Housing design quality in Finland: Room for improvement

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Abstract

Housing is under increasing pressure to respond to societal changes, e.g., an aging population, an increasing number of single person households, increased working from home, climate change and the green transition, and the covid-19 pandemic. This paper investigated how the apartments of a Finnish social housing provider supported residents' daily lives and well-being and how this can be improved. From a total of 142 rental and right-of-occupancy apartment blocks in the Tampere and Turku regions, ten were selected for analyses and reporting of results in this paper. The floor plans of two representative blocks were further analysed to evaluate their housing design quality. The aspects investigated included daylight, circulation, furnishability and spatial connections. Findings highlighted that there is room for improvement to create more resilient living environments: daylight conditions were found to be below good practice, especially where balconies shaded the main living space or where the room depth prevented daylight from reaching the back parts. The furnishable floor area was fragmented and reduced by essential circulation areas, which on average took up 40% of the habitable floor area. Only 28% of the habitable room floor area was both well daylit and furnishable. Potential improvements to achieve more resilient living environments include better connection between the design of furnishable and well daylit spaces; better overlapping of essential circulation areas to improve furnishability and creating multiple routes inside the apartment to enable the residents to adjust their level of privacy.

Keywords: housing, quality, resident, resilience, daylight, circulation, furnishability, spatial connections

PEER-REVIEWED ARTICLE • RESILIENCE

Introduction and research objectives

The majority of people globally live in urban areas and this urbanisation is on the increase (UN 2018); Finland is no exception (Rakennusteollisuus 2019, Vainio 2016). As such, there are increasing concerns about housing design quality (see e.g., Chisholm et al. 2018, Finlay et al. 2012, Helander 2020, Pelsmakers et al. 2022, Punter 2010, Saarimaa & Pelsmakers 2020), caused by increased urban land pressures and densification (Karikallio et al. 2019). Moreover, housing is under increasing pressure to accommodate societal changes, e.g., an aging population, an increasing number of single person households, increased working from home, climate change and the green transition, and the covid-19 pandemic (Pelsmakers et al. 2021), highlighting the need for diversity and adaptability in housing design (Femenias & Geromel 2019, Saarimaa & Pelsmakers 2020).

Housing is under increasing pressure to accommodate societal changes, e.g., an aging population, an increasing number of single person households, increased working from home, climate change and the green transition, and the covid-19 pandemic.

In Finland there appears to be little capacity for recently constructed urban housing to accommodate the demands of these societal changes (Pelsmakers et al. 2021, Saarimaa & Pelsmakers 2020), potentially impacting on resident well-being (Jusan & Sulaiman 2005) or leading to premature building obsolescence if buildings cannot be adapted (Huuhka & Vestergaard 2019, Saarimaa & Pelsmakers 2020). Avoiding building demolition is an essential part of a sustainable built environment and the circular economy (Huuhka & Vestergaard 2019), and necessary for achieving ambitious carbon neutrality goals (Pelsmakers et al. 2020). Housing that supports residents' everyday life and that enables residents to make short-term or longer-term changes when needed, also supports a household's and individual's resilience to deal with and recover from personal or societal difficulties, as was witnessed during the covid-19 pandemic.

This paper investigates whether the living environments (of a Finnish social housing provider) supported residents' every-day life and well-being. For this, two related research questions were set as follows:
RQ1: How do apartments and some living environment qualities support residents' daily lives and possibilities to adapt to changing situations?
RQ2: Where is there room for improvement to support residents' daily lives?

Firstly, housing design qualities are summarised in the next section, followed by a description of research materials and methods, which also describes the building stock sample used in this research. this is followed by the analysis and key findings, followed by a discussion and conclusion.

Background: Housing design quality

Most new homes in Finland and in the Nordic region are in multi-family housing blocks (Vainio 2016). Of around 3.2 million homes in Finland, 47% are in apartment blocks and of these, 45% are two-room apartments, 23% are three-room apartments and 24% are one-roomed studio apartments[1] (Official Statistics of Finland 2021). However, recent studies on housing production found that 40% of new units were studios (i.e., one-room units) (Pelsmakers et al. 2021, Vainio et al. 2021). While slightly over 20% of the Finnish population are solo-dwellers, studio apartments have been found to poorly meet residents' every-day needs or expectations (Backman 2016, Pelsmakers et al. 2021, Tervo & Hirvonen 2019), affecting the quality of their social life (Tervo & Lilius 2017).

[1] In Finland, dwelling sizes are expressed as the number of habitable rooms instead of number of bedrooms (and usually exclude kitchen, bathroom, entrance hall and walk-in closets).

Knowledge about current housing design quality is crucial in understanding how housing stock characteristics support or hinder the resilience of individuals, households and society.

Societal changes affect the ways in which people pursue their needs in the living environment. For example, increased digitalisation has enabled working and studying from home during the covid-19 pandemic. Hence, in addition to the importance of apartment size, housing options need to be versatile (Andersson et al. 2010, Fokkema & Liefbroer 2008, Juntto 2008 & 2010), especially given that Finnish households and their daily practices and life situations are ever more diverse and changing (Keurulainen 2014, Vaattovaara et al. 2010). Concern has been raised about the reduction in urban housing design quality (Finlay et al. 2012, Punter 2010), such as an increasing number of smaller units (Karikallio et al. 2019), lack of adaptability, and deeper building plans with poor daylighting (Pelsmakers et al. 2021, Saarimaa & Pelsmakers 2020, SAFA 2020). Hence, knowledge about current housing design quality is crucial in understanding how housing stock characteristics support or hinder the resilience of individuals, households and society.

Housing design quality refers not only to the quality of the internal environment but also to the quality of the neighbourhood and external environment, and broader sustainability aspects.

