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THE SUITABILITY OF SUSTAINABLE RETROFITTING MEANS FOR SHOPPING MALLS, IN AN ENVIRONMENTAL AND URBAN BACKGROUND. A RESUME OF THE METHODOLOGY.

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HIGHLIGHTS

- A methodology of analysis of sustainable retrofitting for shopping malls was performed, considering both the features of the shopping mall building and its urban reality.
- Was established that Retrofitting means for shopping malls in dense urban area should be aimed in the insertion of green elements
- Was established that Retrofitting means for shopping malls in sprawled or low density urban area should be aimed in the insertion of uses, being important the increase of density and complexity in urban areas.

ABSTRACT

The current paper shows the resume of a methodology of application, developed in the paper's author PHD thesis, showing an overview of the methodology structure, being also included the first results of the case study. The research was focused on the analysis of different means of sustainable retrofitting applied to shopping malls buildings, considering both features of urban background and building conditions (eco efficiency of building, nature and environment capabilities, uses, and current state of the urban surroundings towards urban eco efficiency). Eight cases of study were chosen, placed in different areas in the cities of Sao Paulo, Madrid, and suburban USA. According to the methodology established, the results achieved show that the means of retrofitting for the shopping malls studied, must be aimed to insert green regenerative elements in the background of the dense and complex urban areas of Sao Paulo and Madrid. As contrast to this, in the Suburban USA, retrofitting operations must be focused on the densification and insertion of uses complexity within the urban surroundings.

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1. A BRIEF EXPLANATION OF SUSTAINABLE MALL RETROFITTING.

The analysis of the adequacy of different means of retrofitting of application on shopping malls, is the mainline of this paper. The first step was the study of the concepts, as well as the problems attaining both the sustainability and shopping malls nowadays, being considered lately eight cases of shopping malls placed in the cities of Madrid, Sao Paulo, suburban Denver and Minneapolis to be studied.

Focused mainly on trading activities. Nowadays, shopping malls are buildings with a strong presence in most cities throughout the world. They have a very clear and defined shape, function and architectural image, *result of an analytical projection method* (A. Queipo, 1992), which considers both the importance of the urban facts, and an exhaustive study about the economical possibilities. *Consequently, an important node of activity is created within the city* (Maraschin et al, 2010).

Shopping mall ideas were established by the architect Victor Gruen (Gruen, 1973). He proposed to concentrate the different uses of the city, commercial and social, in an unique building. But in the following years, shopping mall owners removed the non-commercial uses, and tried also to make the malls bigger and bigger. The aim of this was to make the biggest profit, by inserting the biggest number of shops as possible. Apparently, trading economy and the volume of sales are the ideas that rule the project of the shopping mall.

However, other issues of importance nowadays have been ignored, especially the ones related to sustainability, especially in the field of the urban engagement and environment (Oficina Ecosistema Urbano, June 2015).

Sustainability is a concept of primal importance nowadays, and it consists of developing societies, without harming the environment or the life conditions of its people (Bruntland, 1987). The sustainable development is divided into three fields which are economy, society and environment. This way, any development, no matter its nature, may be economically reliable and must support the social and community engagement, as well as be respectful for environment to be considered as sustainable (Naredo, 1997; Losasso, 2016). These concepts are of application to buildings, including shopping malls. By this way, the relations between shopping malls and sustainability fields are described in the following paragraphs.

- **Economy:** As stated formerly, shopping mall ideas look for the economical reliability and benefits over other facts. The shopping mall managers try to overcome the most market capacity as possible, being this the base of the concept of the node of activity (Richard & Jennifer, 1991). To sum up, the more business a shopping mall can attract, the more urban activity and jobs it generates. Assuming this affirmation as true, shopping centers have been considered as a strategy for urban revitalization, being successful partially (Hughes, 1999; Filiond & Hammond, 2006; Sugrue, 2014). On the other hand, the current economical situation of Shopping centers, is not always favourable. In developed countries, due to business overcrowding, a lot of shopping centers are decaying, and going into bankrupt. Opposite to this in some developing countries, market and economical activity related to shopping center typology is growing up. To sum up, every retrofitting operation aimed to sustainability applied to a shopping center, must ensure the economical reliability of it. However, this field could not be considered, because of author's lack of knowledge in economical measures for the shopping mall. The retrofitting means considered, were related mainly to the field of the environment and urban surroundings.
- **Society:** To be considered as sustainable, a shopping mall is required to promote the community engagement. At first, the shopping center is an important node activity, problems related to the urban vitality can happen, especially if there is a lack of meeting spaces in the urban area. If happening, inhabitants of the urban area will tend to use the shopping center as a meeting space, becoming the public spaces in area misused due to the lack of interest. Is important to consider too that the shopping center might never be the substitute of the urban public squares, because the

ownership of the shopping center is completely private. Secondly, the node created by the shopping mall, will mean displacing the urban activity towards it, altering the whole urban activity in the area, leading in some cases to non benefit effects. Related to architecture, shopping mall buildings have problems derived from the large surfaces they occupy, which translate in long distances that will not help in the mobility of handicapped people. In addition, their inner space image and configuration, can favor the behaviors of people addict to the compulsive acquisition of goods (Wakefield & Baker, 1988; Sena et al., 2010; Sgobbo, 2016; Ainsworth & Foster, 2017).

