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## **MULTI-CRITERIA ANALYSIS FOR REQUALIFICATION OF BELO HORIZONTE'S HIPERCENTER: GEOPROCESSING IN ARQUITECTURAL AND URBAN INTERVENTIONS**

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*This paper discusses a proposal of spatial analysis applied to urban areas using Geoprocessing, when characterizing interest areas for requalification interventions in a local scale. The case study of Belo Horizonte's hyper-center consisted on the identification and selection of areas greatly suited for architectural, landscaping and urban interventions, regarding effects of outcome's irradiation. The region is presently going through processes of residential decline and commerce intensification, which generate dead spaces at nighttime, leading to vandalism and safety issues. This work is referenced in studies regarding multiple space use benefiting different and juxtaposed users using different timetables of urban environments. Using Geographic Information System and multi-criteria analysis, the goal was to identify areas which, due to their use and occupations, could benefit from building extensive alterations and, therefore, influence towards urban transformation.*

**KEYWORDS:** Key-words: Urban requalification, Spatial Analysis, Multi-criteria Analysis.

## **INTRODUCTION**

The experiment presented here is part of the achievements done by the "Workshop of Area Requalification and Urban Buildings Issues", from the UFMG Architecture and Urbanism night course, whose purpose is to train the student's skills on the resolution of problems related to the building space inside urban areas, specially degraded areas. The subject proposes the identification of optimal areas for actions of architectural, environmental and urbanistic requalification based on spatial analysis supported by geoprocessing and subsequent elaboration of guidelines and intervention project for accommodation

of a mixed-used architectural complex, being residential use compulsory, in one of the found areas.

The hyper-centre of Belo Horizonte, capital of the state of Minas Gerais, is used as case study. Belo Horizonte is a city that was planned and drawn according to positivist principles and possesses, since its creation, rectilinear tracing ways, rationally organized, designed to host state institutional uses inside its urban centre. Differently from other Brazilian metropolis which possesses historical centralities that lost their original function, the capital of Minas Gerais never lost its vitality and its centrality role, including its role as a metropolis.

However, since the 70's, the hyper-centre has been going through a functional crisis. The intense traffic conflicts associated with the increasing noise, visual and atmospheric pollution lead to a degrading and non-qualified migration of commercial activities, so that the better condition establishments which invest in landscape composition and production of good architectural spaces are been transferred to better qualified central areas, such as Savassi, which is configured as an important commercial and service centre. As a result of these substitutions, in the old buildings stood new traders or service providers without the financial support needed to properly build their facilities, so that a meaningful amount of old residential units were replaced by commercial and service activities with an aspect of degradation.

Without the building of new units to residential use, theses spaces are intensely used during commercial hours, but become lifeless during the night hours, resulting in plundering actions, reduction on the standards of building conservation and degradation of urban equipment's.

Urban intervention inside central areas of the big cities permeates the approach to theoretical concepts discussed by many scholars. Hertzberger (1999) defends the concepts such as public space being an accessible area to everyone at anytime, with the responsibility of its maintenance assumed collectively. Jacobs (2009) proposes that public spaces should be equipped with population interest, with the resulting use and surveillance by the citizens. These concepts were considered in this research and based the requalification and spatial intervention proposal.

It is necessary to stimulate greater density and diversity of uses during different hours of the urban life to ensure a higher standard of appropriation and vitality of the public space and, consequently, greater conservation and safety. The requalification of a particular area matters, initially, to reintegrate it into the urban fabric, moving away from the idea condemned by Jacobs (2009) of understanding the intervention project as a space apart from the city, instead of "sewing it into the urban scheme". Doing so, the creation of spaces economically and socially disconnected from the rest of the city is avoided, as well as the consequent expulsion of poor population inside the central areas through merely hygienic or aesthetics interventions which generates the process of "gentrification".

## **WORK METHODOLOGY – MULTI-CRITERIA ANALYSIS AND TREE OF DECISIONS**

The development of this work consists of geoprocessing application in order to identify areas more inclined to requalification intervention, which led to the choice of the area of work followed by the proposition of the architectural object's program and, finally, to the development of the architectural project.

