

The impact of the global manufacturing industry of electronic devices on higher education institutions in Baja California

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Abstract

The present research attempts to analyze the impact of the development of the global manufacturing industry of electronic devices –especially analogic and electronic TV devices- on higher education institutions in Tijuana from 1965 to the year 2000, which drives the region to the present conditions of cluster-based industrial development in the US-Mexican Border. Thanks to the North America Free Trade

Agreement (NAFTA) this economic development approach reached success attracting the attention of Asian multinational corporations such as Sony, Samsung, Matsushita, and Hyundai that shifted from the east to west of the Pacific Ocean their assembly plants thanks to the opportunities presented by the Mexican maquiladora industry. Furthermore, this research analyzes how higher education institutions have adapted their academic offer in order to meet the requirements of the industry.

Keywords

Electronic devices, Foreign trade, Higher education, Industrial complexes, Industrial plant design, International transport, Public policies, Triple Helix.

1. Introduction

The history of the global manufacturing industry in Tijuana can be traced back to World War II (WWII) when the Bracero Program was first implemented by the U.S. and Mexican governments due to the greater demand of labor in the U.S. Thousands of people from the Mexican interior migrated to the border, especially to work in San Diego, which was one of the major naval bases of the U.S. Army during wartime. However, when the Bracero Program ended, Mexican labor did not return to the interior of Mexico but remained in Tijuana and other Mexican border cities facing unemployment and impoverishment of living conditions. The Mexican government designed the Border Industrialization Program (BIP) inspired by previous experiences from Malaysia and the Philippines. BIP had a modest beginning but later thanks to the North America Free Trade Agreement (NAFTA) reached success attracting the attention of Asian multinational corporations such as Sony, Samsung, Matsushita, and Hyundai that shifted from the east to west of the Pacific Ocean their assembly plants thanks to the opportunities presented by the Mexican maquiladora industry. In Tijuana, particularly, the development of the TV assembly plants had a significant impact on higher education institutions which had to meet the requirements of the industry in order to guarantee employment to their students.

2. Triple Helix in Tijuana

The potential impacts of the industry on higher education systems is early mentioned –in general terms- by Etzkowitz et al (2000) as part of the triple helix model and particularly as trans-institutional impact; and states that in order to reach the entrepreneurial university “an enhanced capability for intelligence, monitoring and negotiating with other institutional spheres, specially industry and government” (p. 316) is required; however, Etzkowiz foresees more difficulties than advantages in Brazil, Colombia and Argentina -no mention to Mexico- for the shift from the traditional and scholastic paradigm to entrepreneurial academic paradigm in Latin America.

Complementary to the present research, studies on the evolution of the maquiladora industry in Mexico has been a continuous research of Carrillo and Hualde (2002, 2009) that allow to map the early origins of the maquiladora industry to the best practices up to date. Regarding a special interest in the region this study focuses on is developed by Ganster, Sweedler and Clement (2000), Chang-Hee (2005) and Coronado, Fullerton and Clark (2004), depicting the US-Mexican Border as a geographic defined region, Tijuana-San Diego as a trans-border metropolis with its own production and labor dynamics. Clusters and their characteristics patterns of co-location, issues, growth, and impact on the region they establish and develop is broadly approached by Kumar (2013), Lund-Thomsen and Vanhamme (2014), and Flores, Villarreal, and Flores (2016). Finally, current data and insights about higher education institutions and their academic offer has been traced and retrieved from the Mexican Institute of Education and Pedagogy Services (ISEP) and the Tijuana Economic Development Corporation institutional websites.

3. Hypothesis of work

Our hypothesis is that the triple helix model and particularly as trans-institutional impact factor stated by Etzkowitz et. Alt. (2000) does work in the industrial cluster of maquiladora industry of electronic devices in Tijuana -located in the US-Mexican border- from 1965 to 2000; despite the fact that Etzkowitz et. Alt. stated in their research that Latin America has no conditions to shift from the traditional and scholastics paradigm to the entrepreneurial academic paradigm. In order to test our hypothesis, we conducted a research based on unrelated data from two sources, being the first all data related to industrial development in Tijuana and the second source data about academic offer in the region. We put the two timelines in parallel comparison and found out patterns of impact from changes in the industry to transformation of academic offer.

