Arquitetura Industrial e Sustentabilidade

Industrial Architecture and Sustainability

Arquitectura industrial y sostenibilidad

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Resumo

A chegada da corte portuguesa em terras brasileiras e a assinatura do Alvará de 1808, por D. João VI, autorizou a instalação de fábricas no país. Tratava-se da revogação do Alvará anterior de 1785, assinado por Dona Maria I, que proibia a instalação de fábricas de tecidos finos no Brasil. Desde então, foram muitas as mudanças que ocorreram na área fabril brasileira e que levaram seus projetos e obras se ajustarem aos diferentes momentos políticos, econômicos e sociais. A arquitetura industrial seguiu essas necessidades e tecnologias que foram surgindo desde então, sempre trazendo soluções que acompanharam as modificações que apareciam, independente da tipologia e característica requeridas. Agora, a sustentabilidade é o ponto imprescindível para que se afirmem os comprometimentos assumidos internacionalmente e se obtenham os quesitos ambientais demandados para um crescimento saudável da economia industrial, refletindo-se nas edificações e áreas de implantação dos complexos fabris, além do seu processo de fabricação, propriamente dito. Este artigo procura fazer uma reflexão sobre projetos sustentáveis de arquitetura industrial no Brasil. O objetivo é traçar considerações sobre os aspectos que são abordados no projeto de arquitetura de indústrias para que este se enquadre em um modelo sustentável, tanto quando se fala em certificações, quanto

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referente ao próprio projeto. Pretende-se com este conteúdo instigar a propagação de projetos com orientação sustentável na arquitetura de indústrias. O texto se baseia em publicações técnicas diversas e em sites de organizações que sistematizam, estruturam e certificam empreendimentos com abordagem de sustentabilidade.

Palavras Chave: Arquitetura, Indústria, Sustentabilidade

Abstract

The arrival of the Portuguese court in Brazilian lands and the signing of the 1808 Permit by D. João 6th authorized factories and manufacturers in the country. This was the revocation of the previous license of 1785, signed by Dona Maria First, which prohibited the fine fabric factories in Brazil. Since then, there have been many changes in the Brazilian manufacturing industry and brought their projects and works to fit the different political, economic and social moments. Industrial architecture followed these needs and technologies that have emerged ever since, always bringing solutions that accompanied the changes regardless of the typology and characteristic required. Now, sustainability is the indispensable point to affirm the commitments made internationally and to obtain the environmental requirements demanded for a healthy growth of the industrial economy, reflected in the buildings and the manufacturing complexes, as well as their manufacturing process. This article seeks to reflect on sustainable industrial architecture projects in Brazil. The goal is to draw considerations on the aspects addressed in industrial architecture design so that it fits into a sustainable model, both when it comes to certifications and the project itself. This work of sustainable orientation in the architecture of industries. The text is based on various technical publications and websites of organizations that systematize, structure and certify enterprise with a sustainability approach.

Keywords: *Architecture, Industry, Sustainability*

Resumen

La llegada de la corte portuguesa a tierras brasileñas y la firma del Permiso de 1808 por D. João VI, que autorizó la instalación de las fábricas y manufacturas en el país. Esta fu ela revocación de la licencia anterior de 1785, firmada por doña María I, que prohibía la instalación de fábricas de telas finas en Brasil. Desde entonces, ha habido muchos cambios que tuvieron lugar en el área de la fábrica brasileña y trajeron sus proyectos y obras para adaptarse a los diferentes momentos políticos, económica y social. La arquitectura industrial siguió estas necesidades y tecnologías que han estado surgiendo desde entonces, siempre trayendo soluciones que acompañaron los cambios que aparecieron independientemente de la tipología y las características requeridas. Ahora, la sostenibilidad es el punto indispensable para afirmar los compromisos adquiridos internacionalmente y para obtener los requisitos ambientales exigidos para un crecimiento saludable de la economía industrial, reflejándose en los edificios y áreas de implementación de los complejos de fabricación, así como en su proceso de fabricación, propiamente dicho. Este artículo busca reflexionar sobre proyectos de arquitectura industrial sostenible en Brasil. El objetivo es extraer consideraciones sobre los aspectos que se abordan en el diseño de la arquitectura de las industrias para que se ajuste a un modelo sostenible, tanto en lo que respecta a las certificaciones, como en referencia al proyecto en sí. Este contenido pretende instigar la propagación de proyectos con orientación sostenible en la arquitectura de las industrias. El texto se basa en varias publicaciones técnicas y sitios web de organizaciones que sistematizan, estructuran y certifican empresa con un enfoque de sostenibilidad.