- Environment and nature: The sustainable shopping mall must consider the impact both its functions and construction generate to the environment. It is important to reduce this impact the minimum as possible. This field of the sustainability is the one this paper was focused on, because currently, shopping malls have carried out serious environmental problems. The environmental handicaps of the shopping malls, are the following ones (Congress for the New Urbanism, 2005; Moccia & Sgobbo, 2013; Del Río Roger & Sánchez, 2013, Khayyambashi & Ghobadian, 2014):
 - Related to water and soil, it is important to consider that a shopping mall, especially a suburban one, is a building which occupies a very large surface. The formalization of the built area, always implies the neutralization of the regeneration capabilities of the terrain considering both water and vegetation. Streams on paved surfaces can pollute underground water because of the dirtiness upon them, and also the shopping mall requires large amounts of water for its functions. This causes also a severe impact on biodiversity. In addition, the construction of the shopping mall implies a harshly reversible impact on the vegetation.
 - According to transportation, the shopping mall generates a strong amount of movements within the city. This is really a problem if the shopping mall access is focused on private transportation means, because of gas emissions and traffic congestion. All this leads to the deterioration of air quality, and a severe impact upon plants and animals.
 - Towards Energetic efficiency, despite the fact that there are shopping malls which have inserted more efficient heating or cooling systems, as well as clean energy devices, the buildings are not designed considering the features of the climate. So, in a mall a rise of energy consumption will take place because of inadequately designed enclosures and gaps.

Once the problems related to sustainability had been explained the next step was to establish a brief state of the art in retrofitting means applied to shopping malls:

- Ecological or environmental retrofitting. It consists of the making of works on a shopping mall with the aim of making it less harmful for the environment (insertion of green ecological, energy save, or clean energy devices among others), the works are expensive and they do not guarantee profits.
- Adaptation to market or re-opening. Retrofitting works are aimed in the update of the shopping mall to market dynamics. This can be done by enlarging the store capacity or updating the inner space to trends. The objective of these works is to maintain profits. (Abrudan et al. 2009).
- Change of use. This mean of retrofitting, consists on the transformation of the shopping mall, totally or partially without altering the building shape, into a building with a function completely different to the commercial one. This retrofitting mean is generally applied on running down shopping malls.
- Building restructuration. In this mean of retrofitting, the building structure of the shopping mall building is completely altered, in order to build new dwellings aimed to house different activities rather than commercial ones. This is considered usually for New Urbanism Current (Duany & Plater-Zyberk, 2003), of application on dead malls (Dunham-Jones & Williamson, 2011; Chebat et al., 2014). The study of the state of the art, made us to consider the following research question:

In which grade the sustainable retrofitting means aimed to shopping malls, are influenced by the features of their urban surroundings?

2. METHODOLOGY OF ANALYSIS.

According to the concepts explained before, the next step was to develop the methodology of analysis considering both sustainability pillars and the retrofitting means described formerly. The research considers only the environment and the city functions.

The first step of the methodology is to establish some quantitative criteria, to evaluate the efficacy and necessity of the means of retrofitting chosen. A scale of ten points was established, being the less score, the most harmful a shopping center is towards the sustainability in the field related the retrofitting mean analyzed. Three thresholds were established into the chart:

- Minimum threshold: If any retrofitting measure scores less than 2 points, this means the shopping mall is far from being sustainable related to environment and urban efficiency.
- Optimum threshold: If a retrofitting mean scores up or more than 8 points, this mean the shopping mall comply with the requirements of urban and environmental sustainability ruling the retrofitting mean.
- Green paradigm: If a retrofitting measure scores up to 10 points this means the shopping center complies more than successfully with the requirement of urban sustainability assigned for the retrofitting mean. Furthermore, retrofitting works in this mean have no sense.

Once the score and the quantitative criteria established, next step was to insert in the chart the means of retrofitting to be of application for the shopping mall to analyze:

Related to the sustainability pillar of environment, the retrofitting means of application to the shopping mall established were the following ones: The facts to be analyzed within the retrofitting means, are shown in the (Annex 1).

