

Normative references and instruments for flexible housing design in Brazil

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ABSTRACT: Housing design can play an important role in the promotion of a better life in the perspective of a more sustainable urban environment. Nevertheless, even though the advances in the regulatory context of civil construction in Brazil, the normative references and wide range of instruments applicable to housing developments have not been sufficient to guarantee design quality, particularly (but not only) of social housing. Those references and instruments do not fully incorporate the necessary requirements for enabling satisfying people-environment relations in housing and for the improvement of the quality of life of its residents, in particular those related to the buildings' capacity for change through adaptable and flexible spaces. In order to contribute to the integration of such values into housing design, the study identifies and revises the content of national and international norms and instruments of classification, evaluation and design management by normative and promoting institutes that present evaluating structures and quality indicators for housing design. The researchers conducted a comparative analysis and critical reflection over the identified data through the specific approach of considering and facilitating flexible and adaptable spaces, also identifying eventual gaps and opportunities for the improvement of such norms and instruments in further research development. Conceptual paths for a future framework of categories, requirements, criteria and design parameters are presented as an initial contribution to the design process of flexible housing in Brazil.

Keywords *Flexible housing. Normative references and instruments. Design process.*

1. INTRODUCTION

For a long time, the absence of quality in production of social interest housing in Brazil has been recognized and addressed under a variety of approaches in academic contributions (Morado Nascimento & Tostes, 2011; Kowaltowski & Granja, 2011; Sant'Anna Jr., 1990). The program of these projects ranges from the viability, efficiency and quality of housing solutions itself to the promotion of a better life from the perspective of more sustainable urban environment. In view of the factors involved, producing housing under the simplistic logic of the amount of low-cost units has implicated in damage to the residents' quality of life. Disregarding the necessary specifics and exceptions, private promotion for various income ranges either reveals concern with the necessary scope of qualitative aspects to contemplate, being guided by the market (Ornstein et al., 2011; Queiroz & Tramontano, 2009; Wilhelm, 2008).

It becomes necessary a stricter relationship between observation of everyday human life within the contemporaneous collective building and the urbanistic and architectural quality of its project. In that matter, being able to respond to the dynamics of uses and to current and future residents' needs and expectations is of crucial importance. Regarding the social-environmental aspect in cities, Du Plessis (2012) considers applying the concept of resilience as the ability to adapt to changes which, in turn, would depend on the diversity of uses and responses, borrowing from how ecosystems work. However, the potential for a process of change in the dynamic of uses, along with the gradual increase of the financial standard of households, is rarely considered. As a result, spontaneous interventions in Brazil's social housing, which lack design guidelines and professional technical assistance, have been causing energy and material losses and an increase in the construction and demolition waste, beyond compromising the soil permeability and the structural and environmental quality of these houses.

Around the world, performance standards, as well as methods and instruments of evaluation, have been gaining prominence, thus raising the complexity and responsibility of the act of design. Opposed to prescriptive standards, aimed at specifying components or details of construction with the use of specific products, the establishment of the performance of the built environment is structured through the definition of qualitative and quantitative criteria requirements, or assumptions, and evaluation methods that allow the measurement of compliance. In Brazil, especially the NBR 15575 (ABNT, 2013) and other normative references, in conjunction with the various instruments of classification, evaluation and management, make important counterpoint to the usually strict and technical standards and indexes of urban and architectural law required for project approval in municipal, State and federal spheres.

In this sense, the present study aims to promote a critical reflection regarding normative and non-normative materials, national and international, related to the design of housing developments, in order to point out possible paths to development of future conceptual framework, which promote consideration and facilitation of spatial flexibility in its design.

2. METHOD

Firstly, the study identified, reviewed and analyzed the content of norms and instruments for design classification, evaluation and management by regulatory and promoting institutes of housing developments in the country, which have evaluation frameworks and quality indicators. It included those prepared by the Associação Brasileira de Normas Técnicas-ABNT, Fundação Vanzolini-FCAV, Green Building Council Brasil-GBCBrasil, Caixa Econômica Federal-CEF, Ministério das Cidades-MCidades, among others.

Then, the study identified, reviewed, and analyzed the content of international norms and instruments, among which stand out those of the Department of the Environment, Heritage and Local Government-DEHLG, the Commission for Architecture and the Built Environment-CABE, the Construction Industry Council-CIC, the International Living Building Institute-ILBI and the United States Green Building Council-USGBC, among others.

A comparative analysis and a critical reflection of the data collected in the national and international spheres were conducted from the specific perspective of the consideration and facilitation of spatial flexibility. Gaps and opportunities for improvement of such standards and instruments were identified for future research development. Finally, paths were indicated for the development of a future conceptual framework.

