

Fostering innovation in small and medium enterprise (SME) clusters through triple helix interactions: Exploring the role of academia industry linkages

Chander Shekhar Dogra

Satinder Kumar

Chander Shekhar Dogra, Research Scholar, DAV University, Jalandhar

Keywords

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Abstract

The Triple Helix Model is a framework for analysing linkages among three institutional spheres namely university, industry and government and their integration for creation and fostering a national innovation system. Academic institutions are central to triple helix interactions as shown by innovative clusters in both developed and developing economies. Clusters in dynamic Asian economies like Thailand, South Korea and Japan pivot around knowledge flows created by universities leading to innovations that can be used and commercialized. The contribution of academic institutions to innovation in a region or cluster can be quantified by analysing transactional relations which refers to business contacts such as commissions, contracts and agreements between the university and clients who use the research. The paper presents a strong case for crafting policies which enable forging of robust linkages between SME clusters and academic institutions within an overall triple helix framework, especially in developing economies such as India where SMEs contribute significantly to output, employment and exports. Qualitative in nature, this study is based on secondary research, drawing upon analysis from research papers, industry reports and magazine articles which explore triple helix interactions.

Corresponding author: Chander Shekhar Dogra

Email addresses for the corresponding author: chander11901472@davuniversity.org

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Introduction

Small and Medium Enterprises (SMEs) form the lifeline of the global economy, especially developing economies by contributing significantly to GDP, exports and employment. Dynamic economies such as India should aspire to create robustly innovative SME clusters with strong triple helix interactions for fostering a vibrant ecosystem of innovation and creativity.

The Triple Helix model is a framework for analysing the linkages among three institutional spheres namely university, industry and government and their integration for creating and fostering a national innovation system. This model emphasizes the importance of linkages and interactions among institutions, private and public firms, universities and government agencies for building a vibrant framework for innovation supported by policies to promote economic development (Harris and Wonglimpiyarat, 2019). Research and Development(R&D) investments are often too expensive and risky for small firms to afford and thus knowledge spill overs play an important role in fostering firms' innovation and economic performance. High tech SMEs tend to locate in areas with dense R&D activities such as universities and private R&D hubs. The US model of entrepreneurial innovation ecosystems notably US Silicon Valley and Route 128 are widely cited and emulated by policymakers all over the world as outstanding examples of triple helix interactions. Located in the heart of Silicon Valley, Stanford University reported an astonishing average industry research income of \$107,000 per academic staff member, as per the Times Higher Education 2021 World University Rankings. The US model of Cambridge Massachusetts is among the most successful hi tech start up regions. Kendall Square in

Cambridge offers an example of a US innovation district. The start-up eco innovation system is mainly fuelled by strong triple helix interactions as Kendall Square is surrounded by many technologically advanced research universities/organizations such as MIT and Boston University. It is popularly referred to as “the most innovative square mile on the planet.”

In Europe, Britain’s life sciences industrial clusters brimming with researchers, entrepreneurs and venture capitals based in the “golden triangle” containing Oxford, Cambridge and London are sparkling examples of vibrant innovation spurred by industry university interaction. The region is home to some of the best universities in the world for healthcare such as Oxford, Cambridge, Imperial College London and University College London besides housing some of the biggest pharma companies such as Astra Zeneca and Glaxo SmithKline. Perhaps the most famous research institution in the region is the Jenner Institute which developed the Oxford-AstraZeneca vaccine as a cure for COVID 19. The biggest cluster is in Cambridge and at its heart is the Cambridge Biomedical Campus, the largest centre of medical research and health sciences in Europe. The British Government’s comprehensive public health system, the National Health Service (NHS) maintains a repository of the cleanest, largest medical data in the world. This unified health system assigns a unique number to an individual over her lifetime, creating a database which is particularly useful in running clinical trials, such as the one for the COVID vaccine. Thus, the NHS is effectively a sample set of 60 million people, which can be used to test and prove medical technology. The success of these clusters in fostering economic dynamism is borne out by the impressive fact that British life sciences firms raised £4.5 billion in 2021, up from a meagre £261 million in 2012. (The Economist: July 20, 2022). As per 2021 World University rankings, Oxford and Cambridge reported average industry research income of \$57000 and \$30000 per faculty member respectively.

