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Reevaluating Social Sustainability in Social Housing: Lessons from Post-War Blocks and the Bouça Housing Model

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Abstract Housing blocks are among the most popular types used in modern architecture to design social housing. However, it received much criticism in Europe regarding the social aspects of post-war housing. This study aims to gain a deep understanding of the social aspects of designing post-war blocks in Europe, focusing on the potential of medium-rise blocks, such as Bouça housing by Álvaro Siza, in comparison to globally remarkable high-density blocks. The main question is, to what extent could the design of this type consider the necessary aspects of social Sustainability, such as privacy, adaptability, and social contact? This study employs site visit observation, literature search, and architectural analysis of the Bouça housing, comparing it to the Unité d'Habitation and Robin Hood Gardens. The comparison between the three cases has provided a deeper understanding of the ideas for interconnecting housing units to achieve social cohesion. The study's main conclusion is that Bouça Social Housing can be considered a pilot project due to its sensitivity to social aspects, compared to other cases. Thus, through the comparison with Unité d'Habitation and Robin Hood Gardens, it becomes evident that Álvaro Siza proposed an alternative to high-rise mass housing by developing compact, layered row housing that fosters shared spaces and ground-level activity. This approach reflects a distinctive contribution to post-modern social housing. Concepts of this case may be replicable and help provide new ideas for future social housing design.

Keywords Housing Blocks, Sustainable Development, Privacy, Social Contact, Adaptability

1. Introduction

The post-war period in Europe witnessed a massive surge in housing construction as cities sought to recover from widespread destruction and accommodate rapidly growing urban populations. Among the most prominent responses were modernist housing blocks designed to offer efficient, high-density living through the use of new materials and planning ideals [1]. While many of these developments aimed to embody progress and equality, they often revealed critical flaws in social integration, architectural flexibility, and long-term livability [2]. Examining these housing blocks provides valuable lessons for addressing today's urban challenges, shedding light on how design decisions impact communities over time. The need for safety, freedom, comfort, and social interaction in housing is a basic human need, but it is not adequately met for low-income families [3]. However, several international charters and agreements of the last century have emphasised the importance of ensuring human rights [4]. The need increased with the growing number of homeless individuals in cities, which has exacerbated problems related to obtaining adequate housing. Some projects have received government support to reduce poverty and homelessness in many European countries [5].

Therefore, governments adopt various strategies and housing policies to support low-income individuals, and social housing (public housing) is one of the most important approaches [6]. Many governments have become aware of the importance of establishing social housing to reduce homelessness and provide adequate housing for low-income individuals [7]. The need for social housing persists in many parts of Europe, particularly in areas experiencing increasing poverty and population growth [8]. Several countries construct social housing in the form of massive housing projects; these are one of the most popular types used through public projects and offer units for families, as seen in the United Kingdom, France, and Portugal. Building massive blocks was a common practice in many European countries during the 1960s and 1970s to meet the housing demand following World War II [9].

The practical application of sustainable society trends has been criticised for its inability to foster social cohesion in many housing blocks. Therefore, sustainable societies must consider the current and future needs of social housing residents [10]. Thus, actions are needed to increase social cohesion in these housing units and mitigate the social problems resulting from the heterogeneity of the adjacent groups of residents within one housing unit. Therefore, the most important humanitarian and social needs of those targeted for housing units should be identified. The design of social housing projects should be linked to Sustainability in all its aspects, especially social Sustainability, in addition to providing decent housing in terms of physical and safe aspects at reasonable prices while ensuring access to essential services [11].

Currently, the housing shortage, in general, and social (or economic) housing in particular, exceeds all expectations. This shortage is represented by the scarcity of social housing units provided annually worldwide in the face of the increasing demand [12]. In light of the high housing prices, there is a need to find new and creative architectural solutions. Accordingly, searching for appropriate design ideas for social housing is paramount to meet the social and economic needs of future generations. When addressing the importance of good design for social housing units, it is not limited to planning the space, interior design, and suitability of the units to the economic and social conditions of the target groups. However, it also extends to the importance of the relationship between that unit and the external design of the project, as well as the availability of open common spaces, in a way that helps bring about positive changes in the perceptions and behaviours of the residents of the social housing units [13].

A search for sustainable models of housing block design led to the discovery of the Bouça housing project designed by Álvaro Siza in Porto, Portugal [14]. Bouça Housing Complex: Originally designed in the 1970s as part of the SAAL (Serviço de Apoio Ambulatório Local) program, the Bouça Housing Complex was intended to provide affordable housing for working-class families. The project was partially completed due to political and economic challenges, leaving some structures unfinished. In the early 2000s, efforts were made to complete and rehabilitate the complex. This rehabilitation was fully realised by 2007 [14]. The revitalised Bouça Housing Complex has since been recognised for its thoughtful design, integration into the urban fabric, and ability to adapt to contemporary housing needs. Including communal spaces and proximity to public transportation, such as the nearby subway station, has enhanced its functionality and appeal to a diverse range of residents, including students, young professionals, and families. This housing project comprises four parallel blocks, as illustrated in Figure 1. It is a unique experience and has a wide reputation among academics for its ability to balance economic, cultural and social needs.

a. Site plan [15] b. General image for one block

Figure 1. Bouça housing project designed by Álvaro Siza in Porto, Portugal

Hence, what lessons can be applied from Bouça housing to contemporary social housing design? How do these projects respond to social Sustainability? The study examines the architectural principles and spatial configurations of the Bouça Housing Complex, as well as remarkably global examples of block social housing to assess how effectively Bouça Housing fosters social housing needs. It supposes that lessons from Bouça housing are a potential approach for future housing development that can be tested outside Portugal regarding social Sustainability. Thus, the study further identifies best practices and lessons that can inform block for a contemporary social housing design.

2. Social Housing and Social Sustainability

The study seeks creative solutions that are convincing during the selected period, both acceptable and economical. Financing social housing, reducing its cost and speeding up its implementation represent the first concerns of those in charge of social housing. However, this should not lead to neglecting the quality of housing. Modern models of European housing can be applied in designing social housing in various parts of the world due to the shared values in social housing design, such as reducing space, promoting flexibility and adaptability, and providing common spaces [16]. The required housing may be smaller in area than in middle and high-income areas, but at the same time, it fulfils the basic human needs of the residents. The small area facilitates the process of building housing using prefabricated and installed construction systems (ready-made housing units), among the most successful systems due to their speed of completion and low cost [17].