Palabras Clave: *Arquitectura, Industria, Sostenibilidad*

Introduction

There is a great deal to be implemented about sustainability in architecture projects for industry. Despite the growth, the numbers of projects for industry in Brazil which uses sustainable innovations in the architectural parties, constructive process, construction materials and energy efficiency are not expressive regardless of the manufacturing process or human aspects.

The Building Technology Center, CTE (2015, p. 26) showed as the result of a research made in 2010 with market builders the following typologies with the objective of mapping the sustainable building

trends in Brazil: 63% of commercial buildings, 25% of residential buildings l, 9% of industrial building and 3% of infrastructure. Within the industrial complex: 79% of industrial sheds, 9% of *Data Center* s, 4% of Distribution Centers, 4% of meat fridge, 4% of factories, meaning that there is a lot to develop in the field.

The New Urban Agenda established stin 2016 in Quito by the United Nations- UN (2016, p.7-8) is committed to ‘’ensure sustainable and inclusive economies’, adding “high productivity, competitiveness and innovation’’ besides ‘’ guaranteeing environmental sustainability, promoting the use of clean energy and the sustainable use of land and resources in urban development; protecting ecosystems and biodiversity’’. These factors are more developed in the Sustainable Development Goals 11 (Sustainable Cities and Communities) and 12 (Responsible Consumption and Production) as global goals, however it depends on our ability of implement them (*GLOBAL TASKFORCE*; UN HABITAT, p.11 e 13).

In relation to industries, the architecture must contain the future architectural items of a project to fit into the finished building that create this relationship between the finished building and the environment.

For any project it is necessary to readily understand the needs required for the future building, the area it will be installed and to analyze all conditions regarding climate, sunlight, legislation, norms, and other topics, to obtain a suitable solution for using natural resources.
The contribution of computational tools such as BIM (Building Information Modeling) which has a version for sustainability is worth mentioning. Such tools optimize the graphic representation and simulations of design and behavior of buildings during their life cycle. According to Asbe

> *In this context, the importance of planning and the project for production and use of the built spaces increase, as essential tools to reduce negative socio-environmental impacts in the manufacturing of construction materials, in construction site implementation of the project, the operation of the building and its demolition and disposal of final waste. (ASBEA, 2012, p.9)*

In the late 20th century the concept of "*green building*" was created, which is a r any space built or constructed with social, environmental and economic sustainability (BRDE, 2019, online).

When we design *´green building´* industries focused on sustainability, there are many factors to be considered that are part of a general system. There are laws, rules and criteria to adjust the projected result to care for the environment and the worker, reflecting on the construction and the built space to be used.

Garcia *et al.* (GARCIA, Danielle; VAZ, Francine; RANGEL, Juliana, 2018, p.4) inform buildings use about 40% of the world energy, and the construction industry sector is the biggest producer of waste among all industries, about 0.4 to 0.5 tons per capita during one year, in addition to consuming the planet's resources. The reduction in water and energy consumption, a rational use of natural resources, and waste control minimize the impacts of climate change. Concepts which are part of the principles of sustainable architecture:

> *1) Analysis of the surroundings; 2) Sustainable use of the land; 3) Detailed and integrated planning; 4) Adaptation to climate conditions with bioclimatic design; 5) Meet the user's needs 6) Compliance with rules and legislation; 7) Rational use of energy; 8) Water efficiency; 9) Rational use of materials; 10) Use of innovative technologies; 11) Sustainable landscape; 12) Prioritize occupants' health and well-being; 13) Economic Viability; 14) Analysis of the construction life cycle; 15) Promote awareness of those involved in the process. (GARCIA; VAZ; RANGEL, 2018, p.8)*

Along with sustainability concepts, there are certifying agencies with their own models that regulate and certify these projects and constructions.

