.

[20] Innovation Trajectories in Developing Countries: How Global Value Chains and Innovation Systems co-evolve https://blogs.lse.ac.uk/gild/2018/11/08/innovation-trajectories-in-developing-countries%E2%80%A8-how-global-value-chains-and-innovation-systems-co-evolve/

FIGURE 6.1: Triple Helix types



TH TYPE I | TH TYPE II | TH TYPE III

TH- Type I	The three helices are strongly defined where the nation state encompasses academia and industry and directs the relations between them, and new knowledge is produced only within universities and research centres.[21]
TH-Type II	It is characterised by decreasing direct control of the state on the functions of Type I with a shift of focus on fixing market failures such that the mechanisms of communication between the actors are strongly influenced by and deeply grounded in market mechanisms and innovations.[22]
TH-Type III	The three actors assume each other's roles in the institutional spheres as well as the performance of their traditional functions where a complex network of organisational ties has developed, both formal and informal, among the overlapping spheres of operations, especially the transformation of universities is of particular relevance. Universities take on entrepreneurial tasks such as marketing knowledge, increased technology transfers and the creation of spin-offs and startups, as a result of both internal and external influences.[23]

[21] Etzkowitz and Leydesdorff, 2000: p. 111).
[22] Nelson and Winter, 1982; Bartels, et al., 2012
[23] (Etzkowitz, 2017; Etzkowitz and Leydesdorff, 2000; Etzkowitz et al., 2000).

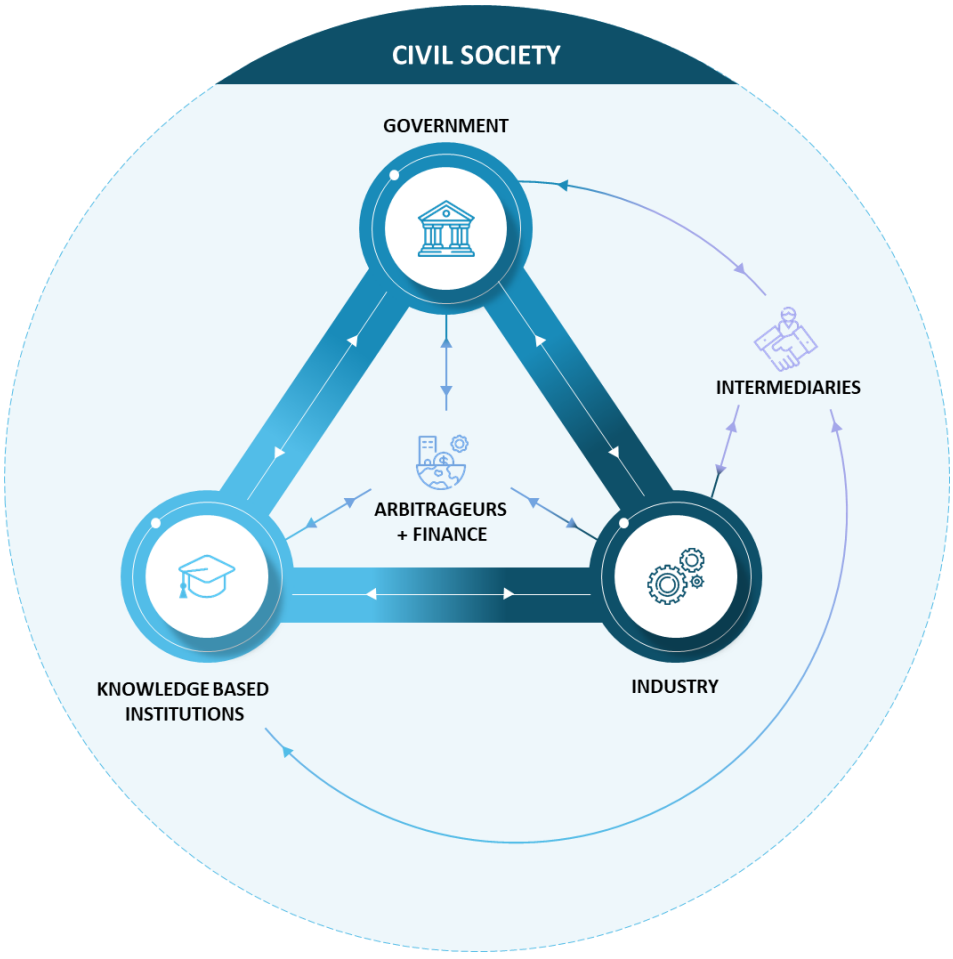
The traditional TH models are extended in two main ways and is referred to as Triple Helix (TH) Type IV (see figure 2). The TH-Type IV has the additional features of arbitrageurs (banks, financial institutions, venture capital and angel investors) and intermediary organisations (industry associations, institutions supporting technical change and incubators), as well as diffused ICT in the context of the fourth industrial revolution for stronger outcomes of SSI.

