A Comparative Study of the Dynamics of Innovation Systems in three Clusters from Korea and Malaysia

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Abstract: 'Spatial proximity' of firms is being increasing cultivated by governments in Asia with policies driving the development to 'cluster' firms. Based on Innovation Systems theory, this 'clustering' of firms is hoped to help increase interactions, not only among firms, but also of firms with other 'institutions' like universities, trade associations, government entities etc.. Which in turn would facilitate sharing of knowledge and increase capacity for localized learning by firms, and thus leading to innovation.. This paper analyses and compares innovations systems in four Asian clusters from Korea, Malaysia and India. The paper identifies leading entities, infrastructures and functional capacities for R&D within these clusters. Then the structural combinations and interrelationships of R&D producing entities such as university and national research institutions, R&D achievements delivering entities like techno-parks and related associations, and also R&D consuming entities such as corporations are also studied. The specific role of governments in these innovations systems is also investigated and lessons are drawn with implications for policy makers and industry.

1. Introduction

The notion of clustering or regional development is increasingly being associated with global information resources, development of advanced skills, continuous innovation and diffusion of new technologies. Based on the concept of National System of Innovation (NSI), it is argued that 'clustering' of firms could to help increase interactions, not only among firms, but also of firms with other 'institutions' like universities, trade associations, government entities etc. - which in turn would facilitate sharing of knowledge and increase capacity for localized learning by firms, and thus leading to innovation (Aziz and Omar 2001). These capabilities are considered essential to sustain international competitiveness and build a knowledge-based economy. Numerous cities and countries across the world have started clustering efforts naming themselves Silicon something e.g., Silicon Island (Taiwan), Silicon Plateau (Bangalore), Silicon Alley (New York), Silicon Hills (Austin Texas), Silicon Fen (Cambridge, U.K.) and attempted to copy the 'Valley's' success story. The 'cluster' based approach for industrial development is becoming popular among many developing countries and more particularly in Asia also in recent times. Various policies have been or being developed and incentives are being offered, infrastructures and institutions have been or are being built to develop these clusters. This study explores leading entities, infrastructures and functional capacities of R&D through the case studies of four clusters - Banwol-Sihwa Cluster and Goomi Cluster in South Korea, and The Multimedia Super Corridor (MSC) Cluster project of Malaysia.

The key Questions that guide the study are:

1. Examines the different institutions / actors that exist or have been developed –in the different clusters that help in the developing innovation capacities.
2. What are their linkages with other institutions, for enhancing innovation, in the three different clusters

The structural combination and interrelationships of R&D producing entities such as university and national research institution, R&D achievements delivering entities such as techno-park and related associations, and R&D consuming entities such as corporations will be explored. Finally the aim is analyse the similarities and differences of the dynamics among institutions in the different clusters studied – and through this inform academics and policy makers of different practices and programmes.

The paper has the following structure – a brief on the conceptual background is presented in the literature review after the introduction section. The framework for the paper and the methodology is outlined. The three cases developed are presented and this is followed by an analysis of the cases and conclusions. Finally some policy recommendations are developed.

2. Some Literature providing the Background to the Study

Clusters as Systems of Innovation

In modern innovation theory the strategic behaviour and alliances of firms, as well as the interaction and knowledge exchange between firms, research institutes, universities and other institutions, are at the heart of the analysis of innovation processes. Innovation and the upgrading of productive capacity is seen as a dynamic social process that evolves most successfully in a network in which intensive interaction exists between those 'producing' and

those ‘purchasing and using’ knowledge. Industry clusters are regarded as an important tool in policies related to national innovation systems (NIS), an important theoretical framework in European national and regional policy circles (Bergman and Feser 1999).

Overview of National Innovation Systems Concept

Pioneering studies on the concept of ‘National Systems of Innovation’ (or National Innovation Systems) include those by Lundval (1988), Nelson (1988) and Freeman (1987). Lundvall (1992) defines NIS as "the elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge. . .that are either located within or rooted inside the borders of a nationstate (quoted in Roelandt and den Hertog 1999, p. 2). The Innovation Systems framework captures the social character of the innovation process by embedding the innovative efforts of individual forms in networks of relationships with other organizations such as supplier firms, universities, research centers, government departments, financial institutions and end-users. The new knowledge required for innovation is created through joint efforts of the above knowledge generating actors operating in an institutional setting, with the support of formal institutional actors (Omar and Aziz 2001). There are several definitions of National Innovation – several definitions of key authors in this field are given in the box below.

Box 1: Definitions of National Innovation Systems

“... The network of institutions in the public- and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies” (Freeman, 1987)

“... The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge... and are either located within or rooted inside the borders of a nation state” (Lundvall, 1992)

“... The set of institutions whose interactions determine the innovative performance of national firms” (Nelson and Rosenberg, 1993)

“... The national system of innovation is constituted by the institutions and economic structures affecting the rate and direction of technological change in the society” (Edquist and Lundvall, 1993)

“... A national system of innovation is the system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology” (Niosi et al., 1993)

“... The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country” (Patel and Pavitt, 1994)

“... That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies” (Metcalfe, 1995)

Source: Niosi, 2002, p. 292

The concept of National Innovation Systems (NIS) focuses on flows of knowledge in and how policy makers can accost possibilities on ways to embellish innovative exploits in the knowledge-based economies of today by understanding these systems (OECD 1997). An NIS is considered important for the development of institutions and the relationships between them to increase national innovative capacity. According to Freeman [4], the importance of national and regional systems of innovation derives from the networks of relationships, which are necessary for any firm to innovate. “Whilst external international connections are certainly of growing importance, the influence of the national education system, industrial

relations, technical and scientific institutions, government policies, cultural traditions and many other national institutions is fundamental [Freeman 1997].” The smoothness of knowledge flows – among enterprises, universities and research institutions – relies firmly on the graceful execution of innovation systems. The implements for knowledge flows can include joint industry research, public/private sector partnerships, technology diffusion and movement of personnel [OECD 1997].

Based on the above arguments from NIS literature – that links and relationships among institutions from industry, government, and academia are important in the evolvement of a cluster with goals of promoting innovation – this study is conducted. In the next section – the broad framework and methodology for the study is outlined.

