

Global Innovation Networks, Regions and Knowledge communities: A Case of Hyderabad Biocluster in India

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Abstract:

The Indian Biopharmaceutical landscape interests scholars from innovation studies, economic geography and policy learning to understand various regional dimensions that fuel knowledge production in relation to emerging technologies. Globalization has a strong influence on such high technology clusters, wherein ‘local’ also play a significant role. With this prelude, the study attempts to understand the nature and typology of Global Innovation Networks (GINs) of firms and non-firm entities, located in India’s Biosciences R&D cluster, Hyderabad. These entities are categories in different knowledge sources and have been further analyses on the basis of their degrees of globalness, innovativeness and networkedness. The paper contends that firms have an export-oriented objective and are competing with their global competitors; innovation seems to be mostly incremental in nature; the sector is battling due to absence of linkages with funding agencies and basic research institutions. However, the locus of innovation in this cluster lies amidst knowledge communities within academic institutions and public research labs, which are significantly, involved in basic as well as translational research activities, thereby making the cluster a potent site for innovation. Also, this paper opens up the scope for future research, by aligning socio-economic aspects of networks and linkages, in terms of the health outcomes or social relevance derived out of the networks and linkages across the globe.

Keywords: Global Innovation Networks, Clusters, India, Biopharmaceutical, R&D, Regional Development

1. Introduction

The biopharmaceutical sector in India has undergone different phases since 1980s, with the amalgamation of biotechnology and pharmaceuticals research. The industry is the front-runner amongst other biotechnological fields, currently growing at a CAGR of 13.61% and is valued at INR 149.23 billion for the year 2014-15 (Biospectrum 2015). This

unprecedented growth is an outcome of many factors, which have made biopharmaceutical sector a boon for Indian economy (Chaturvedi 2007). As per the database of Biotechnology Industry Research Assistance Council (BIRAC) Nearly 760 units are operating in the arena of biotechnology, of which 63% units are engaged in healthcare biotechnology. It has been observed that Indian firms have aggressively increase in the number of linkages, formal or informal, with pharmaceutical MNCs to capitalize on their manufacturing competencies and exploit marketing resources of MNCs for diving in the global economic activities (Chaudhari 2011). This sector has been significantly influenced by the activities undertaken in public research labs and academic institutions, involved in basic and translational research activities.

However, the determinants of ‘attractiveness’¹ is not uniform across the country; certain ‘knowledge hubs’ or clusters have emerged due to the institutional arrangements, which may aid to innovation in biopharmaceuticals. State and Central Governments, through policies, have stressed on the importance of clusters (e.g. ‘Biotechnology Policy, 2001’; Biotechnology policy 2013),² leading to the construction of many state-initiated clusters, in order to erect a robust regional system of innovation for biopharmaceutics (Vaidhyanathan 2008). Notably, there has been a significant increase in the number of bioclusters in different regions. Some of the emerging as well as established biotech clusters are located in the Western (Maharashtra, Gujarat and Goa), Northern (Delhi, Haryana, Uttar Pradesh) and Southern (Andhra Pradesh, Karnataka and Tamil Nadu) regions of India (Biospectrum 2009). These clusters are seen as lucrative sites for business operations and collaborations with entities like companies, universities and R&D institutes, located at one geographic location. Also, the state governments are

¹ ‘Attractiveness’ is used to highlight the ‘pull factors’ of the host country, which attract foreign companies to set-up their facilities or functional centres for innovation and production (Hakonsson 2012)

² The Department of Biotechnology has designed schemes/programs to facilitate cluster development in this field: “*The Biotechnology Parks and Biotech Incubation Centersprovide a good template for the promotion of Biotech startup companies and the promotion of Public Private Partnerships. Biotech Park and Incubation Centers have been established at Lucknow, Uttar Pradesh and Shapoorji Pallonji Biotech Park, Genome Valley, Hyderabad (Andhra Pradesh). The other projects approved for Himachal Pradesh, Karnataka and Kerala for setting up of biotech incubation/pilot plant facilities are at various stages of development*”.

supporting the industry players for setting up their units at the parks by offering incubation facilities, tax holidays and incentive package; venture funding initiatives etc. The dynamics within and outside these clusters, and the role of knowledge sources (what we term as ‘knowledge communities’) are very interdependent and complimentary. This complimentary is influenced by global alliances, linkages and networks, which in turn have a bearing on the growth and sustainability of these clusters. It can be observed that the biosciences clusters have become the most appropriate site of global-local interactions in terms of the proximities amongst sources of knowledge (like academic institutions, research organisations, R&D units), as well as due to the advent of Information and Communication Technologies (ICT) and virtual communication platforms.

With an overview of the biopharmaceutical landscape and its regional character, the study attempts to analyse the extent of global-local exchange of knowledge, experienced by India’s first organised Biosciences cluster, situated in Hyderabad, Andhra Pradesh. In addition, the objective is to understand the nature and typology of Global Innovation Networks that is/are exhibited by firms present in the Hyderabad cluster, which can be further simplified under the following research questions:

- Why global innovation networks exist in Hyderabad cluster?
- What are the types of Global innovation Networks existing within the cluster?
- How are these networks relevant for the cluster?
- How is the cluster orienting/reorienting itself to be a part of the global innovation networks?
- Who is/are driving innovation networks within and outside the cluster?

The taxonomy of GIN (Chaminade and Barnard 2012) is in terms of Globalness, Innovativeness and Networkedness; the intensity and direction of these concepts are determined by the internal (viz. organisational structure, type of operations, human resource, etc.) as well as external (such as geographical settings, infrastructure, collaborations and alliances) characteristics of firms. This paper concludes that these indicators need to be reflected in context to the geography under study, as Indian biopharmaceuticals have a very unique character, which witnesses the prominence of knowledge communities and deep science endeavours.

