

Software clusters in Brazil: a tale of two cities

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Introduction

This paper will present the main findings of a study conducted by the authors about software clusters in Brazil. The main question that conducted the research was how local institutions may foster clusters in a given territory in a sector where proximity is not necessarily linked to the presence of knowledge flows. In particular, we focused our analysis on Technology Parks and tried to assess whether this kind of policy provides the necessary and sufficient conditions for knowledge generation and transmission in a cluster. The paper starts with a brief “state of the art” section on proximity and knowledge flows, then proceeds to a presentation of the methodology and the main findings of the study. The conclusions present the main contributions of the paper and implications for future research.

1. State of the Art about the Topic

The literature on the benefits of the location of technology clusters in a given territory usually points to the advantages this location may provide for regional development. Although some authors may argue that the diffusion of information and communication technologies (ICT's) will abolish the importance of geographical proximity (Cairncross, 1997), others point out that only codified knowledge is easily transmitted by electronic means (Cassiolato et al., 2007); tacit knowledge, on the contrary, is not easily transmitted. Also, in uncertain and highly complex situations such as those that happen in innovation development it is necessary to have a face-to-face communication; on a given territory, the likelihood of people to meet regularly and gradually to build relationship is wider, getting the interactions more extensive, because many are unplanned.

In a second dimension, the theory tells us that clusters render a territory attractive for

companies looking to outsource activities due to the abundance of skilled labor, knowledge circulation, proximity to other businesses, among other factors. Specifically in the ICT industry, an activity that has been often developed in clusters is offshore outsourcing and the increase of this activity leads to an increased specialization of local employees, which improves capabilities of these workers (Tigre and Marques, 2008).

Therefore, in the case of the software and information systems industry, clusters are viewed by local governments as institutional arrangements that increase the skills and abilities of local workforce, promote knowledge spillovers and contribute to establish networks of enterprises. In the software industry networking is often associated to the activity of offshore outsourcing activities.

Benefits of software clusters are related to physical and organizational proximity. Physical or geographical proximity create static advantages as scale economies, possibilities to strengthen productive chains, reduction of transaction costs and access to new markets. It also creates dynamic advantages such as knowledge accumulation and development of innovations. Geographical proximity creates conditions to the sharing of tacit knowledge, which may happen as a result of cooperation between enterprises, rotation of human resources and entrepreneurial activity in the region. Physical proximity is also an advantage for the diffusion of codified knowledge, as its absorption requires an institutional context that allows for joint problem resolution, learning and knowledge creation (Bathelt et al., 2004).

Organizational or relational proximity is related to affiliation and similitude of enterprises, so it is not necessarily contained in a territory. Both kinds of proximity – geographic and organizational – are crucial in the sharing of tacit and codified knowledge (Davenport, 2005). This concept was developed to understand the process of sharing information contained in business trips, common routines, databases, common software and temporary communities of projects and task forces.

Some authors suggest that relational proximity may substitute geographical proximity in certain stages of the innovation development process (Lemarié et al., 2001, Amin and Cohendet, 2005, Davenport, 2005). Geographical proximity is important in the early stages of the innovation process (design) and in the final stages (testing); the stages of development and prototype can be based on long-distance communication. In the case of ICT industries, relational proximity has materialized in the activity of outsourcing, where firms transfer part of the software and services development process to other firms.

As the activities of enterprises are embedded in an institutional context built by social relations, the formation of agglomerations of enterprises can be considered as the result of a

selection process that determinates favorable conditions to answer demands put by technological change. In spite of the fact that user-supplier relationships may extend outside the territory through organizational proximity, some studies suggest that for knowledge generation it is more important to belong to a community than to an organization (Kaufmann et al, 2003, Walsham, 2003). Bathelt et al. (2004) suggest that successful clusters combine the generation of local knowledge with the acquisition of external (codified) knowledge.

In the case of software development, Nicholson and Sahay (2004) suggest that software development depends on sharing organizing principles, routines and standard operating procedures that may be non-migratory due to embeddedness of knowledge in context. Cassiolato et al. (2007) argue that the tacit and complex nature of knowledge necessary to generate innovations in the software industry enhance the importance of communication channels between users and suppliers. If those channels are built on a local basis, an accumulation of competencies in the region will take place, leading to growth and internationalization of local enterprises, given the strong path dependency of the industry.