3. Methodology

A basic NIS based framework was used as the basis for the collection of information to develop each cluster case. According to the NIS framework - science and technology are understood in the context of the innovation system, which means that there are many related actors and the development and utilization of science and technology take place through complex processes. Research at an R&D laboratory does not automatically lead to marketing. To utilize the research results, more actors are needed, like a technology transfer centre, venture capital, a bank, a managerial consulting company, a business entity or an entrepreneur, and so on. The following diagram represents the NIS framework:

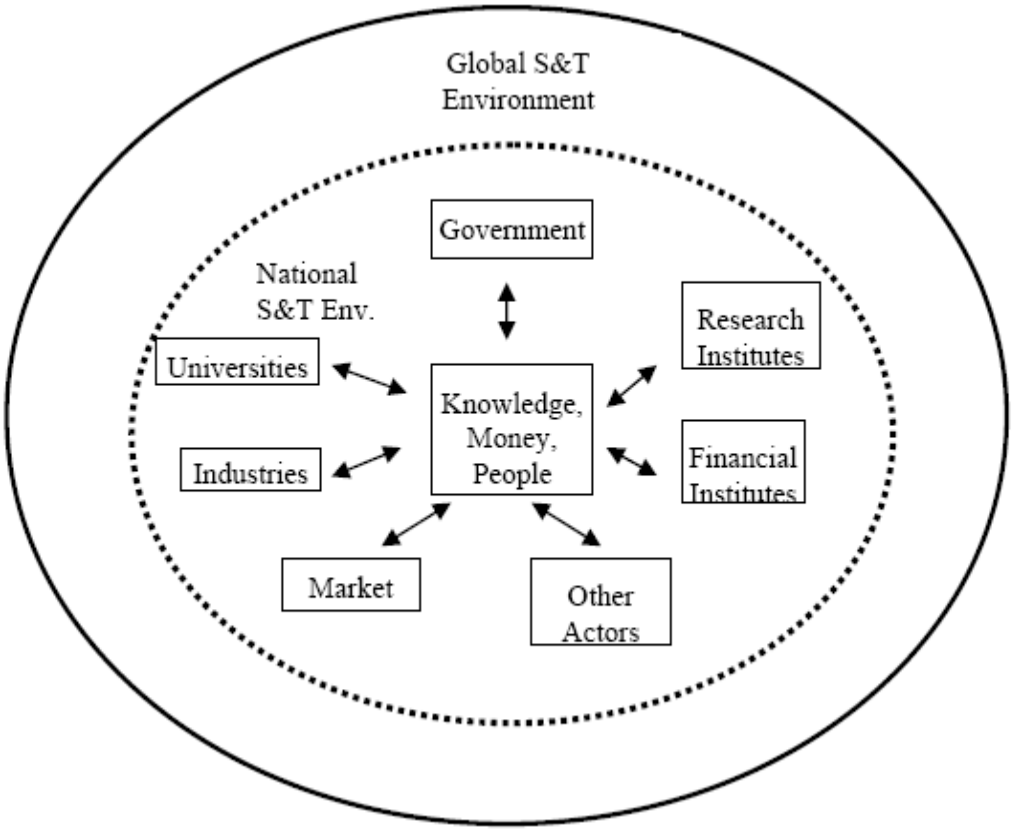

Figure 1: National Innovation System : Source Yim and Agrawal (2006)

From the above general framework – we develop an operational framework for the purpose of this study as follow:

R&D Consumption Institutions
- Large and Small Firms

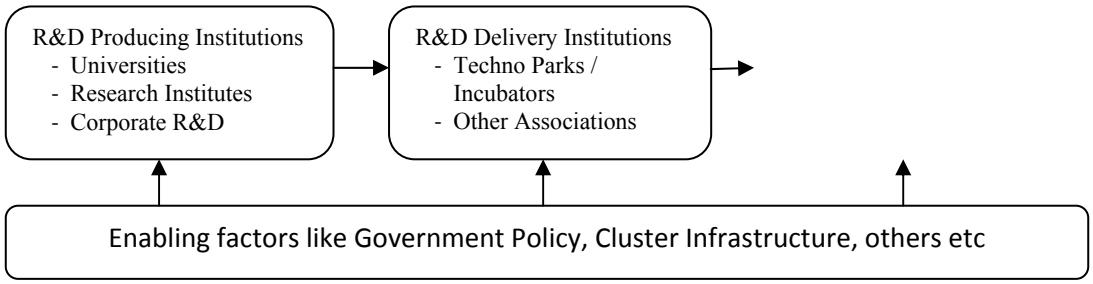

Figure 2: Framework for the Study (Main Entities in R&D Process/ Innovation Capacity)

In order to develop information for the paper – both primary and secondary data have been collected. Several experts in the Korean and the Malaysian Clusters have been consulted and have been interviewed. In addition published relevant material from articles published in magazines, journal and website were gleaned to develop the cases further. We first studied the main entities and their roles of R&D per cluster by consulting with experts on general management policies of cluster. The interviews conducted with respondents from cluster management organisations, universities, some companies, and other associated organizations in relation to R&D capacity in all the clusters. Finally a comparative analysis of the three clusters explored was done. In the next section – the case studies are presented followed by findings from the cases.

4. Cases Studies of the Four Clusters

In this section we present the case studies that were developed for the study. The three cases studies are Shiwa-Banwol and Goomi Clusters in Korea and MSC Cluster in Malaysia. The cases developed are structured as follows. First an overview of the cluster is presented. Some key events in the evolution of the cluster are listed. This is followed by a description of the key institutions in the cluster based on the framework developed. The role played by these institutions and linkages between them is then outlined. Some outputs of the cluster are presented – either through an anecdotal case – or some macro data.

4.1 Case 1 –Banwol-Sihwa Cluster (Korea)

- Strengthening the Innovation Capacity of an Electronics Parts/Materials Cluster

Banwol-Sihwa Cluster, located at the center of industrial belt nearby the west sea of South Korea, is one of the biggest cluster for small and medium companies built from 1977 to 2006. Total number of companies located is 9,484 (Banwol: 3,299, Sihwa: 6,185). Total outputs, exports, and employees of Banwol-Sihwa Cluster are $45 billion, $78.5 billion, and 172,000 respectively as of December 2007. Total outputs, exports, and employees of Banwol-Sihwa cluster represent 14.3%, 5.1%, and 25.7% respectively of total industrial parks located in South Korea. The area of Banwol-Sihwa Cluster is considered to have well developed industrial infrastructure and is located near to the national capital region and to the west sea. Access to international network system is considered easy the Incheon International and Gimpo Airports, the Incheon and Pyeongtaek Harbors, and Bugok freight terminal are nearby. Only 30km from Seoul City, it is part of a network system that includes the Seoul Digital Industrial Park, Sangam DMC, and Namdong Industrial Park. These days, Banwol-Sihwa Cluster, which used to be simple manufacturing centre nearby Seoul, has evolved to be a global supply base of high value-added technical products and parts by strengthening its technical and industrial R&D capacity and competence of

companies located in the cluster.

Course of change in companies and industrial structure of cluster

In contrast to 2000 when industries leading in order were machinery(37.9%), electronics (13.0%), petrochemical(10.3%), transportation equipment(8.7%), and fiber clothing(7.1%), there are currently leading industries in order of machinery(43.4%), electronics(15.1), petrochemical (10.1%), and steel(8.5%), and transportation equipment in 2007.

