

TOOLS FOR ASSESSING SUSTAINABILITY IN URBAN SETTLEMENTS: Case study of the Metropolitan Center neighborhood, Rio de Janeiro, applying the LEED ND environmental certification

Bianca Marinho Quintella Borges Soares

Pontifical Catholic University of Rio de Janeiro, Department of Civil Engineering, Rio de Janeiro, Brasil.
biancamq@gmail.com

ABSTRACT: While increasing the use of sustainability in urban projects, it grows the need to develop sustainability indicators that serve as a reference for assessing urban policies implemented in the city. With it come new evaluation systems that take into consideration the environment, location, urban mobility, infrastructure and environmental management, putting into practice concepts of new urbanism and sustainable development. Through qualitative sustainability indicators, it shows how cities could be designed to absorb urban growth, without ceasing to be self-sustaining, providing opportunities without jeopardizing future generations. After a survey of urban conceptual parameters of sustainability, a case study of the neighborhood Metropolitan Centre in Barra da Tijuca was prepared, indicating the possibility of certification according to the standards required by LEED ND (Leadership in Energy and Environmental Design Neighborhood Development).

Keyword *Urban Sustainability; Environmental Certification for Neighborhoods; LEED ND.*

1 INTRODUCTION

The terms Sustainable Neighborhoods or Green Neighborhoods have been increasingly used by society as a positive way to occupy new areas. This concern for the sustainable development of cities has meant that developers across the country to adhere to this thought, seeking certification as a way to classify their projects at different levels of sustainability and add value to their works. (FARR, 2013)

Currently there are numerous enterprises certified and in process of certification in the country. However, environmental certification for neighborhoods has not been much discussed and used in Brazil.

While the use of sustainability increases in urban projects, it grows the need to develop sustainability indicators that serve as a reference for assessing urban policies implemented in the city. What can be seen nowadays is an urban legislation where the indices for construction differ from the indices required by environmental certifications, and therefore require a compatibility of urban laws with environmental certifications, enabling thus a sustainable urban growth of neighborhoods. (FARR, 2013)

The main problem of this research is: what would be the best way to measure sustainability in urban settlements. The indicators are fully applicable to the Brazilian urban environment?

The construction is major cause of degradation in the environment. Thus it justifies the choice of this subject, as an attempt to gather information and data to encourage the construction of neighborhoods that cause less environmental impacts.

The overall objective of this research consist of listing sustainability indicators for urban neighborhoods and housing developments, which are in accordance with the law of Rio de Janeiro and the local reality.

The methodology adopted for this study consist of the following stages of research: conceptualize the term urban sustainability; describe indicators with essential importance to enable sustainable urban development; list the most used and recognized environmental certifications for neighborhoods; analyze the LEED ND certification; analyze and apply the concepts of LEED ND in the study subdivision.

2 SUSTAINABILITY

2.1 The importance of sustainable development in construction

The construction sector is responsible for major impacts on the environment, transforming the natural environment in the built environment, so it is a major consumer of natural resources, water, energy and generates large amounts of solid waste.

To achieve sustainable development, it is necessary that the environment-economy-society tripod is balanced and develop in an integrated way. You can define Sustainable City as one "skilled urbe" to prevent degradation and the preservation of its environment, reducing social inequality and promoting a healthy environment for its population. Urban sustainability aims to end poverty, to allow equal opportunities, prevent degradation and promote environmental quality of the space. (FARR, 2013)

Some of the guiding concepts to get a city becomes sustainable are: New Urbanism, Compact Cities and Neighborhood Units. "New Urbanism seeks to show that it is technically possible to build cities that have a conventional configuration dedicated to pedestrian and based on streets, sidewalks and courts" (Katz, 1994).

Compact Cities and Neighborhood Units are concepts used by Rogers to define principles of sustainability. This city model is dense and socially diverse where economic and social activities take place together and the community is concentrated around the neighborhood units. For Rogers "compact neighborhoods and mixed-use reduce the displacement needs and create sustainable and filled spaces of vitality" (Rogers et. Al., 2001).

3 SUSTAINABILITY INDICATORS FOR URBAN PLOT

Through the qualitative sustainability indicators, it shows how cities could be designed to absorb urban growth, without ceasing to be self-sustaining, providing opportunities without jeopardizing future generations.

