Characterising Brazilian Housing through an Investigation of Policies, Architecture and Statistics

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Defining common housing characteristics such as typology, floor areas and occupancy rates can be challenging in many countries because of the prevalence of self-built and/or self-promoted accommodation. Yet, for researchers, designers and policy makers, the understanding of these is crucial. Brazil is one of those countries where, despite the fact that the housing sector represents more than one third of the entire construction sector, houses' characteristics vary hugely across the 57 million units that form the existing stock. This variety, mostly a reflection of policies, architectural influences, site restrictions, financial limitations and irregular planning, is not easily documented. In this paper, the authors attempted to bridge this gap through an investigation of housing policies, architectural practices and statistical information, which allowed an identification of predominant dwelling types, sizes, occupancy density and stock availability. These were compared with other cities around the world in order to better contextualise the issue. The findings demonstrated that typological patterns can be found, such as rectangular plans, overhangs, small to medium-sized windows and design simplicity, and this is somewhat influenced by local architecture traditions and consolidated by housing policies.

Keywords: housing; typology; housing stock; housing trends; housing policies; architecture

Introduction

Brazil, the largest country in Latin American, has commonalities with its neighbours but also very particular characteristics, as a result of its ancient local culture, colonisation by Portugal, widespread historical slavery, and immigration primarily from Europe, East Asia and Middle East [1]. These differences are translated into the architecture and,

particularly, the housing.

Characterising Brazilian housing is therefore a complex task due to the mixture of influences in addition to the self-built and/or self-promoted character of the sector. Nevertheless, this characterisation is of great value to researchers, designers and policy makers, and can contribute to the preservation of the culture and support the delivery of better homes.

The housing sector in Brazil represents almost 2% of the national gross product [2] and had an estimated stock of 57.6 million units in 2010 [3]. By 2017, the national new home sales market had increased by nearly 30% compared to the previous period (2012 statistics) but had started to experience a downturn from 2015 [4] due to economic factors, rise of unemployment rates, high interest rates and mortgage budget cuts. Household debt in the country corresponded to 55.5% of the net disposable income in 2016 [5], and Brazilian households spent over 20% of their annual gross disposable income on housing [6]. Despite the economic importance of the sector, and its obvious impact on quality of life, limited information is available on the characteristics of Brazilian housing.

Housing availability and characteristics in Brazil vary enormously across different economic classes. The economic classes in Brazil can be classified as ranging from A to E according to the monthly income range. Economic class A and B are upper economic classes, C corresponds to middle class and D and E represent lower economic classes. Over 60% of the national population is composed by middle-class households, nearly 25% is composed of low-income households and 15% corresponds to upper-income households [7]. Low-income households are those that suffer the most with the shortage of houses estimated to be nearly 6.2 million of housing units [8]. Low-income

and low-middle-income households together constitute 96.6% of the total urban housing deficit [9].

Limited information about the characteristics of Brazilian homes can be found in existing literature. The authors present here a characterisation of Brazilian housing, supported by literature review on policies, different architectural influences, and statistical data analysis. This work is an effort to overcome the gap in housing studies with a focus in Brazil. It is important to mention that, it was not the scope of this work to investigate informal housing such as slums and squatting, as these are covered by a consolidated body of research in Brazil [10].

The vast body of housing-focused literature [11] does not adequately cover architectural design quality [12]. There has been a gap in studies that focus on housing statistics, design and characteristics, especially, those that include middle-class homes. Middle-class homes account for most of the Brazilian homes but are generally excluded from research due to the lack and/or inaccessibility of information. This work particularly covers this gap. The existing literature leaves room for studies on minimum housing sizes [13], specially associated to affordable housing, and this is also covered here.

Method

Two main methods were used to develop this work. Firstly, a literature review was conducted with the aim of creating the basis of this investigation. This included housing policies and architectural design practices. Secondly, a variety of statistical information from various sources was analysed. Three main aspects were the primary focus of the analysis: type, size and occupancy. These two methods were cross-analysed to generate the discussion that follows, and to draw conclusions with respect to stock availability, trends and housing demand.