- A. Eco efficiency and energy focused retrofitting: The means applied and studied within, are aimed to achieve a reduction of energy consumption in the shopping mall building, in addition to the bioclimatic adaptation of it. Related to ecological efficiency, three means of retrofitting were considered. However, was impossible to make an exhaustive analysis due to the lack of data concerning energy consumption and carbon dioxin emissions.
 - A1. Installation of Low emission installations. Current status and consumption of installations were analyzed.
 - A2. Installation of Active energetic systems. Availability of solar active systems and necessity were analyzed.
 - A3. Passive measures. Bioclimatic adaptation of the mall building and availability of passive solar systems were analyzed.
- B. Green and environmental retrofitting: The objective is related in the partial recuperation of the environmental capabilities in the built area, such as green areas, water absorption by the terrain and greenhouse gas assimilation. Three means were considered.
 - B1. Insertion of green areas. Amount of green areas in shopping mall and urban area, as well as carbon dioxin absorption.
 - B2. Water saving and absorption retrofitting. Relative percentage of waterproof surface was analyzed, in addition to climate rain and the availability of water save devices in shopping mall.
 - B3. Heat island treatment. The effects and presence of heat island effect was considered, as well as climate temperatures and clear surfaces in both shopping center and urban area.
- C. Retrofitting by the insertion of uses: The means of retrofitting, were focused in the addition of non-commercial uses in the shopping mall. Three uses were considered.
 - C1. Insertion of residential use. Residential surface in shopping mall and urban area were considered.
 - C2. Insertion of non-commercial business, or productive uses. Productive use surface in shopping mall and urban area were considered. Commercial surface was excluded.

- C3. Insertion of public or social uses. Number of facilities aimed to social uses were considered in mall and urban area.
- D. Retrofitting in urban areas, Because of the paper the city planning has in urban environment, as well as the importance of the interaction of it with the shopping mall, three retrofitting measures of application in the urban area surrounding the shopping mall were considered. Is important to consider that any retrofitting operation on the shopping center is not going to solve the problems in the urban area.
 - D1. Retrofitting aimed to efficient transportation means. Availability of mass transit in urban area, and efficacy of it related to private transportation were analyzed.
 - D2. Retrofitting aimed to density. Density in urban area was considered, as well as urban tissue structure and percentages of surface occupied by buildings.
 - D3. Improvement of Walkability and security. Complexity in urban area was analyzed, in addition to urban tissue structure.

The addition of these measures of retrofitting results in the Sustainable Retrofitting Rose graph. (Figure 1). A resume of the analysis of the related retrofitting operations with their corresponding scores, was done in the Annex 1 table.