These conceptual parameters were organized into three major themes: Urban Morphology, Socio-environmental Quality and Urban Infrastructure. These themes are divided into the main aspects that involve a sustainable neighbourhood (Table 3.1).

Table 3.1 Urban Sustainability Indicators. Source: Prepared by the author

URBAN MORPHOLOGY	SOCIO-ENVIRONMENTAL QUALITY	URBAN INFRASTRUCTURE
* Density and compact Development	* Free Areas	* Solid waste management
* Mixed-use	* Ecosystem and Biodiversity	* Urban mobility
* Universal Accessibility	* Local Food Production	* Basic sanitation
* Walkable streets	* Health Care Access * Access to Education	* Urban Drainage * Renewable energy * Lighting and Security

3.1 Urban Morphology

The theme *Urban Morphology* includes subtopics related to the shape, design and neighborhood design. These sub-themes are:

- **Density and Compact Development:** Incentives for new urban housing developments are designed in areas adjacent to urban areas, reducing the impacts of new infrastructure.
- **Mixed-Use:** The district must have a wide range of housing, work, leisure, education, health and services.
- **Universal Accessibility:** Universal design in units and urbanism. Cheap pedestrian at the same level or with ramps, tactile flooring, among other items.
- **Walkable streets:** Allow people walk and ride a bike through the neighborhood with safety and comfort, leaving the streets and sidewalks more pleasant.

3.2 Socio-environmental Quality

The theme Socio-environmental Quality measures the population's quality of life, providing a healthier life to the neighborhood. The sub-themes are:

- **Free Areas:** Parks and squares provide population living areas with entertainment for children, gymnastics for seniors and contact with nature.
- **Ecosystem and Biodiversity:** the existence of protected areas, allows the population to have daily contact with natural systems.
- **Local Food Production:** Encourage local food production in areas such as green roofs, home gardens, gardens, orchard and community farms.
- **Health Care access:** The health of the population depends on both the quality of service as the quality and comfort of the built environment.
- **Access to Education:** Promoting environmental awareness in the population through education.

3.3 Urban Infrastructure

The theme Urban Infrastructure is very important issue for the proper functioning of the neighborhood. The sub-themes are:

- **Solid Waste Management:** implement measures that contribute to reducing the generation of waste and reduce, reuse and recycle waste generated by the project.
- **Urban Mobility:** encourages the construction of cities Compact, which grow around shopping centers near nodal points of public transport.
- **Basic Sanitation:** existence of supply services of water and efficient and adequate treatment of sewage.
- **Urban Drainage:** Avoid excessive soil sealing and occupation areas near rivers to not impact the local watershed.
- **Renewable Energy:** Design cities using renewable energy sources to meet their needs.
- **Lighting and Security:** Design neighborhoods with efficient public lighting and no waste, allowing the practice of evening activities and greater security.

4 CERTIFICATION SYSTEMS FOR DISTRICTS:

Environmental certifications are designed to measure the degree of sustainability of buildings or neighborhoods. The certificates have emerged as a way to differentiate products through a process which should fulfill various requirements in order to achieve the seal. Some of the most popular environmental certifications for neighborhoods are: LEEDND in the USA, BREEAM Communities in England, CASBEE City in Japan, HQE in France and the AQUA Neighborhoods in Brazil. Within this list, the LEED ND certification was selected for analysis because of its importance in the international arena and its outstanding market acceptance.

4.1 LEED ND Certification

The environmental certification LEED (Leadership in Energy and Environmental Design) was developed by the U.S. Green Building Council (USGBC), with the aim of encouraging the transformation in the projects and works of the buildings, with a focus on sustainability.

The LEED standard combines prerequisites, with optional credits that generate points and result in a score ranking. In addition to a minimum of 40 points, so that the project achieves certification, mandatory items must be met. As the project performance level increases the score increases. According to the number of points the certification may be Certified (40 points), Silver (50 points), Gold (60 points) or Platinum (80 points).

As the LEED ND involves urban projects of long duration, the USGBC provides that the certificate can be done in three stages: Pre-approval -when urban housing development is still in the design phase or under 50% of the urbanized area; Pre-certification - if the company with the approved design and maximum 75% of urbanization made; and certification - when urbanization is completed. (USGBC, 2009).

In the version of LEED ND 2009 (V3) certification has 5 categories, 12 prerequisites, 51 credits and 110 possible points to be achieved. Of these five categories, there are three main: Smart Location and Linkege and Neighbourhood Design, Green Infrastructure and Buildings; and two secondary groups: Innovation and Design and credits Regional Processes.