Results and Discussion

In this section, the results are presented in the form of a discussion under the headings policies, type, architectural practices, size, occupancy and existing stock, which progressively will be building the knowledge in Brazilian housing. This reflects the cross-relation of knowledge acquired from the literature review and the statistical analysis. When relevant, knowledge was drawn from studies in other countries for comparison and contextualisation.

Housing Policies: have they influenced the way occupants inhabit?

In Latin America, most of the housing policies are developed at national levels – in Brazil, this is not different [14]. The reason why this is mostly treated at national levels is because policies are generally dealt within the national government programmes, leaving little autonomy for municipalities and states.

In Brazil, the study of national housing policies is fundamental because they have helped shape the housing sector for low- and middle-income households. This section aims to sum the most important historical housing policies.

Shaping housing ownership and self-promoted construction

First interventions of the government on the provision of housing date back to the 1930's. This was described in-depth in the study *Origens da habitação social no Brasil* [15]. Most of the housing properties were rented in the 1930's. In the city of Sao Paulo, one of the largest southern Brazilian cities, 90% of the population were estimated to be tenants [16]. In 1942, the national government froze the housing rental prices for economic and political reasons. As a result, many householders were progressively evicted in an attempt of the landlords to raise their rents as per new contracts being drawn or due to a change in use of the property [17]. The outcome of this policy was the

discouragement of private investments on the housing market and the consolidation of a peripheral urban growth, where the residents themselves build their homes and also the emergence of the appropriation of privately owned land (*slums*) [18]. The Decree Law 58 of 1937 [19] was created to regulate the acquisition of plots and promote the ownership of land, facilitating self-built and self-promoted housing. At the present time, home ownership is the predominant tenure in the country and it represents 73% of the housing stock in comparison to rented and ceded properties that account for 18% and 8% according to 2010 Census, respectively [20].

Other housing policies were also implemented at the same time. Popular Housing Foundation (*Fundação da Casa Popular*), created in 1946, was the first institution set up to promote low-income housing. Institutes of Retirement and Pensions (IAPs) (*Institutos de Aposentadoria e Pensões)*, created in 1937, invested in financing housing with the use of pension funds for different income ranges. IAPs promoted housing by either in the form of rent for their associates or financing of house construction but, from 1954, these investments focused on higher classes to guarantee the rentability of the funds [21]. The IAPs were responsible for introducing the standardized multi-family residential building typology that, by that time, in Brazil the predominant typology was single-family residences [22].

Building more but at lower quality: Banco Nacional de Habitação (BNH) and Minha Casa, Minha Vida (MCMV) Housing Programmes

Two housing programmes are comparable in Brazil due to their scale and significance. The BNH, created in 1964, financed housing for just over 20 years, ending its activity in 1986 [23]. MCMV, launched in 2009, is the current national housing programme. Other housing programmes were launched between these two programmes, linked to different presidential mandates, but they had less impact, life span, lacked a coherent housing

policy [24] and were decentralised [25]. These were also promoted at municipal and state levels through housing funds, but most schemes were short-lived and targeted more specific issues [26].

Set up by the military governments, BNH produced 4.3 million new housing units in over two decades and it had its policy aligned with the promotion of the ownership [27]. One of the main criticism attributed to BNH was that it overlooked the construction and acquisition of homes for very low-income households because it had no subsidies to social housing: all the financing being based on returnable resources from mortgages [28]. The housing units were built through housing companies or cooperatives contracting construction companies through bidding and offering it to the householders through mortgage loans. In comparison to the IAPs, those dwellings developed under the BNH housing scheme were of lower quality with smaller spaces [29]. It adopted standardized solutions with no consideration of urban, social and climate contexts [30].

MCMV built more than 3 million housing units so far [31], 1.7 million units were built between 2011 and 2014 [32]. MCMV pairs up credit access to low- and middle-income households with construction incentives to developers intended for households meeting certain minimum wage thresholds [33]. Design-build contracts are the basis of the MCMV programme, in contrast to the BNH programme, where design-bid-build contracts were the norm [34]. Housing construction companies are the main promoters of housing in the MCMV programme, whereas in the BNH programme the main promoters were the housing cooperatives.