2. Changing geography of innovation

Geography of innovation as a concept has been widely discussed and debated by various scholars from economic geography, international business and innovation studies. On one hand regions, agglomerations, clusters have been carefully examined by scholars such as Marshall (1920); Weber and Friedrich (1929), Porter (1998) and others have used concepts like clusters and industrial districts to analyse examined local level innovation. Many scholars have advocated that clusters provide respectable environment for nurturing and sustaining competition and technological advancement. Marshall (1920) opined that the agglomeration of firms lowered costs for clustered producers. In another words, a cluster has been defined as a group of co-related firms or enterprises involved in a similar business endeavour, mainly driven by innovation, the catalyst for competitiveness and economic growth (Krugman 1991; Porter 1998; Rosenfeld 1997). Further, concept of Regional Innovation System (RIS) came into existence, visualizing innovation as an outcome of interactive processes, leading to adoption of ‘systemic’ approach to innovation policies and strategies (Lunvall 1992).

Whereas, the proponents of globalisation of innovation (Archibugi and Michie 1995; Coe et al 2008; Desai 2010; Narula 2003), state that clusters or regions are not far away from this global wave and have been experiencing a sense of ‘liquidity’ (Harvey, 1989), Firms need to cross borders for accessing knowledge competencies and sources, which is not present in their proximities (Cooke 2005; Gertler and Levitte 2005; Moodysson 2008; Chaminade and Plechero 2012). More importance is given to external linkages with agencies (firm and/or non firm), for rapid technological advancements (Camagni 1991; Audretsch 2000), concluding that innovation can be generated by a combination of close and distant interactions (Asheim and Gentler 2005; Owen-Smith and Powell 2004); tacit knowledge remains local in a cluster or region (local buzz), while codified knowledge can be transferred through long and distant interactions, i.e., global pipelines (Bathelt et al. 2004).

However, geography of innovation literature has neglected developing countries, considerably. Firms of developing countries are coming up not merely as outsourcing centers but are also engaged in off-shoring their innovation activities (Barnard and

Cantwell 2008). It has been observed that since the mid-1980s, strategic initiatives were undertaken by MNCs to locate R&D in some developing countries. The vast pool of resources, cheap and technically efficient labour as well as other factors of production present in developing countries, compared to the industrialized developed countries, drove these initiatives (OECD 1988; 2006). Considering all the prospects of globally oriented innovation processes, it is significant to undertake a study for validating certain nations of innovation capabilities and orientations for an emerging technology like biopharmaceutical, in the Indian context. Hence, the concept of Global Innovation Networks can be seen as an apt framework for the given research.

2.1. Knowledge communities

The new regionalism literature has developed considerably in theoretical sophistication since its emergence in the mid-1980s. As Henry and Pinch (2000b: 194) describe, ‘while there has been a great deal of discussion about the role of knowledge in gluing together agglomerations of firms there have been few demonstrations of the processes through which this knowledge is spread’. In other words, the study attempted to expand the understanding of the process of knowledge transfer, which is most often tacit in nature. Their contention is that success of the cluster is due to the generation and dissemination of knowledge through the medium of what they term a ‘knowledge community’. One may borrow the definition of a knowledge community in the following way: ‘a group of people (principally designers, managers, and engineers in this case) often in separate organizations but united by a common set of norms, values and understandings, who help to define the knowledge and production trajectories of the economic sector to which they belong’ (Henry and Pinch 2000a: 127). However, the most significant attribute of the knowledge community is that they possess shared discourses, understandings, and ‘ways of doing things’ emerge over time due the dense patterns of social networks that characterize the knowledge community. The work of Oinas (1999, 2000) provides a valuable reminder of the need to keep non-local relations in view when considering processes of innovation and learning. As Oinas (1999: 365) concluded, ‘it seems evident that the creation of new knowledge might best be viewed as a result of a “combination” of close and distant interactions’. These knowledge communities spread across regions

and nations in the form of what one calls ‘Transnationalism/transnational communities’ (Bailey et al. 2002).

As reflected in the increasingly diverse literature that had emerged by the late 1990s, transnational knowledge communities now take many forms and, indeed, the nature of these forms may change over time. Forms of transnational entrepreneurship may also extend to areas of endeavours related to high technology innovation. Nonetheless it has not been argued that such networks cannot be generalized, or say, are a not the component of all innovation systems. Neither it is being stated that the involvement and existence of these communities is bound to reap innovative activities. Nonetheless, in certain contexts and sectors, they may be a crucial source of innovation for the localities they connect (Coe and Bunnell, 2003).

2.2. Global Innovation Networks

The widely discussed literature on innovation systems contended that innovation is becoming a more globalised (Fifarek and Veloso, 2010) and networked concept (Liu et al., 2012) and hence firms are ‘reorganizing’ innovation, ranging from R&D to marketing their products; under the realm of GINs (Ernst 2006; Chaminade 2009). Chaminade (2009) defines GIN as “A globally organized web of complex interactions between firms and non-firm organizations engaged in knowledge production related to and resulting in innovation”. This definition highlights the main characteristics of a GIN: its global dispersion, its focus on innovation (and not production) and the combination of both internal and external networks. The actors found in the GINs challenge existing theoretical frameworks addressing the internal and external organisation of innovation (Herstad et al. 2014; Haakonsson 2012). These networks span across continents and consist of a wider range of actors including headquarters, affiliates, suppliers, customers, competitors, research institutions, universities and others (Narula 2003; Coe et al. 2008; Desai 2009). Various scholars have reflected on GINs as a policy tool advocating international collaborations and knowledge bases (Ashiem et al. 2012) and also strengthening domestic development, through accumulation of specialized knowledge, by and within various MNCs within a geographic location (Herstad et al. 2010).

