WHITE SPACES IN BUILDING INNOVATION CLUSTERS

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Abstract

Clusters are groups of firms, related actors, and institutions that are located near one another and that draw productive advantage from their mutual proximity and connections. Clusters arise and grow because the firms within them profit materially from the presence of powerful "externalities" and "spillovers" that bring them important competitive advantages, ranging from the presence of a specialized workforce to supplier specialization and the exchange of leading edge knowledge. Today, the US economic maps show scores of local agglomerations: biotech in Boston, information technology in Silicon Valley, entertainment in Hollywood, horse trailer manufacturing in north Texas, marine technologies in eastern North Carolina and wine in southern Washington. Clusters are prominent in Europe too. On average, every fourth company (employing at least 20 persons) in the European Union (24%) work in a cluster-like environment characterized by close cooperation with other local businesses and strong ties to local business infrastructure.

Based on US and European success a new movement started all across the globe to promote regional innovation clusters. The paradox is that while all agree that no where governments succeeded in creating an innovation cluster out of nothings, all nations are working to promote clusters and to make them more innovative. The search is for identifying a cluster that already exist but not passed the market test as hot spot though potential exists. Some factors are considered more important than others to determine the potential, like University linkages, Social Capital of cluster, Access to heterogeneous knowledge, Intervention by public authorities.

In India, Innovation Cluster project was initiated at three places, Hyderabad, Ahmedabad and NCR region and in this paper we present our learning on managing white spaces to make a cluster innovative.

Part A: An Overview

"A cluster is a geographically proximate group of companies and associated institutions in a particular field, linked by commonalities and complementarities." Michael F. Porter.

Clusters are groups of firms, related actors, and institutions that are located near one another and that draw productive advantage from their mutual proximity and connections. Clusters arise and grow because the firms within them profit materially from the presence of powerful "*externalities*" and "*spillovers*" that bring them important competitive advantages, ranging from the presence of a specialized workforce to supplier specialization and the exchange of leading edge knowledge.

Clusters, in one respect reside exactly in the "missing middle" of conventional economics, between the general economy and the individual firm. They grow in the often ignored space of places, local institutions, labor markets, and groups of firms rather than single firms. Today, the US economic maps show scores of local agglomerations: biotech in Boston, information technology in Silicon Valley, entertainment in Hollywood, horse trailer manufacturing in north Texas, marine technologies in eastern North Carolina and wine in southern Washington (Mark Muro).

Clusters are prominent in Europe too. On average, every fourth company (employing at least 20 persons) in the European Union work in a cluster-like environment characterized by close cooperation with other local businesses and strong ties to local business infrastructure. Further it was found that Innovative companies active in cluster environment are more innovative than the general sample of innovative European companies (Innobarometer).

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1. University linkages
2. Social Capital of cluster
3. Access to heterogeneous knowledge
4. Intervention by public authorities.

These are discussed in brief here.

University Linkages

Expectations of Universities have changed, not only are they expected to teach & train but also play a pivotal role in building entrepreneurial system around university research. Survey of MIT alumni in 2003 revealed, that 33,600 companies were founded by MIT graduates employing 3.3 million peoples and generating $2 trillion revenues annually. In India, National Innovation Council (NiC) outlined plans to establish University Innovation Cluster (UInC) by taking an established University as the lead institution and building an ecosystem of aligned partners, both private and public, who will enable the University to spur innovation in the entire ecosystem. The primary areas of focus for a UInC as enumerated by NiC are:

- Incubation or promoting entrepreneurship
- Collaborations
- Research & Development
- Continuous evolution of curriculum and teaching-learning methods

The "*knowledge spillover*" from these knowledge creating institutions (and their intellectual property practices) to the local community and network of entrepreneurs is the central process that takes place in fertile innovation clusters.

Ohio University

Before the European settlement, Ohio region for many centuries was center of a continent wide trading empire. Then from the earliest settler days until relatively recently, extractive industries have dominated the economy of Appalachian Ohio. Salt was such an important commodity to the Native Americans and lands containing salt licks were valued higher than the surrounding acreage. Iron ore was another significant natural resource with some hilltop iron ore beds reaching a depth of almost six feet. In addition to iron and salt, one of the first resources found in this region was clay. But it is another crucial mineral, coal that dominated the economy for several generations. Underground mining began in the early 1800s and thrived for more than a century. The arrival of the railroad in 1856 provided a way for coal companies to transport and sell their product easily, paving the way for rapid expansion. Around World War II, surface mining overtook underground mining as the primary way to extract the mineral.

Today the picture is different- the region is known for its high tech cluster of industries. Ohio University the harbinger of change started the process as early as 1894 when chemistry professor Wilbur Stine was awarded a patent for his improved design of the battery. One of Ohio University's biggest success stories in technology transfer is the discovery of growth hormone antagonists by Goll-Ohio Professor of Molecular Biology John Kopchick. This innovation led to the development of a drug, now marketed by Pfizer under the brand name Somavert®, for patients with the growth hormone disorder acromegaly. Ohio University has received approximately $30 million in royalty income to date from this license. The university's second major success story is Diagnostic Hybrids Inc. (DHI), a start-up company based on faculty research. This time Ohio University licensed its IP to Diagnostic Hybrids and also invested in the company. Diagnostic Hybrids recently sold to publicly traded Quidel for $130 million, and Ohio University's equity sale was approximately $40 million.

Ohio University is home to 44 centers and institutes, and many support the commercialization of faculty research and technology. These include: *Edison Biotechnology Institute, Avionics Engineering Center, Ohio Coal Research Center, Institute for Corrosion and Multiphase Technology, Nanoscale and Quantum Phenomenon Institut.* Since 1983, the Innovation Center has incubated more than 100 companies; helped create more than 1,000, assisted with 9 spin-off companies from university-invented technology and supported the start up of 27 companies created by university faculty and staff.