Since it was desirable to obtain an image of the reality in the hyper-centre, the space analysis model used was the Multi-criteria Analysis. Moura (2007, 2900) explains that the multi-criteria analysis methodology is quite suitable for the use of geo-technologies to promote synthesis of variables whose goal is to identify priority areas for determined phenomenon or geographic arrangement.

Considering the investigation objective, there were chosen variables whose synthesis resulted in the identification of areas more vulnerable to environmental degradation and, therefore, more interesting for a requalification intervention proposition.

For methodology application purposes, after clear definition of the synthesis desirable through the combination of variables, which is: the identification, using lot scale, of areas more appropriate for requalification intervention, there was defined the five variables to be crossed. Indicators that could point the places that most needed modification, as well as possibilities of change, were used. These are: density of residents, conservation of buildings, number of floors, a sum of factors related to the use of commercial and residential density, and heritage buildings.

Structured the data collection, they were worked in the form of information plans in matrix format (raster) which pictured the distribution of each variable in the territory.

All information layers were organized in the scale of 1:5000. The territorial unit for data integration, that is, the value of the pixel or cell adopted was of ten times ten meters, which is suitable both for the visual and cartographic accuracy criteria and, mainly, for the dimension of interest for territorial analysis, since the resulting map showed answers in lot scale.

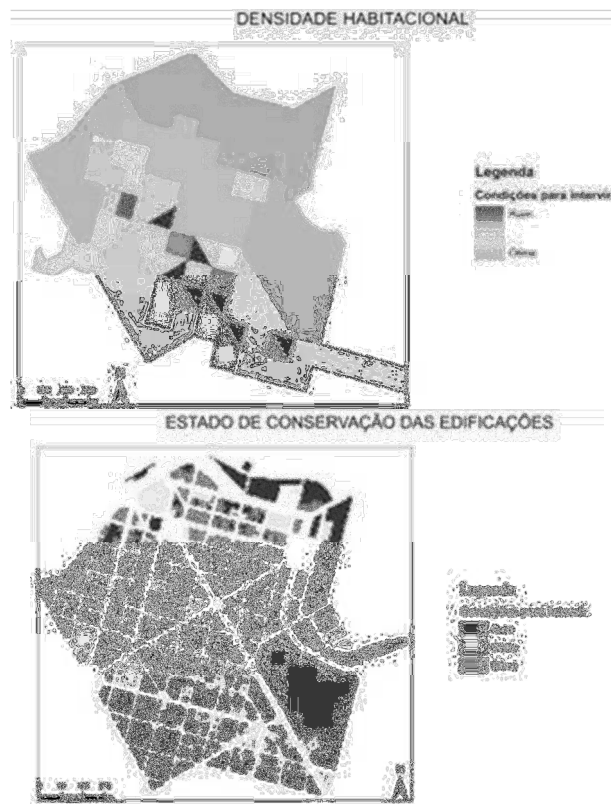
### **Used indicators to spatial analysis**

The first indicator approached was the density of inhabitants inside the hyper-centre. Considering that areas of least housing use are subject to under-utilization during nighttime and consequently lower vitality. Therefore, we established that the least housing density localities were more desirable to intervention than high housing density areas. Following the relationship between housing density, vitality and urban sustainability proposed by Jacobs (2009), we classified in optimum, good and bad area for intervention, respectively, areas below 100, between 100 and 200, and above 300 inhabitants.

The second aspect approached was the state of conservation of the buildings. For that, we established that new buildings are less likely to intervention, while the older ones are more interesting to this work related to the possibility of meaningful transformations. In turn, buildings in medium state of conservation are located between the good and the bad state of conservation. Another variable was the existence of renovation in the place. Those buildings that suffered such intervention were considered less likely to receive our performance.