Housing design quality refers not only to the quality of the internal environment (e.g., size, spatial configuration and organisation, furnishability, adaptability, views, daylight), but also to the quality of the neighbourhood and external environment (e.g., walkability, access to – and quality of – outdoor space and shared spaces, and transportation), and broader sustainability aspects (e.g. energy efficiency, good Indoor Environmental Quality (IEQ)) (Bonaiuto et al. 1999, Burridge & Ormandy 2011, Drexler & El Khouli 2012, EN 16309 2014, Kuoppa et al. 2019, Marco et al. 2022, Nylander 2002, Pelsmakers et al. 2021, Saarimaa & Pelsmakers 2020, UKGBC 2016). Good housing design qualities help to create desirable, sustainable and healthy homes that meet the needs and expectations of people (Housing Corporation England 2007). This includes sufficiently large living spaces to enable socialising and private space away from other household members (Finlay et al. 2012, Kuoppa et al. 2019). The ability to conduct a social life at home supports mental well-being, especially when older adults are housebound due to health issues (Iwarsson et al. 2007). Of importance is also having access to private outdoor space and sufficient storage and utility space (Finlay et al. 2012, Kuoppa et al. 2019). Adaptability of the main living spaces, i.e., the ability to modify and use spaces in different ways to better suit residents' needs, have also been found to be desirable qualities (Atlas & Özsoy 1998: 315, Finlay et al. 2012, Kuoppa et al. 2019). Rather than moving home, the ability to modify one's living environment to meet changing needs means that residents can stay longer in their community, contributing to long-term stability and social sustainability (Femenias & Geromel 2019). On the contrary, poor housing design quality affects residents' well-being and overall sustainability; for example, lack of access to adequate space, good daylight and direct sunlight in the home can lead to reduced sleep and increased energy use (Keall et al. 2010).

The importance of good housing design quality and adaptable housing was further manifested during the covid-19 pandemic, when living environments not only became spaces to live in, but to work from, study and be schooled in (e.g., Hipwood 2022, Hätälä 2020, Lehtinen et al. 2022, Marco et al. 2022, NHF 2020). There are many definitions of adaptability (Schmidt & Austin 2016); adaptability here refers to adjustability (i.e., change of use or user) and versatility (i.e., change of space) after Schmidt & Austin (2016). Typically, this means the ability to use a space for multiple functions or by different users, or the use of space in multiple configurations without needing to change load-bearing elements, such as a space enabling multiple functions and different furnishing options (e.g., sufficient space to place furniture and the ability to place furniture in more than one position, changing connections between rooms or adding a private room).

The housing design quality aspects studied here in more detail are those highlighted as important from the residents' survey responses, i.e., daylight, circulation and furnishability, spatial connections between rooms and privacy levels.

Recently, Lehtinen et al. (2022) conducted a resident survey during the 2020 covid-19 pandemic, which mapped residents' perspectives and experiences of their housing design quality in rented and right-of occupancy housing. Of the 1,315 resident responses received, 74% of the respondents had occasionally or often wished for changes in their apartment during 2020, with 59% stating that the changes would be desirable even without the pandemic. From residents' responses it emerged that housing design qualities that affected their daily lives in different ways were daylight provision, circulation and furnishability, and spatial connections and privacy levels (Lehtinen et al. 2022: 64, 73 & 85). Good daylight was one of the most mentioned housing design qualities as having a positive effect on one's own well-being (Lehtinen et al. 2022: 64). Furnishability was considered by respondents as an important aspect of everyday use of the home, including apartment or room adaptability for different functions and uses; difficult to furnish or use space was considered undesirable (Lehtinen et al. 2022: 73). The changes that respondents had undertaken in their apartments during the pandemic, were connected to their furniture and furnishings. Finally, based on the surveyed residents' responses, different privacy levels and the visual and physical connections between rooms and between internal and external spaces were highlighted as desirable (Lehtinen et al. 2022: 85).

Based on Lehtinen et al's (2022) earlier study, the housing design quality aspects studied here in more detail are those highlighted as important from the residents' survey responses, i.e., daylight, circulation and furnishability, spatial connections between rooms and privacy levels. These are further described in below.

Daylight, circulation and furnishability, spatial connections and privacy levels

As noted earlier, daylight is an important part of Indoor Environmental Quality (IEQ) and residents' well-being. In the Finnish regulations, daylight is addressed through habitable rooms requiring a window of at least 10% of the room's floor area. In addition, '*the window location and other arrangements need to guarantee the natural lightness, views out and the furnishability of the room'* (Decree 1008/2017: 5§). No detailed daylight criteria exist for housing in Finland. However, natural light is often evaluated using daylight factor (DF), which is the relationship of indoor daylight as a proportion of outdoor daylight (Lylykangas et al. 2015, Vikberg et al. 2020). To avoid reliance on artificial lighting, the minimum for DF is typically 1.5% to 2%, although 5% is recommended for good well-being (Baker & Steemers 2019, Lelyveld & Livingstone 2018, Pelsmakers 2015, Vikberg et al. 2020). An often-used rule of thumb to meet 2% DF is that daylight reaches to a depth that is twice the height of the top of the window (Lylykangas et al. 2015, Vikberg 2014). Reinhart (2005) notes similar recommendations to achieve 300 to 500 lux, which are minimum levels recommended in housing (Chris 2021).

Furnishability is the circumstances in which furniture, fixtures and equipment can be reconfigured easily inside the building (Schmidt & Austin 2016). For example, furnishability refers to floor areas which are free from different circulation areas and are thus free to be furnished with loose furniture. Furnishability relates to an apartment's circulation area, and that is why circulation and furnishability are often studied together. Circulation means the floor area that is regularly needed for using the apartment, for example to move from one space to another, use the kitchen, access the balcony etc. The remaining floor area is usable for furnishing and is referred to as 'effective usage area' (Jääskeläinen 2010). Although guidance exists to optimise furnishability in housing design (e.g., RT 93-10924, RT 93-10929), there are no direct regulatory requirements in Finland. Indirectly, furnishability is regulated through spatial criteria, for example: *'The living spaces need to have appropriate spaces for different kinds of functions (rest, daily activities, spending free time, eating, preparing food, hygiene care, services and*

stowage)' and *'the rooms need to be equipped with the essential furniture – –'.* (Decree 1008/2017, 8§).