In terms of design, research has shown that the monotonous repetition of design models adopted by previous housing policies (since the BNH) were not revised across decades, and this should be assessed against households' changing needs [35]. Innovative

design approaches to these housing models are encouraged as well as improved housing quality standards [36].

Research on the desired values of MCMV householders has suggested that a higher number of rooms and larger residential units have been listed as a considerable degree of importance on buildings for low-income householders [37]. The adoption of transitional spaces on the units and construction of different apartments types according to the family needs would also have a positive impact to the householders [38]. Research has shown that changes to repetitive housing design, considering additions to homes, are valued and should be participatory [39]. There have been various design studies that have attempted to stimulate this process by promoting step changes to housing growth according to the needs of householders [40].

Unfortunately, studies conducted on MCMV have suggested that although there has been a strong body of research on this subject, they have had limited impact on promoting positive changes to the design of low-income housing and policy [41].

Type: is there a predominant housing type in Brazil?

Form, space configuration and materials are key aspects of the characterisation of housing and an attempt to interconnect these elements is made as follows.

Form

According to 2010 Brazilian Census, 86.5% of the households live in detached homes and 10.6% of them live in apartments [42]. One of the reasons for the large number of detached houses among the national housing stock is due to the fact that housing construction in Brazil is mostly based on self-promotion. For low-middle income classes, this means that plot owners build their own house due to cost constraints, usually with the help of a contractor and unskilled workers [43], well documented for

example in Lara [44]. For lower economic classes, these dwellings can be built in a plot not owned by their families, although the informal market is not the focus of this investigation. Among the higher economic classes, plot owners build their own bespoke houses to suit their requirements and the houses are often constructed with the help of accredited architects and/or engineers. Apartments and condominiums (of both houses or apartments), on the other hand, tend to be built by developers and are often targeted at specific economic classes. For this reason, it is easier to find data on them as this is used to produce statistics and to inform developers about the economic potential of further developments.

Two-bedroom housing accounts for 45.2% of the overall Brazilian housing stock [45] whilst one and three-bedroom housing account for 29.2% and 21.8% of the stock, respectively [46]. One or two-bedroom houses are predominately for low-middle economic class households, whereas two or three-bedroom houses are mainly for high-middle class households [47].

The typical low-income house is easily identified as it comprises mostly houses financed or provided by the Brazilian government built to a repetitive pattern. These are usually four-storey apartments [48] or one-storey detached house typologies [49], but in both cases, they comprise a two-bedroom one-bathroom home (Figure 1)[50].

The predilection for building detached houses rather than apartments for low-income households dates back to the period of Brazilian dictatorial government, from 1930 to 1950, and were integral to the housing policies. Single-family detached houses were supposed to help control the population behaviour, as they limit interaction with other people when compared to multi-family typologies [51]. Nowadays, apartments are more common in cities with higher population density due to the availability and cost of the land.

Space Configuration

Low-income housing size is set to an area of at least 58 square meters as per NBR 12721 [52], distributed along kitchen, living room, two bedrooms, a bathroom and a tiny laundry area. However, its size can be as small as 36 square meters [53] (Figure 1).

Middle-income typical housing size varies considerably because this is mostly self-promoted, which makes its characterization very difficult. For this income range, apartments and houses are also commonly found. Data from Brazilian standard 12721 [54] shows that houses for this income range are usually three-bedroom two-bathroom homes (one being an en suite), including a small service area with a service bathroom, and built area over 100 square meters. The houses also vary in terms of the number of floors, being mostly one to two-storeys. This is discussed in more detail in the next section.