Another category identified were the feature-less buildings, which were equated to new buildings in a bad state of conservation, for not being possible to say if it is new or old, being however possible to state that it has suffered modifications. That way, there were attributed the following importance to categories: - New and good: (1); - New and bad: (2); - Featureless: (2); - Old and good with renovation: (2); - Old and good without renovation: (6); - Medium state of conservation: (8); - Old and bad: (10). The score attributed was as followed: 0 to 4 – bad; 4 to 7 – good; 7 to 10 – optimum.

Figure 1 and 2: Density of inhabitants inside the hyper-centre and State of conservation of the buildings inside the hyper-centre

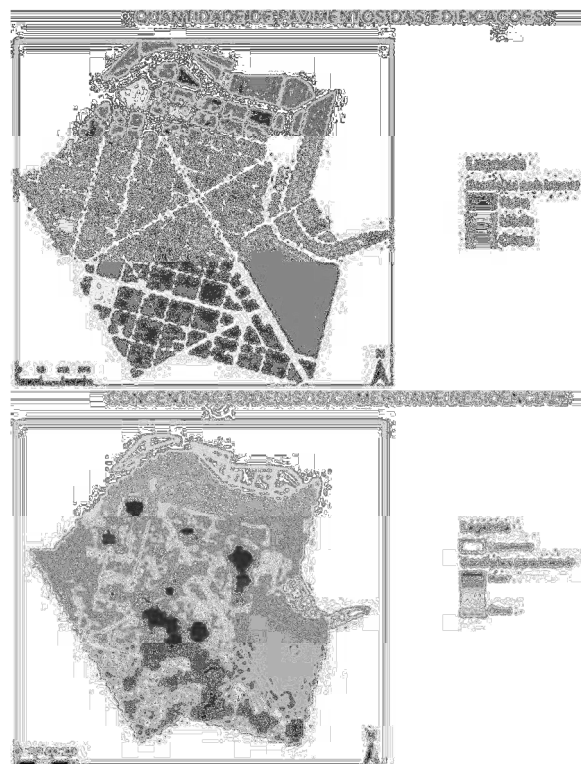


The third factor pointed was the number of floors in the existing buildings. According to such parameter, buildings with higher altimetry show more difficulty to intervention considering the high costs of demolition and dispossession, while areas occupied by buildings of small stature revealed themselves to be more appropriate to demolition and removal, generating less negative impacts. We attributed the following score: 0 to 2 floors – optimum; 3 and 4 floors – good; above 4 – bad.

The fourth indicator used was the crossing of the data related to the density of the number of domiciles with the density of the number of commercial establishments. Such overlap of data justify itself as this work attempts to ensure greater vitality and safety to the area object of intervention through the establishment of greater density and diversity of uses. Therefore, places that show least commercial

density are more appropriate to intervention than those of greater concentration. In the same way, areas with reduced number of domiciles are more likely to intervention. Seeking to ensure greater diversity of uses, the overlap of both factors, low commercial and residential density, reveals itself to be great for intervention, as we seek to enhance the growth of both uses. We highlight that we give more weight to data related to habitation (60%), considering that habitation density ensures prolonged use in time, unlike commercial activity (40%), predominant during determined hours of the day, generating greater commuter displacement, traffic and peaks of infrastructure use.

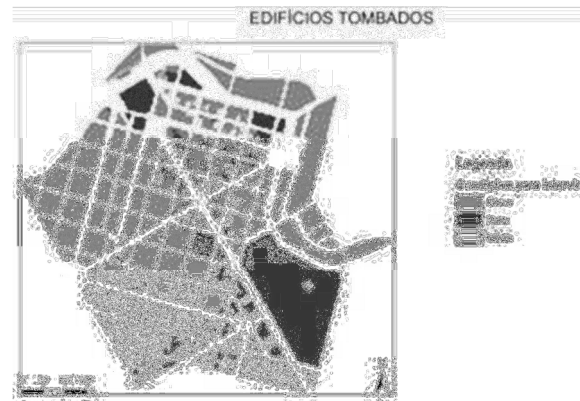
Figure 3 and 4: Number of floors in the existing buildings inside hyper-centre and Density of the number of domiciles with the density of the number of commercial establishments inside hyper-centre



Finally, another relevant aspect was the identification of heritage buildings, so that these heritage buildings are not likely to be

demolished, therefore being excluded from areas identified as proper for requalification, using a boolean analysis.