Spatial connections between different rooms strongly influence the potential use of spaces, and influence experiences of privacy and communality in the home. Different levels of privacy in apartments and their rooms provide possibilities to retreat alone (referred to as 'individuality' by Marco et al. 2022), spend time with family members ('communality' by Marco et al. 2022), and create and maintain a connection with others. While an apartment is considered a single place, it consists of different smaller places and their daily usage (e.g., a work desk, favorite armchair, kitchen area). Different smaller places in a room, their spatial connections and the possibilities of retreating and meeting are an important part of the home experience (Finlay 2012, Tuan 1977, Marco et al. 2022). However, privacy is not regulated in Finland. While the need for communality can change, the need to control one's own privacy is considered universal (Altman 1975, van Dorst 2005, Finlay et al. 2012), however both aspects coexist in a dynamic relation to each other and are important for both the residents' personal and the households' shared wellbeing. Furthermore, spatial connections and the resulting privacy levels are also reliant on spatial boundaries between indoors and outdoors, where for example a window provides both daylight inside and views and connections to – or privacy from – outside (Schmid & Säumel 2021).

Research materials and methods

Building stock sample

The initial studied sample consisted of nearly 8,000 rental and right-of-occupancy apartments by YH Kodit Housing Association, of which 1,315 residents had previously responded to a living environment survey (as described by Lehtinen et al. 2022). The buildings were mainly built between 1992 and 2019, with one exception in 1970. In the sample, special housing was excluded (e.g., older people's homes), and only multi-storey apartment blocks were included given that apartment construction of this building type has doubled in Finland since 2015 (Vainio et al. 2021). This led to the inclusion of 142 properties with 5,929 apartments. After further excluding buildings with missing information or drawings, 105 properties with 4,417 apartments were included.

As described in Lehtinen et al. (2022), the first part of the research focused on categorising the urban social characteristics in which the apartment blocks exist. For this purpose, the sample of 105 properties was first studied from three perspectives: 1) the number and accessibility of the shared spaces (in terms of spatial connectivity); 2) the number of residents and workplaces in the immediate neighbourhood surroundings; and 3) city location, apartment distribution, and local population characteristics (see Table 1). This study led to the categorisation and selection of ten case study buildings as representative of the wider studied YH Kodit Housing Association, housing stock, and especially its newer production. To ensure a necessary diversity of apartment plans required for the apartment-scale analysis, the diversity of building typology and dimensions among the ten case study buildings was undertaken by building plan checks. Following this, a detailed housing design quality evaluation was carried out for a typical, recurring residential floor from each of the ten buildings (comprising a total of 64 apartments) from which two housing blocks were selected for the purpose of this paper.

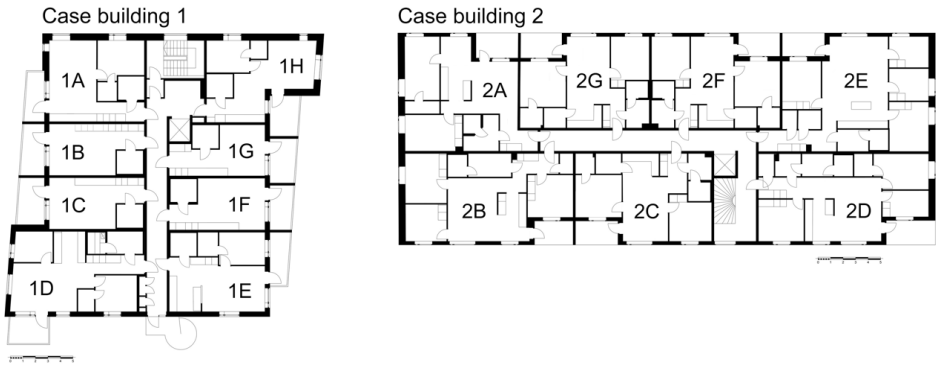

Figure 1. Case buildings 1 and 2 typical (recurring) floor plans, both located in Turku.

In this paper, findings are further illustrated by two housing blocks as illustrative examples (see Figure 1). These two illustrative blocks were constructed relatively recently (Case 1 in 2019 and Case 2 in 2014), and thus these two cases are more representative of the more recent housing production (31 apartment blocks were built after 2010) in the larger YH Kodit Housing Association sample of 105 apartment blocks in terms of layout (e.g., central corridor design and staircase locations, as also noted in current Finnish housing production (Saarimaa & Pelsmakers 2020) cases enable the study of case-specific housing design qualities, prevailing trends and potential solutions are likely to be transferable to the wider YH Kodit Housing Association housing stock, especially more recent and current production, and to the current Finnish housing production – see later for further discussion.

	Range of values present in…						
	Full sample (N=105)			**Case buildings (n=10)**		**Illustrative buildings (n=2)**	
1) the number and accessibility of their shared spaces on the property (in terms of spatial connectivity) [a]	**Min**	**Median**	**Max**	**Min**	**Max**	**Case 1**	**Case 2**
Number of shared spaces	0	4	27	1	10	4	2
Proportion of shared spaces accessible directly from outside	0 %	33 %	100 %	0 %	100 %	25 %	50 %
2) the number of residents and jobs in the neighbourhood [b]	**Min**	**Med**	**Max**	**Min**	**Max**	**Case 1**	**Case 2**
Number of residents	347	1725	6013	690	2687	790 [c]	690
Number of jobs	16	256	10253	27	2235	892	28
3) city location, apartment distribution, and neighbourhood population characteristics							
Cases in both main regions in the sample, Pirkanmaa and Varsinais-Suomi	82 in Pirk., 24 in Vars.-Suomi			5 in Pirk., 24 in Vars.-Suomi		Vars.-Suomi	Vars.-Suomi
Most common apartment type on property	2-room (78 housing blocks)			2-room (7 housing blocks)		1-room	3-room
2nd most common apartment type on property	1-room (40 housing blocks)			1-room (5 housing blocks		2-room	4-room
Proportion of people at least 65 years of age in neighborhood	5%	17%	52%	9%	52%	19%	9%
Summary indicator for low education families with children in neighborhood [d]	45	161	461	45	461	45	263

Table 1. Categories, sub-categories and numerical data used in the case buildings selection process to provide both variety and representativeness for the selected ten and two case buildings.

