Exploring 'Global Innovation Networks' in Bio clusters: A Case of Genome Valley in Hyderabad, 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' play a significant role. With this prelude, the study attempts to understand the nature and typology of Global Innovation Networks (GINs), by assessing the degree of globalness, innovativeness and networkedness of firms, located in India's first organized Biosciences R&D cluster, Genome Valley, Hyderabad (India). On reflecting over the typologies of GINs and their degrees of globalness, innovativeness and networked ness in Biopharmaceutical firms, 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 entire cluster with pre-existing capabilities, vantage points and resources, coupled with GINs, is evolving as 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

INTRODUCTION

The biopharmaceutical sector in India has undergone different phases since 1980s, with the amalgamation of biotechnology and pharmaceutics 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 2012-13.[1] This unprecedented growth is an outcome of many factors, which have made biopharmaceutical sector a boon for Indian economy.[2] 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.[3] 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,[2] leading to the construction of many state-initiated clusters, in order to erect a robust regional system of innovation for bio pharmaceutics.[4] Notably, there has been a significant increase in the number of bio clusters 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.[5] These clusters are seen as lucrative sites for business operations and collabora-

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tions with entities like companies, universities and R&D institutes, located at one geographic location. Also, the state governments are 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. Moreover, the 'global' alliances, linkages and networks also direct 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 organizations, 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 analyze the extent of global-local exchange of knowledge, experienced by India's first organized Biosciences cluster, Genome Valley, 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 Genome Valley cluster, which can be further simplified under the following research questions:

- Why global innovation networks exist in Genome Valley?
- 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?

The taxonomy of GIN[6,7] is in terms of Globalness, Innovativeness and Networkedness; the intensity and direction of these concepts are determined by the internal (viz. organizational 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.

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[8] Marshall; Weber and[9] Friedrich[10] Porter and others have used concepts like clusters and industrial districts to analyze examined local level innovation. Many scholars have advocated that clusters provide respectable environment for nurturing and sustaining competition and technological advancement.[8] Marshall 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 endeavor, mainly driven by innovation, the catalyst for competitiveness and economic growth[10,11,12] 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.[13]

Whereas, the proponents of globalization of innovation[14-18] state that clusters or regions are not far away from this global wave and have been experiencing a sense of 'liquidity'[19] Firms need to cross borders for accessing knowledge competencies and sources, which is not present in their proximities.[20-25] More importance is given to external linkages with agencies (firm and/or non-firm), for rapid technological advancements[26,27] concluding that innovation can be generated by a combination of close and distant interactions.[28,29] 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[30]

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[31] 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[32] 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.

Global Innovation Networks

The widely discussed literature on innovation systems contended that innovation is becoming a more globalized[33] and networked concept[34] and hence firms are 'reorganizing' innovation, ranging from R&D to marketing their products; under the realm of GINs.[35]

[36] 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 organization of innovation.[37,38] These networks span across continents and consist of a wider range of actors including headquarters, affiliates, suppliers, customers, competitors, research institutions, universities and others. [16] Various scholars have reflected on GINs as a policy tool advocating international collaborations and knowledge bases[39] and also strengthening domestic development, through accumulation of specialized knowledge, by and within various MNCs within a geographic location.[40] Interestingly, the regions, or say, clusters are becoming nodes of knowledge in GINs[41] resulting in expansion of clusters and industrial districts within specific industries over several countries, as firms are in search for new knowledge. These firms are targeting locations with expected spillovers, arising due to geographical proximity of institutions and actors.[42] One may look at the variations in global innovation networks, specifically in terms of the typology of networks and the associated strategies[43] intra firm characteristics (size, products, innovation)[44,38] characteristics of the host economy (the attractiveness of the location).[45] and the home country of MNC.[46]

On reflecting over the literature of GIN, different parameters can be operationalized. 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[47] weak and strong ties[48] strategic alliances[49] and others. Clusters remain important with globalizing market relationships. The ability to upgrade regional assets using global networks requires the presence of local institutions able to sustain not only innovation but to stimulate the local-global relationship.[30,16] 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.[50]

