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*Article*

# Residents' Experiences of Privacy and Comfort in Multi-Storey Apartment Dwellings in Subtropical Brisbane

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**Abstract:** Dwellings in multi-storey apartment buildings (MSAB) are predicted to increase dramatically as a proportion of housing stock in subtropical cities over coming decades. The problem of designing comfortable and healthy high-density residential environments and minimising energy consumption must be addressed urgently in subtropical cities globally. This paper explores private residents' experiences of privacy and comfort and their perceptions of how well their apartment dwelling modulated the external environment in subtropical conditions through analysis of 636 survey responses and 24 interviews with residents of MSAB in inner urban neighbourhoods of Brisbane, Australia. The findings show that the availability of natural ventilation and outdoor private living spaces play important roles in resident perceptions of liveability in the subtropics where the climate is conducive to year round "outdoor living". Residents valued choice with regard to climate control methods in their apartments. They overwhelmingly preferred natural ventilation to manage thermal comfort, and turned to the air-conditioner for limited periods, particularly when external conditions were too noisy. These findings provide a unique evidence base for reducing the environmental impact of MSAB and increasing the acceptability of apartment living, through incorporating residential attributes positioned around climate-responsive architecture.

**Keywords:** air-conditioning; apartment; comfort; climate-responsive design; multi-storey apartment building; natural ventilation; noise; outdoor living; privacy; resident satisfaction; subtropical

## 1. Introduction

Apartment buildings are proliferating in almost all major cities in subtropical and tropical countries globally. In Brisbane, a large Australian city in the subtropical zone, apartments are predicted to increase dramatically as a proportion of Brisbane's housing stock over coming decades [1]. This presents problems for the city's key urban sustainability and greenhouse gas emissions reductions policies [2]. Firstly, compared to other multiple-housing types, apartment buildings are intrinsically energy-intensive and may actually contribute to greater overall urban energy consumption and increased greenhouse gas emissions [3–6]. In recent decades there has also been an inexorable trend toward air-conditioning becoming the default climate control solution despite the subtropical climate requiring few energy inputs for thermal comfort. Secondly, Australians prefer the relative autonomy and spaciousness of a detached house and are likely to choose apartment living for transitory periods of their lives, rather than long-term [5]. This may be because apartment buildings currently fail to provide suitable accommodation for various demographic groups, and ultimately outer urban expansion is stimulated rather than dampened by inner-urban construction of apartment buildings that meet a narrow market band [6]. These issues confirm that congruity between people and their living environments is important for sustainable development [7]. The challenges of designing comfortable and healthy residential environments that can better meet residents' expectations of desirable places to live, and minimising energy consumption must be addressed urgently in Australia's cities and cities in other warm climate countries, almost all of which are experiencing rapid growth in high-density residential environments.

The limited long-term appeal of apartments may be due to a mismatch between available housing stock and people's expectations of liveable attributes of dwellings [8] rather than apartment living itself. Several studies of multi-storey residential environments have identified privacy and building quality as important influences on residents' perceptions of liveability [9–13]. Privacy is measured by the extent to which residents can control the intensity of their interaction with neighbours, and is indicated by the amount of ambient noise, noise from neighbours and the amount of outside space for personal use [14]. Building quality indicates a physically healthy residential environment and is measured by standard of construction and energy efficiency [11,14] alluding to a focus on thermal comfort.

Climate-related lifestyle needs are frequently overlooked in residential environment satisfaction research, but are an important aspect of subtropical cities where the climate is conducive to outdoor living all year round. The subtropical humid climate zone has no distinctly dry season [15] and though summers are hot and humid, and winters are cool, the ambient outdoor temperatures (19–29 °C in summer and 9–21 °C in winter) are within a comfortable range for much of the year [16,17]. Humidity is the main factor affecting thermal comfort in subtropical settlements, and is most noticeable when air temperature is high and wind velocity is low [18]. Thus ways of generating air movement or capturing breeze are sought after when these conditions prevail in summer, and sometimes on autumn and spring days. In principle, MSABs can be designed to respond to the climate, by effective use of solar orientation of buildings and external shading devices to admit or exclude direct sun when seasonally appropriate, and siting of openings to effectively generate air movement to reduce the effects of humidity in summer [16,19], yet thermal comfort for dwellings is increasingly provided by air-conditioning. Despite the advantages and disadvantages of the mild subtropical climate, the climate zone is relatively under-researched, in terms of the relationship between climate, multi-residential building design and residents' perceptions and experiences of this relationship. For example, many domestic activities are conducted in exterior private spaces such as verandas, balconies and terraces [20] and are a characteristic feature of multi-storey apartment buildings (MSABs) in subtropical cities like Brisbane (Figure 1). Residents occupying such spaces in dwellings in are potentially exposed to noise discomfort. Noise from external sources such as traffic and roof-top air-conditioning plant is prevalent in urban areas where MSAB are located. Residents using balconies may also be exposed to noise from neighbours, and may generate noise that could bother their neighbours.

**Figure 1.** Multi-storey apartment buildings (MSAB) in Brisbane typically feature balconies on their facades. Source R. Kennedy.

This purpose of this paper is to explore residents' experiences of liveability in apartment dwellings in the subtropical climate. In particular, we focus on residents' perceptions of privacy and comfort, and their satisfaction with the extent that their dwelling modulated the external environment and met their privacy and comfort expectations in subtropical conditions. This research on the impact of apartment building design on liveability and on urban energy needs more broadly is much-needed in the context of Australia's subtropical cities, and will have resonance in almost all major cities in subtropical and tropical zones globally where high-density apartment living is a fact of contemporary society.

## 2. Physical and Social Characteristics of Multi-Storey Apartment Living

A defining aspect of multi-storey apartment living generally is the extent to which everyday lifestyles are affected by proxemics and sharing [21–23]. In the home environment, proxemics are linked to privacy, and concern notions of personal space, particularly the preference or desire for a place that is identified as one's own [24,25]. An important part of this feeling of ownership is autonomy, the right to personalise, and the freedom to adapt one's personal space to one's own needs or desires. Another critical aspect of proxemics is that being separate from others is preferred to sharing [25]. Privacy is an expectation of exclusion from intrusion and preventing the world from encroaching [26]. King's notion of a private place as a thing kept "apart" (p. 54) is an appropriate description for the private dwelling in a multi-residential building—the apartment. People desire both connection with the community, and privacy. They want reciprocal relationships that include living privately with "polite indifference" (p. 57) with their neighbours, and to be able to call on each other for help in a crisis [26]. Thus, privacy is associated with peace of mind and with the freedom of personal space.