Independently of the income range, Brazilian housing seems to follow a similar spatial configuration as suggested by Anitelli and Tramontano [55]. This is highly influenced by the size of the house, its economic level and its construction period. Normally, the entrance of the house is directly connected to the living room spaces, keeping the social and service areas separated. In addition, it is common to see two entrances, one designated as social and the other for services. Another peculiarity commonly found in Brazilian houses is the availability of employee facilities, accessed through the service entrance. These facilities are a remnant from past practices, when householders were likely to have an employee working during the day in their houses or even as lived-in employees. Its origin goes back to the slavery period [56]. Employee facilities have undergone a social transformation in the dwellings, but no longer than three decades ago these facilities used to comprise a small bedroom and bathroom. In

more recent years, however, these arrangements have less common or reduced, even in high standard houses.

Research suggests that contemporary multi-family residential buildings are still based on a tripartite layout, segregating intimate, social and service areas [57]. As a consequence of this approach, layouts are mono-functional, restricting changes in use and activities [58].

Materials

The homes in Brazil are mostly built on-site by unskilled labour [59]. Most of the industrialised materials used are standard such as bricks and blocks, cement, aggregate stones and wood – very little is prefabricated [60]. It is estimated that 90% of the national housing stock is built using masonry and 80% of these are coated and painted [61]. The most typical masonry walls in Brazil are built out of ceramic bricks covered by mortar [62]. The roofs are mostly built out of ceramic roof tiles and the window frames are found in different materials such as steel and aluminium but are more commonly in timber.

A study conducted in southern Brazil [63] suggested that low-income housing is mostly built with masonry or timber walls, fibre-cement or ceramic roof tiles and aluminium, iron or timber window frames. Low-middle-income housing uses a wide range of materials similar to low-income housing, although the masonry is mostly made out of ceramic brick and blocks. Middle-income housing is predominantly built out of ceramic roof tiles, timber window frames and conventional masonry walls.

Architectural Design Practices: Are there predominant characteristics in the Brazilian houses?

It seems relevant to contextualise the architecture that is discussed in this section and how this impacted on the characteristics of the Brazilian houses over the centuries. The

appropriate term to designate this architecture seems to be ’popular’. The term aims to reflect the mixture of influences of the Brazilian architecture that combines the indigenous influence, the architecture developed by non-trained people in both rural and urban contexts and the Western European erudite influence, as result of the colonization and immigration processes. Three main terms emerge in the discussion of this architecture - vernacular, traditional and popular.

Vernacular architecture reflects place-related identity. It is developed to meet specific user needs, is climate-responsive and is practically immutable [64]. The term is, however, more appropriate in countries where the built environment is more homogenous [65]. For the Brazilian context, its use seems to be more pertinent to describe the indigenous architecture, prior to other influences in the country.

Similarly, traditional architecture is the one that tenaciously prevailed in a region, slowly modified over time, transmitted from generation to generation [66], whose elements are of popular acceptance and appropriation [67] and a reflection of social customs and beliefs. It is influenced by the environment with regional variance in response to specific conditions (e.g. materials can differ for a same building construction type) [68]. It is disseminated outside the boundaries of what is considered proper architecture (erudite) [69] and developed by largely non-architects, based on common heritage and sense [70].

Weimer [71], however, discusses that a more suitable term to designate the Brazilian architecture would be ‘popular’. Its etymology is linked to the Latin term ‘*populus*’, which designates what comes from the people, excluding then the high-income architecture – the erudite architecture – and, the very low-income architecture, such as *favela* (slum). Yet, Noble [72] also establishes that the term ‘popular’, as

encompassing elements of traditional buildings with some erudite and stylistic architecture influence [73].

The authors acknowledge that the term ‘popular’ has a broader meaning that comprehends the traditional architecture, developed by the whole people and influenced by the environment, culture, common sense and beliefs, and also the erudite architecture influences, which were incorporated into the traditional Brazilian buildings to some extent. Then, this term is deemed more appropriate in the Brazilian context and it corresponds to the type of architecture described in this research.

In Brazil, even within the same economic class, the characteristics of homes can vary greatly. As mentioned before, one of the reasons is due to their self-promoted characteristic but this is also due to the diversity of architectural influences. Even though the Brazilian housing characterisation is not well-defined, some patterns can be seen in the architecture of the Brazilian homes, mainly at regional levels, which helps characterise the national housing.