[a] *A single 'property' may contain multiple buildings.*
[b] *All 'in neighbourhood' figures determined in a 500 meter radius from property.*
[c] *Housing in case 1 area was/is still largely under construction at the time of the study.*
[d] *Proportion of people aged 0–17' × 'Proportion of working people with only basic level education'*

Research methods

As described earlier, the studied characteristics were daylight, circulation and furnishability, and spatial connections (and deduced privacy levels). To facilitate studying these, both individually and combined, a plan level spatial zoning method was employed. As illustrated in Figure 2 and described in the following subsections, distinct zone types were defined for each characteristic, based on existing literature (and for daylight further informed by a set of simulations). Through this common approach, intercompatible numerical data on the characteristics could be obtained. Furthermore, the simplified zone-based examination enables visually distinguishing properties that might not be apparent in the numerical data, such as the fragmentation of furnishable floor areas into small patches around an apartment, while spatial zoning enables suggestions for design and improvements. The spatial zoning analyses were undertaken for the habitable rooms, thus excluding e.g., bathrooms, walk-in closets and balconies. Figure 2 illustrates the connection of the spatial zonings used and the associated quantitative information obtained, followed by more detailed descriptions of the creation of each type of zoning.

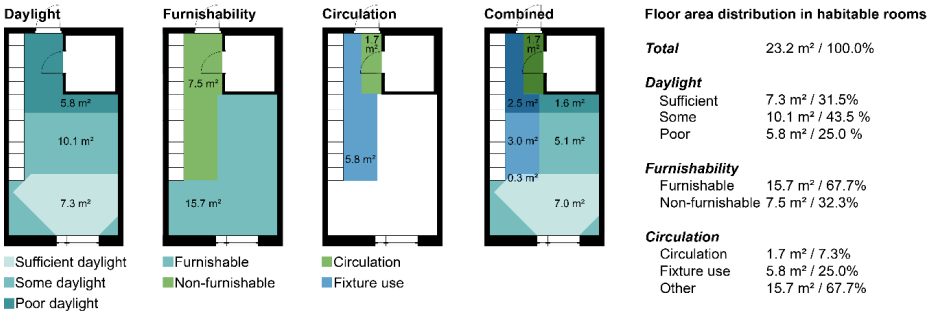

Figure 2. Theoretical apartment to illustrate the manual spatial zoning analyses in plans, and how the spatial zoning can be transformed into quantitative information.

Daylight evaluation

Firstly, for each apartment's daylight evaluation, two different daylight floor zones were estimated based on simplified rules of thumb for an unshaded window; i.e., sufficient daylight (0–2.3m, DF ≥2%) and poor daylight (>2.3m, DF >0 and <2%) (e.g., Lylykangas et al. 2015, Reinhart 2005, Vikberg 2014).

Secondly, to assess the validity of these simplified rules of thumb, and to understand the daylight analysis in more detail, daylight simulations for a set of sample apartments were conducted using DIALux evo 9.2. For the simulation, an outdoor daylight level of 11,000 lux was used based on ISO standard 15469 (2004) on the spatial distribution of daylight and the reflection levels were set to the software default, i.e., 50% for floors (wooden parquet), 50% for walls (painted light grey), and 70% for ceilings (painted white). Other surface materials and colours were tested but had minimal influence on the results. Comparison of the daylight rules of thumb derived zones and the simulations highlighted that the 2% DF zone did not extend fully to the 2.3m zone from the rules of thumb, i.e., the rules of thumb overestimated the sufficiently daylit area. Hence, based on the simulations, an additional daylight zone with 'some daylight' was created to better illustrate the actual daylight conditions instead of only 'sufficient' or 'poor' daylight conditions.

Hence, based on the rules of thumb and simulations, three daylight zones were derived, corresponding to the following distances from the window and

approximate daylight factors: sufficient daylight (0–2.3m, DF≥2%), some daylight (2.3–4.6m, DF >0 and <2%) and poor daylight (>4.6m, DF=0%). A 45-degree spread on both sides of a window was approximated from the simulations, taking into account shading from balconies but excluding site-specific obstructions (e.g., surrounding buildings, vegetation etc.).

Note that further excluded in the daylighting part of this study are apartment orientation, location, ceiling height, furniture, and curtains. This is because the daylight zones do not seek to describe absolute illuminance (lux). Instead, their purpose is to enable combining analysis of typical apartments' daylight qualities with the other housing design quality factors, thus providing understanding on their interconnections and enabling strategic design suggestions for improvement. Related to daylight, balancing heat gains and losses through windows is acknowledged as important but excluded from the current study.

Circulation and furnishability evaluation

Different types of circulation areas are categorised into primary and secondary circulation zones (Jääskeläinen 2010). The primary circulation area is the route from the entrance door into the essential spaces (living space, kitchen and bathroom); the secondary circulation area is the route from the entrance door into the other indoor and outdoor spaces of the apartment, as well as routes to any fixed furniture within rooms. Except for the fixed furniture indicated on the floor plans, apartments were considered unfurnished and circulation areas were drawn as straight routes; the remaining floor area is the effective utilisation area, i.e., the actual freely furnishable space (Jääskeläinen 2010). The widths of the paths were based on the Finnish accessibility regulations, such as turning circles of 1300mm and passage widths of 800mm (e.g., RT 103141, RT 93-10937).