Interestingly, the regions, or say, clusters are becoming nodes of knowledge in GINs (Chaminade and Vang 2008), resulting in expansion of clusters and industrial districts within specific industries over several countries, as firms and non firm entities are in search for new knowledge. They are targeting locations with expected spillovers, arising due to geographical proximity of institutions and actors (Chaminade 2011). One may look at the variations in global innovation networks, specifically in terms of the typology of networks and the associated strategies (Ernst and Kim 2002); intra firm characteristics (size, products, innovation) (Meyer and Peng 2005; Haakonsson 2012), characteristics of the host economy (the attractiveness of the location) (Kuemmerle 1999) and the home country of MNC (Edquist and Hommen 2008).

On reflecting over the literature of GIN, different parameters can be operationalised. Freeman (1995) documents the rapid rise of innovation networks through the 1980s and concludes that they tend to be localized. Over the past decade, however, these networks have become increasingly globalized, extending beyond the developed market economies to the emerging market economies. Several studies have discussed about informal non-contractual innovation cooperation (Powell and Grodal 2005), weak and strong ties (Granovetter 1973; 1983), strategic alliances (Hagerdoorn 2002) and others. Clusters remain important with globalizing market relationships. The ability to upgrade regional assets using global networks requires the presence of local institutions, which have the capabilities to able to sustain not only innovation but to stimulate the local-global relationship (Bathelt et al., 2004; Coe et al., 2008). On the other hand, the Global Innovation Networks influence the innovation activities differently across countries, regions and clusters. In some cases, MNCs act as interface between local and global systems of innovation, subsequently, linking actors and institutions across borders (Chaminade 2011).

Methodologically, it is substantive to employ the typology of Global Innovation Networks as discussed by Chaminade and Barnard (2012), in this work; through varying degrees of Globalness, Innovativeness and Networkedness of the firms, one can analyse their respective typology(s) of GIN. For the given study, Globalness implies extensive

geographical spread and also a high degree of functional integration³ (Dickens 2004); Innovativeness refers to the proportion of firms introducing innovations that are ‘new to the firm’ versus ‘new to the world’ (Chaminade 2009), and Networkedness involves internalised networks of subsidiaries of the same firm, located in different countries and that are performing different functions (Castellani and Zanfei, 2006); and also the externalised networks, i.e., interactions between firms and other organizations (Lundvall, 1992; Nelson,1993).

The study attempts to analyse sources of knowledge, in terms of the kinds of knowledge communities existing, within the cluster

2.2. Hyderabad: The Case Study

Hyderabad has a history of technological advancement; known to be the Indian Pharmaceuticals capital. The city manufactured one third of India's bulk drugs and 16% of biotechnology products. The establishment of Indian Drugs and Pharmaceuticals Limited (IDPL), a public sector undertaking, in 1961 was followed over the decades by many national and global companies opening manufacturing and research facilities in the city. Dr. Reddy’s Laboratories played a seminal role in building the pharma cluster around Hyderabad by establishing an innovation culture among its employees, encouraging spin offs, imparting high quality training, setting up a translational research centre - Dr. Reddy’s Institute of Life Sciences, supporting research at LVPEI and several other activities that made Hyderabad a vibrant biopharma cluster. With the inception of the biotechnology policy in 2001, that drew inspiration from the National Biotechnology policy, the government of AP declared an area of 1283.06 acres in Ranga Reddy (RR) and Medak districts to host the biotech sector area mainly in Shamirpet Mandal (RR district) and Mulugu Mandal (Medak district).

³ The concept of ‘Functional Integration’ has emerged in the IMF document (2008) which distinguished between internationalization and globalization; it iterated that globalization go beyond mere extension of economic activities and integrates various sets of processes/functions, in diverse geographies, thereby deepening interdependencies between various countries (Dicken 1998)

Table 2.1: Major Public R&D centres in Hyderabad, Andhra Pradesh	
Life Sciences Research Centres	Other Research Institutes
1) Centre for Cellular and Molecular Biology (CCMB)	1) National Geophysical Research Institute (NGRI)
2) Centre of DNA Fingerprinting and Diagnostics (CDFD)	2) Defence Research and Development Organization (DRDO)
3) National Institute of Nutrition (NIN)	3) Defence Metallurgical Research Laboratories (DMRL)
4) Indian Institute of Chemical Technology (IICT)	4) Electronic Corporation of India Limited (ECIL)
5) International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	5) Bharat Electronics Limited (BEL)
6) National Academy of Agricultural Research Management (NAARM)	6) Bharat Heavy Electricals Limited (BHEL)
7) Institute of Life Sciences (ILS)	7) Bharat Dynamics Limited (BDL)
8) Center for Stem Cell Sciences (CSCS)	8) Hindustan Aeronautics Limited (HAL)
9) Directorate of Oilseed Research (DOR)	
10) Directorate of Rice Research (DRR)	
11) Laboratory for the Conservation of Endangered Species (LaCONES)	

Source: Author's compilation

The conceptualisation of formalizing the Hyderabad cluster took place in 1999, to attract R&D companies and boost the existing life sciences companies. It came as a surprise for many as there was handful of companies like Shantha Biotech and Bharat Biotech which one could recall.⁴ The infrastructural development is credited to KoduruIshwari Varaprasad Reddy, the man behind Shantha Biotechnics, which came into existence in 1993 from a small laboratory in Osmania University's Department of Biotechnology. He and other entrepreneurs persuaded the government that the way to strengthen the local biotechnology business is to attract foreign funds, for promoting innovation and global

⁴ Barkha Shah, (2006), "Making of India's genome Valley", Business Standard, [online web] accessed on 21st March, 2013, URL: http://www.business-standard.com/article/Companies/Making-of-India-s-genome-valley-106060201162_1.html