If there is a purpose for the future or Old enterprise to be 'retrofitted' to have a sustainable certification, the criteria required or recommended according to the type of certification to be obtained for the project and built work. In this regard, there are several ways to evaluate buildings to identify how sustainable they are, from design, construction and use, with certificates being offered informing the percentage assessed and considered by each organization. *Environmental certifications for buildings are granted to projects that are subject to performance evaluation methods and, through these, prove good levels of efficiency in terms of sustainability. (ASBEA, 2012, p.107)*

According to Tello and Ribeiro (TELLO; RIBEIRO, 2012, p.80), certifications are Leed rating system (*Leadership in Energy and Environmental Design*), provided by *Green Building Council*; the Aqua process of French origin HQE- *Haute Qualité Environmental -Green Building Council Mundial*, which means High Environmental Quality - World Sustainable Construction Council) conducted in Brazil by Vanzolini Foundation. The Casa Azul developed by the Brazilian Bank Caixa Econômica evaluates only homes , the Town Hall of Belo Horizonte issues the BH Sustainable Seal, so does the Santander Bank with Sustainable Construction Seal. There is also the Procel Edifica Seal, which classifies the level of energy efficiency of buildings.

There are other rating system such as: Breeam (*Building Research Establishment Environmental Assessment Method*, English institution responsible for the development of the certification in 1990; DGNB (German origin); Qualiverde, granted by the Town Hall of Rio de Janeiro, focused on local projects; Passive House, an energy efficiency evaluation standard used in Switzerland and the Triple A Brazilian certification, developed by Real Estate Study Group of the Polytechnic School of the University of São Paulo, which rates the building in construction industry, users, and the place where the building is (NÚCLEO DE REAL ESTATE, 2019, *on line*)

There is still another certification process like ISSO, *International Organization for Standardization*, or International Organization for Standardization, a Swedish entity of standardization which developed among many norms some related to environmental management. In the same way the OHSAS, *Occupational Health and Safety Assessment Series also developed by the British* 'BSI Group'. Both certify the business management system.

The certification can contribute favorably for sustainability so far as they are guiding good practices for a sustainable construction which are fundamental for the country to accomplish the objectives of The Paris Agreement (2016). They are in the Brazilian Agenda 21, of the Ministry of the Environment), as an answer to the international context (Brazil, 2017). the Brazilian Agenda 21 is a "process and a planning tool for sustainable development with sustainability as its central axis"

Conditioning

It is necessary to question how we can improve the process of sustainable projects in order to reduce additional costs in the sustainable building project. According to Yudelson:

> *How can project teams design, build and operate commercial and institutional projects that are 'sustainable'? In particular, how can we build saving at least 50% in energy consumption following the local construction codes and satisfy the energy code requirements? (YUDELSON, 2013, p. XVII)*

Sharp (SHARP, 2013, p. XIII-XVI) still lists the items for the design of an economical project for sustainable buildings, what he calls “The Ten Commandments”:

1) Commitment, which must be formal and integrated with the approval and certification processes.

2) Leadership of the client or the project manager, maintaining the criteria established and reducing the risk of deviations.

3) Obligation to inform, maintain transparency and communication between all subjects involved.

4) Process Management, ensures that opportunities will not be missed and greater cost control.

5) Integrated Project, which can generate significant innovations and savings.

6) Energy modeling simultaneously with the integrated project and life cycle cost assessment.

7) Building performance tests performed by a specialist. The project needs to have measurements, monitoring and control.

8) Contracts and Specifications, meeting the requirements of the clien, the approval and certifying agencies.

9) Life Cycle Cost Assessment should be established from the beginning and be in contracts to have continuous assessments.

10) Continuous Improvement, lessons learned should be used.

An effective graphical management tool is SWOT analysis (Figure 1) to visualize the status of the project and opportunities or correct flaws. It points to be treated and managed in the project or construction such as: improving energy efficiency, linking the present situation with the desired result and devising ways to correct vulnerable aspects through action plans.

