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BUILDING RENEWAL ON SOCIAL HOUSING – CASE STUDY ON THE RUBEM BERTA SETTLEMENT, PORTO ALEGRE, BRASIL

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Abstract
This study proposes a method and presents a proposal to re-qualify social housing complexes, with diversification and expansion of units. The construction of large social housing condominiums can be criticized from several points of view. These projects has limited financial resources and there is a gap among the project and user' requirements, generating a low quality product, which have an accelerated degradation and generate more maintenance' waste in life cycle. Building renewal is a form of recycling and has influence in social, economic, and environmental issues. The aim of this paper is to propose a design methodology for the renovation, which is sustainable and oriented to value creation. It consider environmental and economic feasibility based on embodied energy in materials and hedonic price models, respectively. We conducted design simulation, focusing on a typical housing complex, located in the Rubem Berta settlement, in Porto Alegre, Brazil, and verify a potential for value adding. This work contributes to the discussion of alternatives to social housing deficit in Brazil.

Keywords: Social housing; Design; Building renewal; Sustainable construction; Waste reduction.

INTRODUCTION

There are several benefits on rehabilitate existing buildings, such as maintaining structures of social or historic value and already adapted to urban and architectural reality; take advantage of the energy involved in the existing physical structure, with less need for new resources;

maintaining social relationships, community and neighbourhood; and provide value adding in the region and the building itself (Gorse and Highfield, 2009). A part of existing social housing estates in Brazil has problems of conservation and rehabilitation is an important measure to restore the quality of life of their users. Improving the use of existing buildings reduces the need for new buildings and then decreases the need for new urban land, contributing to sustainability.

There are examples of mass housing rehabilitation on developed countries. In North America the main focus is on reducing energy consumption (retrofit). In Europe the problem is also linked to the renewal of a large number of buildings built after the II World War. The standards adopted at the time of construction are considered not suitable for the present moment, and people look for new solutions to expand the built environment and reduce energy consumption for heating in addition to value adding of the region. The low population growth in developed countries and the search for sustainability does not recommend demolition (Bragança et al., 2007; Cukovic-Ignjatovic and Ignjatovic, 2006; Giussani, 2007; Ham and Schamhart, 2006).

Developing countries have different needs, such as production to cover housing deficit, as well as economic viability. Still, part of the housing issue is linked to poor care of the demands of users, caused by deficiencies in the original design or aging buildings, in addition to the problems based on the low quality of social housing (Bonduki, 1999; Boselli, 2007).

Housing deficit in Brazil is about 10%, regarding to existing stock. A part of this deficit is inadequate housing. As well as, a family have a housing, but with lower quality or size that your needs (FJP, 2004). Rehabilitation is a way to fix this part of deficit. In Brazil, an opportunity to study is in the vertical housing complexes built in the period of the National Housing Bank (BNH), from 1964 to 1986. In quantitative terms, that production is significant in several Brazilian cities. In general, these housing complexes were originally designed to low-class or low-mid class people. Most complexes are composed of hundreds of apartments with 2 or 3 bedrooms. They have social areas and parking areas, and had at building time reasonable architectural and building standards. Projects built around the country have large similarities (Azevedo, 2007; BNH, 1979; Bonduki, 1999, Sampaio, 2002).

However, too many properties currently present a bad conservation state and lower market values. It has impact on property tax, generating in some cases a lack of interest of the public administration to invest on improvements in the region. It is also common to occur the stigmatization of the residents. There are lost in relation to the quality of life for families and beyond, in the neighbourhoods. This situation occurs in Brazil and in other countries, such as Argentina and Chile (Dunowicz and Hasse, 2005; Krasuk and Gerscovich, 2005), with some known proposals for renewal (Ganem and Esteves, 2003; Ganem et al., 2005, Rodriguez and Sugranyes, 2004).

