IT Clusters as a Special Type of Industrial Clusters

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Economic and industrial clusters have become in the last years the object of a new economic theory that has proved important for regional and even national (Porter, 1990) development. The papers objective is to emphasize the particularities of IT clusters, especially their characteristics that are derived from the special features of this type of technological clusters. IT clusters represent an important type of technology clusters and at global view they represent most successful and efficient examples of clusters. The paper describes the characteristics that are behind the creation, the continuous development and the success of the IT cluster and aims to emphasize those particular features which define an IT cluster and separate it from another type of industrial cluster. In order to emphasize the importance factors, there are described different types of IT clusters.
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1 Introduction

Industrial and economic clusters have emerged as a special form of spatial organization in economics theory regarding organizations efficiency based on their geographic locations, networks and relations. The concept and its economic benefits have been firstly described by Marshal [1] in its papers regarding "*industrial districts*". In Marshals vision, the cluster is an agglomeration of companies that operate in the same industry sector in a well defined and small geographical area, which in most cases and at that time was an urban area. The Marshal model takes into consideration only the economic relation between cluster companies as reduced transportation and transactions costs, access to more resources, a pool of qualified work force and access to information. Despite the initial analysis, the cluster model that has been identified in the last decades, based on the analysis of modern clusters, is more complex than that.

The research on economic clusters has been reached a real importance level starting with Porter study [2] [25] that gives a more actual definition for a cluster as a "*socioeconomic entity characterized by a social community of people and a population of economic agents localized in close proximity in a specific geographic region*" [3]. This model adds into analysis the social relation and the transfer of knowledge between cluster members [4].

The concept of cluster is different from the classical approach of competition policy at organization or government level because it requires an analysis of "*geographic concentrations of interconnected companies and institutions in a particular field*" [2] that works in a competitive environment to increase productivity and efficiency of the cluster and implicitly of each member.

The paper objective is to analyze a special type of technology cluster [5] [6], which is the IT cluster that is generating IT related products and services. Technology clusters are different from the classic economic cluster because the economic process has some important characteristics:

- the output of the economic process is new technologies which are reflected in the development of new type of goods as machines, industrial equipment, electronics and semi-conductor devices and components; based on this observation, and to make a separation between a technology cluster and a industry one,

- the main activity of firms is R&D so it is difficult to quantify the result; for a economic cluster that produces auto parts it is clear how you measure the firm efficiency; for a technology cluster one

possible way to measure the innovation if it is represented as number of registered patents.

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2 Clusters background

Starting with Marshal's view on "*industrial agglomerations*" [1] the cluster model has been evolved as economic theorists and practitioners tried to understand and describe the cluster concept. The Marshal model takes into consideration mainly the economic relation between cluster firms but other studies [26-27] have shown the model is more complex than that because it shaped also by the social relations and the inter-entities cooperation and competition.

Clusters can appear based on normal private initiatives in a geographic area that offers some facilities or they can be the results of public regional development strategies. As an economic process, the cluster life-cycle describes a birth, an evolution or growth and a maturity phase [7]. This last phase is very important because after that the cluster can stagnate and loose its advantages or it can reinvent itself.

The relation between firms inside a cluster based on regular inter-firm activities such as supplier–customer transactions has been analyzed in order to describe cluster topologies. Markusen [8] takes this factor into analysis and indentifies four categories of industrial clusters, described in Figure 1.
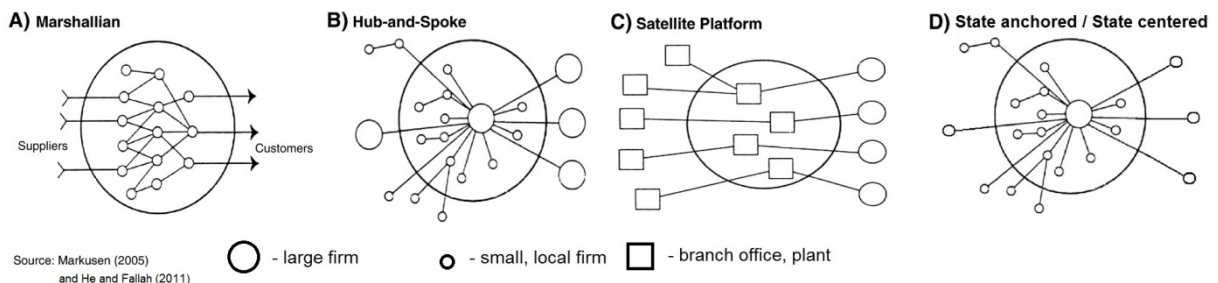

Fig. 1. Topologies of technology clusters[6] [8]

The topologies described by Markusen [8] emphasize the role of different cluster members and the interaction between them.

