



DOI: <https://doi.org/10.38027/ICCAUA2025EN0073>

Designing inclusive loggia spaces for urban resilience to climate change

* ¹ & ² Dr. Carlos Mourão Pereira , ¹ Dr. Teresa Valsassina Heitor and ² Dr. Ann Heylighen

¹ CiTUA, Instituto Superior Técnico, University of Lisbon, Portugal

² Research [x] Design, Department of Architecture, KU Leuven, Belgium

E-mail ¹: carlosmourao@tecnico.ulisboa.pt , E-mail ²: teresa.heitor@tecnico.ulisboa.pt , E-mail ³: ann.heylighen@kuleuven.be

Abstract

Received: 14 January 2025
Revised: 16 June 2025
Accepted: 18 June 2025
Available online: 5 July 2025

Copyright © 2025 by the author(s).
All rights reserved.

This article is published under an open-access model and is made available in accordance with the terms of the Creative Commons Attribution 4.0 International Licence (CC BY).



The publisher maintains a neutral stance concerning jurisdictional claims in published maps and institutional affiliations.

This article has been selected and peer-reviewed for publication in this journal as part of the 8th International Conference of Contemporary Affairs in Architecture and Urbanism, held on 8–9 May 2025 in Alanya, Türkiye.

Based on the experience of people with diverse abilities, recent qualitative research suggests semi-open loggia spaces to face extreme weather conditions in buildings and cities. Aiming at social justice and resilience to climate change, it is pertinent to question the morphological implications of the mentioned qualitative research for architecture and urban rehabilitation. To bridge the gap between theory and practice, we used this qualitative evidence as starting point to study exploratory forms of loggias, through research-by-design. The results suggest that safety and multisensory experiences may be improved by 1. pathways free of obstacles in sidewalks; 2. shading devices without possibilities of child climbing over balconies; 3. relaxing areas in different levels than the main walkways in urban beaches. These findings may contribute to improving the design of loggia spaces and to increasing the adaptation of buildings and cities to climate change.

Keywords: architecture; climate change; loggia; spatial justice; urban rehabilitation.

1. Introduction

The loggia, the study object of this research, is a covered, semi-open space that provides a microclimate. It was already used in ancient Egypt in the entrances of temples such as in the one of the Hatshepsut (Fig. 1).



Figure 1. Loggia at Temple of Hatshepsut, Deir el-Bahari, Egypt.
(Picture Credits: Roberto Shumski, 2019; Diego F. Parra, 2022)

In ancient Greek and Roman architecture, loggia spaces such as porticos or colonnades shade outdoor areas as well as contributing to the passive cooling of buildings interiors (Yıldırım 2020). A loggia space with colonnades of ancient Greece are called pastas, and the term peristyle is often used for the late Hellenistic and Roman periods (Philokyprou et al. 2021). The architectural designation of loggia was widely used in the Italian Renaissance. Iconic spaces of this period are the Loggia dei Lanzi in Florence and the Loggia delle Benedizioni at St. Peter's in Rome. These spaces contrast in both the building position and the way of access - the first is on the ground floor of a building with public access from the walkway, whilst the second is positioned on a high floor that is only accessible from the building interior. In cities

with a humid subtropical climate such as the ones in China, Japan, Malaysia, Singapore, and Taiwan, public loggia spaces like arcades or colonnades are used to adapt sidewalks to local weather conditions, contributing to urban liveability and vitality (Juan et al. 2017). In central Iran, the loggia (talar or eyvan) is often a term used to designate a residential open-air room, covered and open on one side to a courtyard (Foruzanmehr 2015; & Foruzanmehr & Vellinga 2011). Philokyprou et al. (2021) classify five types of loggia in the vernacular architecture of Cyprus, specifically: 1. the iliakos, a longitudinal loggia on the ground floor of the building facade; 2. the portico, a tunnel loggia between the street and the backyard; 3. the hayati/balcony, a loggia on the building's upper floor; 4. the entrance-stegadi, a loggia protecting the main building entrance; and 5. the pergola, a plant-covered loggia at a building entrance. The zaguán is a type of loggia that, in the vernacular architecture of Cuba, provides passive cooling through natural ventilation between the street and courtyard (Tablada et al. 2009). Although the mentioned spaces are permanently open-air, there are spaces temporarily enclosed with glazed windows designated as loggia (Lejeune 1999). In short, it is possible to find several semi-open loggia spaces with different designations and morphologies in diverse parts of the globe, always adapting buildings and urban environments to their local climate.

To study the loggia is pertinent considering that researchers point out that passive cooling provided by vernacular architecture is forgotten in contemporary spaces (Foruzanmehr & Vellinga 2011; & Philokyprou et al. 2021). It is important to consider that cooling systems and air conditioning consume 15% of global electricity. Passive Design is a pertinent strategy for building performance (Masoumi et al. 2017). Foruzanmehr and Vellinga (2011) point out that global warming during high temperature days in hot climate buildings is dependent on electro-mechanical devices if passive cooling is not considered. Moreover, heat gained by windows and sun exposure may be reduced by 22% through natural ventilation (Masoumi et al. 2017). Furthermore, urban geometry, considering passive design, is one of the most efficient ways of providing thermal comfort to pedestrians (Sharmin et al. 2015). Beyond thermal comfort and environmental performance, the loggia may be an important social space for urban life. In this scope, Yildirim (2020) studied the urban loggia spaces of Sanliurfa in Turkey and found that these passageways were integrated into its streets, providing passive cooling in a hot climate whilst also becoming a rest area for pedestrians, and a playground for children. In literature, the loggia is widely present in architectural history and environmental design. However, it is rarely studied in social sciences. Specifically, it is pertinent to study its inclusiveness, or in other words to study the spatial justice of integrating people with diverse abilities into its spaces.

This research focuses on spatial justice, combining the principles of equality and equity inherent to social justice within the use of built space. Spaces not designed with principles of equality and equity foster exclusion and social injustice.

The premise of considering the diversity of all users as widely as possible has various designations despite their similarity, such as design for all, inclusive design or universal design. In academic literature, Heylighen et al. (2016) use the term inclusive design, as it semantically expresses the intention to include people as much as possible.

Including persons with diverse abilities in loggia spaces may improve the multisensory qualities of these environments. According to Pallasmaa (2012), our body perceives space as multisensory.

Devlieger and Froyen (2006) highlight that disability questions our relationship with the world and that the specific attention of blind people may provide new knowledge about multisensory urban spaces. In this context, it is pertinent to formulate the following question: What are the most inclusive and multisensory spatial components within improvement to the design of an urban loggia and its resilience to climate change?

This question seeks to explore knowledge that contributes to the following objectives: 1. Reduce mortality and injuries related with the impact of climate change; 2. Foster inclusion of people with diverse abilities in loggia spaces.

Three types of loggia are explored with this research. Specifically: 1. The public loggia connecting building entrances with sidewalks; 2. The private loggia that provides an open or glazed balcony in residential buildings; 3. The semi-public loggia providing sun shelter on urban beaches. Therefore, the sections of the context, results and discussion are organized in three subsections each one related with the aforementioned loggia types.