Box 2: Chronological Events in the Banwol-Sihwa cluster Policy

- 2004.06.: Industrial Park Innovation Cluster selected as an official national task. First Promoted some exhibition parks and assigned additional exhibition parks (Exhibition parks: Banwol-Sihwa: parts, Changwon: machinery, Wonju: medical equipment, Goomi: electronics, Gunsan: Machinery and vehicle parts)
- 2004.12 : Established basic business plan for innovation cluster to facilitate the execution of cluster plan
- 2005.02 : Reformed the organization of Korea Industry into cluster system
- 2005.04 : Established cluster promotion team (Started industrial park cluster business as exhibition parks)
- 2007.11 : Assigned 5 additional exhibition parks in the Conference on Innovation Cluster Policy
- 2007.12 :Established detailed strategies for each additional park by creating a task force team of experts from industry, academy, and research
- 2007.12~2008.02 : Established a networking system of industry, academy, and research and established a masterplan including the core R&D- 5 additional parks : Namdong in Incheon(Machinery Parts), Daebul in Chunnam(medium ship building), Sungseo in Daegu(mechatronics), and Ochang in Chungbuk(electronic information)
- 2008.04 : Established cluster promotion team and started industrial park cluster business

Current state of Research & Development in cluster

R&D institutions and Investments

There are 3,071 R&D institutionss in Gyeonggido that surrounds Banwol-Sihwa region, which makes up 28.2% of total R&D institutions in South Korea. Amongst them, Corporate Research Centers make up 26.7%, Public Research Institutions make up 18.6%, and University Research Centers make up 18.7%. Some of Research institutions include Korea Institute of Industrial Technology (KIIT), Korea Testing Laboratory (KTL), Korea Electrotechnology Research Institute, and Korea Ocean Research & Development Institute. Amongst research institutions for companies located in Banwol-Sihwa cluster, there are Korea Institute of Industrial Technology, Korea Testing Laboratory, Korea Electrotechnology Research Institute, and Korea Electronics Technology Institute.

In case of KIIT, it obtains/accesses fundamental technology related to manufacturing, through a networking system with foreign universities and research institutions, and has a capacity to develop the core technology in relation to high-end intelligence robots and such. KTL has the role of approving the quality of products manufactured, assists companies attaining approval certificate from foreign countries, provides general quality approval related information like electronics products quality approval and other national approval, verifies the security and efficiency of public and industrial equipments through its testing laboratory technology, executes its R&D process on testing laboratory technology, and other takes charge of other major testing like environmental equipments quality approval, medical equipments quality approval.

Total R&D investments of Gyeonggido are known to be approximately $11.2 billion, which make up 41.1% of total investments of South Korea and total numbers of researchers at research institutions are 87,246, which make up 34.0% of total researchers in South Korea. There are 41 public research institutions, 55 universities, and 2,974 companies; especially, there are many company-owned research centers.

University and other Higher Education Entities

In Gyeonggido province (where the Banwol-Sihwa cluster is located), there are a total of 56 colleges; 23 4-year colleges and 33 2-year and 3-year colleges. In Banwol-Sihwa cluster, there are two 4-year colleges such as Hanyang University and Korea Polytechnics University as well as 2-year and 3-year colleges including Gyeonggi Institute of Technology, Ansan Institute of Technology and Ansan 1 University. There are various universities including Hanyang University and Korea Polytechnics University that provide machinery/electronics/parts related classes, which are directly associated with parts material industry. Meanwhile, major universities have been strengthening their linkages with companies and public research institutions in the cluster. For example, Hanyang University (Ansan Campus) and Korea Polytechnics University focus on joint-research with companies and research institutions. There are also other major technology distribution and transferring programs such as academy/research institution/industry cluster (Hanyang University), Engineering House (Korea Polytechnics University), Family company policy (Korea Polytechnics University and Gyeonggi Institute of Technology), and Consumer Order Education (Ansan Institute of Technology).

In terms of education business, there are remote technology center (Korea Polytechnics University), Korea and Germany joint Bosch training center (Gyeonggi Institute of Technology), and technology teaching university(Ansan Institute of Technology). These universities are also considering letting public taking a benefit of their attained machinery and equipments by letting them using their machinery and equipments with some fees. There are also various support and research centers including Siheung Environmental Technology Development Center (Korea Polytechnics University), Gyeonggi Small and Medium Business Center, New Product Development Center, Precision Measurement Technology Center (Gyeonggi Institute of Technology), and Design Research Center (Ansan Institute of Technology)

R&D Delivery/Intermediary Entities / Institutions in the Cluster

There are several entities developed to help in building the innovation capacity of the Banwol-Sihwa cluster – with the role of helping the R&D outputs to be developed into marketable products. They include the 47 technology business incubation and business incubation centre with the sole purpose being encouraging the establishment of new business. For technology business incubation, there are two centre; at Gyeonggi Techno Park and at Kunggi Daejin Techno Park. Most of the Business Incubation centres are operated by universities in the cluster. There are also two business incubation centers operated by public research institutions like Korea Institute of Industrial Technology.

In addition to technology business incubation and business incubation, for most of other R&D related business supporting program, central and regional governments provide the funds and some funds are also provided by private sector. For example, Ministry of

Knowledge Economy supports various programs including industrial park innovation cluster business, regional innovation center business, local technology innovation business, and industry/academy cooperation focused university development business. Ministry of Education, Science, and Technology supports programs such as 2-year and 3-year college specialization business and industry/academy/research institution networking system encouragement business. Small and Medium Business Administration supports industry/ academy/research institution joint technology development business.

Box 3. Example of Business by Korea Industrial Complex Corporation

1. DAEMO(www.daemo.co.kr)
○ Established date/year: 1989. 10. 01
○ Number of Employee: 74 in Korea (132 in USA/China/Europe)
○ Revenue: $34.9 million as of 2007(As of November 2008, $40 million is anticipated)
○ Participated in development of customized technology business

Daemo, selected as a company in charge of the sub mini cluster kick-off held in 2005, experienced a dramatic increase in sales by developing "70-ton hitting power adjustable oil pressure brake"in cooperation with Korea Polytechnics University. Especially, it developed 8 new technologies with the assistance from Korea Industrial Complex Corporation (ex, heat treatment expert's instruction) and external consulting firm. In details, although it only received small amount of funds through customized technology business, it was able to test its new prototype product. In the past, it used to cooperate with Hanyang University and Korea Institute of Machinery and Materials. However, it cooperated with Korea Polytechnics University through minicluster in this case for structural and FM analysis as well as finding of a solution.

2. Jeis(www.jeiskorea.co.kr)
○ Core products/services: Aluminum parts precise manufacturing/anodiging/electrolytic polishing(EP treatment) and other surface treatment services provider
○ Established date/year: 2000. 10
○ Participated in development of customized technology business
- Started from 2005 and saw achievement through R&D task. Jeis was a company in charge of and Hanyang University was a participating institution.
- Funds for task were $100,000 on average. It didn't participate in 2008 and is now under joint-study with Korea Research Institute of Standards and Science.

○ Patents
- Amongst 15 patents it currently has, it received 3 from this task.(It only has 50% ownership for those attained in cooperation with Hanyang University)

○ Appropriate amounts of R&D expenses for development of new product
- Although $100,000is enough to fix bottleneck of technology, $7 to $8 million is needed for development of new product, which should be enough to cover worldwide company.
- Especially, when deciding the task, it should be noted that it has "structure to contribute newly developed technology to society". Duration of the task should be 3 years at the minimum and 5 years at the maximum.