This phenomenon occurs in Latin America and several developed countries (Brattbakk and Hansen, 2004, Hastings, 2004; Verhage, 2005). To Brattbakk and Hansen (2004), there is evidence that some of the social and economic problems are linked to the repetition of the projects. To these authors, seems to be a relationship between long sets of buildings for social housing and the existence of social problems such as segregation and prejudice. The generation of stigma is most common in large housing complexes. The media identify or amplify the problems occurred in a given set, but the population can be generalized to other sets of similar project (Brattbakk and Hansen, 2004). In addition to overcrowding and poor

quality of design and construction, many residential complexes are built on the fringes between urban and rural areas with poor infrastructure, exacerbating the problem.

Chanagnon et al. (2003) state that one of the objectives of the rehabilitation of social housing in Europe is value increasing. Another objective is to reduce energy consumption. Ham and Schamhart (2006) argue that the renewal allows the utilization of existing infrastructure and structure, with less waste generation and lower energy consumption. Camarero Martínez et al. (2008) argue that rehabilitation should include sustainable design features.

Hastings (2004) argues that urban regeneration must consider the public image of the housing complexes along with the physical renewal. There are cases of urban renewal projects developed in Britain in which the poor image remained after the completion of the works. Esteban Galarza (1989) discusses some social consequences of regeneration projects in urban areas, such as increased levels of property prices and attracting groups with higher income levels, but at the risk of displacement of the original people. One of the known consequences is the gentrification. Gentrification is the conversion of marginal properties for working class areas located in central city areas in new residential uses for middle or upper class, by reflecting a movement of private capital investment. Was related to the recovery of damaged buildings architecture as well as supply of new services and usually occurs in the CBD (the city "core"). With this conversion, lower classes are displaced. In some cases, improvement it do not appropriate, on the contrary, it creates peculiar types of spatial segregation, often with increased income concentration (Smith, Williams, 1986; Zukin 1987).

Meanwhile, as well as the degradation of the built environment causes economic and social waste, building renewal has the potential to improve the quality of life of families affected and of the cities as a whole. It is possible to reduce poverty and crime improving built environment. Of course, projects requirements includes sustainability, looking at environmental (preference for low-impact materials), economic (economic viability) and social aspects (low impact on users).

This paper presents some results of research on sustainable solutions for building renovation. The work begins listing some elements to build a methodology and exposes a simulation study in a social housing complex in Porto Alegre, a Southern Brazilian city. Results indicate a good potential to consider rehabilitation as an alternative to contribute to the social housing issue.

SOME ELEMENTS TO BUILD A METHODOLOGY

The basic premise adopted is that to expand, improve and prolong the useful life of buildings is a form of recycling, avoiding new constructions, and then reducing the generation of waste, saving natural and financial resources, energy and urban land. It is assumed that there are economic benefits and better resource use with the renovation of buildings.

The rehabilitation project must be based on certain assumptions, including: (i) technical and economic feasibility, with proposing solutions to renew the appearance of buildings, promoting economic increasing, (ii) use of materials available in the region, low cost, that generate less waste and are recyclable, (iii) propose solutions that allow flexibility of use. These three points establish economic, environmental, and social sustainability. These premises are detailed to follow.

Viable and valued projects

Construction costs are a very important element in the social housing sector. In general there are too few resources and projects should attempt too many needs. So it is important to examine carefully the costs of rehabilitation projects to be economically viable. And further on, solutions must be technically feasible.

The costs were calculated by conventional budgets, measuring materials, labour, additional works, and administrative and legal costs. This part follows the traditional methods of budgeting. The feasibility analysis also requires estimates of increase on property values. We propose a basic way to measure the value using hedonic pricing models (Appraisal Journal, 2001; Rosen, 1974; Pagourtzi et al., 2003).

The models relating the price of a property with their characteristics are known as hedonic pricing models, which are econometric models, with a long application in economic studies and research (Rosen, 1974; Sheppard, 1999). Thus, value increasing may be measurable by comparing the current situation with the potential situation, which is based on the proposed rehabilitation.