Taiwan, an Asian economic powerhouse has forged strong triple helix interactions since the 1980s by developing technology clusters which provide a vibrant trilateral framework for innovation partnerships. A notable example is the remarkably successful Hsinchu Science-based Industrial Park(HSIP), a 1400 hectare complex of hi tech firms, located about 70 kms southwest of the capital city of Taipei. The park has been established and almost entirely funded by the Taiwanese government offering a range of incentives to participating firms, such as low interest government loans, R&D matching funds, tax benefits, commodity and business taxes, special tariff exemptions and government subsidized purchases of foreign technology. HSIP contains the country’s largest firms such as ACER, TSMC and USMC besides prestigious institutions including the National Chiao Tung University and National Tsing Hua University, both being technical powerhouses in areas of electronics and information technology. They bring to the park a wealth of talent for basic research, high quality human resources for cutting edge innovation and diffusion of knowledge on recent scientific breakthroughs. HSIP also houses specialized research institutions like the National Synchrotron Radiation research Centre(NSRRC) and National Centre for High Performance Computing(NCHPC) which conduct cutting edge research. With six high technology industries namely semiconductor, photoelectronics, computer and peripheral, communications, precision equipment and biotechnology, the park has played a critically important role in making Taiwan a global powerhouse in manufacturing and supplying semiconductor chips ((Zengqi, 2016).

India, another Asian economic giant is emerging as a frontrunner in global life sciences on the back of strong triple helix interactions. The southern Indian state of Telangana has emerged as one of Asia’s leading life sciences hubs, housing more than 800 life sciences companies with a combined valued of \$ 50 billion. It accounts for a third of global vaccine output and is regarded as the vaccine capital of the world, while also contributing to 35% of India’s pharmaceutical production. It contains the “Hyderabad Pharma City” the world’s largest integrated cluster for pharmaceutical industries established by the Telangana Life Sciences Division of the state government of Telangana, about 25 kilometres from the state capital. With a thrust on R&D and manufacturing, the cluster has been recognized as National Investment and Manufacturing Zone (NIMZ) by Government of India. Hyderabad is also home to more than 20 incubation centers focused on health- tech and med-tech, highest for any city in India. The Government has also conceived Research and Innovation Circle of Hyderabad (RICH) , a platform which aims to link research institutions, academia and industry along with venture capitalists, angel investors and incubators. Overall, the state has created a conducive ecosystem for the growth of the life sciences

industry, with a strong focus on innovation, research, and entrepreneurship. The state also contains the "Genome Valley Cluster," India's first organized cluster for Life Sciences R&D and Clean Manufacturing activities, with world-class infrastructure facilities such as Industrial/ Knowledge Parks, Special Economic Zones (SEZs), state of the art laboratories and incubation facilities. Besides several global pharma giants, the cluster houses highly innovative firms such as Bharat Biotech, a biotechnology firm set up by returnee entrepreneurs from the US (EXIM Bank:2023). The firm collaborated with the National Institute of Virology (NIV), a premier public research institute in Pune in the western Indian state of Maharashtra, to develop "Covaxin," India's indigenous COVID 19 vaccine. Pune also houses the Serum Institute of India (SII), a leading vaccine manufacturer which mass produced the Oxford-AstraZeneca vaccine "Covishield," a stellar addition to its vastly diverse portfolio of products. It is estimated that about 65% children globally receive at least one vaccine manufactured by SII. These organizations demonstrate the innovative prowess of the Indian economy which can be invigorated with stronger triple helix interactions.