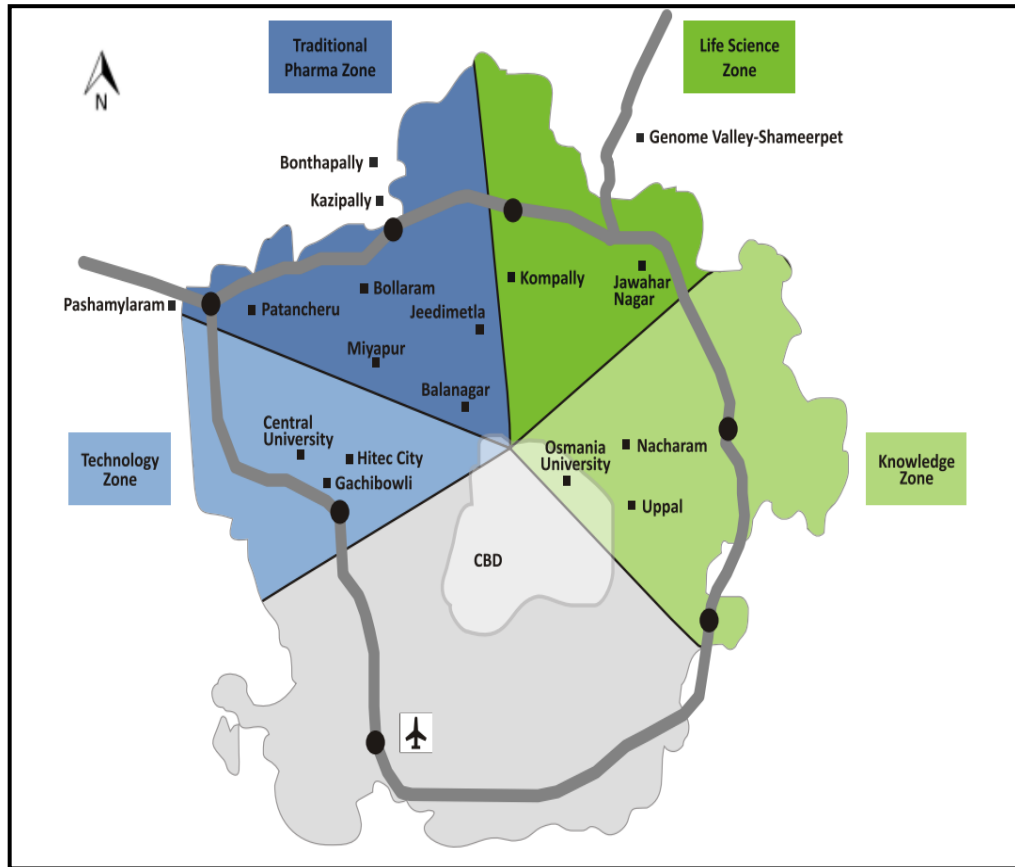
competitiveness. Consequently, with the proactive state policies to develop India's first organised biotech cluster came into existence.⁵ In the Industrial investment promotion policy (2005-2010) of Andhra Pradesh, impetus has been given to aggressive R&D activities, industry-academia linkages, export promotion, incentives for FDI investments, etc. There is also a mention of cluster development as a strategy for industrial growth, under the "Industrial Infrastructure Up-gradation Scheme" of Government of Andhra Pradesh, 6 clusters have been identified.⁶ Hyderabad houses some of the major public research and development centres, enlisted in the table 2.1. A strong agglomeration of basic and knowledge-led research community and their inter-linkages have created a strong foundation of advancing in a technologically intensive sector like Biopharmaceuticals.

With a concentration of various pharmaceutical as well biotech firms, it has evolved as the second largest recombinant DNA therapeutic production facility in the world. It is called "Bulk drug Capital of India", and is accounted for nearly one third of India's total bulk drug production. It's the one of the largest urban agglomerations, well connected through rail, road and air. Hyderabad ranked 3rd amongst top 20 cities in the world to become 'Global Mega Hub' by 2020. The added advantage is driven by government policies, which encourage foreign as well as domestic firms to station in these geographies.

⁵ Information given by officials of Commissionerate of Industries, Andhra Pradesh

⁶ In the policy document on industrial investment promotion, the Government of Andhra Pradesh has identified six Clusters namely pharma cluster in Hyderabad, auto components cluster in Vijayawada, marine food processing cluster in Bheemavaram, power loom cluster in Sircilla, leather cluster in Hyderabad and precision engineering tools and components in Ranga Reddy. Apart from these, 14 more clusters are in the process of development under DCSSI assistance.

Figure 2.1: Zone-wise classification of Hyderabad Cluster



Source: APIIC Newsletter, June 2002

In general, the broader picture of the cluster encompasses the entire Hyderabad. It is divided into four zones,⁷ namely:

- 1) The Life Science Zone: It comprises of regions like Shamirpet, Jawahar Nagar and Kompally. Some of the enterprises located in these regions are GlaxoSmithKline Pharmaceuticals, Dr. Reddy Labs and others.
- 2) Traditional Pharma Zone: It includes areas of Pashamylaram, Patancheru, Bollaram, Jeedimetla, Kazipally, Bonthapally, Miyapur and Balanagar clusters. There are predominantly pharma based companies like Aurbindo Pharma, Lee Pharma, Vindhya Pharma, etc.

⁷ The Genome Valley News letter, January-June, 2002, Issue 1[online web] accessed on 2nd November, 2012, URL: <http://www.genomevalley.co.in/pdf/GV-Newsletter.pdf>

- 3) Knowledge Zone: The Uppal region is covered under this zone, including centres of excellence like CCMB, IICT, NIN etc and Nacharam industrial area, including some prominent pharma companies like Avra Labs, GVK biosciences and Pathnstu Technologies, etc.
- 4) Technology Zone: It comprises of Hitec City, Gachibowli, Jubilee Hills, Banjara Hills and Ameerpet. It houses technology based companies like Novartis, Samaya Biotech and some major educational hubs like Central University and IIIT, Hyderabad.

One of the objectives of cluster is to position local firms, start-ups and SMEs, in the given region. The on-going infrastructure development in this clusters, including development of wet labs, constitution of BRIC (BIRAC Regional Innovation Council); formation of SEZs to support the local entities. As per the APIIC estimates, in total, the direct employment generated is 4300 scientists and 1900 technicians and 700 individuals working on varied areas of the cluster. Each of these aspect, brings the knowledge communities, within and outside the region, in dialogue, at different levels of knowledge exchange.