※ Jeis R&D center is under construction

In addition the other institutions and programme in the cluster include the Techno Park Establishment Business programme, Regional Innovation Center Business which supports regional companies by building an innovation center at university in order to assist building machinery and equipments, R&D, developing workforces, establishing a new company, seeking business opportunity for new technology, and marketing. *Local Technology Innovation Business whose role is in* building infrastructure to strengthen technology innovation capacity to attain self-generated growth potential for the region. There is also a *Industry/Academy Cooperation Focused University Development Business.*

An Example of the Structure and Role of a Techno Park in the Cluster

Gyeonggi Techno Park, the representative techno park in Banwol-Sihwa Cluster, has attracted domestic companies as well as 11 foreign companies and is considered to be the more successful techno park. Some of the reasons for its success are given as follows:
it is located near a university for the faculty and students to be easily and activelyinvolved with companies located in techno park.
it has national research and public testing institutions like Korea Testing Laboratory, which can help companies fix bottlenecks of their technology and to also develop new technology.
Thirdly, the entrepreneurial role of of Head of the Gyeonggi Techno Park, Dr Bae Sung Yeol – who although is currently employed as a full-time professor at Hanyang University, has been actively involved in developing a creative company-friendly environment of Techno Park by forming a proactive networking system with regional government and other major innovation entities in the cluster.
He has also recently established a 'technology conference' for each core technology developed by companies located in Banwol-Sihwa Cluster – where both large and small and medium companies seek to proactively participate in and to collaborate each other.

Other Supporting Institutions in Cluster

The followings are major functions, tasks, and businesses run by company supporting institutions located in Banwol-Sihwa Cluster. Korea Industrial Complex Corporation takes a charge of establishment of industrial park innovation cluster and development and management of industrial park and provides general supports for companies in Banwol-Sihwa Cluster. Parts and Materials Researchers have developed supporting system to enhance the technology to deal with parts and materials technology fusion and promote effective investments by utilizing the research resources that public institutions have such as workforce, equipment, and information. Small Business Corporation provides funds for small and medium companies as well as training program, consulting, international collaboration services. Gyeonggi Small Business Center is operating E-business information center and takes charge of Gyeonggi WTC. Gyeonggi Research Institute publishes innovation roadmap for each strategic industry and supports establishment of regional industrial policy.

Overall from the case and some anecdotes, it can be seen that there is a plethora of institutions developed for R&D production and consumption and also intermediary institutions and several supporting programme by the governments within the cluster to link the different stages of the R&D process. The next case looks at Goomi Cluster.

4.2 Case 2 – Goomi Cluster

Goomi Cluster is located in the Kyoungbook province (in the South East part of Korea) was first built in June 1969 with a purpose of balanced development among the different regions of Korea as well as national economic growth by expanding industrial parks and increasing exports of electronics products. The Ministry of Knowledge Economy has assigned 7 exhibition parks as a future innovation clusters including Goomi Cluster – as it is supposed to have successfully transformed into innovation center from a simple gathering of technology companies.

Key Institutions in Goomi Clusters

The main education institutions in Goomi are Kumoh Institute of Technology, Kyungwoon University, Goomi 1 University, and Korean Polytec. While these institutions may not have capabilities to supply needed workforce for companies in Electronics Parts/Materials Industry Cluster - there are enough universities in Daegu region to supply additional workforces for Goomi cluster. Other critical institutions are the 14 financial institution including Industrial Bank of Korea and Korea Credit Guarantee Fund in Goomi Cluster, companies have access to raise needed capital, which is one of the most significant elements of innovation cluster. There are many supporting institutions including Korea Industrial Complex Corporation in Goomi cluster, which all provide supports for both manufacturing and R&D activities of company. As most of companies in Goomi Cluster export their products, there is a customs office in the cluster while there are also taxation office, registry office, and Gyeongbuk Small and Medium Company Business Center. Goomi Cluster also has well-built medical institutions and welfare facilities to provide the most comfortable working environment for employees.

Status of Supporting Institutions for Companies

The Small and Medium Company Business Center, located in the 3rd complex, has an incubation center, comprehensive consulting center, exhibition area for products of small and medium company, large conference room, small conference room, seminar room, and other administrative offices in order to facilitate networking among small and medium companies.

Box. 4. Example of successful joint-research project between Kumoh Institute of Technology and Korean Industrial Complex Corporation

○ Incase of strengthening capacity project promoted by Korean Industrial Complex Corporation, it has been promoted in Bottom-Up process. 10 companies chose the item and promoted 3 tasks. It was a huge project with $5 million funds, whereas 75% came from national fund, 15% from companies, and other 10% from regional government. The project was "Development of flexible display by utilizing flexible element" and was limited to Kolon and Woongjin Chemical for large company. Although the role of professor is to provide supports or to carry out consigned research, it is very significant in terms of overall research process and project management. Furthermore, with Goomi Cluster promotion team as the entity in charge of this project, human network proved to be indeed very important.

- With the structure of 'element-film-development of equipment', all participating companies are able to benefit from it.

○ Success factors of the task

- If total R&D funds are above $5 million, it is perceived to be possible to develop a new product utilizing its technology. Moreover, universities and government agencies should keep a balance of the project as the project managers while large companies become end-users and small and medium companies supply the needed materials or manufacture the products themselves. Our interviews with experts and project-related personnel in cluster confirmed it as well. In addition, for such a huge project to be successful, there should be a trustworthy networking system amongst participating companies, which all should be located near to each other for continuous collaboration and exchange of information and knowledge.

Goomi industrial technology information center, promoted by joint-consortium project between city of Goomi and Kumoh Institute of Technology, provides information in relation to domestic industrial technology, foreign industrial technology, domestic/foreign patents, and other general information. It facilitates networking by operating Korean Standards Association Goomi branch, business center for small-sized business in Goomi, business center for small and medium company in Daegu/Kyungbuk region, Goomi industrial technology information center (joint-consortium between ity of Goomi and Kumoh Institute

of Technology), Kumoh Institute of Technology precise measurement center, technology supporting center for automation of small and medium company manufacturing process (Korean Polytech University), and information conference for venture companies in Goomi.

Goomi Cluster promotion team of Korean Industrial Complex Corporation is currently operating 6 mini clusters for specialized industries and has 581 members (400 companies, 136 from university, 23 from research center, and 22 from supporting institution). It is actively engaged in providing solutions to bottlenecks of technology and developing a new technology.

For venture-related research centers operated by either university or company, Kumoh Institute of Technology has 9 research centers including RRC, industry/academy/research institution center, applied electronics research center and has about 270 researchers. Kyungwoon University, Goomi 1 university, and Korea Polytechnic VI university has its each research center and there are about 140 researchers. For company, there are 500 researchers in wireless communication research center by Samsung Electronics and 171 researchers in image product research center by LG Electronics. In addition, there are 82 other research centers with more than 4,000 researchers in Goomi Cluster.