2. Context

2.1. Public Loggia

Juan et al. (2017) advance the use of semi-open spaces in public loggia to improve the thermal comfort, ventilation, and breathability of pedestrians in cities. Moreover, Masoumi et al. (2017) point out the potential of an urban morphology that produces shade and adequate wind velocity through the design of semi-open spaces (loggia in tunnels, central yards, trees, orientation of air flow and building proportion) to allow passive performance and user comfort. In addition, Sinou and Steemers (2004) point out the potential of designing urban loggia spaces not only to provide shade in hot climates but also for rainfall and cold weather conditions.

The porosity of urban spaces within the loggia may also contribute to more lively cities. Castel' Branco and Costa (2024) define architectural porosity as a gradual transition between inside and outside, public and private, with potential of appropriation and walkability, that contributes toward a fluid connection between people, more resilient communities and better health and wellbeing.

In terms of environmental behaviour, research suggests that users prefer to walk in shaded areas when they feel hot and directly exposed to the sun in cases of perceived cold (Xue et al. 2021). In this scope, Pereira et al. (2023) suggest that the design of public loggia spaces may provide partially covered sidewalks to give a shady option.

According with Castel' Branco and Costa (2024) walkability is encouraged by pathways in close proximity with building entrances and street crossings. Regarding spatial justice it is essential to include within the design pathways free of obstacles. Furthermore, it is important to consider that risk of injury needs to be considered during urban planning and architectural design (Pollack et al. 2014). In this context, Pereira et al. (2019) interviewed blind persons from diverse

nationalities and did participant observation in the absence of sight in public loggias. These findings suggested that safe pathways on the sidewalks near buildings prevent risks related with car traffic. Moreover, these spaces with a loggia may deter the need for shading devices, such as awnings or other protruding components that are not detectable with long canes, therefore reducing risks related to physical or headlong collision.

Nunes (2024) highlights the pertinence of interdisciplinary research to approach the complexity of the heat waves phenomena, considering resilience and public health. In this scope, Pereira et al. (2023) combined the experiences of diverse users with a transdisciplinary study carried out by experts, revealing that some loggia spaces may inadvertently create obsolete voids, resulting in problematic areas. The mentioned study suggests that a public loggia needs to consider local climate, social behaviour, usability, urban cleaning, visibility and connections, as far as possible, with the main urban walkways.

2.2. Private Loggia

The loggia presents a residential space in vernacular architecture, expressing a socio-cultural adaptation to local climate (Philokyprou et al. 2021). Beyond the advantage of socialization, the loggia is not sufficiently valorised in several residential buildings of the 21st century. Specifically, there is the perception that with electromechanical cooling these spaces became obsolete and impractical - only requiring cleaning efforts (Foruzanmehr 2015). However, Foruzanmehr and Vellinga (2011) and Foruzanmehr (2015) point out that loggia spaces are a representative component of vernacular houses to foster passive cooling with potential to contribute to a more sustainable future. Moreover, the loggia in the tall buildings of Singapore have an important role in the interaction and connection between people, being horizontal breezeways a morphology of deep shade and multi levels with protected balconies (Gamero-Salinas et al. 2021).

Castel' Branco and Costa (2024) proposes balconies wide enough for people to use as an outdoor space of interaction, contributing to the life of cities. Furthermore, through the experience of the lockdown of the COVID-19 pandemic, Mesa-Pedrazas et al. (2023) highlight that the impossibility of using public areas underscores the importance of balconies as a space in between private and public. Li et al. (2023) propose a multidisciplinary approach to designing loggia spaces in residential buildings. In this context, Pereira et al. (2022a) interviewed users with diverse abilities and experts from different fields and combined these experiences with participant observation in the absence of sight, finding that a residential loggia need to be designed considering local climate, rationally dimensioned, spacious enough to guarantee inclusive use, and with privacy regulation for physical exercise and social interaction with the neighbourhood.

The morphology of the private loggia may be synthetized into three types, specifically the open, the glazed, and the eliminated; the last one is characterized as a change to indoor environment connecting with adjacent spaces (Rodriguez-Algeciras et al. 2021; & Shamseldin 2023). The passive cooling of open loggias is highlighted in several research works (Foruzanmehr 2015; Foruzanmehr & Vellinga 2011; & Saleh 2015). In addition, the depth of an open loggia increases thermal comfort and air distribution, in indoor adjacent spaces (Izadyar et al. 2020; & Loche et al. 2024). In this scope, with adequate solar adaptation, there are economic and environmental advantages of open loggia spaces connected with living rooms (Yang et al. 2021). Moreover, an advantage of the open loggia is that the vertical movement of fire can be reduced through its design (Mammoser III & Battaglia 2004).

Shamseldin (2023) states the importance of considering changes in the morphology of loggia spaces, from open to glazed, or changing their design through adaptations with movable panels, to establish an adequate environmental performance in hot and cold conditions. Environmental research presented thermal advantages of the glazed loggia in cold weather (Afshari et al. 2023; & Hilliaho et al. 2016). Specifically, Afshari et al. (2023) studied the materiality of these loggias to maximize the thermal performance during cold weather and concluded that the combination of double glass with black indoor walls is an efficient strategy for passive heating, reducing the consumption of fossil fuels. By contrast, Saleh (2015) does not recommend a glazed loggia for hot climates in the scope of energetic consumption, despite the advantages of providing less air and noise pollution.

It is important to consider that in a metropolis, several multi-residential buildings are located near trafficways and exposed to severe noise (Wang et al. 2015). The building envelope, through its form and materials, may provide noise reflexion or absorption (Yang & Jeon 2020). In this scope, an open loggia in a building facade may amplify or reduce noise from car or rail traffic (Leader 2024). Specifically, the depth of an open loggia may influence its acoustic performance (Dien & Woloszyn 2005). Also, the use of acoustic ceilings in open loggia spaces may provide noise correction (Tang 2018). Instead of absorption materials applied to these ceilings, which may result in the accumulation of bacteria and respiratory risks, Wang et al. (2015) proposed inhomogeneous surfaces built with hollow narrow tubes to reduce noise.

However, there is the risk of a poorly designed residential loggia does not consider child safety. Home hazards contribute significantly to injury and mortality of children (Turner et al. 2006). In the United States, falls are the leading cause of injuries at home and the leading cause of injury-related deaths, with children under 5 years old being a group at risk (Shields et al. 2011). In a study in China, Li et al. (2019) highlighted that children aged between 1 and 4 years old are more vulnerable to fatal falls, mainly from heights of 3 m and above. It is important to consider that structural failure of the balcony is a representative cause of falls (Shields et al. 2011). Therefore, the design of balcony railing needs to consider children's age, human morphology, and strength (Cordovil et al. 2012).

In short, only by including the challenge of designing a safe loggia for all users will it be possible to think about its environmental performance and urban resilience.