Spatial connections and privacy levels evaluation

Spatial connections and passage through rooms affects not only furnishability, but also privacy of the associated spaces. Connections provide possibilities to meet family members in daily life or multi-task (e.g., cooking and baby care). Hence the circulation and furnishability zones (see Figures 7 & 8) were also used to study connections between spaces and privacy levels in the apartments. Specifically, also 'multipaths' were studied, i.e., where some habitable rooms have several doors or openings which enables different types of connections between spaces, affecting different levels of privacy. Spatial connections are often analysed using space syntax theory (e.g., Femenias & Geromel 2020, van Nes & Yamu 2021), which was utilized as a background theory for the spatial connections analyses of this research, but not directly employed. Instead, the focus of the analysis was first on the configuration of connections between rooms, and later between smaller places within rooms, following different apartment functions (e.g., cooking, dining, resting).

Analysis and findings

Daylight

For the ten studied housing blocks, the daylight zone analysis revealed that in habitable rooms an average of 61% of the floor area had 'some' daylight, 36% was 'sufficiently' daylit, and 3% was 'poorly' daylit. This reflects the Finnish regulations which require a window in each habitable room and the fact that only few habitable rooms were deeper than 4.6m. There was, however, much variation in the apartments' amount of sufficiently daylit floor area (see Figure 3) with values ranging between 0% and 66% (with a median of 38% and half of the apartments between 30–45%).

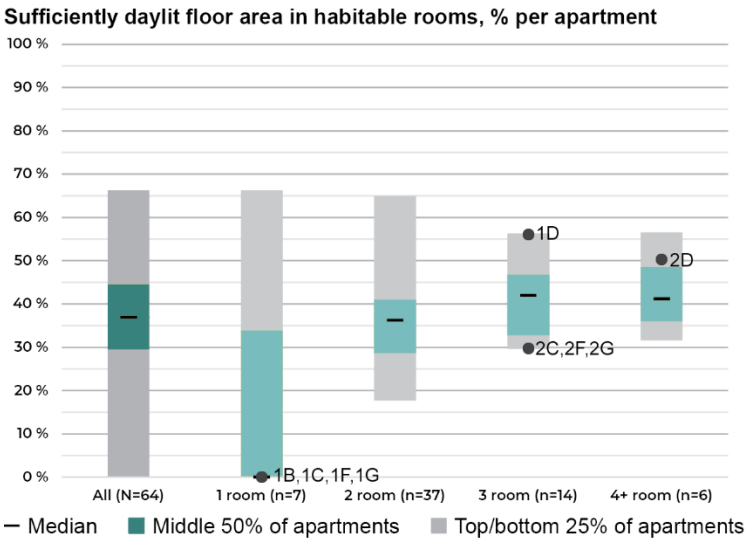

Figure 3. Illustrates the sufficiently daylit floor area in habitable rooms, for all apartments in the ten studied buildings (N=64). Grey dots represent the example apartments in the case buildings 1 and 2 described in the text below.

The lowest daylight was in rooms with their main windows behind a balcony, which obstructs daylight from the overhanging balcony above and from the enclosure of the balcony in front of the apartment's window. Notably, these cases were mostly studio apartments. In some apartments, single rooms had more daylight than the per apartment averages reported here, particularly if the window in the room was not shaded by a balcony. The best daylit rooms were typically bedrooms, because the balconies were generally located in front of the main or only living room windows. Considering that the simulation also showed the balcony to approximately halve the daylighting of the space behind it, this study highlights the critical role of the balcony's location for the daylight conditions of apartments.

The daylight zoning analyses of the two case-study buildings are presented in Figure 4. 87% of the habitable floor areas in the studios in Case 1 (1B, 1C, 1F and 1G) had some daylight and completely lacked a sufficiently daylit zone. The reason for this is that all of the windows were behind a balcony and the floor plans were deep. In Case 2 there were three almost identical two-bedroom apartments (2C, 2F and 2G) with 30% of their habitable floor areas sufficiently daylit and 61% with some daylight. Because the apartments were 7m deep and had windows only in one orientation, the cooking area had very poor access to daylight. The balcony obstructed the window of the main bedroom, preventing sufficient daylighting. In contrast, the best daylit apartments tended to have two orientations, e.g., in apartment 1D (Case 1), 56% of the habitable floor area was sufficiently daylit and a further 27% had some daylight; in apartment 2D (Case 2), 50% was sufficiently daylit and 47% of the habitable floor area had some daylight. These cases were shallow plan and had windows facing more than one direction. In apartment 2D, a balcony shaded the only window in the smallest bedroom, but daylight could have been improved by opening a window in the other external wall.

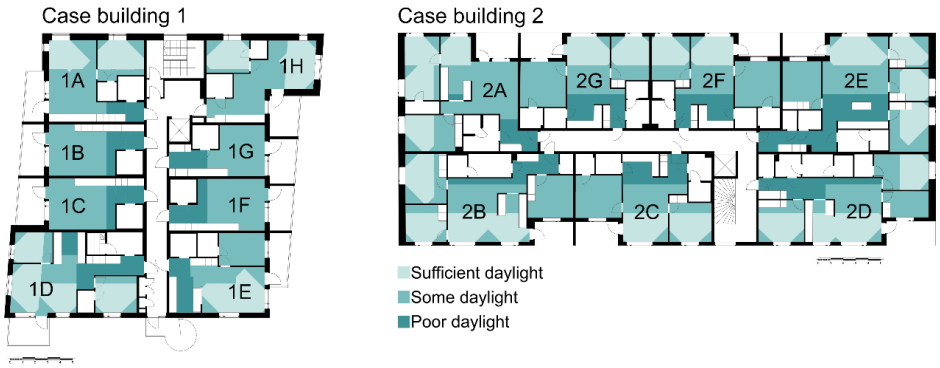

Figure 4. Case buildings 1 and 2 typical floor plans with daylight zonings.