3. Data Collection and Analysis

A single case study approach (Yin 1994), has been considered, with multiple embedded units of analysis: firstly, it is the firm(s) participating in the cluster; secondly, the non-firm entities within the cluster and thirdly, the cluster, itself. The data collection has been carried out with the help of an array of tools like in-depth interviews, semi-structured discussions, reports and policy documents, followed by the analysis. Due to lack of access to firms, ten out of 54 firms were analyzed through in-depth interviews. However, two public research labs and three academic institutions were also covered to understand their role. The fieldwork was conducted in the month of February-March 2014 and the analysis is based on the collected data.

Sources of Data

In this research, both primary and secondary data have their significance. The primary data is the information collected with the help of an array of tools, namely, structured

questionnaires, online survey, formal meetings and discussions. Whereas, firms' annual reports, public research organization periodic manuals and reports, financial statements from CMIE database and policy documents from different government agencies were some of the sources for secondary data.

The study is predominantly dependent on primary data, collected in the course of in-depth personal interviews of the respondents, who were employees of concerned firms, working at the strategic level; scientists and academicians of respective research organizations and academic institutions as well as officials of government departments; the interviews were based on a semi-structured questionnaire.

3.1. Measure of Global Innovation Networks

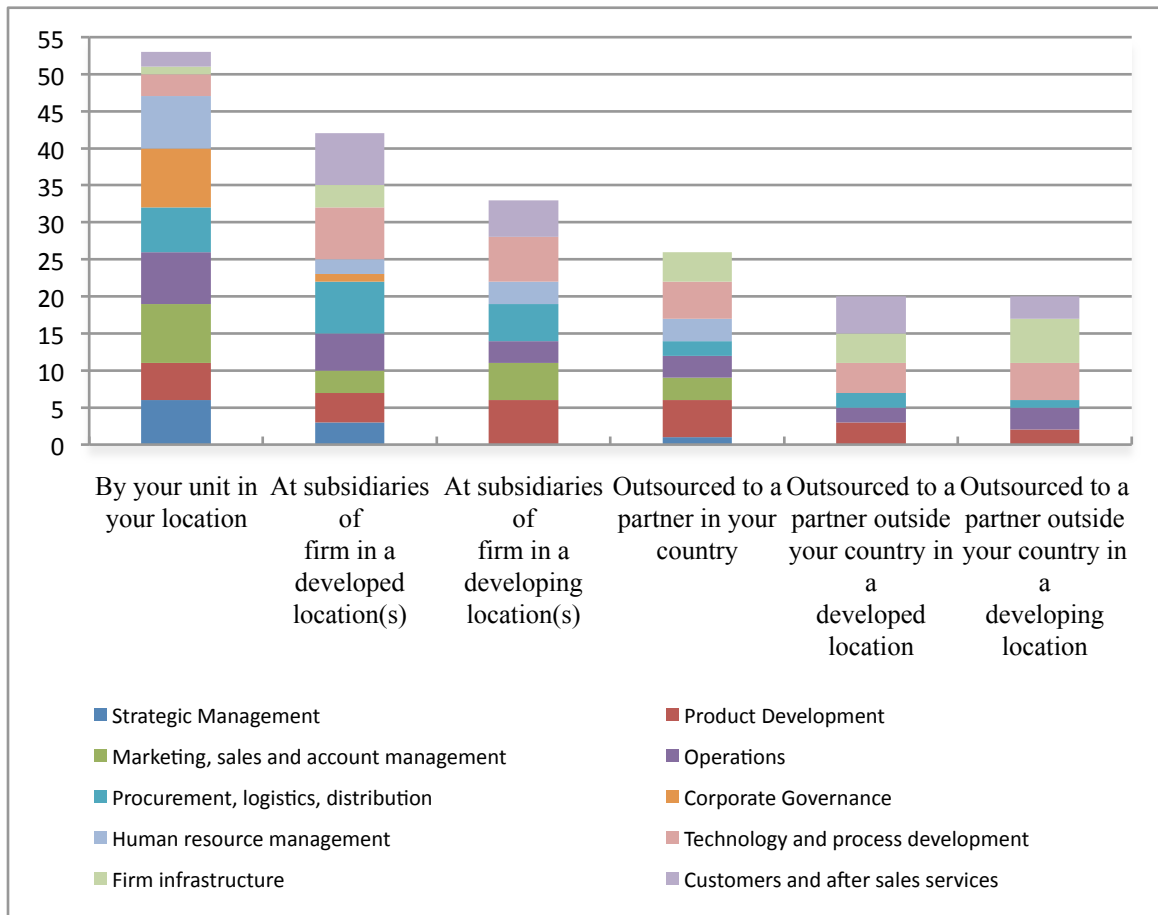
Globalness

One may reflect on this construct from the perspectives of firm and non-firm entities. In case of firms, majority of the respondents represented foreign and Indian MNCs. It signifies the 'stickiness'⁸ of firms in selecting their clientele in the home country. Many of the respondents stated that the focus has been on strengthening the local clientele, which goes beyond establishing a market for our goods, but to build trust and brand image in one location, in order to push operations at other places. Firms are developing interest in Brazil, Venezuela, Japan, Australia, China and some other South-Asian countries, while expanding their markets. These countries have shown high potentialities in terms of the consistent demand for biopharmaceutical goods, steady manufacturing set-ups, corporate friendly policies and trade relations. Another aspect evident that firms are collaborating with the clients, suppliers, competitors, consultancies, academic institutions, research labs, etc., in the home country. For seven out of the ten firms, the home country is India, whereas there are three foreign multi-nationals companies (MNCs) belonging to United States (North America) and Switzerland (Europe). It is interesting to note that majority of the firms collaborate with entities in the home country,

⁸ Stickiness is used in context to the generation of knowledge, which is partly embedded in the regional patterns of interactions and mutual learning (Malmberg 1997); the idea of 'sticky' has also been used in relation to coherence of culture, language, values and institutional thickness (Asheim and Isaksen 2002).

whether it is informal or formal linkages. However, there is an emergence of collaboration with entities beyond proximate locations. One of the unique features of this emerging trend is that firms are collaborating with universities and research labs, in distant geographies, for R&D and basic research.