The transformed Athens County is now home to a variety of small companies (784 start-ups between 1995 and 2000) specializing in biomedical research, renewable energy and gourmet food.

The university centered clusters are called by different names such as Knowledge city, Ideopolis, Knowledge Ring, Knowledge Harbour, knowledge Valley, Knowledge Metropolis, Learning City, Creative Cluster, Smart City, Teleport, Electronic City, ICT Park, Science City, Technopolis, Science Park, Knowledge Park, Silicon valley, Futuropolis, Nano city, Biopolis, Cuber City and Innovation Cluster.

Social Capital of Cluster

Social capital is defined as the importance of networks of strong personal relationships that provide the basis of trust, cooperation and collective action. Structural social capital describes the impersonal configuration of linkages between people and units while relational capital describes the personal relationships that people have developed through a history of interaction. Key factors in this type of capital are trust and trustworthiness based on a history of successful exchanges. The study on effect of social capital on new venture creation at Cambridge high tech cluster had important findings:

- A limited number of individuals, together, shaped the Cambridge High tech cluster. At the center of a high tech cluster is a mini cluster of key individuals (investors, academics and serial entrepreneurs) who can influence the success of the cluster.
- There is a high level of relational social capital in Cambridge arising from the association of individuals who have worked together in other companies over time. It is also noted that the high level of structural social capital arising from interlocking directorships is supplemented by the clustering of VC investments and by membership of business angel groups, and networking organisations.
- Successful entrepreneurs tended to have multiple directorships or ownership stakes. *Alpha entrepreneur* is a lead entrepreneur different from other entrepreneurs by his/her networking behavior and ability to build and use networks strategically in founding and growing a new venture.
- Structural social capital is critical for the efficient functioning of the cluster. Formal links between companies increase awareness of opportunities for strategic alliances (that take advantage of complementary expertise) and for outsourcing activities for greater efficiency. They also provide a channel for information on industry trends, government initiatives and grants, laboratory space and new business opportunities.
- Relational social capital is leveraged extensively in the formation of new ventures for evaluating promising business opportunities, for forming connections between investors and entrepreneurs, and for staffing new enterprises with experienced management teams.
- A vibrant cluster needs a pool of individuals who are physically located in close proximity so that they are better able to interact, build and maximise both structural and relational social capital.

Cambridge High-tech cluster

Acorn was co-founded by Hermann Hauser with Andy Hopper, an academic and Chris Curry in 1978. Walter Herriot and Matthew Bullock, bankers from Barclays Bank at that time, persuaded their regional office to lend money to Acorn in its business critical stage. Acorn’s engineers Steve Furber and Sophie Wilson designed a RISC chip in-house which was the origin of the ARM chip technology. ARM was founded in 1990 by 12 Engineers from Acorn and Robin Saxby joined ARM as CEO. When Acorn was acquired by Olivetti, Andy Hopper and Hermann Hauser joined Olivetti and then Andy started the Cambridge-based Olivetti Research Limited in 1986 which became Olivetti and Oracle Research before it was bought by AT&T in 1999. Hermann Hauser and Andy Hopper founded Virata (Advanced Telecommunications Modules Ltd) as a spin-out from Olivetti Research in 1993. Two years later, Charles Cotton, an ex-Sinclair Research employee joined to help launch the initial products of the company. Charles Cotton now sits on the board of Level 5 Network which was founded by Andy Hopper and his team from AT&T Cambridge Laboratory when AT&T ceased in 2002. The other companies which were founded when AT&T Cambridge Laboratory ceased are Ubisense and Real VNC.

Once an organisation stops growing, the team splits but technology motivation still exists which leads to a series of new technology ventures.

Heterogeneity of Accessible Knowledge

Innovation, knowledge creation and learning are all best understood if seen as result of interactive processes where actors possessing different types of knowledge and competencies come together and exchange information with others. If the information exchanged is neither novel nor varied then repeated local interaction may not be conducive to innovations.

The development of the heterogeneity during the cluster life cycle is illustrated by Max-Peter Menzel. As the cluster emerges, there are only a few companies and the heterogeneity increases strongly because every new company ventures into new technological areas of the cluster. In the growth phase, the technological path becomes increasingly focussed. The heterogeneity decreases until the cluster has matured and a distinct development path has taken shape. However, if the cluster is focused too narrowly, it loses its capacity for renewal and declines. The connections between quantitative and qualitative development of the cluster indicate that its heterogeneity of knowledge is the foundation of its development. The cluster declines if its heterogeneity cannot be sustained. If the heterogeneity increases again, the cluster moves "back" in the cycle and enters a new growth stage.

This increase in heterogeneity can be incremental, e.g. the integration of new knowledge from the respective technological trajectory into the cluster. Examples of this are clusters which manage to maintain their heterogeneity by incrementally adapting to a changing environment. But the increase of heterogeneity can also be of a more radical nature. Clusters can renew themselves by integrating new technologies, like the accordion cluster in Marche/Italy whose companies use electronics in their previously traditional musical instruments. The step up can be larger, when clusters are transformed and move into completely new fields. Such a shift took place in the declining coal and steel complex of the Ruhr Area towards environmental technologies. Additionally, the cluster can increase its heterogeneity by changing its developmental rationale, for example from production to the local organisation of global value chains.

A declining cluster is defined by a decrease in the number of companies and especially of employees due to failures, mergers and rationalisations. Start-ups are rare during this phase. A region with a shrinking cluster is marked by companies strongly focussed on specific markets and technologies. The competencies of such a cluster are contained in only a few companies. Despite the decline, competitive pressure can lead to high innovation rates. These innovations, however, arise within the existing and exhausted technology path and the cluster is negatively locked into its previously successful development path.