The recognition of the importance of the ICT industry has lead many regions to support clusters of those activities. Governments have several support options to foster high-technology activities in their regions. In the case of Brazil, a policy that has been implemented in several regions is the creation of Technology Parks. Technology Parks have been created in many countries because they are vehicles for the promotion of innovation. Normally they are created to increase the competitiveness of local businesses, stimulate technology transfer between universities and enterprises, increase wealth of the region and raise the technological content of productive factors. Technology Parks can promote the growth of the region and strengthen micro and small local businesses through the generation of knowledge in technology-based companies, whose dynamism, innovation capacity and networking capability will ultimately boost the business environment and stimulate local businesses (La Rovere and Furtado, 2008).

However, a Technology Park can effectively contribute to the economic and social development of a region, only if it is able to promote synergies between the companies located in the Park and local companies and institutions, so that there is dissemination of knowledge generated between companies and a better articulation between the different institutions involved in the management of the park (La Rovere and Furtado, 2008).

2. Research Focus and Methodology

If clusters provide a solid basis for the development of software companies, we may propose questions about the role of local governments and universities in developing clusters. Is it possible for a local government to create a cluster of software companies by providing incentives to them such as those that support Technology Parks? Or are Technology Parks

successful when they articulate clusters already in place, formed due to pre-existent favorable local conditions? This paper will try to shed light in this question by reporting the cases of two cities in Brazil where local governments had a strong role in supporting the software industry and created Technology Parks. One city, called Recife, is a case of success, whereas the other, called Petrópolis has not been successful so far. The paper will explore the differences between the cities and their clusters and discuss their perspectives, based on a research the authors did between 2007 and 2009. The research involved revision of the literature, analysis of statistical data on ICT production and employment in Recife and Petrópolis as well as semi-structured interviews in those two cities. The choice of the interviewed enterprises was made with the participation of local institutions, and the composition of the sample was built to reflect the importance of the enterprises in the territory. The empirical studies thus allowed us to identify patterns of local insertion and understand the potential of dissemination of knowledge and innovation of enterprises of the two cities.

3. Main Findings

3. 1. The case of Recife: Institutional support and favorable conditions

3.1.1 - Local characteristics

The development of the computer industry in Pernambuco, a state located in the North-east of Brazil, and its concentration in Recife, the capital of this state, had three determining factors. The first was the presence in Recife of data processing centers of large companies and banks. The second was the dynamism of the Centro de Informática da Universidade Federal de Pernambuco- CIN/UFPE (Centre of Informatics of the Federal University of Pernambuco), as a center of excellence in the training of qualified manpower and in the creation of spillovers, and the third was the Government initiative to promote a Technology Park focused on ICT in a historic district of Recife, called Porto Digital (Digital Harbor).

In the late sixties of the 20 century, Banco Banorte, a bank whose technological development allowed it to be one of the pioneers in the process of banking automation in Brazil, installed in Pernambuco the first IBM mainframe in the North and northeast of Brazil, and the first privately owned data processing center was created.

At those times, computer production was protected from imports in Brazil, in an effort to develop local technology. Therefore the Department of Informatics of the Federal University of Pernambuco, founded in 1972, developed the first computer in the Northeast region in the 1970s. Another computer, "Corisco", was developed and marketed by Elógica group, founded in 1974. Also, the firm Dirigene rode in Recife a production line of computers in 1983 (completed

five years later).

After these interesting, but frustrated industrial attempts during the years 1970-80, the protection policy ended and the computer industry has had a strong development in Brazil. A SOFTEX study (2009) indicates that the total number of software and ICT services in Brazil grew 7% between 2003 and 2006. Using the same classification we found that in Recife the total of software and ICT services companies grew 6.6% in the same period, therefore keeping up with the growth of sector at the national level. We also found that in this industry the percentage of high qualified workers in the total workforce of local companies grew from 31% in 2003 to 41% in 2006, well above the average of the industry in Brazil in 2006 (34%).

A crucial element for development of the ICT sector was the presence of the Federal University of Pernambuco, one of the best universities from Brazil in the technological area. In particular, the centro de informática (CIN) is among the three best in the whole country (CAPES, 2008). In this context, the presence of the University was and still is crucial in the development of the ICT cluster, not only because it provides training of highly qualified human resources, but also because of spillover effects. The most important spin-off of the University is a non-profit organization called Centro de Estudos e Sistemas Avançados do Recife - CESAR (Center for Advanced Studies and Systems of Recife).