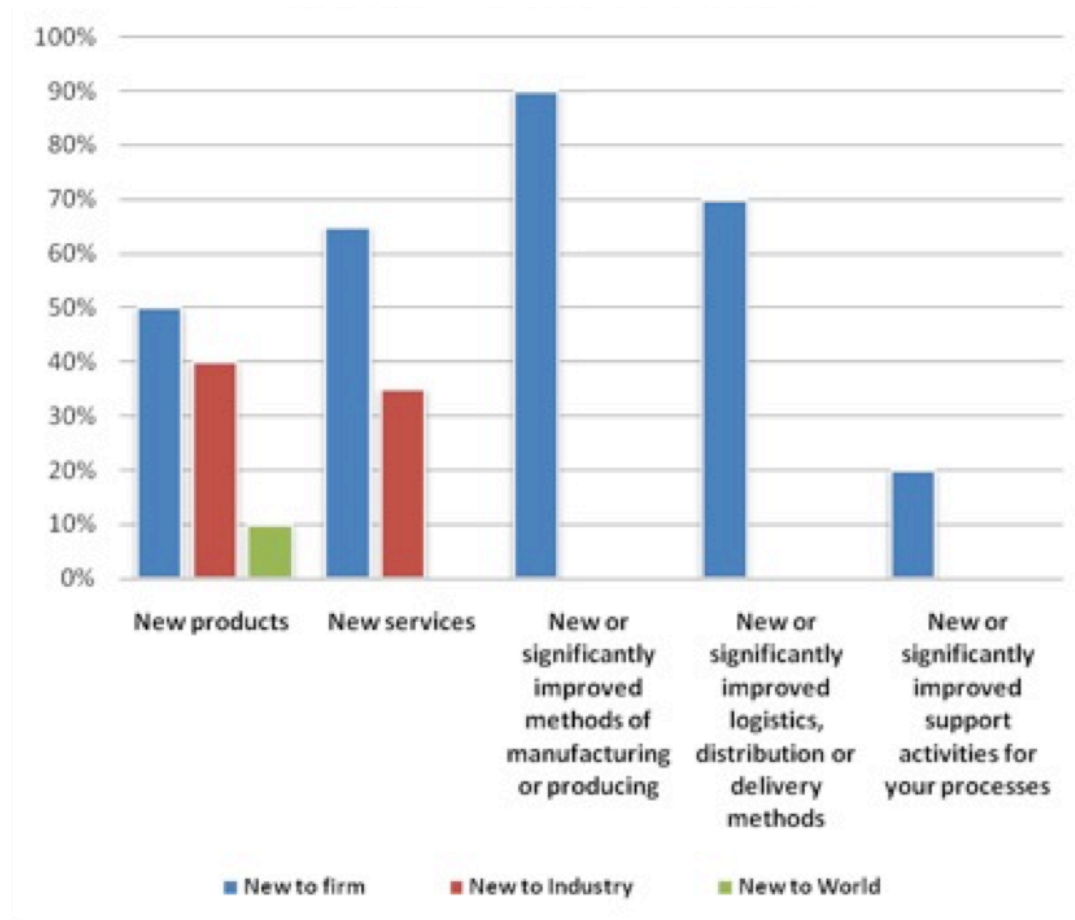
Figure 3.1: Location-wise distribution of functions of firms



Source: Fieldwork

Innovativeness

Figure 3.3: Innovativeness of the firms



Source: Fieldwork

Questions were asked to the respondents pertaining to activities in the five different categories. These categories are measured on three different levels of innovation, ranging from 'new to the firm', 'new to the industry' to 'new to the world'.⁹ In figure 3.3, it has

⁹ As discussed by Henry Edison, Nauman bin Ali and Richard Torkar (2013), *New to the firm* refers to the minimum level of novelty of innovation is that it must be new to firm. It is defined as the adoption of an idea, practice or behaviour whether a system, policy, program, device, process, product, technology or administrative practice that is new to the adopting organisation (Parashar and Sunil Kumar, 2005; Carmona-Lavado et al., 2010).; *New to the industry* describes all the aforementioned innovations which are new to the firm's industry sector (Garcia and Calantone, 2002; Beugelsdijk, 2008); and *New to the world* infers that these innovations imply a greater degree of novelty than new to the market/firm/sector and include innovations first introduced by

been observed that the range of products offered by the sample of firms, are predominantly new to the firm (50%), followed by being new to the industry (40%) and new to the world (10%). In the case of new services, innovative activities restrict to being new to firm and new to industry. For the other novel practices and processes, the firms have acquired 'best practices' from the industry, which are new to the firms.

It has been realized that Innovation is very crucial for firms and non-firm entities in the biopharmaceutical sector. Different measures of innovation, patents, publications and others are required to create cutting-edge technologies for development of novel drugs, vaccines and other products. In doing so, the quest for capabilities, financial resources and markets in different geographies are inevitable.