Figure 5: Heritage buildings inside hyper-centre



### **Weight of the indicators used**

Moura (2007: 2902) explains the logic of combination of variables: "The use of the weighted average creates a classificatory space, ordinal, which can also be understood as a scale of interval. This process can also be used in nominal scale provided the events are ranked according to some criteria of value. The weighting must be done through 'knowledge driven evaluation', in other words, by someone who knows the phenomenon and variables of the evaluated situation, or by 'data-driven evaluation' which refers to prior knowledge of similar situations. In this process, the possibility of weighting a particular situation in an inappropriate way is the inverse of the number of weightings assigned."

In this way, the synthesis map which identified optimal areas for requalification resulted from the crossing of the plans of information. Each of these plans received a weight owing to their greater or lesser importance, which added together resulted 100%. Besides, each caption component for each information plan received a score from 0

to 10 according to the relevance level of their participation in the group.

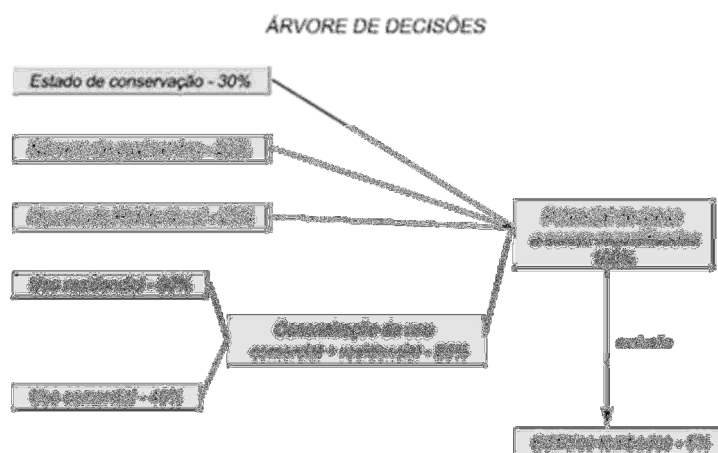
We considered that buildings' conservation is the factor with greatest weight on the indication of necessity of requalification, assigning it the weight of 30%.

In turn, combined data concerning residential and commercial use density received the weight of 25%, considering that it will be through diversity of uses and housing density by area that we will seek greater vitality and conservation of the place.

The number of floors received the same weight as population density factor (20% each), while heritage buildings received the weight of 5%, for even though we consider it a restrictive factor, we understand it as being of minor importance.

In figure 1 it is presented the Decisions Tree, which show how the variables were combined through the process of weighted average.

Figure 6: Decisions Tree in the structuring of the synthesis of optimal areas for intervention



## RESULTS AND VERIFICATION OF THE POSSIBILITIES OBTAINED

With the crossing of the five planes of information we obtained the synthesis map presented in figure 2, from which areas classified as optimal to receive intervention have predominance on the map.

Figure 7: Synthesis map: Identification of optimal areas for intervention



The conclusion that a great portion of the hyper-centre is formed by degraded areas was not effective for the choice of area to intervene, for it was necessary a more objective map which represented, between the degraded areas, the ones that were critical and with greater urgency of intervention. To get around the problem we applied the "histogram equalize" method which, redistributing the data grouped by equal intervals in the ramp of color allowed obtaining a map (figure 3) which presented more contrasts between the classifications.