Rajkot Diesel Industry cluster

Rajkot Diesel Engine Industry is the leader in Indian Diesel Engine market with more than 60 % of India's total diesel engine production. It accounts for around 0.3 million diesel engines per year valued around Rs. 2500 million with sizes from 3.5 HP to 20 HP. Majority production is in the range from 3.5 HP to 8 HP. The industry is made up of small-scale manufacturers and has about 400 foundry units in the city. Their annual production is more than one hundred thousand tones of casting. It employs more than

40,000 workers. The cluster is a network of units manufacturing different components of the diesel engines and the units assembling the components to get finished products. Thus the network of suppliers and buyers is within the cluster itself.

R. A Lister and Company Was Founded In Year 1867 In England in the 1920's they made Lister CS (Slow Speed Diesel Engines). They made many models of this engine and sold them world over. Many of these were also in India and after independence there was suddenly a great need for spares .Some enterprising people in the state of Gujarat started importing the same and later started to make these spare parts. Slowly entire Lister Type Clone Called a Listeroid started being developed in the state of Gujarat and Rajkot became a grand daddy for all Lister type clone manufacturing. In 1987 Lister in England stopped making Lister Engines of slow speed.

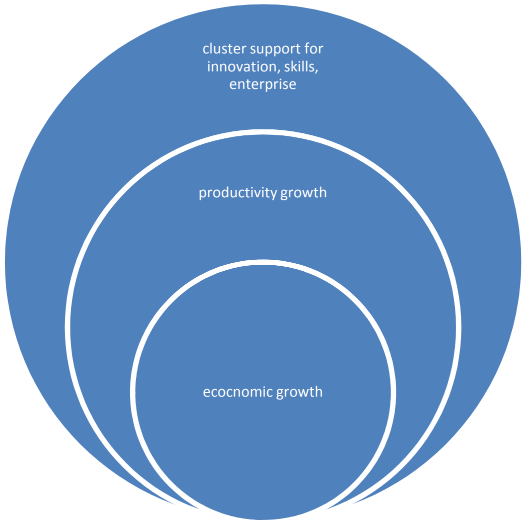
The Seventies, as the First Stage of cluster development, saw the demand phase wherein the supply was short. Efforts were concentrated on indigenizing and increasing production. Investments were made in production technology developed during the Sixties. The Eighties, as the second Stage, saw the manufacturers' attention focused on improving fuel efficiency following fuel crisis of the seventies. The third Stage began in the early Nineties when the rest of the developed world was changing towards rotary pump and the electronically controlled engine management systems. India, however, continued to rely on the indigenous diesel engines.

The Rajkot Diesel Engine industry started facing severe problems of competition and product innovation. These entrepreneurs are working without any support from outside sources. Their knowledge loop in the network is limited to themselves as entrepreneurs, and they have to try to find solutions to their problems from inside.

The limitations surfaced soon as most of the entrepreneurs who are involved in the business of manufacturing these diesel engines, are from the same caste and from about the same family background. And the major use of the cluster is for relationship maintenance, not for information sharing. They possess high knowledge about each other as persons but less knowledge about their competencies.

The role of public authorities

Since the 1990 description by Prof. Michael E. Porter how clusters or locally based networks of firms in the same industry could constitute a source of competitive advantage, most advanced economies are increasingly using cluster policies. Some tools governments have are identification of existing or potential clusters in their region; providing clusters with strategic information such as benchmarking or trends; invest in technologies and capabilities that are beneficial to cluster firms; fill in gaps in the cluster with FDI or others; link firms to training programs from local universities and centers; foster networking, service centers and associations; etc. Support to firms in clusters, directly or through suitable supporting structures is now accepted a basic priority in the economic development and industrial policy political agendas.



Best practices from Europe highlight the role played by government. Some of the important support activities:

- Organisation of public events.
- Support the improvement of the region/ cluster reputation.
- Facilitate transmission of information.
- Direct financial support to finance specific projects.
- Facilitate networking with universities, administration.
- Facilitate networking with firms.
- Facilitate admin procedures.
- Facilitate transnational relation with other clusters or geographic areas.
- Provide buildings or other infrastructure.
- Support incubator development.
- Tax reduction schemes on R&D and innovation expenditures.
- Tax reduction schemes on non-R&D and non-innovation expenditures

Swiss Medical Technology

With the clock ticking on their watch industry in the late 1970s because of a glut of cheaper, digital Japanese watches, the Swiss timepiece and mechanical engineering sectors desperately needed a shift and then came medical technology. A combination of government technology development programs, a talented and well-educated labour pool, a supportive academic community and favorable tax rates have combined to make Swiss medtech one of the fastest growing industrial sectors in the country. The Swiss medtech sector in 2008 comprised of about 700 companies, employing 49 000 people in the production of products such as dental and orthopedic implants, urinary infection diagnostics, surgical tools, sterilization products for the healthcare sector, electrocardiographs, and precise ophthalmology measuring tools. Sales in the medical technology sector topped 22.9 billion Swiss francs in 2008,or about 2% of the country's gross domestic product, the highest percentage of any country.

The sector has flourished because of highly educated and skilled people, world-class research, and the strong partnerships between universities, colleges of applied technology and the industry. Medtech companies could also benefit from the national, government-funded CTI Medtech (Commission for Technology and Innovation), established to promote innovation and competitiveness. In the past 12 years, the commission has provided nearly 250 million Swiss francs to 235 projects.

Under the Obama administration the regional innovation clusters are emerging as a vital part of his economic agenda. New Cluster Moment is based on research findings that strong clusters foster innovation because of dense knowledge flows and spillovers that positively influence regional economic performance. Connection between regional innovation clusters and neighborhood revitalization is a vital one for the US policy.

When trying to replicate innovation cluster model in India, several questions arise, such as;

1. *Can a university drive the development of a cluster? What are the conditions essential to make a technical University- center of regional economic activity?*
2. *What is needed to increase social capital of a cluster?*
3. *In the absence of appropriate knowledge flows from local institutes, how could the cluster firms access external knowledge?*
4. *Can the public authorities prioritize support activities?*

Part B: Knowledge flows in cluster

Knowledge linkages surfaced with Hub and Spoke model of Industrial Districts, where one or more firms/facilities act as anchors or hubs to the regional economy, with suppliers and related activities spread around them like the spokes of a wheel. A single Large firm (e.g. Boeing in Seattle and Toyota in Toyota City) or several large firms in one or more sectors (such as Ford, Chrysler and GM in Detroit) may act as hubs, surrounded by smaller and dominated suppliers. The large hub firms often have substantial links to suppliers, competitors and customers outside the district.