4. Maquiladora industry in Tijuana as part of the global manufacturing industry of electronic devices

4.1 Maquiladora Industry in Tijuana: Historic background

Maquiladora Industry is “an arrangement created by the Mexican government that permits the flow of materials and products in and out of Mexico with only the value added being taxed,” (Hodgetts and Luthans, 2003, p. 13). The history of the global manufacturing industry in Tijuana can be traced back to World War II (WWII) when, according to Ganster, Sweedler and Clement (2000, p.77), the Bracero Program was first implemented by the U.S. and Mexican governments in 1942 “in response to the wartime labor shortage in the United States.” The purpose of the Bracero Program was to permit Mexican laborers to work in the United States in agriculture and other sectors. The program ended in 1964. Due to the greater demand of labor in the U.S. from 1942 to 1964, thousands of people from the Mexican interior migrated to the border, especially to work in San Diego, which was one of the major naval bases of the U.S. Army during wartime. However, when the Bracero Program ended, Mexican labor returned and also remained in Tijuana and other Mexican border cities facing unemployment.

The Mexican government, - Ganster, Sweedler and Norris (2000. p.78) continues- “fearing significant unemployment as the Bracero program ended and guest workers returned from the United States,” established the Border Industrialization Program (BIP) in 1965 (Carrillo and Zárate, 2009, p. 336). The BIP’s objective was the generation of welcoming conditions for foreign industries to allocate assembly plants or maquiladoras in border cities. “The program initially enjoyed only modest success. However, beginning in 1984, stimulated by simplified regulations and lower wages brought by the devaluated peso, the industry has achieved double-digit increases in employment each year,” (Ganster, Sweedler and Clement, 2000, p. 78).

There are two critical facts that additionally boomed the maquiladora industry in the U.S.-Mexican border: (a) In 1986, the Mexican government decided to enter the General Agreement on Tariffs and Trade (GATT). As a consequence of it, import licenses were eliminated and tariffs reduced. Additional changes in maquiladora regulations produced a significant increase in this industry sector, especially in border cities; and (b) in 1992, the North American Free Trade Agreement (NAFTA) was signed by the United States, Canada, and Mexico. As a result, since 1994, NAFTA has removed all barriers to trade, increase bilateral trade, and created more jobs in the border region.

By the year 2000, - Ganster, Sweedler and Clement (2000, p. 73) claims- 12 million people were living in the U.S.-Mexican border and will likely double by the year 2020, “with most of this growth taking place in the urban regions on both sides of the border.” The major urban concentrations in the border were Tijuana (1,309,634 people) and San Diego (2,758,849 people) accounting for 40 percent of the U.S.-Mexican border population.

4.2 Maquiladora Industry in Tijuana: Statistical Facts

By the year 2000, -according to the National Council of the Industry in Mexico- the maquiladora industry in Mexico was already employing 1,338,970 people in 3,655 manufacturing plants. Sixty-two percent of the maquiladora employees and fifty-nine percent of the manufacturing plants were located in the U.S.-Mexican border region, leaving the remaining forty percent on employment and facilities for the Mexican interior including Mexico D.F. One of the reasons for the stressed development of the maquiladora industry along the U.S.–Mexican border is the proximity to the U.S. market.

Table 1: Maquiladora Industry in Mexico

Country	Region	Number of Foreign Manufacturing Plants	Number of Employees
Mexico	Border	2,187	833,553
	Interior	1,468	505,417
	Total	3,655	1,338,970

Source: Consejo Nacional de Industria, 2000

The preferred allocation pattern over the border and close to the U.S. market is repeated even in smaller areas such a Baja California, where Tijuana, Mexicali, and Tecate (border cities) have more maquiladoras in place than Ensenada (relative interior) despite the fact that Ensenada is a maritime port.

Tijuana is by far the preferred city for maquiladoras not only in Baja California but also all along the U.S.-Mexican border. According to the Mexican Secretaría Nacional de Desarrollo Económico de México (SEDECO) Tijuana accounted, in the year 2000, for 819 plants and 196,002 employees.

Table 2: Maquiladora Industry in Baja California

Mexican State	City	Number of Plants	Number of Employees
Baja California	Tijuana	819	196,002
	Mexicali	199	64,301
	Ensenada	108	16,038
	Tecate	146	12,709
	Total	1,272	289,050

Source: Secretaria Nacional de Desarrollo Económico de México (SEDECO), 2002

Out of the total number of people working in the maquiladora industry, 7.1 percent were working in management positions, 11.2 percent as technicians, and a vast 81.6 percent of employees were working in production lines.

Table 3: Maquiladora Industry in Tijuana by Occupational Sectors

City	Plants	Employees	Occupational Sectors					
			Production	%	Technicians	%	Management	%
Tijuana	819	196,002	159,968	81.6	21,976	11.2	14,058	7.1

Source: Secretaria Nacional de Desarrollo Económico de México (SEDECO), 2002

It was not possible, for the present paper, to find out if Multi-National Companies (MNCs) that operate a maquiladora in Tijuana preferred home-country nationals, host-country nationals, or third-country nationals for management positions. It will be also important, in further research, to determine (a) the percentage of Mexican citizens holding a management position in the industry, (b) if there has been a shift from home country-nationals or third–country nationals to Mexican managers since the Border Industrialization Program (BIP) started in 1965, and (c) in which maquiladoras this hypothetical shift has been taking place.