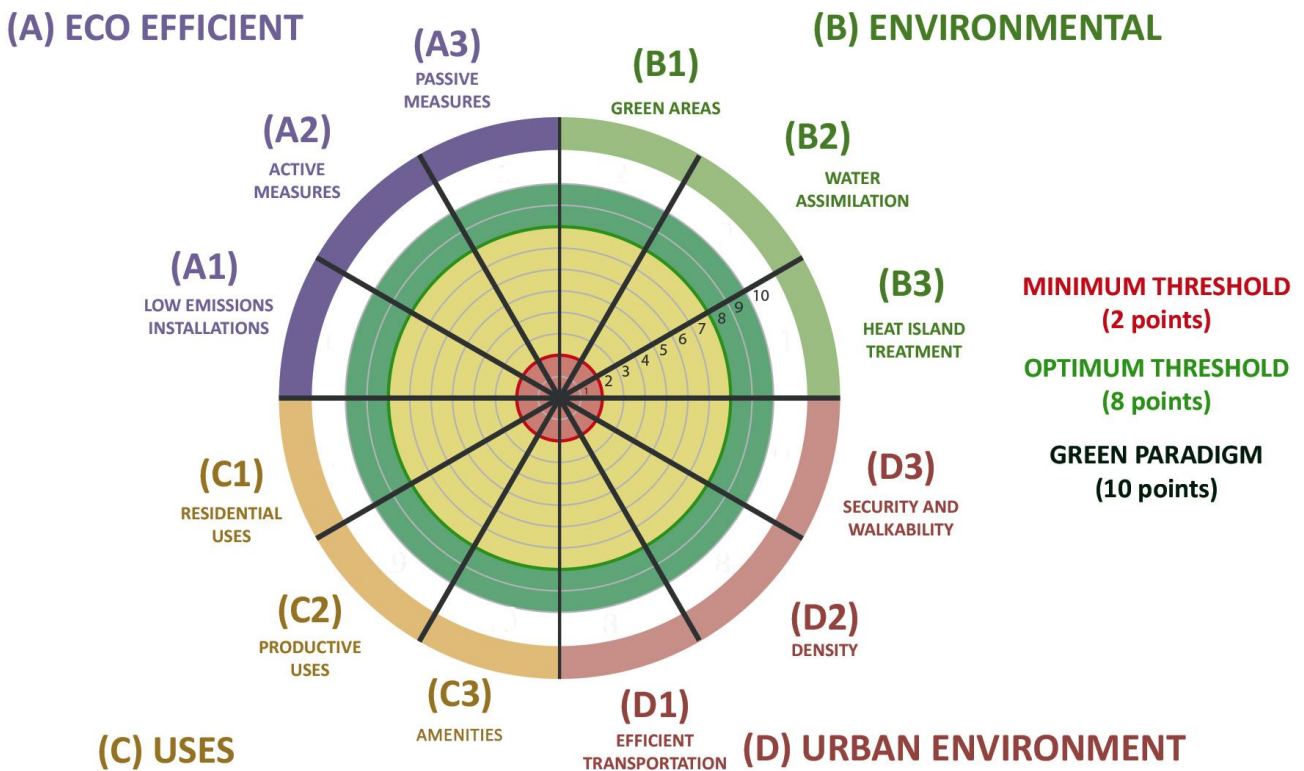


Figure 1: Sustainable Retrofitting Rose graph. *Source: own's source*

Once headlines were featured, the study concerning shopping mall data was established in these steps:

- Study of quantitative parting data: Official numbers describing both the shopping mall and the city where is placed, were taken and analyzed.
- Urban area analysis, this analysis was conducted mainly upon urban draft plans. Both qualitative and quantitative data about the area surrounding the shopping mall were extracted.
- Comparative analysis of relations between the shopping mall and urban area. In this part of the

analysis, data about the plots nearby shopping mall were extracted as they were analyzed in a similar way the rest of the urban area was. An analysis of accessibility was done, considering the arrival times to the mall by public transportation and by private vehicle.

- Shopping mall building analysis. A quantitative and qualitative analysis was done, related to the shopping mall building. Energetic efficiency simulations were conducted using the IDAE CE3X program. In addition, the uses inside the shopping mall were considered.
- Evaluation of data according to retrofitting measures established: once all data achieved from the formerly mentioned analyses were obtained, the last step is to compare it with the requirements of the retrofitting measures established.

3. CASE STUDY, APPLICATION OF THE METHODOLOGY.

The first step in the case study, was to choose the shopping malls to be studied. Eight cases of shopping malls were analyzed, located in the cities of Sao Paulo (shopping Light, Eldorado and Aricanduva), Madrid (ABC Serrano, La Vagua and Parquesur) and Suburban U.S.A (Belmar and Mall of America). The cases were chosen according to the urban features of their respective environments (Figure 2).

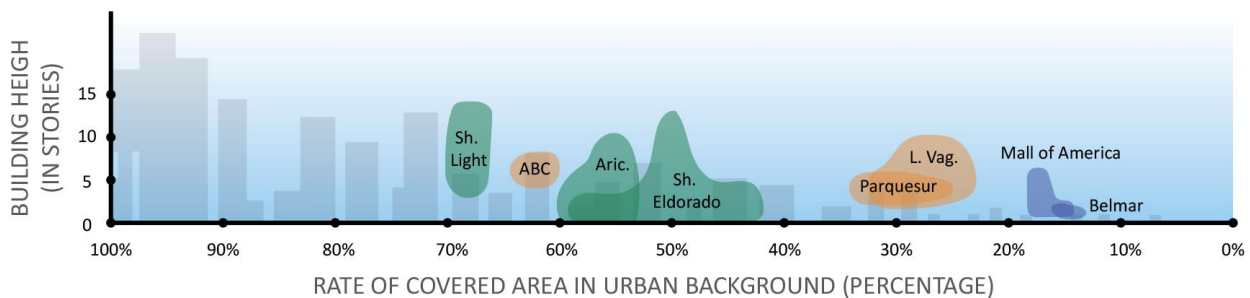


Figure 2: Location of the centers studied according to urban tissue structure. *Source: own's source.*

To establish the urban area of analysis related, the following mathematical formula was established, based on Victor Gruen recipe, to dimension shopping malls (2 sq meters per person).

$$\text{Urban Area size (m}^2\text{)} = (\text{SH} \cdot 0,5) / \text{D} \quad (13)$$

being (SH) the surface of the shopping mall in area, and (D) the density of population of the area where the shopping Mall is located. It is important to highlight that the areas of Belmar and Mall of America analyzed were reduced with the aim of establishing a representative area could describe the current status of the extremely large surface these malls are able to cover.