Networkedness: Prominence of Knowledge communities

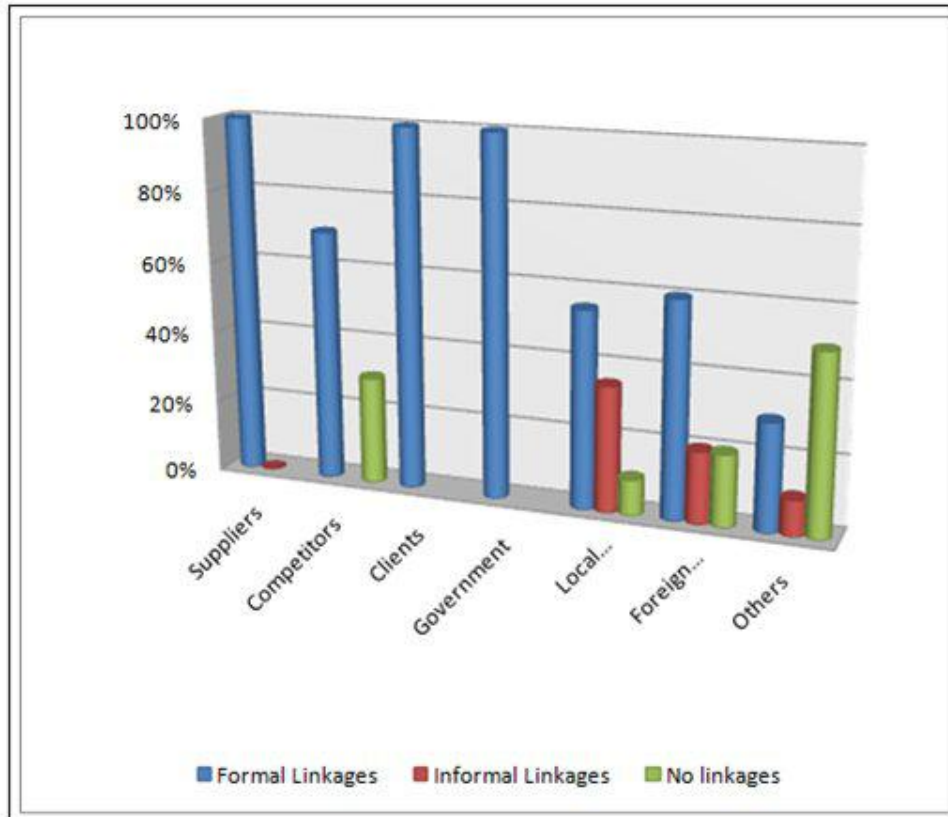
Networks are the ultimate unification of two or more entities, which is built once the collaborating entities develop a sense of comfort and trust, beyond strategic mergers and commercial agreements. In other words, it is considered that the depth of networks has its roots in the socially embedded character of individuals, working in firms and non-firms entities. This characteristic is coupled with mutual risk-taking aptitude and sharing of resources and capabilities.

Academic institutions at local level qualify for having formal, as well as informal linkages. Some of the institutions like Hyderabad Central University (HCU), Jawaharlal Nehru Technical University (JNTU), Andhra University and Osmania University are hubs for basic research in biomedicine, therapeutics and life sciences. Such collaboration aim for basic research expertise and in turn the firms invite scholars, students for internships and sponsored research programs. Though from conversations with scientists of CCMB and Dr. Reddy's Institute of Life Sciences (DRILS, previously institute of Life Sciences), it was observed that these interfaces are occasional, and efforts should be made to create proximity between academia and industry. On the other hand, some firms are 'skeptical' to deepen relationships with academic institutions, due to lack of

the firm to all markets and industries, domestic and international (OECD, 2005; Berger and Revilla Diez, 2006).

confidence in their capabilities. They also believe that students are not trained to possess the risk-taking aptitude and deal with pressure of the corporate world. Hence, minimal linkages are formed.

Figure 3.4: Formal and informal linkages of firms and non-firms



Source: Fieldwork

As far as foreign institutions are concerned, some prominent collaborating institutions include the University of Pittsburgh, Oxford University, University of Cambridge, New York Academy of Sciences, University of Pennsylvania, University of Cape Town, Infectious Disease Research Institute (IDRI), the City College of New York (CCNY), University of Dundee, National Institute of Health (NIH), etc.

4. Typology of Global Innovation Networks in Hyderabad Cluster

Table 4.1: Typology of GINs of sample firms			
	Types of GIN	Description	Firms
Forms of GINs	Balanced GINs (GIN)	All elements are in alignment	A, E, G
	Global asset exploiters	Global reach is greater than the extent of innovation or networkedness	D
	Innovators	Firms are relatively more innovative than their global reach	I
	Global asset exploiters + Innovators	Firms are more global as well as innovative, but extent of network is less or negligible.	B, F, H
	Innovators + Networkers	Firms are more innovative and extent of networks is large; innovation is low.	J
	Global networkers	Innovation is not as high as both the globalness and the networkedness. This is the only common combination of two stronger dimensions.	C

Source: Typology of GINs (Barnard and Chaminade, 2012); firm and non-firm classification based on fieldwork

In the table 4.1, the typologies of GINs showcased by those firms and non-firms are enumerated. It is observed that apart from the classical typology of GINs, there are two emerging categories of GINs, exhibited by the firms and non-firms. GINs have several interpretations ranging to have technology oriented market expansion, to engage

with like firms across the globe and to make one's presence in different geographies. Wherein, the connotation of Innovativeness confines to novelty of products and services as per the demand and requirements of the clients. The interpretation of Networkedness, is close to the theoretical definitions, i.e. formal and informal linkages with firms and non-firms entities.

The Innovators category, standalone firms with the ability to churn the efficiently from local or regional institutional setup, in terms of producing goods and services with high novelty belong to this group. These firms are very important for India's economy, but due to lack of support from the state, these firms fail to self-sustain and are taken over or merged with big firms or MNCs. Nevertheless, these firms show a lower degree of exports and a lower presence in the international markets. Fascinatingly, some firms fall in particular overlaps of these typologies of GINs. This ascertains the evolving nature of GINs, and also of the firms' capacity to globalise, innovate and form networks.