3. NORMS AND INSTRUMENTS: SYNTHESIS, ANALYSIS AND REFLECTION

3.1 National norms and instruments

In order to promote livability, the NBR 15,575 (ABNT, 2013) proposes the requirement "Possibility of extension of the housing unit", among others relevant to the factor "Functionality and accessibility". For units on the ground floor and with an evolutionary potential, the standard requires the Builder to provide architectural design and complementary projects along with the user manual for operation and maintenance with instructions for the expansion of the building. The necessary construction details for connection or continuity of walls, floors, roofs and facilities must be specified. The AQUA Process (FCAV, 2013) sets out as environmental quality of the Building-QAE the capacity of the set of its intrinsic features to meet the requirements related to the control of impacts on the external environment and the creation of a comfortable and healthy indoor environment. Fourteen categories of QAE are separated in the main concerns associated with each environmental challenge, and then on requirements and performance indicators. The category "integrated Choice of products, systems and construction processes" includes the optional item "Flexibility of the housing unit after delivery", which requires that the design of the housing unit and the construction process allow the evolution and changes of use or distribution of environments.

The seal Casa Azul from CAIXA (John et al., 2010) inserts the criterion "design flexibility" as not required, within the category "design and Comfort". It recommends that the project present the ability for modifications or extensions in plants, cuts, views and details and alerts for consideration of the near surroundings, technical systems and structural efforts

without large financial and material costs. As illustration brings only two projects of the Chilean Office Elemental, and only one was built.

A social housing project contest for state of São Paulo requiring a certain degree of spatial flexibility was also identified. In order to explore and establish new typologies for social housing in the state of São Paulo, the Housing and Urban Development Company - CDHU promoted a contest of architectural project of new typologies for social housing (Government, 2010). The proposals were required to consider the possibility of expansion from two to three bedrooms in both single and multifamily housing types, but with no further guidelines for that matter.

Other national non-normative instruments provide contribution to the objectives of the research. Integrating a broader proposal of interdependent social and environmental sustainability with humanizing concepts, Barros (2015) highlights the consideration and facilitation of spatial flexibility in design as opportunity for adaptability to uses and people, as a support to life quality improvement without compromising environmental quality. Indicates the structural elements in the scales of building and housing implementation. Pereira (2015) focuses on the functionality and flexibility concepts as strategies that benefit the housing project, aiming to support contributions to NBR 15,575 (ABNT, 2013) based on requirements and criteria that meet users' functional needs.

3.2 International norms and instruments

The DEHLG (2009) has normative character and is an illustrated practical guidelines for project design starting at neighborhood, location and the housing scales. Criteria in three ranges have a greater or lesser degree of relationship with the spatial flexibility. On the criterion Adaptability, indicators include: learning from existing typologies; energy efficiency for the anticipated challenges by climate change; possibility of expansion of housing without prejudice to the character of its internal and external arrangements; structural system open character, that allow adaptation and subdivision; possibility of expanding coverage or garage.

CABE (2008) supports the analysis of the quality of design proposals using the criteria of the English standard "Building for Life". It consists of twenty criteria for quality housing design and design illustrations clearly demonstrate the proposed guidelines. It values aspects of the performance of buildings as well as the careful consideration of the context and the users in the process. Criteria specifically related to the subject of flexibility refer to: facilitate the addition, conversion and extension of houses; allow variety of uses for the environments; provide flexibility in the housing unit and its other combined areas; make possible the conversion of underutilized spaces for future use. Although LEED (USGBC, 2009) considers the matter "space flexibility" more directly for the design of health care facilities, the proposed parameters apply to the project of adaptable housing developments. The provision of interstitial spaces, "soft" spaces programmed for easy offset allowing for next-door expansion, spaces "without shell" delimited by the external cover and left unfinished, spaces for horizontal expansion and spaces with moveable inner walls and partitions.

Other international non-normative instruments provide contribution to the research objective. Coelho & Cabrita (2009) go into detail about the architectural criteria for

housing evolution and adaptability. They consider the adaptability and gradual improvement possibility for the dwellings, making possible for its own residents to become privileged agents, as fundamental for fitting these dwellings to different lifestyles and to autonomy and economy of interventions. Loureiro & Mateus (2015) analyze oversized homes built in the years 1970 and 80 on the outskirts of Braga in Portugal, in order to stimulate its densification. The authors propose ways of use and planning considering three different levels of intervention -- slight, intermediate and deep -- in addition to three levels of typological options. Forms of raising density are proposed from functional, energetic, bioclimatic, and aesthetical considerations.