Brazilian housing architecture is very distinct throughout the country and specially between north and south, mostly due to climatic differences and the nature of land occupation [74]. Northern Brazil, located in warmer climate, was occupied earlier than other parts of the country by the Portuguese and remained mostly dominated by this influence. In contrast, southern Brazil, which has milder climate, was occupied later through migration at the beginning of the nineteenth century, mainly by Portuguese, Germans, Italians, Poles and Japanese immigrants [75]. This resulted in a mosaic of regional diversity [76].

The indigenous architecture, developed in the northernmost and warmest areas of the country, explored the use of high ceilings and permanent cross-ventilation for thermal comfort purposes. Vernacular dwellings in the Amazon region are mostly stilt

houses to ensure better ventilation and are built of materials sourced from nature such as wood, palm straws and natural ropes [77]. Even traditional town houses, located in the northern areas of the country, exploited these same principles through the use of pitched roofs to moderate the indoor temperatures and low internal partitions in order to allow for permanent cross-ventilation. These characteristics are illustrated in the book *Encyclopedia of Vernacular Architecture of the World* [78].

The use of verandas is also common in Brazilian architecture, being mostly employed in the northern architecture during the colonial period but also appearing in different ways across the country. Verandas work as shading devices and protect the facades from sun and rain, but also as an intermediate space between outdoors and indoors [79].

Brazilian architecture shows that the openings appear mostly in small and medium sizes, usually covered by shutters. Shutters are found in most of the Brazilian houses and are used for privacy and as a shading device. Solar radiation is high throughout the country and these shutters are an effective strategy to totally shade the windows when desired.

Overhangs are also used extensively in Brazilian architecture. They have been employed to protect the facades and to control solar radiation entering the building. Houses in the region of Sao Paulo, the most important and populous city in Brazil, were made out of thicker walls of *taipa-de-pilao* combined with long roof overhangs for wall protection [80]. Large overhangs are more popular in southern Brazil due to sun's position and rain protection and for the same reason are less common in northern Brazil.

Interestingly, according to Weimer [81], despite the mixture of influences, Brazilian houses consisted basically of two main typologies: the house of the Portuguese colonizer (and its evolution over the centuries) and the house of the black

African slave immigrant (Figure 2) [82]. Even though the house of the colonizer presented a variety of different plan configurations as per site, region, cultural influences and social status, the facades tended to follow a formal rigorous pattern and doors were mostly connected to the living room areas. The number of bedrooms varied according to the size of the family and their financial conditions. Symmetry was adopted and linked to colonising practices rather than to traditional architecture. Two-storey houses were prioritized rather than one-storey as one-storey house was more associated to poverty. The African immigrants, on the other hand, contributed to the simplicity of house constructions; the main characteristics of homes were their reduced size, double sloping roofs and frontal access. Roofs were covered in natural materials and, later replaced by ceramic tiles [83]. Windows were generally limited size, but some of the houses had no windows at all, following original African housing practices. The most common house was detached, with the existence of one or two doors, depending on the kind of African influence and its degree of development. Generally, each room had its own small window, independently of its size. The size of the eaves and the existence of verandas also varied according to African influences. Commonly, in Brazil, these African styles houses were built in rectangular or square floor plan shape.

The division made by Weimer [84] somehow connects the house of the Portuguese colonizer to the current Brazilian middle-income dwelling through its variety of configurations, number of storeys and more complex facades. Similarly, the black immigrant house is linked to the low-income dwelling through its simplicity, roof type, limited windows size, single-storey and rectangular plan. Both influences are found in current Brazilian architecture, although they vary according to household economic levels.

The existence of two main housing typologies of the Brazilian colonial period is corroborated and extensively described in the book *Sobrados e Mucambos* (*The Mansions and The Shanties*, in its English version) [85]. The mansions were urban buildings of two or more floors depending on site conditions, with the use of verandas and balconies and built out of granite stone (some in bricks in Bahia and Rio de Janeiro or rammed-earth in Sao Paulo), owned by rich families or those families that had acquired wealth. The use of durable materials (tiles, brick stones, steel) was preferable for these buildings instead of directly sourced natural ones. The construction of housing with more than one storey was also preferred. These features follow the style of housing described by Weimer [86].

