



## Production strategies: the best practices of the electrical and electronics industry in Brazil

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### Abstract

Productive systems that efficiently meet cost, time limit and quality requirements have become increasingly relevant due to the economics and technological turbulences that periodically hit the global economy. In the electrical and electronics industry, the fierce competition has demanded innovation, dynamism, and quick answers in developing new products and production management from the enterprises. This work aims to investigate the ways of action adopted by enterprises from this industry in Brazil. The methodology analyzes in details primary data obtained from interviews, direct observation, participant observation, document analysis and study of multiple cases in 5 large and medium-scale Brazilian enterprises as a validation mechanism. The data collected and later analyzed in this survey corresponds to the period from 2011 to 2015. As a research contribution, were identified some of best practices have been chosen for the definition and implementation of their production strategies. The main similarities and differences were also highlighted, compared and analyzed among the practices adopted by the investigated enterprises and cited authors.

**Keywords:** Electrical and electronics industry. Production strategies. Best practices.

### Introduction

In a time of high competition, great technological changes, capital and knowledge fast mobility, scarce natural resources, industries try to incorporate strategic aspects to manufacturing decisions [1]. In nowadays competitive market, the life cycle of products is shrinking, whereas their variety is increasing. The mix of these products in small batches contributes to the manufacturing uncertainty. The growing globalization directly affects the production [2]. The manufacturing enter-

prises are facing increasingly frequent and unpredictable changes from the world market, stimulated by high competition, fast introduction of new products and constant variation in their demand [3].

The production management and its operations have become more strategic, as it gets clearer its potential contribution to strategic performance of the organizations of which they are part [4]. Since there is an intense relationship between production systems and the environment of which they are part, the strategic decisions must be understood as a dynamic process and they may go through alterations as the market and the competition are placing them [5]. If well managed, the production area may be a formidable competitive weapon that is able to provide means to the organization so it acquires sustainable competitive advantages. However, if badly managed, it can be an obstacle in the path of the organizational performance [4].

Also according to the researched authors, the right production strategy choice together with the global strategy of organization, helps to maximize the results, enhances the process and operation performance, reduces costs and waste by creating a higher value to clients and to the own enterprise. Thus, by strategically using the production function, organizations keep their competition and sustainability both within the productive plants of the same business group, as well as outside in relation to their competition, which may be located in several regions of the world.

Therefore, the research has investigated production strategies adopted by Brazilian enterprises in the electrical and electronics industry, so that they keep themselves competitive facing relevant factor impacts of high competition, new knowledge and constant change of products, processes, and technology that are characteristic of this industry, presenting as a main contribution the best practices adopted in this segment.

### **Justification, general objective and specific objectives**

This research is justified by the lack of official up-to-date information about this industry in Brazil, not to mention the difficulty in obtaining strategy data due to high competition, dynamic launching of new products and secrecy inside enterprises that are part of this industry. The choice of the electrical and electronics industry was also because of its representation in the group of industrial activities and its economic and social importance, besides its organizational, productive, and technological innovations that it produces, which contributes to studies done by the scientific community in the Production Engineering area.

As a general objective, this work has proposed to identify which are the production strategies used by a sample of enterprises from the delimited market, getting from them their best practices. Among these practices, some tools, models and actions adopted in the decision area can be considered, divided by the researched authors in structural (industrial facilities, industrial capacity, used technology, vertical integration level, and ethnical and social issue), and infrastructural (industrial organization, human resources, quality management, relationship with suppliers, production planning and control) that are part of a production strategy actions and used by the investigated enterprises and that have demonstrably brought positive, meaningful results and that were financially measured after being implanted.

The specific objectives of this research were: i) introduce an overview of the electrical and electronics industry in the world, in Brazil, in Curitiba and its metropolitan region, where the field research was performed, that is; ii) relate which are the main competitive priorities, influent factors and actions both in the structural and infrastructural areas considered in this work development.

## **The electrical and electronics industry in the world**

According to Digitivity Electrical & Eletronics Industry Marketplace [6] – a famous business to business online marketplace that holds up-to-date information about the world electrical and electronics industry – the worldwide electrical and electronics industry is experiencing phenomenal and remarkable changes these days. The worldwide electronics industry is distinguished by fast technological advances and has grown rapidly than most other industries over the past 30 years. It has grown in a fast rhythm with the invention of innovative technologies and because clients (consumers and other market parts) are increasingly keen on electrical and electronics goods. This poll also states that this industry is highly worldwide fragmented, consisting of several secondary industries, for example, electronic components, computer equipment, telecommunications, appliances, industrial electronics, and electronic assembling services – which is the focus of this research, etc. Besides, it mentions that United States, Japan and Korea are the top three electrical and electronic goods manufacturing country in the world. The United States of America is the largest producer of electronic products in the world, contributing a total share of around 21%. Furthermore, it also occupies the largest market share with about 29% in the global market.