Schneider & Till (2007) proposes questioning the ability of the building to be adaptable over time in the levels of design and construction. A rich variety of strategies and tactics are incorporated and illustrated through diagrams drawn from built examples. Durmisevic et al. (2011) present an inter-institutional experimental project developed for a multipurpose building with a transformative capacity at three levels: spatial, structural and material. They argue that in order to achieve the desired transformation capacity of buildings, it is necessary to develop a design for disassembly approach.

3.3 Comparative analysis and critical reflection

The international norms and instruments for classification, evaluation, and management of projects (DEHLG, 2009; USGBC, 2009; CABE, 2008) and also other non-normative references (Loureiro & Mateus, 2015; Durmisevic et al., 2011; Coelho & Cabrita, 2009; Schneider & Till, 2007) present elaborated structures of the technical possibilities to promote spatial flexibility, with concrete contributions to the objective of this research. These references associate the flexibility concept to the innate opportunity for adaptability, making it possible for different social uses, and go into detail about the levels of a required embedded capacity for transformation in its design and construction. They illustrate strategies and tactics using diagrams from built examples and characterize different levels of intervention aiming the densification of the existing environment.

The analyzed national normative materials describe the possibility for flexibility of housing as an optional item and do not draw the principles that could foster new possible solutions from built examples of housing. ABNT (2013) considers only the possibility for expansion of one-story and two-story housing units. FCAV (2013) highlights the importance of constructional processes that allow for the evolution and change in use or in spatial distribution. ABNT (2013), FCAV (2013) e John et al. (2010) points out the need to consider the implications in the structural, electric and hydraulic systems and in the ventilation and natural lighting of spaces to be expanded or modified. Government (2010) only requires the possibility for expansion from two to three bedrooms. Housing design competitions in state of São Paulo eventually promote the possibility for flexible or expandable spaces, but in those initiatives there is a higher concern regarding lowering the costs and increasing the construction scale (Barros, 2012).

In this sense, the perspective shown in the analyzed national materials is here considered very limited in comparison to the challenge of improving the quality of social housing design in Brazil towards a higher level of sustainability.

4. PATHS FOR DEVELOPMENT OF CONCEPTUAL FRAMEWORK

The comparative analysis and critical reflection about the normative references and applicable instruments identified the possible pathways for the development of a conceptual framework for flexible housing design. Given the limited perspective identified in national materials, the pathways presented and illustrated below were drawn mainly from international references. These pathways are complementary and make up working axes. The project guidelines included are not ready-to-use solutions and require the compatibilization of different local realities of people and places.

4.1 Site planning structural elements

It is necessary to consider the importance of housing unit types concerning exterior openings (Fig.1a) and its location in the lawn (Figs 1b-1c), which allow for expansions in single and multifamily typologies.

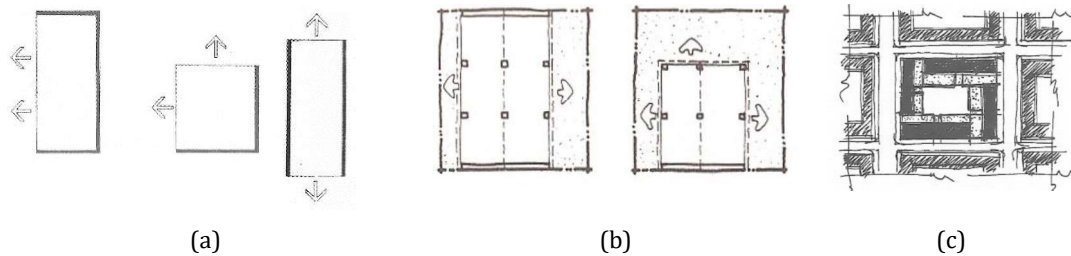


Figure 1: (a) Housing types: number of sides facing outside; (b), (c) Dwelling location in the lawn: expansions in single and multifamily typologies. Source: (a) Sherwood (1994, p.3, 17); (b) Hamdi (1991, p.98); (c) Coelho & Cabrita (2009, p.299).

The proportion between width and depth of the lot has impact on the possibilities of different internal arrangements and of expansion of the housing unit, the individual variety, the quality of natural lighting and ventilation, privacy and contact with the yard. Narrow and long lawns (Fig.2a) limit the mentioned aspects, whereas wide and short lawns (Figs 2b-2c) facilitate these possibilities.