It may be easy for the designer to meet the population's basic biological and material needs by providing healthy housing and appropriate infrastructure. However, failure to consider legal, social, and cultural needs in the design of social housing may lead to social and health problems for residents, and these issues are often not identified until it is too late [18]. This calls for the need to develop new study methods to measure the success of social housing projects before implementation, to avoid this problem. This can be achieved by including the cost of studies and construction in the total cost, thereby alleviating financial burdens.

The role of the architect also covers several design levels through which architectural design can improve social housing: technology, modular housing, simplicity, reconsidering the lifestyle of residents, optimal use of land in order to reduce the impact of its high price by increasing density, which means increasing the number of housing units and distributing the price of land over a more significant number of units. - Exploiting parking lots and unused spaces in public and private spaces to build social housing, as they are wasted lands and because they do not cost the state anything [19]. Another role of the architect in the context of applying sustainability standards is to seek to develop new designs that are environmentally friendly through solutions to reduce energy consumption and develop green areas [20].

Social Sustainability is one of the important pillars of sustainable development, as it is a fundamental goal of Vision 2030, aiming to achieve sustainable development that raises the standard of living of citizens and improves their quality of life [21]. This standard requires attention to providing housing that achieves social needs, to ensure that it reflects the culture of society and its social characteristics, achieves a sense of stability, enhances a sense of belonging, and works to strengthen ties, mainly since global contemporary housing models were greatly influenced by the social backgrounds of the places in which they were built [22].

Social Sustainability refers to a society's ability to maintain and support the social structures, relationships, and values that contribute to a stable and cohesive environment over time [23]. Before analysing housing designs, it is essential to understand the relationship between the built environment and social Sustainability, as all physical components of housing, such as housing units, streets, collective spaces, and shared services, will impact the social Sustainability of housing [24]. Several studies have explored the different dimensions of social Sustainability in housing. For example, Bramley and Sinead [25] argue that social Sustainability can be promoted through social justice in access to services and facilities, as well as through community sustainability, fostered by social contact, privacy, safety, and overall satisfaction with the home environment.

Hancock focused on creating a suitable environment for social contact complete with activities and services, which constitute a necessary basis for social sustainability [26]. Another study concluded that four values enhance social Sustainability: justice, adaptability, safety, and social contact [27]. Based on the above, many previous values are related to housing design. Therefore, there should be a criterion for social Sustainability in the housing design of any community, serving as a reference for all design, review, and evaluation work. Achieving social Sustainability requires first identifying the core human values and needs that are shared across communities. These values can be understood through a conceptual framework inspired by Maslow's hierarchy of needs, which emphasises essential social aspects such as privacy, social interaction, respect, and self-actualisation [28]. Accordingly, the ability of housing design to meet those needs is an important factor in achieving social Sustainability [29]. This study argues that values such as safety and equality have become self-evident in the design of housing. However, three values of social Sustainability form an analysis criterion for social Sustainability: privacy, adaptation, and social contact. These values should be given special attention because they play a significant role in the cohesion of communities, as shown in Figure 2.

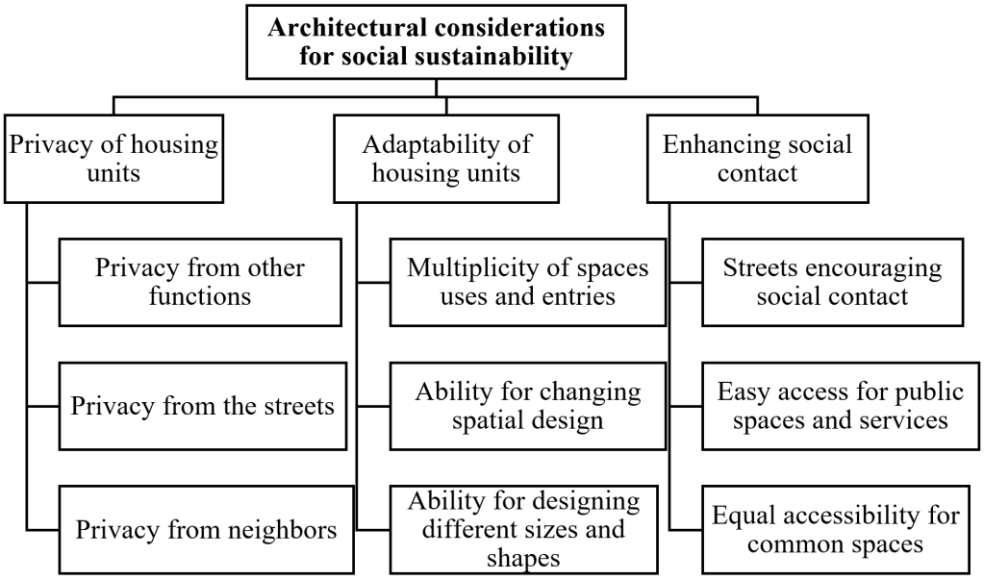


Figure 2. The proposed criteria for analysing social housing design in terms of social Sustainability

This study argues that the three mentioned values are encouraged by the selected case studies of block design in post-war housing, but in different ways and proportions. Although the block pattern has been subjected to too much criticism regarding social cohesion, it is assumed that it could achieve social Sustainability to some extent through architectural design that considers privacy, adaptation, and social contact.

Therefore, the primary objective of this paper is to understand how architectural design engages with post-war housing values comprehensively and to extract relevant lessons for the future design of residential blocks. To evaluate the potential of Bouça housing, the study compares it with two internationally recognised examples of social housing from the modern movement, selected based on specific criteria: their innovative approaches to high-density living, their socio-architectural ambitions to reshape community life, and their relevance as post-war housing experiments. The first is the Unité d'Habitation in Marseille (1952), designed by Le Corbusier, which pioneered the concept of the "vertical city" by integrating residential units with communal facilities within a single structure. It represents a foundational model of socially-oriented architectural thinking [30]. The second is Robin Hood Gardens in London (1972), designed by Alison and Peter Smithson, known for its "streets in the sky" concept, which aimed to foster social interaction among residents [31]. Both buildings, like Bouça housing, reflect efforts to translate modernist ideals into livable social housing, offering a meaningful basis for comparison in terms of social Sustainability, spatial adaptability, and community life.