Moreover, a new wave of industrialization is throwing up several business opportunities for electrical and electronics market. There is a vast growth in the sales of computers, software and networking products. Younger generation is increasing becoming tech savvy and spending huge amount of money on digital products such as smartphones, games, MP3 players, Dvd players, speakers, headphones.

The future seems prosperous for this electrical and electronics industry in terms of the expected surge in global demand and upsurge in investments. Many trends such as over-capacity in developed markets, globalization, technology advances, regulation and environmental consideration, market fragmentation and product proliferation will lead to the accelerated growth of this sector.

From this change on, many of these enterprises were designated as Electronics Manufacturing Services, or simply EMS, and others as Contract Manufacturing, or CM, providing services that are beyond the simply assembling of the circuit boards or individual parts of certain products. The technological evolution that took place in the world of the electrical and electronics industry in the last ten years, the miniaturization of components and products and its impact in practically all other industrial areas are unquestionable and noticeable.

Board 1 lists the considered 10 main world EMS's in the year 2014.

**Board 1** – The 10 biggest world EMSs

<b>Main 10 world EMSs and their home countries</b>	
1 - Foxconn ((formerly Hon Hai Precision Industries)) Taiwan	6 - Celestica Canada
2 - Flextronics Singapore	7 - Advanced Semiconductor Engineering (Former USI) USA
3 - Jabil Circuit USA	8 - Benchmark Electronics USA
4 - FIH Mobile (Foxconn International Holdings) China	9 - Plexus USA
5 - Sanmina USA	10 - Venture Corporation Singapore

Source: Venture Outsource, 2014.

## The electrical and electronics industry in Brazil

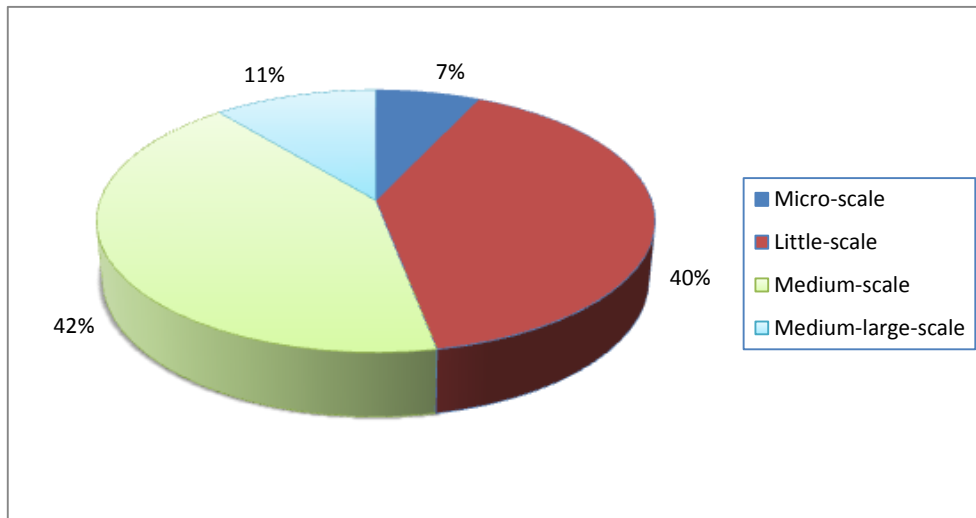
According to the publication “A voz da indústria elétrica e eletrônica no Brasil” (The voice of the electrical and electronics industry in Brazil)[7]. The Brazilian Electrical and Electronics Industry Association is an unprofitable civil society organization of which main objective is to represent the electrical and electronics industry all over Brazil. In the country, this industry was originated from the precision ground ball screw enterprise that belonged to the Lorenzetti family, founded in 1923, and which little by little expanded its product line by creating the electrical shower, patented by the enterprise. Around the 1940's, the Brazilian industry was dominated by imported items, and during the Second World War, the possibility of supplying it aroused, and it grew and got a local scale production. Because of that, as economists call it, the Import Substitution Industrialization occurred, implementing the Brazilian industrial vocation. From 1947 on, the government, overrating the exchange rates, which substantially increased the importation cost, and adopting import barriers to consumer goods and products that had a national similar, caused an industrial boom, especially in the electrical material industry, term that was used to name this industry at that time. On the 26 of September, 1963, businessmen and executives decided to create this association, of which goal was to defend the general industry objectives and particularly the ones from the electrical and electronics industry.