Global Production Networks played a similar role with de-risking model of supply. Global foreign buyer emerged as main carrier of knowledge flows in Tirpur cluster. Spinning mills integrated towards into apparel and garments, small producers have moved from producing fabric to finished items such as home furnishing under contract from chains such as IKEA,Wal-Mart. The integration into the global economy, through international networks and markets, corporate hierarchies, global production and technological organization is boosting the importance of functional integration.

In recent years, some studies have emphasized that geographically bounded clusters should be viewed as systems of knowledge accumulation rather than just production systems. In simple terms, '*combinations of internally organized capabilities with external knowledge resources, and the links between them*' is referred to as innovation or knowledge systems. An application of '*innovation systems'* concept to a cluster would require an analysis of capabilities internal to the cluster (or firms in a cluster) and their linkages with external knowledge sources including organizations like universities, R&D institutions, certification agencies, external firms, customers and so on. Rakesh reviewed the available literature on geographically bounded clusters to explore the determinants of knowledge flows in these clusters. The available evidence suggests that various dimensions of the cluster contribute to knowledge flows in the cluster itself.

These cluster specific factors can include: size of the cluster, extent of diversification, division of labour (and the associated buyer supplier relations), nature of products (hi-tech v/s traditional), levels of competition, nature of markets, location (developing/developed economy), links with other clusters and non-cluster firms (global networks, MNCs etc) and so on. Other important factors relate to public policy and macro-economic environment.

Knowledge flows can occur into firms from outside the system, between firms (and other institutions) within the system or indeed internally within firms themselves. All of these various kinds of knowledge flows may contribute to the accumulation of those knowledge stocks and resources often labeled `*technological capabilities.*' At one end of a complexity spectrum these include the most routine production capabilities required simply to maintain the efficiency of an established production system of materials, labor and customer requirements. At the other extreme are the most innovative capabilities required to specify and design new products, develop novel machines and install new processes, establish new channels of supply and distribution.

Knowledge systems and production systems obviously overlap, but they are not identical. Actors in one may not be actors in the other. Similarly, knowledge flows may be carried along the same channels as those concerned with market transactions over goods but it is also very clear that in some situations goods-centered linkages play little or no role in creating or diffusing knowledge.

In place of knowledge and production systems, some people refer to them as knowledge using elements and knowledge changing elements. The knowledge-using elements are involved, for example, in maintaining or expanding capacity using given modes of production; training workers in established operating procedures, or within a cluster context, the imitation of production techniques used by neighboring firms. The knowledge changing elements are involved, for example, in the management of innovation processes; in product design and development; or in the search for, selection, adaptation and assimilation of new product or process technology
(from outside the cluster).

	Sources of increase in knowledge-using Capabilities	Sources of increase in knowledge-changing capabilities
Intra firm sources	Learning by doing production. Improved process and practices derived from trial and error experimentation.	Learning by changing. Adaptation and improvement of existing technologies (reverse engineering etc).
Intra cluster sources	Intra cluster mobility of skilled labor. Knowledge spillovers/diffusion between producers. Knowledge spillovers/diffusion between	Creative collaboration between firms and cluster-based technology institutions. Training and skill development through cluster based/mediated initiatives Collaboration among cluster based

	users and producers of machinery/ material or production related services.	enterprises for adaptation and technology development (machinery, product design) Links between enterprises and customers located in the cluster (MNC, large firms).
Sources outside the cluster	Externally linked technical advice and consultancy services. Customers and traders knowledge. Machinery and other input suppliers.	Collaborative testing or technology development with technology institutions or firms outside the cluster.

Knowledge generations and flow is quite associated with institutional set up of a cluster. Florian Taube and Amit karna analysed organizational distance and Geographic distance in their study of Knowledge flows in Bangalore IT cluster. In the first phase of the evolution of Bangalore cluster the ties are between the headquarters and the MNC subsidiary in Bangalore. Ties are characterized as *non-local* and *intra-organizational separated by geographical distance*s. In the next step, these innovation networks were seen to develop in form of strengthening of internal networks within subsidiary teams. Innovation networks developed in form of more *local* ties, however remaining as *intra-organizational* as before because of the focus being on the subsidiary. The next step of development of innovation networks was seen to be surpassing organizational boundaries. This phase witnessed a prominence of innovation networks that involved the subsidiary and the local stakeholders in the environment viz. suppliers, educational institutes, competitors and customers. In the final step, the innovation networks that were established by MNCs and grew within Bangalore region started going back to their roots, in form of non-local ties. These ties that linked the innovation from subsidiary to the headquarters, brought along the inter-organizational ties that subsidiary had developed.

In a different part of the world, Own Smith and Powell from study of Boston Biotechnology concluded that `*decisive, non-incremental knowledge flows*' are often generated through networking pipeline rather than through undirected, spontaneous local broadcasting. Roman Marting analyzing knowledge flows in Sweden found that companies in the life science industry rely primarily on knowledge stemming from scientific research and recruitment from the higher education sector, and that knowledge flows occur foremost in globally configured networks. There is an overall agreement that the establishment of external knowledge networks is fundamental even in the most dynamic cluster. The links with external sources of knowledge are not simply a way to overcome lock-in and avoid entropic death but also to maintain and accrue local endogenous existing dynamism.

Buzz Vs Pipeline

Buzz refers to the information and communication ecology created by face to face contacts, co-presence and co-location of people and firms within the same industry and place or origin. This buzz consists of specific information and continuous updates of this information, intended and unanticipated learning processes in organized and accidental meetings.