Methodologically, it is substantive to employ the typology of Global Innovation Networks as discussed by[6,7] in this work; through varying degrees of Globalness, Innovativeness and Networkedness of the firms, one can analyze their respective typology(s) of GIN. For the given study, Globalness implies extensive geographical spread and also a high degree of functional integration[1] Innovativeness refers to the proportion of firms introducing innovations that are 'new to the firm' versus 'new to the world'[36] and Networkedness involves internalized networks of subsidiaries of the same firm, located in different countries and that are performing different functions[51] and also the externalized networks, i.e., interactions between firms and other organizations.[52,53]

Genome Valley: The Case Study

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 as Genome Valley to host the biotech sector area mainly in Shamirpet Mandal (RR district) and Mulugu Mandal (Medak district). The conceptualization of Genome Valley 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.[2] The inception of Genome Valley 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 competitiveness. Consequently, with the proactive state policies to develop India's first recognised biotech cluster, the Genome Valley 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.

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.

In general, the broader picture of Genome Valley encompasses the entire Hyderabad. It is divided into four zones,[3] namely:

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.

Table 2.1: Major Public R&D centres in Hyderabad, Andhra Pradesh.

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

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.

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.

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. The topographical illustration of these zones is given in Figure 2.1.

After observing these figures, it can be said that the one of the objectives of cluster, to position local firms, start-ups and SMEs, in the given region, have been well incorporated. The on-going infrastructure development in this clusters, including development of wet labs, constitution of BRIC (BIRAC Regional Innovation Council); formation of SEZs are with due consideration 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.

Data Collection and Analysis

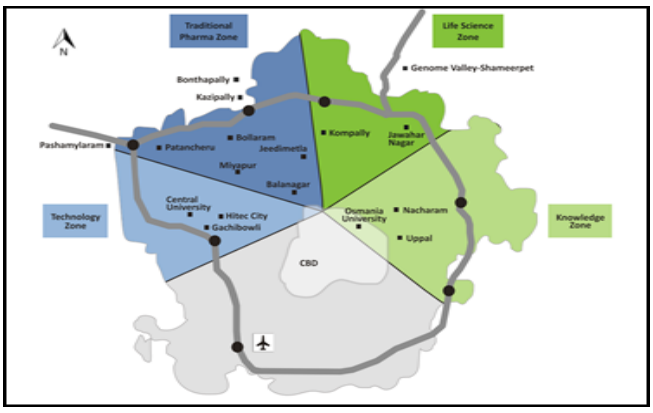

Figure 2.1: Zone-wise classification of Genome Valley.

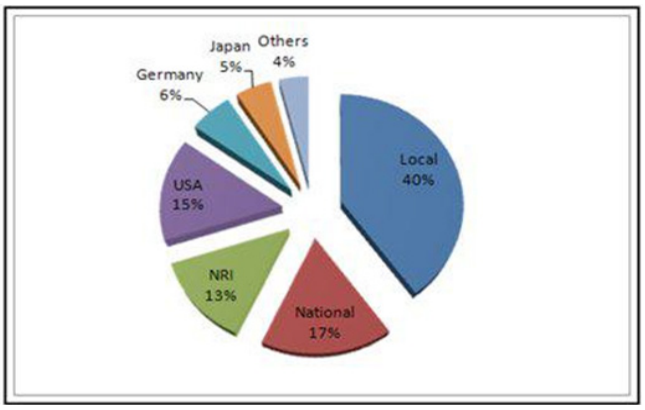

Figure 2.2: Percentage of firms by the country of their origin.

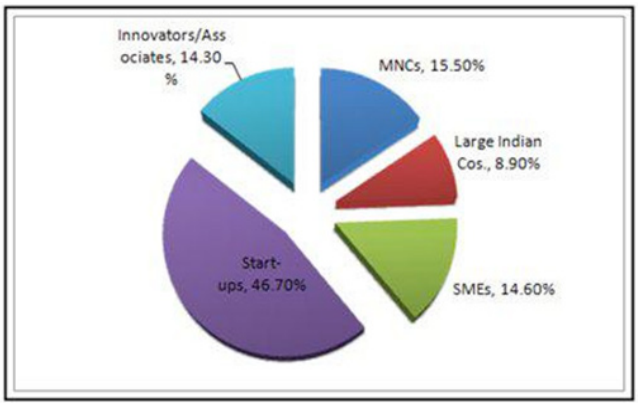

Figure 2.3: Size-wise percentage of firms in Genome Valley.