Review of Literature

Cooke (1996) conducted an in depth analysis of the Regional Innovation Systems (RIS) approach pioneered in industrial clusters in US and Europe which yielded notable successes in promoting innovation and enhancing productivity. The approach involves creation of an innovation infrastructure and dense networks of innovation which share critical knowledge and expertise, transfer skills and impart training, helping build up the knowledge base of SMEs and enhancing productivity. **Simmie and Sennett (1999)** discussed major factors determining clustering of innovative firms and classified them into agglomeration advantages, internal economies of scale, localisation economies and urbanisation economies. Analysing the reasons for concentration of innovative firms in the London metropolitan region, the study identified the availability of quality infrastructure, access to financial capital, availability of professional labour and access to specialized and general business information as critically important factors impacting innovation among SMEs. **Kharbanda (2001)** discussed the importance of industrial clusters in fostering innovation and technological upgradation among SMEs. Clusters facilitate diffusion of tacit and accumulated knowledge by promoting learning by interaction through formation of strategic alliances, partnership and linkages among firms and institutions. They form a kind of knowledge network working like a honey beehive with constant sharing of knowledge and benefits. **Fingleton et al. (2004)** used an econometric model for measuring impact of horizontal clustering on employment generation in select hi tech clusters in Britain. Based on the concept of innovative milieux given by the GREMI group, it ascribes innovation, competitiveness and economic performance in a cluster to interaction and learning carried out in close networks comprising various agents such as firms, institutions such as universities, centres of research, associations and government agencies which exchange information and knowledge flows. **Schrammel (2013)** discussed cluster services directed at filling "institutional voids" which are insufficiencies in the institutional environment occurring due to absence of specialized intermediaries, which are actors placed between other actors to facilitate a transaction. An important cluster service directed at filling institutional voids is the linking of firms to universities and R&D institutions which is critically important for SMEs which lack resources and capability to create in-house R&D departments. **Zengi (2016)** discussed two major kinds of triple helix models, one in developing countries with the government playing a dominant role and the other in mature economies led by industry initiatives. The paper cited the case of Singapore which has instituted mechanisms for facilitating robust triple helix interactions for SMEs. Two key government agencies, the Economic Development Board (EDB) and the Standards, Productivity and Innovation Board (SPRING) are responsible for spurring entrepreneurship by creating strong linkages among the participants of the innovation ecosystem.

Research Methodology

The research is qualitative in nature and draws upon analysis from research papers, industry reports and magazine articles which explore triple helix interactions as means of fostering innovation. It cites examples of innovative ecosystems from US, Europe and Asia and highlights specific policies followed by dynamic East Asian economies to encourage collaboration among universities, SMEs and government

agencies. The paper suggests an approach for quantifying the contribution of universities to regional innovation ecosystems by citing example of commissioned research undertaken by the University of Salento in southern Italy for its clients including SMEs . It discusses the role of incubators, government programs, and private-sector partnerships in strengthening SME clusters with examples drawn from India.

Key Findings

The paper analyses policy initiatives in dynamic East Asian economies for creating innovative ecosystems with particular focus on SMEs. Science parks and innovation corridors which provide an enabling environment to SMEs to share skills and knowledge with large corporations, connect with universities and research institutions and avail critically needed support from government agencies, help create flourishing SME clusters engaged in cutting edge innovation and research. Economies which initiate targeted interventions for building up the R&D capability of small businesses through financial and non financial incentives are likely to witness exponential growth in SME R&D expenditure and number of SMEs engaged in R&D. A high level of engagement between industry and academic institutions involved in “guided research” aligned with current industry needs is an essential feature of such highly innovative and creative ecosystems. In developing countries where these linkages may be weak, the role of incubators in nurturing small businesses becomes especially critical.

Discussions and Conclusions

Dynamic economies create national innovation frameworks by facilitating and promoting cooperative networks among various stakeholders such as public and private firms, universities and research institutions. This facilitates pooling of resources and information thus helping to mitigate the risk and unpredictability associated with innovation. The following are measures initiated by dynamic Asian economies for fostering growth and innovation in SME clusters, which could offer valuable insights for other developing countries.