Global pipelines are purpose built connection between a given local firm and parties on the outside world. Partners can range from other firms, suppliers, customers, universities, research centers. Establishing global pipeline is costly, it is possible with a conscious effort on the part of partners at both ends of the pipeline, making the exchange highly targeted towards specific pre-defined goals.

Study of Finnish innovations showed that firms that develop international partnerships are likely to innovate, firms that rely on national and local interactions are not, meaning that the transfer mechanisms of knowledge and innovation within close geographical proximity are either broken or less prominent than previously thought. Firms therefore cannot rely on local interactions for new knowledge. The creation and engagement in pipeline is a must if they are to remain innovative and competitive.

Establishment of global pipelines with new partners require that new trust is being built in a conscious and systematic manner. This process of building trust takes time and involves cost. Knowledge flows through pipelines are not automatic and participation is not free. Selection of external partners is not easy because information about the set of potential partners is usually truncated and knowledge of these firms and their capabilities is incomplete. Partners on both ends have to develop a joint interpretative context in order to engage in interaction. This can be accomplished through a set of procedural rules involving a sequence of transaction and interaction wherein small risks are followed by large ones and commitment progressively increases.

New and valuable knowledge will always be created in other parts of the world and firms who can build a pipelines to such sites of global excellence gain competitive advantage. Information that one cluster firm can acquire through its pipelines will spill over to other firms in the cluster through local buzz. In developed economies, pipelines to the outside world are regarded as key source for radical innovation, channeling new knowledge and practices to local firms, while local interaction represent a more genuine vehicle for incremental innovation. But the position in developing country could be different, as we will learn from Indian story.

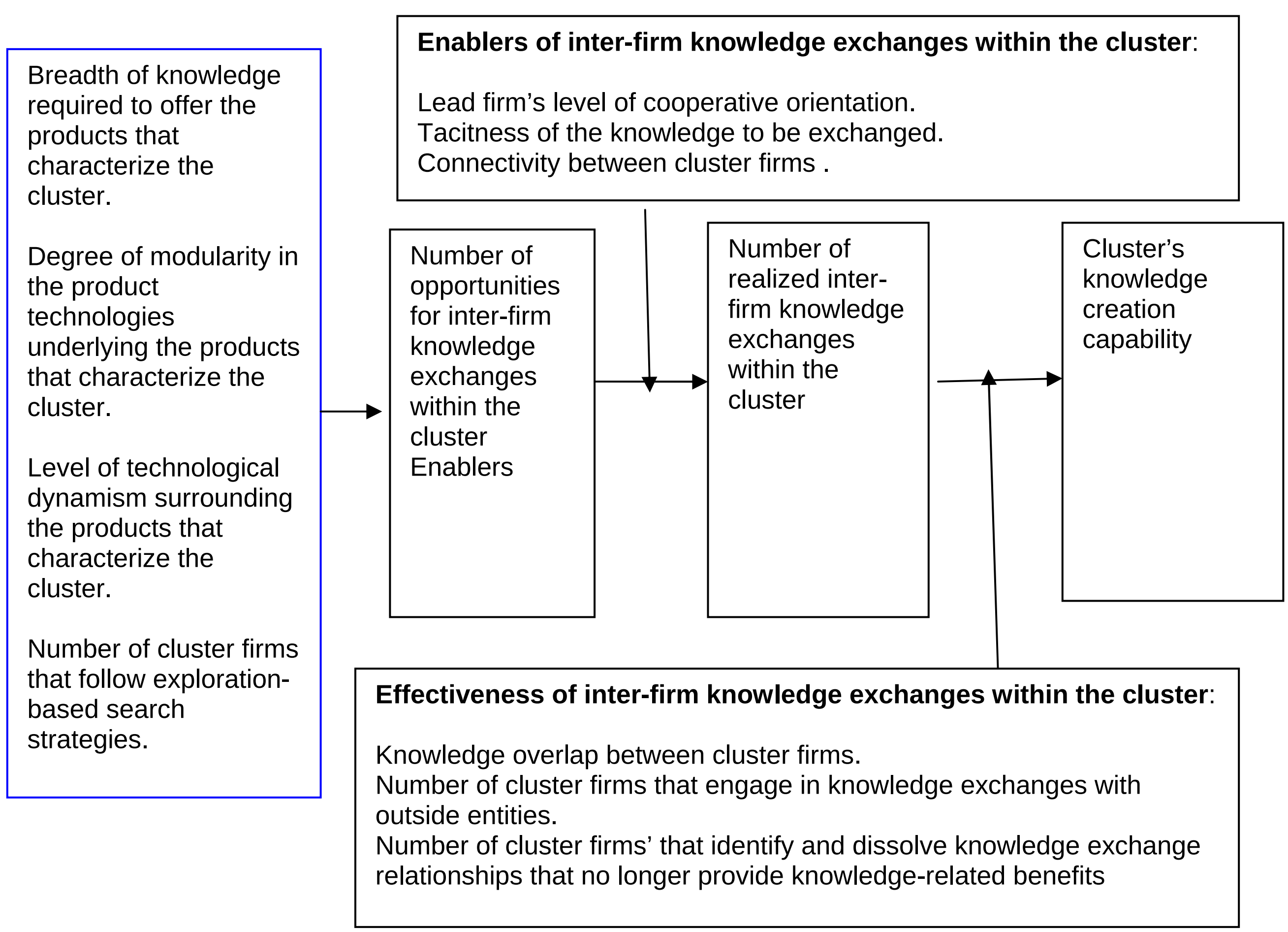
Cluster's knowledge creation capability

Arican defined a *cluster's knowledge creation capability* as the ability of the collectivity of firms in the cluster to enhance knowledge creation at the firm level. A cluster that has a high level of knowledge creation capability is one where knowledge held by individual firms is effectively shared among cluster firms through *inter-firm knowledge exchanges* and amplified by individual firms' knowledge spirals leading to enhanced knowledge creation by individual firms. Inter-firm knowledge exchanges are defined as formal or informal interactions between firms that involve either voluntary (e.g., alliances, licensing) or involuntary (i.e., knowledge spillovers) forms of knowledge exchanges. Three types of knowledge-creation failures could thwart that attempt.