4.3 Global manufacturing of electronic devices in Tijuana’s maquiladora plants

According to Carrillo and Hualde (2002), the three main sectors of the maquiladora industry in Tijuana are textiles, electronics, and auto parts. Among them, a closer look will be placed over the electronic sector.

The global manufacturing of electronic devices in Tijuana's maquiladora plants is producing from TVs and VCRs, to computer monitors and semiconductors. The major employers in Tijuana electronic maquiladora industry, according to the Tijuana Economic Development Corporation (2002) were Sony with 7,500 employees, Samsung with 5,400 employees, Matsushita with 5,450 employees, Sanyo with 4000 employees, and Hyundai with 1,900 employees.

All the companies operating in maquiladoras of electronic products conformed a multicultural business core that could include management practices from Japan (Sony), South Korea (Hyundai), the USA (Bose), and The Netherlands (Phillips). The managerial practices and strategies of MNCs that operates a maquiladora in Tijuana might be, in some way, changing the behaviour of thousands of people currently working in their facilities as a result of training programs and corporative culture.

4.4 Global TV brands and in Tijuana's maquiladora plants

The global relevance of the Mexican TV maquiladora industry has been stated by several sources, according to the Mexican government office for exports promotion ProMéxico (2016), "[t]he TV production in Mexico was 1.7 million in 1987 and grew to 25 million in 1998 (...) México's share of international TV imports in the US went from 40.6% in 1990 to 63.5% in 1996". Carrillo and Hualde (2002) claimed that 18 out of 26 millions of TVs that were sold in the USA in 1998, were produced in 10 industries located in the northern Mexican border. Indeed, 7 out of 10 Color TVs sold in the US market were produced in Mexico. By the year 2003 the "ever-growing pace (...) reached a peak of almost 35 million TVs" (ProMexico, 2016) The reasons behind this trend are the proximity to the U.S. market, lower wages, and skilled labor.

Table 5. TV Maquiladora Industry in Tijuana by MNCs in 1997

Company	Entrée year	Headquarters	Branches	Yearly production capacity (number of TVs)
Sony	1985	Japan	Sony	3,000,000
Samsung	1988	South Korea	Samsung	1,850,000
Matsushita	1980	Japan	Quasar, Panasonic, National	1,500,000
Sanyo	1982	Japan	Sanyo	1,100,000
Hitachi	1986	Japan	Hitachi	1,200,000
JVC	1996	Japan	JVC	700,000
Total				9,350,000

Source: Carrillo and Hualde, 2002, p. 146.

Tijuana and the electronic maquiladora industry was not the only case of sustained economic growth in the northern Mexican border. Other industries along the border might have also emerged thanks to implementation of "policies based on interregional economic cooperation strategies" (Torres, Polanco-Gaytán y Tinoco Zermelo, 2014, p. 191).

4.5 The Impact of global manufacturing of electronic devices in Baja California Higher Education System

The Tijuana Economic Development Corporation (TEDC) claimed that Tijuana has the highest education rates among the Mexican population. Statistical data from the Instituto Nacional de Estadística, Geografía e Informática (INEGI) in Mexico confirm that while the national average of literacy is 90.45%, Baja California has a rate of 96.29% and Tijuana reach the 97%. Additionally, as a strategy to attract foreign investment, TEDC states that because of the quality of the higher education, labor is skilled enough to meet the needs of the companies.

According to this information, the maquiladora industry had a direct impact in the creation of some majors, and modification of curriculum of others in the higher education system in Tijuana. Educational institutions tried to be in tune with the productive system, especially with the electronic industry, because when majors were oriented to the needs of the labor market, it was easier for students to find a job. However, there is no data available to measure if educational institutions were controlling the number of professional required in each field.

Nevertheless, it is obvious that since the Border Industrialization Program started in 1975, several universities had opened their doors to local and regional students. Up to date, the statistics of the higher education system shows that the percentage of increase of registered students in the system is bigger that the percentage of increase of population, meaning that the coverage of the higher education system has increased as well.

Table 6: Population Coverage in Higher Education System - Baja California

Academic Year	Registration	% Increase or Registered Students	Population in between 19 to 24 years old	% Increase on population	% Coverage
2010-2011	85.277	5,0	350.053	1,9	24,4
2011-2012	93.201	9,3	356.050	1,7	26,2
2012-2013	100.068	7,4	361.975	1,7	27,6
2013-2014	102.188	2,1	368.591	1,8	27,7
2014-2015	106.581	4,3	374.451	1,6	28,5
2015-2016	114.543	7,5	379.624	1,4	30,2
2016-2017	116.970	2,1	383.715	1,1	30,5

Source: Inst. Of Education & Pedagogy Serv. (ISEP) 2017

Taking a closer look to the Baja California Higher Education System, at the level of municipalities, it is the municipality of Tijuana the one with the biggest academic population on higher education institutions, with 61.302 students and 6.280 faculties distributed in 118 schools on the system.