1. Thailand

Thailand is attempting to emulate the US model of fostering vibrant triple helix interactions as per the policy of “Thailand 4.0,” an agenda for promoting SME innovation in three key sectors namely, biological and cultural diversity, high value services and advanced technology industries. The primary objective of Thailand 4.0 is to transform the Thai economy from one reliant on manufacturing to a modern dynamic powerhouse driven by innovation, research and development. The government established the Eastern Economic Corridor of Innovation (EEC), a cluster of start-ups working with financiers, venture capitalists, business angel investors, research universities, firms and corporations to promote entrepreneurial ventures. The primary aim of this hi-tech vibrant start up ecosystem is to translate R&D results into practical industrial applications. The total investment in Thai startups during 2011-18 is estimated at US\$337 million with bulk of it concentrated in food, biotechnology and restaurants (Harris and Wonglimpiyarat, 2019). The technology clusters of Thailand Science Park in northern Bangkok and digital park in Chon Buri were established to emulate success of Silicon Valley and Route 128. Thailand Science Park is situated in the Northern Bangkok Industrial Cluster and surrounded by several universities and industries such as Asian Institute of Technology, Thammasat University, Rangsit University, Bangkok University and the industrial estates of Nava Nakorn.

2. Singapore

Singapore, a dynamic Asian economic powerhouse has put in place institutional mechanisms for robust triple helix interactions. Two key government agencies, the Economic Development Board (EDB) and the Standards, Productivity and Innovation Board (SPRING) are responsible for spurring entrepreneurship by creating strong linkages among the participants of the innovation ecosystem. The government has framed specific policies for promoting investment by local entrepreneurs in high tech sectors with risks and costs of industrial upgrading offset by the government. Both EDB and SPRING have created strong ties with the biotech industry and local public universities. They provide funding for productivity training of local start ups and help forge linkages between them and multinational

corporations (MNCs) thus kickstarting innovation through diffusion of knowledge and knowhow. An innovation city known as “One- North” was created in late 2000s housing public research institutions, higher education centres, local start-ups, intellectual property law firms, hotels and convention halls, SMEs and offices of leading MNCs. The city has two specialized science hubs-(1) Biopolis, which houses biomedical related institutes and (2) Fusionopolis which is an ICT hub focused on engineering. To enhance coordination in policy making, both EDB and SPRING have been relocated in One-North along with another government institution, The Agency for Science, Technology and Research (A*STAR) which has an innovative program for developing scientific talent. It funds PhDs in science and engineering at top US and UK universities for highly talented students who then return to A*STAR for serving a scholarship bond, thus ensuring a steady stream of talented manpower to innovation clusters (Zengqi, 2016).

3. Japan

In Japan, major thrust of cluster development policies is on provision of credit and grants to cluster associations for R&D by the Ministry of Education and Ministry of Economy, Trade and Industry (METI). The grants are subject to rigorous oversight and controls requiring achievement of milestones and meticulous documentation for continued access to funds. Grants given by METI typically cover one third to a half of the cost of a project, the remainder coming from financial institutions and banks whose participation in cluster activities enhances their understanding of industry dynamics and helps to foster a symbiotic knowledge sharing relationship with SMEs. In order to commercialize research output and knowledge, the government has recognized 24 Technology Licensing Offices (TLOs) in universities and clusters. These TLOs facilitate the creation of revenue sharing contracts among universities, researchers, and private companies and may also lead a consortium when competing for grants from METI or other funders. The royalty sharing arrangement for intellectual property is that 3% of revenues from product sales are shared between the researcher, the university and the TLO in the proportion of 40%, 30% and 30% respectively. The TLO in the TAMA cluster in Tokyo is run by the cluster association and known for spearheading “guided research” focused on projects aligned with current industry needs. Additionally, the government established The Tokyo Metropolitan Research Institute (TIRI) for providing technological support and access to high capital cost equipment to SMEs. With five facilities in the Tokyo area, it has set up facilities for prototyping and testing besides setting up services for knowledge management and sharing between universities and SMEs (Planning Commission, 2012).