In a hub-and-spoke cluster, few dominant firms represent the core of the cluster and are surrounded by numerous small firms that are linked directly to them. The most part of the cluster firms represent suppliers of raw materials, of externalized services or are specialized in a particular phase of the hub production process. The small firms trade directly with the large ones and depend on their client strategy. The hub firms define the relation inside the cluster and its dynamics. Clear examples of hub-and-spoke clusters are found in automotive industry, like Detroit Auto cluster that is concentrated around the "Big Three" auto manufacturers.

In a satellite platform cluster, a group of branch facilities of externally based multi-plant firms, [8] are located in a particular geographic region in order to benefit from governmental facilities or low costs with supplies and workforce. A particular characteristic of the satellite platform is that there are no relations between satellite firms and they are entirely controlled by the remotely located parent firm.

The last category, the state centered [6] or state anchored cluster, [8] is defined around a

public, governmental or non-profit organization that dominates the region and the economic relation between cluster members. This entity, which in many US scenarios is a large military base, is surrounded by numerous small firms that benefit from public-private contracts. The state centered type can be compared to a hub-and-spoke cluster in which there is one dominant key player that is not controlled by the private sector.

In time, due to its dynamic, the cluster can change its type by strengthening the relation between firms, in which case can become a Marshallian cluster, or by supporting the emergence of multinational corporations, and becoming a hub-and-spoke cluster.

In any case, the evolution of the cluster is influenced by a series of factors defined by the business environment of that specific location. In order to describe this complex concept, Porter [9] has defined the so-called "diamond" of four elements: factor conditions, demand conditions, the context for strategy and the supporting industries.

In the Triple Helix Model THM [10] are defined the main components, government, academia and industry that can influence the cluster evolution. Despite the fact is not required a consensus regarding common strategies between the three [11], each can contribute to the cluster success.

Another classification of factors is done by Morosini [3], who defines two categories: external and social. External factors are represented by customers, product and services markets and demographic trends. The social impact on the cluster is given by knowledge flows defined by learning, knowledge creation and knowledge sharing [3].

Economic benefits for firms located in a strong cluster have been emphasized by the cluster literature, [2] [3] [10]:

- a bigger local market for products and services;
- reduce costs in transport, supply chains and more ease access to resources; the cluster provides higher degree of specialization in services and products;

- a better concurrency environment that provides better motivation and measurement;
- the agglomeration of firms with activities in the same field will create a pool of experienced and specialized workforce; this will provide better access to skilled employees;
- Marshall-Arrow-Romer (MAR) spillover [12] has shown that proximity of firms from the same industry allows an exchange of knowledge and ideas between them through direct contact and through movement of workforce;
- the cluster organization impose and sustain a high pace of innovation and higher productivity [13];
- firms in clusters tend to specialize in order to maintain or gain a competitive advantage;
- in clusters, firms are more opened to communicate, collaborate and exchange information inside the cluster because the proximity between them creates a trust relation

3 Technology and IT Clusters

IT clusters represent an important type of technology clusters and at global view they represent most of the successful and efficient examples of clusters. In United States, the IT clusters have a 0.8% share in national employment [14] but also the second average wage in U.S, which is double than the nation mean. In India, the two important IT clusters Bangalore and Hyderabad, are composed from over 3000 companies and had a great impact on the Indian IT total revenue of around 50 billion USD in 2009 [11].

Though there are many known technology parks and regions, an IT cluster, as analyzed in this paper, represents a region with companies, SME's and large, that are producing IT products and services. These companies are interconnected with each other and with public institutions, mostly from educational environment. Despite the great number of employees and the impact on the industry revenues, groups of large

chaebol firms like the "Seoul macrocluster" [15]that include LG, Samsung and Hyundai are not considered clusters, mainly because they don't collaborate, they have distinct market shares and are in direct competition to each other.

The success of IT clusters is generated by the increased use and implementation of different information technology services and products in most of human activities. With each day we enter more and more in a fully digital era and because there are many advantages that makes our life better, IT products and services have become a normal need for most of us. The market of IT products and services is in a continuous demand for faster, more reliable and more functional devices and solutions. As the need for IT related products is on a continuous increase curve, another factor that influenced the success is defined by the particularities of production process:

- for software products, the production process means to develop an instance of the solution and to generate copies with near zero costs; from this point of view, this production process is different than any other economic activity because that product is obtained by copying the initial prototype without consuming initial needed resources; in any other economic activity that generates a tangible good, this is not possible as you need same raw materials for each item;
- for IT devices or hardware products, the classic production model that is based on raw materials applies, but the costs are very small because the level of technology and the extent of producers is very high.