While the resident survey highlighted access to natural light in the apartments as a positive quality in support of residents' self-reported well-being, the objective daylight analysis highlights that there is room for improvement.

While the resident survey highlighted access to natural light in the apartments as a positive quality in support of residents' self-reported well-being (Lehtinen et al. 2022), the objective daylight analysis highlights that there is room for improvement. For example, the main windows in the studio apartments were obstructed by the balcony, reducing access to sufficient daylighting. Correspondingly, sufficiently daylit floor areas were found near windows not obstructed by a balcony. In addition to balcony placement, other factors that negatively influenced the amount of sufficient daylit floor zones were found to be deep apartment types and apartments with windows facing only in one direction.

Circulation and furnishability

On average, in the ten case-study building sample, essential circulation areas took up 40% of the floor area in the habitable rooms. The largest share of circulation areas occurred in two roomed (one-bedroom) apartments (see Figure 5), which comprised 37 of the 64 units studied. This is because typically in one-bedroom apartments the kitchen, bedroom, and balcony are accessed through the living room. In this sample it was also observed that in comparison to one-bedroom apartments, most larger apartments had proportionally less circulation area, as did studio apartments – especially if without balcony – which do not have other rooms to go to.

The remaining floor area that was usable for loose furnishing covered on average 60% of the apartments' total habitable room area. There was a fair amount of variation in this share of furnishable floor area: from 42% to 71% with half of the apartments between 56–63% (median of 61%) (see Figure 5). The different apartment types or sizes did not have notable differences. There was more variation in the one-bedroom units and a slightly lower proportion of furnishable area was observed. However, this might be due to the comparably large number of one-bedroom apartments in the sample. In the studied sample, the (few) larger apartments had on average a slightly larger proportion of furnishable space. For any single apartment this was dependent on the design and organisation of spaces. For example, there might be more passages through the living space if there are more rooms and no corridors.

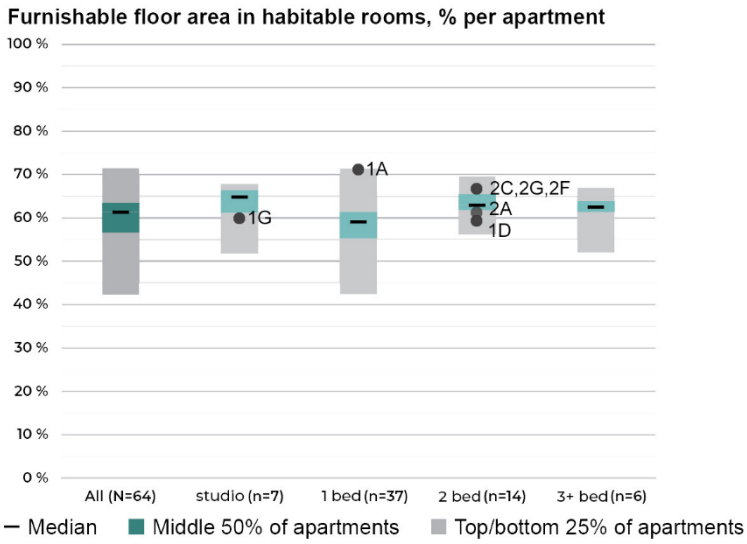

Figure 5. Furnishable floor area in habitable rooms, for all apartments in the ten studied buildings (N=64). Grey dots represent the example apartments of the case buildings 1 and 2 described in the text below.

The more detailed furnishability analyses of the case study buildings 1 and 2 are presented in Figure 6. Case 1 had a lower proportion of furnishable floor area; for example, apartment 1D had 59% furnishable floor area in its habitable rooms, and 50% when including the entrance area. Studio 1G had 60% (and 53% when including the entrance area). In both these apartments the passage to the balcony increased the circulation area and reduced the furnishable area in the living room. In Case 2, apartment 2A had the lowest proportional furnishable area (61.4% in habitable rooms and 60.5% when including the entrance area). In all three of these apartments with the lowest proportions, much space was required for the kitchens and entrances, their fixed furniture and the floor area needed to use those. This contrasts with the best proportion apartments; for example, in apartment 1A, where the area needed to use the kitchen and storage fixtures overlapped with the passages to the balcony, bathroom, entrance door and living room, leading to 71% furnishable area in habitable rooms (63% when including entrance area). In Case 2, the three two-bedroom apartments (2C, 2G and 2F) had 67% furnishable floor area in habitable rooms (65% when including the entrance). However, these apartments also had the lowest proportion of sufficient daylighting in the building. In these cases, the circulation areas were centralised into the living rooms, and the relatively compact kitchen and walk-in closets decreased the needed usage area. This left plenty of free furnishable floor area, albeit not well daylit and with rather fragmented living areas – see Figure 6.

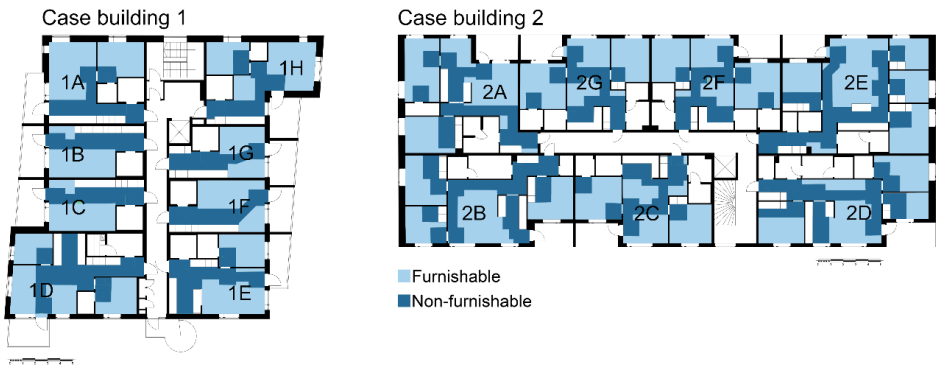

Figure 6. Cases 1 and 2 typical floor plans with furnishability zonings.