However, residents of MSAB share walls, ceilings and floors with their neighbours adjacent, above and below them [27], as well as collective entries and circulation spaces, parking garages and communal facilities such as swimming pools, washing lines, gardens and barbeques. They also share the hardware (ducts, pipes and wires) delivering services such as energy, water, drainage, waste management and communications to their dwellings. Furthermore, because most apartment buildings in Australia are generally multi-title (strata title) developments and owners form a "body corporate" entity, residents share governance and management arrangements as well [28,29]. In order to avoid or manage social issues that these sharing circumstances could generate, resident cohesion is very important and a level of familiarity on which to base positive interrelationships is essential [30]. However, there is an overall impression of social withdrawal among residents of apartment buildings [31]. A level of anonymity may permit privacy in a setting where physical proximity makes it otherwise difficult to achieve [32], and the careful balance of privacy and territorial control is a key factor in the success of MSAB design.

*Resident Perceptions of Comfort*

Residents' comfort is situated on a spectrum where their physiological and psychological needs are met [11,33,34] and are in balance [35]. Comfort parameters comprise both quantifiable factors, (for example, thermal comfort, acoustics, air quality and illumination) and qualitative considerations (for example, perceptions of privacy and personal control over the comfort of one's private space). All elements interact and influence the way occupants use a dwelling and a building, and consequently their appreciation for how the overall design functions or is best modulated [36]. For example, in Singapore, a tropical city, residents on lower floors of MSAB were concerned about noise from passers-by and street traffic, as well as view obstructions, lack of privacy, and odours from garbage, [13,37–41] while dwellings on higher floors were sought-after for cleaner air [42] less noise, more privacy and better views [13]. In Vancouver, a city in the Temperate Zone, residents of MSAB valued large windows for views, much-needed natural light and a sense of spaciousness, but also reported overheating and visual privacy issues [43].

The climatic variables, air temperature, humidity, radiation and air movement influence an individual's sensation of thermal comfort simultaneously with many subjective factors such as level of clothing, age, gender, health and personal preferences. Ventilation may be perceived to be adequate for thermal comfort when velocity of air movement is appropriate for level of activity, and [44,45] and acceptable when air quality is not marred by unpleasant odours or stale air [46].

Various studies have identified noise in the urban residential environment as the greatest source of annoyance to residents [10]. Aural comfort is experienced when sound levels are acceptable for the prevailing spatial-temporal conditions, including perceptions of acoustic privacy, and stressful or annoying or loud noises are absent [47]. Natural lighting and views to natural surroundings are associated with beneficial social and psychological effects [48,49].

Generally, people are not overtly aware of ambient physical conditions and tolerate a range of variation [50] unless comfort limits are exceeded. The design challenge is to utilise the physical attributes of building design and performance (construction quality) to create an environment that is acceptable to most building users and conducive to human comfort and well-being. Focussing solely on objective measures (such as thermal comfort) does not ensure good design and does not necessarily account for occupants' well-being [51]. Therefore, a well-designed dwelling is one which provides a diverse range of conditions that enables individuals to meet their personal sensory requirements when and where desired, for example noise at night in bedrooms is not desirable, but well-ventilated bedrooms are recommended for sleep health. Residents' understandings of what makes a good environment in the domestic setting is influenced by the relative importance they place on the need for personal control with other social and cultural influences [51,52]. Currently, few researchers have specifically examined the relationship between privacy and comfort of the individual dwelling within the MSAB and residents' everyday dwelling practices in the subtropical climate and lifestyle context.

## 3. Research Design and Method

This paper on residents' experiences of privacy and comfort and the actions they take to modify the effect of the external environment on their dwellings' comfort performance, presents a subset of qualitative and quantitative data obtained from an extensive study investigating the positive and negative social, environmental and economic impacts that residents associate with higher density (HD) living in a subtropical environment. At the outset it is important to note that the founding study investigated residential satisfaction [53] and the findings indicated quite a high degree of congruity between these residents and their HD environments. Most residents were extremely satisfied with the overall HD residential environment, when taking into account their neighbourhood, neighbours and dwelling. Overall, the findings indicate a strong sense of belonging and security with most residents indicating that they would regret it if they had to move (p. 334). Nevertheless, several environmental aspects that depreciated their living experience, including traffic noise, dust and sirens, were identified. These data indicate that there is a difference between the predictors of residential satisfaction and the attributes that residents perceive to be important indicators of environmental quality.

### *Procedure and Participants*

The inner city urban area of Brisbane was identified using the boundary defined by the Australian Bureau of Statistics. Within this boundary, six precincts demonstrating the following characteristics were purposively selected: they support residential densities greater than conventional Brisbane suburbs (based on 30–45 dwellings per hectare compared to 8–12 dwellings per hectare); have diverse land uses and services; have multi-dwelling housing typologies diverse in design and age; have a culturally diverse population; and have an engaged community. As well, these precincts represent areas with and without obvious amenity impacts (such as, heavy traffic generating noise and air pollution). Within each precinct, all multi-dwelling buildings and the total number of apartments within each building were identified, representing the HD population of the sample. A proportionate sampling technique was applied to select one third of the dwellings within each building, within each precinct. 2311 households received a postal questionnaire on "Living in the City", to be completed by the household member (18 years or older) who had most recently had a birthday. There was a 28% response rate, with 636 questionnaires returned by post. While most addresses included in the survey were in MSAB, it is possible that some respondents lived in other types of multi-residential buildings such as walk-up flats, duplex, boarding houses, or warehouse/lofts.

Participants answered approximately 140 open and closed questions about their current dwelling, neighbourhood and neighbours, quality of life and social capital. Standard socio-demographic categories drawn from the Australian Bureau of Statistics 2006 census [54] were used to obtain relevant data on respondents' personal characteristics. Data for this paper were obtained from questions on design characteristics such as spatial properties of the dwelling, access to breezes and natural light, indoor climate of the dwelling, view from the dwelling, privacy, construction quality, and whether the dwelling is designed to suit the local Brisbane climate. A variety of Likert scales (typically scales with one to five response alternatives ranging from "not at all" to "extremely", with "fairly" being the midpoint on the scale) allowed residents to circle the appropriate response indicating their level of agreement with a statement, level of satisfaction with a dwelling element and level of awareness about an issue or design aspect. Binary "yes/no" responses were also included. Open ended questions allowed participants to add an extra response. Analysis of the questionnaire was conducted using the Statistical Programme for Social Sciences (SPSS), with basic descriptive statistics such as frequencies, percentages and means calculated for all residents. The open-ended questions were analysed thematically to identify key terms that were regularly invoked by the respondents.

In addition, follow-up repeated semi-structured qualitative interviews with 24 residents, explored issues in more depth and covered their likes and dislikes of their current dwelling and neighbourhood, social contacts within the dwelling, opinions on sustainability, and design perceptions. Interviews, which were recorded and transcribed verbatim, provided rich narrative data. A thematic analysis identified key themes expressed by interviewees. More men (14) than women responded to the invitation to be interviewed, while most interviewees were owners (19). Survey respondents were predominantly aged between 25 and 59 years old (71%) and female (60%). Households were predominately one (31%) or two people (54%). The low number of households with children under 18 years old (7%) was a critical difference between the respondents and the resident population of the local statistical area (21%) [53]. The number of renters in the study sample (44%) was higher than the ABS 2006 Census data for Brisbane area (30%), possibly illustrating the more transient nature of this population [53]. The remainder were either owners (27%) or paying off their mortgage (28%). Participants had been living in their present dwelling for an average of 3 years and 5 months. The longest period of residency was 39 years, while the shortest was one month. Respondents lived on various floor levels, ranging from below ground (one respondent) to the 19th floor (one respondent), with the majority located on floors 1–3 (68%).