2.3. Semi-Public Loggia

Climate change may induce heat-related illnesses, such as heat stroke. Moreover, it may exacerbate chronic heart and respiratory diseases (Nunes 2024). A strategy to prevent risks during heatwaves is to use sheltered spaces.

According to Amorim-Maia et al. (2023) climate refuge is an inclusive public space where it is possible to find a shelter from extreme weather.

Several studies state the use of cooling centres during heat waves, to prevent risks related with public health (Fraser et al. 2018, Lee & Han 2024, Nunes 2024, Sehgal & Sehgal 2023). Formal cooling centres are parks, libraries and community spaces provided by governmental agencies, whilst, by contrast, informal cooling centres are commercial areas and swimming pools where people seek refuge from extreme heat (Derakhshan et al. 2023).

Moreover, there are several spaces beyond cooling centres where people seek an informal climate shelter specifically, beaches, terraces and cafeterias (Amorim-Maia et al. 2023; & Sehgal & Sehgal 2023). Shopping centres are more frequently used as a heat refuge than formal cooling centres (Derakhshan et al. 2023).

Several urban spaces around the world are in adaptation to provide shelters for vulnerable populations through cooling centres and gardens (Amorim-Maia et al. 2023). It is important to consider that public cooling centres located near vulnerable populations are critical for health prevention during extreme heat (Fraser et al. 2018). Already in 2019 one third of the population of New York State is within walking distance of a cooling centre (Nayak et al. 2019). Moreover, in 2023, 77% of the population of Boston have a cooling centre in a walking distance of 15 minutes (Sehgal & Sehgal 2023). Furthermore, Barcelona aims that for 2030 all residents will have a climate shelter within a five minutes walking distance (Amorim-Maia et al. 2023).

However, formal cooling centres contain difficulties regarding their use. Potential users of these spaces do not perceive themselves to be vulnerable, do not want to be surrounded by old people, or are afraid to leave their homes for a long period of time, resulting in these public spaces not being used therefore inconclusive in their effectiveness (Kearl & Vogel 2023). Moreover, Ortiz et al. (2022) studied the relationship of extreme heat with COVID-19 pandemic and pointed out that indoor public spaces of cooling centres may have the risk of air contamination. In addition, Kondo et al. (2021) point out the advantage of promoting shade for adaptation to extreme heat and to reducing costs and environmental impact of air condition related with energetic consumption.

Therefore, a possible solution for informal cooling centres are sun shelters in urban beaches. According to Pereira et al. (2022b) these spaces can have free access during critical times to promote their use whilst costing a fee for the remaining periods due to the economic reasons related to maintenance, being semi-public loggias with passive cooling.

Pollack et al. (2014) state the combination of injury prevention with the promotion of physical exercise to better foster public health. In this scope, sun shelters of loggia spaces may provide an area for physical activity, making it even more useful. Studying motivations to stay in the shade, Pereira et al. (2022b) interviewed beach users during periods of excessive ultraviolet radiation, suggesting loggia spaces with the following uses: recreational, rest, cultural, sportive, nutrition, health and well-being, pedestrian circulation and work spaces. Moreover, to find creative ideas to design sun shelters in a multisensory way, Pereira et al. (2024) interviewed blind persons, suggesting the use of natural materials and spatial continuities with the beach environment. In addition, studying a semi-covered pool, Pereira et al. (2020) combined the sensory experience of blind persons with participant observation in the absence of sight, suggesting that a thermal appealing shaded water environment may be obtained with skylights with filters to avoid excessive ultraviolet radiation. Therefore, sun shelters in urban beaches may provide bathing facilities to motivate their use during heat waves or excessive ultraviolet radiation, contributing to health prevention and stimulating enjoyable spaces.

3. Methodology

This study builds upon qualitative research, a methodological approach well-suited to exploring how social experience is created and given meaning (Denzin & Lincoln 2005). Unlike quantitative research, qualitative inquiry acknowledges that reality cannot be separated from sensory experience and understanding. The researcher, the participants, and the context in which information is obtained all play a crucial role in shaping the study (Lloyd & Gifford 2024). In other words, qualitative research is a situated activity that positions the observer within the world (Denzin & Lincoln 2005). To test research findings and generate new knowledge about loggia spaces, we employed a research-by-design approach. Specifically, the first author's blindness was considered an opportunity to explore multisensory qualities beyond visual perception. This approach, which integrates architectural design with the absence of sight, has been previously discussed in the literature (Heylighen 2010; Heylighen et al. 2023; & Vermeersch 2013). The process involved participant observation of spaces, as well as audio and visual documentation.

The design problem was synthesized through the creation of mental images, which were then communicated using tactile drawings made with assistive paper for the blind and physical models constructed with interlocking building blocks (Pereira et al. 2017). These elements formed the foundation for generating digital renders with the assistance of a sighted collaborator. The final images were reviewed by additional sighted individuals, who helped verify visual details and suggest potential refinements.

In qualitative research, reflexivity and subjectivity are recognized as integral to the investigative process (Flick 2009). Therefore, participant observation was documented through a research diary, which recorded critical spatial components and challenges encountered in design decisions.

For data analysis, the research diary was systematically coded. The purpose of coding is to break down the text, categorize key elements, and organize them in a meaningful way (Flick 2009).

We developed a design proposal for each type of loggia, drawing inspiration from real-world case studies. Several loggia examples in the Lisbon region presented both positive and negative spatial characteristics, allowing for a nuanced exploration of the study's central research problem. Given that the first author resides in Lisbon, this facilitated site visits, optimizing time and minimizing transportation costs.

4. Results

4.1. Public Loggia

A relevant example of public space that can serve as inspiration for the design of an urban loggia is Avenida Almirante Reis in Lisbon, a major historical thoroughfare known for its diverse architectural styles, high-density urban environment, and role as a key transit corridor connecting the city center to its eastern districts. Due to its North south orientation, during midday time the sidewalks are fully exposed to the sun. In the mid 20th century loggia spaces were introduced in some buildings. However, it is not interesting to walk in these spaces because they are only partial structures without a continuous walkway (Fig. 2A).

Therefore, it is pertinent to design loggia spaces that allow adapting these sidewalks to extreme temperatures, mainly during heat waves.

Our proposal eliminates some existing loggias, increasing indoor area spaces, with the exception of terraces convertible in open or glazed spaces (Fig. 2B).

Moreover, we introduced a row of protruding loggia spaces partially covering the sidewalk. With these changes, it was possible to eliminate obsolete public spaces with corners difficult to keep clean (Fig. 2C). Our challenge was to design a sidewalk protected by a loggia without obstacles. For this we propose a safe pathway where it is forbidden to introduce obstacles such as scooters or terraces, as this space is designed to clearly define its boundaries.

Furthermore, we increased sensory stimuli in the sidewalk, through a row of trees giving shade, olfactory presence and sound of the leaves moving with the wind (Fig. 2D).



Figure 2. Public Loggia (Existing vs. Proposal).