Table 1. Status of supporting institutions for company

Institutions	Main duties
Business Center for Small and Medium Company	Business incubation, consulting, exhibition of small and medium company's products
Goomi Industrial Technology Information Center	Provides onshore/offshore new technology and information, marketing supports(Establishment of networks), industrial technology, international patent information, technology books, technology map, and EC-Bank Joint Consortium of city of Goomi and Kumoh Institute of Technology
Korean Standards Association Goomi branch	ISO14000 Approval, QS9000 Approval, Sets standards for tast
Business center for small-sized business in Goomi	Small-sized wholesale or retail business, food business, lodging business For service business less than 5 employees Manufacturing and construction business less than 10 employees
EMC	Provides EMC and other safety size tests Supports manufacturing technology Develops workforces
Goomi Venture Company Seminar	Number of Member : 58(Number of member in assigned zones : 26) Number of INNO BIZ : 11
Kumoh Institute of Technology Precise Measurement Center	Provides small and medium company the access to its facilities
Technology supporting center for automation of small and medium company manufacturing process	Automation of manufacturing process and development of technology in regards to system Builds automation machinery for supports standardization of flexible manufacturing system
Korean Industrial Complex Corporation Goomi Innovation Cluster	Operates mini cluster Provides various types of R&D supporting program such as development of new technology and solution for bottleneck of technology

Source: Presidential Committee on Balanced National Development(2004), Changes to exhibition industrial park innovation cluster plan

Goomi Cluster is considered to be a successful cluster (despite recent decline in exports from

the cluster) as it has expanded its size for four times in last 30 years. There are also companies such as Samsung and LG and many small and medium companies that are in a close collaboration with them. As a result, Goomi cluster is perceived to have the biggest growth potential among exhibition innovation clusters in Korea. The total size of Goomi Cluster is 22 million m^2 and the total number of companies is 1,069. The total outputs are $45.2 billion and the total exports are $38.1 billion. Especially, there are 74,000 employees working in Goomi Cluster. Goomi Cluster is said to be a world-class cluster in PDP, LCD, and mobile phone industry.

Table 2. Company Structure in Goomi Cluster

Types	Number of Company	Name of Company
Mobile	218	Samsung Electronics and others
Display	186	LG Electronics and others
Semiconductor	10	Magna Chip, KEC, and others
Machinery	162	Ilsung Machine and others
Electronic parts/materials	187	Kolon, Toray Saehan, and others
IT fiber	65	Hyosung, Cheil Industries, and others

The core products manufactured in Goomi Cluster include LCD, PDP, CRT, mobile phone, digital tv, and electronic exchanger, most of which are electronics and information technology related products. In PDP, LCD, and DTV industry, top 3 companies in terms of market share are all large Korean electronics companies that manufacture top 22 selling products. In addition, Goomi Cluster is the world's third largest manufacturing site for mobile phone industry. Goomi Cluster has produced 22 products including mobile phone, TFT-LCD, and display that were chosen as world's top products(pertain to products that are ranked in top 5 in terms of world's market shares) and is producing 17 products that could be chosen as world's top products within next 3 years. It is predicted that as the paradigm and role of electronics are rapidly changing, PDP TV and LCD TV will be slimmer and bigger, information technology products will be those equipped with both digital and optical science technology, and parts/materials products will be like TFT-LCD, flash memory, and secondary battery.

4.3 Case 3 – The Multimedia Super Corridor (MSC) Cluster in Malaysia

Overview on MSC cluster

The Multimedia Super Corridor in Malaysia is a policy driven cluster development, and is to help Malaysia to leapfrog into the information age by creating an environment that encourages innovation by attracting local and multinational companies and their eventual partnering with IT players around the globe. Originally, it includes an area of approximately15km by 50km squared, which stretches from the Petronas Twin Towers to the Kuala Lumpur International Airport, and also includes the town of Putrajaya and Cyberjaya. This corridor houses core MSC initiatives (also called Flagship Applications), which include high-technology projects such as e-Government, Telemedicine, Smart School, Multipurpose Smart Card System, Research and Development Cluster, e-Business and Technopreneur Development.

Box 5 – Creation of Smart Cities to develop the MSC Cluster
Two Smart Cities are being developed in the Corridor; (1) Putrajaya, the new seat of government and administrative capital of Malaysia where the concept of electronic government will be introduced; and (2) Cyberjaya, an intelligent city with multimedia industries, R&D centers, a Multimedia University and operational headquarters for multinationals wishing to direct their world- wide manufacturing and trading activities using multimedia technology. Together, Putrajaya and Cyberjaya are to be the nuclei of the MSC. It has since been expanded to include the entire Klang Valley (Kuala Lumpur and surrounding sub-urbs) and to other parts of the country like Penang, Melaka, Pahang. By the year 2020, it is expected that the MSC will be extended to the whole country, transforming Malaysia to a knowledge-based economy and society, as envisaged in Vision 2020.

History and development progress of MSC cluster

Malaysia's path towards an IT-literate and knowledge society is a part of continuous government policy to chart the country's economic future since its independence in 1957. The success story of Malaysia becoming a "tiger" nation is considered largely due to the government's determined effort to transform the society from a predominantly agrarian one where the economy focused on rubber, palm oil, and petroleum to an industrial one with a significant manufacturing sector, focused on electrical, electronic and other sectors.

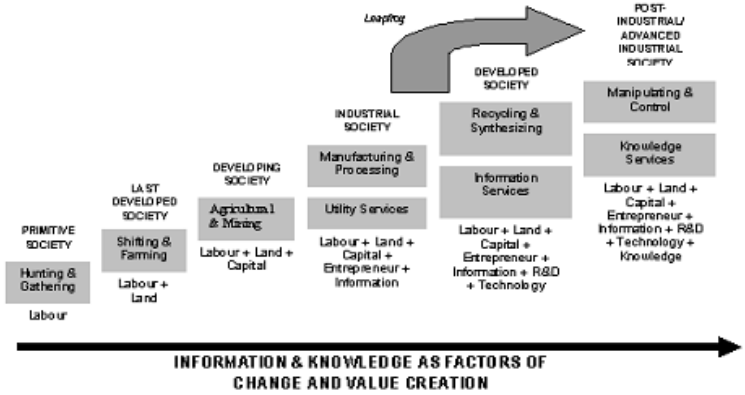

Fig. 3. Vision 2020-Fast-Tracking the Nation's Transition
Source : NITC Malaysia, Access, Empowerment and Governance in the Information Age, Building Knowledge Societies Series, Volume 1, UITC Malaysia, NITC Malaysia Publication, 2000

While earlier policies were formulated to bring Malaysia forward from a commodity- based economy to an industrial one, during the 90s the planning to transition to an information society and that to a knowledge-based economy (see Fig. 3) with a focus on the ICT sector was started. The Vision 2020 was introduced for becoming a developed country by the year 2020 and amongst various other initiatives; the National IT Agenda and Multimedia Super Corridor (MSC) Project was articulated as a cluster of firms in the ICT (information and communication technology) sector. In August 1995, Dr. Mahathir Mohammed the then Prime Minister of Malaysia, announced the "Multimedia Super Corridor" (MSC) as the centrepiece of the national IT strategy under the Seventh Malaysia Plan (1996-2000).