## 4. Results and Discussion

### *4.1. Dwelling Functional Characteristics*

Table 1 below describes the number and type of functional spaces of dwellings described by residents. Most dwellings contained at least two bedrooms and two bathrooms, and other normal domestic functional spaces. The majority had at least one outdoor private space (balcony or courtyard) while 5.6% had no outdoor space for their exclusive use.

**Table 1.** Number and type of functional spaces in dwellings.

| Space Type | Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| Bedroom | 0.3% | 17.6% | 55.8% | 23.8% | 2.4% | 0.2% | |
| Living room | 0.3% | 90.9% | 8.5% | 0.3% | | | |
| Kitchen | | 99.8% | 0.2% | | | | |
| Bathroom | | 37.2% | 57.8% | 4.9% | 0.2% | | |
| Outdoor private space | 5.6% | 54.8% | 28.0% | 9.4% | 1.9% | 0.2% | 0.2% |
| Laundry (private) | 6.0% | 91.2% | 2.3% | 0.2% | 0.2% | | |
| Laundry shared | | 5.5% | 0.5% | | | | |
| Car parking space | 4.5% | 64.1% | 28% | 2.7% | 0.6% | | |

A limitation of this study is that the floor plans of the apartment buildings and the different types of configurations of floor layouts and individual plans of dwellings including balcony private outdoor space were not directly recorded for reasons of anonymity of survey and interview respondents. Thus the spatial characteristics of apartments such as the size of rooms, heights of ceilings, and widths of balconies are not described in this paper. In response to an open-ended survey question, one of the most frequently cited issues that residents would change about their dwelling if they could related to adding or increasing the size of their balcony or other outdoor private area. (Refer to Table 5 below).

### *4.2. Perceptions of Privacy*

Privacy was highly valued by 91% of residents. (60% considered privacy as "important" or "very important", and 31% considered privacy to be "extremely important"). Overall, residents were "fairly satisfied" with privacy from neighbours (mean = 3.67). Most (88%) considered aural privacy to be more important than visual privacy (75%). This suggests that ability to control noise travelling between apartments was more of a problem for residents than their ability to control being seen. Balconies or other exterior private spaces, were also associated with lack of privacy for residents, but there were mixed attitudes. Despite a general preference for outdoor living (described later), residents expressed a desire for privacy and to not have to hear, register or engage with sounds made by other residents in the building. At the same time, residents were conscious of maintaining their own privacy, and not annoying the neighbours with loud conversations. Unsurprisingly, privacy was an important consideration for 77% of respondents when selecting their current accommodation. Interview data (See Table 2) confirmed that residents were highly aware of the need for aural privacy for themselves, and for neighbours in the building. Residents did not want to feel pressure or obligation to talk to neighbours, and preferred to confine their relationship with their neighbours to a polite greeting. Some residents also expressed a preference for their balcony to face the street rather than a communal courtyard. In these ways, residents used a degree of "anonymity" to manage physical and psychological boundaries between themselves and immediate neighbours as unobtrusively as possible.

**Table 2.** Residents' perceptions of appropriate MSAB dwelling design for privacy and comfort in the subtropical climate.

| Issue | Indicative comments |
|---|---|
| Proximity and aural privacy | *I think that especially with apartment living, because you are that much closer. With a house you have a bit more space between you and your neighbour so that the noises and everything's not so close and you don't know so much about them. Whereas apartment living, it can be really quite intimate at times. You can hear fighting; you can hear bathroom sounds and all that sort of stuff. (5#)* |
| Preference for anonymity—cordial but not sociable | *I don't know my neighbours even though you would think you would. ... I will say hello if I see them….I like that when we go out we don't have to stand and have a little chat every five minutes you can just come and do your own thing. (#6)* |
| Preference for outward facing private balcony | *Some balconies back on to that main (communal courtyard) area and we wouldn't have taken it had that been our only option. We needed to be above (the street) without having people walking by and looking in. (#6)* |
| Orientation and thermal comfort | *In winter I find the apartment's very warm because you get the sun because we face east and north so that's pretty good and in summer time it really doesn't get that hot. I mean even on a hot day the unit is not hot. (#8)* |
| | *This is about the best in the block. It's on the right side of the building. Because you don't get the summer sun so it's much cooler. When they come in from next door, they say 'you haven't even got the air conditioning on' and they've got theirs belting away next door. And this is all a nice cool breeze coming in most of the time. And in the winter it's warm again." (#7)* |
| Spatial characteristics and liveability: natural light, high ceilings, and view | *(I like) its height, its layout, there's light… There's plenty of light. (#3)*<br>*It [the view] is good for unit living you don't feel confined. (#7)* |
| Balcony as extension of living area | *The best point about this apartment is definitely this area – the lounge area opening onto the balcony." (#6)* |
| Balcony essential feature of subtropical design for living | *Otherwise we'd want a townhouse and a courtyard where you could go and sit out in. Especially with the climate we've got here. (#7)* |
| | *I think it's one of the worst designs I've ever seen in my life. There's actually no outdoor living what so ever, no balconies at all. You've got windows that you can just open the top, from memory when I was in there just the top part of the window opened and that was about it. You're relying totally really on air conditioning and a controlled environment. Ah, and I think that's bad. (#2)* |
| | *So, anybody that builds units without awnings, without balconies, without areas where there's a transition between outside and inside is just nuts because they're just not thinking of the lifestyle of the people who are going to be living in them. (#1)* |

### *4.3. Perceptions of Suitability of Dwelling Design for Subtropical Climate*

Overall, residents assessed design quality to be satisfactory when measured in terms of their spatial layout (mean = 3.89), internal and external upkeep (mean = 3.87 and 3.70 respectively) standard of construction of the building (mean = 3.56), and energy efficiency of their dwelling (mean = 3.30) indicating an overall sense of a physically and psychologically healthy environment. However, mean satisfaction with the extent their dwelling design suited the subtropical climate was 3.57. Just over half (56%) perceived that their dwelling was appropriately designed for day-to-day comfortable living in the subtropics, whereas the remainder were either neutral (32%) or dissatisfied (13%). See Table 3 below. Nevertheless 71% found their dwellings to be thermally comfortable, with satisfactory air movement, levels of natural light, and many were satisfied with the view. However, thermal comfort and air-movement could be improved for nearly one third of dwellings while 42% of the residents reported that they were "fairly" to "not at all" satisfied with natural light levels in their home.