4.2. Private Loggia

A relevant example of private space that can serve as inspiration for the design of a residential loggia are the balconies of the buildings in Praça de Alvalade, a central square in Lisbon known for its modernist urban planning, and commercial activity. They are open loggia spaces with the advantage of a shading panel that provides more passive cooling to an open loggia. Moreover, they regulate the privacy of their users. However, these balconies are noisy due to the exposure of car traffic, possibly a reason for the conversion to glazed loggia spaces in several balconies of these buildings (Fig. 3).



Figure 3. Private Loggias (Alvalade Square in Lisbon).

Therefore, rethinking this case we designed a loggia facing a backyard with trees that provide silence combined with the sounds of birds (Fig. 4A).

Furthermore, to increase bioclimatic performance and thermal comfort the design proposed is a convertible loggia that allows the polyvalency of changing the space to an open or glazed environment (Fig. 4B).

Our main challenge in the design of the shading device was child safety. For that reason, in this sliding panel, we used vertical shading to avoid the risk of children climbing (Fig. 4C).

Moreover, we used floor mounted folding seats to provide an adequate mobility of wheelchair users and also for child safety.

Another challenge was fire safety when the loggia is eliminated and altered to an indoor environment. For this condition we designed the building envelope with the protection of a wall between the loggia ceiling and the floor of the apartment above. Specifically, this increases the time that fire could spread to other apartments (Fig. 4D).

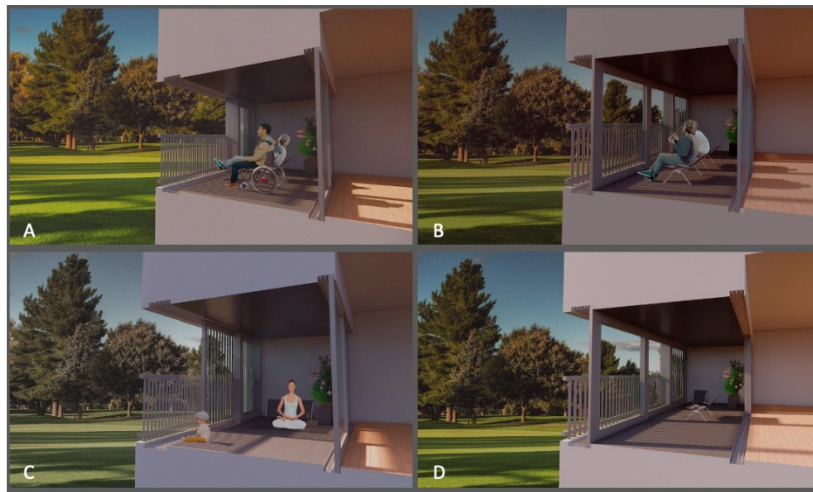


Figure 4. Private Loggia (Proposal).

4.3. Semi-Public Loggia

A relevant example of a semi-public space that can serve as inspiration for the design of sun shelters in loggia structures is the bathing facility at Tamariz Beach, in the Lisbon region. Designed and built in the 1960s, the ground floor originally housed locker rooms and restaurants, while the first floor was dedicated to private beach areas. These spaces consisted of loggia structures with sand-covered floors, providing shade and protection from the sun (Pereira 2013). Over time, these semi-open spaces were transformed into collective areas and are now used as a bar and a nightclub (Fig. 5A). We designed a bathing facility with sun shelter, with loggia spaces on both floors, with collective uses to motivate bathers to stay temporarily in the shade during midday hours and avoid the risk of excessive ultraviolet exposure. Our challenge was to design relaxing areas in front of a seaside promenade, so we proposed to have dynamic attractions on the ground floor and relaxing areas with sea views on the upper floor (Fig. 5B).

We designed loggia spaces with the polyvalency of being enclosed with glass on cold days. This flexibility supports the facility's economic sustainability by offering paid services during the off-season while maintaining free access during periods of excessive sun exposure (Fig. 5C).



Figure 5. Semi-Public Loggia (Existing vs. Proposal).

In our proposal the dimension between the floor and ceiling in the ground floor is adequate to be reduced for adaptation to climate change (Fig. 6A).

With global warming and consequent sea level rising it will be required to raise the seaside promenade and the ground floor of the sun shelter (Fig. 6B).

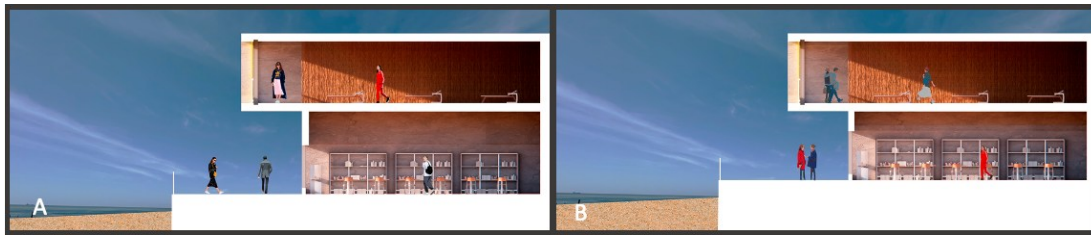


Figure 6. Semi-Public Loggia (Adaption to Climate Change).

To maximize building evolution and spatial integration we designed two modules that can be built isolated or in groups. The first features an asymmetrically positioned vertical circulation, with the stairs and lift located on one side. This arrangement connects two loggia spaces—one on the ground floor and the other on the upper floor (Fig. 7A).

By contrast, the second module has the vertical circulation in the centre with a loggia on each side on both floors (Fig. 7B).

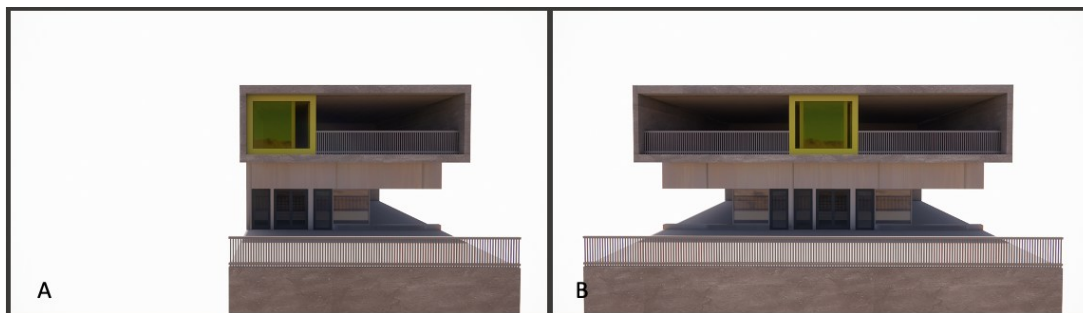


Figure 7. Modularity.

To motivate bathers to stay in the shade we designed several loggias, some of them combining diverse uses and materials identified in literature (Pereira et al. 2020; Pereira et al. 2022b; & Pereira et al. 2024).