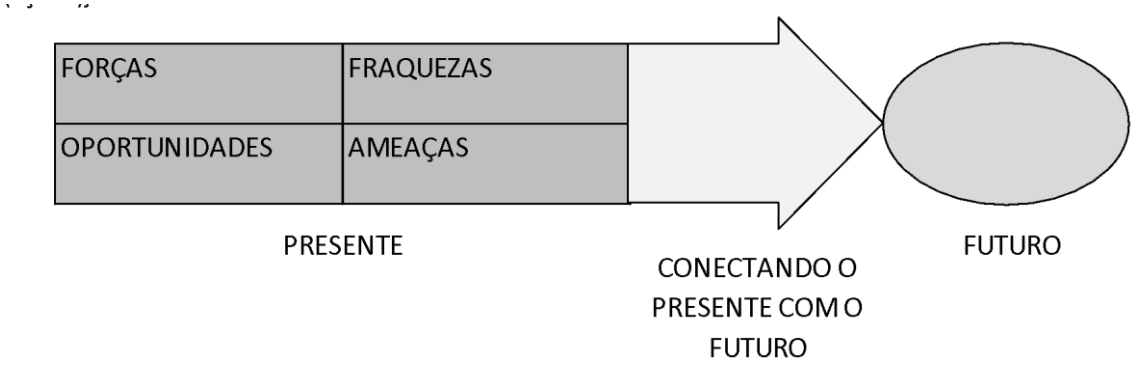

Figure 1: Author's drawing. SWOT Analysis. Source: YUDELSON, J. (2013. P. 71)

On this graphic (Figure 1) what is known as Strengths and Weaknesses which are internal to the project and the Opportunities and Threats that are external to it. When looking over these items, we can observe and take corrective action plans to achieve what was planned and thus include solutions in the project or work.

Conceptualizing

The construction may generate environmental impact proportional to the dimension of enterprise so it is important to think of it as a whole. Industrial architecture can establish criteria to soften future impacts, opting for an efficient architectural part that uses constructive techniques, material and finishing that generate fewer losses and less waste. The generation of greenhouse gases can already be considered in the extraction of raw materials and also in their transport.. The CTE publication (CTE, 2015, p. 8 -9) mentions that the construction sector consumes 16.6% of potable water of the planet, 40% of the fossil fuels destined for power generation per year and 25% of all annual logging (Figure 2).

Figure 2: BRANDÃO, Margarete. Forestry Logging. Avaliable ON: https://commons.wikimedia.org/wiki/File:Extra%C3%A7%C3%A3o_em_floresta.jpg. Access on 08 Oct. 2019.

Knowing that ‘’a sustainable building generates environmental, economics and social benefits’’ (CTE, 2015. p. 15) some criteria are recommended when designing sustainable industrial architecture, starting by information sharing and integration between different professionals working in the creative process.

The land

The definition of which land will be used is essential to plan an industrial enterprise especially if the project has a sustainable focus and needs to use the available urban structure according to CTE (2015, p.42-43). The team will be able to run simulations on the types of wind and solar power generation so that the implementation is done with awareness of the technological opportunities (Figure 3), to

accommodate the facilities in a compatible manner with the land and its topography, trying to reduce cuts and removal of ground. The Procel (PROCEL, 2019, *on line*) provides Energy Efficiency Simulators on its website to choose a project's energy source. Earthmoving can include adjustments in the terrain, to meet the productive needs in the architectural program, without causing environmental and visual impact taking care of the surroundings for a harmonization in the landscape.