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. The fieldwork was conducted in the month of February-March 2013 and the analysis is based on the collected data. The profile of the firms is described in Appendix-1.

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 and 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.

Measure of Global Innovation Networks: Globalness, Innovativeness and Networkedness

The concept of Globalness, Innovativeness and Networkedness [6,7](Chaminade and Barnard 2012) has been incorporated in the study, to understand the forms of GINs prevailing in Genome Valley. A list of indicators has been considered to measure the extent of Globalness; Innovativeness and Networkedness is exhibited by the firms present in Genome Valley. They have been examined as per the objective(s) of the study in the subsequent sections.

Globalness

Several indicators have been used to measure Globalness, include the geographical location of firms' largest markets, location of partners with whom firms collaborate for innovation, location of different functions of the firm (by the unit in a location, by dispersed subsidiaries or outsourced), and the percentage of total sales derived from exports. Reflecting on these indicators to measure the globalness of the ten firms that were interviewed, one may attempt to understand the nature of globalness in Genome Valley. For the ten firms that were studied, each indicator unveiled a new dimension to the globalized character.

A) Geographical Location of Firms' Largest Markets

As per the data obtained from the interviews, most of the respondents preferred India as the largest market. Majority of the respondents represented foreign and Indian MNCs. It signifies the 'stickiness' [8] of firms in selecting their clientele in the home country. As stated by the Associate Director, Business analytics division of a Foreign MNC subsidiary in India:

'*Strengthening the local clientele is crucial not only to establish a market for our goods, but also to build trust and brand image in one location, in order to push operations at other places***.'**

The respondents also informed that 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. Under this indicator, the typology of firms plays a crucial role in determining the extent of globalness. It has been observed in the sample that MNCs have a greater global market, and domestic firms are also showing 'outward' flow of products and services, in order to cater to markets beyond regional boundaries. As per the primary data and an assessment of investor reports, domestic firms are indulged in various off-shoring activities as well as have built markets in foreign location.

B) Location of partners with whom firms collaborate for innovation

The focus of this indicator is to highlight the stretch of collaborations of the firms for innovation. For each firm under this study, its relation with different firms as well as non-firm entities have been considered. During the formal discussions with representatives of various firms, it was evident that firms are collaborating with the clients, suppliers, competitors, consultancies, academic institutions, research labs, etc., in the home country, which was further validated by the information in their annual reports. 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, whether it is informal or formal linkages. However, there is an emergence of collaboration with entities beyond proximate locations, especially when collaborating with clients, suppliers, and consultancies. Moreover, 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.

C) Location of different functions of the firm (by the unit in location, by dispersed subsidiaries or outsourced)

The following indicator reflects on centralized or decentralized nature of different operations, undertaken by firms. Figure 3.1 re-emphasizes on the 'localness' of various functions, undertaken by the units present in genome valley. It is to be noted that out of the ten firms studied for the research, four are subsidiaries of MNCs (foreign as well as domestic). And these subsidiaries, themselves, can be connoted 'global'. Some of the core activities like strategic management; corporate governance; decisions regarding marketing, sales and account management; procurement, logistics, and distribution; human resource management, are undertaken by the units present within the cluster.

Whereas the activities pertaining to product development; procurement, logistics and distribution; technology and process development, have been assigned to the subsidiaries at developing and developed locations. The role of subsidiaries is considered important, in the division of responsibilities between the holding firm and its subsidiaries. The idea of outsourcing is evident, to vocalise that a single entity incapable of performing tasks of high risks and complexities.