3.1.2 The CESAR: a successful spin-off of UFPE

The CESAR is one of the numerous projects that emerged from CIN/UFPE in recent years. It was created in 1996, with the goal of generating a favorable environment for ICT companies in Recife and halt the migration of professionals trained in the Federal University of Pernambuco to other regions of the country. Its basic philosophy is to promote a greater interaction between the academic community, the business sector and society (La Rovere and Rodrigues, 2006).

While providing software development services and other ICT services for large national and multinational companies, CESAR also promotes the creation of new companies and attracts venture funds for these companies, working on developing alliances, between CIN/UFPE and private companies. Created as an NGO, the CESAR is self-sustaining and receives no funding from UFPE. Currently, the fundraising is derived from services provided and the sale of its equity interest in businesses.

The functions of CESAR changed as this organization gained experience. Initially focused on stimulating business alliances, the CESAR later went into pre-incubation activities and nowadays has a complete cycle of business creation. This cycle involves identification of market demands, development of customized solutions, often in cooperation with CIN/UFPE, creation

of companies to bring these solutions to the market, including attracting venture funds for these projects (Bercovich and Suassuna, 2008).

Most of the projects developed by CESAR are supported by the federal Informatics Law, which encourages large ICT companies to invest and subcontract R&D activities in regions like Pernambuco. This law provides a rebate of the Brazilian industrial value-added tax (IPI) for companies that invest 5% of its turnover by activities of P&D. According to the law, 40% of resources should be applied outside the company, in academic institutions and technological duly accredited.

The creation of CESAR made possible for CIN/UFPE to engage in more applied and productive activities, accepting a greater collaboration with the private sector. CESAR has also started its own technology education courses in collaboration with CIN/UFPE and created the "Institute for Innovation in Informatics". This is an NGO formed by University researchers, which develops R&D activities, offers postgraduate courses and serves as Technological Observatory.

3.1.3 The Digital Harbor: a triple helix initiative

The Porto Digital (Digital Harbor) is a Technology Park that was created in 2000 by the Secretariat of Science, Technology and Environment of the State Government of Pernambuco - SECTEMA, with an initial investment of approximately U\$ 15 million in infrastructure improvement and creation of venture capital funds and promotion. In addition to the State Government, different institutions, universities and enterprises participated in the initiative (Bercovich and Suassuna, 2008).

The Digital Harbor is located in an old port area of the city of Recife that was abandoned until the year 2000. The Digital Harbor project main goal was to create a Technology Park to enhance the ICT cluster in Recife, and at the same time stimulate urban regeneration and development of the area where it is deployed. The project was implemented by a non-profit organization, called Núcleo de Gestão do Porto Digital -NGPD (Group of Management of the Digital Harbor) that is responsible for project management and structure, as well as perform public initiatives and investments through management contracts with the State Government and in collaboration with the city of Recife and federal institutions. The NGPD plays a decisive role in the process of development of the Digital Harbor. This institution manages public policies for the sector, seeking to articulate them in joint initiatives that include different public actors, private, academic and institutional (Bercovich and Suassuna, 2008).

Besides NGPD, institutions that operate within the geographical area and who are important to

the decision-making processes are: CESAR, SECTEMA, and the local representatives of business entities such as the SOFTEX (Association for the Promotion of Excellence in Software) and ASSESPRO (Association of Brazilian Businesses on Information Technology, Software and Internet).

Along with the creation of Digital Harbor was created a Venture Capital Fund, a "Human Capital" Fund targeted at the professional training, and a "Collateral Fund" to support the operations of funding by public banks offering software firms up to 70% of the required collateral (Bercovich and Suassuna, 2008).

Since the creation of NGPD, all companies of the Digital Harbor can access services in communication, training, marketing and business facilitation, organization of business meetings and participation in trade fairs. In addition to this set of initiatives, the Digital Harbor is articulating a network of human resources and training, that assembles numerous local and regional Universities.