**Table 3.** Residents' levels of satisfaction with suitability of dwelling design for local climate.

| Likert Scale Response | 1 Not at all | 2 A Little | 3 Fairly | 4 Very Much | 5 Extremely |
|---|---|---|---|---|---|
| | % | % | % | % | % |
| Overall performance | 3.5 | 8.8 | 32.3 | 38.3 | 17.2 |
| Thermal comfort | 1.3 | 5.7 | 22 | 50 | 21 |
| Access to breeze | 3.6 | 8.2 | 16.8 | 40.6 | 30.7 |
| Natural light | 2.5 | 18.2 | 21.2 | 42.7 | 25.4 |
| View | 5.3 | 10.5 | 20.2 | 26.3 | 37.7 |
| Noise | 10.6 | 18.4 | 32.4 | 31.3 | 7.2 |
| Outdoor air quality | 6.5 | 10.7 | 28.0 | 37.8 | 17.0 |
| Natural surroundings | 3.8 | 6.3 | 23.8 | 37.4 | 28.7 |

Critically, noise was the environmental phenomenon that bothered residents most, with 61% reporting being "fairly" to "not at all" satisfied. Residents heard neighbours' voices, music or sounds from animals less frequently (mean = 2.60) than motorcycles or cars, which were heard most commonly (mean = 3.12), but 42% of residents found the noises made by other people, including from nearby houses, most annoying. Apart from neighbours' voices, other types of resident-identified noise included traffic noise, construction noise, and noise from wildlife. Interestingly, while not all of these were seen as intolerable, 41.5% rated traffic noise as the most annoying form of pollution followed by smog (30.5%) and dust in the air (21.4%).

Some residents acknowledged the role of orientation, air flow and thermal mass in their experiences of year round comfort of their residence. Interview data also revealed that views, natural light and high ceilings were also associated with spaciousness and liveability in the subtropics. See Table 2. While these aspects are not unique to the subtropics, they have resonance with subtropical residents because much inner-urban MSAB stock in Brisbane was developed from the 1970s to the 2000s and has 2400 mm ceilings, the minimum acceptable ceiling height of habitable rooms under the *Building Code of Australia* [55]. Such low ceilings, though legal, are perceived to be undesirable because they limit the potential for daylight admission and do not allow warm air to rise above the occupied zone of rooms. They are also considered by many to be too low to comfortably operate ceiling-mounted fans.

Higher ceilings are valued in naturally ventilated buildings because warmer air can rise above the activity zone of rooms.

Having a functional outdoor space for their exclusive use was considered to be an integral part of the subtropical urban lifestyle. The vast majority of residents (89%) reported that they had a balcony in their dwelling, and 87% considered the specific physical and spatial design characteristics of the balcony to be an "important" to "extremely important" influence on their experiences of spaciousness for everyday living functions, and control over privacy, and indoor environment comfort. See Figure 2.

**Figure 2.** Balconies are valued for outdoor living and views but also provide an environmental buffer between dwelling interior and noise and dust of external urban environment. Source: Queensland University of Technology QUT) Centre for Subtropical Design.

Most respondents described how they utilised their balconies for a wide variety of home-based activities such as entertaining (85%), preparing and eating meals (74%) and gardening (66%) on their balconies. Drying laundry (62%) and storage (19%) were also important functions of the balcony. Residents frequently used their balconies for hobbies and everyday activities, such as reading, relaxing, studying, keeping pets, exercising or just sitting out. Contentiously, some residents smoked on their balconies, causing annoyance to residents of other dwellings. In the interviews, lack of a balcony or usable private exterior space was considered to be an omission in good apartment design. (Refer Table 2 above).

### *4.4. Managing Acoustic and Thermal Comfort—Natural Ventilation* versus *Air Conditioning*

The majority of residents (66%) rated the average temperature of their living space as comfortable (neither too warm nor too cool). Notably, 78% of households reported having some kind of air-conditioning system (the majority of these, 52%, were reverse-cycle split systems and 10% of dwellings that were air-conditioned also had ceiling fans). 27% had ceiling fans in their dwelling but no air conditioning. While 9% of residents used the air-conditioning all summer, most (61%) only used air-conditioning on a few days or nights, with 15% stating that they had air-conditioning in their dwelling yet did not use it. Residents reported taking active steps to manage their thermal comfort within their dwelling (see Table 4 below). In summer, the most frequent strategy was to use natural ventilation by opening the windows and doors (83%). Turning on air-conditioning (63%) was the second most frequent strategy. Half (53%) adjusted their blinds, or turned on a personal portable fan (40%) and/or ceiling fans (24%).

**Table 4.** Resident actions to manage climate control in their dwelling in summer.

| Action | Yes | No |
|---|---|---|
| Open windows/doors | 83% | 17% |
| Turn on air conditioner | 63% | 37% |
| Open or close blinds and shutters | 53% | 47% |
| Turn on portable or personal fan | 40% | 60% |
| Turn on ceiling fans | 24% | 76% |

Despite the desire for air movement, the lack of ceiling fans in apartments is noteworthy. This is likely to be attributable to low (minimum 2400 mm) ceilings in many dwellings. Meanwhile, some residents had made modifications or adjustments to the outside of their dwelling to improve thermal comfort, such as adding air-conditioning units (17%), sunshades or external shading (12%) and enclosing balconies (3%). In response to an open-ended question about what they would like to change about their dwelling to increase overall satisfaction, 16% of all responses (total = 875) related to modifications to aid thermal performance and outdoor lifestyle. See Table 5 below.

**Table 5.** Resident-identified proposals to increase dwelling satisfaction.

| Proposed Modification | Frequency | % |
|---|---|---|
| Increase balcony size | 22 | 2.51 |
| Add awnings to block noise and provide shade | 19 | 2.17 |
| Orientation | 16 | 1.83 |
| Natural ventilation | 14 | 1.60 |
| Increase private outdoor space | 11 | 1.26 |
| Add/install/upgrade air conditioning | 10 | 1.00 |
| Add a balcony | 8 | 0.91 |
| Natural light | 8 | 0.91 |
| More outside areas | 7 | 0.80 |
| Larger outdoor areas | 3 | 0.34 |
| More windows | 5 | 0.57 |
| Improve privacy on balconies | 3 | 0.34 |
| Add ceiling fans | 4 | 0.46 |
| Add double glazing | 4 | 0.46 |
| Better ventilation | 4 | 0.46 |
| Separate a/c internally (zoning) | 2 | 0.23 |
| Add insulation to reduce temperature | 1 | 0.11 |
| Add water taps for gardening on balconies | 1 | 0.11 |
| **Total** | **142** | **16%** of 875 responses |

Some residents also linked air-conditioning with unpleasant odours or stale air, and were happy to avoid it. However, in an urban context where the potential for traffic noise annoyance and indoor air quality issues is high and amenity issues compel residents to use air-conditioning rather than keeping windows open. While most evaluated their dwelling as being appropriately designed for the subtropical climate, they perceived that "openness" has privacy and noise implications in MSAB environments, while a "closed" residential environment implies an undesirable reliance on air-conditioning.