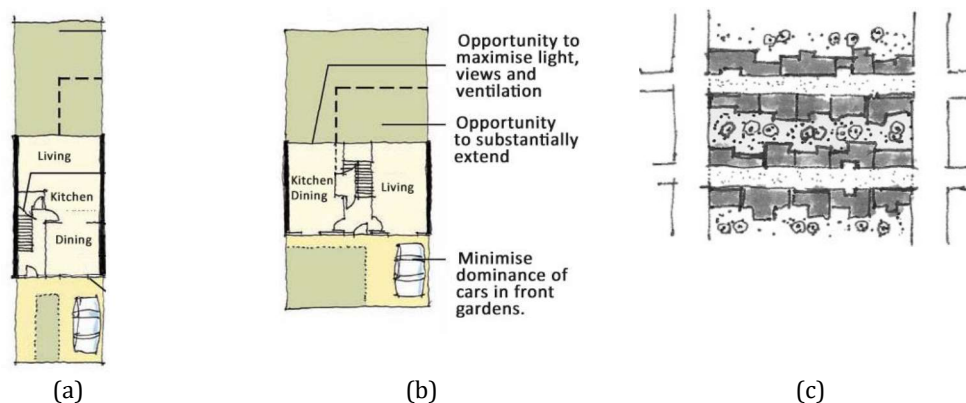


Figure 2: Proportion between width and depth of lawns: (a) narrow and long lawn, (b) and (c) wide and short lawn. Source: (a), (b) DEHLG (2009, p. 71); (c) Barros (2015, p. 1968).

It is necessary to consider the importance of infrastructure for movement and access of people to buildings composed of housing units and its impact particularly on the possibilities of expansion. Single-family buildings with individual access (Fig.3a); multifamily buildings with vertical collective access and horizontal runways (Fig.3b) and multifamily with collective access by internal corridors (Figs 3c-3d).

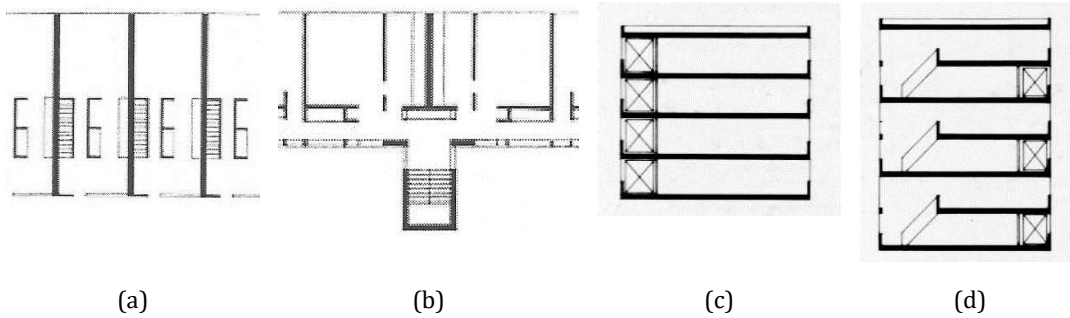


Figure 3: Access and movement in single-family typologies (a) and multifamily (b), (c), (d). Source: Sherwood (1994, p. 17, 19).

4.2 Design ability to eliminate inflexibility

The provision of spaces with an adaptive capacity concerning the possibilities for flexibility and expansion starts with questioning the ability of design for adaptability over time (Figs 4-5). The central issue is about uses. How to design with the appropriate degree of flexibility to accommodate current and future users' needs and aspirations? Design can eliminate the inflexibility of the housing environment through typological studies.



Figure 4: (a) neutral environments for different uses; (b) Usable Attic: adequate ceiling height and structural system. Source: (a) Schneider & Till (2007, p. 189); (b) Hamdi (1991, p. 99).

It is necessary to consider the capacity of the future building to promote a potential for expansion. The typology modalities require specific planning from conception through construction project. It is necessary to consider the structural reinforcements, quality assurance of the inside environment, attention to standards of fire safety and consistency with the surroundings, especially regarding horizontal additions. Different typology modalities may facilitate space use by residents through horizontal and vertical additions (Fig.5a), terrace additions (Fig.5b), penthouse or garage additions (Fig.5c), considering isolated housing units or conjoined ones.



Figure 5: (a) vertical and horizontal additions; (b) terrace additions; (c) penthouse additions.
 Source: (a) Barros (2015, p. 1969); (b), (c) DEHLG (2009, p. 71, 73).

4.3 Construction ability to eliminate inflexibility

Constructional strategies enable the implementation of spatial flexibility. They include disassembly and interchangeability of constructional elements, inside movable screens and the service modules, for electrical and hydro-sanitary installations (Fig.6).