For this, it was developed a pricing model for the correspondent property sector, according to traditional procedures for hedonic pricing models. This procedure is not detailed here for space limitations of this work. The information about sales data of the units was obtained from Sales Tax files in the Porto Alegre Tax Department, and statistical analysis was developed with 41,975 condo sales data in the period from 1998 to 2010. The resultant equation is as follows (Equation 1):

$$\begin{aligned}\text{Price} = (&73.59658 + 0.98101*\text{Building\_Area} + 0.01836*\text{Land\_Area}^{0.5} - 0.83540*\text{Building\_Age} \\ &+ 1.02090*\text{Sale\_Month} - 4.21273*\text{Sale\_Month}^{0.5} + 6.22984*\text{Building\_Standard} + 0.48867* \\ &\text{Settlement\_Quality} - 3.75147*\text{Distance\_to\_Parks} - 1.23628*\text{Distance\_to\_Shoppings})^2 \end{aligned} \quad (1)$$

Where: Price is the selling price in US dollars; Building_Area is the total surface of the property (in m^2); Land_Area is the ground surface (m^2); Building_Age is the age of the building (years); Sale_Month is the time of sale (Month = 1 is October'98); Building_Standard is the quality of construction; Settlement_Quality is the quality of neighborhood; Distance_to_Parks and Distance_to_Shopping are distances to these points (kilometers). The model in Equation 1 was adopted before proven by the conventional tests, such as ANOVA, significance of the variables, and behavior of the errors; and it has a R^2 of 0.906.

Data sample is large in size and time period, allowing a reasonable confidence about market behaviour covering. In future applications, one may add new market data and to recalculate the model. Market do not change a lot in small time periods (e.g. some months), then it can expected small changes in the coefficients (the "shadow prices" of each building characteristic present on the Equation 1).

Sustainable projects

It's very clear the influence of buildings on the environment. The buildings require significant resources for its construction, as well as for operation and maintenance. The built

environment accounts for almost 50% of emissions of greenhouse gases, and a similar fraction of energy consumption and water (Gauzin-Müller, 2002; Yeang, 2001).

The issue of sustainability in construction have a link to sustainability in general, including problems of degradation of the natural environment, climate change and greenhouse effect, for example, and has three basic aspects: economic, environmental and social. These aspects should be pursued consistently (Gauzin-Müller, 2002).

There are several available criteria and principles for sustainability in construction, based on life cycle analysis, recycling of materials, components or construction and calculation of the energy involved (Kibert, 2005). Rehabilitation is a form of recycling the building, which attempts to use the existing structure of the building and infrastructure in the region, with less waste generation and lower energy consumption in the life cycle of the building. For the specification of new materials are adopted the choice based on the energy involved in each option, considering also the costs and the need for resources in the life cycle (Boussabaine and Kirkham, 2004).

Flexible projects

The repetition of the project can be considered as a cause of devaluation of social housing. In general, the mass housing market is seen as low quality housing, monotonous and intended for low-income population (Brattbakk and Hansen, 2004, Hastings, 2004; Verhage, 2005).

Kleinhans (2004) recommended the diversification of housing types and encouraging various economic activities (shops, offices, services), in order to attract a population with different socio-economic conditions. These are important actions to reduce crime and pollution, to expand and qualify the transport and urban infrastructure. Verhage (2005) also maintains that the building and urban renewal should encourage diversity of typologies, to attract different people and thus reduce the possibility of segregation.
Another premise is that the building should accommodate users along its life cycle and not vice-versa. For this, the design must incorporate some degree of flexibility. The research line "Open Buildings" continues studies of Habraken (1972, 1998) and represents a strategy of design, construction and operation of the built environment looking for flexibility (increasing the ability to adapt to the changes that occur throughout the life cycle of a building).

From this point of view, the building has basically two parts: shell (constructive form with durable characteristics) and infill (internal parts that can be performed with lightweight materials and should provide flexibility to adapt). This concept applies to new projects, where one can specify the structures, fences and building systems in a simple, yet also adaptation or renovation projects of buildings can (or must) take into account the flexibility (Habraken, 1998 , Kendall, 2005). There are some rehabilitation studies in Brazil for the social housing sector, such as (Folz, 2008; Marroquim and Barbirato, 2007; Szücs, 1998).

SIMULATION STUDY IN PORTO ALEGRE

This part of the work presents a study about on the possibility of renewal of an housing complex in Porto Alegre, Brazil. The investigation was conducted following the principles presented through simulation of alternative projects with actual costs and market values.