In Brazil LEED ND certification is starting to be used. At the moment it is possible to identify two certified projects (*Ilha Pura* - Rio de Janeiro and *Parque da Cidade* - São Paulo) and in the certification phase (Quartier - Pelotas).

5 VALIDATION OF ENVIRONMENTAL CERTIFICATION FOR DISTRICTS - LEED ND:

5.1 Metropolitan Center - Barra da Tijuca

With an area of approximately 360 ha located in the Baixada de Jacarepaguá, the site was bounded by Lucio Costa in the Pilot Plan for the urbanization of the area between Barra da Tijuca and Jacarepaguá, in order to become a new center for Rio de Janeiro. The Metropolitan Center is a subdivision under development, having few urbanized areas and built projects. It is located near the current Olympic region. In the surroundings of this area you can find residential projects already consolidated and significant volume of people.

5.2 Analysis by LEED ND

The diagnosis made below is intended to indicate the viability of the neighborhood become certified by LEED ND, showing the points that are already guaranteed and the ones that must be worked to meet certification. Because of its size, the neighborhood was divided into phases for certification. In this study will be the analysis only Phase 1 of the project (Fig. 5.1).



Figure 5.1: Phases suggested Certification. Source: Image prepared by the author.

For the presentation of the diagnosis was made a spreadsheet indicating each prerequisite and credit, which were classified as: C - According, M - Goal to be achieved, EA - In evaluation or D - Disposed. They will be analyzed in more detail the most significant prerequisite and credit of each category. The other prerequisites and credits are classified in the tables below (Table 5.1, 5.2 and 5.3).

5.2.1 Smart Location and Linkege

This category focuses on the selection of land that minimizes adverse environmental impacts, helping to avoid urban sprawl and its consequences on the environment (USGBC, 2009).

Table 5.1 Check List of Smart Location and Linkege category.
 Source: Prepared by the author from the Checklist provided by GBC Brazil.

C	M	EA	D	Smart Location and Linkege - SLL		27 points
x				Prerequisite 1	Smart Location	mandatory
x				Prerequisite 2	Endangered species in ecological communities	mandatory
x				Prerequisite 3	Wetlands and water bodies conservation	mandatory
x				Prerequisite 4	Conservation of farmland	mandatory
x				Prerequisite 5	Deviation from the flood quota	mandatory
3		2	5	Credit 1	Preferred Location	10
			2	Credit 2	Redevelopment of contaminated sites	2
		7		Credit 3	Location with reduced car dependence	7
		1		Credit 4	Network and cycling infrastructure	1
		1		Credit 5	Proximity to housing and work	3
1				Credit 6	Steep slope protection	1
					Project design for conservation of habitats or wetlands and watercourses bodies	1
1				Credit 7		1
		1		Credit 8	Restoration of habitats or wetlands and water bodies	1
					Conservation management of habitats or wetlands and watercourses bodies	1
			1	Credit 9		1

Prerequisite 1 - Smart Location:

LEED ND prompts for all project types should choose a location that already contemplate infrastructure such as sewer and water or provide new infrastructure for water and sewer

to the site. Besides, you should identify the category of the site that will be the district among the four following options:

- Infill site - where at least 75% of the neighborhood's perimeter is adjacent to previously developed areas.
- Local with connectivity - at least 90 crossings per square mile, 800m LEED Boundary.
- Located near transit corridors - 50% of entries are 400m walking distance from the bus stop and 800m walk distance from the subway or train stations.
- Locate the neighborhood in an area with more than 30% of residential buildings at a 400m distance of 5 different uses or 800m from 7 different uses, measured from the geographical center of the project (USGBC, 2009).

The Metropolitan Center allotment is located close to Abelardo Bueno avenue, and BRT and bus stops. The longest distance traveled on foot to the BRT stop would be approximately 600m.

Credit 5 - Proximity to housing and work:

This credit encourages balanced communities with a variety of uses and employment opportunities.

The Metropolitan Center has most of the lots with commercial use, public transportation and residential units to a walking distance of up to 800m, with enough units to meet 50% of local jobs.

5.2.2 Neighborhood Pattern and Design

This category values the creation of compact neighborhoods, vibrant, walkable, mixed-use and well connected. (USGBC, 2009).