IT Clusters are technological clusters in which production generates IT knowledge as patents and innovative solutions, services and products, mostly software.

A classification if of IT Clusters can be done based on their products or on the main activity of firms that are defining the cluster:

- IT Clusters that generate low-value IT services like the Bangalore IT Cluster [11] [16]; firms in this type of IT cluster are mainly outsourcing activities for large firms because they offer professionals at relatively low costs; low-value IT clusters provide different IT services to important companies that externalize different phases from the IT products lifecycle, customer support or quality assurance and testing processes; they depend entirely on few worldwide IT companies for external input of technologies and financial support'
- IT Clusters that generate high-value IT activities, Silicon Valley, Boston Route 128, Cambridge Technology Cluster or Taiwan IT cluster; the high-tech cluster develops innovative, generic products; they fuel their development by innovating and producing new technologies.

Because IT clusters are a particular type of technology clusters, the initiative that starts the development of the cluster takes birth in areas with strong connections to important research and university centers. In this field and for present times, the needed resource as a raw material, workforce or existing market has a small or minimized importance, as for an industrial cluster.

For a high value IT cluster the main resources consists in:

- the innovative idea, the knowhow or the technology; the technology is generated by universities or research institutions and through spin-off and entrepreneurial initiatives the technology generates a business; an example is the story Google that started as a research project for a better Internet search engine;
- the financial support needed to finance the business and to help the company to generate revenue; the banking system is the main engine for starting new IT companies, but there are venture capital institutions that seek to invest in new promising technologies.

Knowledge and research results are important factors for the evolution of an industry which is based entirely on selling technology. The triple-helix model [10] of factors for the cluster is representative and important for an IT Cluster:

- the educational system, through universities, master and doctoral programs, is providing high-skilled human resources;
- research centers, public and private, represent the engine for the development of new technologies; even the research center can represents part of the companies as R&D departments, the complexity of the technology paths is too great to be handled by them; without being able to generate research, the companies are dependent on other sources and in order to satisfy this resource the cluster must import new technology;
- the government can sustain and promote the cluster development improving the infrastructure and flow of resources; modifying its fiscal and administrative policy, governments and public administrations can limit the cluster initiative or promote it; For example, China has offered limited power to its regional representatives in order to facilitate and attract foreign IT companies wanting to relocate in China for lower costs [17]. India has granted fiscal deductions to companies that generate new workplaces [11].

The IT industry has some particularities that defined the premises for the success of IT clusters. In this field the vital resource is the technology, the knowhow. Because it can be acquired and because it is hard to block the access to it for competitors, the technology gap between members of a cluster can be reduced with ease in short periods. Also the experienced workforce needed to implement new technologies can be acquired with ease from the cluster members. In order to be competitive, firms from IT clusters have two approaches:

- to maintain a high pace of innovation and to be the first to implement new technologies;
- to specialize on particular products and services and to be recognized as the leader of that market segment through continuous innovation.

From this point of view, Silicon Valley and Boston IT clusters are defined by well known IT companies which have imposed on the market specialized products. On the other hand, other IT clusters, like the ones in India or China, gather companies that succeed in reducing their production costs and maintain same level of quality for their products and services. These are the low value IT clusters which provide external services to other large companies that control its development and its existence.

4 Characteristics of IT Clusters

As described in previous chapter, IT clusters are technology clusters generated by firms that produce IT services and products. The particularities of these business processes and products influence the characteristics of this type of cluster and its important factors.

The resources needed to generate and to sustain an IT cluster are:

- a base of qualified IT professionals; this prerequisite can be achieved by a strong higher-education education framework that generates bachelor and master graduates with strong IT knowledge; the Indian IT cluster has become what it is today because the two regions Bangalore and Hyderabad provided "*a large pool of English speaking, technically trained Indian workers, excellent location, and low labor costs.*" [18];
- a clear financial regulations and opportunities provided by government;
- venture capital invested by large IT firms which are extending or relocating their production.

