

Brief Review of Concepts of Needs in Rehabilitation of Housing Buildings and their Consequences on Living, Comfort and Indoor Air Quality

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Abstract—This paper presents a retrospective on housing policy in Brazil in the last century, addressing regulations, laws, decrees and some technical standards (Brazilian and Portuguese) regarding rehabilitation of buildings to improve the technical performance (thermal, acoustic, luminaire, among other aspects) of the dwellings. In this context, it is observed that indoor air quality is essential to the health of the occupants, since in many countries people spend much of their day inside their homes, a place that due to many social and economic factors does not present satisfactory conditions for maintaining good health. Studies also show that most buildings do not have the minimum conditions necessary for good technical performance according to legislation, in times of remarkable climate change, thus having to raise awareness of the problem in various sectors of society by incorporating strategies or action plans aimed at transformation of environments into smart spaces, favoring the health and well-being of its occupants.

Keywords—Building Rehabilitation, Housing, Indoor Air Quality, Technique Performance.

I. INTRODUCTION

The human being since no longer being nomadic, has sought better conditions of fixation in space through his housing. However, centuries of history have shown its effort in this improvement, directly related to interpersonal relationships, social working conditions, economics, and depending on mastery of techniques and opportunities of its application. The industrial revolution in Europe from the 18th century onwards led a large part of the population to gather in industrial areas, especially in urban areas, making the poor quality of buildings used as housing become the main disease-promoting aspect, the low or almost no health qualities and the proximity between people in the transmission of simple but deadly diseases to the conditions in which they lived. These include respiratory, allergic, diarrhea, health problems aggravated by excessive heat or cold, air pollution, moisture, mold and fungus, as well as pests, insects and rodents that lived with waste and sewage and they were part of the conviviality of people.

This context led public services from European countries such as England, France, Spain and others to start implementing regulations on the health problem, in order

to ensure the minimum necessary for people's living conditions so that they could continue to serve as a workforce to industries.

The aim of this paper is to present a historical approach of some regulations, norms, laws and guidelines related to health conditions and the quality of buildings that occurred in Portugal and Brazil in the 20th and early years of this century, and the influences on the indoor air quality of these buildings, knowing the vast diversity of bioclimates present in the Brazilian territory with their distinct characteristics between north and south, in addition to the urban micro-climates capable of altering the climate in general in Brazilian cities, and possible consequences occupant health.

II. POPULATION GROWTH AND HOUSING PROGRAMS

In Brazil, there was a population jump from 40 thousand in 1886 to 580 thousand people in 1920 in the city of São Paulo alone, an increase of 14.5 times in 34 years, due to the intense migratory flow related to coffee production of the time (BONDUKI, 1994); and despite this population scenario, housing conditions contained

serious social inequalities, which made it impossible for most of the population to access housing, being restricted to the periphery, segregation, degradation of nature and poor quality of life, among other problems intensified with the approval of the law 601/1850 (HOLZ, MONTEIRO, 2008). Urban population growth was observed in the 1940s and 1970s due to the modernization of agriculture and the consequent decrease in the workforce, coupled with the absence of favorable policies to maintain the population in the countryside (MONTEIRO, VERAS, 2017). This trend of increasing urban population is marked, as the urban population went from 31.3% (42 million people) from 1940 to 84.36% (161 million people) in 2010 (IBGE, 2018).

Until the mid-twentieth century the tendency of the entrepreneurial initiative to provide housing conditions for workers in the so-called "working villages" next to the factory, providing control over the social, political and moral way of life of workers, who could count on school, church, warehouse, recreation room, facing their possible revolts, in a model taken by the government as an example to be followed.

State intervention as an activator of Brazilian housing growth occurs with the creation of the building documents of the Retirement and Pension Institutes (Institutos de Aposentadoria e Pensões - IAPs) in 1937 and the Popular House Foundation (*Fundação Casa Popular - FCP*) in 1946. However, the fragility of the system was clear, and with the lack of resources and disarticulation with agencies of other public sectors, it was not possible to achieve effectiveness in this area. Bonduki (1994) mentions that even with limited FCP resources and political problems making the IAPs unfeasible, the production was about 140 thousand housing units, housing about one million people in large Brazilian cities.