The three housing projects - Bouça Housing in Porto, Unité d'Habitation in Marseille, and Robin Hood Gardens in London - differ notably in scale, density, and architectural philosophy. However, all are rooted in social housing ideals. Bouça Housing, designed by Álvaro Siza, occupies a compact plot of approximately 8,000 m², featuring 4-storey linear blocks that provide around 120 units for 300–400 inhabitants. In contrast, Le Corbusier's Unité d'Habitation is a vertical city block situated on a 17,600 m² plot, featuring a massive built volume that rises 18 storeys to house approximately 337 apartments and roughly 1,600 residents. Meanwhile, Robin Hood Gardens, designed by the Smithsons, spans a 20,000 m² site, with two curved slab blocks (up to 7 storeys) enclosing a central green space and accommodating approximately 210 dwellings for over 600 people. While Bouça emphasises integration into the existing urban fabric through modest scale, the Unité introduces a self-contained megastructure with mixed-use programs, and Robin Hood Gardens seeks a middle ground by combining high-density housing with public landscape and street-in-the-air circulation [32].

The three projects emerged from distinct social contexts yet shared a commitment to addressing post-war housing needs. Bouça Housing was conceived during Portugal's post-revolutionary period, aiming to rehouse displaced families through a democratic and participatory process that emphasised community integration. Unité d'Habitation responded to France's post-World War II housing shortage, with Le Corbusier envisioning a vertical city that redefined collective living for the modern industrial society. Robin Hood Gardens, constructed during Britain's late 1960s urban renewal era, addressed the housing needs of working-class residents within a decaying inner-city context. In terms of design goals, Siza emphasised modest privacy, resident adaptability, and a human-scaled urban insertion in Bouça, using clear thresholds between public and private zones. Le Corbusier prioritised collective identity, with semi-private corridors

and adaptable duplex units that sought to balance privacy and communal life within a single building [33]. The Smithsons, similarly, aimed to foster social contact through elevated access decks and a shared green space; however, they often compromised individual privacy due to open circulation routes. While all three architects aimed to enhance social life, their strategies reflect varying responses to context: from Siza's restrained sensitivity, to Corbusier's utopian unity, to the Smithsons' social experimentalism [34].

3. Methodology

In order to verify the potential of Bouça housing for social sustainability design, the study adopted a qualitative approach consisting of three interconnected methods to identify the research goals as follows:

1. Overview of the literature about Bouça significance for social Sustainability

The first method is to analyse the data by reviewing the previous literature that discussed the social features of Bouça Housing in detail. The explored studies spanned the period from 2007 to 2024, which is the date of completion of the rehabilitation interventions to date. A survey was also conducted on the official websites on the Internet that deal with the architectural characteristics of Bouça Housing in January 2025.

2. Observation and site visit

Observations were conducted on the housing site of Bouça, which had undergone a rehabilitation process a few years prior, over several months. Observations were conducted informally and repeatedly during my stay in Portugal, from June 2013 to June 2016. Approximately seven site visits were conducted at various times of day—mainly during daylight hours—and across different seasons, allowing for a more comprehensive understanding of how the spaces are used over time. Each visit lasted around 2 to 3 hours, focusing on everyday resident activities, the use of shared spaces, and interactions between public and private zones. Observations were documented through notes, sketches, and photographs, forming the basis for insights into the social dynamics and spatial quality of the complex.

Furthermore, the way in which the housing users act in their houses, internal streets, and common areas was observed. The observation noticed people's interaction with the design elements and how completing this design facilitated their daily activities. Various notes were taken, and random interviews were conducted with residents and engineers familiar with the project. The visits included taking photographs and drawing sketches on site. Users were observed in terms of gender, age, and the frequency of their presence in shared spaces, as well as their behaviour, including seating, walking, and interaction with others. The observation also investigates whether common spaces encourage social contact and promote prolonged use.

A copy of Le Corbusier's work, the Unité in Berlin, was also visited, and the building was surveyed and photographed to gain a deeper understanding of it. Regarding Robinhood Gardens, the researcher was unable to visit it and therefore relied on the information obtained from the sources listed at the end of the research.

3. Case Study Architectural Analysis

The study conducts a detailed architectural analysis of Bouça Housing Unité d'Habitation in Berlin and Robin Hood Gardens in London. The analysis focuses on design components, social sustainability encouragement, and contextual integration. The study uses the criteria developed in Figure 2 to compare design principles, spatial configurations, user adaptability, and the social impact of these projects. Figure 3 summarises the used method and its sequences.

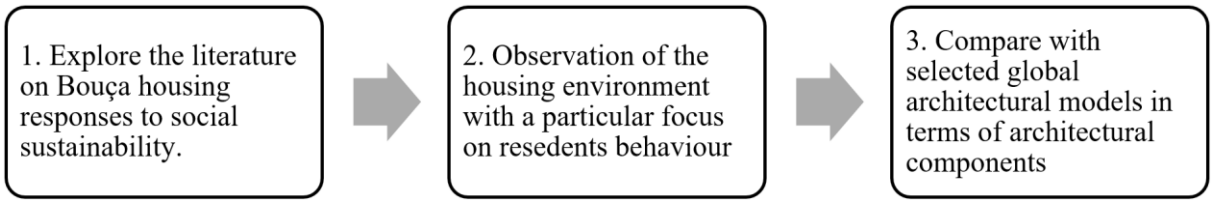


Figure 3. The sequence of methods employed in the study

4. Overview of the Literature about Bouça Housing

The socio-economic landscape of Portugal in the 20th century, particularly following the 1974 Carnation Revolution, played a pivotal role in the development of Bouça in Porto. As industrialisation increasingly shaped urban life, a significant housing crisis emerged, driven by a rapid influx of population into urban centres seeking new opportunities. This context necessitated innovative architectural responses to accommodate the working class, leading to the design of social housing complexes that emphasised community and accessibility [35].

Exploring the social sustainability dimensions of the Bouça housing project offers a compelling lens through which to evaluate modern urban living. Situated in the heart of Oporto, Bouça was conceived during a period of socio-economic transition in Portugal, reflecting both the architectural innovation and the pressing need for community-oriented living spaces [36]. Siza's design implements principles that prioritise the neighbourhood's social fabric, aiming to foster a sense of belonging among residents. The project challenges conventional notions of housing by integrating public and private spaces, thereby encouraging interaction and cooperation among inhabitants and their neighbours in previously existing buildings. There are various elements of social Sustainability present in Bouça, demonstrating how Siza's architectural vision not only addresses immediate housing needs but also cultivates enduring community relationships essential for a vibrant urban environment with simple constructions [37].

Furthermore, the ongoing dialogue about Bouça reflects a broader examination of architecture's role in addressing contemporary societal challenges, emphasising the need for interdisciplinary methodologies in urban design. The project embodies modernist design ideals while fostering community cohesion and social Sustainability, addressing the housing crisis in the rapidly urbanising city of Oporto. The emphasis on social Sustainability is underscored by the need for a dialogue between architecture, community needs, and urban regeneration, as highlighted in contemporary academic discourse on architecture today, which stresses the importance of interdisciplinary collaboration and innovative methodologies. [38] The following discusses the literature review of the sustainability elements of privacy, adaptation, and social contact in Bouça.