These projects usually have a repeating pattern and follow a common pattern (BNH, 1979). There is hundreds of this kind in Brazil, and in many cases they are in not too good conditions, or they have no requirements that families need today. It is still important to think about collective solutions to the joint through a strategy that will allow differentiation of the properties without losing the characteristic of the housing estate.

For build the proposals, were also considered good examples of social housing built in Brazil and other countries (French, 2008). It is important to note that we do not discuss the architectural quality of the project alternatives itself, which were generated to allow analysis and discussion of some issues. In addition, a more precise analysis of a building renovation project must involve the users (Giussani, 2007; Suschek-Berger and Ornetzeder, 2005).

Description of condominium blocks

The case study is about Rubem Berta settlement, considered the largest housing settlement of the state of Rio Grande do Sul and one of the largest districts in the country. It is an 8.7 km² built area and about 80 thousand inhabitants. The occupation in this region began in the 50's, to be formally established by a municipal law of Porto Alegre in 1968. It is a neighborhood occupied almost entirely by vertical buildings (Rigatti, 1999, Severo, 2006). Figure 1 show an aerial image, where one can see the density of occupation in the neighborhood, and a set of blocks in detail, with some façades. This set is located on the 22' Street (Rua Vinte e Dois). It was completed in March 1980 with the financing of BNH, consists of four blocks, with 4 levels and 8 apartments per floor, with a total of 5,872 m^2 and 128 units. The region has dozens of blocks of similar size and standard.

Figure 1 *– Aerial image and façade – 22' Street - Rubem Berta settlement*

Figure 2 shows the original floor design. It has three types of apartments, with one (R1=35m^2), two (R2=46m^2) and three bedrooms (R3=56m^2). Each level has 367m^2, with 5 double bedroom units, 2 units of 3 bedrooms and a single bedroom unit. Construction is on conventional reinforced concrete structure and masonry bricks walls covered with mortar joint; the windows are built on steel tubes, the roof has asbestos-cement shingles, and the rooms have parquet on the social areas, and ceramics at the service fields. There is no lift on the building.

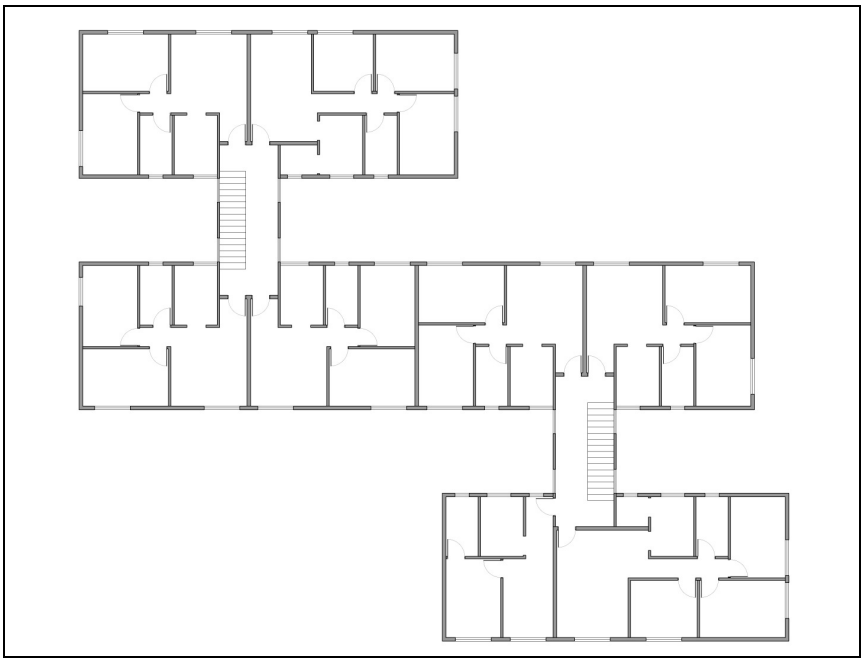

Figure 2 *– Original floor design – with 1, 2 and 3 rooms*

Internal rehabilitation design

This proposal seeks to use the existing structure, still generating internal differentiation in the building. They were proposed alterations from the original floor plant. The internal diversification of the apartments was explored, recombining existing units to form lofts, horizontal and vertical duplexes; with a greater variety of floor plans in the building (Figure 3). The project includes the expansion of the blocks including a new level. The flexible plan allows residents of the building to change property type without change your address along time. Thus, neighbourly ties are not lost and the community remains united.