4. South Korea

The South Korean government makes concerted efforts for promoting science, technology and innovation in SMEs for building up their knowledge intensity and scientific capability critical for driving economic growth. The government has deployed incentives such as R&D loans issued by state-controlled banks and carrying low rates of interest, direct R&D subsidies and tax credits along with tax based indirect subsidies. The Ministry for SMEs and Startups promotes R&D cooperation among universities, research centres and SMEs possessing limited internal R&D capabilities. In continuation of these efforts, the government introduced a series of R&D subsidy programs during 1987-1996 and founded the Korea Technology Credit Guarantee Fund (KOTEC), an innovation financing agency tasked with providing collateral free support to businesses associated with emerging technologies. The momentum created by these efforts continued to yield impressive results as SME R&D expenditure increased fourfold from 595 billion Korean won in 1999 to 2.2 trillion Korean won in 2002 while number of SMEs involved in R&D jumped threefold from 6472 to 18101 during the same period. SME R&D expenditure in the manufacturing sector rose from 2.4 trillion Korean won in 2003 to 5.1 trillion Korean won in 2007 (Cin et al., 2017). The Government has also launched a technology innovation programme for SMEs, which part funds their technology development expenses. These units also get a 30% contribution from Government as technology fees upon successful product development (EXIM Bank: 2012).

Quantifying role of Educational Institutions in Promoting Innovation

Innovation does not imply scientific discovery or engineering invention but the Schumpeterian creation of a new combination of production resources and new ideas to increase profits. In other words, it is commercialization of existing ideas (Sonube & Otsuka, 2015). Universities are uniquely positioned as catalysts of innovation with their rich pool of researchers, faculty and students from diverse backgrounds. They are wellsprings of knowledge, spurring new and creative ideas. Increased collaboration between firms, particularly small firms, and universities is important for diffusion of knowledge. Clusters and innovation districts, which promote and foster linkages between firms and universities by providing firms with access to research labs and human talent, have immense potential to boost average productivity. Therefore universities and training institutes in the vicinity of industry clusters in developing countries should emphasize a dual focused theoretical and practical curriculum facilitated through vibrant collaboration programs with major industry firms and other companies in the area.

The contribution of universities to regional innovation ecosystems has been traditionally assessed by number of patent filings. However, a more pertinent approach would be analysis of data pertaining to “commissioned research” which includes business contacts such as commissions, contracts and agreements signed between the university departments and clients for consulting services and research. Such data on specific client projects reveals where the research is used, who uses the knowledge and where the users are located. A study on the University of Salento, a public university in Southern Italy’s Salento area, a sub region of Apulia, reveals interesting insights. The Salento region has a thriving economy with more than eleven thousand enterprises forming a diverse mosaic of Micro, Small and Medium Enterprises (MSMEs), consolidated local enterprises and multinational corporations. Small businesses hailing from sectors as diverse as textiles, clothing and footwear manufacturing, mechanical engineering and building, agro industries and tourism create a vibrant ecosystem. The region also houses several scientific research centres with direct or indirect links to the University of Salento. Data regarding commissioned or “paid” research conducted by the university between 2008 to 2012 reveals that it signed more than fifteen hundred contracts with a range of clients, generating an overall income of 10.5 million euros. Of these, 77.3% were signed with individuals or private enterprises with average income per contract being 6300 euros. The remaining contracts were signed with public bodies and average income per contract was approximately 7800 euros. However, the portfolio was diverse ranging from small contracts amounting 250 euros for small firms to large contracts for provincial governments running into hundreds of thousands of euros. The innovations of this university are thus critical to the entire socio-economic system (Calignano and Quarta, 2014).

