

Creating innovative SME clusters in India: An overview of RIS approach

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Keywords

SME; cluster; innovation; university-industry linkage; ANRF; NSF

Abstract

Developing countries such as India should create highly innovative Small and Medium Enterprise (SME) ecosystems by adopting the Regional Innovation Systems (RIS) approach which envisages industrial clusters surrounded by innovation supporting organizations, particularly universities and research institutes. Policies should be crafted to advance partnerships among colleges and universities, government institutions, nonprofit agencies and SMEs for creating a highly innovative milieu of innovation. The Anusandhan National Research Foundation (ANRF), an apex body set up by Government of India for fostering Research and Development(R&D) in the fields of natural sciences, should follow the lead of the US National Science Foundation (NSF) and the US Small Business Administration (SBA), both federal agencies that manage programs for advancing innovation in small businesses. The NSF invests in basic research across all fields of fundamental science and engineering and runs the Small Business Innovation Program for assessing potential business ideas through involvement of small businesses in research and development. The SBA runs Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, specifically designed to help SMEs plan, start and expand their businesses by connecting companies with lenders and funding. Though Indian SMEs have demonstrated acumen for innovation in hi tech industries such as space research, their full potential needs to be harnessed. Indian academic institutions produce high quality research but rank poorly in terms of academia industry interaction, thus hindering the innovative potential of the economy. The paper presents an India specific perspective on the RIS approach, and gives policy prescriptions for unleashing the economy's innovative potential.

Introduction

An industrial cluster can be described as a geographic concentration of companies from one and related industries and other organizations such as research institutes and support agencies. These institutions are linked on the basis of business-related commonalities and complementarities and derive economic advantages from that (Maskell, 2001). The cluster concept for industrial growth is widely adopted by governments for pursuing regional economic development and enhancing productivity and efficiency through sharing of resources to achieve common goals. In other words, an industrial cluster is a regional agglomeration of sector or value chain related firms and other organizations such as universities, Research and Development(R&D) centres and public agencies which derive economic advantages from co location and collaboration. It is imperative for fast growing economies like India to create innovative Small and Medium Enterprise (SME) clusters with robust industry academia linkages since small businesses are key to driving growth and employment in developing economies. Hence, creation of innovative SME ecosystems is central to fostering a national milieu of innovation.

Cluster services can help fill “institutional voids” or insufficiencies in the institutional environment resulting from absence of specialized intermediaries or actors placed between other actors to facilitate a

transaction. Such an intermediary may be an institution which connects buyers and sellers thus enabling smooth functioning of the market, provides capital, specialized information, research and consultancy, talent search or acts as contract guarantor. An important cluster service is the linking of firms to universities and R&D institutions. These linkages are important for SMEs which lack internal resources and capability to establish in-house R&D departments. Other cluster important services include provision of access to venture capital, public relations and marketing services, personnel procurement and imparting of relevant skills, education and training, provision of support in writing grant proposals and acting as export intermediary for small firms (Schrammel, 2013). These services can cumulatively foster a vibrant ecosystem of innovation and creativity. A cluster or region acquires innovative potential due to learnings imbibed from a set of networks comprising firms, universities, centres of research, associations and government agencies, all of which are active participants. Interaction happens not only through formal relationships but also informal linkages present in a local environment. SMEs depend on tacit knowledge and less capable of searching for and using codified knowledge. Small businesses form tight networks, encompassing personal and business relationships. This makes them reliant on personal ways of transferring tacit knowledge and on learning-by-doing and interacting. In high technology clusters, innovation occurs through generation and maintenance of crucial knowledge flows, hence interaction among various agents in a network is critically important. The endogenous growth theory for which won Paul Romer the Nobel Prize in Economics for 2018 emphasizes the important role played by institutions and human capital in facilitating innovation and knowledge transfer. Clusters create knowledge and technology spill overs emanating from availability of ideas on new products, inputs, production processes and marketing channels with benefits flowing to all units of a cluster without any commensurate payment or compensation to the originators of the idea (Arif,2012). Two crucial factors which influence the creation and dissemination of knowledge and skills in context of SME clusters are educational attainment and the strength and the diversity of local science base in universities.