D) Percentage of average sales derived from exports (year-wise)

In figure 3.2, though the data conveys the fact that, for the last five years, the sampled firms show a similar trend of exports, they do not similar kind of export patterns. The MNCs were experiencing a rise in the percentage of sales from exports, ranging from 30% in 2007-08 to 58% in 2011-12. In the case of domestic firms, the export may not be higher, but lies between the range of 18% (2007-08) to 28% (2011-12). Some of Clinical Research Organizations (CROs) focus more on the clientele in foreign countries and have recorded export revenues as high as 53% for 2011-12.

Innovativeness

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

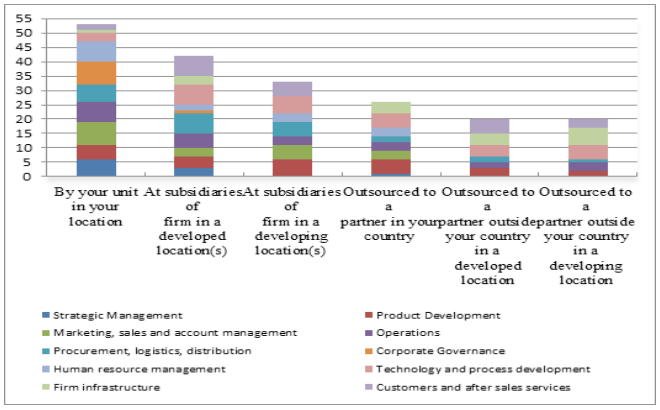

Figure 3.1: Location-wise distribution of functions of firms.

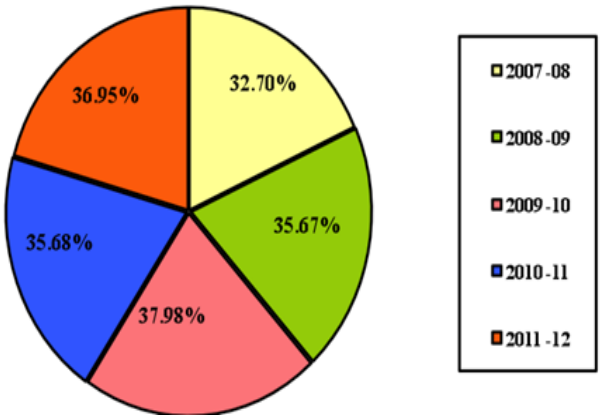

Figure 3.2: Year-wise average sales derived from exports.

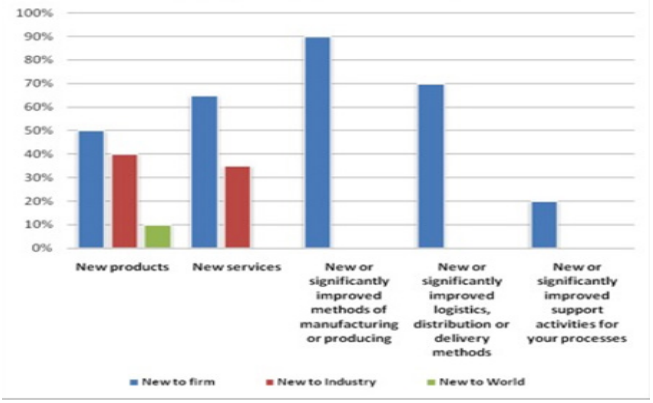

Figure 3.3: Innovativeness of the firms.

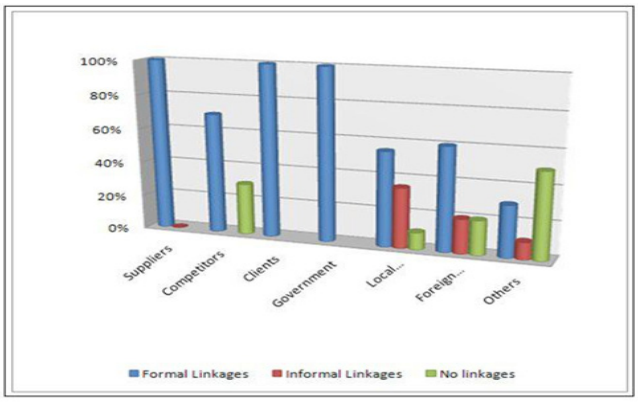

Figure 3.4: Formal and informal linkages of firms.