The first type of failure occurs when opportunities for inter-firm knowledge exchanges do not emerge. The lack of opportunities may be due to characteristics inherent to the clusters' industry(ies) such as low knowledge intensity or narrow breadth of knowledge requirements. Another reason why knowledge-exchange opportunities disappear over time may be the emergence of a large number of weak firms in the cluster. A dynamic knowledge exchange environment is likely to attract entry by weak firms that want to exploit the knowledge assets within the cluster. This situation creates incentives for firms with advanced knowledge assets to move outside of the cluster in order not to lose their valuable knowledge to local competitors through un-intentional spillovers.

The third type of failure occurs due to ineffectiveness of inter-firm knowledge exchanges by cluster firms. It is crucial that cluster firms realize the important role developing their own knowledge creation capabilities plays on increasing their cluster's knowledge creation capability. Only if cluster firms are capable firms can they use external knowledge effectively to create new knowledge inside the firm and then feed it back into the cluster so that the enhanced knowledge creation process within the cluster continues. It is crucial for cluster firms to keep investing in developing absorptive capacity in different knowledge domains and improving the operation of their knowledge creation spirals so that they can utilize external knowledge to the fullest extent and keep making contributions to the knowledge base of the cluster.

Antecedents of a Cluster's Knowledge Creation Capability (ANDAÇ T. ARIKAN)



Part C: Indian pilot

There are currently 24 cluster based public support programmes (since year 2000) across more than 1200 clusters (out of estimated 7000 clusters) with an estimated financial outlay of about Rs. 7000 crores over the 11th Five Year Plan (2007-12). This is a testimony to the potential that clusters hold in terms of policy level interventions to develop MSMEs in the country.

However, all these initiatives have focused on helping alleviate poverty, sustain employment or build efficiency (factors) driven competitiveness by way of promoting passive as well as active economies among stakeholders. Traditionally, these are achieved in a cluster through strong consortia of firms, pro-active industry associations, vertical linkages, mutually enhancing public-private partnerships and delivery of specialised institutional services etc. Little has however been done to promote 'innovations' among micro, small and medium enterprises (MSMEs) across clusters under these initiatives and have at best remained limited to technology dissemination.

Department of Science and Technology (DST), Ministry of Science & Technology has initiated a Programme on "Promoting Innovative Clusters (PIC) with a vision to promote collective research, development and commercialization among MSME clusters to promote production of high value goods and services using the innovation route. Investment in knowledge creation, acquisition, absorption and diffusion is critical for this purpose. This project aims to promote collective research and learning in clusters by facilitating linkages among enterprises and with knowledge providers/creators (i.e. institutions, consultants) to develop new and high value added products aimed at national and global markets. It is an action oriented project that builds on the best practices around the world and the FMC (Foundation for MSME Clusters) competence to foster cluster based MSME development.

The expected end of the project situation is stated as under:

(i) Pilot support initiatives implemented in select clusters to achieve innovations in traditional and modern sectors with a greater focus on the latter;

(ii) Scaled up initiatives to promote innovation in the targeted clusters with other public institutions/ ministries;

(iii) Knowledge base on promoting innovation clusters for SMEs in developing countries including methodology with case studies on best practices, training curricula and innovation index for clusters;

PIC initiatives are ongoing in six clusters. These are two pharmaceutical clusters of Ahmedabad-Vadodara (state of Gujarat), Hyderabad (state of Andhra Pradesh); Information and Communication Technology(ICT) cluster of Delhi-NCR and three foundry industry clusters of Samalkha, Faridabad and Kaithal (all in state of Haryana).

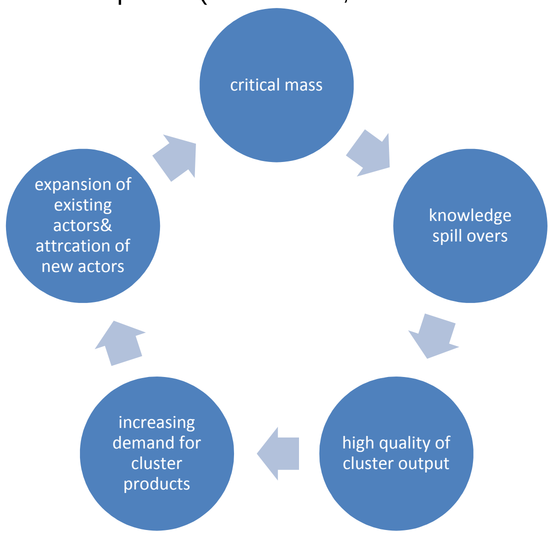
Strategic objective:

Foundry cluster	Build social capital
ICT cluster	Create demand for innovations
Hyderabad Pharma cluster	Transform to clean cluster
Gujarat Pharma cluster	Breed a new generation technopreneurs