5. Results

5.1. Privacy

Álvaro Siza's architectural philosophy is rooted in a deep understanding of preserving local family privacy, ensuring the dense built environment and the dynamics of community housing do not disrupt it. A principle most prominently evident in his work in Bouça is the Home Independence for each unit [39]. Siza's designs prioritise the traditional human experience of autonomy in row housing, focusing on access and facilities within residential buildings, thereby enhancing the sense of family belonging to the home. His strategic placement of the residential units in such a way as to maintain distance from common spaces between blocks to reduce tension between neighbours illustrates how architecture can act as a catalyst for social cohesion by seeing the development of access to the upper apartments via suspended streets so that all residents on the upper and lower floors feel as though they are living on the ground floor [40]. This conscious approach respects the traditional fabric of the community, which is built on the privacy of families. It stimulates new forms of interaction by designing two layers that do not compromise the privacy of individual units, while advocating for a sustainable future that considers both human and environmental factors [41]. Siza's work powerfully embodies these principles by utilising thick walls between units to enhance acoustic insulation, offering invaluable insights into architectural practices that prioritise family autonomy.

5.2. Adaptability

Modular design is used to produce all housing units. The module allows for modifications over time, accommodating changing family structures and needs influenced by the modern architectural movement. Siza's attention to interior proportion ensures natural light, and materiality enhances the livability of spaces [42]. Livability ensures that housing projects remain viable and desirable for residents in the long term. With modern buildings facing scrutiny for their inflexibility, the need for architects to adopt interdisciplinary approaches has become apparent, underscoring the shift toward more inclusive practices in urban design. Siza's work, particularly at Bouça, constitutes a monumental case study that bridges the gap between historical and contemporary architectural movements, seeking to generate meaningful interactions between residents and their built environment in a modern way [43]. Furthermore, the focus on sustainable materials and energy-efficient construction techniques demonstrates a progressive approach to adapting architectural spaces to reach comfort naturally, a message ahead of its time that resonates with contemporary environmental concerns. Ultimately, this design philosophy positions Siza's work as focused on a multiplicity of choices for using the unit to critically study the interrelationship between architecture and society [44].

5.3. Social Contact

Siza assumed that the participation of families in the

design process would increase their belonging to the place and thus to the micro-community of Bouça. He worked closely with residents to ensure that the design met their needs. The literature emphasises user participation: residents contributed to decisions about unit layouts, shared spaces, and project development, fostering a sense of ownership [45]. The participatory process empowered marginalised communities to address their social and economic needs through housing. This dimension consistently fosters strong community bonds and enables active citizenship in social sustainability frameworks.

Additionally, Siza incorporated courtyards, walkways, and common areas to encourage social interaction. Shared courtyards are vital hubs for community interaction and social cohesion, and each space is connected through paths crossing housing blocks [46]. Additionally, the design does not entirely enclose the courtyards, allowing for connections between housing units and the surrounding urban fabric, thereby enhancing accessibility and promoting inclusion in public life. These shared spaces contribute to the social dimension of Sustainability by fostering a sense of belonging and reducing isolation.

As a result, Bouça architectural features embody a deep engagement with social Sustainability, reflecting a thoughtful integration of form, space and community needs. Factors such as reduced height, connectivity between outdoor spaces, and aesthetics are often overlooked in traditional mega-housing projects, which frequently ignore these aspects. In contrast, Bouça serves as a model for providing privacy, adaptation, and social contact simultaneously. Siza's design prioritises outdoor spaces in terms of function and aesthetic appeal, enhancing social cohesion. Open and accessible, these spaces serve as vital gathering spaces for the community, fostering social bonds and reinforcing the collective identity of the neighbourhood.

5.4. Observation and Residents Satisfaction in Bouça Housing

The general observation during the site visit revealed a noticeable sense of satisfaction, harmony, and cooperation among residents. The housing complex remains vibrant, with shared courtyards that are actively used by children and adults alike, reflecting a strong sense of community, as noted in [47]. Residents were observed sitting in front of their units, engaging in casual conversations and participating in informal communal activities, which suggests that the architectural layout supports social interaction. The spatial configuration of circulation paths and the semi-private entrances strikes a balance between privacy and sociability. However, despite these observations, recent academic research directly measuring residents' satisfaction with Bouça Housing remains limited. A prominent exception is the study entitled “Social Ascent of Housing Intervention: Álvaro Siza’s Project for the Bouça Neighbourhood", which offers valuable insight into the socio-spatial impact of the project, particularly across its two construction phases. Although it does not provide a quantitative assessment of resident satisfaction with the architectural design, it offers a valuable evaluation of how design decisions support social life. Additionally, broader studies on social housing in Portugal [14, 36, 39] offer contextual understanding, while the study [44] emphasises the role of participatory design in fostering resident satisfaction, which is relevant even if not specific to Bouça.

5.5. Comparing Bouça Housing to Unité d'Habitation and Robin Hood Gardens

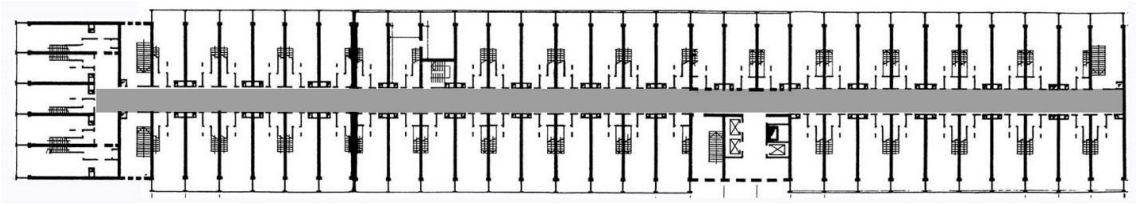
5.5.1. Privacy

Le Corbusier separates functions vertically within the same block to maintain the privacy of housing units by defining spaces for shops and other activities, as shown in Figures 4a and 4b. Smithson, however, did not integrate functions other than housing due to the project's location near city services, as illustrated in Figures 4c and 4d. Siza designed collective places and social services, but separated them from the residential blocks and used different forms (the Simi circle is an example). As a result, the parallel blocks contain sole housing, as shown in Figures 4e and f.