Figure 8: Synthesis map: Identification of optimal areas for intervention with greater urgency

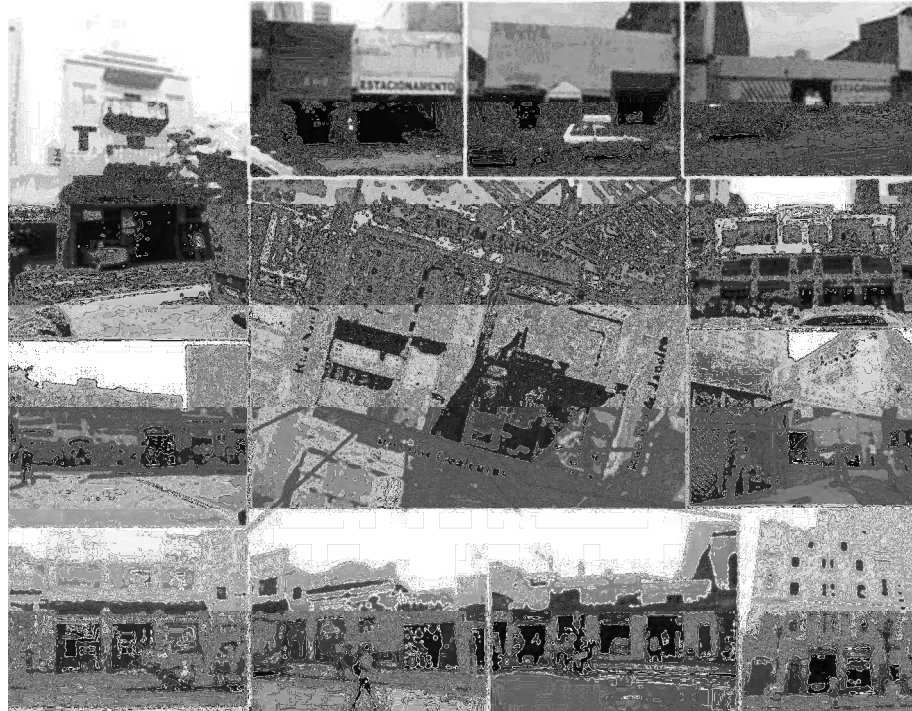


From the new synthesis map we identified the triangle on the north of the hyper-centre, delimited by Afonso Pena Avenue, Amazonas Avenue and Contorno Avenue, as the portion which most needed requalification.

As Moura (2007) explains through works of analysis, every time syntheses are produced through determined criteria, the obtained results must be verified according to some procedure in order to be validated. In this case, a field work was carried, which confronted the obtained data with local reality. Despite the greater assertiveness of the produced maps, some divergences were found:

- The 'state of conservation' map pointed some buildings in good state, but in certain places reality was the inverse;
- The 'number of floors' map pointed some buildings with such altimetry that did not match with reality observed in place.

Figure 9: The block delimited for intervention



Gathering the data obtained in maps and in field, among indicated priority areas for intervention, the block delimited by São Paulo Street, Guaicurus Street, Rio de Janeiro Street and Contorno Avenue was elected. Inside it, it is possible to list the following characteristics pointed in the synthesis map: low edification altimetry; low commercial and residential density; low inhabitants density; predominance of old buildings in bad state of conservation and absence of heritage buildings.

### **Identification of conditions to propose a project**

When elaborating a project, the identification of issues to be solved is fundamental to elaborate the guidelines and to better answer the real local demand. Out of the analysis of the present area elected for our performance, the following conditions were identified:

- Sound/acoustic pollution (traffic noises coming from Contorno Avenue);
- Insolation (strong insolation in Contorno Avenue);
- Ventilation;

- Accessibility (high number of bus lines and proximity to subway line);
- Field of view;
- Uses (predominantly commercial: parking places and scrap yards);
- Maintenance of some existing uses and its compatibility with new activities;
- Safety;
- Lighting;
- State of conservation (bad);
- Legislation (minimum soil permeability/ floor area ratio: 2.7/ minimum lateral distance: 1.5 m/ minimum set back distance: 5 m);
- Pedestrian flow (predominant between Rio de Janeiro Street and corner of streets São Paulo with Oiapoque);
- Service hubs/ attractive spots (Shopping Oiapoque, Bus Station, Shopping UAI, Pedestrian Bridge to Floresta neighborhood).