The mansions' architectural space configuration consisted of large well-ventilated living room at the front end, with the other domestic spaces usually less well-lit at the rear. The space configuration and construction materials, emphasized by social and culture aspects of the period, prioritised privacy and sun protection, through the installation of a particular type of wooden shutter, that tended to darken the interior spaces.

'Shanties' were a form of housing built out of straw, some with two to three layers of thatch roof, inhabited by members of the black community and mixed-race populations (miscegenation of either black or indigenous people with European people) [87]. Its origins are linked to African as suggested by Weimer [88]but also to indigenous and to Portuguese people (reference to the Portuguese shack). They had regional differences across the country in terms of the materials employed and their main cultural influences.

Table 1, produced by the authors, shows a summary of the main house characteristics identified and investigated in this research according to different income

ranges. High-income houses are not part of this investigation as they account for less than 15% of the national houses. [Table 1 near here]

Size: is there enough space to live in?

Despite the fact that the Brazilian standard NBR 12721 [89] gives an indication of the expected average size of houses across the country, according to their economic standard, the real floor area of houses tends to be much smaller than those values stated by the standard. Data collected in two main Brazilian cities, by two different organisations dealing with construction research, shows that the average size of houses is in fact smaller than expected and has been progressively declining (Figure 3)[90].

A precise value of the Brazilian average housing size is difficult to establish, mainly because there is a lack of data at national level and a lack of uniformity in the data found at local level. The available data focuses on new commercial developments (i.e. new housing units that are built to be sold, not including self-promoted houses or social houses). Therefore, this data covers mostly the private market of middle-income housing.

In Sao Paulo, the average new housing size was estimated to be 83.56 square meters in 2016 [91], 71.96 square meters in 2015 and 87.46 square meters in 2014 [92]. Two-bedroom housing was more popular in 2016, followed by three-bedroom and one-bedroom housing, respectively. The average area per number of bedrooms was estimated to be 36.16 square meters for one-bedroom housing, 51.91 square meters for two-bedroom housing, 83.74 square meters for three-bedroom housing and 168.99 square meters for four-bedroom housing or bigger [93].

In Porto Alegre, one of the most important cities in southernmost areas of the country, the average new housing size was estimated to be nearly 85 square meters in 2016 and this was the largest value registered since 2010 [94]. Two-bedroom flats were

found to be the most common housing typology built, followed by a three-bedroom flats [95]. Three-bedroom houses were mostly built followed by a two-bedroom housing typology between 2010 and 2015, and by a four-bedroom configuration in 2016 [96].

In comparison to European dwellings newly built since 2000, Brazilian dwellings are smaller (Figure 4)[97]. Only a few countries such as United Kingdom and Italy are building similar average new dwelling sizes when compared to Brazil, around 70-80 square meters. The vast majority of the European countries are even building larger than their own existing housing stock of 80-100 square meters [98] and the size of new dwellings are predominantly over 100 square meters. The average new dwelling is nearly 120 square meters in Germany, Netherlands and Spain (Figure 4). It should be stressed that European countries had massive influence in southern Brazil, especially the Portuguese, Italians and Germans.

Research on housing spaces [99] suggested that the reason why most of the countries have bigger new dwellings than previously is that they now have standards that set minimum floor areas. In those countries where the standards have not set minimum floor areas, studies suggest that housing spaces have got worse.

In Brazil, there is no standard to regulate minimum housing spaces, and this is certainly impacting on the quality and size of housing spaces built. The only available guidance is the standard NBR 15575-1[100] that suggests that domestic rooms should accommodate the minimum furniture in the corresponding space. For example, the master-bedroom should fit a double bed, two small tables and a wardrobe and there is no provision of furniture for any other function such as for studying. For the second bedroom, a study desk is mentioned as part of the furniture, but its adoption is non-mandatory.