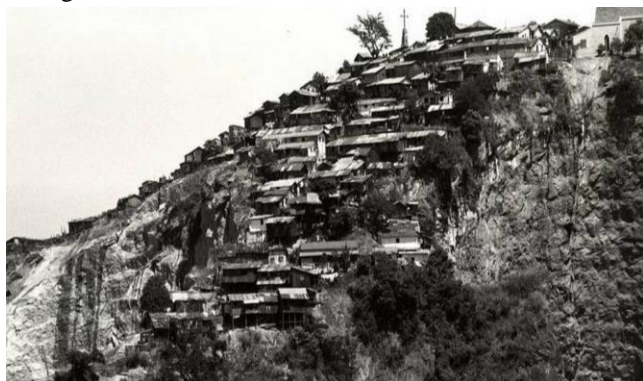


Fig.1: Morro da Providência, Brazil's first slum.

Source: Journal O Globo (2017)

With the high inflation of the 1940s, the Government launched the Tenancy Decree-Law in 1942, instituting the freezing of rental values, trying to regularize relations

between landlords and tenants; However, it generated large evictions by the owners, which aimed to rent the property to another family with higher cost. As a result of the evictions, together with thousands of newly arrived migrants in São Paulo, finding housing with compatible value was almost impossible, which led to the formation of the first *favelas*(slum) in São Paulo and Rio de Janeiro (Fig.1). Thus, the alternative was to live far from commercial centers, in unauthorized subdivisions that arose as an option for low-income families.

Santos (1999) notes that the largest Brazilian housing program was the Housing Finance System (SFH), created in 1964, which made it possible to finance over six million new homes in more than thirty years

of existence. However, SFH's performance would depend fundamentally on the ability of the FGTS(*Fundo de Garantia por Tempo de Serviço*: Lifetime Warranty Fund), which was created in 1967) to collect and default on the financed properties, as well as any other long-term financing system that is vulnerable to global macroeconomic systems; until 1979 SFH had no major problems as inflation was no more than 45% per year; but the acceleration of inflation at 100% in 1980 and 200% from 1983, in addition to the high borrower's defaults, substantially changed the situation of the system.

Municipal Law 2371/1982 (BAURU MUNICIPAL COUNCIL, 1982) for example provides basic information on minimum housing areas, minimum compartment sizes (such as bedroom, kitchen room, bathroom, corridors, stairs and access), ceiling height, minimum lighting for each room, size of the minimum ventilation openings in the compartments, minimum height of mandatory location of wall tiles and ceramic floors, sanitary and safety installations and accessibility for both single-family and multi-dwelling buildings, ensuring the minimum necessary for habitability conditions.

Another program with positive results in the National Housing Policy was the so-called "Letter of Credit," which financed about \$ 5 billion from January 1995 through June 1998, benefiting the construction of housing for about 265,000 families; In this system, the citizen proves the family income to receive resources for the acquisition or construction of their housing, thus being a program of spontaneous demand, leaving the State to be the main responsible for the housing problem, only acting as an inductor or facilitator of the process (SANTOS, 1999).

Housing is known to be a very important asset and a right of every citizen, as stated in Article 25 of the Universal Declaration of Human Rights of the United Nations General Assembly (UN, 1948); In Brazil, there are two important legal frameworks of legal guarantees, the

Federal Constitution (BRASIL, 1988), and the Law called the *City Statute*. The Constitution in its Article 7 and 23, includes housing as one of the social rights, and in its Article 182, determines the Municipality, through the Master Plan, to be responsible for the ordination of the city to ensure criteria of application of the social function of property, observing the well-being of its inhabitants and guiding urban policy; Law No. 10257 / 2001, (City Statute) (BRAZIL, 2001), provides for the development of the social functions of the city and property, in favor of the collective good, security and well-being of citizens. This achievement comes a century late when compared to what happened in European cities about the use of urbanistic instruments as a social regulator of the real estate market combined with social policies.