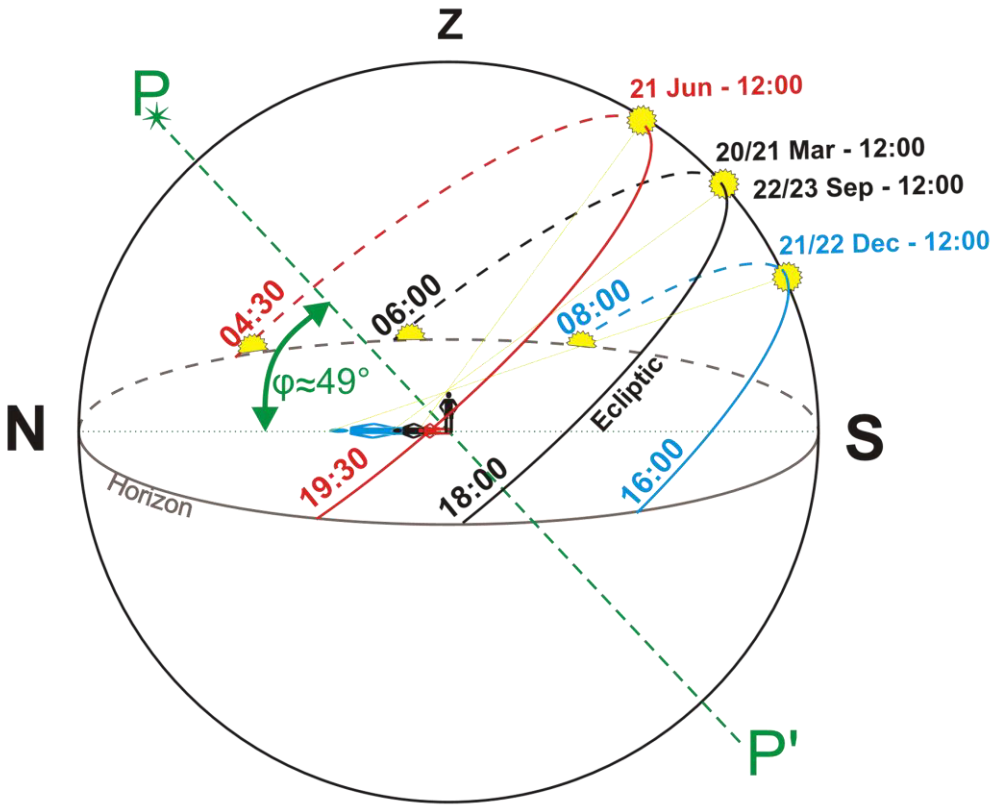

Figure 3: KRASTEV, Zlatko. Insolation and Shading Study. Available in: https://upload.wikimedia.org/wikipedia/commons/9/99/Solstice_and_Equinox.svg. Access 08 October. 2019.

This option must also consider urban mobility issues with the minimization of the use of private motor vehicles and encouraging the use of strategies to reduce traffic such as bike racks (CTE, 2015, p. 42-43) (Figure 4). In Yudelson (YUDELSON, 2013. p. 189), it was considered the existence of stones, trees, clays, or other materials in the existing land that can be reused in the new enterprise. Another issue is how much can we improve or limit the impact caused by the new building eventual wildlife habitat in the area and possible removal of vegetation and facilities near water bodies.

Figura 4. Author's photograph. Bicycle Parking. Amsterdam. May 2017.

Architectural part

The project starts from the needs of the client and the simulations carried out on the terrain, considering structural systems and the applicability of innovative construction materials within the sustainable objective, establishing the architectural part, remembering the definitions established by Biselli (BISELLI, 2011, *on line*). The project may use construction and finishing materials produced without environmental damage, but also with air circulation solutions to minimize the use of ventilation or refrigeration equipment, ensuring thermal and acoustic comfort.

Water

Yudelson (YUDELSON, 2013, p. 190-191) believes water should be seen holistically, thinking about a water balance of the place as a whole. The planning of water consumption of the enterprise should be focused on water efficiency. If the industrial complex needs a great deal of water consumption, industrial process team should be consulted regarding reusable industrial water lines, for the manufacturing system to reduce waste. It is recommended to install effluent treatment plants

suitable for manufacturing residues to treat them, making them environmentally acceptable to dump them in the public network or even reuse that "water" in the manufacturing process again.