Residents interviewed were strongly aware of the link between thermal comfort, energy conservation, and the cost of living, and nominated various active steps they had taken to reduce reliance on air-conditioning, including installing physical barriers and limiting their usage of air conditioning. Some residents used air-conditioning during summer at certain times, and particularly at night to avoid sleep interruptions from noisy traffic and sirens, but using air-conditioning in winter was an anathema to them. Finally, air conditioning condensing units are also often installed on balconies and are implicated in loss of outdoor amenity for residents. As well as generating excess heat and noise for the occupants of the dwelling itself and for adjacent apartments including those above or below, causing dissatisfaction. See Table 6 below).

**Table 6.** Some resident issues and solutions for managing comfort and privacy.

| Issue or Action | Indicative Comments |
|---|---|
| Physical barriers to manage thermal comfort | *We put blinds up that are thermal. They knock out all of the U.V. rays as well as in winter time keep the heat in and keep the cold out to ninety eight percent. (#22)* |
| Limiting a/c usage, and conserving energy by opening windows for air flow | *We try and use the air conditioner as little as possible, and so we haven't used it at all this year. Last year we probably used it 3 or 4 times, maybe a couple of hours but generally if you open the windows you get a good breeze, it's generally fine.…" (#14)* |
| | *I open the back door and let the breeze go through. That's just the simplest form of conserving energy. Most people would go and turn the air conditioner on. Well, there are times in the year where I have to do that but, you do simple things with what you've got to reduce the amount of energy you take to live there and you can live more cheaply and very, very comfortably. (#16)* |
| Limiting a/c usage | *I do use air-conditioning, yes. Probably only in the summer time from about say, 4 in the afternoon through until 8 at night. (#12)* |
| Seasonal norms | *I never put the air-conditioner on heat (in winter). It would be very strange to do it. (#12)* |
| Indoor air quality concerns | *I don't really like that idea of having a common tube of air conditioning flowing in from one room and out of that room and into the next room. Cooking smells and cigarette smells and all those sorts of things permeate your building. So the upside is it's got good airflow when I open the window (#1)* |
| Noise and dust concerns | *Then you get the brake dust that comes up and the city pollution that dirties your balcony and furniture. So if you leave the doors open all the time you get the nice breeze coming through, but then you get all the dust and the pollution. (#19)* |
| External noise and interrupted sleep | *If it wasn't for the traffic noise [I would open the windows at night]. But I mean this sort of noise ... is worse at night ... during the day it's a steady noise. At night you'll get a motorbike roar past, an ambulance go by with the sirens going or that sort of thing, heavy trucks. If anything it's worse at night than during the day. There might be less vehicles but it's a different type of noise. (#16)* |
| | *Sometimes we open the windows, but in the bedroom we never open the door because you don't want the noise when you're sleeping (#19)* |

**Table 6.** *Cont.*

| Issue or Action | Indicative Comments |
|---|---|
| Inappropriate location of air-conditioning condenser units | *Our bedroom and our flatmate's bedroom go on to a little balcony and it's nice you can go and sit there but the air-conditioning [condenser] is on the wall, the big fan, so it just blows everything – hot air. So if you put pot-plants out there they just burn… you can't sit out there with that air blowing, it's like an oven. It heats our room up (#6)* |
| | *The builders mounted the air conditioning units, for the adjoining unit there, right by where our bed head is supposed to go. So during the night when they're running their air conditioners you hear the air conditioners groaning away. I mean that is a stupid building design (#16)* |
| Body Corporate restrictions | *We virtually have to dry everything (in the clothes drier) because we have strict rules: you shall not hang washing out on the balcony and that's common to most properties (#16)* |

### *4.5. Private Open Space—Subtropical Living and the Contradictory Roles of Balconies*

The apartment balcony offers flexibility and provides an alternative space that is distinct from the indoor living environment. Importantly a private balcony allows the resident to move to an outdoor space without leaving the residence, and without necessitating social contact. As one resident explained, "*You need that balcony. You need to be able to get outside*"*(#2).* For some residents, balconies are clearly providing flexible space for a diversity of activities including storage (thus providing an intermediate space as described by Steele and Keys [56] while for others, the short-comings of balcony design (too small, too hot, not private enough) are disappointing.

Ideally, in the residential environment, private exterior spaces, like gardens or verandas, allow residents a degree of privacy and territorial control as well as options to contact and interact with adjacent public space or neighbouring properties [57]. Ozaki [58] also discusses formality rituals and the impact on the way domestic space is used—the perception of the "front" and "back" regions of the dwelling is closely associated with the demarcation between the public symbolic life and the private secular life. The extent to which private outdoor space is revealed to public view is a unique aspect of MSAB living, and multiple contradictory expectations are placed on this space by regulators or other stakeholders. For example, the balcony is an individual's access to open space for private utility purposes but these spaces are often located at the "front" of a building (where it interacts with surrounding neighbourhood), and some activities traditionally associated with "backyard" use in detached housing—for example, drying laundry and airing bedding may be considered to be unsightly at the front of MSAB [59] particularly where a high degree of transparent glazing applied to balcony balustrades provides minimum privacy and exacerbates problems of perceived "unsightliness" by others. (See Figure 3). In some cases, MSAB bodies corporate governing use ruled such activities to be carried out indoors. If clothes driers are used in the private dwelling, energy use and air quality are significantly negatively affected. As well as problems of unsightliness and lack of utility for residents, extensive glazing on facades and balconies may also compromise resident privacy, indoor air quality, energy use, and shade and thermal comfort on balconies.

**Figure 3.** Glazing on balconies reveals private outdoor space and everyday domestic activities to view. Source: R. Kennedy.

Kearney [60] found that when building orientation maximised residents' views to nature and minimised views of traffic and neighbours, negative feelings about density were reduced. However some planning codes also rely on exterior private space that overlooks streets to provide casual surveillance in the community. In many cases, this means overlooking vehicular traffic as well as pedestrian traffic. Contrary to Kearney's findings, the street side of a building may prove to be residents' preferred location for private outdoor space, rather than facing a communal courtyard. (Refer Table 2). It seems that while residents wish to be screened from others in close proximity, they also desire to relate to the broader neighbourhood and prefer a varying and activated outlook. The type of street character and volume of vehicular traffic is likely to have an effect on residential quality and tolerance of this aspect, and should be investigated in future research.

## 5. Challenges for Privacy and Comfort Design in the Subtropics

The findings confirm that residents consider that privacy and comfort are important attributes of liveability in subtropical MSAB, and that their ability to control these factors is influenced by building design. There are multiple challenges of meeting residents' desires for personal control over their own space, including the desire for outdoor living, in MSAB in the subtropical urban environment. The key finding is that residents overwhelmingly prefer natural ventilation but choose air-conditioning when external conditions are too noisy or dusty to leave windows and doors open. Therefore paying attention to the control of noise is a high priority design issue for the success of MSAB living in the subtropics. The inter-relationships between thermal performance, natural ventilation and acoustic privacy and comfort in architectural design integrating layout, structure and materials specifications are extremely important to resolving this issue, rather than assuming that air-conditioning can be used to mitigate design problems.