Due to the diversification that there is in the product line of the associates, the enterprises are distributed among Section Area Boards, that were created in order to gather them. The main section areas are: industrial automation; electrical and electronics components; industrial equipment; electrical power generation, transmission, and distribution; computing; electrical material installation; telecommunication; household appliances; and manufacturing service in electronics. Following, some data about the industry in Brazil is presented by the Economical Panorama and Industry Performance survey, done from the year of 2008 till 2015 [8].

As reference, the classification done by BNDES – Banco Nacional de Desenvolvimento Econômico in 2010 (Brazil's Economic and Social Development Bank), which establishes two main criteria to be followed: Annual Gross Revenue and Number of Employees were adopted [8].

In this work, the size of the companies compared to the Annual Gross Revenue classification was adopted, as it is present below and illustrated on Graphic 1.

- Micro-scale Enterprise – up to R\$2.4 million;
- Small-scale Enterprise – up to R\$16.0 million;
- Medium-scale Enterprise – up to R\$90.0 million;
- Medium-large-scale Enterprise – up to R\$300.0 million;
- Large-scale Enterprise – over R\$300.0 million.



**Graphic 1** – Size of the companies considering Annual Gross Revenue Classification  
Source: Banco Nacional de Desenvolvimento Econômico e Social (BNDES), 2014.

Board 2 illustrates some important indicators from this industry in Brazil, from 2012 to 2015 extracted from Economic Panorama and Industrial Development from Abinee (2015).

**Board 2** – Important indicators in the electro and electronics industry in Brazil

Indicators	2012	2013	2014	2015
Revenue (R\$ Billions)	144.5	156.7	153.8	142.5
Revenue/PIB (%)	3.0	2.9	2.7	2.4
Number of employees (in thousands)	308.0	308.6	293.6	248.1
Revenue/employee (US\$ in thousands)	240.1	235.2	222.5	172.1
Investments in fixed assets (% over revenue)	2.6	2.7	2.5	2.3
Exports/total exports of Brazil (%)	3.2	3.0	2.9	3.1
Imports/total imports of Brazil (%)	18.0	18.2	18.0	18.3

Source: prepared by the authors, 2015.

Board 3 presents the Brazilian revenue by industrial area from 2012 to 2015.

**Board 3** – Electro and Electronics Industry revenue by industrial area

<b>Total Revenue by Area (R\$ millions)</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Industrial automation	3.920	4.368	4.523	4.508
Electrical and Electronics components	9.755	10.696	10.370	10.071
Industrial Equipment	22.322	23.599	25.718	26.550
Generation, Transmission and Power Distribution	15.307	16.220	15.742	16.103
Computing	43.561	47.046	37.660	30.170
Electrical and Installation Material	9.019	9.478	9.689	8.742
Telecommunications	22.811	26.689	29.592	28.309
Electrical and Electronics Household appliances	17.841	18.649	20.522	18.357
<b>Total</b>	<b>144.536</b>	<b>156.745</b>	<b>153.816</b>	<b>142.540</b>

Source: prepared by the authors, 2015.

The electrical and electronics industry revenue in 2015 reached R\$142.5 billion, which represents a 14% reduction when compared to 2014 (R\$ 153.8 billion). The investments retracted 16% and the number of employees reduced by 45.531 workers. These indicators reflect the serious political and economic crisis facing the country, which led to inflation rate higher than 10% shrinkage of PIB by 3.8%, increase in gross public debt to 66.2% of PIB.

As it was previously said, Abinee represents the electrical and electronics industry in Brazil, and it has around 650 associated companies with national and international capital, of different sizes and segments. Due to the great diversity of product lines, these companies are distributed into different industrial areas – which were previously enumerated – and among of them it is the electronics manufacturing services. It is necessary to clarify that, according to information from the association itself, the values from the electronics manufacturing service of the industrial areas are not covered in these surveys for they are suppliers of basic input to the others: the printed circuit and in some cases even assembled subproducts/products [8].

To the Association, due to the strategic importance that the electrical and electronics industry have gotten now in any strong and modern economy in the world, an industry survey and some scientific research have become another way of action to take advantage of the industrial power that is now installed in the country.