Circulation areas should be designed effectively because they are essential for the functionality of the apartment. One of the design solutions to optimise the remaining furnishable space would be to overlap different circulation areas.

This study highlighted that different types of circulation areas take up a substantial proportion of the apartments' floor areas. The previous survey responses had touched on this subject from two perspectives; some residents had experienced difficulties in furnishing their apartments due to lack of space, while on the other hand some also expressed appreciation of spatial efficiency (Lehtinen et al. 2022, 36). Circulation areas should be designed effectively because they are essential for the functionality of the apartment. One of the design solutions to optimise the remaining furnishable space would be to overlap different circulation areas (e.g., access to balconies and other rooms and usage of fixed furniture). While studio apartments typically have less circulation area, they also overall have less furnishable area compared to larger units, leaving few options for placing essential furniture such as a bed or a kitchen table, easily affecting the usability and comfort of the residents and their living experiences. The same is also caused by the fragmentation of furnishable areas especially in main living spaces in larger units.

Spatial connections and privacy levels

The passages through the rooms as well as openness or closability of the rooms were further investigated to study both the connections and privacy levels of the spaces. Closability can be achieved through doors, while openness can be achieved through combined living rooms, kitchens and dining rooms (separate kitchens were an exception in the studied sample), or by placing the entrance straight into the main space. The most private rooms are typically closable bedrooms. In the sample studied, bedrooms usually had no passage through them and 51% of all habitable rooms were closable with a door, with no passage to other rooms, though 62% had passage to a balcony. Except for studios (where there is only one main space), most of the living rooms had some kind of passage through to the other rooms (89%), and 39% of all habitable rooms had a passage to another room. Generally, the studied apartments had similar connection and privacy aspects, which could be partly explained by the prevalence of one-bedroom apartments in the sample. For example, typically they had combined kitchen and living rooms, hence the ratio between closable rooms (i.e., the only bedroom) and open rooms (i.e., the main living space) was about 50–50%.

When most spatial connections are arranged through combined living rooms and kitchens, as was found in the studied sample, there is an increased activity level in the main space, creating greater communality but fewer private quiet areas in the space. Where there are no intermediating spaces between the shared living rooms and private bedrooms, possibilities for controlling privacy levels between different uses within the apartment are reduced. It was also observed that the studied apartments lacked multipaths, i.e., multiple routes provided by several doors or openings between rooms or by several possible paths between smaller furnishable places within the rooms. This feature is more typical in older apartment blocks and generally (though not always) in larger units than in the studied apartment stock (Tarpio 2015: 194–199). While multipaths affect the furnishability of a room, they also provide possibilities to create different types of connections and levels of privacy inside the apartment.

In Case 1, there were clearly overlapping and optimised connections, while in Case 2 the connections were more fragmented and complex (see Figure 7). For example, in Case 2 circulation was centralised in the main living spaces, making them more communal, in contrast to the private bedrooms. Simultaneously, as described in the previous section, the furnishability of the living rooms became rather fragmented, difficult and pre-defined (e.g., where the dining table and sofa can be located). These two illustrative cases do not include any separate kitchens, nor – with exception of living rooms – habitable rooms with a passage into other habitable rooms, although there were a few cases like this in the larger sample.

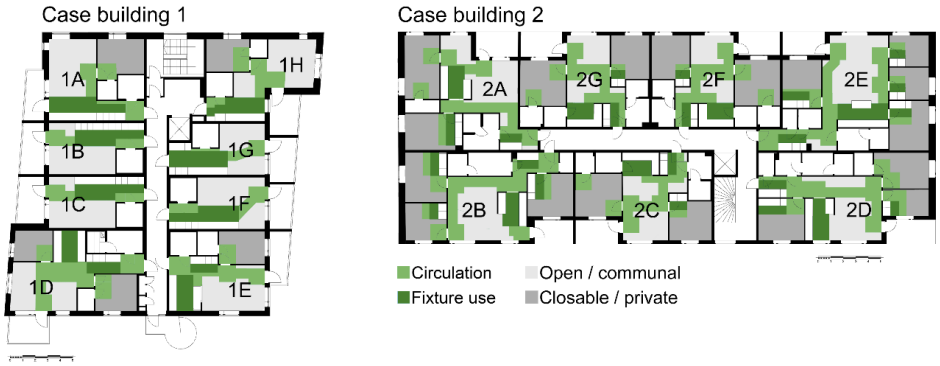

Figure 7. Case buildings 1 and 2 typical floor plans with connections between spaces (green colours) and openness/closability of the rooms with a door (grey colours).

Only few apartments in the studied sample offered the opportunity to separate the kitchen and living area, thus adjusting the privacy level. While there are different preferences regarding separate or combined kitchen spaces, this highlights the need for adaptability potential over the life-time of an apartment.

Only few apartments in the studied sample offered the opportunity to separate the kitchen and living area, thus adjusting the privacy level. While there are different preferences regarding separate or combined kitchen spaces (e.g. RT 93-11231, Tervo & Hirvonen 2019, Lehtinen et al. 2022, 36), this highlights the need for adaptability potential over the life-time of an apartment. In the resident survey 74% of respondents expressed the desire to be able to change their home, of which 15% wished to be able to adapt especially the main living spaces (living room, kitchen and dining room) (Lehtinen et al. 2022). Apartment 2A was an example of where the kitchen area could be separated by adding walls with doors and including the adjacent dining area. In the same apartment, the walk-in storage room could be removed, and its space combined into another more private room (e.g., study or bedroom). Alternatively, the storage area could be enlarged into a private habitable room if it had a window – see Figure 7. Case 1 had remarkably less adaptability potential than Case 2, partially because of the small apartments, but also because of windowless kitchens in the larger apartments (1D and 1E), thus being unsuited to being closed off from the living room (as this would result in spaces without daylight).