Today Digital Harbor has 130 institutions: six affiliates of multinational companies (IBM, Motorola, Samsung, Dell, Nokia and Microsoft), four research centers, local representations of state institutions at the federal, state and city level and more than one hundred local enterprises that have created 4.000 jobs since 2000.

3.2. Petrópolis-Tecnópolis: Emergence and organization

3.2.1. Local Characteristics

Petrópolis-Tecnópolis is a Technology Park created in 1999. Its main objective was to stimulate socio-economic and technological development in the region in perfect harmony with the environment (La Rovere and Furtado, 2008).

The case of Petrópolis-Tecnópolis is quite different from the Digital Harbor in several respects, particularly relating to their history, the degree of cooperation between companies, the activities of institutional actors and the development of cluster as a whole.

Petrópolis is located at a mountainous region about 65 km from the city of Rio de Janeiro. Because of its pleasant climate, it attracts a large number of visitors. This city is considered a regional economic centre due to activities related to tourism, industry (textiles, clothing, machinery and equipment) and the services sector (Albagli and Maciel, 2007). Most companies of the city are small: 97% of establishments have less than 50 employees, and there are only 24 establishments with more than 250 employees, of which three with more than 1000 employees

(Rodrigues, La Rovere and Carvalho, 2007).

In 1999, a study conducted by the Association of Industries of Rio de Janeiro (FIRJAN) to identify the potential of Petrópolis resulted in a project aimed to diversify the local economy, as the main local industry - textiles and apparel - went through a severe crisis in this year affected by the crisis in the textile industry. According to Albagli and Maciel (2007), the idea of building a Technology Park in Petrópolis was not new: in 1986, was created the Foundation Technology Park of Petrópolis (FUNPAT), whose goal was to attract companies to the city.

Counting with some circumstantial evidence, such as the transfer from Rio to Petrópolis of the National Laboratory of Scientific Computing (LNCC) in 1997, the project for a Technology Park was made by a small group of people (mainly directors of FIRJAN FUNPAT, and local government) and without significant involvement of other local institutions. Changes later followed the same pattern.

Ambitious in its intentions, but with weak ties with the local business community, the project's main goal was to attract high-tech firms, particularly in ICT and biotechnology, to Petrópolis, using tax incentives and other forms of support, mainly in infrastructure. It was hoped that this influx of new business would increase the levels of employment and income, while increasing the opportunities for the training of highly qualified human resources (Albagli and Maciel, 2007).

The project has not been created only in "top-down", but also was built based on a unbalanced governance: the original project listed in Council 14 different institutions responsible to formulate and coordinate the yearly planning and guidelines to be followed by the Technology Park, with the participation of only 10 firms (Albagli and Maciel, 2007).

Later, as a result of the negotiations made by FIRJAN and by FUNPAT, the regional section of the SOFTEX moved to an area inside the Technology Park with the goal of creating actions in the region that could stimulate the development of software. The environment created by these actions favored activities of knowledge-based companies and contributed to attract technology enterprises during the period 1999 to 2002. In 2004, were 20 supporting institutions and 50 ICT companies linked to this initiative acting in the areas of software, e-commerce and distance learning over the Internet (La Rovere and Furtado, 2008). In 2007, the data on the Internet page of Petrópolis-Tecnópolis listed 80 software companies in the city, of which 46 directly linked to the Technology Park (La Rovere and Furtado, 2008). In 2008 Petrópolis-Tecnópolis had 74 enterprises related to the areas of software, biotechnology and telecommunications services. The ratio of high qualified jobs in the local ICT industry grew from 33.1% in 2002 to 68.6% in 2006.

Although there was a steady but limited growth in the number of ICT companies, and a significant growth in qualified employment, the interaction between this local institutions and enterprises and is considered very poor. Albagli and Maciel (2007) attribute this to lack of participation of local businesses in the original planning of the Technology Park. Mello and Rocha (2004) also observed some design limitations in the Petrópolis-Tecnópolis project. First, more efforts should be directed to establish a basic infrastructure for research, in more fields of knowledge, in order to promote knowledge transfer. This would facilitate access to and interaction with other research institutions more consolidated that could contribute to the local technological development. In addition, for the success of the project, it is essential that all institutions establish coordinated actions, and not individually.