The importance of innovation, as a defining factor for the evolution and success of an technology cluster is highlighted in the comparative analysis between California's Silicon Valley and the Route 128 corridor near Boston, Massachusetts, [4]. Both IT clusters have started in the same environment defined by strong research and university centers, public military projects funded by government and a large base of entrepreneurial initiatives. But after reaching their limits one has stagnated and the other

one, Silicon Valley, has reinvented and continued to grow. The main conclusion of Saxenian study [4] was that, despite both IT clusters were very much alike they had two different cultures regarding innovation. Silicon Valley, with many success stories started form a garage, has embraced innovation by supporting new technologies and adopting them no matter where they came and in a fast manner. On the other hand, the Route 128 companies had a firm-based view of development by supporting mostly technologies developed in-house and by using a long and inflexible process for adopting innovative technologies.

Another important characteristic for the success of an IT cluster, also analyzed by Saxenian's study [4] is the degree of collaboration between cluster members by sharing information amid competition. The transfer of information is made directly through collaboration or by buying technology. Indirectly, information flows by:

- analyzing competition products and services and replicating them; in this field, it is hard for companies to block or restrict access to resources for their competitors; the particular solution for a technology can be protected using patens and other copyright laws but the idea behind it becomes public information with the release of the product or service;
- allowing free movement of workforce between companies; it is impossible to stop the transfer of knowhow, experience or technology understanding.

Because IT clusters are focused on technology and innovation they require specialized and qualified workforce that can use the technology and that can generate new one through research. These resources can be provided by strong university and research centers. All three most successful IT clusters, Silicon Valley, Boston Route 128 and Indian IT cluster are placed around university centers like Stanford, MIT and Bangalore. The latter, even if it doesn't have the renown of the first two it has been able to provide a large pool of qualified specialist able to

understand and adopt on short time new technologies.

The influence of universities and research institutions on the creation of an IT cluster is given by their capacity not only to provide highly qualified workforce, but to generate new technologies or to generate entrepreneurial initiatives. Though there are world renown IT companies in Korea, like Samsung, LG, Hyundai, this region has not developed any kind of successful IT cluster. Companies do not collaborate with universities or research centers and they invest in their own R&D internal departments. The reason for this situation, as described by Sohn and Kenney [15], is the initial governmental policy to support these large companies to acquire technology and to increase their internal capacity for research. Avoiding to promote research transfer between university centers and industry, and the lack of support for university entrepreneurial initiatives has proved to be main reason for the absence of an IT cluster in a region which is highly developed and has a great market for Hi-Tech and IT products, [15].

Rather than just providing qualified and highly specialized workforce, the university and research centers have an essential role on generating high-technology spin-offs. These are the essential factors for generating an IT cluster initiative and for reinventing it.

Despite the need for a specialized and skilled workforce pool, IT clusters are not natural resource dependent. If the cluster has reached high levels of innovation and economic performance the cost of attracting high skilled professionals from other regions is small comparing it with the benefits. This is the case of Silicon Valley and the Boston IT cluster, which have as development policy to attract high skilled individuals.

The IT cluster has no other important dependencies because there is no need for material resources and the transportation costs are almost equal with zero when taking into consideration software products. For IT products as devices, the cluster will contain components manufactures and companies

that will assemble the final product, as all members will benefit from the proximity.

Everything needed by firms, in terms of technology, patents, ideas can be obtained either by technology transfer, import, by own development in R&D facilities or through partnerships with research centers. Another particular aspect of these resources is that the firm needs to acquire these resources only to reduce the difference with competing firms or to achieve a competing advantage.

Based on the description of clusters life cycle, the IT cluster life cycle is determined by its innovative capability. In case of low-services IT clusters, where the outsourcing is the main activity that sustain the cluster, other financial factors, like the cost of labor have a more important influence on the cluster evolution.

For its future development, high-tech IT clusters must innovate and must keep in line with the latest break-outs in technology in order to maintain its development [18].In fact, high-value IT clusters are all about technology and how to produce new one. In opposition, low-value IT clusters must keep costs low and must provide high-skill IT professionals in order to be attractive to major companies that are supporting these clusters through outsourcing.

Resources important for an IT cluster different for each type:
- for high-value IT clusters is the know-how represented by a patent or by a group of specialists which are developing the IT solution; also developing or having access to a pool of skilled specialists is the premise for future innovations;
- for low-value IT services, the cost and especially the workforce cost has a higher importance than the cost of getting qualified; regarding an analysis of the Indian IT clusters, D'Costa [16] has emphasize that a low-value IT cluster is dependent on very few external markets for its exports, its capital infusion and in the end, for its growth; the cluster model is highly dependent on the production shift towards other low-cost locations; because the dependence nature of low-

value IT clusters on bigger companies, maintain a low cost on running the business and a high quality of services and products is the recipe for the cluster success of failure.