The finding that residents were not likely to use air-conditioning in winter, and were more likely to manage thermal comfort in summer by opening windows and doors is promising in terms of energy demand management, suggesting that designs that enhance air-flow within dwellings have significant potential to reduce MSAB residents' need to use air-conditioning. The standardisation of notions of thermal comfort in affluent societies is leading to "thermal monotony" [61] which is becoming the norm in indoor environments as air-conditioning is used in housing to replace living spaces that are designed to respond climatic variations with human intervention. Typically, the meaning of *thermal comfort* commonly used in conditioned spaces is based on the approach that assumes: (1) that "comfort" is universal; (2) that thermal variation outside the band is undesirable and (3) that occupants of buildings want neutral, dry, still air [17]. Clearly in the subtropics, residents do not want thermal monotony and they also desire greater choice and control over personal comfort in their own homes.

However, dwellings in multi-storey buildings are potentially exposed to more noise than other housing types due to more expansive views and direct lines of sight to noise sources such as rail corridors, roads, and rooftop heating, cooling, or ventilation equipment on other structures [62–64]. Traffic noise may also reflect upwards off the facades of the structures on either side of streets [65]. In a vicious circle, high external noise levels are often used to justify the use of sealed environments and air conditioning in commercial and residential buildings. However, conversations and other personal noises made by humans are often the most annoying sounds and some degree of ambient noise that helps mask neighbours voices and other noise [24] may be an important part of living in close proximity, and being able to remain "private".

Traffic noise may be less annoying than sounds from other people in the complex, or from neighbours in other types of dwellings, during the day, but becomes less tolerable at night. Avoiding the combined impacts of traffic generated noise and air pollution is not a matter of simply closing windows and utilising air conditioning, especially with compelling evidence that people prefer natural ventilation. As well as air-borne noise, structure-borne noise is also a problem in MSABs when noises of impacts and vibrations are transmitted through the buildings' structure and services. Acoustic privacy is highly valued by residents and the *Building Code of Australia Volume 1* requires inter-tenancy walls to have a discontinuous construction (a wall must have a minimum 20mm cavity between two separate "leaves") to reduce noise transmission between dwelling units [55]. The need to eliminate noise annoyance and enhance privacy is imperative, but these internal linings effectively rule out exposed thermal mass as the main element of passive thermal performance in apartments. Therefore, in a sub-tropical climate-responsive design approach, maintaining the cooling effect of natural ventilation, combined with thermal mass, must be a design priority. An approach to acoustics which integrates building plans and cross-sectional design and acoustic treatments to building facades is necessary so that windows can be kept open according to residents' preferences. Well-designed balconies can play an effective role as sound insulators in this regard [63,66].

High-rise residential buildings often have large glazed areas where natural lighting levels are achieved but excessive solar heat gains or glare in both winter and summer, are introduced if orientation and external shading are inadequate [43,67]. These instances illustrate that objective knowledge is required to solve an array of problems simultaneously, but creative intuition is also required to provide practical solutions that respond to the human aesthetic and emotional needs of a user group (residents) with whom architects generally have no direct contact during the design process.

In the subtropical humid climate, the challenge for designers is to find a balance between natural ventilation and noise, rather than designing solely for one parameter or the other. Environmentally, therefore, facilitating climate-responsive design in MSAB may help mitigate the need for air-conditioning, leading to direct reductions in apartment household energy use and contributing to the stated objectives of urban consolidation policies. In the urban environment, it seems there may be a need to provide air-conditioning as well as climate-responsive design. An ideal solution would combine the best practices of energy efficient specifications with strategically placed operable glazing that residents can adjust to capture prevailing breezes and allow daylight infiltration, exclude heat and glare, minimise unwanted noise, and provide privacy and views to the outside, according to their personal preference. Traditionally, the veranda has played this role in subtropical houses. In the MSAB, adjustable layers of external screening applied to openings and balconies may be one way of addressing multiple interrelated problems. Evidently some local apartment buildings already apply some of these principles (Figure 4) however, concerning issues for further design research are how to provide much-needed open space and personal climate control as towers increase in height and the effects of wind conditions make cross-ventilation difficult and projecting balconies extremely uncomfortable. Further, the influences of balcony structures on the environmental behaviour of MSABs also need careful examination in conjunction with functional criteria to enable residents of various building forms and configurations to benefit from the favourable subtropical conditions.

(**a**)

(**b**)

**Figure 4.** Adjustable layers of external screening applied to openings and balconies in Brisbane apartment buildings. Source: (**a**) Centre for Subtropical Design QUT (**b**) Glenn Weiss.

## 6. Conclusions

This paper places multi-storey apartment buildings (MSAB) within the context of urban sustainability in the Australian urban system, and identifies the conundrums associated with the suitability and acceptance of apartment buildings as a housing type in this mix. Not only is the multi-storey building very energy-intensive in terms of both embodied energy and operational energy, but Australian residents have expressed a reluctance to transition to higher density neighbourhoods and apartment buildings. The findings contribute evidence that should help inform property developers, policy-makers, designers and residents about the key attributes that enhance the liveability of MSABs in a subtropical context, and specifically of the need for a design approach that can mitigate the environmental impact of MSABs while improving the social acceptability of MSAB dwellings as a housing type in Australia's subtropical cities.

In particular this paper examined residents' day-to-day experiences of their MSAB dwelling in the context of subtropical climate and lifestyle. The key findings are that residents seek flexibility and choice in how they manage privacy and comfort issues at different times of the day. Residents valued outdoor living and overwhelmingly prefer natural ventilation over continuous air-conditioning to manage thermal comfort in their dwellings. The discussion has shown the intense design interrelationships that exist between several comfort and privacy parameters in habitable apartment design (thermal comfort, acoustics, air movement, daylighting, visual and aural privacy). As well as the need to reduce reliance on air-conditioning and to deliver more nuanced personal control to residents over their private dwelling environment, the challenges of providing resident-identified liveability attributes of "openness" in the noise-laden urban environment and in taller buildings subject to windy conditions were identified, and require further research.

In mediating the surrounding environment, practical issues for MSAB design in the subtropical climate are to ameliorate the combined effects of traffic-generated noise and air pollution, and gain both acoustic amenity and the cooling effect of natural ventilation. In mediating the shared environment of the collective building, reducing noise transmission between dwellings and maintaining the moderating effect of exposed thermal mass must be addressed. Therefore maintaining the cooling effect of natural ventilation is a design priority. Achieving the right balance between thermal mass, operable openings and glazing is critical in achieving an indoor environment which is neither over- nor under-heated, is well-lit but not glary, and affords views to the outside but may not be overlooked by passers-by or other residents, and finally can be opened to breezes but is not noisy.