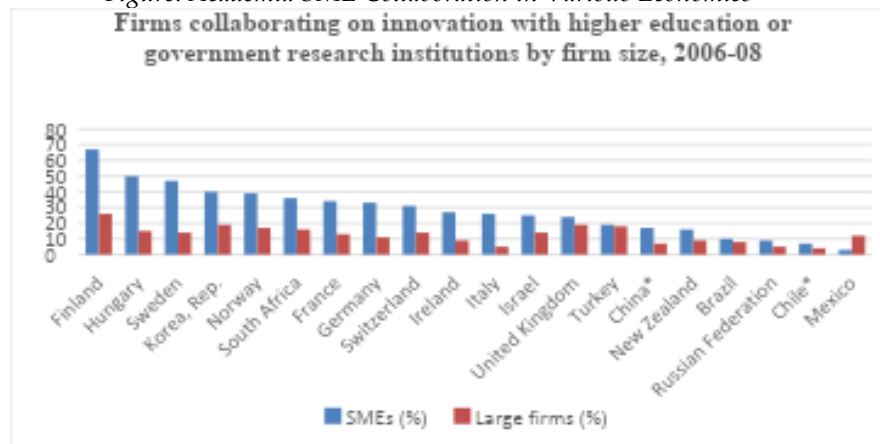
The Regional Innovation Systems (RIS) approach pioneered in industrial clusters in US and Europe envisages building innovation infrastructure through creation of dense networks sharing critical knowledge and expertise, transferring skills and training, helping build up the knowledge base of SMEs and enhancing productivity (Cooke,1996). Thus, RIS identifies both technological and support services as a key to fostering innovation. It envisages a group of industrial clusters surrounded by organizations which enable and promote innovation. The RIS approach lays down that innovation in SMEs takes place not only from access to technology but also the creation of human capital through upgradation of academic qualifications and skill sets, organizational change and most importantly building up social capital, which is the network of relationships among organizations and individuals built on trust and reciprocity. It refers to formation of strong linkages among SMEs, consumers, raw material suppliers, vendors and other actors in the ecosystem to build mutually beneficial relationships aimed at enhancing business productivity. Thereby, the RIS envisages two main kinds of actors; the first are companies and their support industries including customers and suppliers, while the second set backing up the innovative performance of the first kind of actors includes research and higher education institutes such as universities, technical colleges, R&D institutes, technology transfer agencies, vocational training organizations, business associations, finance institutions and so on. These supporting organizations create and diffuse knowledge, train labour, provide necessary finance and so on to support regional innovativeness (Chaminade and Vang, 2006). These services become critical for SMEs which lack qualified human resources, face poor managerial skills of decision makers and have difficulties in accessing strategic information, all of which hinder innovation, especially in developing Asian economies. Thus, an important shared resource available to clusters is in the form of supporting organizations like academic institutions, financial institutions and supporting agencies. These webs of extensive relationships lead to

skilled labour creation, new enterprise creation, training and consultancy services and R&D collaborations. Industry associations also play critical roles in knowledge dissemination and cluster upgradation.

Universities and research institutions are central to the RIS approach, acting as catalysts for generating innovative ideas, consequently ecosystems with higher levels of university industry engagement demonstrate greater innovative potential. Governments around the world have deployed innovative measures for integrating universities into their ecosystem and facilitating industry university interaction for leveraging university talent to drive innovation. These initiatives vary in their nature and approach, from heavy investments in R&D in South Korea to nurturing university run enterprises in China, achieving impressive results and offering lessons for other developing economies. As part of economic reforms of the 1980s, China developed a unique model for fostering innovation and entrepreneurship in universities. Leading tech institutions established startups which exclusively employed university developed technology and were managed by academicians who were concurrently allowed to retain their teaching jobs, thus promoting entrepreneurship among researchers. With strong government support, these enterprises expanded rapidly, developing and commercializing critical technologies and transforming universities into powerhouses of innovation. Examples include The Founder Group, a prominent player in Information Technology established by Peking University in 1986, which grew into a hugely successful conglomerate (Jin,2014).