1. Shopping Light: Placement on a thriving urban area with strong interactions due to important buildings and mixture of uses, strong presence of public transportation. Not very energetically efficient building, poor rate of green areas, and carbon dioxin absorption. Serious problems with water absorption by the terrain and heat island treatment.
2. Shopping Eldorado: Placed in a thriving area, but mainly ruled by private transportation paths. Mixture of uses limited to located areas, and strong presence of business areas. The building of Shopping Eldorado building is not energetically efficient. Despite the fact that the shopping mall has an urban orchard in roof, the rate of green areas, and carbon dioxin absorption is very low.
3. Shopping Aricanduva: This shopping mall is located in an urban area with poor and located mixture

of uses, ruled by private transportation despite having non-efficient at all mass transit facilities. The building is not efficient at all. Although there are green areas surrounding the mall, these are not enough to achieve an acceptable carbon dioxin rate, and are scarce related to population.

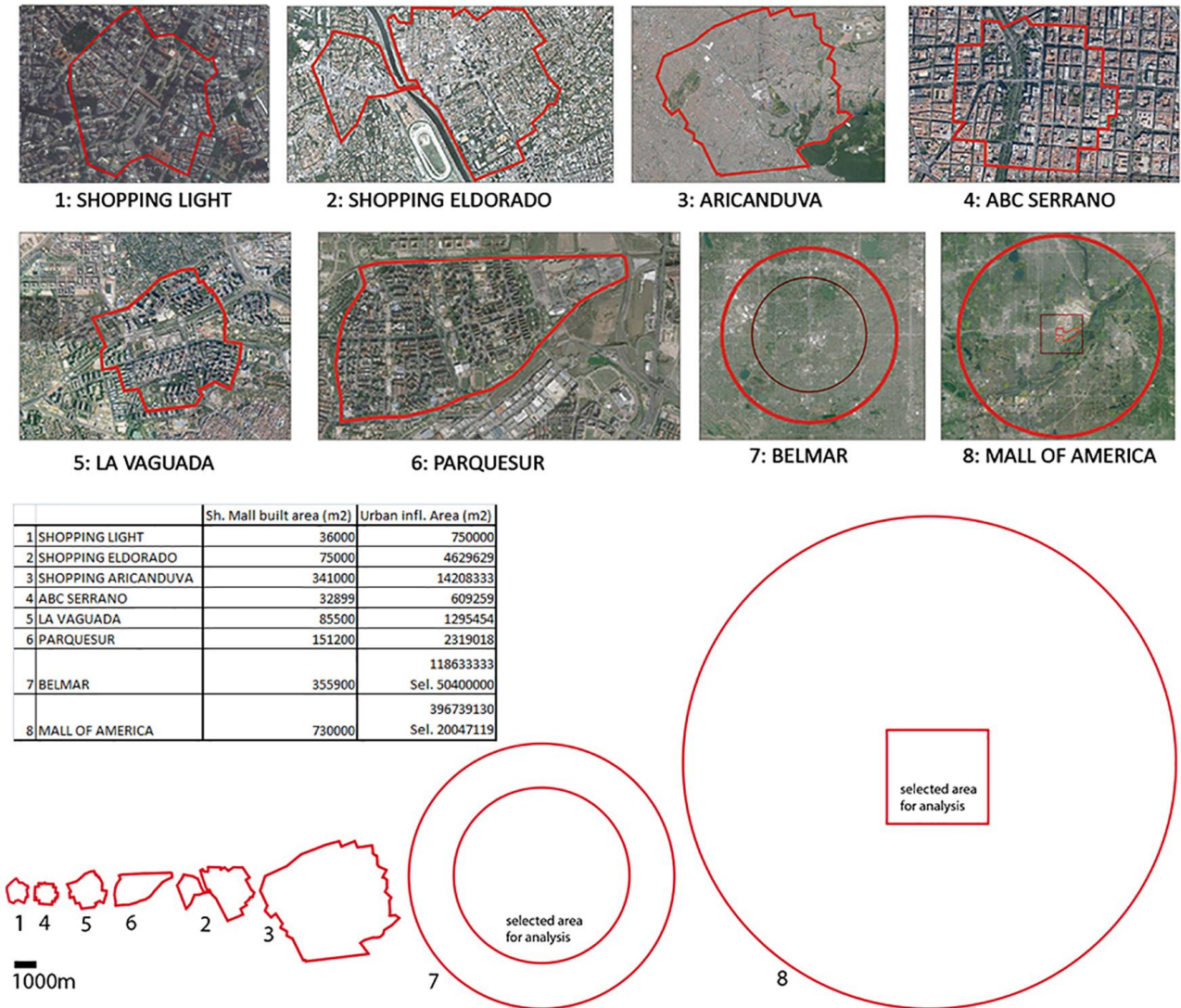


Figure 3: Shopping malls influence areas, delimitation and size. *Source: Google, Own's source*

4. ABC Serrano: The urban area surrounding this shopping mall is characterized for the high density, the complexity of uses, and the availability of efficient mass transit. However, towards environment, the urban area of the center scores very poorly, because of heat island, and the lack of green or water absorbing surfaces.
5. La Vaguada: This center is located in an area with an average presence of green areas despite having problems with heat island. The mix of uses is strong, and the urban environment has a correct rate of density. There are averagely efficient mass transit facilities.
6. Parquesur: Important node located in the edge of a wide and complex urban area with a relevant mixture of uses, Serious problems with heat island. The shopping mall has public transportation

facilities. Green areas, despite having a strong presence in the area, are not enough to assimilate the carbon footprint.