Another fertile area for future research is whether there are any differences in the experiences or adaptive practices of tenants when compared to owner-occupiers. Our findings suggest that residents have similar experiences whether they own or rent. Nevertheless the question is pertinent and will be addressed in a future paper because much new MSAB development in Brisbane and similar cities is speculative and is aimed at the "investor" market, meaning that most residents are likely to be tenants.

There is a clear need for further design research to be undertaken with respect to designing MSABs that perform better socially, economically and environmentally, to assist residents to interact positively with the subtropical climate and urban environment, and to control the intensity of their interaction with neighbours.

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## Author Contributions

Rosemary Kennedy and Laurie Buys conceived research design and methods; Rosemary Kennedy, Laurie Buys and Evonne Miller analyzed the data; Rosemary Kennedy wrote the manuscript with contributions from Laurie Buys and Evonne Miller.

## Conflicts of Interest

The authors declare no conflict of interest.

## References


1. Urbis. *Urbis Brisbane Apartment Insights 04 Qtr 2013*; Urbis: Brisbane, Australia, 2014.
2. Brisbane City Council. Reducing Brisbane's Emissions. 2014. Available from: http://www.brisbane.qld.gov.au/about-council/governance-strategy/vision-strategy/reducing-brisbanes-emissions (accessed on 5 September 2014).
3. Myors, P.; O'Leary, R.; Helstroom, R. Multi-Unit Residential Building Energy and Peak Demand Study. *Energy News* **2005**, *23*, 113–116.
4. Perkins, A.; Hamnett, S.; Pullen, S.; Zito, R.;Trebilcock, D. Transport, Housing and Urban Form: The Life Cycle Energy Consumption and Emissions of City Centre Apartments Compared with Suburban Dwellings. *Urban Policy Res.* **2009**, *27*, 377–396.
5. Kelly, J.; Weidmann, B.; Walsh, M. *The Housing We'd Choose*; Grattan Institute: Melbourne, Austraila, 2011.
6. Coiacetto, E. Residential sub-market targeting by developers ins Brisbane. *Urban Policy Res*. **2007**, *25*, 257–274.
7. Moser, G. Quality of life and sustainability: Toward person—Environment congruity. *J. Environ. Psychol*. **2009**, *29*, 351–357.
8. Kelly, J. *Getting the Housing We Want*; Grattan Institute: Melbourne, Australia, 2011; p. 42.
9. Cho, S.H.; Lee, T.K.; Kim, J.T. Residents' Satisfaction of Indoor Environmental Quality in Their Old Apartment Houses. *Indoor Built Environ*. **2011**, *20*, 16–25.
10. Cho, S.H.; Lee, T.K. A study on building sustainable communities in high-rise and high-density apartments—Focused on living program. *Build. Environ*. **2011**, *46*, 1428–1435.
11. Lee, J.; Je, H.; Byun, J. Well-Being index of super tall residential buildings in Korea. *Build. Environ*. **2011**, *46*, 1184–1194.
12. Phillips, D.R.; Siu, O.L.; Yeh, A.G.; Cheng, K.H. The impacts of dwelling conditions on older persons' psychological well-being in Hong Kong: the mediating role of residential satisfaction. *Soc. Sci. Med.* **2005**, *60*, 2785–2797.

13. Yuen, B. Liveability of Tall Residential Buildings. In *High-Rise Living in Asian Cities*; Yuen, B., Yeh, A., Eds.; Springer: Amsterdam, The Netherlands, 2011; pp. 129–146.
14. Pacione, M. Evaluating the quality of the residential environment in a high-rise public housing development. *Appl. Geogr.* **1984**, *4*, 59–70.
15. Stern, H.; de Hoedt, G.; Ernst, J. Objective classification of Australian climates. *Aust. Met. Mag.* **2000**, *49*, 87–96.
16. Hyde, R. *Climate Responsive Design: A Study of Building in Moderate and Hot Humid Climates*; E& F N Spon.: London, UK, 2000.
17. Miller, W.; Kennedy, R.; Loh, S. Benefits and Impacts of Adjusting Cooling Set Points in Brisbane How Do Office Workers Respond? In *Sustainable Retrofitting of Commercial Buildings, Warm Climates*; Hyde, R., Groenhout, N., Barram, F., Yeang, K., Eds.; Earthscan from Routledge: London, UK, 2012; pp. 407–416.
18. Robeson, K.R.; Burton, D.R. The Effect of Air Movement on Thermal Comfort. In *AIRAH Conference*; Hobart, Australia, 17 August 1975.
19. Kennedy, R.; Thompson, S. The Subtropical Residential Tower; Investigating sustainable Practices in Tall Buildings. *Counc. Tall Build. Urban Habitat (CTBUH) J.* **2011**, *2011*, 24–29.
20. Kennedy, R. *Subtropical Design in South East Queensland. A Handbook for Planners, Developers and Decision-Makers*; QUT, Brisbane City Council and the State of Queensland: Brisbane, Australia, 2010.
21. Zeisel, J. *Inquiry by Design; Environment/Behavior/Neuroscience in Architecture, Interiors, Landscape, and Planning*, Revised ed.; W.W. Norton: New York, NY, USA, 2006.
22. Rapoport, A. *House Form and Culture*; Prentice-Hall: Upper Saddle River, NJ, USA, 1969.
23. Hall, E.T. A System for the Notation of Proxemic Behavior[1]. In *American Anthropologist*; John Wiley & Sons, Inc.: Hoboken, NJ, USA, 1963; Volume 65, pp. 1003–1026.
24. Deasy, C.M.; Lasswell, T.E. *Designing Places for People: A Handbook on Human Behavior for Architects, Designers, and Facility Managers*; Whitney Library of Design: New York, NY, USA, 1985.
25. Bell, P.A.; Green, T.; Fisher, J.D.; Baum, A. *Environmental Psychology*, 5th ed.; Harcourt College Publishers: Fort Worth, TX, USA, 2001.
26. King, P. *Private Dwelling Contemplating the Use of Housing*, Housing, Planning and Design Series; Gallant, N., Tewdwr-Jones, M., Eds.; Routledge: London, UK, 2004.
27. Easthope, H.; Judd, S. *Living Well in Greater Density*; University of New South Wales: Sydney, Australia, 2010; pp. 1–78.
28. Easthope, H.; Randolph, B. Governing the Compact City: The Challenges of Apartment Living in Sydney, Australia. *Hous. Stud*. **2009**, *24*, 243–259.
29. Fisher, R.; McPhail, R. Residents' Experiences in Condominiums: A Case Study of Australian Apartment Living. In *Housing Studies*; Taylor & Francis: Abingdon, UK, 2014; pp. 1–19.
30. Randolph, B. Delivering the Compact City in Australia: Current Trends and Future Implications. *Urban Policy Res*. **2006**, *24*, 473–490.
31. Huang, S.-C.L. A study of outdoor interactional spaces in high-rise housing. Landsc. *Urban Plan*. **2006**, *78*, 193–204.