According to Amaral (2007), the project Petrópolis-Tecnópolis went through three distinct phases: genesis (1998-2000), growth (2001-2004) and consolidation (2003-2006). In each of these steps, various institutions were mobilized, and from then configured a network strongly based on interpersonal relationships. The author notes that the trajectory of the Park has been marked so far by "victories and defeats, support and desist, growth and shrinkage" (p. 16). This may explain why there are different interpretations about the "success" of the project.

3.2.2 Cooperation between companies

A study conducted by La Rovere and Rodrigues (2008), where they applied a questionnaire and made interviews with 20 companies of Petrópolis-Tecnópolis, indicated that there are several challenges in the contribution of the Technology Park to local development.

First, the study found that most companies feel the negative effects of lack of training of the workforce. In fact, more than 80% of companies reported they need technical training in the areas of managerial training and product marketing. Also, companies that went to the Technology Parks because of incentives kept their former R&D networks, with institutions outside Petrópolis and even outside the state of Rio de Janeiro. Because of this, learning processes between local businesses are harmed. Nevertheless the study also concluded that the main sources of information for innovation are coming from the company's previous experience and exchange of information with customers and suppliers, suggesting that in Petrópolis companies realize the importance of cooperation ties. This result confirmed the findings of another study made by Rodrigues, La Rovere and Carvalho (2007) that was conducted among high tech companies and traditional companies as well.

Second, in the analysis of advantages and disadvantages of location, 70% of companies have pointed to the infrastructure of services available and the cost of labor as the positive elements,

while the disadvantages cited by most companies was the reduced availability of labor, the absence of government programs and the lack of tax incentives. In relation to the demand for supporting policies, the primary need of companies is in attracting potential customers, (90% of results). Marketing is a need for most companies, because about 80% of entrepreneurs have reported does not have a clear vision of market. Besides these, other demands such as fiscal support and training of personnel were cited as important.

According to a study conducted by Britto and Stallivieri (2007) with a group of 131 firms from four clusters dedicated to producing software located in the regions of Petrópolis (Rio de Janeiro state), Recife (Pernambuco state), Curitiba (Paraná state) and Brasilia (Federal District), it was found that Petrópolis was the only city where the level of cooperation between companies of this sector was considered important. Cooperation between firms of Petrópolis manifests itself in different ways. The most common type of cooperation is the exchange of information with customers and suppliers, sharing of equipment and tests of inputs, products and processes (Rodrigues, La Rovere and Carvalho, 2007). Local entrepreneurs are using the Internet as an important means of information, especially to collect information about firms' competitors and market opportunities. The main source of tacit knowledge is the set of relationships with customers and consultancy agencies outside Petrópolis. Local entrepreneurs consider that these informal contacts are best to acquire knowledge than the meetings held by managers of Petrópolis-Tecnópolis (Albagli and Maciel, 2007).

A study conducted by La Rovere, Rodrigues and Shehata (2007), where they applied a questionnaire and interviews with 30 companies of the Technology Park, identified that these companies have a strong bond with the city as regards the origin of equipment: most companies stated they buy most of its equipment, raw materials and other inputs in the city. This relationship may favor cooperation among local companies. Another factor that may explain the more intense level of cooperation in Petrópolis is reduced interaction and integration between companies and local institutions. The reduced interaction and integration between research institutions, managers of the Technology Park and the productive sector leads entrepreneurs seek to overcome the difficulties linked to their business through cooperation with other companies (La Rovere and Rodrigues, 2008). Finally, our interviews suggest that Petrópolis firms establish cooperation links as a way to compensate for the low-growth and the lack of institutional support. In fact, local companies seek to cooperate as a way to strengthen competitiveness within the market in which they are inserted.

3.2.3 Governance and diffusion of knowledge

The reduced integration and coordination between local companies and institutions entails numerous problems for local ICT entrepreneurs. In their sector knowledge is a crucial element,

therefore the presence of a range of institutions related to science, technology and innovation is essential for the dissemination of knowledge within the cluster. In addition, there must be coordination between the institutional actors responsible for the management of the Technology Park and local entrepreneurs. These elements are not present in Petrópolis. Although there are projects to encourage and support innovation for small and micro companies in the city they are implemented in a top down way, generating dissatisfaction and lack of credibility with the local entrepreneurs.