Table 5.2 Check List of Neighborhood Project and Standard category.
Source: Prepared by the author from the Checklist provided by GBC Brazil.

C	M	EA	D	Neighborhood Pattern and Design - NPD	44 points
	x			Prerequisite 1 pedestrian pathways	Mandatory
	x			Prerequisite 2 compact development	Mandatory
	x			Prerequisite 3 Connected and Integrated communities	Mandatory
1	3	2	6	Credit 1 walkable streets	12
5			1	Credit 2 compact development	6
		4		Credit 3 Uses of Diversity in Neighborhoods Centers	4
		7		Credit 4 Community with a diversity of incomes	7
	1			Credit 5 small parking areas	1
		2		Credit 6 Road system	2
	1			Credit 7 Means of transportation	1
	2			Credit 8 transport demand management	2
1				Credit 9 Access to public spaces and civilians	1
	1			Credit 10 Access to leisure areas	1
	1			Credit 11 Universal accessibility	1
		2		Credit 12 Scope and community involvement	2
	1			Credit 13 Local food production	1
1	1			Credit 14 Shading, tree-lined streets	2
		1		Credit 15 Schools in Neighborhood	1

Prerequisite 2 - Compact Development:

Encourages the development in areas already urbanized, thus protecting farmland.

Projects planned or existing transport service that meet:

- SLLp1 prerequisite - Smart Location - collective mass transportation
- Possess 140 valid intersections in 1 square mile
- SLLc3 - Location with reduced car dependence (min 2 points.)

And meet the following densities:

- Residences: 30 pcs. resid./ha of buildable land for residential purposes.
- Do not residential: 0.80 IAT in lots for residential purposes (USGBC, 2009).

For the Metropolitan Center area it would need to have 28 intersections near the allotment and the same will have 122, so that urbanization is complete. In addition to local law allows 1.50 IAT (Dec. 3046), thereby fulfilling this prerequisite.

Credit 14 - shaded and wooded streets:

Encourage walking and bicycle use in the neighborhood, improving local air quality.

Should meet:

- At least 60% of the streets must have trees on both sides, with a minimum distance of 13m.
- Planting tree species that in a period of 10 years, provide a shading at least 40% of the areas of the sidewalks (USGBC, 2009).

The afforestation project for the neighborhood is according to the minimum distance between the trees and their locations. You will need to produce a technique of landscape responsibility to report on the project for a period of 10 years.

5.2.3 Green Infrastructure and Buildings

This category focuses on measures to reduce the environmental impact of construction and operation of buildings and urban infrastructure. (USGBC, 2009)

Table 5.3 Check List of Green Infrastructure and Buildings Category.
 Source: Prepared by the author from the Checklist provided by GBC Brasil.

C	M	EA	D	Green Infrastructure and Buildings - GIB	29 pontos
x				Prerequisite 1 Edifícios com certificação ambiental	Mandatory
	x			Prerequisite 2 Eficiência energética mínima nas edificações	Mandatory
	x			Prerequisite 3 Eficiência hídrica mínima nas edificações	Mandatory
	x			Prerequisite 4 Prevenção da poluição nas atividades de construção	Mandatory
1	2	2		Credit 1 Buildings with environmental certification	5
			2	Credit 2 energy efficiency of buildings	2
			1	Credit 3 water efficiency of buildings	1
			1	Credit 4 Landscaping with efficient water use	1
			1	Credit 5 Use of existing buildings	1
			1	Preservation of historical heritage and its adaptations to use	1

	1	Credit 7	Designing and building with minimal impact on the ground	1	
	1	3	Credit 8	Pluvial waters Management	4
1			Credit 9	Reduction of heat islands	1
	1		Credit 10	Solar orientation	1
	1	2	Credit 11	Renewable energy sources on site	3
		2	Credit 12	Urban Systems of heating and cooling	2
1			Credit 13	energy efficiency of the infrastructure	1
1	1		Credit 14	Management of waste water	2
	1		Credit 15	Use of recycled materials in infrastructure	1
1			Credit 16	solid waste management	1
1			Credit 17	Reducing light pollution	1

Prerequisite 2 - Minimum Energy efficiency in buildings:

Encourage the construction of energy efficient buildings, to reduce pollution caused by energy production and consumption. This would require that 90% of the buildings would meet the requirement: (USGBC, 2009)

- New buildings: reduce consumption by 10% over the ASHRAE 90.1-2007 index
- Renovated buildings: reduce consumption by 5% over the ASHRAE 90.1-2007 index.