7. Belmar: Complex of residential, commercial and office buildings being the centrality of a very wide and low density urban area with almost no mixture of uses and urban space ruled by private vehicles. there are mass transit facilities, they are not enough to cover the whole area. Related to energy consumption, some buildings in the Belmar complex have LEED Qualification, and there is an effort to reduce energy consumption. There is a lot of green surface in both the center and the urban area.
8. Mall of America: This large commercial facility is characterized for being placed in an area with almost no mixture of uses and activity in public spaces. The interactions between the shopping center and urban surroundings are very poor, being this center focused the accessibility from large transportation facilities, such as derivations of interstate highways, or the nearby airport. Green surface in area is abundant, and also there are almost no problems with heat island.

As a result of this, the score for each center is the following one (Figure 4).

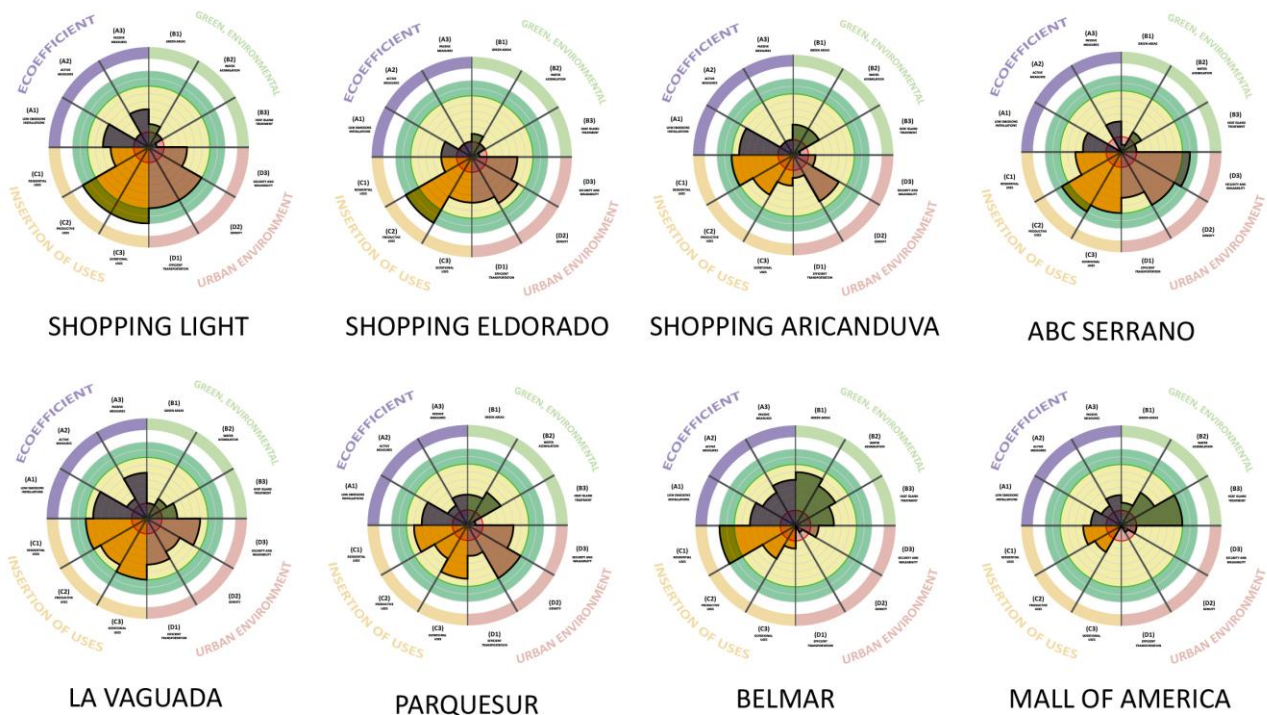


Figure 4: Results of the analysis, indicating the current state of shopping malls toward retrofitting measures. *Source: Own's source*