Assuming its commitments to the Istanbul Charter (Habitat Conference II / 1996), the government launches the Brazilian Habitat Quality and Productivity Program (*Programa Brasileiro da Qualidade e Produtividade do Habitat - PBQP-H*) to improve the construction sector in terms of quality and modernization of the sector, since until then the cost medium was high and there was a lack of standardization of the building materials used (BRASIL, 1998). In 2005, in the promotion of housing policies and programs, Federal Law No. 11124 was promulgated, establishing the National System of Social Interest Housing (SNHIS) (BRAZIL, 2005) for the low-income population, and in favor of this phase, launched in 2009, the My House My Life Program (*Programa Minha Casa, Minha Vida - PMCMV*) (Fig. 2) provides conditions for expanding the housing market for low-income families of up to 10 minimum wages, being delivered by December 2018 a total of 4.87 million homes (BRAZIL, 2009a). However, even with this advance, Brazil still has a deficit of 7.8 million homes (BRASIL, 2009b).

In Portugal, having noticed the deterioration of housing conditions and health of the population at the end of the nineteenth century, the beginning of the twentieth century saw the promulgation of regulation on this theme: Health Regulations of Urban Buildings in Portugal, in 1903 (SILVA, 2018), facing the needs of major cities such as Lisbon and Porto due to the industrialization process; Almost half a century later, in 1951, the General Regulation of Urban Buildings (RGEU) was enacted, already observing the details of items related to the healthiness of land, interior arrangements and free spaces, such as lighting and aeration of dwellings, as well as toilets and sewage, drinking water supply and disposal of wastes, fumes and gases, including general fire safety requirements and provision for sanctions, showing concern

for housing quality and consequent improvement of habitability.

In the second half of the twentieth and early twentieth centuries, several other studies were conducted to find safe and adequate systems for the health of housing occupants, including governmental entities observed in other countries, to dictate certification systems for thermal performance qualities, acoustic, luminaire and energy, both residential and commercial and utilities buildings.

Freire (2014) mentions that Ordinance 461/2007 defined in Portugal the Energy Certification and Indoor Air Quality System (SCE) for new and existing buildings, being mandatory to verify and comply with the system; and more recently, Decree Law 118/2013 (Diário da República Eletrônica, 2013) apply the Regulation of Energy Performance of Housing Buildings (REH) defines minimum values of air renovation rate in buildings. It should be noted that this Decree Law 118/2013, although recent, has already received six new amendments: 3 amendments in 2015, and others in 2016, 2018 and 2019, transposing directives of the European Parliament and of the Council on the energy performance of buildings intended wholly or predominantly for residential use.

III. HOUSING REHABILITATION AND INDOOR AIR QUALITY

Noting the need for the quality of buildings, especially the construction and housing characteristics, ISO 6241 (1984), being the first international standard for building performance, was a basis for other standards from other countries, such as the Brazilian Association of Technical Standards, that launched in 2013 the Norm 15575, about Housing Buildings Performance, covering seven user requirements, namely: water tightness; thermal performance; acoustic performance; light performance; health, hygiene and air quality; functionality and accessibility; and tactile and anthropodynamic comfort of buildings (ABNT, 2013).



Fig.2: My House My Life Program.
Source: Brasil (2009b)

Thus, a range of programs, regulations and regulations in the search for plausible solutions to the good condition of housing can be observed; and depending on this housing problem, there is a growing challenge due to the consequences of climate change, recorded by discussion events and promulgations focused on these changes, which directly affect people wherever they are. Events and results such as ECO92, Kyoto Protocol, Agenda 21, among others, indicates problems such as coastal flooding, hurricanes, dengue transmission, cholera, diarrheal diseases, malaria, yellow fever, stress, schistosomiasis, among other diseases, which are consequences in sub or developing countries. In developed countries, common problems are related to air pollution, either stress or hot or cold waves (KOVATS et al, 2003).

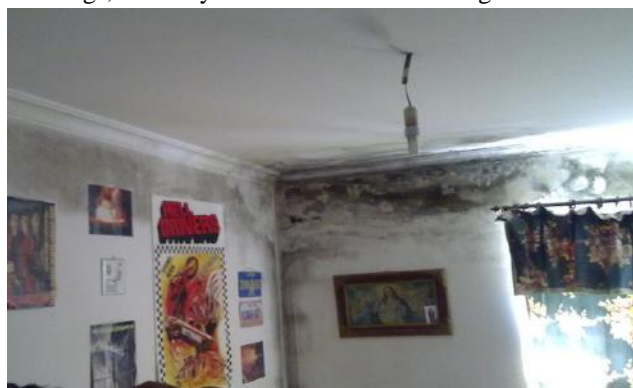
Betts and Sawyer (2015) also report problems such as cardiovascular disease, severe climates that cause fatalities, as well as impacts on mental health and damage to families. More recently, environmental degradation, territorial conflicts, scarce water or food have forced populations to migrate, aggravating sanitary and housing conditions in various parts of the globe. Kukadia and Upton (2019) warn of the great population growth of the metropolises. According to studies by the United Nations (2018), 55.3% of people today live in urban centers, and between 2020 and 2030, the forecast is that there will be a jump from 23 to 60% of the world's population living in cities with more than 1 million inhabitants, and warn of the cause of millions of deaths each year due to housing problems. These authors (KUKADIA, UPTON, 2019) further report that the cost of 3.5 million poor housing for England's healthcare system generates about £ 1.4 billion in public health care costs per year, only in the first year.