Independent reports on the 5 SSI sectors provide visualisation of a) linkages between the core actors of the respective SSI, b) significant barriers to innovation and innovativeness, and c) relative success of current policies in overcoming these barriers.

6.1 LINKAGES

Our analysis determines which type of engagement occurs when an actor interacts with players in the system. This can be broken down in terms of intra- and inter-relationships. There are some interactions which are robust. What emerges, however, is the need to bolster certain truncated relationships in order to facilitate knowledge and resource flows within and between the actors, hence fostering innovation.

FIGURE 6.2: Triple Helix Model extension (TH Type IV)



Automotive sector

In the specific case of the automotive sector, our assessment is that the Indian Automotive Sectorial System of Innovation (IASSI) falls into the traditional category of a Triple Helix (TH) Type II transitioning to Triple Helix Type III. Industry actors in this sector have the lion's share of interaction with themselves; knowledge-based institutions primarily interact with industry and government; intermediaries mostly interact with themselves and the government interacts with industry and intermediaries. Finally, financial institutions and arbitrageurs primarily interact with industry. Consequently, there is a need to foster linkages between crucial actors of the IASSI, particularly for the use and application of joint research, skills orientation and development, as well as access to finance. Based on this observation, the inter and intra interactions that need attention are listed below:

- Industry relations with KBIs in the form of 'Secondments' and 'Recruitment' need to be bolstered to foster tacit exchange of knowledge.

- Industry intra-linkages with other industry actors in terms of 'Joint research' is missing and needs to be promoted in order to reduce costs, minimise risk, promote knowledge and technology transfer and improve market access.
- Intra-linkages between KBIs in the form of 'Joint research' need to be strengthened as they can result in the bolstering of direct support to industry.
- Research collaborations between universities, and public and private research institutions require better management therefore generating firm-level benefits leading to innovative ideas and impulses and the provision of support for technological development.

Pharmaceutical sector

In the specific case of the pharmaceutical sector, our assessment is that the Indian Pharmaceutical Sectorial System of Innovation (IPSSI) falls into the traditional category of a Triple Helix (TH) Type II transitioning to Triple Helix Type III. Industry actors in this sector have the lion's share of interaction with intermediaries, namely industry associations. Knowledge-based institutions primarily interact with industry. Intermediaries mostly interact with themselves, whereas the government interacts with intermediaries. Finally, financial institutions and arbitrageurs primarily interact with the knowledge base. Consequently, there is a need to foster linkages between crucial actors of the IPSSI, particularly for the use and application of joint research, skills orientation and development, and access to finance. Based on this observation, the inter- and intra-interactions that need attention are listed below:

- Joint research amongst industry actors needs to be fostered with an aim to make the sector more strategically collaborative rather than competitive.
- Industry-academic interactions for applied research need to be bolstered, along with improving participation of public knowledge-based institutions.

- Industry relations with KBIs in the form of 'Secondments' and 'Recruitment' need to be bolstered in order to better orient human capital development.

- Communication channels amongst the knowledgebase and intermediaries, particularly industry associations, need to be strengthened.
- Better knowledge sharing amongst government bodies to promote an 'all of government approach' to innovation thus translating into more coordinated joint research in strategic areas.
- Reducing the rigidity of communication between knowledge-based institutions in order to foster better knowledge exchange and collaboration in the areas of research, particularly with the inclusion of T2 and T3 institutions.

- Channels of funding from venture capital and angel investors need to be increased to support the process of ideation to market.

Food and Beverages sector

In the specific case of the food and beverages sector, our assessment is that the Indian Food & Beverages Sectorial System of Innovation (IFBSSI) falls into the traditional category of a Triple Helix (TH) Type I transitioning to Triple Helix Type II. Industry actors in this sector have the lion's share of interaction with the government and intermediaries. Intermediaries mostly interact with themselves and the government. Financial institutions and arbitrageurs primarily interact with the government. The government is seen to mostly interact with itself, and knowledge-based institutions primarily interact with themselves and intermediaries. Consequently, there is a need to foster linkages between crucial actors of the IFBSSI, particularly for the use and application of joint research, skills orientation and development, and access to finance. Based on this observation, the inter and intra interactions that need attention are listed below:

- Joint research amongst industry actors needs to be fostered.
- Joint research between industry and the knowledge base needs to be promoted.
- Boosting joint research between knowledge-based institutions, being inclusive of T2 and T3 institutions.