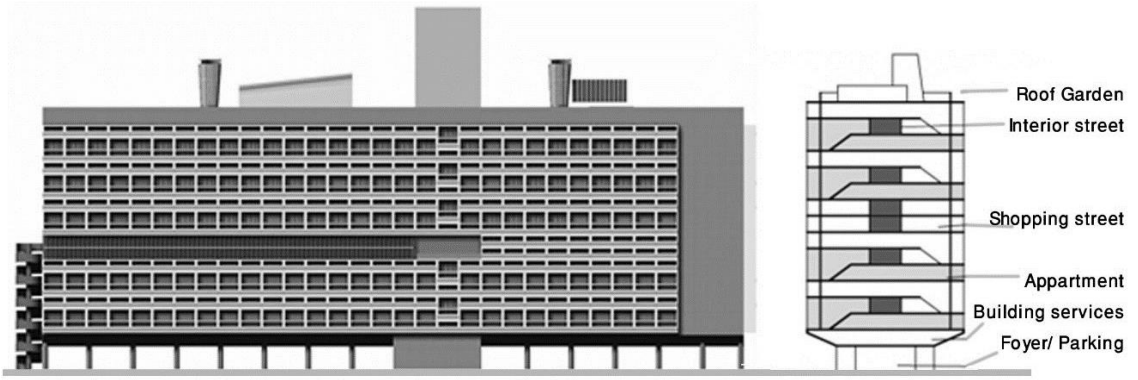
Regarding privacy from the surroundings, the unit's articulation around streets plays a crucial role in ensuring privacy from streets and neighbours. Le Corbusier designed an internal residential street between the residential apartments as a double corridor. The street is located on the second floor, then disappears on the third and fourth floors, reappears on the fifth floor, and so on, as shown in Figures 4a and b. Hence, the design is based on the repetition of three floors with the street in the middle. He also designed a commercial street at the end that appears on the external facades and distinguishes it from the residential street. However, in the residential street, he did not pay much attention to the street's depth, so its lighting was artificial. The doors for the entrances to the houses were adjacent and opposite each other, so they did not define semi-private areas for the houses. On the contrary, the Smithsons designed a street overlooking the city with a relatively vast proportion and named it “Street in the Sky”. It would be a suitable place for the family to stay in front of their houses, serving as an alternative to the deck of the ship (or roof garden) that Le Corbusier proposed. So, the street would become a semi-public space for all the houses. They also considered the privacy of the houses that open onto the street by creating a small, semi-private area that brings together every two houses. The entrance was bent so that it would not be directly exposed to the street, as shown in Figures 4c and 4d.

The streets in Siza housing are continuous and extend around the four blocks of the project. On the ground level, they are in the form of walkways adjacent to the courtyard. On the upper level, suspended streets are similar to those in

Robinhood Gardens, but they are added to the block and not carved into it; they are open to the air. Siza utilised the difference in levels between the entrance to the house and the suspended street to enhance the house's privacy and create a semi-private area before entering the interior, as shown in Figures 4e and f.

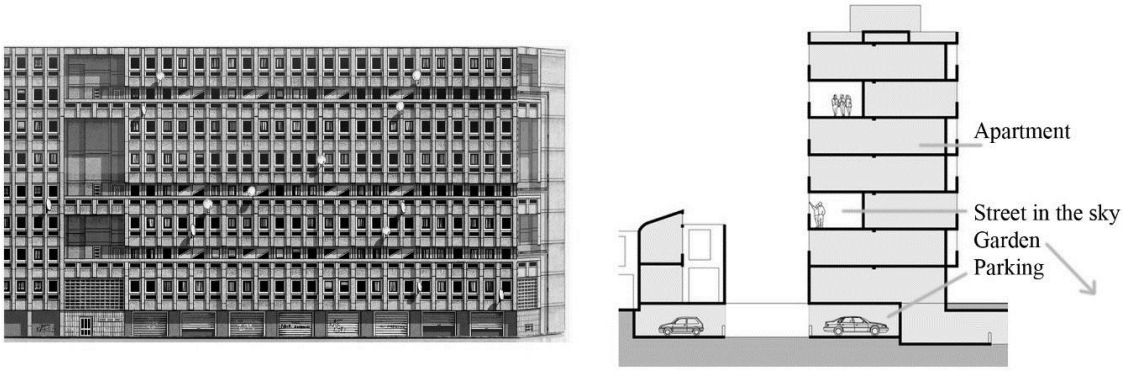


a. Street –plan of the Unité d'Habitation [48]

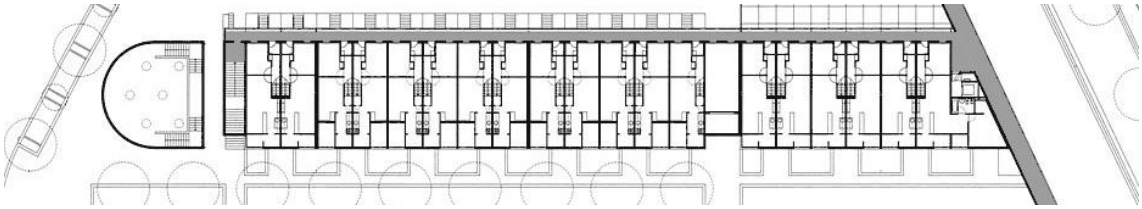


b. Main elevation and section in Unité d'Habitation [48]

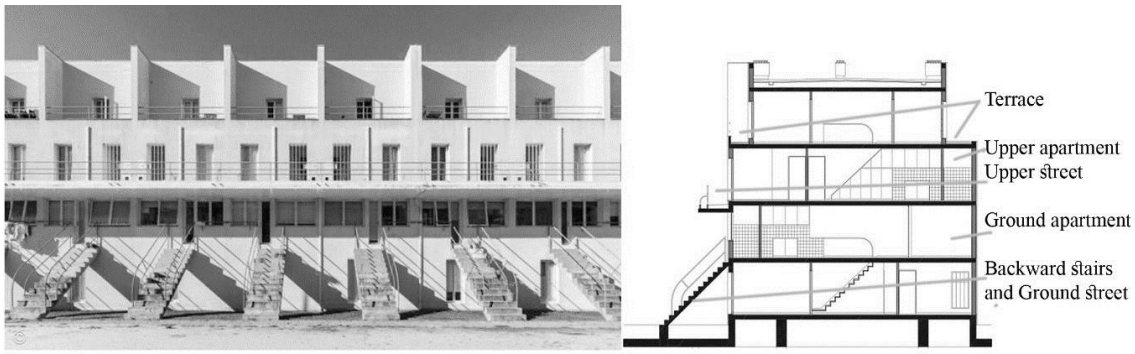
c. Street –plan of the Robinhood Gardens [49]



d. Main elevation and section in Robinhood Gardens [49]



e. Street plan of the Bouça Housing [50]



f. Main elevation and section in Bouça Housing (Author 2016)

Figure 4. Plans, elevations, and sections of the selected case studies

In conclusion, each of the three projects has its method of maintaining the house's privacy from the surroundings. The Unité suggested the internal street repels crowding and separates functions by floors. Robinhood Gardens minimised other functions and made treatments to maintain privacy from the street. However, the potential of the Bouça proposal aligns with the advantages of both Unité and Robinhood Gardens. It provides services and other functions similar to those of Unité, but separates them horizontally rather than vertically. It makes the residential function well-defined in a more social street to maintain privacy. It also employs architectural treatments, as seen in Robinhood Gardens, but with distinct themes that create a gradual hierarchy in the street system, progressing from the main street to the upper street, and ultimately reaching the semi-private areas between the street and the house entrance.