The World Intellectual Property Organization (WIPO), a United Nations agency focused on global intellectual property related services, ranks more than 130 countries annually with respect to innovation by releasing a “Global Innovation Index (GII).” WIPO has placed Sweden, Republic of Korea, United Kingdom, Finland, China and Germany on second, fourth, sixth, seventh and joint tenth rank respectively on the GII for 2025. These economies have consistently featured among the top 15 innovators on the GII since 2021 and have historically had high levels of SME engagements with higher education and government research institutions. Approximately 47% SMEs in Sweden, 67% in Finland, 40% in South Korea, 24% in the UK, 33% in Germany and 17% in China collaborated with educational institutions on innovative projects during 2006-08 (Science, Technology and R&D statistics OECD,2011). India features at the 38th position on the index for 2025.

Figure: Academia SME Collaboration in Various Economies



Source: OECD Science, Technology and R&D Statistics, 2011. (Accounting for Science-Industry Collaboration in Innovation: Existing Metrics and Related Challenges, WIPO Global Innovation Index,2012)

Literature Review

Simmie and Sennett (1999) explore the agglomeration benefits in the London metropolitan area, where clustering provides MSMEs access to infrastructure, financial capital, and skilled labour, enhancing productivity. The concentration of resources and specialized services in clusters allows firms to operate more efficiently, improving overall productivity. Kharbanda (2001) emphasizes the productivity gains for SMEs within clusters, where firms benefit from knowledge-sharing networks and collective efficiency. Examples of clusters in Ludhiana, specializing in woolen garments, sewing machines, and bicycle parts, illustrate how close linkages within clusters facilitate high productivity through shared resources and specialized support. Gomes (2001) examines Italian industrial districts or "distretti industriali," showing how SMEs in clusters benefit from enhanced productivity owing to their proximity to suppliers and competitors. This structure allows firms to upgrade production processes, adopt new technologies faster, and maintain competitive productivity levels due to both rivalry and cooperation within clusters. Garone et al. (2015) study in depth Brazil's Cluster Development Program (CDP), revealing how clusters enhance SMEs' productivity by providing access to financial resources, facilitating export connections, and supporting sustained productivity improvements over time. These productivity gains are attributed to the supportive environment created within clusters. Gwebu et al. (2019) explain how clustering within science parks in the US boosts productivity of SMEs by offering access to skilled labour, innovation resources, and collaboration opportunities. Science parks facilitate productivity growth by creating knowledge spillovers and collaborative synergies that benefit all firms in the cluster.

Research methodology

The research is based on secondary sources such as reports by international multilateral agencies including World Bank, Asian Development Bank and United Nations, research papers, industry publications besides newspaper and magazine articles which explore the RIS approach. It builds up a cogent argument for fostering innovation in SME clusters, drawing on a wide array of sources ranging from government websites, newspaper reports of leading national dailies, research papers focused on SME innovation and project reports by multilateral institutions, bringing out the current dynamics and global trends in SME innovation. Secondary research focuses on the critical importance of "triple helix interactions," or linkages among academia, industry and government institutions in fostering regional innovation and competitiveness, with particular reference to SMEs. Such interactions are indispensable for small businesses which do not have the in-house capabilities needed for executing expensive and risky R&D projects and thus rely on cluster generated knowledge spill overs for boosting innovation and economic performance. Examples of highly productive SME clusters from the developed world include Italy's 'distretti industriali' or 'industrial districts' which are hotbeds of innovation powered by robust interaction among firms, vocational training institutions, universities, financial institutions and R&D centers. These clusters are supported by close proximity to raw material suppliers, equipment suppliers, component producers, sub-contractors and final goods producers, all of which enhance productivity and move the entire cluster forward. Italian SMEs are trailblazers in flexible and lean manufacturing, employ cutting edge technology, invest in R&D and produce for world markets. They are a model for developing countries such as India. Similarly, a study on potential advantages to SMEs located in science parks in the US clearly reveals benefits from social signaling, image effects, innovative and entrepreneurial culture, easier access to a wider customer market and skilled labour besides value added services including flexible leasing arrangements, training, business advice and brokerage to finance. Firms benefit from diffusion of uncodified knowledge resulting from information exchange, knowledge spillovers and cross fertilization of ideas. The munificent environment within which SMEs operate serve as enabling conditions for better sales and sales growth performance. These are model strategies for developing

countries to follow, particularly Indian SMEs. Therefore, robust interactions among the three institutional pillars of the innovation ecosystem are critical for creating a national milieu of innovation.