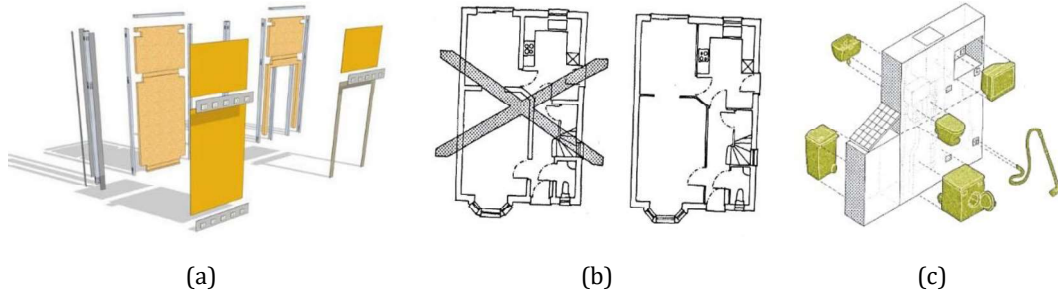


Figure 6: (a) Disassembly and interchangeability; (b) Inside movable screens; (c) Service module.
 Source: Durmisevic et al. (2011, p. 52); (b), (c) Schneider & Till (2007, p. 196, 197).

4.4 Levels of intervention for the densification of existing housing

It is necessary to consider the different levels of intervention to support the densification of existing housing without compromising the quality of the internal environment. Level 1 (Fig.7a) admits slight changes with the definition of a new fraction and maintenance of existing typology. Level 2 (Fig.7b) admits the division of area for the addition of one or two fractions, depending on the area available and the existing layout, with restructuring of interior spaces. Level 3 (Fig.7c), with extensive changes, admits the addition of new floor and the division into two or three fractions independently besides changes in order to create areas of double ceiling (Loureiro & Mateus, 2015).

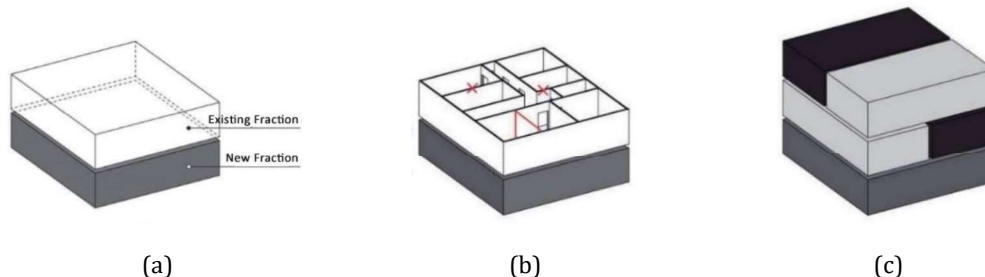


Figure 7: Levels of intervention: (a) Level 1-Slight, (b) Level 2-Intermediate, (c) Level 3-Extensive.
Source: Loureiro & Mateus (2015, p. 921).

5. CONCLUSION

The study offers an initial contribution from normative references and applicable instruments, along the lines of performance standards, under the specific focus of the promotion of spatial flexibility in design. It emphasizes the necessity of improvement of the design process for social housing in Brazil. The study interposes the contribution and contrast of normative and non-normative material, national and international, related to the design of housing developments, in order to promote a critical reflection and show the way for the development of a future conceptual framework.

The study synthesizes the content of norms and instruments of classification, evaluation and design management from regulatory and promoting institutes for housing developments in the country and abroad and offers a comparative analysis and critical reflection with regard to the topic of space flexibility. It identified gaps and opportunities for improvement with a view to the possibility of considering and facilitating spatial flexibility in the design of housing developments. From these gaps and opportunities, complementary paths to the development of a conceptual framework were outlined.

This set of results obtained from Leo (2016) contributes to the achievement of the goal of a broader research in which the identified paths will be matched in a conceptual structure of categories, requirements, criteria and design parameters, along the lines of performance standards. Such a structure, open and dynamic, aims to promote the integration of requirements for the generation and evaluation of solutions in the conception of housing projects in the country with regard to the possibility of considering and facilitating spatial flexibility in your project. Additionally, it is necessary to establish scenarios, which may facilitate the implementation of constructional processes for flexible social housing in Brazil, signaling possible future research developments.

The authors are thankful to the Conselho Nacional de Desenvolvimento Científico e Tecnológico-CNPq for the financial support (Institutional Scientific Initiation Scholarship Program-PIBIC).

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