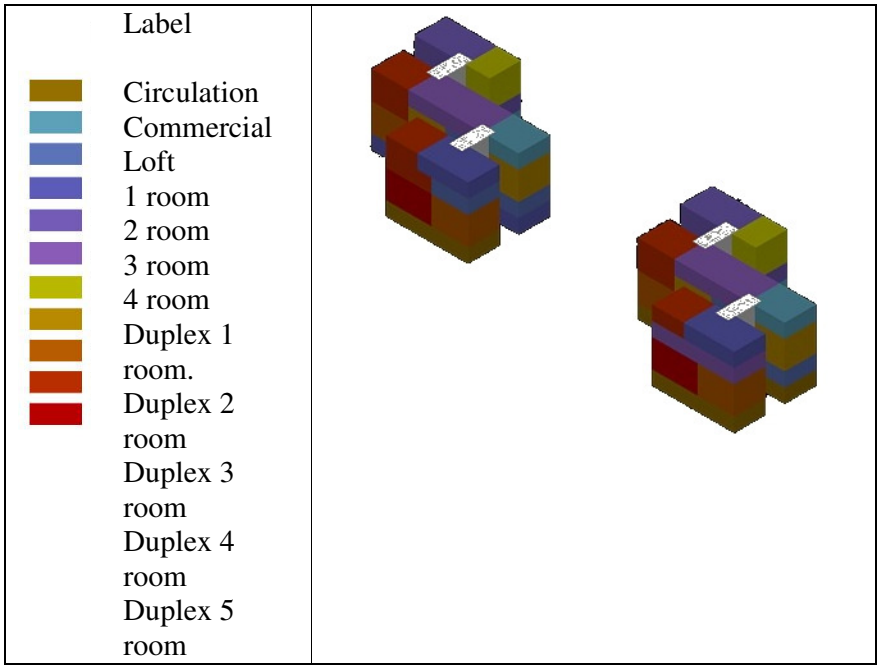

***Figure 3** – Different building types – Two block examples*

The project includes the expansion of the blocks including a new level in some blocks. The reinforced concrete structure is conventional. It has 30 years old and was calculated according to odd customs and rules, perhaps more demanding than today. We checked the quality and status of this structure through detailed field inspections. Can be seen that the structure is to extra-dimensioned in relation to existing concrete structures. Under these considerations, we can add a further layer in the block without loss of structural performance. The income from the sale of new units may finance the work. One can make the differentiation of units without undoing the basic features of the condominium, which maintains a regular appearance (Figure 4).

***Figure 4** – Buildings with different levels – 4 and 5 stories*

Façade rehabilitation design

The proposal adopts metal structural elements connected to the building's facade, including open or closed balconies. All the balconies incorporate barbecue equipment (grill), which is a very important element on local culture. The part of balcony positioned side by side on living room is open while the part at side of bedroom it's closed by a mobile brise (Figure 5). It was designed to obtain major environmental comfort on bedroom, which reduce sunlight and at the same time, allow free air circulation. The location of the wind may vary according to the needs of residents, keeping the same building pattern (Figures 5 and 6).

***Figure 5** – Façade options – building with and without balconies; open and closed balconies*

Roof housing rehabilitation

The structure is relatively old and we can say it's extra-sized in relation to existing concrete structures. In addiction, the new plant allows the use of a green roof. This green roof collects rainwater for reuse (Figure 5). The roof also contributes to the upgrade of the facade. We propose two different roof styles. In the first, the cover remained as originally, and on another was covered with a green protection, with thermal effect about the last level apartments (Figure 6). They have similar costs.

***Figure 6** – Roofs – Option A (conventional) and B (green roof)*

Economic viability of the rehabilitation project

The costs were calculated per apartment (average per unit). After that, we did the calculation of value adding using Equation 1. There are many different configurations of building renewal, but we presented one option, to examine the feasibility and to demonstrate the methodology of analysis. It is the simplest (assumed to be the most likely option in a real case): the inclusion of balconies with barbecue equipment, a very important element in local culture. Budget was considered for the buildings with one, two, or three bedrooms. Costs are different by building type (Table 1).