Drawing upon the conceptual underpinnings of the RIS approach in contemporary economic literature, the paper cites examples of innovative policies from other dynamic economies such as US, China and Brazil, particularly those holding relevance to India. Thus, it relies both on conceptual synthesis and comparative policy analysis to suggest policy prescriptions which are relevant not only for India but the developing world in general. Being qualitative in nature, the paper essentially makes a case for harnessing the innovative potential of Indian SMEs by encouraging industry academia collaboration.

Findings

The study underlines the high correlation between level of industry academia engagement and innovativeness of an economy. Therefore, developing countries like India should formulate policies aimed at fostering robust interaction among universities, research labs and SMEs, especially as India ranks a poor sixty sixth in university academia Interaction. The Anusandhan National Research Foundation (ANRF), an apex body tasked with fostering research, innovation and entrepreneurship, should be deployed for creating robustly innovative clusters in industries allied with agriculture such as food processing which have a significant presence of SMEs. In order to promote high tech innovation, India can learn from government programs of the US Small Business Agency (SBA), which aims to select SME winners through a competitive process and nurture them into hi tech champions.

Discussions and conclusions

The Government of India announced setting up of the Anusandhan National Research Foundation (ANRF) in the Union Budget for 2021-22, designed to strengthen the overall research ecosystem with a focus on identified national priority thrust areas. The Parliament took the initiative a step further by passing the ANRF Bill 2023 by creating an apex body for providing high level strategic direction for research, innovation and entrepreneurship in the fields of natural sciences including mathematical sciences, engineering and technology, environmental and earth sciences, health and agriculture. In line with the recommendations of New Education Policy (NEP), the strategy is expected to be aligned with the vision of creating a “Developed India” by 2047. The ANRF is expected to foster a culture of research and innovation throughout India’s universities, colleges, research institutions and R&D laboratories with an outlay of approximately \$6 billion over five years from 2023-28. The initiative aims to transform India’s research infrastructure by aligning academic research with industry needs, driving practical, solution-oriented innovation.

ANRF needs to be utilized for fostering innovation in SMEs, key catalysts for driving productivity and growth in developing economies and therefore central to creating a national milieu of innovation. The ANRF could take the lead of the US National Science Foundation (NSF), an independent federal agency tasked with supporting and promoting progress in science and engineering. The NSF invests in basic research across all fields of fundamental science and engineering other than medical sciences, in high technology equipment such supercomputers and telescopes as well as in extensive education and training programs across several disciplines. One of its major focus areas is forging partnerships among colleges and universities, industry, non-profits, government and other organizations. The agency also runs the Small Business Innovation Program, a novel initiative for assessing the innovativeness of potential business ideas by involving small businesses in research and development.

India’s Sweet Spot: Food Processing Industry

Industries related to agriculture and allied activities have potential to generate employment across a wide spectrum of skills and augment rural incomes. India’s sweet spot is a thriving food processing

industry, which categorized as a sunrise sector owing to its significant potential in terms of production, exports and consumption, and is projected to reach \$535 billion in annual economic activity by 2025-26 (Economic Times, 2025). The sector attracted Foreign Direct Investment (FDI) of approximately \$6 billion and increased its share of agricultural exports from 13% to 23% during the last decade (Economic Times, 2023). India is among world leaders in production of milk, coffee, wheat, rice, sugar, fruits and vegetables, but only one tenth of the produce is processed, adding negligible value in terms of productivity and income. A robust partnership among food companies, capital goods manufacturers, research and academic institutions and start-ups for developing processing and packaging technology can be a game changer for Indian economy. SMEs dominate agricultural supply chains which comprise farmers, small processors and millions of small retailers. As per survey conducted by the Ministry of Food Processing Industries, there were more than forty thousand registered food processing units in India in 2018-19, an overwhelming majority them being SMEs. It is estimated that 72-83% of all food consumed in India is handled by SMEs (Hindu Business Line,2023). Therefore, ANRF should be deployed for fostering collaboration between universities and SME food processing units, funding joint research programs to generate ideas, develop new products and ensure their successful commercialization.