You must run a report showing that it is possible to reach the target of 10%, through a simulation.

Credit 9 - Heat Island Reduction:

To meet the credit can reach one of two options:

- Project at least 50% of floor area with the following measures: use materials on the floor with SRI (Solar Reflection Index) > 29 - low heat absorption; floors using at least 50% of the material permeability; provide a proportional shading the treetop 10 years.
- Design green roof by at least 50% of new buildings (USGBC, 2009).

You will need to put a goal the above items for the project to get the points of this credit.

5.2.4 Innovation and Design Process and Regional Priority Credits

In addition to the above categories there are two categories of lower scores on certification, namely: Innovation and Design Process and Regional credits (Table 5.4).

Table 5.4 Check List of Innovation Project and Regional Priority Credits categories
Source: Prepared by the author from the Checklist provided by GBC Brazil.

C	M	EA	D	Innovation and Design Process - IDP	6 points
C	M	EA	D	Regional Priority Credit - RPC	4 points
14	37	26	31	TOTAL	Certified: 40-49 points, Silver: 50-59 points, Gold: 60-79 points, Platinum: 80+ points
51				POTENCIAL OF METROPOLITAN CENTRE	

5.3 Analysis of Results

As a result, it is possible to verify that the certification of the neighborhood is possible to be acquired, since all prerequisites are compliant or were placed as a goal. In total the neighborhood has 14 points already compliant, however for the neighborhood becoming

certified would need it able to meet at least 26 points of the criteria that were placed as a goal. If all goals are met it is possible to reach 51 points, the equivalent of LEED ND Silver Certification (Fig. 5.2).

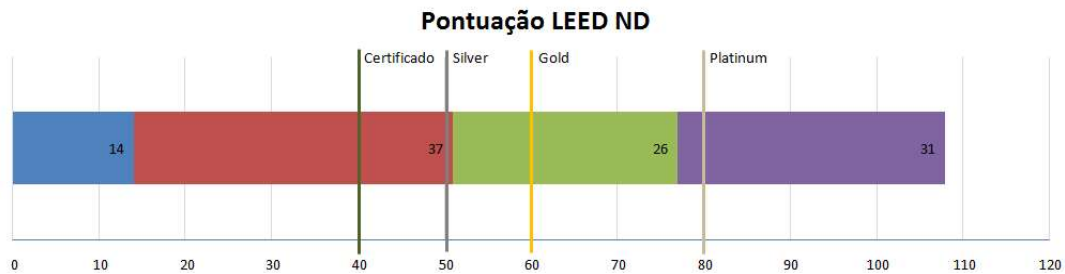


Figure 5.2: Score Graphic LEED ND. Source: Figure prepared by the author from the table above.

6 CONCLUSION:

After analyzing the importance of sustainable urban development and identify the events responsible for the emergence of this concept, we identified several qualitative indicators of sustainability necessary for a neighborhood becomes sustainable. These conceptual design parameters have been described in order to become the basis for the analysis of the Metropolitan Center neighborhood, according to the environmental certification LEED ND.

The analyzed neighborhood has great potential to become certified. However LEED ND certification is not easy to be achieved, mainly because Brazil does not have the culture to implement various items required by USGBC.

After the assessment made were identified that LEED ND certification has topics that are not applied frequently in the Brazilian urban areas, due to culture, nature or local law, but none of them is not feasible to put into practice.

LEED ND certification has a methodology that covers all project levels. Throughout the analysis certification instigates the designer to consider several issues related to sustainability, leaving only him the responsibility to put or not that activity in practice.

REFERENCES:

- FARR, Douglas. *Urbanismo Sustentável: Desenho urbano com a natureza*. Tradução: Alexandre Salva terra – Porto Alegre. Editora Bookman, 2013.
- KATZ, P. *The new urbanism: Toward an architecture of community*. New York. McGraw Hill, 1994.
- ROGERS, Richard; GUMUCHDJIAN, Philip. *Cidades para um pequeno planeta*. Barcelona. Editora Gustavo Gili, 2001.
- U.S. Green Building Council. *LEED Neighborhood Development Rating System*. 2009. Disponível em: <<http://www.gbcbrazil.org.br/leed-neighborhood.php>>. Acesso em: 09 de julho de 2015.