The low-value IT services cluster can grow into a high value IT cluster if there are present four factors [19]: entrepreneurs, software engineering talent, availability of capital and access to markets.

Other research on the factors that can influence the transition to a high-value IT cluster have emphasize the importance of diasporas [20] by promoting homeland resources and by establishing trust relations with venture investors and the coming back to the origin country of professionals that have worked in powerful IT clusters located outside the country.

A most debated case of transition from a low-value IT cluster, composed from groups of small and medium enterprises, to a high-value one is the development and transformation of the Taiwan components cluster to a world renown manufacturer of IT products[21]. The factors that helped the transition of the cluster to a self-independent hub-and-spoke one are [21]:
- the relations inside the low-value IT cluster between external companies and the small suppliers were not stable; the large companies exerted constant pressure on the suppliers to increase quality and output and to reduce business costs; that has imposed on the successful firms, that remained and continued to grow inside the cluster, to adopt efficient business processes;
- the low-value manufactures have acquired technological and product design capabilities from their clients; using this experience, they have increased their innovative and R&D capacity;
- the small firms were delivering products directly to clients and thus they have formed a strong network of client connections.

Because knowledge is important in the IT cluster, the aggregation of firms has benefits

to each other based on MAR spillover. In this industry is very difficult to fully appropriate knowledge [22] because the transfer of specialist means more than loosing or getting workforce. IT specialists gain know-how, experience and by can fuel the innovation process. By relocating to another company from the cluster, they bring this knowledge with them. Because IT clusters are based on knowledge, their success and future development depend on the knowledge spillover [4] [23]. As Saxenian has observed "Geographic proximity promotes the repeated interaction and mutual trust needed to sustain collaborations and to speed the continual recombination of technology and skill" [4].

If we consider other criteria to classify clusters, like the relation with market elements, IT clusters are not tied to their location based on the need to be close to the customer. The particularities of most IT development processes or services can locate them in a different geographic location than its market and in many cases IT clusters are not "local industries" [24]. One example can be a help desk service located in an Indian IT cluster that has European clients. This type of cluster is more a "traded industry" [24] because its market can be anywhere in the world.

IT clusters are mainly horizontal clusters [5] because in the cluster region is not present an entirely vertical chain of production. The reason is that the market is located in different places. Also, in IT clusters, firms have the tendency to specialize in different market segments. In Silicon Valley, most of the companies that are providing IT technologies and solutions are specialized in specific types of products and services. In low-value IT clusters, companies compete to gain more outsourcing contracts or to strengthen the relation with their clients with are larger IT companies. Taking into consideration that the market for IT products is not localized in a particular region but instead is spread worldwide, IT clusters are horizontal clusters.

Using Markusen [8] clusters categorization, IT clusters, as a particular type of industrial clusters, can be:

▪ hub-and-spoke when a large firm is surrounded by multiple small suppliers; this can be the case of one Taiwanese IT cluster[17] in which a large Benq production plant controlled the cluster of small supplier firms or the case of the Seattle cluster in which Microsoft attracts firms providing IT services[8];

▪ satellite platforms when multinational IT companies move their production in low-value IT clusters like India and China to minimize their costs with workforce and for other benefits; high-value IT clusters can be organized as satellite platforms when firms can locate around important research and university centers as they will benefit from their highly skilled specialists, laboratories and their capacity to innovate; also governments or local administration can attract firms through the benefits of technology parks; a high-value satellite type IT cluster is the Research Triangle Park from North Carolina which groupsR&D centers of high-tech multinational firms or the Cambridge Technology Cluster;

▪ state-centered [6] or state-anchored [8],IT clusters are found around governmental institutions, like aerospace complexes, military research labs or state universities, that receive large budgets for research and development; this situation generates a lot of opportunities for private contractors that can supply IT services and products.

5 Conclusions

The current evolution of technology and the integration rate of software solutions in social, economic and public activities are real motives to invest and to sustain the IT industry. Examples of successful IT clusters in China, India and US and their impact on the country economic development show that governments should define macro strategies that will allow foreign investors to establish IT clusters or that will promote the creation

of natural cluster initiatives based on a strong relation between universities and the local IT industry.

The particularities of the IT industry, especially its needed resources, allow the creation of IT clusters in emerging markets that lack physical resources needed for other type of industry. The technology difference can be reduced by importing it or through partnerships with IT leaders. The only important prerequisite is the skilled human resource and the capacity to integrate and to generate knowledge, to innovate.

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