Special Cluster Policies and Institutions

The Government recognises local and international companies that undertake ICT activities in the MSC cluster by awarding them with a 'MSC Status'. Companies with 'MSC-status' enjoy a special incentives and benefits from the Malaysian Government that is backed by a ten-point 'Bill of Guarantees' – those organizations wishing to attain a MSC Status need to

abide by certain guidelines provided by the Multimedia Development Corporation (MDeC). The MDeC is a government owned but autonomous cluster development organization – specially set up – to play the role of a champion, facilitator, and partner for the companies that operate in the MSC. The MDeC markets the MSC initiative and some other roles which will be discussed in the following sections.

Government and Policy Factors

The role of the government in the MSC is pronounced through the establishment of Putrajaya, the new federal capital also housing the office of the Prime Minister of Malaysia. But what is more important it is the bed of the Electronic Government 'flagship application' initiatives. Putrajaya, the new seat of Government and Administration, is designed as a paperless environment experiment at electronic government. The Malaysian Government's legislative activities include the passing a number of acts and legislatures aimed to create the right environment for the development of the communications and multimedia industry. They have been termed as cyberlaws.

Comprehensive policies have been developed and being updated to encourage the development of the MSC, to encourage use of ICT and also accelerate the growth of the ICT sector. The Trade and investment policies, such as financial and non-financial incentives, a fair trade system, and import and export duties are in place promoting local and foreign investment. The Malaysian government has also defined attractive policies for foreign investment, such as streamlining the investment approval process, unrestricted employment of foreign knowledge workers, and freedom to obtain capital globally. More specifically for the firms in the MSC cluster, a number of incentives and projects are underway to foster entrepreneurship and business efficiency.

The government provides both financial and non-financial incentives to Malaysian businesses. Government's role as a financier is apparent where substantial financial incentives are made available to those companies given MSC status including a 10-year tax holiday, waived import duties on multimedia equipment, R&D grants, and a 100 percent investment tax allowance on new investment in the MSC. Non-financial incentives include unrestricted employment of foreign knowledge workers, no restrictions on global capital, and limited restrictions on ownership. A censorship-free Internet and a business environment free of the endless bureaucratic hassles that make setting up shop in MSC easier are also in place. All companies that create, distribute, integrate, or use multimedia products and services can apply for MSC Status. Once given the status, they do not only enjoy the above mentioned financial incentives but they also get exclusive rights to bid for flagship applications implementation tenders. To ensure all these policies are implemented the Malaysian Government commits to what is termed as a 'Bill Of Guarantees' are given to the firms operating in the MSC cluster.

Some other Cluster Entities to help in building Innovation Capacity

Advisory Body - The IAP

As part of the development of the MSC, the government has appointed an International Advisory Panel to provide advice and direction. The International Advisory Panel (IAP) is a group of leading CEO's and International experts who provide counsel to the Malaysian Government in shaping Malaysia's Multimedia Super Corridor (MSC). IAP Members' inputs and expertise have so far contributed significantly towards achieving this vision. MDC as the

body responsible for overseeing the development of the MSC has organized five IAP meetings, commencing from 1997. The last IAP meeting was held on 6-8 September, 2001. Recommendations from the 1st to the 5th IAP meeting have been taken into consideration and has been used as part of the strategy for the development of the MSC. For the 6th IAP meeting, MDC has decided that members from the local business community should also be invited to present their views and provide appropriate suggestions towards the development of the MSC.

The Cluster Development Agency – Multimedia Development Corporation

The Multimedia Development Coporation (MDeC), the government owned but autonomous organization, plays the role of a champion, facilitator, and partner of companies choosing to operate in the MSC. The MDeC markets the MSC initiative globally. Some of the roles, among many others, set for MDeC to develop the MSC Cluster include the following:

- Foster the development of "web" based collaboration in the MSC, Malaysia and globally.
- Catalyse and nurture local companies and SMEs to become global players by forging successful smart partnerships between Malaysian and international companies.
- Realise the promise of mutual enrichment by making it easy and cost effective for companies to do business in the MSC.
- Promote technology and knowledge development in the MSC through incentives for commercial R&D and through the establishment of leading incubation centers.
- Facilitate innovation and entrepreneurship by supporting the development of a financial infrastructure that provides venture capital and public listings for smaller companies.

The Finance Element of the MSC

In order to build technological capacities among SMEs, it was recognised that the existing traditional financial institutions could not help. In the MSC Cluster more options have made available like venture Capital from the MDeC for creating tech-entrepreneurial culture in addition, to other VCs. The MDeC also provides Special Grants for developing risk taking culture to help in developing an R&D culture. The government has also creating some innovative funding products and the ones from two funding agencies that stand out are - the Cradle Investment Programme (CIP) of the Malaysian Venture Capital Corporation and Malaysin Debt Ventures.

Research University and Incubators

The need for an University was seen to helping in technology development and to help in making available technically trained manpower for tech-based companies. For this purpose, in addition to identifying universities in the neighborhood, a new university, the Multimedia University was set up within the MSC cluster. It not only provides the required manpower – but more importantly serves as a research support base for SMEs which cannot afford to set up expensive infrastructure needed to conduct R&D activities for enhancing their technological capabilities. In order to enhance the numbers of technology based SMEs in the MSC region - a central incubator was identified to be the nucleus for the National Incubator Network that would link eight other centers which are already in operation. These centers include Technology Park Malaysia, UPM-MTDC Incubator and Kulim Hi-tech Park. The establishment of this incubator network was considered crucial to help generate the much needed pool of small and medium enterprises (SMEs) to meet the demands of the MSC cluster project when it rolls out nationwide. The incubator is located within the Multimedia

University (which is in the MSC Cluster) with 62,500 square feet of space. The MSC Incubator is now part of a larger nationwide incubator programme that is spearheaded by the Multimedia Development Corporation (MDeC).

The MSC Flagships Applications:
Institutional Network Arrangements for Enhancing Innovation Capabilities of firms

Another support element in the MSC Cluster is the "MSC Flagships". The government of Malaysia provided major government ICT projects to consortiums/network of companies to help kick start the MSC project. This network of firms would also help to develop technological capabilities among the local firms in the networks and the projects themselves were for social development, On one hand this provides 'demand' oriented incentives to attract the foreign firms to come into the MSC and partner with local firms while facilitate "learning" and some sort of transfer of capabilities to the local companies while providing market to the foreign technology providing companies.

Multimedia Development Flagships Clusters

This comprises of firm networks that develop applications to facilitate the development of society and government while they offer concrete business opportunities or in other words create demand for the services of the firms in the MSC. The four identified 'flagship applications' networks of firm within this group are

1. Electronic Government flagship
2. National Multi-Purpose Card flagship
3. Smart Schools flagship
4. E-Health flagship

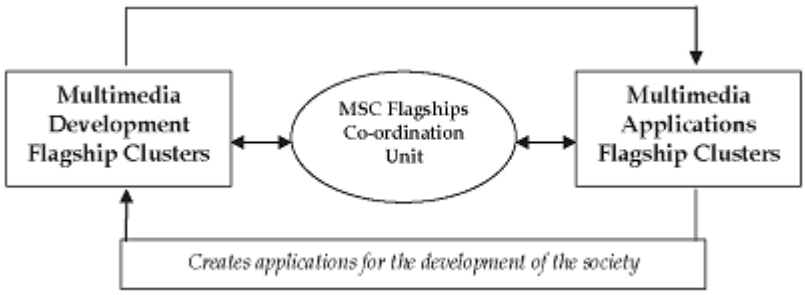

Fig. 4. The MSC Flagships and Co-ordination Units

Mu1timedia Environment Flagships Clusters

In the case of this flagship groups, firms involved carry out their activities within interactive clusters to develop ICT technology, products and applications, designed for enabling the applications in the Multimedia Development Flagship. Thus the main aim of this flagship is to aid the Multimedia Development Flagship firms. This category consists of firms developing applications and classified under the

1. R&D Flagship Cluster,
2. E-Business Cluster (combining Worldwide Manufacturing Web and Borderless Marketing Flagships), and most recently the
3. Technopreneur Flagship Cluster
4. Currently, in planning is also a Biotech Cluster.