Moreover, according to entrepreneurs there are barriers to approach the board of managers of the Technology Park, because it gives priority to large firms. An interesting feature of the governance of the Park is that often the same person occupies more than one position, in more than one institution, sometimes including private and public agencies. This contributes to the flow of information and of tacit knowledge among leaders and simultaneously generates a concentration of power in the management of Petrópolis-Tecnópolis. While partnerships are strong within the institutional context, some entrepreneurs receive more attention than others, leaving doubts on the capability of the governance of the Park to include all entrepreneurs from the Technology Park. Also, entrepreneurs complained about the lack of a strong local innovation system in Petrópolis. LNCC is not capable to provide all R&D needed by companies, and local universities are focused on training of the workforce in traditional sectors. Local entrepreneurs have limited access to universities and institutions of technical support, and they ignore the technological and market opportunities in the region (La Rovere and Rodrigues, 2008).

4. Conclusions: contributions and implications

We presented in this paper two cases of Technology Parks implemented by local institutions: the Digital Harbor, located in Recife, state of Pernambuco, and the Petrópolis-Tecnópolis, located in Petrópolis, state of Rio de Janeiro. The Digital Harbor has been consolidated in recent years as a success, while the experience of Petrópolis-Tecnópolis has not been successful so far.

The success of the Digital Harbor can be explained by a number of factors. First, it articulated institutions and companies that were already present in the territory. Second, it searched to involve all institutions - local networks, companies, academic institutions, State institutions at the three levels (local, state and federal) and NGOs. Third, Digital Harbor management successfully took advantage of the federal Informatics Law and encouraged national and multinational companies to engage in partnerships with local institutions like CESAR and CIN, not only for the subcontracting of services but also for the development of joint R&D projects.

Finally, we must mention the early development of the ICT industry linked to banking activity in the city; the consolidation over time of CIN/UFPE as a Center of excellence; and the dynamism of relations between local companies, CIN, CESAR, NGPD and multiple domestic and foreign academic institutions, to generate new projects with other companies and firms consolidating the innovative activities of the cluster.

In Petrópolis, different from Recife, the design of the Technology Park involved several institutions but in fact those institutions were represented by a small group of people that did not establish solid relationships with the business community and civil society. Because of this, the processes of circulation of knowledge and interaction between the institutional actors were inhibited, which undermined the development of the cluster.

In addition, Petrópolis does not have local institutions related to science, technology and innovation able to meet the demands of local entrepreneurs with training, technical and technological support. Universities and research institutions that exist in the city do not act in a coordinated way and are not integrated with entrepreneurs, so the knowledge generated in these institutions is not directed to meet the needs of local firms. According to Amaral (2007), Petrópolis-Tecnópolis could encourage the establishment in the city of a minimum research infrastructure in its selected fields of knowledge, which would stimulate the attraction to the Park of innovative firms and facilitate access to external research institutes that are more consolidated. A mapping of technological demands from firms already installed in the Park is essential.

Despite all the problems that inhibit the growth of Petrópolis-Tecnópolis, the fact that enterprises located in this cluster attribute more importance to cooperation than enterprises located in Recife is positive because it paves the way for diffusion of knowledge and a sustained growth. This process will depend whether the management of the Technology Park succeeds to implement a policy capable of reinforcing the integration and interaction between research institutes, managers of the Park and the productive sector.

In addition, we must highlight the relationship between low growth of Petrópolis-Tecnópolis and the highest level of cooperation shown in this cluster. Cooperation as a compensation mechanism of low growth is a hypothesis that needs to be investigated in greater detail in future.

Finally, our research shows that the characteristics of the regions are important for the development of software industry. As for the institutional environment, governments have an important role in the promotion of software clusters, because of their potential to create a favorable environment for the industry. At the federal level, governments may create specific

laws that support innovative activities. At the local level, governments may stimulate software clusters by creating Technology Parks or other initiatives to support links between governments, industry and universities. However, even when institutional conditions are favorable, software clusters may not grow as expected. Success of a software cluster depends also on how firms access markets and whether they are capable of continuous innovation, either by establishing partnerships to develop new technologies with local universities or with their clients.

As observed by Nooteboom (2009) governance and competencies are complementary and essential for innovation. While in Recife we observe both, in Petrópolis limited competencies inhibit growth of firms and development of innovation, thus making the local Technology Park an initiative that still has to render fruits.

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