A major benefit in the loggia of the children's pool is the natural light filtered by skylights that contain UV glass. On the deck there are seats for adults to increase child surveillance and safety (Fig. 8A).

Another loggia contains a rest area, where it is possible to read, sleep, or relax with a massage. A well finished bamboo wood is the main material of this space (Fig. 8B).

One loggia, with a playground, is designed with a smooth cork floor to prevent injuries from falls. The slide does not have a floor below it, to avoid head injuries in blind children (Fig. 8C).

Other loggia is an informal space with tables and seats where is possible to talk, work on a laptop, play table games, or eat and drink. Solid wood is the main material of this space (Fig. 8D).

This space is characterized by an auditorium with an audiovisual display, noise absorbing acoustic wall and ceiling. To increase polyvalency and inclusivity toward wheelchair users, this space is designed with a levelled floor and with mobile seats (Fig. 8E).

Another loggia is characterised by a polyvalent empty space where it is possible to dance or do physical exercises. A floor made of solid wood, with inner voids, may amplify the sounds of body movement (Fig. 8F).

By contrast, another loggia has a wood floor without inner voids, to allow better stability for fitness machines (Fig. 8G). A space for sand sculpture workshop activities is designed in stone. Tables with suitable dimensions for wheelchair users promote inclusion (Fig. 8H).

Finally, a loggia is integrated into a wooden wall with acoustic absorption, serving as a small library combined with an information point (Fig. 8I).

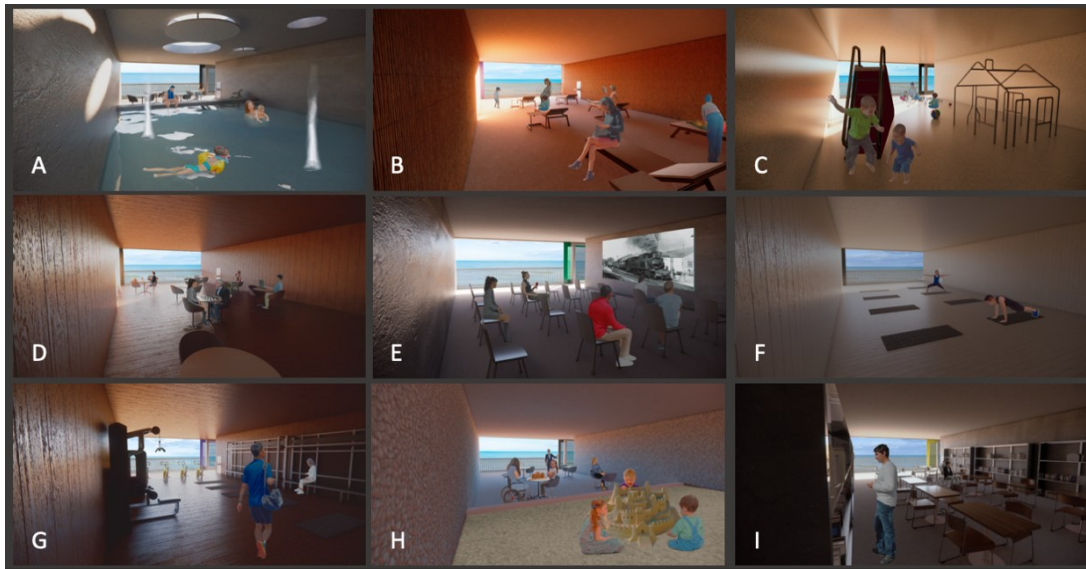


Figure 8. Loggia Spaces with Diverse Uses.

5. Discussion

5.1. Public Loggia

In a research with blind participants to explore multisensory qualities beyond sight, Pereira et al. (2019) suggested a safe pathway adjacent to building facades that connected with porch loggias, as terraces. Moreover, concerning pedestrian mobility, Pereira et al. (2023) suggested partially covered sidewalks with portico loggias. Combining these findings we design an inclusive and safe pathway, that is covered by a portico loggia and connected with an inner terraced porch loggia. In cases where spaciousness permits, it will be interesting to build a pathway with double width to permit the option of mobility with or without the protection of the portico loggia, that considers multisensory differences related to the visual and auditory perception of walking under a ceiling structure.

Furthermore, Pereira et al. (2019) suggests the temporary elimination of porch loggias during night time. In addition, we eliminate some of these loggias changing them for a continuous walkway that avoids corners that are difficult to clean, contributing toward a better olfactory experience.

Regarding tactile quality, Pereira et al. (2019) mention the risk of collision with awnings in the mobility of blind persons. Therefore, changing awnings next to loggia spaces may provide more climatic protection and more safety for people in the absence of sight. The materiality of a loggia that is cantilevered needs to be structurally adequate for the diversity of building envelopes. Several types of structural details may be required to ensure the resilience of each protruding loggia. Concerning building materials it is important to ensure that they have an adequate thermic isolation so as not to radiate heat in the shade. Regarding visual aesthetics, it looks more interesting in our opinion to use colours adequate for each building, so as not to lose diversity in non-homogeneous urban morphologies.

5.2. Private loggia

Rodriguez-Algeciras et al. (2021) point to the fact that urban morphology has an evident impact on improving users' comfort on open balconies. As suggested in Pereira et al. (2022a) balconies in quiet backyards containing trees provide the sensory comfort of privacy and the sound of birds. Moreover, we designed a loggia with this characteristic to avoid noise from car traffic. In addition, we think that a courtyard with trees instead of a large backyard may provide more protection from the wind, combined also with thermal comfort.

Shamseldin (2023) states that the use of adaptable loggias allows for climate adequacy and prevents visual pollution on the building's facade due to unplanned changes during the design phase.

The results suggest a proposal for a flexible loggia that prioritizes polyvalency over adaptability, eliminating the need for assembling and disassembling architectural components. By simply opening or closing glazed panels and adjusting shading, users can regulate privacy and climatic comfort efficiently.

Concerning child safety, having shade near the balcony railing is not a very common arrangement. When considering this solution, we encountered absences in building standards (IPQ 2009). Specifically, we recommend including details in the standards to alert designers that not all shading devices prevent children from climbing.

Furthermore, Pereira et al. (2022a) suggest wall-mounted folding seats to enhance children's safety and create a wheelchair-friendly space. Based on our findings, we propose floor-mounted folding seats as an alternative, providing greater adaptation in spaces where wall-mounted options are impractical, such as areas with glass doors behind the chairs.

5.3. Semi-Public Loggia

In their research on defining sun shelters for urban beaches, Pereira et al (2022b) highlight the need for acoustic separation between noisy loggias and quiet spaces, recommending the building of walls near these areas. Moreover, the results suggest to design relaxing spaces in different levels than the main walkways in case of urban beaches with seaside promenade to not disturb these areas with pedestrian or car mobility.