The Paraná State is the fourth Brazilian state in number of workers in this industry, behind São Paulo, Amazonas and Minas Gerais states, according to data from Perfil Industrial do Setor Eletroeletrônico no Paraná (Industrial Profile of the Electrical and Electronics Industry in Paraná) from Abinee [8]. Only five enterprises in Curitiba and in its metropolitan area, which work directly in the industrial field being studied, agreed to take part of the interviews and allowed that the results of this work were disclosed. Other six companies refused to take part of it alleging that there were some secrecy issues due to the high competition and also said that any information about strategies are limited to their own internal areas. Three enterprises did not answer the attempts to contact them and they did not assume any position in it. The investigated companies outsource the printed circuit board assembling, set up and test electronics systems and complete products that are used in computers, telephones, cellular telephones, cellular telephone chargers, consumer electronics products, magnetic encoders, radio base station boards, among others.

The industrial manufacturing process in electronics practically comprises all the kinds of sets found in many current electronic devices, and it is characterized as a multistep process, that basically includes components – of which, because of the technological advance, were miniaturized – and the printed circuit board or PCB were assembled by the SMT (Surface Mounting Technology).

## Literature Review

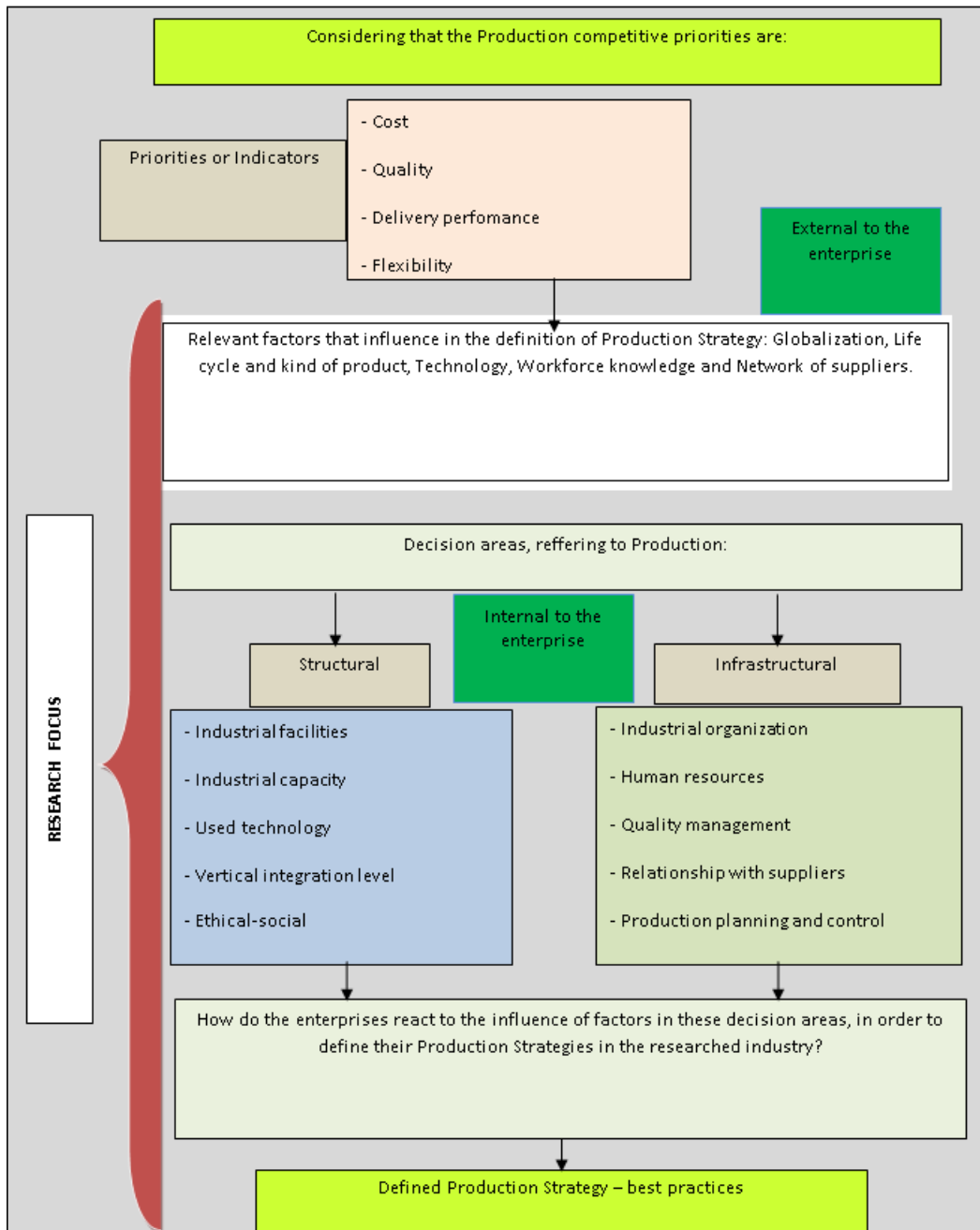
Military and diplomatic strategies have existed since pre-history. One of the jobs of the first historians and poets was to collect accumulated knowledge from these life and death strategies, whether they had been successful or not, and convert them into future knowledge and guidance [9]. Business strategy, in turn, consists of a deliberated choice of a different set of activities that provide a unique and exclusive position to the business or industry, that is, a unique way to compete in which an enterprise may stand out and distinguish itself [10]. The birth of the manufacturing strategy appears with two articles written by the American academic Wickham Skinner, from Harvard University. He tried to justify some reasons that were leading the American industry to lose its competitiveness. The concept has evolved a lot since pioneer Skinner's time, along with contributions from important academics such as Robert Hayes and Steven Wheelwright [12], in the United States, and Terry Hill, Nigel Slack [13] and others in Europe [16].