Role of Technology Incubators

A major factor inhibiting effective commercialization of technology in developing countries is weak triple helix interaction among the institutional players. It is in this context that technology incubators and accelerators become critically important for technology transfer and commercialization. While technology incubators are mechanisms for helping companies take off through various stages of growth by incubating them, accelerators are meant to speed up the process. Technology incubators and accelerators provide business assistance to nascent firms to increase their survival rates. Both programs lead to wealth creation by commercializing new technologies and creating jobs. Governments use technology incubators for linking technology, entrepreneurs, small and large firms and sources of capital for technology development and commercialization. They are tools vital for SMEs to enhance absorptive capacity, which is the dynamic capability of firms to take advantage of knowledge and information in their environment, eventually to process it and commercialize it (Chaminade and Vang, 2006). They represent the ecosystem which contains infrastructure specifically geared towards supporting and nurturing SMEs, which lack requisite human capital and organizational ability to engage in innovation combined with low absorptive capacity for acquiring technology and knowledge generated elsewhere. Incubators in leading universities around the world such as MIT, Harvard and Stanford have been incredibly successful in producing famous entrepreneurs and their success is being emulated by developing countries.

It is in this regard that the Government of state Telangana in southern India has promoted a startup ecosystem enabler known as “T Hub” based in Hyderabad, the capital city. It is India’s largest incubation centre facilitating collaborations between startups, venture capital firms, corporates, governments and academia for fostering entrepreneurship and innovation. T-Hub has designed and delivered more than hundred innovation programs in the last seven years, enabling two thousand startups to scale nationally and globally by connecting them with various influential ecosystem stakeholders. It has also enabled academia to introduce innovation and an entrepreneurial approach in curriculum and empowered corporations to build a culture of innovation. A model for other Indian states and other developing countries to follow, it creates synergies among startups, corporations, governments, academia and investors to drive transformative change.

Another notable initiative for encouraging innovation and entrepreneurship in India is the Atal Innovation Mission (AIM), a Government of India(GOI) program for creating an ecosystem to devise innovative solutions for a range of everyday economic issues. Under the program, a network of one hundred incubators known as Atal Incubation Centres (AIC) has been created to take business incubation into diverse sectors such as defence, healthcare, agriculture, energy, textiles, agricultural commodities and so on. An ingenious initiative is the setting up of Atal Tinkering Labs (ATLs) in high schools, workshops designed to create “tinkerpreneurs” to foster innovative problem solving. There are now 10,000 such workshops in 722 districts. Launched in 2015, AIM has produced a fifth of India’s start-ups and it is estimated that every rupee spent has accrued benefits of ₹17 to the economy, testifying to its high economic impact (Times of India: January 15, 2025).

Conclusion

SMEs are critical drivers of economic growth and productivity in developing countries. Hence, creation of innovative SME ecosystems is central to fostering a national milieu of innovation. While academic institutions of excellence exist in most developing countries, their linkages with universities, venture capitalists and other supporting institutions need to become more robust and vibrant to create a culture of innovation and productivity.

India is also home to a vibrant food processing sector and 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 (Economic Times: May 26, 2020). A robust partnership between farmers, food processing companies, and academic institutions leading to robust triple helix interactions can be a game changer for Indian economy leading to significant gains in productivity and employment.

Limitations and direction for future research

While this paper limits itself to analysis of government policies aimed at fostering linkages between academia and SMEs in East Asian economies, wider studies on innovative ecosystems from other regions across the world would offer additional insights and lessons for developing countries besides helping create a more balanced and holistic perspective on SMEs. The paper offers an approach for assessing contribution of universities to regional innovation by citing example of commissioned research or paid projects carried out by a public university in Italy for a range of clients including SMEs. Collection and analysis of macro level data pertaining to such projects for small businesses across developing countries would help portray current industry requirements and the role of universities in fulfilling them. This would help to identify priority areas and address gaps to give a thrust to the innovation ecosystem and to frame a “national innovation policy,” with academic institutions at the centre of it. Indian SMEs which are at the forefront of cutting-edge innovation and research would immensely benefit from such measures. India should focus on coordinated policy initiatives for enhancing innovative potential of SMEs which have demonstrated immense promise and acumen in industries ranging from food processing to space exploration.

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