4. COMPARISON OF THE MOST ADEQUATE RETROFITTING MEANS.

The conclusions of the current paper, where aimed in the establishment of the most adequate mean of retrofitting, related both to the shopping mall and urban background. By this way for each group of measures, a rank of priority was established concerning the means of retrofitting. This rank value is ruled by the following formula:

$$R_{Pm} = 10 - ((m_1 + m_2 + m_3) / 3)$$

Being m_1 , m_2 and m_3 the scores of the retrofitting means per group, this priority range was done per group of retrofitting measures for all of the shopping malls analyzed, the bigger is the score of the priority rank per group of retrofitting measures, the poorer conditions and more impact the mall has towards sustainability; so the most efficient and important the retrofitting measure is going to be. In order to establish a first approaching to the conclusions, all priority ranks per shopping mall and per city, were put together in a graph. (Figure 5)

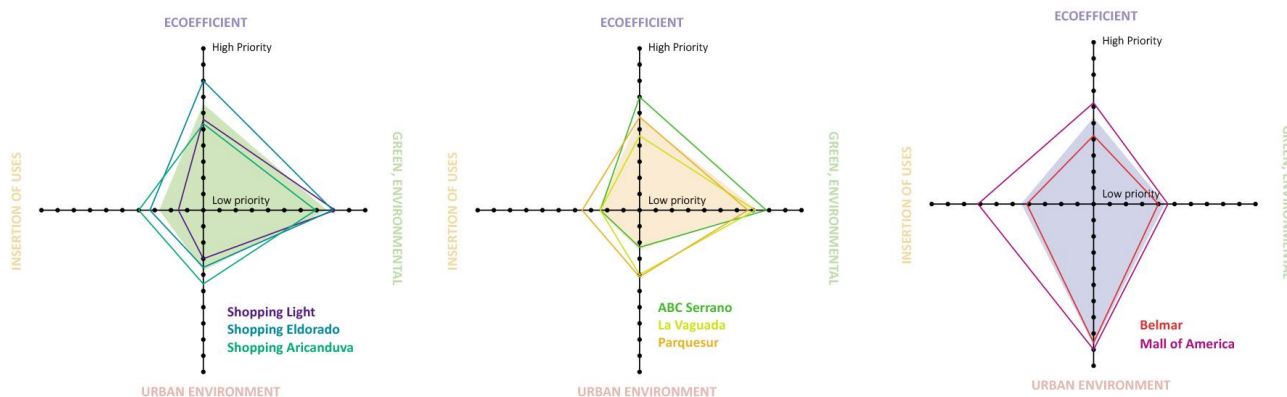


Figure 5: Priority ranks of retrofitting to be of application on the analyzed shopping malls.
 Source: Own's source

In a wide view, and according to the graph, the following can be established as first conclusions:

In the case of Sao Paulo, the three centers analyzed have as first grade priority retrofitting family, the green and environmental, being the eco-efficient in second place. The retrofitting means related to uses, or applied to urban area are more important as far as the mall is located away from the city center. The most sustainable mall analyzed is Shopping Light, despite the fact that shopping Aricanduva has the better score related to green areas and environment.

In the case of the centers of Madrid, the retrofitting priorities graph has almost the same structure as the one related to the malls analyzed in Sao Paulo, even though there is a slight difference in the values of the scores of about one point less. This means the shopping centers in Madrid are a bit more sustainable than in Sao Paulo, despite also being necessary the application of retrofitting means.

Related to the cases in the suburban USA. Despite being in better condition than the malls of Sao Paulo or Madrid concerning green areas and related to uses and urban sustainability, both cases analyzed have serious lacks. This means the most efficient retrofitting means to be applied on the malls are the ones related to the insertion of uses, or to the refurbishment of their urban surroundings. Between the two centers, Belmar has better score towards sustainability than Mall of America. This is because of the refurbishment program applied, which turned a dead shopping mall into a complex urban area, with more green surfaces and low energy consumption buildings. However, being the refurbishment program located in a concrete plot, problems concerning urban sustainability in the areas surrounding Belmar complex have not been solved yet, being in the same conditions as the rest of the North American suburbs (Figure 6).

By comparing the priorities towards the different means of retrofitting, the following statements could be established as a conclusion. In complex cities with density and mixture of uses (Sao Paulo and Madrid) the retrofitting means on shopping centers should be aimed at the insertion of green elements, especially in the areas with high density rate, and little amount of green surfaces. The aim of

the green surfaces applied on the malls are mainly the water absorption, the reduction of heat island effect, and the providing of green areas to population, rather than carbon dioxide absorption. This last task will be done in large green areas with trees, which can be placed within the city in the non-built spaces, or in large green belts aimed towards this goal.