From this theoretical investigation of several authors during a timeline and based on their work, the competitive priorities were defined, the relevant factors that have some impact in the definition of a production strategy and actions in the structural and infrastructural areas taken by the enterprises in the field and that were considered in this work. To these authors, [4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21] briefly: i) the competitive priorities are a consistent group of parameters that the manufacture will have to compete with it in the market, during some time horizon. According to most of these authors, nowadays, the most worldwide used priorities are cost, quality, flexibility and delivery performance; ii) the factors to be considered as the most relevant ones in the definition of production strategies are: globalization, life cycle of the product, technology, workforce knowledge and network of suppliers and; iii) they considered as structural decision areas: industrial facilities, industrial capacity, technology, vertical integration and as infrastructural decision areas: planning and production control.

## Methodology

The present work has investigated production strategies used in enterprises from the electrical and electronics industry in the city of Curitiba and in its metropolitan area, that belong to the industrial area of electronics manufacturing services in the period from October/2011 to March/2015. The research, of a qualitative exploration character, was done from a depth investigation on existing bibliography, data collection through interviews, direct observation, participant observation inside the enterprise where one of the authors work, and document analysis. Subsequently extensive studies were undertaken in five companies as a comprehensive validating

exercise. The data collection and the steps of this research followed the illustrated guide in Figure 1.



**Figure 1** – Research guide used to identify the best practices  
 Source: prepared by the authors, 2015.

The used data collection tools are described and explained on Board 4 below.



**Board 4** – Guide of the data collection tools of the research

<b>Tool</b>	<b>Characteristics and place of application</b>	<b>Involved</b>	<b>Justification</b>
1- Bibliographic research	Reading and selection of concepts and relevant comments in books, articles, theses, dissertations, symposiums, and internet.	Selected authors according to the research purpose.	Theoretical foundation, argumentation.
2- Interviews	Done by open, specific and deeply detailed questions. The interviewee, representing the company, is directly connected to the production area.	Five enterprises, of medium and large scale in Curitiba and in its metropolitan area.	Identify the priorities, factors, and actions in the decision areas and adopted production strategy.
3- Participant observation	It will be used because one of the researchers is involved in the day-by-day of the enterprise where he works, interacting with the investigated issue.	A researcher author.	Practical foundation, enhance the reliability of the obtained data.
4- Direct observation and document analysis	It will be used to gather information from the investigated companies, besides the enterprise where one of the authors work.	The researcher authors.	Practical foundation, data collection, reference corroboration.

Source: prepared by the authors, 2015.

## Characterization of the enterprises and of the respondents

The five enterprises that were investigated in the field belong to the electronics manufacturing service in Curitiba and its metropolitan area, and they perform the assembling of printed circuit boards with conventional components, also with SMD (Surface Mounting Device) components, sub-assembling, assembling and tests of electronics products that are targeted to several market segments. As it was previously explained, in order to preserve the enterprises' identities and of their respective respondents, they will be simply identified as enterprises and respondents A, B, C, D, and E.

Out of the five enterprises that were visited in the field, according to the Economic and Social Development National Bank (BNDES) criteria for the annual gross operating income, three of them were included as large-scale enterprises and two of them as medium-scale enterprises from Curitiba and its metropolitan area, as the research was delimited. All of the enterprises are in the industry for over 15 years. The Board 5 presents, in an objective way, a comparison among the investigated enterprises during the mentioned time that the research was conducted as to their: market representation in the industrial area, position in their main operational industry, total number of employees (of which, how many of them are in the production area), and capital origin.