'new to the world.[4] In Figure 3.3, it has 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.

The Senior Vice-president of an Indian MNC rightly quoted, "Innovation is very crucial for firms in the biopharmaceutical sector. Different measures of innovation, patents as well as non-patents, are required to create cutting-edge technologies for development of novel drugs, vaccines and other biopharmaceutical products. In doing so, the quest for capabilities, financial resources and markets in different geographies are inevi Table."

Networkedness

The concept of networkedness is driven by two measures, span and depth. The degree of 'span of network' is considered to at the highest level, if the firm has connections or relationships with many other people, enterprises or institutions [6,7] (Chaminade and Barnard, 2012). The 'depth of the network' is measured in terms of the informal or formal nature of linkages. Interestingly, areas pertaining to research and development, which was earlier restricted to the firm, is now forming the basis of various linkages of firms with non-firms entities and thus create external networks.

In one of the interviews conducted, the Chief Operating Officer of a clinical research organization, stated of a clinical research organisation, stated, Networks are the ultimate unification of two or more entities, which is built once the collaborate 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 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.

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.

Typology of Global Innovation Networks in Genome Valley

In the Table 4.1, the typologies of GINs showcased by those 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 in Genome valley. Globalness has 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 globalize, innovate and form networks.

In relation to Genome valley, 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. 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 Genome Valley

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 classification based on fieldwork

Genome Valley's attractiveness 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 Bio pharma sector, in diversifying the typology of collaborations and in promoting capacity building.

(a) Meeting socio-economic goals of Indian bio pharma sector

It has been observed that firms characterized by Balanced GINs, are playing a significant role in meeting the socio-economic objectives of Bio pharma. For instance, Biocon's recent tie-up with Mylan, through the re-licensing of three insulin bio similars 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 Genome Valley. Avra Laboratories, a locally based CRO, stretches to harness knowledge from foreign institutions, line 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 Programmers 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.

DISCUSSIONS AND CONCLUSION

On comparing the status of the biopharmaceutical sector in Andhra Pradesh before and after the inception of Genome Valley, 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.

Much before the formation of Genome Valley, 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 mobilizing 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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Appendix 1

Profile of Sample Firms

Name of firm	Designation of the respondents	Year of establishment	Nature of the firm		Size of the organization | Valuation (1 Crore = 10 Millions)	Form of organisation	Type of organisation	Nature of Business (Areas of operations/ components of manufacturing)
A	Scientific Manager	1978	Indian MNC	Public	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Headquarter of a MNC	Research and Consultancy	Pharmaceuticals, biomedicinal, clinical research
B	Senior Vice President		Domestic	Private	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Headquarter	Research and Manufacturing	Pharma outsourcing
C	Chief Operating Officer	1996	Domestic	Private	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Headquarter	Research and Manufacturing	Pharma outsourcing
D	Operations Manager	2008	MNC	Public	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Subsidiary of a MNC	Research	Biotechemical research, Agriculture and Industrial Biotechnology

E	Senior Director, Clinical Development	1993	Indian MNC	Public	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Headquarter	Research, Manufacturing	Pharma services & API
F	Associate Vice President	2007	MNC	Public	Large enterprise (investment in plant and machinery): More than ten crore Rupees		Manufacturing	Pharmaceutical, API and clinical research
G	Associate Director, Business Analytics	1996	MNC	Public	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Subsidiary (formed by the merger of Ciba-Geigy and Sandoz)	Research and Manufacturing	Drug delivery, clinical, Biomedicin-al, genetics
H	Vice President, (R&D)	1989	Domestic	Public	Large enterprise (investment in plant and machinery): More than ten crores.	Headquarter	Manufacturing	Biopharma-ceuticals
I	Head, Global Business Development	2000	Domestic	Private	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Headquarter	Manufacturing	Biopharma-ceuticals
J	Director, Business Development	2001	Domestic	Public	Large enterprise (investment in plant and machinery): More than ten crore Rupees	Headquarter	Manufacturing	Biopharma-ceuticals

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