There are some attempts to develop minimum living alternatives by adopting flexible spaces with built-in furniture at inner areas of the large cities (examples are found in Porto Alegre and Sao Paulo). Even though there has been a criticism whether the size of these house units is appropriate, this proposes new paradigms of living at modern times, allowing living at central neighbourhoods, near to the services while affording the cost of living (Figure 5) [101]. These buildings also propose changes on the use and occupancy of spaces with the overlapping of uses, adaptable/folding furniture and the share of communal areas and office spaces. Their impact on the householders and their acceptability on the real estate market are relevant and should be further investigated.

However, the limited size of homes tends to reduce the usability of the rooms for multiple functions such as resting and studying at the same time as there is not enough space to allocate extra furniture [102]. Research has shown that the multiplicity of uses and overlapping of functions have been neglected on housing developments, and only the primary 'functionality' of rooms has been considered (e.g. bedroom to sleep) [103]. Low-income householders are those who suffer the most with poor housing space standards, as the homes are designed using minimal internal spaces that are compartmentalised and have little flexibility for enable different life-styles in the future and therefore new furniture configurations [104].

Research on Brazilian dwellings for low-income households undertaken in southern Brazil [105] shows that minimum areas of Brazilian dwellings varies according to the rooms, their function and layout: a master bedroom is estimated to be around 9-9.5 square meters; a second bedroom is estimated to be about 8 square meters; a living room is estimated to be 10 square meters, mainly when it corresponds to an open space area, combined with a dining room; a kitchen is estimated to be at least 5 square meters

but it depends on the household appliances and the space configuration; a bathroom is estimated to be 2.5 square meters. Nevertheless, the real problem is that these limited areas are associated to a high occupancy rate of the houses, a common problem particularly in low-income households. This is discussed in the next section.

Occupancy: are Brazilian houses too densely occupied?

Many countries have initiatives to regulate minimum space requirements according to the occupancy and housing type. In the United Kingdom, minimum space standards do not currently exist at national level but minimum space requirements have been introduced by the Greater London Authority [106] and are applied to new houses built in London to ensure minimum functional spaces. The guidance correlates minimum area for new houses with housing type and number of occupants that each home is designed to accommodate. Examples are show in Table 2[107] and this is cross compared with available data from Brazilian housing already mentioned in this paper. [Table 2 near here]

For example, a typical two-bedroom low-income Brazilian house is 36 square meters for an occupancy of three and four people, whilst the London benchmark of minimum housing space standards would suggest a minimum area between 61 and 70 square meters [108], the double of the Brazilian area. Interestingly, a study by RIBA [109] has suggested that the average new home in England is only 92% of the recommended minimum size and therefore still considered too small.

These statistics indicated that Brazilian dwellers should be aware about the houses that have been delivered and this leads to question whether some new homes are fit for purpose and whether they meet the space needs of the households. Adequate spaces are a pre-requisite for basic living and homes must offer functional and adaptable

spaces that meet the needs of families, children, older people and disabled residents, with enough room for residents to cook, eat, relax, store and socialise [110].

Data from 2010 Brazilian Census shows that the average number of persons per dwelling unit corresponds to 3.3 [111]. 3.3 is actually equivalent to European dwellings occupancy in the 1960's [112]. Trends in the housing sector show that the average number of persons per dwelling is expected to decline to 2.5 by 2030 [113]. In addition, the predicted occupancy of 2.5 persons per dwelling for 2030 in Brazil is still higher than in European countries in 2011 when the occupancy index per dwelling corresponded to 2.4 [114]. One of the drivers for this reduction on occupancy per dwelling in European countries is an increase in the number of single occupier households [115]. In Brazil, the trends on the reduction of the occupancy per home are linked with the availability of new houses, reduction of the housing deficit and the increase of household's income.

The occupancy per dwelling in Brazil is high mainly due to the high number of low-income homes, which are more likely to be overcrowded, and the vast number of people in poverty, which was estimated to be 8.7% of the population in 2015 [116]. Many low-income households live in a cohabitation situation, in which more than a family live in the same house. Cohabitation is critical in Brazil and it affects approximately 4.3 million households [117].