**Board 5** – Characterization of the investigated industries in the field

<b>Electrical and Electronics - Key Areas</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
<i>Industrial automation</i>				X	
<i>Electrical and Electronics Components</i>					X
<i>Industrial Equipment</i>				X	X
<i>Electrical and Electronics household appliances</i>				X	
<i>Computer</i>	X	X	X	X	
<i>Telecommunications</i>	X				
<i>Automotive/Agricultural</i>	X			X	
Ranking in the main market in which it performs in Brazil	Among the top 3	Among the top 3	Among the top 3	Among the top 10	Among the top 10
Total number of employ- ees/in production area	650/410	4200/2000	400/300	1000/800	350/270
Funds origin	Foreign	National	National	National	National

Source: prepared by the authors, 2015.

Board 5 reinforces the explanation why the electronics manufacturing service industrial area is not in the statistical data from Abinee [8], since it is a supplier of basic input or of sub-assembled parts to all the others, contributing this way to their respective revenues.

When it comes to the respondents, all of them ranged between 41 and 50 years old, had over than a 15-year experience in the production/manufacturing area, and post-graduated. None of them has gotten a master degree. Except for enterprise “E”, all the interviewed people directly took part in defining the production strategy. All of them considered the production area as vital to keep the competition, as well as for the success of the corporative strategy in the respective enterprises.

## Results presentation and analysis

As a contribution from this work, the best practices in establishing a production strategy were identified. In the field research, it was detected that there is a process to define the production strategy, in which, once the product has been established, it is defined the competitive priorities and the one in which the industry is really going to focus so it creates its differential in the market. After that, all the actions to be taken in the structural and infrastructural decision areas are defined, considering all relevant factors, the ones that have a direct impact over such actions.

From the conducted comparative together with the obtained results in the field, it is concluded that the enterprises adopt certain decisions, many of them similar since they have presented positive and measurable results after they had been initiated by the competition and spread throughout the market, which leads to the

conclusion that a production strategy that shows positive results have got some best practices, which are going to be described as follows based on the collected data.

When it comes to actions in the structural decision areas:

a) **Industrial Facilities:** the use of Lean Manufacturing and its tools is a strong trend. The mixed arrangements, interspersing the assembly line with flexible systems is very used. The cells, in cases in which the products have got high diversity and smaller volumes, are largely used. The reconfigurable manufacturing systems are used because of constant demand variation in this market. Another important aspect to highlight is that, some of the most simultaneously used Lean tools in the investigated large-scale enterprises were: the waste reduction, the value stream mapping of processes and visual management, the continuous improvement, the Kanban systems, cell manufacturing and the 5S methodology.

b) **Industrial Capacity:** all the enterprises used the temporary employment, increasing of shifts and outsourcing or leasing of machinery whenever they need to enhance the capacity during production peak periods. Flexible manufacturing systems are largely used. The managers initially must decide whether they invest in a flexible manufacturing system, which has a higher initial investment or in a dedicated system. Yet, the flexible benefits are higher than the initial costs and it also gives some freedom to the process.

c) **Technology:** all the enterprises use high technology in the production and in its tests, which is a prerequisite to maintain oneself competitive in this industry. In order to fulfill new market niches, the reduction of batches, short lead-times, and an increasingly smaller life-cycle of the product, the enterprises have been dramatically increasing their mix of products and as a result, a degree of equipment and technology flexibility is also needed nowadays. The tendency of using ERP's (Enterprise Resource Planning) with wide resources is high because of the increasing complexity of operations and the need for fast answers and practically online interaction among all the departments in the enterprise, this way reducing the total time process.

d) **Vertical Integration:** it was noticed the use of outsourcing in very specific activities in which equipment investment, low occupation or the cost of being internally made is unfeasible. The industries prefer to keep high priced products internally gathered, outsourcing low complex productions and volume with approved partners, for defined periods of time. It was also evident the increasingly search of enhancing the mix of products with an increasingly level of customization, but respecting a certain level of similarities in the technical characteristics for sharing the same resources, workforce, and equipment.

e) **Ethical and Social Issue:** in the industry, Quality Certifications, Environmental Certifications and social responsibility actions are prerequisite. Also the concerning with the way collaborators behave and the enterprise image in the society is highly relevant.

When it comes to actions in the infrastructural areas:

a) **Industrial Organization:** the conventional hierarchy use is unanimous, distributed into traditional departments, such as engineering and development, purchasing, production, quality, etc. The majority of the enterprises keep an open com-

munication channel by sharing, selecting, and disclosing some pertinent information to each hierarchical level.

b) Human Resources: the tendency is the reduction of their own workforce and of training investment. The use of temporary, low-qualified hired workforce in the productive areas is the current reality. In high-specialized positions, the substitution of old employees for new ones with lower salaries is a rule. Multifunctional teams focusing on high-performance teams (HPTs) are what the enterprises looking for. More specific trainings are only performed if the product or the customer requires so. Basic and unsatisfactory motivational programs were highly evidenced in these companies.

c) Quality: the increasingly search for Certifications, tools, technology, and systems that reduce inspections and the non-conformities are constant goals in all of them. Quality has become a basic and surviving issue in this industry and it is no longer a requirement winner factor, but a prerequisite to be part of this specific market.