More recently, dozens of studies on the evaluation methodology of building rehabilitation processes have appeared, aiming to improve these conditions. Thibodeau, Baraille and Sié (2019) observed 41 articles (between 2005 and 2017) compared to ISO 21931-1 (Sustainability in Construction) and ISO 14044 (Environmental Management), EN 15978 (Construction Lifecycle) and Regulation 305 / 2011 (EU). In the same period, Lanzinha (2009) presents research on diagnostic methodology and intervention in buildings regarding their rehabilitation, noting concern about occupant health and indoor air quality. However, if many people work outside, they do not stay in the dwelling for so long. However, Brasche and Bischof (2005) present a study result on the average time people spend indoors (in their homes) in Germany. The survey addressed 5530 single-family apartments and houses, and resulted in an average of 15.7 hours per day /

per person. Among older women over 64, this average exceeded 19.9 hours per day at home.

Nevertheless, in a closer analysis to the internal conditions of the dwellings, Lanzinha (2014) considers that the Portuguese housing system is increasingly showing evidence of advanced state of degradation of most of its buildings, especially the older ones. Since maintenance depends on the economic condition of the owner or condominiums in the case of multifamily buildings, any financial crisis directly affects the rehabilitation business.

Abreu (2010) evaluated the consequences that the deficient conditions and situations of the interior environment of the dwellings have on the health of its occupants. Among the observed dwellings, 73% were old (from the 1960s) and had no renovation work on the building, which can be detected by poor conservation and use. This author also points out that humidity and mold (Fig. 3) were permanently present in 55% of older buildings, and only in 11% of newer buildings.



*Fig.3: Moisture and mold on walls.
Source: Own authorship.*

As physical pathologies are responsible for the interior quality of the building, Freire (2014) evaluates other impacted factors such as indoor air quality, thermal, acoustic and visual comfort, relative humidity, lighting, air velocity, odors, concentration of micro-airborne organisms or dusts, among others.

If indoor air quality in dwellings is so important to occupant health, what about Rosenbaum et al. (2015)? These listed 947 chemical components capable of polluting the home environment, which are present in products such as perfumes, flavorings, cleaning materials, food, tobacco, building materials, glues, varnishes, adhesives, foams, toys, printed matter, shoes, electronic equipment, wood, among others.

However, Kukadia and Upton (2019) show that the understanding of indoor air quality is very complex due to several factors acting as causes and consequent effects, since there is a range of polluting sources, type and

location of the building, place decoration, as well as the mode of use of its occupants. Lifestyle and subjectivity are also observed by Hasselaar (2012) and Freire (2014) citing studies from the World Health Organization.

How people live and what they do inside their homes influence the factors and quality of housing as well as the quality of people's own health. Freire also points out that in the 1970s symptoms were observed in occupants of newly constructed buildings, identified at the time as "Sick Building Syndrome", triggering a comparative series between sick and healthy buildings through chemical content analysis of building materials, a fact that led manufacturers to change manufacturing systems to improve their products, using new materials less harmful to people's health.

IV. POSSIBILITY OF ACTIONS AND PERCEPTIONS

So much is evident that Marcelino and Lanzinha (2017) observe the high degree of interest of residents to detect technical priorities of intervention, especially when there are vulnerable people occupying the space. In their research, these authors found in dwellings in a social neighborhood in Portugal that more than half (55%) are over 61 years old, clearly demonstrating the aging of residents, and that they do not usually move and stay in same housing for decades (83% own and only 17% renters).