Research undertaken in the 1990's [118] suggested that low-income dwellings had an occupancy rate of 13 square meters of floor area per person, considering one-storey two-bedroom house with a built area between 41 and 46 square meters and an occupancy of four people. However, current trends in these homes show that the occupancy rate can reach a maximum index equivalent to 9 square meters per person when considering a two-bedroom detached house for a family of four people, based on a minimum area of 36 square meters accepted by the national social housing programme

[119]. Current practices deliver an occupancy rate under 9 square meters per person, which is indeed less than the minimum requirement of 12 square meters per person suggested by the former BNH, responsible for regulating the housing financing in the 1970-1980's in Brazil [120].

The Brazilian occupancy rates of low-income dwellings greatly differ from those found in Europe, as shown in Figure 6[121]. Even when compared with the average new dwellings data from the cities of Sao Paulo and Porto Alegre, which are more likely to reflect middle-income class, the occupancy rates are still much higher than the average occupancy rates of European countries (approximately 40 square meters per person). However, they are similar to those rates found in the dwellings stock such as in Poland and Greece, which are those European countries with higher average occupancy rate.

Housing stock: are there enough houses to live in?

Research has shown that one in every three households in Latin American countries struggles with some form of inadequate housing and 5 million out of 130 million households rely on another family for shelter [122].

In Brazil, these housing issues are similar. It is estimated that Brazil requires an annual output of more than 1.2 million housing units simply to replace the existing housing stock exceeding their lifespan [123]. On the top of that, the housing deficit almost reaches 6.2 million housing units (approximately 10% of the national stock) and nearly 11 million housing units that are inadequate to live in [124]. The problem gets even more critical considering the fact that many families cohabit and therefore there is a need for extra homes to accommodate this demand. Cohabitation corresponds to 1.7 million housing units, which is equivalent to over 28% of the national housing deficit [125].

Trends on the Brazilian housing sector suggested that in 2017 the number of homes should have exceeded 72 million homes for a predicted population over 210 million people. In 2030, the Brazilian housing sector would expect to have about 93.1 million homes for a population contingent of more than 233 million people [126]. This means that the rate of the availability of homes per number of people will decrease from 2.9 to 2.5, according to these figures. With the increased number of households, there is a need for a greater number of new dwellings to meet the demand.

Final considerations

This investigation was carried out with the use of literature review and analysis of statistical data in order to help characterise Brazilian housing. It revealed how Brazilian housing policies have influenced the way that occupants inhabit domestic structures. The main outcomes of these policies were the stimulation of the self-promoted houses and property ownership. Housing developments, under the umbrella of national housing programmes, promoted the construction of a standardized typology, at first for low-middle-income households, but this was also perpetuated by the construction of housing for low-income householders.

The findings reveal that a common set of characteristics can be identified in Brazilian dwellings according to their economic class. Low-middle income dwellings mostly consist of one-storey two-bedroom houses with areas up to 58 square meters of very simple characteristics, but this can be smaller as 36 square metre for low-income households. Middle-income dwellings mostly consist of one to two-storey three-bedroom houses with areas over 100 square meters with more spacious rooms, made of more durable materials and less densely occupied than low-income dwellings. Characteristics, which are remnants of traditional buildings, can be traced in

contemporary dwellings such as the use of small to medium windows, overhangs, shutters and verandas.

In addition, it was concluded that an expressive number of low-income households live in under dimensioned and over occupied homes. Even middle-class households live in houses that are less spacious than the references suggested by the Brazilian standards. These findings suggest that there may not be enough space in new homes to ensure their functionality. Research should be carried out and minimum space standards should be developed to ensure minimum functional spaces in Brazilian dwellings. This was supported by a comparison with housing in other countries.

Middle-class dwellings, influenced by the erudite European architecture, varies significantly in shape, area, number of storeys (one or two-storeys), materials and space configuration. This research identified that there is a housing market data shortage and its study is imperative for implementing positive changes in the residential sector.

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