Additionally, Pereira et al. (2022b) highlight the need for adaptable sun shelters in response to rising sea levels. Our results incorporate two modular units, each with vertical circulation, where the floor-to-ceiling height of the ground floor can be adjusted. It is important to consider this floor elevation for stairs and lifts. Furthermore, the modularity of our enables flexible, evolutionary building development, allowing for the testing of these proposals.

Moreover, this modularity provides the ability to build sun shelters in smaller portions of empty land, such as urban beaches, thus avoiding building demolitions, contributing toward mitigation and adaptation to climate change.

In a study with blind participants to assess sensory qualities of sun shelters in urban beaches, Pereira et al. (2024) identified materials, as stone, sand, solid wood, bamboo or cork. The design results showcase loggia spaces that engage users through tactile, auditory, and olfactory experiences, enhancing their overall sensory interaction with the environment. However, durability requirements demand an adequate application, e.g. bamboo was used on walls instead of the floor and as a finishing material in the relaxing area.

6. Conclusion

To address the increasing risks of mortality and injuries associated with climate change, this research explored inclusive and multisensory morphologies of urban loggias. These semi-open, covered spaces create microclimates that support passive cooling or heating, enhancing environmental performance whilst promoting spatial justice and urban rehabilitation.

Recent studies suggest that loggias can help mitigate extreme weather conditions, yet their potential remains underexplored in inclusive and multisensory architecture. While loggias have been extensively studied in architectural history and environmental design, their sensory and accessibility dimensions are often overlooked. To bridge this gap between theory and practice, this research employed a research-by-design approach, using the absence of sight to emphasize non-visual sensory modalities that are frequently disregarded in contemporary architecture.

By adopting qualitative research, we integrated the subjectivity of the researcher into the design process, enriching the spatial experience through a critical exploration of three key types of loggias in the city of Lisbon:

1. Public loggias—connecting building entrances and sidewalks;
2. Private loggias—integrated into residential buildings;
3. Semi-public loggias—providing sun shelters in urban beaches.

These real-life case studies exhibited both positive and negative spatial components, offering valuable insights into the complexity of urban loggia design.

- Public Loggia: Findings emphasize the need to design inclusive pathways adjacent to building facades, free from obstacles and protected by continuous loggia spaces. When sidewalk width allows, it is beneficial to provide a partially uncovered area, offering users the choice between walking under the loggia or in an open space, depending on sensory preferences and temporary climatic conditions.
- Private Loggia: Findings highlight the importance of integrating shading devices and designing balcony railings to prevent children from climbing and falling. Additionally, floor-mounted folding seats, positioned away from railings, can enhance child safety while maintaining free space for wheelchair users.
- Semi-Public Loggia: Findings underscores the necessity of designing sun shelter relaxation areas at different levels from the main promenade to minimize disturbances caused by pedestrian or vehicular movement.

However, these categories do not fully represent the diverse uses and morphologies of urban loggias. Future research should explore loggias in office buildings, where an inclusive and multisensory approach could create breakout spaces that reduce worker stress while enhancing outdoor connectivity. Such interventions could also lower energy consumption through passive cooling and heating, thereby contributing to urban resilience in the face of extreme temperatures.

Acknowledgments

We are grateful to the Foundation for Science and Technology's support through funding from the research unit CiTUA (10.54499/UIDB/05703/2020).

Moreover, we are grateful to Francisco C. Castro (renders), Margarida M. Pedroso and Pedro O. Teixeira, for the visual assistance to the first author, a blind person.

Conflict of Interests

The authors declare no conflict of interest.

References

- Afshari, F., Muratçobanoğlu, B., Mandev, E., Ceviz, M. A., & Mirzaee, Z. (2023). Effects of double glazing, black wall, black carpeted floor and insulation on thermal performance of solar-glazed balconies. *Energy and Buildings*, 285, 112919. <https://doi.org/10.1016/j.enbuild.2023.112919>
- Amorim-Maia, A. T., Anguelovski, I., Connolly, J., & Chu, E. (2023). Seeking refuge? The potential of urban climate shelters to address intersecting vulnerabilities. *Landscape and Urban Planning*, 238, 104836. <https://doi.org/10.1016/j.landurbplan.2023.104836>
- Castel' Branco, R., & Costa, A. R. (2024). From maximum urban porosity to city's disaggregation: Evidence from the Portuguese case. *Cities*, 148, 104836. <https://doi.org/10.1016/j.cities.2024.104836>
- Cordovil, R., Vieira, F., & Barreiros, J. (2012). Crossing safety barriers: Influence of children's morphological and functional variables. *Applied Ergonomics*, 43(3), 515-520. <https://doi.org/10.1016/j.apergo.2011.08.003>