A remarkable success story of such innovation is the Taiwanese flower industry which has developed linkages with universities and research institutions, thus drawing upon scientific infrastructure and qualified human capital to foster innovation. Producers have upgraded from cultivation of natural species to hybrid varieties such as blue orchids, stemming from innovations resulting from investments in biotechnology and linkages forged with universities. They now aim for international markets with a knowledge intensive product and aspire to become leaders in orchid production.

Developing countries can also learn from the Netherlands whose farms are among the most productive in the world and exports of agricultural products touch € 65 billion annually, second only to the United States. The country pioneered several innovative practices including vertical farming and use of robots in harvesting and milking, a success that grew from decades of nurturing links between farms and universities.

Indian SMEs and Hi-Tech Innovation

Indian SMEs have also shown potential for novel high-tech innovations. Examples abound, such as Bangalore based Bellatrix Aerospace Pvt Ltd which patented a “Microwave Plasma Thruster” that uses water as propellant to power a satellite into space. Pune based Intech Harness Pvt Ltd. developed a smart “farmer obedient motor controller” for use in electric pumps for irrigating crops. The device precisely regulates flow of water to fields at preset timings thus obviating need for manual intervention besides accruing huge savings in water and electricity. Delhi based Chakr Innovation Pvt Ltd. developed a novel technology, which retrofitted on diesel generators helps capture 90% of particulate emissions which are converted into ink and paint, thereby cutting down on air pollution and creating a useful by product. (Economic Times: India’s Top Innovative MSMEs).

Putting in place right set of policies can accelerate creation of globally recognized innovative SME leaders that can become active partners in India’s space economy and other hi tech sectors. Innovative programs should be launched to select winners through a competitive process and nurture them into champions in their respective fields, similar to ones run by the US Small Business Administration (SBA), a federal agency which helps small businesses to start, build and grow by providing counseling, capital and contracting assistance. The agency administers, specifically designed to help SMEs the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs plan, start and expand their businesses by connecting companies with lenders and funding. These programs help small businesses to innovate, develop ingenious technology and eventually chart a path towards

commercialization by awarding non-dilutive seed funding. They select eligible candidates through a competitive awards-based selection process to help them explore their technological potential and give the right incentives to profit from its commercialization. The STTR program specifically aims to bridge the gap between performance of basic science and commercialization of resulting innovations.

The programs fund eligible candidates through eleven different federal agencies which among others include the Department of Agriculture (USDA), Department of Commerce (DOC), Health and Human Services (HHS), Department of Education (DOE), National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA). These federal agencies fund enterprises in two stages, namely Phase 1 which covers concept development with a duration between 6 months and 1 year and Phase 2, which covers prototype development and has a duration of 24 months. Besides these, the agencies also award grants and contracts. These programs function in a highly innovative and dynamic milieu comprising diverse players collectively called SBIR Support Organizations which include Small Business Development Centres (SBDCs), Procurement Technical Assistance Centres (PTACs), universities, accelerators, incubators, state economic development offices, Regional Innovation Clusters (RICs), Women's Business Centres (WBCs), and other technology-based economic development groups. The central feature of the STTR program is the mandatory collaboration between small businesses and non-profit research institutions such as universities, both in Phase 1 and Phase 2 stages of the program. These programs fund an average 4000 companies every year investing \$4 billion in seed funding.

Innovative Ecosystems in India

The southern Indian state of Telangana offers a striking example of proactive government policies for promoting innovation, research, and entrepreneurship, making it a model for other state governments. Telangana houses more than 800 life sciences companies with a combined valued of \$ 50 billion and contains highly innovative clusters powered by university academia interaction. The state contains the "Hyderabad Pharma City," the world's largest integrated cluster for pharmaceutical industries and the "Genome Valley Cluster," India's first organized cluster for Life Sciences R&D and Clean Manufacturing activities. These vibrant hubs are supported by world class infrastructure including knowledge parks, Special Economic Knowledge (SEZ), laboratories and incubation facilities. To drive innovation, the state government has conceived the Research and Innovation Circle of Hyderabad (RICH), a platform aimed at linking research institutions, academia, industry, venture capitalists, angel investors and incubators. Hyderabad, the state capital has more than 20 incubation centers focused on health tech and medtech, highest for any city in India. Besides several global pharma giants, the state is home to highly innovative firms such as Bharat Biotech, a biotechnology firm set up by returnee entrepreneurs from the US. The firm developed "Covaxin," India's first indigenous COVID-19 vaccine in collaboration with the Indian Council of Medical Research (ICMR) and the National Institute of Virology (NIV), which is based in Pune in the western state of Maharashtra. (EXIM Bank,2023).