The two groups of MSC Flagship networks of firms function or operate separately with their own goals. The MSC Flaghsip co-ordination unit, an institution under the regional development organisation MDeC,links the firms in two groups of MSC Flagships to realize the synergies planned between them (Figure 4).

The MSC Technopreneur Development Programme Flagship (TDP)

The MSC Technopreneur Development Flagship (TDP) is a specific flagship cluster designed for the promotion of SMEs in the ICT Sector. In recognising the need to further enhance the MSC Malaysia's efforts to develop Malaysian SMEs in the ICT and other strategic high technology industries;Government launched the Technopreneur Development Divisionin November 2001. The lead agency driving theis the Ministry of Science, Technology with Multimedia Development Corporation (MDeC)as the implementing agency. The core objectives of theTechnopreneur Development Divisionare to:

- To facilitate the development of technopreneurs, start-ups and existing ICT companies
- To catalyze and nurture a cluster of ICT SMEs
- To assist and facilitate the growth of ICT SMEs into world-class companies

The TDP described as Sub-National System of Innovation for SMEs in Malaysia

The TDP flagship of the Multimedia Super Corridor project is presented as a sub-system of the larger innovation system or as a sub-national system of innovation for SMEs in Malaysia's ICT sector. The key actors in this "Sub-national system of innovation to support the Entrepreneurs and SMEs are identified as:

- Government and Government agencies
- The specific regional development Authority
- Universities or Institutes of Higher Learning
- Local Firms and MNCs as Partners for Market Access and Technology
- All types of Finance Providers
- Other SMEs in the market.

The Figure 4 illustrates the linkages in the TDP programme between the various actors in the support system for SMEs to enhance their business and technology capabilities.

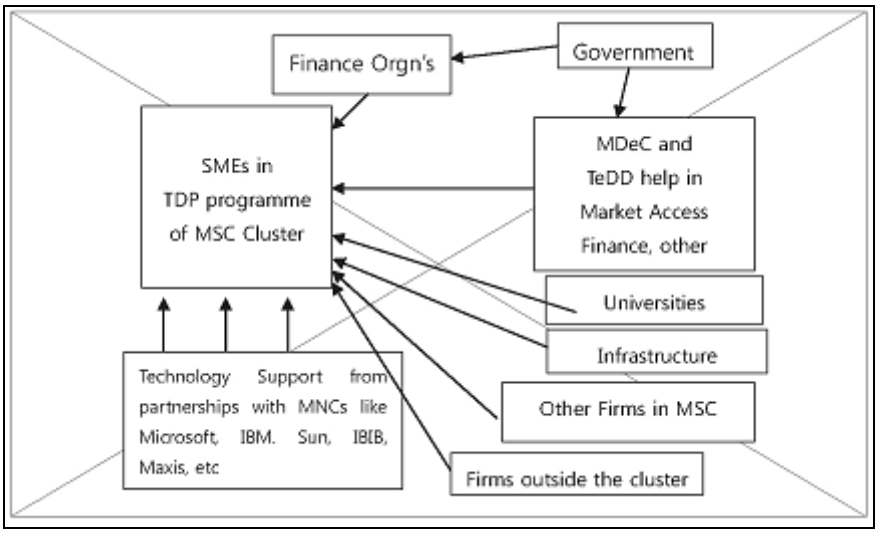

Fig. 4 TDP Flagship Catalysing Actors like a Support System for Entrepreneurs and SMEs in the MSC

The role of TDP in development of SMEs in ICT Sector is seen as a facilitator in linking up

the actors in the system for building up the business and technological capability of the SMEs who are in various part of the Value Chain (Technoprenuer Value Chain)/ An example of its role is when a SME client seeks help, the TeDD personnel assess and then partners these ICT-SMEs with companies like IBM, Sun Systems, Maxis (a Local Mobile Telecommunication Giant), all of whom have 'partnership development programmes ' providing technology support in terms of hardware/software and also training programmes for SMEs. In addition to the SMEs being networked through the MTD flagship programme there has been a slow and steady growth of ICT SMEs leveraging on the actors in the sub-national system and creating linkages with firms and other institutions locally and overseas – sometimes on their own initiatives and in come cases through interventions from the cluster players and are enhancing their technological capabilities.

Partnership Programmes as part of the TDP

The MSC project in general, recognises MNCs playing a major support role in the development of the ICT sector of Malaysia. By partnering with MNCs the TDP hopes to benefit the overall eco-system in terms of:

- **Leveraging** on the MNCs partners expertise, experience, knowledge and networks in strengthening the eco-system
- Adopt the **best practices** in developing and maintaining the best eco-system
- Improve **service delivery time and cost** to technopreneurs and minimize failure points across the technopreneur value chain
- Gain greater **access to markets** like business outsourcing opportunities, etc.
- Wider **networking platform** to build contacts, share knowledge and share experiences
- Greater access and exposure to **technical experts and technology trends**

In the case of the MSC cluster in Malaysia – to the answer the question do the clustering efforts made by the government in the MSC imitate NIS/RIS - with the various actors and their interactions lead to any beneficial outcomes? The answer seems to be yes. It must be remembered that MSC started off as a Greenfield project where there was very little background experience in the sector.