5.5.2. Adaptability

Going into more detail in the design of the selected case studies, the residential units in all of these projects are designed using modular repetition to facilitate economic and fast production. The Unité consists of cottage-style residential units, each featuring two levels: one for the day wing and the other for sleeping. Le Corbusier took into account the flexibility of the unit to produce an adaptable environment in two ways: first, the ability to add prefabricated residential units to the structural frame gradually, and second, the house's ability to adapt to changes. He employed two basic methods: flexibility in dividing the interior space, where he utilised sliding walls to adjust the space's size by dividing or merging it. He also resorted to multiple uses in the same space, as the dining area can be used for studying at other times. However, all the residential units were typical and similar, and there was no difference in the interior division except for the presence of two patterns: entering from street level to the day wing and then going up to the upper floor to sleep. The second option is to enter from street level to the day wing and then proceed down to the lower floor, where the bedrooms are located, as shown in Figure 5a. All the houses are equal in area and number of rooms.

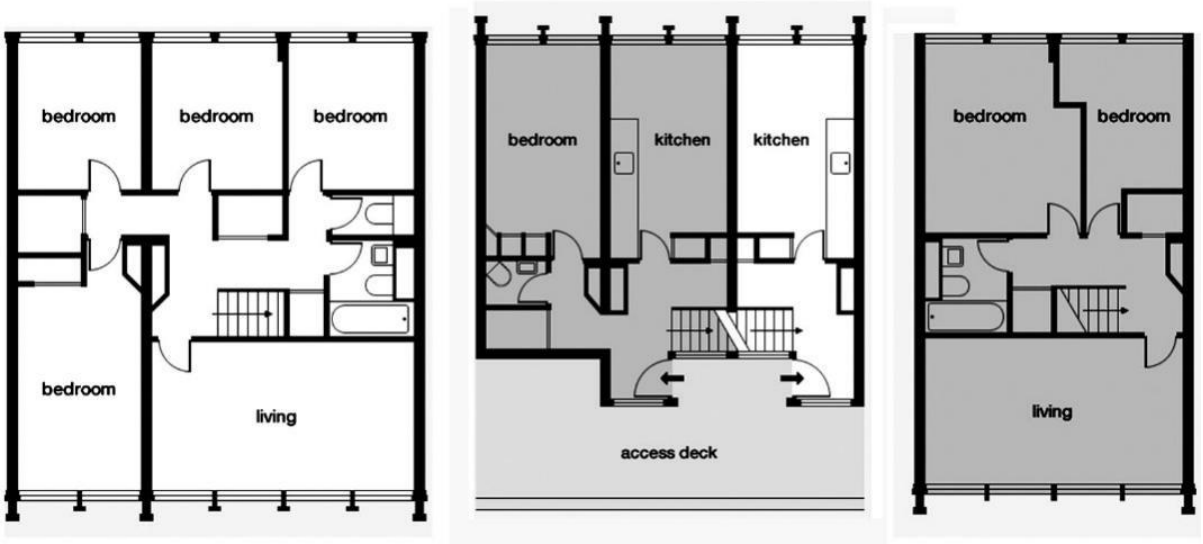
On the contrary, Smithson significantly changed the division of the residential units compared to the Unité. However, the outline maintains the pattern repetition, which reflects a monotonous rhythm of equal spaces, indicating prefabricated construction and adherence to the grid in the design. However, this repetition did not prevent the designers from using a variety of residential units to create diversity in the units' shapes, areas, and room numbers. Hence, all residential units in the building are designed with a cottage system, one level for the day wing and one for sleeping, as shown in Figure 5b.

Siza's theme in designing the units did not differ significantly from that of the Unité and Robinhood Gardens in terms of pattern repetition. Each apartment is designed with economical use of space and is in the form of a cottage. However, the presence of only two rows on top of each other is what distinguishes the design and gives the block an average height of only four floors. In addition, all houses, whether in the lower or upper row, have direct contact with the street, either ground or suspended. Siza enhanced the adaptability of the house by incorporating multiple entrances and external stairs, which characterise the design. They also utilise terraces in the upper units, which enhances their ability to adapt to the diverse needs of users, as shown in Figure 5c.