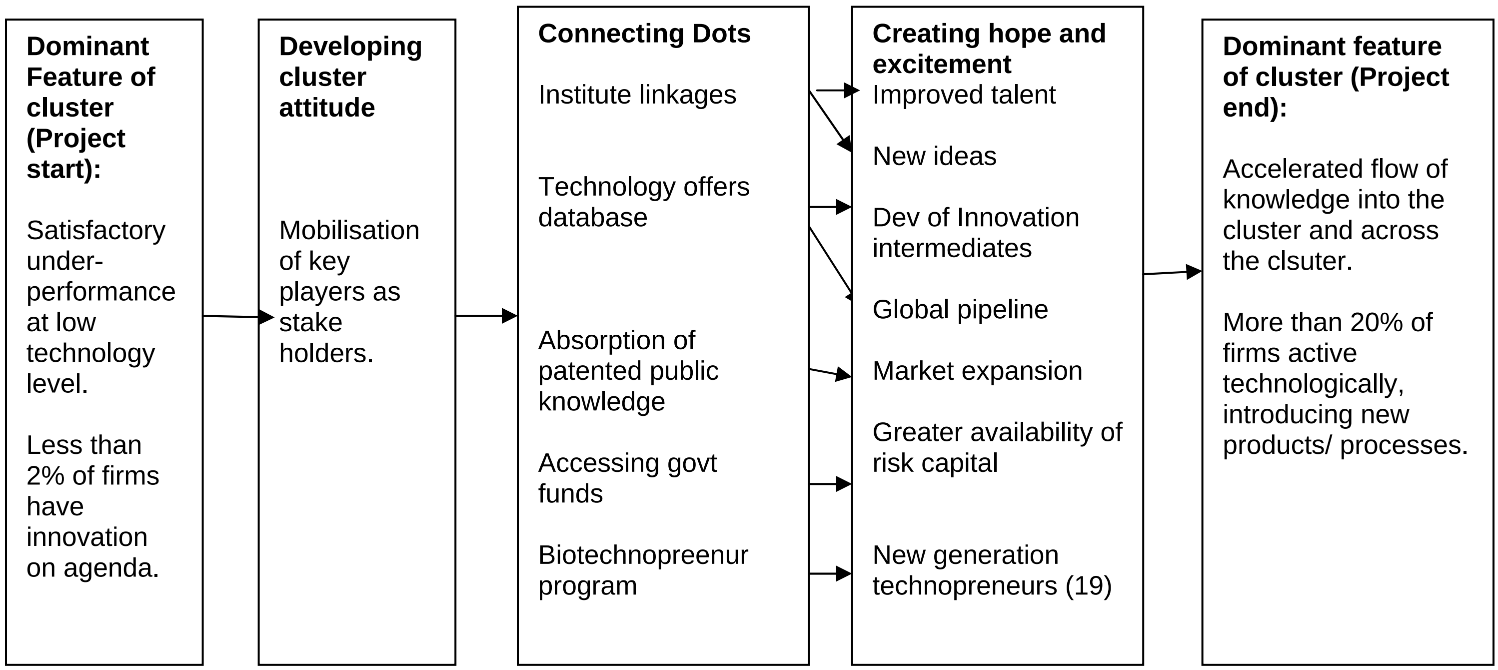
As part of this DST project, Prof Mohan and Dr Nirmalya, ASCI carried out `Pilot Study on INNOVATIVE SMEs from the PHARMA Sector in HYDERABAD Cluster'. Their findings:

- The majority of companies in Hyderabad have been set up by technical entrepreneurs. First generation entrepreneurs of 70's were employees of IDPL. Several companies like Dr. Reddy's Laboratories, Uniloids, Standard Organics, Jupiter Biosciences, Suven, etc. started their operations during this period. The second and explosive phase of growth of the cluster took place during the mid 90s, many employees of the first generation private pharma companies started their own enterprises. Most of these new entrepreneurs were former Dr Reddy's employees. The second phase of expansion of the cluster has led to the formation of a lot of SME that cater to specific APIs.
- Innovation in Hyderabad has been in the area of process reengineering and input substitution. In the formulation space, the innovations are either in NDDS or in coming out with a combination product or in coming up with a different form or dosage.
- Most of the local pharmaceutical graduates or chemistry graduates lack understanding of the bulk drug industry and have to be trained for 3-4 months to become productive. Universities in and around Hyderabad do not teach medicinal chemistry which is a big bottleneck.
- The character of the bulk drug industry is similar to the chemical industry in India and hence the BDS providers have played a limited role preoccupied with reengineering, coming into the picture only during setting up of a plant or restructuring of a plant. Very few BDS providers have an offering to engage with a bulk drug industry on a sustained basis.
- Cluster survived switch over to product patents but at a loss to deal with strict environmental regulations. During the mid nineties a PIL was filed in The Hon'bl Supreme Court of India against the pharma companies for discharge of effluents. Pollution control regulations require drastic reduction in existing effluents and hence scaling up becomes a big problem.

Virtual cycle for cluster development (DÜMMLER, THIERSTEIN 2002.)



To create a virtual cycle of accelerated knowledge flows in the cluster, several actions needed to be planned simultaneously. A series of activities planned to transform Gujarat cluster into an innovation cluster are shown below.



Part D: An appropriate model for Innovation Cluster.

Accelerated knowledge flows are central to development of innovation cluster and success of Knowledge transfer depends on the degree to which the knowledge is *re-created* in the recipient, mastering and getting into practice product designs, manufacturing processes, and organizational designs that are new to them. All aspects of technology transfer between commercial firms are covered in literature. The knowledge at source is embedded in different forms and articulated in varied forms. In the case of cluster, assuming absence of Knowledge gate keepers and chief Innovation officers, the innovation intermediary maps the knowledge and skill sets embedded in tools, practices, networks, people and develops a methodology to decode before re-packaging for transfer to new organisation.