32. Skjaeveland, O.; Garling, T. Effects of interactional space on neighbouring. *J. Environ. Psychol*. **1997**, *17*, 181–198.
33. Amerigo, M.; Aragones, J.I. A Theoretical and Methodological Approach to the Study of Residential Satisfaction. *J. Environ. Psychol*. **1997**, *17*, 47–57.
34. Adriaanse, C.C.M. Measuring residential satisfaction: A residential environmental satisfaction scale (RESS). *J. Hous. Built Environ*. **2007**, *22*, 287–304.
35. Steemers, K.; Manchanda, S. Energy efficient design and occupant well-being: Case studies in the UK and India. *Build. Environ*. **2010**, *45*, 270–278.
36. Gann, D.; Salter, A.; Whyte, J. Design Quality Indicator as a tool for thinking. *Build. Res. Inf.* **2003**, *31*, 318–333.
37. Yuen, B. Singapore High-rise a Sustainable Housing Model. In *Sustainable Building South East Asia*; Institute Sultan Iskandar of Urban Habitat and Highrise: Kuala Lumpur, Malaysia, 2007.
38. Yuen, B. Romancing the high-rise in Singapore. *Cities* **2004**, *22*, 3–13.
39. Yuen, B.; Nyuk Hien, W. Resident perceptions and expectations of rooftop gardens in Singapore. *Landsc. Urban Plan.* **2005**, *73*, 263–276.
40. Yuen, B.; Yeh, A.; Appold, S.J.; Earl, G.; Ting, J.; Kwee, L.K. High-rise Living in Singapore Public Housing. *Urban Stud*. **2006**, *43*, 583–600.
41. Yuen, B.; Yeh, A.G.O. *High-Rise Living in Asian Cities*; Springer: Amsterdam, Netherlands, 2011.
42. Fung, Y.W.; Lee, W.L. Identifying a common parameter for assessing the impact of traffic-induced noise and air pollutions on residential premises in Hong Kong. *Habitat Int.* **2011**, *35*, 231–237.
43. Hofer, N. *Compilation Report of the Process, Findings and Recommendations from the False Creek North Post-Occupancy Evaluation*; University of British Columbia; School of Community and Regional Planning: Vancouver, BC, Canada, 2008; p. 257.
44. Koenigsberger, O.H.; Ingersoll, T.G.; Mayhew, A.; Szolay, S.V. *Manual of Tropical Housing and Building Part 1 Climatic Design*; Longman Group Limited: London, UK, 1973.
45. Lai, J.H.K.; Yik, F.W.H. Perception of importance and performance of the indoor environmental quality of high-rise residential buildings. *Build. Environ.* **2009**, *44*, 352–360.
46. Morawska, L. *Air Quality for Sustainable Subtropical Communities*; QUT: Brisbane, Australia, 2009.
47. Croome, D.J. *Noise, Buildings, and People*, International Series in Heating, Ventilation, and Refrigeration; Pergamon Press: Oxford, UK, 1977; Volume 11.
48. Tregenza, P.; Wilson, M. *Daylighting. Architecture and Lighting Design*; Routledge: Abingdon, Oxon, UK, 2011.
49. Waite-Chuah, S. Living in the Comfort Zone: At What Cost? *Sustainability* **2012**, *5*, 386–389.
50. Hedge, A. Where are we in understanding the effects of where we are? *Ergonomics* **2000**, *43*, 1019–1029.
51. Chappells, H. Comfort, well-being and the socio-technical dynamics of everyday life. *Intell. Build. Int.* **2010**, *2*, 286–298.
52. Moezzi, M. Are comfort expectations of building occupants too high? *Build. Res. Inf.* **2009**, *37*, 79–83.
53. Buys, L.; Miller, E. Residential satisfaction in inner urban higher-density Brisbane, Australia: role of dwelling design, neighbourhood and neighbours. *J. Environ. Plan. Manag*. **2012**, *55*, 319–338.

54. Australian Bureau of Statistics. Census data. Canberra. 2006. Available online: http://www.abs.gov.au/ (accessed on 15 June 2015).
55. ABCB. *National Construction Codes (Building Code of Australia)*; The Australian Building Codes Board: Amsterdam, Australia.
56. Steele, W.; Keys, C. Interstitial Space and Everyday Housing Practices. *Housing, Theory Soc.* **2014**, *32*, 112–125.
57. Cooper-Marcus, C.; Sarkissian, W. *Housing as if People Mattered- Site Design Guidelines for Medium-Density Family Housing*; University of California Press: Berkeley, CA, USA, 1986.
58. Ozaki, R. House Design as a Representation of Values and Lifestyles: The Meaning of Use of Domestic Space. In *Housing, Space and Quality of Life, Ethnoscapes Series;* Ashgate Publishing: Burlington, VT, USA, 2005.
59. Niu, J. Some significant environmental issues in high-rise residential building design in urban areas. *Energy Build.* **2004**, *36*, 1259–1263.
60. Kearney, A.R. Residential Development Patterns and Neighbourhood Satisfaction: Impacts of Density and Nearby Nature. *Environ. Behavior* **2006**, *2006*, 112–139.
61. Brager, G.S.; de Dear, R.J. *Historical and Cultural Influences on Comfort Expectations*, in *Buildings, Culture & Environment—InforSming Local & Global Practices*; Cole, R.J., Lorch, R., Eds.; Blackwell: London, UK, 2003; pp. 177–201.
62. Vlek, C. "Could we all be a little more quiet, please?" A behavioural-science commentary on research for a quieter Europe in 2020. *Noise Health* **2005**, *7*, 59–70.
63. Naish, D.A.; Tan, A.C.C.; Demirbilek, F.N. Simulating the effect of acoustic treatment types for residential balconies with road traffic noise. *Appl. Acoust*. **2014**, *79*, 131–140.
64. Kennedy, R. Research Report. A subtropical urban community. Investigating medium to high density residential typologies. Findings and recommendations from the Design Charrette. In *A Subtropical Urban Community: Investigating Medium to High Density Residential Typologies by Design Charrette*; Kennedy, R., Ed.; Centre for Subtropical Design, Queensland University of Technology: Brisbane, Australia, 2009.
65. Nicol, F.; Wilson, M. The effect of street dimensions and traffic density on the noise level and natural ventilation potential in urban canyons. *Energy Build.* **2004**, *36*, 423–434.
66. Lee, P.J.; Kim, Y.H.; Jeon, J.Y.; Song, K.D. Effects of apartment building façade and balcony design on the reduction of exterior noise. *Build. Environ*. **2007**, *42*, 3517–3528.
67. Lam, J.C. Residential sector air conditioning loads and electricity use in Hong Kong. *Energy Convers. Manag.* **2000**, *41*, 1757–1768.