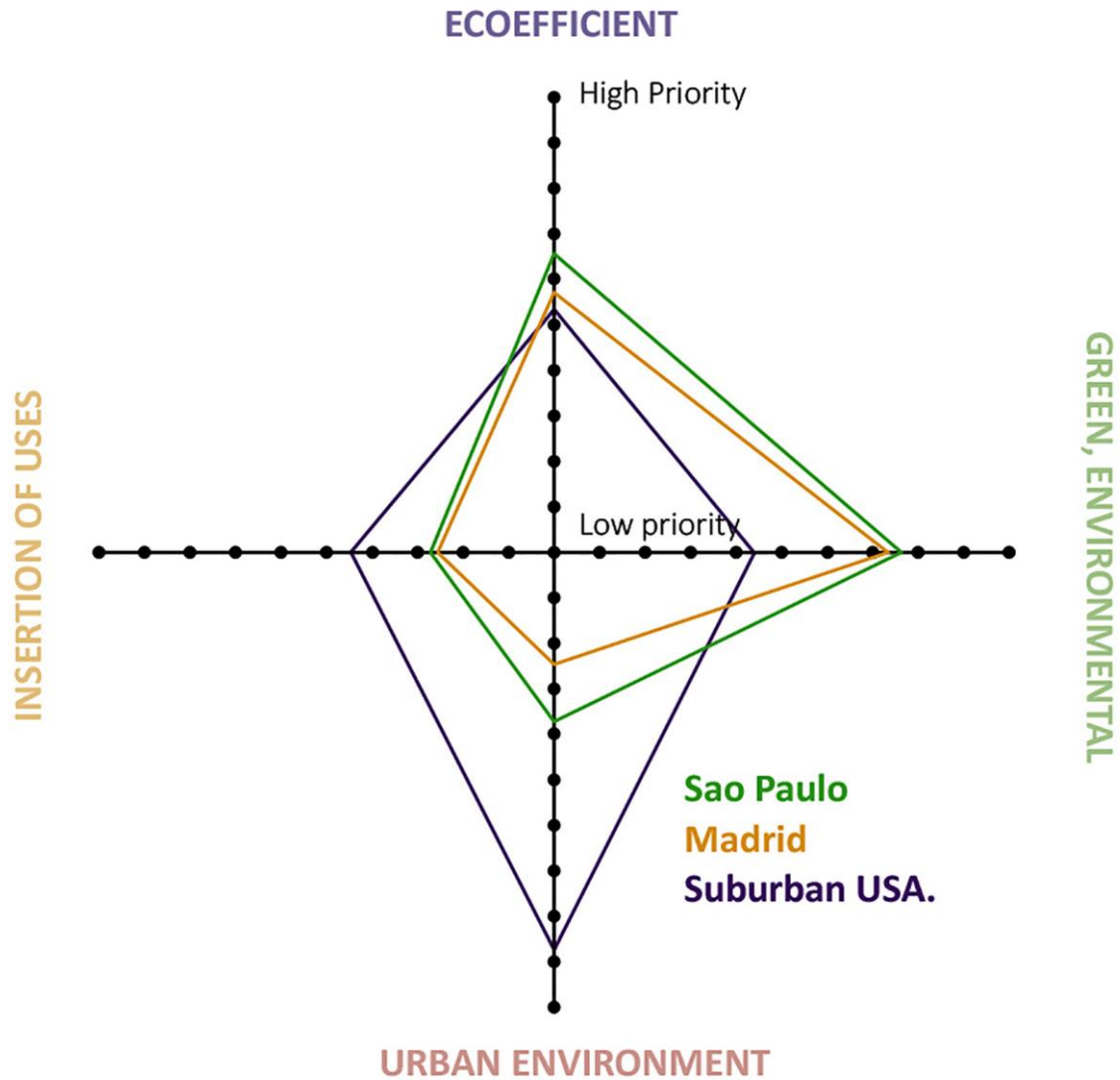


Figure 6: Priority ranks of retrofitting to be of application per urban area analyzed. *Source: Own's source*

In the Suburban USA, the priorities in retrofitting must be aimed at improving the urban sustainability in the low-density areas (a moderate increase of density, insertion of uses, insertion of mass transit or sustainable mobility devices...) applying these measures into the whole urban area, rather than a into a located shopping mall, this task is very complicated, and must be thought in very long term.

The study performed, shows that the success of a retrofitting methodology for a shopping mall is heavily influenced by the features of its urban reality. This happens if the retrofitting mean is going to

suppose an alteration of the urban reality. Within these sorts of measures, are the insertion of uses, the increase of green surface or the change of the urban structure of the shopping mall.

However, is also of importance in the shopping malls sustainable retrofitting, the application of means aimed to energy consumption reduction and usage of clean energies, no matter their urban location. This last must be focused as a complementary measure. By this way, in shopping malls is important to consider mixed retrofitting solutions, according to the current status of the shopping mall, and their urban area configuration, in order to make them more sustainable towards the environment, and their urban background.

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The Annex 1: Resume table of scores related to case study can be downloaded as supplementary material.