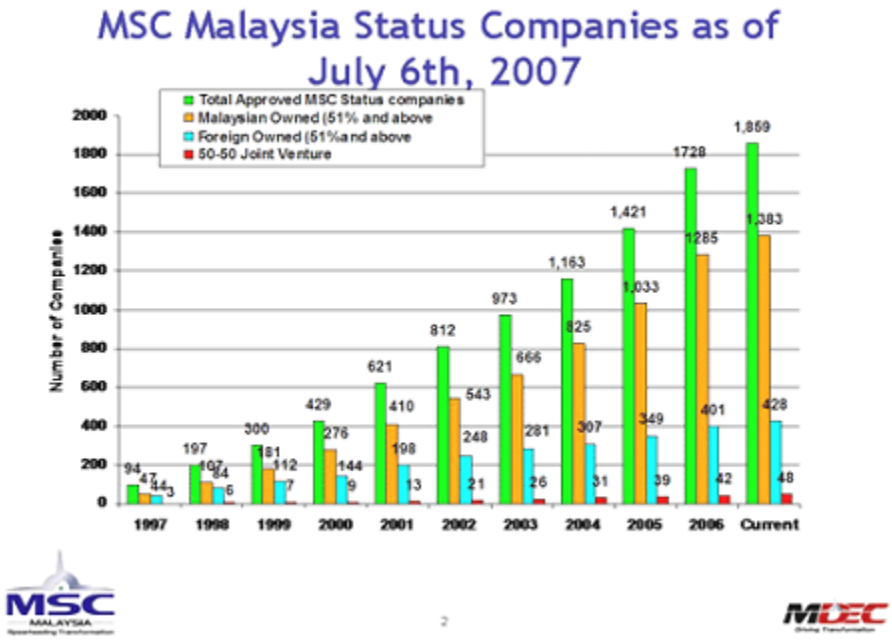

Fig. 5. Growth of Establishment in the MSC Cluster in Malaysia

The MSC appears to have done well in starting off a sector and also opened opportunities for small and medium local companies to enter the ICT sector and operate in collaboration with large MNCs. The large MNCs that have come into the MSC have provided opportunities for local technical graduates. In terms of self-sufficiency, it lacks large firms and supporting industries such as specialized suppliers. The MSC was built from scratch, but judging from the degree of networking activities in the MSC, we can say it is at an emerging stage of cluster development

5. Analysis of the Different Cluster Institutions and their Impact

In this section we try to understand the impact of the different institutions in the clusters. While it is apparent that each cluster has similar and different institutions that help in producing R&D outputs, consuming the outputs and the intermediaries to develop the linkages between these two – it is interesting to see the different roles they play in different clusters. In addition. for the Korean Cluster (Banwol-Shiwa and Goomi) Clusters – data was collected from 245 companies; 145 companies from 10,193 companies located in Banwol-Sihwa Cluster and 100 companies from 873 companies located in Goomi Cluster. A Correlation Analysis between the several institutions and companies (which can also be seen as Open Innovation channels on companies / firms output) is presented in Table 3 below:

Table 3. Analysis on interrelationship between individual open channel and company output

Company Output in the cluster Open Innovation Channel		Banwol-Sihwa Cluster	Goomi Cluster
		Company Output Correlation with Open Innovation Channel	Company Output Correlation with Open Innovation Channel
University and Research Center	Private Research Center	.118	.274
	University and Research Center University	-.058	.321*
	University and Research Center National and Public Institution	.172	.087
	University and Research Center NGO	.059	.135
External Company/Market	Worldwide Company/Products Benchmarking	.274**	.289
	External Company/Market Competitors	.183	.221
	External Company/Market Suppliers	-.013	.188
	External Company/Market Core Clients	.230*	.237
	External Company/Market	.173	.155
	External Company/Market External Human Resources	.031	.218
Public Information or Information Media	External Patents	.387***	.232
	Public Information or Information Media Exhibition, Fair, Academy	.211	.191
	Public Information or Information Media Information Network	.327**	.125
	Public Information or Information Media	.215*	.153

	Other Comanies/ Industries		
Acquisition of Company /Licensing	Acquisition of Company or Research Center	.047	.332*
	Acquisition of Company /Licensing External Technology Licensing	.164	.208
Internal	Purchasing Division	-.009	.014
	Internal Marketing/Sales Division	.320**	.106
	Internal Research Division	.271**	.281
	Internal Development Division	.100	.002
	Internal Manufacturing Division	.107	.013

*** p <.01, ** p <.05, * p <.1

As a result of correlation analysis on open innovation channel and company output, it has been found that (1) in the Goomi cluster there seems to be no effect of the cluster institutions on companies in Goomi Cluster. (2) In contrast, in Banwol-Sihwa Cluster, company output has been found to have increased as seem to they had attained more ideas or knowledge by utilizing public information or information media. In addition, as more ideas or knowledge had been attained internally, company output has also increased.

The table below gives a simplistic summary of a content analysis of the three clusters studied.

Table 4: Comparison of Key impact making institutions in the three Clusters

Banwol-Sihwa Cluster Korea	Goomi Cluster Korea	MSC - Malaysia
Several Institutions – Several Roles	Several Institutions – Several Roles	Fewer Institutions – Government and related Cluster Institution major role
Government Plays Facilitating Role	Government plays Facilitating Role	Government – major role in providing 'Market' and in networking between local companies and technology producing MNCs
Several Associations, Incubators	Moderate number of Associations and Incubators.	Fewer Business Associations in the Cluster Incubators strong Linkages to MNCs for Technolgy
Academic Champion – Tech Park Chief – Prof in Unviersity		Former Prime Minister – As Cluster Champion
Universities – Strong Map Power Supplier, Technology Supplier Professors involved in Associations promoting linkages	Universities – Not very Strong Technology Manpower supplier, Technology Suppler, Professors involved in Associations promoting linkages	Universities - Man Power Supplier, Links with MNC – through hosting of joint Labs Not large role in Cutting Edge Technology Development
Several Local Firms	Local Large Firms	MNCs have Major Role

Overall the Banwol-Siwha cluster appears to be better placed in terms of the number of and variety of institutions available for the development and sustenance of the cluster. Although from the correlation analysis there several institutions / open innovation channels which are still not showing impact on the company's outputs. For the Goomi cluster, based on the qualitative research it seems critical that more professional education and training institutions could be established to provide continuous supply of available workforces as companies

become more technological and specialized. And as there are frequent changes in electronics industry, there is a strong need for networking of either technology or industry experts. Moreover, research centers operated by company seem more focused more on enhancing manufacturing capacity than on developing a new technology as they lack highly qualified workforces. In the case of MSC Malaysia - there are some innovation centers such as Universities, a few R&D units of large corporations, and entrepreneurial companies in the MSC and there seems to be an awareness but lack of networking activities among them. The interrelationships of MSC firms with outside research institutes, universities, industries in the MSC are still minimal are still too weak to generate the necessary synergy effect. For the issue of not having any breakthrough Innovations coming from the MSC, the reason has been mentioned before that the MSC seemed to more focus on creating a critical mass and meeting targets in terms of numbers.

Conclusions

This study explored the some inner dynamics of three clusters in Korea and Malaysia – Institutions, some R&D achievements, R&D business opportunity, and their interactions. From this exploratory paper it can be concluded that interrelationship between the different institutions and company output can be very different by cluster. So, there should be a customized and dynamic political platform for facilitating the innovation by cluster. Secondly, we confirmed that the interrelationship between open innovation and output of company tends to be higher if there is a free flow of information and knowledge exchange inside the company. In other words, to facilitate the open innovation externally outside the company, company should allow the free exchange of information and knowledge inside the company first for higher creativity. C.E.O of the company should first promote the open innovation insde the company. Thirdly, we confirmed that there some are institutions / open innovation channels which exert a more direct effect on enhancement of company output while there are other institutions / channels which don't exert as much. So, it is crucial for both governments and companies to search and utilize the most appropriate channel at the first place.

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- The paper draws most of the information from ***" A Study of R&D Capacities and Company Output in Clusters – Open Innovation Approach for Some Asian Clusters***" By Yun Juin Hyo and Avvari V. Mohan – A Report prepared for MEST and DGIST Korea.