According to CTE (CTE, 2005, p. 50, 54, 57) several norms and laws are enacted with the aim of promoting the rational use of water on projects and works, including economical devices that limit the water volume used in home flushes as Act 13309/2002 establishes the reuse water of sewage plants for washing floors and irrigating public areas. There are other alternative sources of non-potable water that can be considered in this systemic planning, such as: rainwater catchment, shower water, washbasins, washing machines and tanks. To think in the possibilities of reuse water and installation systems with the goal of cost reduction and efficiency are crucial objectives. Tools for measurement and management of consumption must be expected in the project and construction to use after plant start up, even for leak detection and water quality control.

Energy Efficiency

When we talk about energy efficiency in the 21st century new digital control systems and building automation have made it possible to make buildings more ''intelligent'' and ''healthy'' for their users, following international trends.

Several factors contribute to this efficiency the implementation of the enterprise in the land, the constructive system and construction materials of the facade and its performance capacity in the exchange of external - internal heat, possible solar protection made with brise-soleil, shading, adhesive films that reduce the absorption of solar radiation, high-performance glasses, low-e type (low emissivity), coverings with zenith lighting and the demands for air conditioning or heating, as well as cooling systems.

CTE (CTE, 2015, p. 62-71) informs that factory buildings can shelter industrial heating or cooling processes which will consider thermal energy efficiency calculations and environmental comfort. The process equipment can have less energy consumption, lightning can be efficiently designed , besides electrical installations with an intelligent distribution in office equipment . Any electrical plans to meet the evolution of process equipment must be previously established in the project program.

This system must be constantly monitored after delivery of the work since the air conditioning is added with filtering and air treatment, to guarantee the quality and healthiness of the building workers and the lighting so that there is no waste. The appropriate system must meet the work standards that aim at the health of employees. Smart buildings are committed to environmental issues, ventilation and natural lighting, energy efficiency and reduced use of non-renewable resources in their project. That is why they are named: *eco buildings, green buildings* or *sustainable buildings* (ROCKENBACH, 2007, p. 53).

Figure 5: SUPERSAITO. Solar Thermal Energy. Available in: https://commons.wikimedia.org/wiki/File:Energia_solar_termica.jpg. Access on October 8tht. 2019.

Alternative or renewable energy can increase the capacity to reduce network consumption and even produce energy for resale, like in photovoltaic solar energy which uses roof panels (Figure 5) or glass films. The solar energy for water heating can also be designed for changing rooms, industrial kitchens and even in the manufacturing process, when applicable. (CTE, 2015, p. 73)

Green Covering

We need to consider the ‘’ heat islands caused by the concentration of impermeable surfaces such as asphalt and concrete as opposed to green areas ”(CTE, 2015, p. 45) and if we use garden coverings to reduce this heating, it is desirable to observe what else will be positioned on the local. As refrigeration equipment of air conditioning everything needs to be planned in order not to interfere with the effectiveness of each system, waterproofing being well designed and well executed is a major factor to ensure tightness.

Construction

The materials, structural systems and constructive processes should be studied and chosen considering low environmental impact since their production, transportation, application and waste generation even if the disposal must be carried out consciously, forwarding it to the appropriate sanitary landfills (YUDELSON, 2013, p. 199, 214). The construction is made to not produce waste, generate less waste. The management of the construction site must guide workers so that the construction is carried out with low environmental impact. The commissioning of all equipment by system will point out any flaws that can be corrected and maintained for the project's environmental performance.

All project specifications must be detailed to be a reference for contractors and subcontractors and ensure that the building is a reflection of how it was designed. A factory whose owners intend to have a financial return, sustainable design is an additional positive aspect to construction. The

budget must be strictly monitored so the benefits of this sustainable construction can be measured

(CTE, 2015, p. 94).

Final considerations

The necessary tools to have industrial buildings designed within the concepts of sustainability exist and are available in several ways such as architectural part, efficient construction method, choices of construction and finishing materials, methodologies for using processes and waste, among other options seen during this study .The certifications are also as process stimulators because they provide methodologies and add market values to the built product.

Gradually, the numbers of sustainable industrial architecture projects are growing in Brazil, due to a greater awareness and commitment of the industry to sustainable development: social, economic and environmental. By increasing the quantity of this type of design and construction within the "green building" model, improvements are being made in broad aspects and the possibility of helping the country to fulfill its commitment to the 2030 Agenda.

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