Table 1 – Budgeting details of façade renovation – average by unit – on USD

Rooms	Simple (R1)		Double (R2) or Triple (R3)	
Element	Dimension	Cost	Dimension	Cost
Foundation – radier on concrete	3.5 m^3	900.00	4.0 m^3	1,000.00
Steel balconies: 5.6m^2 – structure, floors and laterals	490 kg	3,950.00	650 kg	5,250.00
Aluminum brises	6.0m^2	1,350.00	8.0m^2	1,800.00
Inner changes (masonry, carpentry) – changes on windows, changes on the external walls		810.00		820.00
General painting	47.0m^2	910.00	49.0m^2	970.00

Project, tax, management	12.5%	880.00	12.5%	1,120.00
Unit costs		8,800.00		10,945.00

The market values for each apartment were calculated using the actual data of each type of building, for the month of December 2010. These values were obtained for the current state of the building. In a second stage it was proposed lowering the age for 15 years and increases the standard of level 2 for 3, for the purpose of updating and renovation of the façade (compare Figures 1 and 5, 6). It is a use of the concept of "apparent age" as used in commercial appraisals (Appraisal Journal, 2001; Pagourtzi et al., 2003). The change of standard is justified by the addition of the balcony with a barbecue equipment. In addition, we calculated the effect of increasing the area by the addition of the balcony. The calculated values for each unit are shown in Table 2. As the valuing is greater than the costs, we demonstrated economic viability. There is an advantage of about $ 300 to $ 1,100 per unit with the renovation. This small difference may decrease the risk of gentrification, why not bring a significant enhancement to the property. Properties maintain affordability, as well as, target group is not removed of your dwellings after refurbishment project.

Table 2 –Economic analysis of façade renovation

Apartment	Area (m^2)	Original value – USD	Area (m^2)	Value with renovation – USD	Valorization – USD	Profit – USD
Simple room – R1	35.00	36,800	40.6	46,700	9,900	1,100
Double room– R2	46.00	41,060	53.5	52,330	11,270	325
Triple room – R3	56.00	45,133	63.5	56,910	11,777	832

Economic viability has been demonstrated. Design strategy allows the differentiation of the blocks without mischaracterize the condominium. The quality of life for residents is extended with the addition of balconies and brises, and improving thermal comfort of the units. Sustainability is achieved through the use of steel, which is cheaper and has less energy incorporated than reinforced concrete.

FINAL CONSIDERATIONS

The Brazilian condominiums developed under BNH' period were built since the late 60's to the beginning of the 80's, with thousands of similar estates. Actually there are opportunities for renewal. This study used simulation proposing building renovation with maximum use of existing infrastructure. We develop design alternatives with budgets based on real costs. Final cost of refurbishment was compared with predicted value calculated by hedonic price models. HPM was based on a large data sample (in terms of size and time period), allowing confidence about market behaviour covering.

The renewal proposal adds differences in the condominium. The overall appearance of a monotonous, repetitive complex, with all the equal blocks, shown in Figure 1, is changed to a set that has common design features, but it has different characters in each block, with different heights (Figure 4), with balconies (Figure 5), conventional or green roof (Figure 6), and so on. In addition, there are buildings with different number of rooms, allowing that families with different configurations can share the same urban space (Figure 3).

The design process incorporated sustainability features, with the analysis of energy involved - preference for materials of lower total energy and greater potential of recycling - and economic viability analysis, which confronted the costs of implementing the building renewal. To partially fund the renovation of the building by selling units, or replacement of the residents of each block was designed adding a new level. This research has already shown it is possible to rehabilitate old buildings and blocks design with flexible design units, with this flexibility vertical or horizontal.

The small differences verified on property prices reduce the risk of gentrification. Properties maintain affordability and people are not removed of your dwellings after refurbishment project. To refinement of this method, we recommend to test different design options, to verify the best one, in economic and environmental terms.

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