- Denzin, N. K., & Lincoln, Y. S. (2005). Introduction: *The Discipline and Practice of Qualitative Research*. In: N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 1–32). London, UK: Sage Publications Ltd. ISBN 9780761927570
- Derakhshan, S., Bautista, T. N., Bouwman, M., Huang, L., Lee, L., Tarczynski, J., Wahagheghe, I., Zeng, X., & Longcore, T. (2023). Smartphone locations reveal patterns of cooling center use as a heat mitigation strategy. *Applied Geography*, 150, 102821. <https://doi.org/10.1016/j.apgeog.2022.102821>
- Devlieger, P., & Froyen, H. (2006). Blindness/City: A Disability Dialectic. In: P. Devlieger, F. Renders, H. Froyen, & K. Wildiers (Eds.), *Blindness and the Multi-sensorial City*, (pp. 17–38). Antwerpen, Belgium: Garant. ISBN 978-9044117394.
- Dien, H. H. E., & Woloszyn, P. (2005). The acoustical influence of balcony depth and parapet form: Experiments and simulations. *Applied Acoustics*, 66(5), 533-551. <https://doi.org/10.1016/j.apacoust.2004.09.004>
- Flick, U. (2009). *An Introduction to Qualitative Research*. London, UK: SAGE publications. ISBN 978-1-84787-323-1
- Foruzanmehr, A. (2015). People’s perception of the loggia: A vernacular passive cooling system in Iranian architecture. *Sustainable Cities and Society*, 19, 61–67. <https://doi.org/10.1016/j.scs.2015.07.002>
- Foruzanmehr, A. & Vellinga, M. (2011). Vernacular architecture: questions of comfort and practicability, *Building Research & Information*, 39:3, 274-285. DOI: 10.1080/09613218.2011.562368
- Fraser, A. M., Chester, M. V., & Eisenman, D. (2018). Strategic locating of refuges for extreme heat events (or heat waves). *Urban Climate*, 25, 109-119. <https://doi.org/10.1016/j.uclim.2018.04.009>
- Gamero-Salinas, J., Kishani, N., Monge-Barrio, A., López-Fidalgo, J., & Sánchez-Ostiz, A. (2021). Evaluation of thermal comfort and building form attributes in different semi-outdoor environments in a high-density tropical setting. *Building and Environment*, 205, 108255. <https://doi.org/10.1016/j.buildenv.2021.108255>
- Heylighen, A. (2010). Studying the unthinkable designer: Designing in the absence of sight. In: J. Gero (Ed.), *Design Computing and Cognition DCC' 10* (pp.23-24). Springer. ISBN-13 978-94-007-0510-4
- Heylighen, A., Nijs, G., & Pereira, C. M. (2023). RE-ARTICULATING PREVAILING NOTIONS OF DESIGN: About designing in the absence of sight and other alternative design realities. In: P. A. Rodgers & J. Yee (eds.), *The Routledge Companion to Design Research* (pp. 201-214). London & New York, UK & USA. DOI: 10.4324/9781003182443-19. ISBN: 978-1-032-02227-7
- Heylighen, A., Van der Linden, V., & Van Steenwinkel, I. (2016). Ten questions concerning inclusive design of the built environment. *Building and Environment*. <http://dx.doi.org/10.1016/j.buildenv.2016.12.008>
- Hilliaho, K., Köliö, A., Pakkala, T., Lahdensivu, J., & Vinha, J. (2016). Effects of added glazing on balcony indoor temperatures: Field measurements. *Energy and Buildings*, 128, 458-472. <https://doi.org/10.1016/j.enbuild.2016.07.025>
- IPQ (2009). *Guardas para edificios. Características dimensionais e métodos de ensaio*. NP 4491:2009. Caparica, Portugal: Instituto Português da Qualidade.
- Izadyar, N., Miller, W., Rismanchi, B., & Garcia-Hansen, V. (2020). A numerical investigation of balcony geometry impact on single-sided natural ventilation and thermal comfort. *Building and Environment*, 177, 106847. <https://doi.org/10.1016/j.buildenv.2020.106847>
- Juan, Y.H., Yang, A.S., Wen, C.Y., Lee, Y.T., & Wang, P.C. (2017). Optimization procedures for enhancement of city breathability using arcade design in a realistic high-rise urban area. *Building and Environment*, 121, 247-261. <https://doi.org/10.1016/j.buildenv.2017.05.035>
- Kearl, Z., & Vogel, J. (2023). Urban extreme heat, climate change, and saving lives: Lessons from Washington state. *Urban Climate*, 47, 101392. <https://doi.org/10.1016/j.uclim.2022.101392>
- Kondo, K., Mabon, L., Bi, Y., Chen, Y., & Hayabuchi, Y. (2021). Balancing conflicting mitigation and adaptation behaviours of urban residents under climate change and the urban heat island effect. *Sustainable Cities and Society*, 65, 102585. <https://doi.org/10.1016/j.scs.2020.102585>
- Leader, J. (2024). Strategies for the measurement and prediction of balcony insertion loss. *Applied Acoustics*, 216, 109806. <https://doi.org/10.1016/j.apacoust.2023.109806>
- Lee, J. S., & Han, A. T. (2024). Heat vulnerability and spatial equity of cooling center: Planning implications from the Korean case. *Urban Climate*, 55, 101869. <https://doi.org/10.1016/j.uclim.2024.101869>
- Lejeune, J. (1999). *Loggia en Ville: Convivialité et efficacité en logement collectif?* [Master thesis, École Polytechnique Fédérale de Lausanne].
- Li, F., Zeng, J., Huang, J., Zhang, J., Chen, Y., Yan, H., Huang, W., Lu, X., & Yip, P. S. F. (2019). Work-related and non-work-related accident fatal falls in Shanghai and Wuhan, China. *Safety Science*, 117, 43-48. <https://doi.org/10.1016/j.ssci.2019.04.001>
- Li, N., Miao, X., Geng, W., Li, Z., & Li, L. (2023). Comprehensive renovation and optimization design of balconies in old residential buildings in Beijing: A study. *Energy and Buildings*, 295, 113296. <https://doi.org/10.1016/j.enbuild.2023.113296>
- Lloyd, S., & Gifford, R. (2024). Qualitative research and the future of environmental psychology. *Journal of Environmental Psychology*, 97, 102347. <https://doi.org/10.1016/j.jenvp.2024.102347>
- Loche, I., Bre, F., Gimenez, J. M., Loonen, R., & Neves, L. O. (2024). Balcony design to improve natural ventilation and energy performance in high-rise mixed-mode office buildings. *Building and Environment*, 258, 111636. <https://doi.org/10.1016/j.buildenv.2024.111636>
- Mammoser III, J. H., & Battaglia, F. (2004). A computational study on the use of balconies to reduce flame spread in high-rise apartment fires. *Fire Safety Journal*, 39(4), 277-296. <https://doi.org/10.1016/j.firesaf.2003.11.011>