Challenges facing SME Clusters in India

A key constraint inhibiting growth of Indian SMEs is the low level of engagement between firms and innovation supporting organizations. Productivity and innovation are hindered by inadequate presence or complete absence of high-quality vocational training institutes, technical centres of excellence and R&D hubs that can offer knowledge support services which are of central importance to small businesses. This dearth of institutional support hinders their ability to execute complex and high-end technical jobs needed for a competitive advantage, and also negatively impacts their supply of skilled manpower. A prime example of innovativeness are Germany's small businesses or "Mittlestand," which are among the most competitive in the world, mainly owing to robust university industry linkages in German clusters. A case in point is the Baden- Wurttemberg industrial cluster which runs a system of dual vocational training

whereby apprentices spend one third of their three year's study in college and two thirds at the workbench, thus creating a pool of highly skilled job ready graduates.

Another area of concern requiring immediate redressal is inadequate physical infrastructure including poor-quality roads, erratic and expensive power supply, ill developed transportation systems and networks, all of which cumulatively add to cost of transportation and impact competitiveness. For instance, the Baddi Barotiwala Nalagarh (BBN) industrial belt in Solan district in the northern Indian state of Himachal Pradesh contains ninety percent of the state's manufacturing industry and is a leading pharma hub, but does not have access to freight railways. This impacts the supply chain and contributes a significant mark up to logistics costs, rendering SME exports uncompetitive.

Small businesses are also hindered by dearth of financial support for technical modernization, and should be given priority access to subsidized loans specifically for purchase of new machinery or adoption of high-end technology. These funds could either be channeled through existing institutions like Small Industries Development Bank of India (SIDBI) or by setting up specialized agencies like an "MSME Bank" in each state or in major clusters.

Conclusion

Academic institutions of excellence exist in developing countries, but have limited linkages with universities, venture capitalists and other supporting institutions. These interactions should be vibrant to enhance innovation and productivity. Public research institutions in India contribute 56% to the country's R&D expenditure of \$18 billion while companies and universities contribute 37% and 7% respectively. This is miniscule compared with the global scenario where 71% of the cumulative R&D spending of \$ 1.72 trillion emanates from university engagement with companies. R&D expenditure in China is 16 times that of India while it is 36 times greater in the US, primarily due to robust university industry interaction (Times of India,2023). Indian institutions and academics have impressive credentials but limited collaboration with industry. India ranks third in the world in research publications, sixth in patent filings and ninth in quality of research measured in terms of citations. However, it ranks a poor sixty sixth in terms of academia industry partnerships, a critical factor inhibiting the economy from reaching its full innovative potential (Times of India,2024). Indian institutions should aspire to follow the trajectory of American and European universities which have multiple collaborations with industry across a wide array of fields including material science, engineering, chemistry, physics, computer science and medicine. Creating the right set of policies designed to nurture innovation can accelerate the process of creating globally recognized innovative SME leaders. The scope of activities of ANRF should be expanded on the lines of the US NSF to promote new ideas and creative approaches which can accelerate innovation and help transform knowledge into tangible benefits for society.

Limitations and direction for future research

The principal limitation of the study is that while it conducts an exploratory study of policy initiatives to foster innovation in SMEs in the US, it does not dwell on ecosystems in other parts of the world, which could hold valuable lessons for India. From Brazil in South America to China and South Korea in the east, dynamic economies have implemented unique models to make SMEs export powerhouses and leaders in product and process innovation, thus helping them integrate with the global economy. For example, Brazil's Cluster Development Program for SMEs has created significant improvements in key indicators of beneficiary firms, including level of employment, value of total exports and likelihood of exporting.

Future research should focus on the potential of such policies and their relevance and applicability to India and the developing world in general.

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