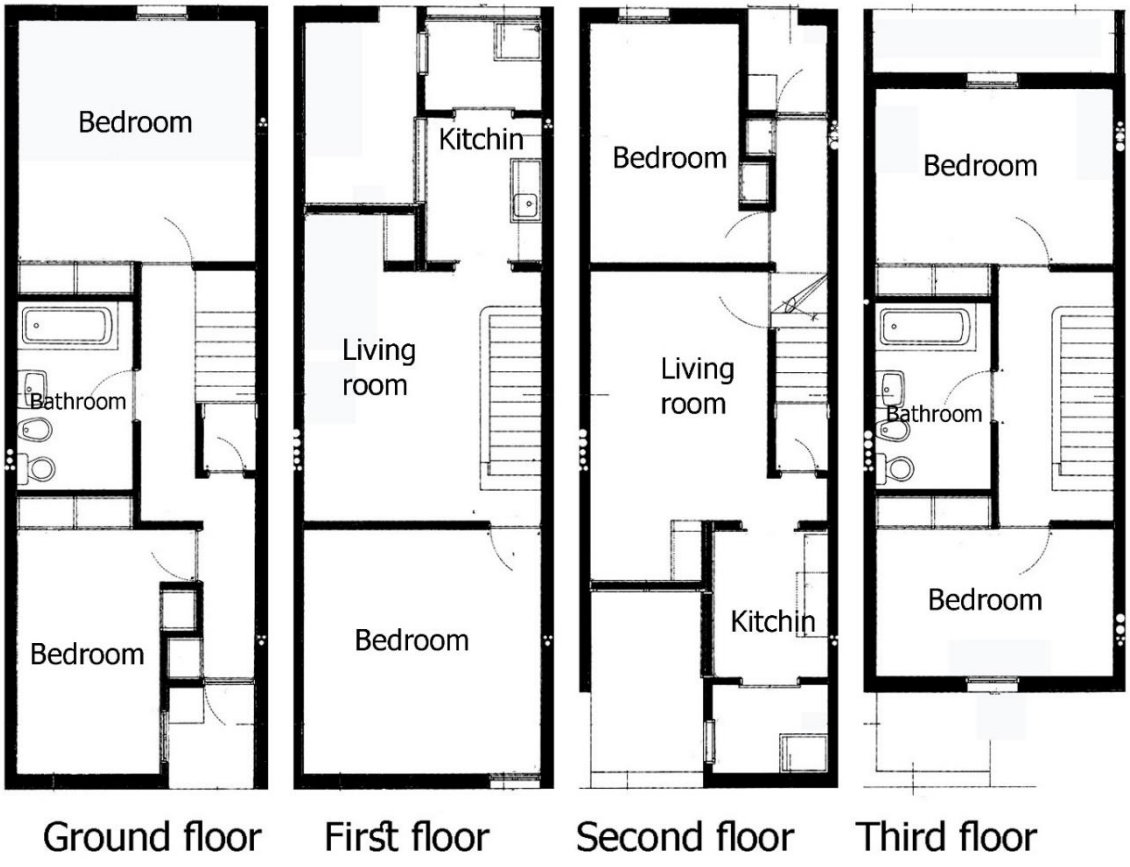
It is worth mentioning here that the Unité and Robinhood Gardens paid more attention to the residential units, focusing on flexibility in internal spaces and offering a variety of unit types and shapes. However, these techniques can be easily integrated into the Siza approach to create a residential environment that is more adaptable to the family's requirements in future designs, as it relies on pattern repetition, like others. While Unité was influential in architectural discourse, its rigid design and standardised living units posed challenges to adaptability over time, as the fixed nature of the interior layouts limited flexibility for residents. Modifying the living spaces to suit evolving needs is hard. Furthermore, Robinhood Gardens faced several challenges, including social issues, maintenance problems, and a lack of adaptability in its design over time. Large communal spaces, intended to foster social contact,

often became areas of neglect and antisocial behaviour. The building's design did not easily accommodate changes or improvements, ultimately leading to its demolition, which began in 2017. The site is undergoing redevelopment, marking the end of Robin Hood Gardens as a social housing project.

a. Housing unit in Unité d'Habitation [48]



b. Housing units sample in Robinhood Gardens [49]



c. Housing units in Bouça Housing [50]

Figure 5. Housing units in the selected case studies

5.5.3. Social Contact

Le Corbusier designed the Unité to be unique, meticulously detailing every aspect of this building. However, the idea was based on a unique, multi-storey, high-density building surrounded by gardens and landscape, leaving as much empty land as possible. This idea was reinforced by raising the building on columns to utilise the ground floor for gardens and parking, and using the roof for standard functions such as a children's play area, a clinic, and a restaurant (see Figures 6a and 6 b). As for the Smithsons, they employed a similar approach to Le Corbusier: they designed two long blocks wrapped around a large garden, which is why the building was called Robehood Gardens. The shape of the building took the boundaries of the land, so we find that the blocks are broken and not straight, unlike Le Corbusier's building, which had an approximately regular rectangular surface. However, the design of the Robinhood Garden retained the high-rise style, with massive blocks accommodating a large population density within the building, while providing common spaces for residents' daily and social activities (see Figures 6c and 6d). The external space may be better defined in the Robinhood Building due to its location within London, unlike the Unité, which was designed to be built in several locations in different cities, on the city's outskirts, and not in a specific urban context.

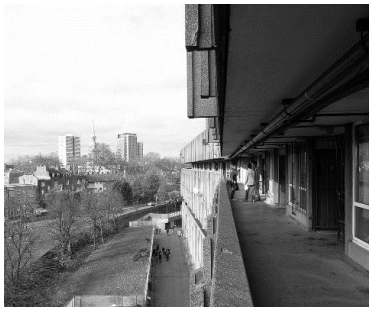
Bouça aimed to break the previous patterns and introduce a new concept for blocks consisting of only four floors, repeated on the site designated for construction in the form of four parallel blocks. Dealing with the site was also evident, as the land is adjacent to a railway line. Accordingly, the designer built a large wall and a buffer zone that isolates the housing from the train lines, then chose to direct the blocks perpendicular to this wall to reduce the effect of disturbance and potential vibrations from the train lines. Repetition of the block and reducing its height also allowed for the formation of multiple courtyards between the blocks, rather than one extensive garden, as seen in the Unité and the Robinhood Gardens (Figure 6e,f).

In conclusion, Boca is significantly superior in urban design to the other two projects. Reducing the height, repeating the blocks, and creating shared spaces in the form of corridors make the residential environment in this housing suitable for social contact and strengthening the bonds between neighbours.

a. Common spaces –gardens- of Unité d'Habitation (Author 2016)

b. Shopping street in Unité d'Habitation (Author 2016)

c. Shared spaces –gardens- of Robinhood Gardens [49]



d. Street in the Sky of Robinhood Gardens [49]

e. Shared spaces –gardens- of Bouça Housing (Author 2016)

f. Upper Street in Bouça Housing(Author 2016)

Figure 6. Common spaces and streets of the selected case studies

6. Final Remarks

Alvaro Siza contributed to social housing design by inventing intensive row housing consisting of two layers to replace the high-rise blocks and using multiple linear blocks instead of massive ones, allowing for the repetition of such blocks, creating shared spaces between them, with the focus on considering that all residents have facilities living on the ground floor. Even those living in upper units use upper-side streets, forming a continuous network of roads throughout the residence. Table 1 summarises the differences between the three cases studied in terms of privacy, adaptability, and socially inert action, referring to the criteria presented in Figure 2.

As a result, the table shows different ways and degrees of dealing with social Sustainability. Each may be appropriate for the society and the context in which it is designed. However, future housing designers can benefit from the methods used in previous cases to achieve social Sustainability. Although there is a clear difference in the degree to which each item on the table is addressed, the designer determines the extent to which previous methods should be applied, taking into account the context and society for which they are designing.