- Masoumi, H. R., Nejati, N., & Ahadi, A. A. (2017). Learning from the Heritage Architecture: Developing Natural Ventilation in Compact Urban Form in Hot-Humid Climate: Case Study of Bushehr, Iran, *International Journal of Architectural Heritage*, 11(3), 415-432. doi: 10.1080/15583058.2016.1238971
- Mesa-Pedrazas, Á., Nogueras-Zondag, R., & Duque-Calvache, R. (2023). The new town square: Twitter discourses about balconies during the 2020 lockdown in Spain. *Cities*, 143, 104595. <https://doi.org/10.1016/j.cities.2023.104595>
- Nayak, S. G., Shrestha, S., Sheridan, S. C., Hsu, W.-H., Muscatiello, N. A., Pantea, C. I., Ross, Z., Kinney, P. L., Zdeb, M., Hwang, S.-A. A., & Lin, S. (2019). Accessibility of cooling centers to heat-vulnerable populations in New York State. *Journal of Transport & Health*, 14, 100563. <https://doi.org/10.1016/j.jth.2019.05.002>
- Nunes, A. R. (2024). Resilience: Conceptualisations and challenges for effective heatwave public health planning. *Public Health*, 230, 113-121. <https://doi.org/10.1016/j.puhe.2024.02.023>
- Ortiz, L., Mustafa, A., Herreros Cantis, P., & McPhearson, T. (2022). Overlapping heat and COVID-19 risk in New York City. *Urban Climate*, 41, 101081. <https://doi.org/10.1016/j.uclim.2021.101081>
- Pallasmaa, J. (2012). *Pensamento em Forma. Dez ensaios sobre arquitetura*. Centro Regional das Beiras da Universidade Católica Portuguesa. ISBN 978-989-674-004-0.
- Pereira, C. M. (2013). *A Dimensão Multi-Sensorial da Arquitetura: Uma abordagem qualitativa ao espaço balnear marítimo centrada na invisibilidade [The Multi-Sensory Dimension of Architecture: A qualitative approach to the sea bathing space through invisibility]*, [Doctoral dissertation, University of Lisbon, Instituto Superior Técnico].
- Pereira, C. M., Heitor, T. V., & Heylighen, A. (2017). Exploring Invisibility through Multisensory spatial research methods in: *ECQI European Congress of Qualitative Inquiry*, Leuven, Belgium, February 7-10, 2017 (pp.9-18). KU Leuven. ISBN 9789067841979.
- Pereira, C. M., Heitor, T. V., & Heylighen, A. 2019. “Exploring Multisensory Qualities of Loggia Spaces for Urban Resilience to Climate Change.” *Modular Journal*, 2(2): 1-20. ISSN 2651 - 5210
- Pereira, C.M., Heitor, T.V. and Heylighen, A., 2020. Improving outdoor pools by combining insights from architectural history and spatial experience. In: *ARCHTHEO'20 /XIV. International Theory and History of Architecture Conference, Conference Proceedings*. Istanbul, Turkey, 6 November 2020. Istanbul: DAKAM. pp. 50-63. ISBN: 978-625-7034-03-6'
- Pereira, C. M., Heitor, T. V., & Heylighen, A. (2022a). Connecting experiences of balconies for more resilient cities, *Cities in a Changing World: Questions of Culture, Climate and Design 2021* (pp. 112-122). AMPS Proceedings Series 24.1. AMPS City Tech, CUNY, New York, USA
- Pereira, C. M., Heitor, T. V., & Heylighen, A. (2022b). Sun Shelters for Urban Beaches. In Husain, H. (Ed.). *Heritage and the City: Values and Beyond* (pp. 139-147). Cinius Yayınları. DOI: <https://doi.org/10.38027/N1ICCAUA202310>
- Pereira, C. M., Heitor, T. V., & Heylighen, A. (2023). Rethinking the public loggia to improve urban resilience to climate change. In: H. A. Nia, R. Rahbarianyazd (ed.), *6th International Conference of Contemporary Affairs in Architecture and Urbanism – Full paper proceedings of ICCAUA2023, Istanbul, 14-16 June 2023* (pp. 999-1009). Alanya, Türkiye: Municipality of Alanya & Alanya University. DOI: <https://doi.org/10.38027/iccaua2023en0079>
- Pereira, C. M., Heitor, T. V., & Heylighen, A. (2024). Exploring shaded spaces through experiences of blindness. In *Blind spots in architecture, RIXARCH II. International Architectural Design Conference Proceedings* (pp. 41-46), Riga, Latvia. ISBN: 978-9984-705-65-1
- Philokyprou, M., Michael, A., & Malaktou, E. (2021). A typological, environmental and socio-cultural study of semi-open spaces in the Eastern Mediterranean vernacular architecture: The case of Cyprus. *Frontiers of Architectural Research*, 10(3), 483-501. <https://doi.org/10.1016/j.foar.2021.03.001>
- Pollack, K. M., Bailey, M. M., Gielen, A. C., Wolf, S., Auld, M. E., Sleet, D. A., & Lee, K. K. (2014). Building safety into active living initiatives. *Preventive Medicine*, 69(Supplement), S102-S105. <https://doi.org/10.1016/j.ypmed.2014.08.010>
- Rodríguez-Algeciras, J., Tablada, A., Nouri, A. S., & Matzarakis, A. (2021). Assessing the influence of street configurations on human thermal conditions in open balconies in the Mediterranean climate. *Urban Climate*, 40, 100975. <https://doi.org/10.1016/j.uclim.2021.100975>
- Saleh, P. H. (2015). Thermal performance of glazed balconies within heavy weight/thermal mass buildings in Beirut, Lebanon's hot climate. *Energy and Buildings*, 108, 291-303. <https://doi.org/10.1016/j.enbuild.2015.09.009>
- Sehgal, N. K. R., & Sehgal, A. R. (2023). Spatial access to cooling centers in the city of Boston. *The Journal of Climate Change and Health*, 11, 100231. <https://doi.org/10.1016/j.joclim.2023.100231>
- Shamseldin, A. (2023). Adaptation opportunities for balconies to achieve continuity of their environmental functions. *Alexandria Engineering Journal*, 67, 287-299. <https://doi.org/10.1016/j.aej.2022.12.037>
- Sharmin, T., Steemers, K., Matzarakis, A. (2015). Analysis of microclimatic diversity and outdoor thermal comfort perceptions in the tropical megacity Dhaka, Bangladesh. *Building and Environment*, 94(2): 734-750. <https://doi.org/10.1016/j.buildenv.2015.10.007>
- Shields, B. J., Burkett, E., & Smith, G. A. (2011). Epidemiology of balcony fall-related injuries, United States, 1990-2006. *The American Journal of Emergency Medicine*, 29(2), 174-180. <https://doi.org/10.1016/j.ajem.2009.08.023>
- Sinou, M., & Steemers, K. (2004). Intermediate space and environmental diversity. *Urban Design International*, 9, 61–71. DOI:10.1057/palgrave.udi.9000113
- Tablada, A., DeTroyer, F., Blocken, B., Carmeliet, J., & Verschure, H. (2009). On natural ventilation and thermal comfort in compact urban environments – the Old Havana case. *Building and Environment*, 44, 1943–1958. DOI: 10.1016/j.buildenv.2009.01.008

- Tang, S. K. (2018). Reduction of sound transmission across plenum windows by incorporating an array of rigid cylinders. *Journal of Sound and Vibration*, 415, 25-40. <https://doi.org/10.1016/j.jsv.2017.11.027>
- Turner, J. V., Spallek, M., Najman, J. M., Bain, C., Purdie, D. M., Nixon, J., Scott, D., & McClure, R. (2006). Socio-economic distribution of environmental risk factors for childhood injury. *Australian and New Zealand Journal of Public Health*, 30(6), 514-518. <https://doi.org/10.1111/j.1467-842X.2006.tb00778.x>
- Vermeersch, P. W. (2013). *Less Vision, More Senses. Towards a More Multisensory Design Approach in Architecture* [Doctoral dissertation, KU Leuven].
- Wang, X., Mao, D., Yu, W., & Jiang, Z. (2015). Acoustic performance of balconies having inhomogeneous ceiling surfaces on a roadside building facade. *Building and Environment*, 93(Part 2), 1-8. <https://doi.org/10.1016/j.buildenv.2015.06.027>
- Xue, P., Jia, X., Lai, D., Zhang, X., Fan, C., Zhang, W., & Zhang, N. (2021). Investigation of outdoor pedestrian shading preference under several thermal environments using remote sensing images. *Building and Environment*, 200, 107934. <https://doi.org/10.1016/j.buildenv.2021.107934>
- Yang, W., & Jeon, J. Y. (2020). Design strategies and elements of building envelope for urban acoustic environment. *Building and Environment*, 182, 107121. <https://doi.org/10.1016/j.buildenv.2020.107121>
- Yang, Q., Li, N., & Chen, Y. (2021). Energy saving potential and environmental benefit analysis of application of balcony for residence in the hot summer and cold winter area of China. *Sustainable Energy Technologies and Assessments*, 43, 100972. <https://doi.org/10.1016/j.seta.2020.100972>
- Yıldırım, M. (2020). Shading in the outdoor environments of climate-friendly hot and dry historical streets: The passageways of Sanliurfa, Turkey. *Environmental Impact Assessment Review*, 80, 106318. <https://doi.org/10.1016/j.eiar.2019.106318>