In relation to Hyderabad, the development of the cluster is a collaborative effort of firms and non-firm entities, which generate revenue for the region as well as provide adequate employment to the people within the region. These entities are also the 'knowledge communities'. Such entities have a prominent role to play to judge the There are underlying motivations for firms to be a part of the cluster like, skilled human resources, accessibility, and familiarity with the region and corporate-friendly government policies. But, local level dynamics may not be sufficient for the growth and sustainability of the cluster. Hence, Global Innovation Networks (GINs) is equally significant as it results into enhancement of capabilities of entities associated with it, foster academia-government-industry linkages, and accelerate the process of innovation, at local, regional and global levels

Contribution of GIN in the Hyderabad Cluster

Attractiveness of the cluster, as a location for R&D and innovation activity has grown manifolds due to the conditions that affect the location of production as well as costs (production, labour, tax) becomes critical. Global Innovation Networks to some extent have contributed in meeting socio-economic goals of Biopharma sector, in diversifying the typology of collaborations and in promoting capacity building.

(a) Meeting socio-economic goals of Indian biopharma sector

It has been observed that firms characterised by Balanced GINs, are playing a significant role in meeting the socio-economic objectives of Biopharma. For instance, Biocon's recent tie-up with Mylan, through the re-licensing of three insulin biosimilars analog products, is aiming to reduce the cost of production, thereby lowering the price of the drugs; also at regional level, Syngene, a subsidiary of Biocon has collaborated with Abott, to develop affordable nutritive products, to fight against malnutrition and other deficient diseases. Another example is that of Biological E (BE), which has launched the first indigenous Vaccine, JEEV to prevent Japanese Encephalitis, through a successful technological collaboration with Austrian Vaccine firm, Intercell. Also, firms like Dr. Reddy's Laboratories and Bharat Biotech are catering to WHO, Gates Foundation and UNICEF, to tackle issues of affordability, access and to battle maladies of diseases in India.

(b) Diversifying the spread and typology of collaborations:

Academic institutions, research labs, at global and local level, are actively seen in the GIN of Hyderabad. Avra Laboratories, a locally based CRO, stretches to harness knowledge from foreign institutions, like Scripps University, the University of Cambridge; even a similar type of organisation GVK biosciences has collaborations with CCNY (US), NIH (US) and University of Dundee (UK) for production of knowledge. Contrastingly, Foreign multinationals like Novartis, Mylan, have been collaborating with regional and local institutions like Jawaharlal Nehru technical University, Indian Institute of Sciences, Indian Institute of Chemical Technology, Centre for Cellular and Molecular Biology, Osmania University, the University of Hyderabad (HCU), etc. For start-up firms, it is observed that the government is one of the main actors for funding, building infrastructure, providing resources for production, thereby facilitating innovative activities.

(c) Catalysing capacity building and boost employment

Many firms like GVK Biosciences, Novartis India, Firms, of foreign and Indian origin, have bio-campuses to train, educate and facilitate knowledge sharing among technical

qualified individuals. Exchange programmes are organised by firms, for employees to explore avenues of research in foreign universities. These individuals, in turn, become assets for firms to accelerate their innovative capacities. To some extent, GIN facilitates capability enhancement and caters to the issue of unemployment of competent technical human resource.

5. Discussions and Conclusion

On comparing the status of the biopharmaceutical sector in Andhra Pradesh before and after the state intervention, the cluster possessed pre-existing resources of knowledge creation (universities, public research organisations, government agencies), production (producers, suppliers) and dissemination (clients and consumers). But gradually, through policy interventions and infrastructural development, attempts are being made to elevate the essentials for a successful cluster, ranging from adequate biotechnology education for better human resource development to avenues for funding. On the hind side, these development and promotional activities haven't really addressed the basic objective of these clusters in providing facilities and incentives to domestic firms, specifically Small and Medium Scale Enterprises (SMEs) and Start-Ups.

Hyderabad has been the hub for vaccine and bulk drugs, and have some of the world- class research organisations; domestic firms like Shantha Biotech and Bharat Biotech have been leaders in therapeutics and vaccine manufacturing, since last few decades. Besides regulatory regimes, infrastructural support and funding avenues, the success of the cluster is highly dependent on the entrepreneurial efforts, which are at the frontier to produce novel products and services, whilst linking with other knowledge actors and institutions, for satisfying local and global needs. The development of this cluster has emerged from the socio-economic, political and historical transformations of the city and its peripheries.

On reflecting over the typologies of GINs and their degrees of globalness, innovativeness and networkedness, some implications can be concluded through the firms' characteristics. It can be drawn from the analysis that, Biopharmaceutical firms in India, whether domestic or multinational, have an export-oriented objective and are competing with their global competitors. Certain large Indian firms like Biocon, Dr.

Reddys are making efforts to achieve adequate health outcomes and aid in access to medicines, for all. The global trajectories of these firms are significant, specifically on their off-shoring activities. Interestingly some SMEs, though not a part of the same, are also attracting foreign firms, due to their service-oriented characteristics.

The idea of innovativeness seems to be restricted to incremental type of innovation, where Indian units are producing drugs and vaccines, with minute modifications. These drugs are of higher market value, produced at low labour cost and cater to a large number of global consumers. Interestingly, India is known for its predominance in biosimilars and generic drug supplies. However, firms are also engaged in radical innovation, but their numbers are considerably low. The bigger challenge lies in constructing networks between entities to accomplish the health needs of this country. Indian academic institutions and research labs vis-à-vis the industry has their own conflict of interests as well as trust deficit issues. Efforts are to be made for mobilising policy imperatives to create these clusters as platforms for encouraging networks and alliances. A greater and intensive institutional support will strengthen the cluster building processes, synergise intra and inter cluster networks and provide avenues and incentives for safeguarding interests of local stakeholders of knowledge creation & dissemination.

However, the variables measuring globalness, innovativeness and networkedness are not adequate to capture the complexities of networks. In Indian context, there is a need to reflect on the type of drugs and vaccines produced by these firms, where debates around access and availability of medicines have grown manifolds. An in-depth reflection is required to understand the technological competences of firms and the health outcomes, derived out of these networks within the cluster, which are shaping the global and regional landscape of innovation.

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