### **Guidelines elaboration**

Connected to the conditions we elaborated the following guidelines seeking to solve the issues observed in this work:

Regarding sound pollution existing in the area, especially in Oiapoque Street and Contorno Avenue, we seek to reconcile the existence of this factor with the commerce generator of sound impact choosing for this place the occupation by bars.

Regarding insolation, we took advantage of the presence of two buildings with considerable altimetry among the existing buildings at

the corners of Contorno Avenue, which ensures thermal and environmental comfort to the subject area of intervention.

Regarding uses, we looked for commercial diversity and adding of economic activities to residential use, enhancing density and variety of uses. The project foresees installation of underground garage.

Ventilation was ensured by occupying the central area of the block with small stature buildings and an open central corridor, ensuring air circulation.

The fields of view were planned to take advantage of the view to the square for the commercial enterprises bordering the Contorno Avenue, and the presence of verandas in the residential building facing the internal corridor, ensuring the presence of determined surveillance by the residents of the circulation area as well as commercial activity in the place.

The pedestrian flow inside the block was designed to establish a connection between the Rio de Janeiro Street pedestrian bridge and Shopping Oiapoque, taking into account the bus stops, meaning a useful passage for passers-by, in such a way that also favors their permanence inside the area of requalification.

It should be noted the plans for a movie theater and cultural centre at Rio de Janeiro Street which, along with areas reserved to commerce and handicrafts, will enhance the movement between the poles of Rio de Janeiro Street and Shopping Oiapoque by the planned corridors inside the block.

Regarding criminality and also depredation of buildings, once again we applied the concept that higher densities and diversity of uses cause greater surveillance and consequent conservation. We highlighted the absence of covered facades in our project,

encouraging the presence of verandas, windows and shop windows for every passage and circulation.

## **CONCLUSIONS**

The experience presented here means to the students of Architecture and Urbanism the possibility of empowering new technologies and testing a methodology with reproducible criteria that support the justification for choosing the place of intervention. According to Moura (2011, p.6), through this it is possible to "think urban issues as something more complex, resulting from the inter-relationship between variables and the conjugation of different views".

The methodology developed in the works of the Geoprocessing Laboratory of the School of Architecture of UFMG can be extremely useful not only for architects and urban planners, but also for the public sector, since allowance of the knowledge of the territory situation benefits transparency for decision making. It appears in many articles and has been tested on many different scales and objectives of planning and urban management, having been applied in local studies (Integrated Development Master Plan for the Metropolitan Area of Belo Horizonte), cities from Minas Gerais, neighborhoods and local architectural scales, such as those presented here.

Methodology has proved to be very useful to public politics and environmental governance, as it promotes transdisciplinary integration of different views and different variables intervening with the urban environmental quality. Even though they were not used in this work, variables such as shadow graphics, wind tunnels, temperature measuring, declivity and morphology, presence of expressive vegetation coverage, environmental fragility and climatic conditions could be used as criteria for decisions, as well as any other

variable related to environmental conditions with the objective of enhancing the general conditions of human occupation inside the territory and, consequently, the urban occupation responsible for climatic changes.

Therefore, the multi-criteria analysis, enabling a simplified representation of the reality, is also an efficient system to support decision. As well as representing a documented basis of the decision process and avoiding decisions to be taken in a subjective or particular way, the process depicted through this work provides important characteristics for the elaboration of the requalification architectural proposal.

The work presented here leads to an understanding of how the spatial analysis fits into the current urban planning practice, allowing us to position ourselves in face of social, environmental, economical and prescriptive issues, relevant to the proposition of urban and architectural interventions.

Finally, we believe that geoprocessing is an important tool to face the complex task of understanding and discerning the urban spatial dynamics. Even though little diffused in the courses of Architecture and Urbanism, we understand that it can make the work of the architect and urban planner easier and, above all, since it provides a better knowledge of the reality, the needs of a particular environment reflects more effectively in project solutions.

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