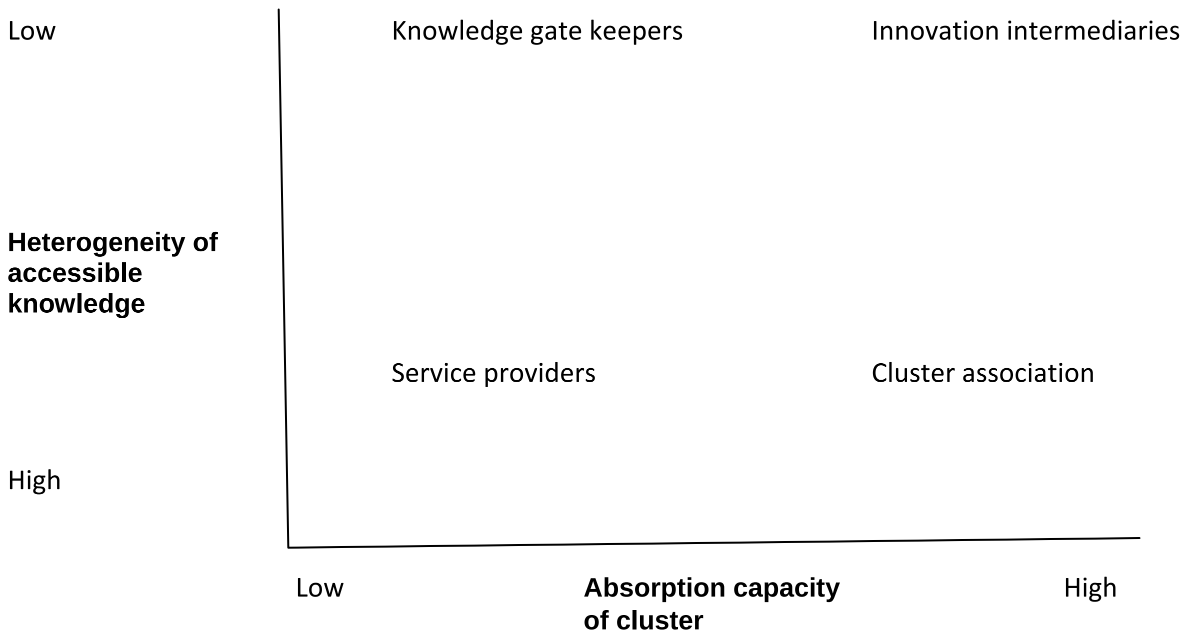
Successful transfer also depends on organisational distance, physical distance and knowledge distance. Knowledge flows in Bangalore IT cluster showed the interplay between organizational distance and physical distance. Knowledge distance is the degree to which the source and recipient possess similar knowledge. It has been found that, for organizational learning to take place, the knowledge distance or 'gap' between two parties cannot be too great. The reason is that too many learning steps will be required if the knowledge gap (or distance) is significant. The literature on inter-firm learning has emphasized the concept of "absorptive capacity", which means that firms differ in terms of their ability to learn. That is, a firm's ability to learn is related to the fit between the knowledge of the source and of the recipient.

Gilwlian defined cluster absorption capacity as capacity of the cluster to identify, assimilate and exploit knowledge coming from sources external to the cluster. Firms with higher absorption capacity work as receptors of external technology change, diffusing it to other firms. Accordingly he categorized the clusters;

Cluster absorption capacity (Gilwliani)

Basic	Absence of firms or institutions that link local knowledge flows to external sources of knowledge. Firms tend to operate independently. Knowledge spillovers seem to constitute a weak basis for enhancement of localized knowledge.
Low intermediate	Few cluster firms connect globally, remain like an external star with poor cluster linkages.
Intermediate	Knowledge flows are tapped, local creation effort is limited.
Upper intermediate	Knowledge absorbed and knowledge generated.
Advanced	Local knowledge flows nurtured by external knowledge flows.

For industry clusters focused on innovation, lock-in situations provide a problem as the process of innovation requires a variety of input enabling search and selection of new ideas. An optimal stream of input requires a combination of cognitive distance for the ideas to be novel and a fit to the absorptive capacity possessed within the cluster so that the value of the ideas can be rightly assessed.



Starting the process of building innovation cluster begins with identification of key players and taking only two parameters, accessible knowledge and absorption capacity, four groups emerge.

Association of cluster units: The knowledge is accessible and within the absorption capacity of the cluster. There will be need to participate in tradeshows, organize buyer-seller meets, lobby for funding modernization, train the students (the future employees). In Gujarat cluster, Industry-institute linkages were created for students of Bio Medical Engineering Colleges by providing them access to industry sponsored projects.

Service providers: In traditional clusters, new knowledge is introduced by consultant. Similarly in Innovation cluster the consultant is needed in several fields as knowledge base of cluster firms tend to be narrow. Consultant was supported in Hyderabad cluster to provide solutions for solvent recovery.

Knowledge gate keepers: Services of local research institutes to be enlisted to keep track of developments. Vibrant social community created in Hyderabad and NCR clusters with speaking sessions on new technologies.

Innovation Intermediaries: To scout for new technologies and put in a global pipeline of knowledge flows, Innovation intermediaries need to be groomed for network database, network construction and network management. Two organizations supported at Ahmedabad and Hyderabad to develop a database of technologies on offer suitable for cluster firms.

Summery

A sustained and large investment of time, money, expertise and leadership is not only desirable but fundamentally necessary to the creation of innovation clusters across the nation. An analysis of biotechnology clusters across the United States showed each of these areas has had an average of $500 million annually in funding from the National Institutes of Health (in 2001 dollars) for more than a decade, and $750 million in new venture capital investment during the past six years. And each area also has one or more of the nation's 20 top-ranked medical research universities, and two or more of the nations' 50 principal biotechnology venture capital investment firm.

A beginning has been made with DST project and learning is crucial to roll over scale up versions all across the nation. Some pointers:

- Orchestrate support for research, start-ups and cluster together. Innovation Cluster strategies are less a specific program than a framework through which to shape and coordinate disparate policies.
- Recognize and strengthen the crucial role of knowledge-generating institutions.
- Fund and encourage the development of a pro-entrepreneurship and pro-business culture.
- Incentivize and support credit flow to startups as well as to more established companies.
- Create and invest in workforce development programs that are the foundation of a high tech economy.
- Cultivate through structured programs and informal gatherings strong networks of regional cluster stakeholders.

Acknowledgement
A question - Are Innovation Clusters real?' posted on October 12, 2009 on LinkedIn group `Science, Technology & Innovation Policy professionals' elicited response from across the globe. Many shared their views and papers. Acknowledge contribution by all the practitioners.

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