- Closer relationships between industry and the knowledge base for the absorption of skilled human capital.
- Closer linkages between industry and financial institutions for the purposes of knowledge transfer and ultimately better access to finance.
- Linkages between knowledge-based institutions and arbitrageurs need to be strengthened in order to facilitate ideation to market.

- Fostering knowledge sharing between industry and the knowledgebase through secondments with the objective of aligning curricula in line with the requirements of industry.

Textiles and Apparel sector

In the specific case of the textiles sector and apparel, our assessment is that the Indian Textiles & Apparel Sectorial System of Innovation (ITASSI) falls into the traditional category of a Triple Helix (TH) Type II. Industry actors in this sector have the lion's share of interactions with themselves and the government; Intermediaries mostly interact with themselves, and knowledge-based institutions primarily interact with intermediaries and the government. Financial institutions and arbitrageurs primarily interact with the government and the government agencies interact with themselves and industry. Consequently, there is a need to foster linkages between crucial actors of the ITASSI, particularly for the use and application of joint research, skills orientation and development, as well as access to finance. Based on this observation, the inter and intra interactions that need attention are listed below:

- Knowledge exchange between industry actors in order to make them more collaborative rather than competitive which is particularly important in the area of new technology adoption.
- Knowledge exchange and dissemination as well as joint research between knowledge-based institutions (KBIs), particularly in applied areas.
- Knowledge dissemination between arbitrageurs on the technological aspects of the textiles sector, particularly high-tech applications.
- Inter-governmental communication and knowledge sharing on the technical applications and uses of textiles.

- Joint applied research between industry and the knowledgebase needs to be promoted.

- Industry linkages with the knowledgebase in order to generate the requisite skills for the sector. This can be supported through structured placement programmes.

- Knowledge-based institutions (KBIs) seconding industry experts as faculty to foster practical knowledge exchange.

- Intermediaries should better communicate industry needs to KBIs.

- Government to better disseminate information on funds amongst industry players, in particular MSMEs.
- Increased access of funds for KBIs particularly for the process of ideation to market.

Information and Communication Technology (ICT) sector

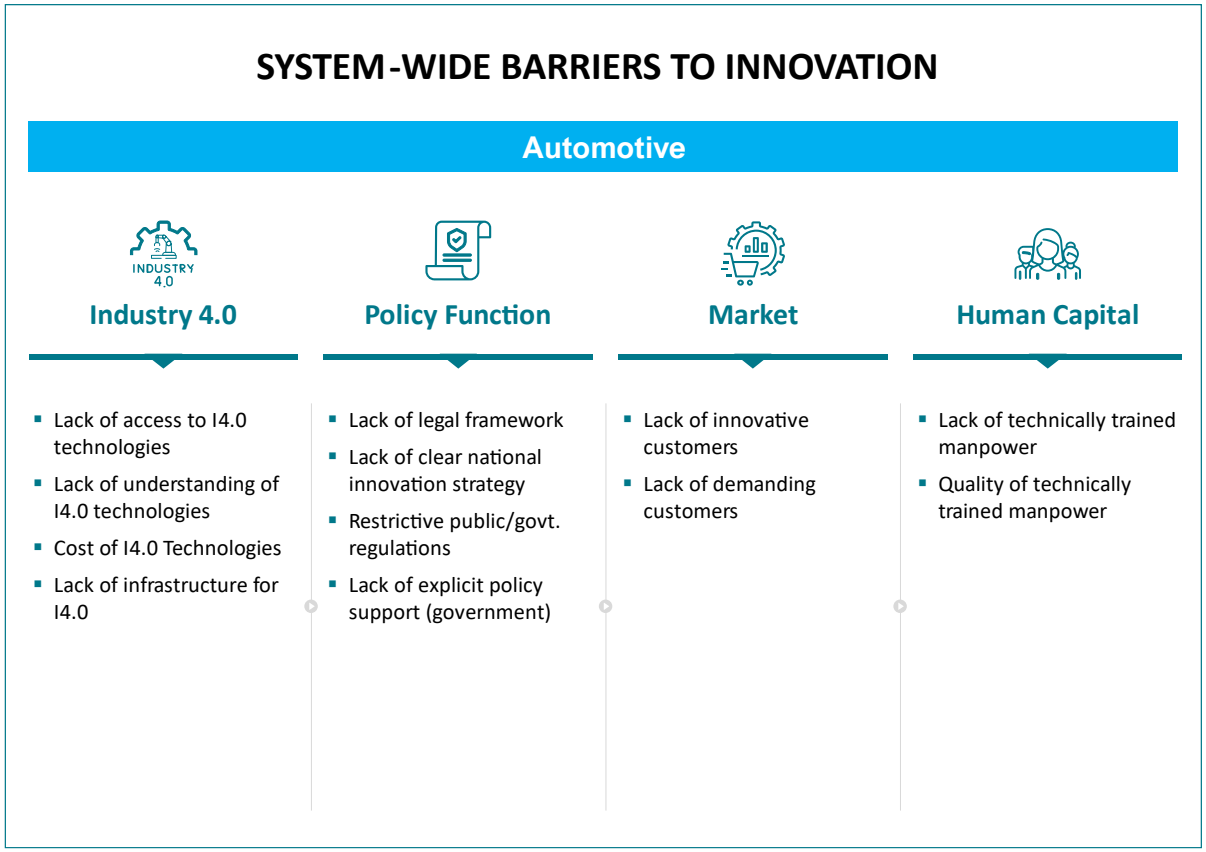
In the specific case of the ICT sector, our assessment is that the Indian Information & Communication Technology Sectorial System of Innovation (IICTSSI) falls into the traditional category of a Triple Helix (TH) Type III. Intermediaries in ICT mostly interact with themselves, while industry actors have the lion's share of interaction with the government. Knowledge-based institutions primarily interact with the government and themselves, while financial institutions and arbitrageurs primarily interact with intermediaries and the knowledge base. Finally, the government mainly interacts with knowledge-based institutions. Consequently, there is a need to maintain and strengthen the relationships between the actors of the IICTSSI, thus fostering a favourable environment for innovation. Based on this observation, the inter and intra interactions that need attention are listed below:

- Fostering joint research between industry players, similarly for government and knowledge-based institutions, as well as government and industry, particularly in strategic areas such as quantum computing.
- Promoting secondments between knowledge-based institutions and the ICT industry as programmes benefit individuals and companies by developing new skills, boosting engagement and increasing retention. They can also resolve specific problems and needs of the ICT sector.
- Better connectivity between the knowledgebase and intermediaries in particular industry associations in terms of technical knowledge dissemination.
- Closer linkages between the knowledgebase and arbitrageurs to facilitate the process of ideation to market.

The above analysis highlights that relationships between actors in the SSI are imbalanced, hindering the flow of knowledge and information crucial to the innovation process. This is mainly due to a suboptimal understanding of each actor's role within an effective system of innovation and due to the terms and conditions that are unfavourable to meaningful participation. Finally, it could be said that the interactions between the actors of the system are more competitive rather than collaborative in nature.

6.2 BARRIERS TO INNOVATION

The survey analysis provides important insights into the barriers to innovation that exist within a sectorial system of innovation. Identifying significant barriers to innovation within a sector is crucial for understanding where resources should be directed to strengthen the innovation system and promote innovation in that sector. To this end, factor analysis is used to indicate the underlying factors that significantly influence barriers to innovation, enabling evidence-based policy design to be targeted specifically and accurately to remove the highest barriers to innovation in prioritised sequencing. The below graphs capture the system-wide barriers to innovation faced by all actors in each of the 5 SSI sectors.



SYSTEM-WIDE BARRIERS TO INNOVATION

Pharmaceutical

Industry 4.0

- Lack of access to I4.0 technologies
- Lack of understanding of I4.0 technologies
- Cost of I4.0 Technologies
- Lack of infrastructure for I4.0

Policy Function

- Lack of legal framework
- Lack of clear national innovation strategy
- Restrictive public/govt. Regulations
- Lack of higher resolution regulations

ICT

- ICT capacity
- Rate of access to ICT

Market

- Lack of innovative customers
- Lack of demanding customers
- Lack of competition

SYSTEM-WIDE BARRIERS TO INNOVATION

Food & Beverages

Market

- Lack of innovative customers
- Lack of clear national innovation strategy
- Lack of demanding customers
- Lack of explicit policy support (government)
- Lack of traditional infrastructure
- Excessive perceived economic risk

Industry 4.0

- Lack of Understanding of I4.0 technologies
- Cost of I4.0 Technologies
- Lack of access to I4.0 technologies
- Lack of infrastructure for I4.0

ICT

- ICT capacity
- Rate of access to ICT
- Lack of willingness to share knowledge

Human Capital

- Brain drain
- Lack of competition
- Hierarchical organizations

SYSTEM-WIDE BARRIERS TO INNOVATION

Textiles & Apparel

Industry 4.0	ICT	Knowledge stocks and function	Market	Human Capital
▪ Lack of understanding of I4.0 technologies ▪ Cost of I4.0 Technologies ▪ Lack of access to I4.0 technologies ▪ Lack of infrastructure for I4.0	▪ ICT capacity ▪ Rate of access to ICT ▪ Brain drain	▪ Lack of information (knowledge gap) ▪ Lack of technology (technology gap) ▪ Lack of legal framework	▪ Lack of innovative customers ▪ Lack of demanding customers ▪ Lack of explicit policy support (government)	▪ Lack of technically trained manpower ▪ Quality of technically trained manpower