The architectural analysis of Siza's design reveals a reimagining of space that aligns with historical narratives while enhancing future possibilities, thus suggesting new models for sustainable architectural practice, as emphasised by Lebre [35] and Melenhorst et al. [36]. Siza's work in Bouça serves as a model for future endeavours in socially sustainable housing, as argued by Bramley et al. [25] and Ghahramanpouri et al. [26]. A. Reflecting on the long-term Implications of the Bouça design for social Sustainability in urban environments, the long-term implications of the Bouça design by Álvaro Siza extend beyond its immediate architectural aesthetics, as it resonates deeply with social sustainability principles in urban contexts. By emphasising shared spaces, walkability, and a strong sense of community, Bouça promotes vibrant social life and inclusion among residents, as highlighted by de Campos [45]. The adaptability potential is evident as the design has endured for decades and has been rehabilitated to not only meet the current needs of its residents but also ensure that the space can adapt to future generations, encouraging Sustainability through resilient urban living, as emphasised by Fernandes [43]. Integrating natural light, green spaces and local materials enriches the environment, making it a residential area and a model for environmentally conscious urban planning. Ultimately, Bouça's architectural legacy is a critical reference point for contemporary urban designs, emphasising that sustainable housing must support social cohesion and enable communities to thrive amidst urban challenges [39].

Table 1. The comparison between the selected cases regarding privacy, adaptability, and social contact

	Criteria	Bouça Housing	Unité d'Habitation	Robin Hood Gardens
Privacy of housing units	Privacy from other functions	Separating other functions from housing rows horizontally. Zoning of public and private areas is less defined, leading to some overlap between the housing and its surroundings.	Ground-floor spaces are designated for non-residential use, separating living areas. The mixed-use design features shops and services, with residential units arranged vertically.	Lack of multiple functions in the same blocks. Parking is located in the basement, and all other floors are reserved for residential units.
	Privacy from the streets	On the ground, a buffer zone of green space separates the house from the street. The upper floors of the housing units are elevated and semi-enclosed, providing some protection from direct street access, and utilise a hierarchy of street widths, ranging from public to private.	Apartments are set back and elevated on pilings, creating separation from the growing street below. However, inner streets lack treatments to preserve the privacy of house entrances.	Housing blocks are oriented to reduce direct street visibility, but walkways create some exposure. Streets in the sky feature architectural treatments designed to preserve entrance privacy, including semi-private areas and entrance piers.
	Privacy from neighbours	A terraced design with clear demarcation between units helps reduce intrusion. The distance between the houses is enough to preserve the unit's privacy.	Open view and separation from the context ensure privacy from other units.	Streets in the sky and shared spaces sometimes compromise the privacy of houses from neighbours.
Adaptability of housing units	Multiplicity of space uses and entries	Units feature flexible layouts and multiple entrances, accommodating a range of uses. Duplex apartments with dual-level entries provide flexibility for family activities.	Interior spaces have the ability for flexible spatial design, allowing for multiple uses of the same unit.	Unit designs are not uniform, with high variations in size and layout, but each house has a single entry.
	Ability to change spatial design	Modular construction allows for the potential reconfiguration of interior layouts.	The ability to change spatial design is founded on an open plan and sliding walls to merge and divide the rooms' spaces.	Units were designed as modular systems, allowing for some spatial adjustments.
	Ability to design different sizes/shapes	The terraced design of the upper units allows for varied unit sizes, accommodating households of different sizes and configurations.	Standardised unit designs with options for families of different sizes enhance adaptability.	Multiple solutions for housing types that suit a wide range of families' needs in terms of the number of rooms and housing unit form.
Enhancing social contact	Streets encouraging social contact	Semi-public courtyards and pathways foster interaction between residents.	Elevated walkways do not aim to foster interaction, but sometimes create isolation effects.	"Streets in the sky" create shared spaces for residents to meet.
	Easy access to public spaces/services	Integrated public spaces and proximity to urban amenities enhance accessibility.	It features internal amenities, including shops, a gym, and a nursery, thereby reducing the need for travel time.	Public spaces exist, but they are underutilised due to accessibility issues.
	Equal accessibility for common spaces	Equal accessibility for shared spaces. Courtyards and walkways are easily accessible to all residents.	Pilotis' roof garden (deck) allows open access to ground-level public areas, promoting inclusivity.	Upper streets are crowded, but green spaces can sometimes feel neglected.

7. Conclusions

This study aimed to highlight the potential of Bouça housing as a pilot project for social Sustainability in social housing compared to remarkable post-war housing examples. The method used in this study is to analyse the housing blocks based on their fundamental values and focus on the relationships between the housing units and the surroundings to create a suitable social environment in future designs. The analysis revealed that the modern movement influenced the designers of the three cases, Bouça, Unité d'Habitation, and Robin Hood Gardens. They shared similar goals in improving social housing conditions in Europe while developing housing concepts from both economic and social perspectives. The three case studies of linear blocks from different European cities were designed in different periods. However, Siza created a new housing type in Bouça that combines the features of linear and block housing. It can be called dense linear housing, where two lines of linear housing are built on top of each other to increase density and utilise the land more efficiently. The design also combines many features of Unité d'Habitation and Robin Hood in terms of privacy and social contact, thereby providing block residents with as many features of row housing as possible.

In that sense, focusing solely on the design of the

housing unit is insufficient; the spaces between the housing units must also be addressed. Instead, each group of residents and each location has its own characteristics that must be considered in each case. Therefore, architectural design is a highly effective tool for enhancing the quality of social housing. Appropriate architectural design can achieve effective social solutions without compromising the economic aspects required in these projects.

In summary, the Bouça Housing Complex's ability to adapt to contemporary needs, integration into the urban environment, and successful completion and rehabilitation efforts have contributed to its ongoing success as a social housing project.

Finally, the study contributes to social housing design by addressing Bouça housing in Portuguese as an outstanding example of the modern movement. While this study compares only three projects, the contrast between the vertical concentration of the Unité and Robin Hood Gardens and the layered linearity of Bouça reveals a clear shift in design philosophy. Siza's approach reclaims the ground level and enables more human-scaled interactions." It is recommended that further studies explore social housing design and highlight other types of housing in other countries. It is also hoped that this paper will assist designers and planners worldwide to pay much more attention to the importance of social Sustainability when designing social housing.

Furthermore, the paper relied on the architectural treatments to investigate social Sustainability; however, when housing projects are developed, the architect's sensitivity and design vision are essential, but they are only part of a broader set of influencing factors. Urban planning constraints - such as zoning regulations, building codes, and density limits - play a significant role in shaping what is feasible. Equally important is the budget, which affects everything from materials and construction methods to the level of detail and long-term Sustainability. As a result, further research is needed to investigate the impact of such border sets on housing sustainability.

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