Table 7: Higher Education Student Population by Municipality in Baja California

Municipality	Student population	Faculty Population	Number of Schools
Ensenada	21.845	2.621	52
Mexicali	42.515	4.971	92
Tecate	1.298	176	6
Tijuana	61.302	6.280	118
Playas de Rosarito	546	546	5
TOTAL	127.506	14.119	273

Source: Inst. Of Education & Pedagogy Serv. (ISEP) 2017

The most preferred degrees in Tijuana -up to 2009- were obviously those related to the job opportunities offered by the maquiladora industry: Industrial Engineer, Electronic Engineer, Electronic Systems Engineer, Electrical Mechanic Engineer, Computer Science Engineer, Computer Systems Engineer, Telecommunication System Engineer, Digital Design Engineer, Information Systems, Business Management, International Business, Accounting, Economics, Marketing and Advertising, Foreign

Commerce and Customs, and International Affairs, according to the Institute of Education and Pedagogy Services (ISEP).

During the last decade there has been a shift of the academic offer as well as on the academic preferences of the students, since most of the graduate academic offer for master and doctoral programs are now focused on areas related to Environment and Development, Biotechnology and Molecular Ecology, Coastal Oceanography, Planning and Sustainable Development, Comprehensive Environmental Management, Comprehensive Water Management, Socio-Cultural Studies, Regional Studies, Migration Studies, Affirmative Action and Social Development, according to a survey by Hilario (2016, pp 84-89).

It does mean that during the period 2001-2010 the higher education system in Tijuana focused on providing professional required to meet the technical and administrative needs of the industry, while the period 2011 to present the academic offer is promoting programs that allow the region to have professionals skilled to deal with environmental and social issues that might arise from the industrial development of the region.

4.6 University-Industry Agreements in Baja California

Both companies and educational institutions tend to establish relationships through agreements of mutual convenience. According to Carrillo and Hualde (2002), large companies were more likely to sign up agreements than medium size companies.

The objective of these agreements was to allow Mexican students to carry on internships and professional practices in factories, especially in production but excluding all aspects of research and development (R&D). Carrillo and Hualde (2002) also mention that Samsung and the Instituto Tecnológico de Tijuana currently have an agreement to provide 15 to 20 scholarships to students who want to complement higher education with training in Samsung facilities.

Faculty members, Carrillo and Hualde (2002) continues, are also an important link between education and industry because some of them work in both sectors. "By 1992, one third of all higher education institutions had 205 or more of its faculty members working in the maquiladora industry. Also, in one third of all higher education institutions, ten percent of faculty members left the education sector to work in the maquiladoras," (Carrillo and Hualde, 2002, p.176). The reason given by the former professors to leave campus, Carrillo and Hualde (2002) explains, was the better salaries offered by the industry sector.

In addition, Carrillo and Hualde (2002) finally said, a recent trend on university-industry cooperation is taking shape as training and continuous education programs carried on not in the classroom but in the company's facilities. Medium-sized companies were more likely to take this option while large corporations tend to use their own corporative staff for these courses.

5. Summary and Conclusions

Tijuana's geographic location is a critical factor in understanding why this city has become the largest maquiladora industry complex in the U.S.-Mexican border. Its proximity to San Diego and the access to San Diego's maritime port are highly attractive to Asian multinational corporations.

Due to a sustained process of industrial development carried on in Tijuana for almost forty years, since the Border Industrialization Program started in 1965, there is in Tijuana a skilled labor pool.

It is important to remember that maquiladora industry is not Mexican industry and be aware that maquiladoras might leave the place leaving behind large-scale unemployment.

Tijuana was able to sustain its economic growth thanks to a cluster-based industrial development, which was leveraged by a proactive response from the higher education sector and its academic offer designed to respond the requirements of the industry.

Evidently, Tijuana's higher education system is being influenced by the industry. Students in Tijuana already have access to internships and professional in some industries. However, those professional practices are limited to production lines.

The evidence found in Tijuana's case suggests that the triple helix model proposed by Etkowitz also Works in developing countries. It seems that the system of Maquiladora in the electronic manufacturing sector allows to develop the conditions proposed by Etkowitz, as long as the main companies of the field are located and gathered in permanent industrial clusters.

Data found shows that there is a co-relation between the need of highly skilled workers in the electronic manufacturing sector and the rising of the academic offer from universities. Therefore, universities have become specialized suppliers of workers to trans-national companies.

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Biography

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