SYSTEM-WIDE BARRIERS TO INNOVATION

ICT

Industry 4.0	Policy Function	ICT	Human Capital	Finance
▪ Lack of understanding of I4.0 technologies ▪ Lack of access to I4.0 technologies ▪ Cost of I4.0 Technologies ▪ Lack of infrastructure for I4.0	▪ Lack of legal framework ▪ Restrictive public / govt. regulations ▪ Lack of clear national innovation strategy ▪ Lack of higher resolution regulations	▪ Rate of access to ICT ▪ ICT capacity ▪ Lack of technology (technology gap) ▪ Lack of information (knowledge gap)	▪ Lack of technically trained manpower ▪ Quality of technically trained manpower ▪ Lack of willingness to share knowledge	▪ Lack of finance ▪ Innovation costs (too high) ▪ Excessive perceived economic risk

The overall implication for policy emerging from the analysis of the above barriers to innovation is that resources should use more overarching interventions at the level of the system. However, the specific needs of actors should be taken into consideration for optimal impact. A structured dialogue between stakeholders is required to orient which policies can be most effectively used to address barriers and challenges. Policies and their targets should not be unattainable or out of reach and issues need to be addressed from a realistic perspective.

6.3 SUCCESS OF POLICY INSTRUMENTS

One of the key objectives of the SSI survey is to analyse the relative success of current policies in overcoming the above barriers to innovation. To achieve this, the survey assesses how actors perceive various policies and provides an understanding of whether or not they are effectively calibrated and configured to reach their intended target's needs. Policy instruments of the Indian manufacturing sector are broadly grouped into: i) Supply-side finance policies include – research grants, subsidised loans, government-backed venture capital, and donor funds, ii) Supply-side services include – ICT access and focused skills development initiatives, and iii) Demand-side measures include – tax breaks, spatial policies (science, technology parks, economic zones), government procurement, standards setting, regulation and labour mobility (laws and incentives). The system as a whole, as well as the views of each of the individual actors were reviewed to understand how successful policy is through the aforementioned lens and based on the responses of all actors, the following findings have emerged for each sector:

TABLE 6.1: Top 5 "successful" policy instruments

Top 5 "successful" policy instruments				
Automotive	**Pharmaceutical**	**Food & Beverages**	**Textiles & Apparel**	**ICT**
ICT access	ICT access	ICT access	ICT access	ICT access
Regulation	Tax breaks	Subsidised loans	Regulation	Spatial policies
Standards setting	Standards setting	Labour mobility	Labour mobility	Set-up of business support organisations
Focused skills development initiatives	Subsidised loans	Regulation	Research grants	Research grants
Tax breaks	Research grants	Tax breaks	Subsidised loans	Tax breaks

TABLE 6.2: Top 5 "not successful" policy instruments

Top 5 "not successful" policy instruments				
Automotive	**Pharmaceutical**	**Food & Beverages**	**Textiles & Apparel**	**ICT**
Explicit firm innovation policy support	Explicit firm innovation policy support	Explicit firm innovation policy support	Explicit firm innovation policy support	Labour mobility
Government procurement	Government procurement	Focused skills development initiatives	Spatial policies	Regulation
Government backed venture capital	Set-up of business support organisations	Spatial policies	Focused skills development initiatives	Explicit firm innovation policy support
Set-up of business support organisations	Focused skills development initiatives	Standards setting	Government procurement	Standards setting
Subsidized loans	Government backed venture capital	Set-up of business support organisations	Set-up of business support organisations	Government procurement

It can be seen that the supply side measure, 'ICT access', has emerged as the most successful policy instrument as reported by all actors across 5 sectors, followed by tax breaks as the second most successful policy instrument, while 'Explicit firm innovation policy support' emerges as the most unsuccessful policy instrument across all sectors except ICT (where it assumes third place after 'Labour mobility' and 'Regulation'). This is reflective of the need to clearly articulate high-level goals and visions down to the level of industry. This is also reflective of the barriers reported by all actors.

6.4 RECOMMENDATIONS FROM SYSTEM LEVEL ASSESSMENT

As discussed above, all actors in the system of innovation have a specific view on effective or ineffective policy instruments for each sector, which needs to be considered when selecting an optimal innovation policy mix. Policy selection should be based on evidence and reflect the needs of the actors in the system (adopting a system of innovation approach) and be in line with India's overall strategic orientation. In addition, the inclusion of civil society in policy craft is important, particularly as they: provide

bottom-up insights; represent demand-side perspectives; facilitate the creation of social innovations, legitimation and justification for innovations; and crucially promote commitment to and ownership of a development agenda.