Regarding the social neighborhood, Patino and Siegel (2018) indicate that there is no universal definition of social housing, but consider, in the analysis of 49 articles related to the interior quality of the environments, that the increased exposure to bad qualities of spaces Housing interiors are a health concern to their residents as they are more vulnerable because of their age and economic condition. And they cite clear evidence in the literature on disparity in morbidity between nonresidents and residents of this less affluent housing type.

However, even though there are performance standards, decrees and laws regarding the quality of building construction as seen before, Pinto (2016) in his work on housing health noted that when a technical inspection was applied to several existing buildings under study, it was found that most of the cases showed non-compliance with the minimum requirements for approval, especially in relation to kitchens and sanitary facilities, and therefore were not able to be approved under the legislation.

The residents' perception regarding the anomalies found in the dwellings, Marcelino and Lanzinha (2017) also show that the residents can identify several points of

anomalies, such as moisture stains on the walls and ceilings, cracks, degradation, bad smell in the kitchen and toilets, noise from the building and the exterior, excessive high and low temperatures, lack of sunscreens and adequate air currents, even if in many cases they do not make the repairs or installations necessary to solve the anomalies for financial reasons or simply for convenience.

In the same vein, Kovats et al. (2003) analyzed articles on climate change from 1989 to 2002, and concluded that there is a need to raise awareness of the problem in all sectors of society, as they realized that the concept of health impact assessment of people is not yet incorporated into strategies or action plans in many countries.

Technologies capable of holistically integrating diverse disciplines such as Engineering, Architecture, Sociology, Anthropology and Economics, Arts and Leisure already exist (CIB, 2018), and can transform environments into intelligent buildings, which will favor the health and well-being of occupants, whether living spaces or workplaces, with resilience solutions, low energy use, meeting real human demands in every way.

Therefore, the standards of construction and the formation of the working professionals need to be broader and more rigorous, since in the case of a process that will attend people, social issues cannot be suppressed, as well observed by Assi (2002). This author shows that when residents often need to be part of the actions so that they can understand and accept proposed technical solutions, making the process continuous and circular rather than linear as previously seen. Thus, if solutions are of high quality, they will tend to be lasting, especially when it comes to serving people who are in increasing age and therefore increasing the level of demand and risk rating to which they are exposed.

Anand and Amor (2017) clarify that even with an extensive increase in studies on life cycle analysis of built environments, in the order of 929 articles published in the Scopus database between 2011-2015 alone, the subject is too complex and open to interpretation; because there is a difficulty in comparing the results due to different methodologies used by the authors. They will be able to analyze energy use, study site identification, building age, source and complexity of data, among dozens of other parameters, and if in a project or technology, the analysis considers it sustainable, it may not be in another one situation, if different aspects with behavioral parameters of its users are observed.

If every housing project, whether new or rehabilitated, considers these factors, and requires decision-making in favor of people's health, it will become a trend in indoor air pollution mitigation control strategy and improvements,

considerable in people's way of life. An intra-wall social gain that expands to society, as the building being properly cared for and with safe equipment (Fig. 4) and the neighborhood being valued will prevent the loss of cultural identity of cities (LANZINHA, 2014), improving the perception of security, diminishing areas of crime scene in many cities due to the abandonment of central areas by municipal administrators and the population itself.



Fig.4: Recent dwelling kitchen with safe equipment.

Source: Own authorship.

V. FINAL CONSIDERATIONS

Having observed this problem about the quality of housing since the satisfaction of basic requirements of habitability, and the respective need for analysis systems, control, and processes for updating the conditions of manufacture and use of these environments, it can be seen that an effective implementation may occur when there is a large amount of work related to the orientation and participation of users involved in the transformation of housing, associated with government incentives for investments necessary for a correct improvement of physical and constructive aspects, as well as personal behavioral changes related to the use of space.

Still, more effective support and oversight will be required to make the changes real and the results become visible both in people's quality of life and in their own perception, infecting them with confidence and willingness, making people feel the improvement in their health and well-being.

Still, a lot of research work will have to be developed on this theme, so that the parameters are better analyzed, understood, described and explained to those who will put them into practice with the areas involved. Areas include technicians, architects, engineers, designers, labor managers and the users of living space themselves, together with public administrators tasked with meeting the needs of urban growth involving economic, social, ecological, accessibility to transport, and from work to

leisure: minimum requirements for sustainable life in society.

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