On the other hand, the high workforce turnover, the little specialization and the low salaries have got a direct impact in the product quality. Many enterprises face some losses when providing training to a great number of those collaborators, losing them to the competition and to other industries since they do not have some retention policy established, hiring expectation or internal development plan.

d) Suppliers: the use of Asian partners, due to the characteristics of the products and the lack of national industries of components, is a fact. The trend is the establishment of homologation programs, development and monitoring of suppliers only for A and B items (highest valued items in the final product) and that must present some specific characteristics, in which quality and deadline are differential. To all the others, the aim is the cost-benefit relationship. However the main objective, no matter the supplier, is what can be called a win-win relationship.

Another important issue that is being adopted is the ensured quality partnership, which transfers all the quality responsibility, inspection and eventual penalty to supplier. Most companies have presented an assessment methodology to their suppliers, however none of them proved the actual effectiveness of this development, monitoring all of their main suppliers. In some of them, there is no constant monitoring except when there are problems and non-compliance issues.

e) Production Planning and Control: it was noticed the intensive use of MRP (Material Requirements Planning) programs and software specifically developed to minimize programming errors. In spite of that, the parallel control based on excel sheets and the know-how of collaborators are still the adopted solutions in great part of the cases, not to mention that really convincing studies about the performance of the productive systems of the enterprise were not noticed. Here there is a great opportunity for the development of scientific works and academic researches, since there is a lack of solutions that reduce losses and delays.

Board 6 shows other best practices characteristics presented by the researched authors and that are frequently used by the investigated enterprises.

**Board 6** – Identified strategies in the bibliography and that are normally used in the field

Enterprises	Characteristics of the identified best practices in the bibliography and applied in the studied Enterprises
<b>Common to investigated Enterprises</b>	<ul style="list-style-type: none"> <li>- Using manufacturing resources to compete in quality, cost, efficient delivery and flexibility;</li> <li>- The production area is a competitive differential;</li> <li>- Equally emphasizing the structural decision areas and the infrastructural decision areas, aiming for some balance between them;</li> <li>- The production area is adapted to the product, market characteristics, volume and mix of products;</li> <li>- Performance criteria are defined and respective priorities;</li> <li>- The production area constantly aims for innovation and diversification in the processes;</li> <li>- A survey is frequently done to find out what the market wants, how the production area currently is and what is needed to improve it. They use informal Benchmarking;</li> <li>- Communicating strategy details, goals and indicators to everyone who is involved in it;</li> </ul>
<b>Different among Enterprises</b>	<ul style="list-style-type: none"> <li>- In enterprises A, B, D, and E, the production area also supports the corporative strategy mainly aiming for leadership by the cost;</li> <li>- In enterprises C and D (in this one, in a specific product), the production area also supports a corporative strategy aiming for leadership mainly through differentiation;</li> </ul>

Source: prepared by the authors, 2015.

## General conclusions and limitations

Culturally, the term strategy reminds of something secretive, observing and disclosing restricted. Even in an informative level, the limitation of exposing details that are related to this theme has become something forbidden in most of the organizations, mainly if monetary issues were involved or if they would evince their products, projects or clients.

Thus, in this research some requirements that would indicate monetary values were not considered, eliminating then possible conflicts of interest or uncomfortable situations that would certainly harm this study.

It is also important to point out that the participants were properly informed about the research, its objectives and the adopted methodology and these were in accordance to the laws and regulations of the country where they were performed, as well as following all international norms, standards and ethical issues.

In spite of the difficulty of a first contact and of scheduling the interviews, the obtained information contributed to reaching the proposed objectives, since the goals of the case study are not to provide a precise knowledge about the characteristics of a population, but it was to provide a general vision of the problem or identify best practices and possible factors that have some influence on it or are influenced by it [26].

As a contribution, the best practices have been identified and they have proved how important the theme is when facing the dynamic scenery that forces the enterprises to look for enhancements and actions that result in creating competitive advantages by keeping the business sustainability. It also rescued the related authors have approached this theme for over twenty years in order to define the competitive

priorities, the relevant factors and the main actions considered by the structural and infrastructural areas.