Overall, the major implication that emerges from the analysis across all 5 sectors is that there are very few externalities that emanate from the public goods of funding and support, and innovation inputs need to be better translated into innovation outputs. This alludes to the presence of certain system failures.

The formulation of effective policy is therefore a highly complex affair and the policy recommendations presented in each report offer a range of evidence-based policy choices to facilitate policy decisions. Key cross-cutting system-wide recommendations that emerge from the analysis conducted include:

Integrate and standardize national actor databases, creating a national public good

- Consolidation of existing databases and integration of feedback mechanism for improvement.
- Purpose-driven platform to be developed in PPP approach for hosting and maintaining data.
- Ensuring robustness, credibility and ease of access of data.

Innovation is an all of government approach and not the purview of one ministry

- Cross-referencing of policies across ministries to foster consensus building and avoid duplication.
- Framing of larger projects focusing on innovation (and adopting a system of innovation approach), spearheaded by multiple ministries.

Repeated system-level measurement to guide policy

- Make SSI surveys a mandatory census (4 years) and link to the national database.
- Institutionalise the SSI mapping within a national institution with a top-down mandate.
- Targeted promotion and incentivisation at actor/entity level.
- Institutional coordination at national and state level for systematic mapping and measurement of the SSI.

Better articulation of policy, reducing complexity and building awareness especially at the level of MSMEs

- Simplification of policy documentation.
- Utilising industry associations as a conduit for disseminating information about policies.
- Standardisation of terminology used in policy/national documentation.

Bridging the knowledge gap - better institutional coordination between regions/clusters

- Creating fora for joint research.
- Commonly agreed structured framework for joint activities.
- Ease of skills and knowledge flows and sharing best practices.
- Planning and onboarding to make utility of champions at national and regional level.
- Creation and transmission of information using contemporary multimedia resources

7

NMIS Policy Directions

NMIS Policy Directions

From the evidence and learnings from NMIS 2021-22, i.e., from both the survey of firm-level innovations and the survey of the sectorial system of innovation, a few key policy directions are drawn that need priority action and are succinctly presented below, especially for the consideration of experts and policymakers.

'Innovate to Make in India' as a manufacturing innovation strategy

The survey findings demonstrate that despite proven business benefits, manufacturing firms showed high-risk aversion and limited entrepreneurial appetite to engage with innovation. Predominantly, it was observed that firms were responding to the immediate demands in the market, instead of competing for new products that are needed to compete in the future. In this context, a long-term manufacturing innovation strategy is critically urgent. Thus, to make innovation a priority for manufacturing firms, a concrete step forward would be to complement the make in India with an "Innovate to Make in India" strategy. This may then include broad-based awareness, promotional measures and investment incentives, along with sectorIal sub-strategies with concrete innovation targets or roadmaps.

Make SSI a policy objective for handholding and incentivising the system of innovation and collaborations to strengthen manufacturing innovation and ecosystem

The survey of sectorial systems of innovation (SSI) have shown promising evidence of evolving and maturing SSIs, yet it is equally evident that manufacturing sectorial system of innovation and collaborations are only in their 'adolescence'. The survey findings show that there is low transparency regarding institutions and actors and their capacities, achievements and roles in the innovation ecosystem. While such transparency and impartiality of innovation information are necessary for investment decisions on innovations, knowledge-based institutions (KBIs) and firms operate in relative silos and the findings show the limited linkages and low willingness to engage with the challenges of each other. Further, the intermediary functions in technology transfer and commercialisation are insufficient. These challenges are more profound within tier-2 and tier-3 institutions. The Government can focus on an efficient SSI as a policy objective and invest in the development and promotion of sector-specific innovation activities. This will facilitate and promote the establishment of databases and collaboration platforms, which will also offer capacity building for firms, KBIs and arbitrageurs.

These sectorial systems of innovation platforms can facilitate the organisation of innovation competitions and awards, foster the development and sharing of best practices, and ultimately strengthen the linkages and interactions among actors and institutions involved in the innovation ecosystem.

Support pre-competitive, collaborative industry focused research and innovation

The NMIS survey found low evidence of effective future-oriented collaborations in research and innovations, among firms and with innovation stakeholders. There is no evidence for - and potentially a low interest – in the development of a pre-competitive knowledge and innovation base that multiple firms and possible sectors can benefit from, i.e., with their own and different new products and technologies. This would require partnerships between companies in the same industry that collaborate on research, development, and innovation projects, which benefit the industry as a whole. While such collaboration between industry competitors can appear counterintuitive and therefore resisted, lessons from innovative nations show a strong government arm can facilitate and even mandate such collaboration. Such interventions can be dedicated to GoI R&D programmes for large-scale and long-term funding allocation for pre-competitive industry-focused research and innovations, where collaboration can be mandated as a qualifying criterion for accessing any research grant. The Government may consider launching funding allocation for pre-competitive, collaborative industry-focused research and innovation, drawing inspiration from the success of similar programmes in countries as diverse as Australia, UK, Germany, the Netherlands, Israel, Japan and the Republic of Korea.

Enhance state government participation for fostering innovation in MSMEs

State governments are better connected with MSMEs and are a vital link in the delivery of MSME-oriented policy and incentive schemes. This is true for innovation as well. State governments can use the data generated through the NMIS survey and the results of the Indian Manufacturing Innovation Index 2022. Together they provide valuable and specific areas where their targeted response can make a difference. The overarching barriers to innovations observed in the systems of innovations[24] offer strong baselines for updating and orienting various MSMEs schemes. The design of future initiatives to amplify manufacturing productivity and competitiveness may examine existing policy success using manufacturing innovation and SSI lenses. In addition, significant differences exist across states in innovation enablers, barriers and performance leaving ample scope for cross-learning and benchmarking.

Implement innovation-linked incentive schemes across sectors

Government may consider fiscal and non-fiscal mechanisms to help firms improve their risk appetite in pursuit of innovation. Innovation-linked incentive scheme could be launched to help firms, especially MSMEs, to address the

[24] In the 5 sectors studied under NMIS 2021-22, barriers are grouped across Policy function, Market, Human Capital, ICT Knowledge and Flows, Knowledge Stocks and Function and Industry 4.0.

financial risks linked to innovation uncertainty. To this end, Government should co-fund all research, even research and innovation that fails. While the benefits of the scheme can be linked to the output and outcome indicators, the purpose is to help firms address internal enablers and barriers, hence it is particularly important to include innovation failure as a potential outcome, and the related learnings are captured.

Improve the quality and availability of firm-level and sectorlal data on innovation

Government may regularly update data on innovation indicators especially in manufacturing and related services such as R&D expenditure in manufacturing, investment in advanced technologies, turnover and investment by manufacturing firms and employment data of manufacturing firms with respect to R&D. With this, public data on innovation in Indian manufacturing will significantly improve, and it will be latest to the reporting year, thus addressing the data gaps and lags. More importantly, the government will have a more accurate picture of innovation trends and can dynamically respond with appropriate policies.

Support firms to mitigate innovation-related risks

Firms often face risks in their pursuit of innovation, which can act as a deterrent to progress. These risks are further magnified by various other barriers such as inadequate access to external funding, high innovation costs, insufficient market linkages, and uncertain market demand. To support firms in overcoming these obstacles, the government can implement both fiscal and non-fiscal measures to encourage firms to take calculated risks and engage in innovation.

Increase private sector innovation investment through crowding-in

India is one of the countries with high public sector funding in innovation. The government may redirect some of its innovation expenditure for purposes of crowding in private sector funding and participation in innovation. Success factors of successful schemes such as Start-up India could be adopted for similar crowding in of private sector investment with appropriate suitability to the characteristics of innovation life cycle.

Annexure

Table-A: Share of firms across the 80 indicators at the national-level (%)

Indicators	Share of firms (%)
Pillar 1: Innovation Activities and Investment	
Firms that engaged in tangible activities for innovation	8.71%
Firms that engaged in knowledge-based capital (KBC) or intangible activities for innovation	13.54%
Firms that invested in tangible activities for innovation	14.90%
Firms that invested in KBC or intangible activities for innovation	21.28%
Pillar 2: Innovation Capabilities	
Firms with internal sources of financing available for innovation activities	22.76%
Firms that used innovative tools and practices among staff that are successful	13.62%
Firms highly satisfied with innovation capabilities of employees	51.03%
Firms that made use of internal information sources for innovation	37.78%
Firms that used advanced, enabling or emerging technologies	6.48%
Firms with an R&D strategy	14.55%
Firms that employed highly qualified personnel, by level of educational attainment	29.61%
Firms with R&D staff	12.36%
Firms that employed experts in Industry 4.0 and advanced digital tools in house	23.15%
Firms with an I4.0 strategy	3.86%
Firms with internal funding available for training	23.35%
Pillar 3: Innovation Linkages & Knowledge Flows	
Firms highly satisfied with investment climate in the state	52.89%
Firms highly satisfied with ease of doing business in the state	55.52%
Firms highly satisfied with govt. support for enabling innovation	41.53%
Firms highly satisfied with innovation infrastructure in the state	46.57%
Firms highly satisfied with innovation capabilities of external talent pool	33.24%
Firms with formal cooperation agreements for innovation	3.78%
Firms that engaged experts in Industry 4.0 and advanced digital tools from external sources	7.51%
Firms that exported to international markets	21.96%
Firms that imported from international markets	9.03%
Firms with informal cooperation for innovation	5.14%
Firms that collaborated with Indian entities on innovation activities	14.02%
Firms that collaborated with foreign entities on innovation activities	3.74%
Firms making use of external information sources for innovation	33.25%