Many similarities among the actions taken by the enterprises were noticed and also that there are differences due to the characteristics of the products, the profile and demands of the costumers being served, however many of them are adopted as the best practices in this industry and they are quickly copied and broadcasted among the competitors.

According to the authors surveyed in this work, some of important points are listed below.

Regarding Industrial Facilities, it was confirmed what Koren and Shpitalni state [3], the reconfigurable manufacturing systems in addition to combining dedicated assembly line high efficiency with the flexibility of flexible systems, are also able to respond to changes in the market by adapting the production system elements fast and efficiently, bringing together the best qualities of both types. As well according to what was presented by Bhasin [22], some of the most simultaneously Lean tools are used in this segment. Besides, this author reinforces that the organizations need to acknowledge that there is no unique formula or direction to follow to guarantee success, however a combination of appropriate tools and their culture is necessary for the success of the Lean.

Regarding Industrial Capacity, according to Fernandes et all [23] pointed out, decisions that involve restructuration, enhancement and new investments in manufacturing areas are critical. A restructuration study may be conducted by a number of strategic decisions as a wish to adopt a new, more flexible and modular way of operating in order to meet the business dynamic enhancement or simply to improve the development by cost reduction or productivity gain. It was confirmed what Erozan [24] wrote, own investments or the enlargement of factories are rare due to market variations and to the volatility of the electrical and electronics industry.

Regarding Technology, according to Fernandes et all [23] wrote, the strategic problem of offering some standardized products is due to the fact that some other suppliers may easily copy the solution and the operational dilemma of investing in new equipment is if it can be used with both standardized products and customized ones. Then, the newest technology is prerequisite to maintain oneself competitive in this industry.

Regarding Suppliers, it was confirmed what Yin et all [25] wrote, both suppliers and customers are partners and together they must cooperate so that this win-win relationship is reached in order to avoid any losses. If there is no direct cooperation, there will be no benefit between both of them.

Regarding Production Planning and Control, according to Erozan [24] pointed out, the decision to restructure a productive system in order to enhance its performance is complex because it means determining, controlling, and assessing all the requirements and since managers do not have enough knowledge and experience, this decision making is going to be tougher on them.

There is some concern about the workforce appreciation. The multi-functionality issue was confirmed, the search for a lean production and the increasingly demand for qualifications have caused a decrease in the workforce and conse-

quently an overload to those who have remained in their work stations, mainly in the tactical and operational levels.

On the other hand, the trainings provided by the enterprises, the acknowledgement and the appreciation for the workers have decreased in the last five years. Because of the specialized workforce demand, the enterprises, in a way, have transferred this responsibility to the own worker by cutting off training subsidies and investment, which are considered expenses in some situations according Gronovicz [27].

## Recommendations and Future Researches

When it comes to the future perspectives for the electrical and electronics industry, all of the respondents stated them as positive. In spite of the world crises, mainly in the European and Brazil market, all of them believe in the continuing growth in the Asian countries, due to new releases, consumer demands and new technologies that promote a constant renewal in this industry, which generates opportunities to the local market as well, however this one must be prepared.

Thereby, despite all the difficulties that they have been facing, the enterprises must keep themselves competitive and with well-defined, established and rigorously monitoring their corporative and production strategies in order to prospect new businesses.

For this purpose, it is also necessary to establish more partnerships among enterprises and institutions, mainly universities, so that they develop together new strategies, tools, processes and professionals that ensure productivity, flexibility, profitability and competitiveness of the national enterprises facing the eminent risk of becoming obsolete in the near future.

By the way, this work noticed some of enterprises investigated (A, C and E) were in a delicate situation in terms of market share and acquisition of imported components due to Brazilian crisis and currency fluctuations.

As a suggestion for future researches, the use of similar methodology to investigate other sections or areas of the electrical and electronics industry or even other industries is recommended.

Another good contribution would be to develop a model to turn the decision making easier when defining actions in the structural and infrastructural decision areas with their respective indicators, since this is a difficulty that was noticed by this work in all of the investigated enterprises.

It was also noticed a huge deprivation and unawareness of some companies about themes that are aimed at the production area and that are part of new technologies, qualities and their tools, statistics, production planning and control and even of a new methodology for production strategy elaboration. Many of them are still thinking regionally, with a reduced theoretical foundation and using obsolete or resource-limited techniques and tools.

Another opportunity to be taken from this work is the continuity of the research by broadening the sampling in order to achieve a view of the Brazilian industry and not only of the region as was delimited here. This certainly corroborates for a better understanding of the realities and the needs of this industry turning it into an

important source of information to students, researchers, enterprises, learning institutions and the society.

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