Firms with external sources of financing for innovation activities	6.60%
Firms with external funding available for training	2.50%
Pillar 4: Potential & Capabilities Barriers (absence)	
Firms that reported no impact of insufficient innovation capability (R&D, design, etc.) On innovation activities	37.83%
Firms that reported no impact of organizational rigidities (inflexibility) within the firm on innovation activities	43.86%
Firms that reported no impact of lack of need due to prior innovations by the firm on innovation activities	45.81%
Firms that reported no impact of lack of qualified personnel on innovation activities	38.11%
Firms that reported no impact of lack of good ideas for innovations on innovation activities	44.86%
Firms that reported no impact of lack of firm-level infrastructure on innovation activities	42.41%
Pillar 5: Financing Barriers (absence)	
Firms that reported no impact of lack of funds within the firm or group on innovation activities	26.52%
Firms that reported no impact of lack of finance from sources outside the firm (credit) on innovation activities	30.86%
Firms that reported no impact of excessive perceived risks on innovation activities	34.59%
Firms that reported no impact of innovation costs too high on innovation activities	30.78%
Pillar 6: Policy Barriers (absence)	
Firms that reported no impact of regulations, standards, and taxation in hampering innovation activities	41.16%
Firms that reported no impact of weakness in protection, acquisition and/or utilization of intellectual property rights on innovation activities	47.94%
Firms that reported no impact of legislative barriers on innovation activities	35.76%
Pillar 7: Market & Linkage Barriers (absence)	
Firms that reported no impact of lack of information on markets on innovation activities	40.19%
Firms that reported no impact of deficiencies in the availability of external services on innovation activities	39.21%
Firms that reported no impact of difficulty in finding cooperation partners on innovation activities	41.78%
Firms that reported no impact of lack of information on technology on innovation activities	39.53%
Firms that reported no impact of market dominance by established firms on innovation activities	39.06%
Firms that reported no impact on innovation activities because of lack of incentive to innovate due to very little competition in firm's market	48.18%
Firms that reported no impact of uncertain demand for innovative goods or services on innovation activities	36.72%
Firms that reported no impact of low demand for innovations in the market on innovation activities	35.24%

Pillar 8: Innovation Incidence & Characteristics	
Firms with new or significantly improved goods	13.50%
Firms with new or significantly improved services	3.73%
Firms into innovations in operations and product/process development	12.22%
Firms into innovations in marketing and sales	6.94%
Firms into innovations in procurement, logistics, and distribution	5.15%
Firms into innovations in administration and management	4.59%
Product innovators that reported new-to-market (NTM) innovations	6.42%
Business process innovators that reported NTM innovations	2.43%
Firms that reported in-house product innovations	95.87%
Firms that reported in-house business process innovations (BPI)	80.06%

Pillar 9: Innovation Objectives & Outcomes	
Innovation Objectives	
Firms that reported innovation objective of increasing their turnover	28.70%
Firms that reported innovation objective of increasing their market presence	30.75%
Firms that reported innovation objective of enhancing product/process in terms of quality and quantity	25.27%
Firms that reported innovation objective of reducing environmental impacts	20.32%
Firms that reported innovation objective of reducing costs	24.71%
Firms that reported innovation objective of improving health and safety of their employees	19.41%
Firms that reported innovation objective of meeting regulatory requirements (e.g. Standards, etc.)	19.40%
Firms that reported innovation objective of catering to Corporate Social Responsibility	17.35%
Innovation Outcomes	
Firms that reported improvement in their firm's turnover as a result of innovations	20.84%
Firms that reported opening up of new market opportunities as a result of innovations	20.18%
Firms that were able to respond to market pressures as a result of innovations	19.33%
Firms that were able to respond to cost pressures as a result of innovations	18.06%
Firms that were able to respond to existing or forthcoming regulatory provisions as a result of innovations	13.57%
Firms that attained any of the above innovation outcomes through I4.0 technologies	4.68%
Firms that were granted IP rights	16.79%
Firms that reported turnover from new-to-market product innovations	42.72%
Firms that reported turnover from NTM business process innovations	22.29%
Employment in innovative firms (as a percentage of total employment)	45.18%
Turnover of an innovative firm (% of GSDP per capita)	47.80%

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