While in this studied sample most apartments were fairly similar with regard to their spatial connections and levels of privacy (openness/closability and passage through); a wider range of options would benefit residents by enabling them to meet different needs at different times of life. The resident survey highlighted needs for quiet separate spaces for concentrated work and study, or private moments of relaxation, but also unity and spaciousness for family life (Lehtinen et al. 2022, 36–37). Multipath connections can help adjust the privacy levels inside an apartment and increase the adaptability potential of the apartment itself.

The housing quality aspects combined

By combining the different housing design qualities of daylight (Figure 4), circulation and furnishability (Figure 6), spatial connections and privacy levels (Figure 7) through the common method of spatial zoning, interconnections between these qualities can be analysed and a better understanding can be gained about if – and how – some aspects support or hinder one another.

When combining aspects, it was highlighted that generally more than half of the floor area in habitable rooms that was furnishable also received both sufficient or some daylight (average 59%, median 60%), but there was much variation (see the second row in Figure 8). On average, only 27% of the floor area was both sufficiently daylit and furnishable, with a wide variance (see the first row in Figure 8). Lowest proportions were found in rooms with windows behind the balcony, typically in the main living spaces or studio apartments, where most of the daily routines take place that require daylight for activities but also for residents' well-being. The sufficiently daylit area in apartments needed on average 25% of the

floor area for circulation or fixed furniture usage, but there was again a wide variety (see Figure 8).

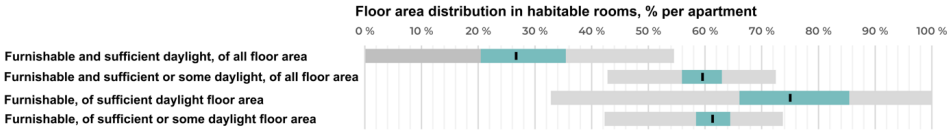

Figure 8. Floor area distribution in habitable rooms, for all apartments in the 10 studied buildings (N=64).

Figure 9 illustrates the combination of daylight and furnishability with both good or poor situations in either aspect. A key observation is that except for one studio apartment, they all had their sole window behind a balcony (e.g., apartment 1F with 0% sufficiently daylit floor area and 56% somewhat daylit furnishable floor area). The furnishability of larger apartments was also affected by compromised daylight access to enable its effective use (e.g., apartment 2F with 25% of habitable floor area both sufficiently daylit and furnishable, and 65% with at least 'some' daylighting and furnishable). In 2F, while the small proportion of the somewhat daylit area is furnishable, there is a lot of circulation in this daylit zone as the main living spaces are used for connections. Contrary to this, the optimised circulation areas in apartments 1D and 2D were mainly located in the darker parts of the apartment, ensuring simultaneously sufficiently daylit and furnishable habitable floor areas (46% and 35% of respectively).

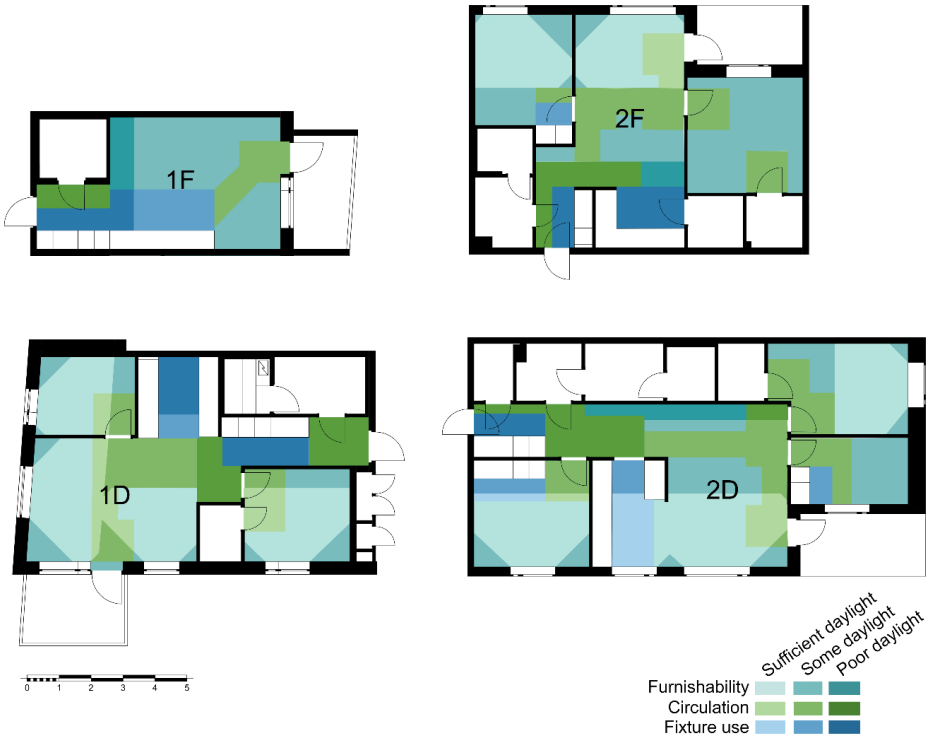

Figure 9. Case apartments with bad (1F and 2F) and good (1D and 2D) combinations (1:150).

When considering daylight and furnishability together, zones with sufficient daylight or some daylight should be prioritised for the furnishable area where everyday activities need to take place. Doing so enables everyday functions to take place without the need for artificial lighting; to offer visual connections to the outside and enabling different uses of a space – all in support of resident well-being. Despite this, half of the habitable floor area was only somewhat daylit and only about a quarter of the area was sufficiently daylit. In addition to overlapping different types of circulation areas, locating them in the darker areas optimises sufficiently daylit furnishable floor areas. It is notable that the balcony relates to all the studied housing qualities, impacting the daylight of the room behind it,

creating circulation and connections through the room therefore affecting both the furnishability and the privacy of the room. It is also worth mentioning that the balcony was the most commonly mentioned apartment property that had provided joy during the 2020 pandemic restrictions in the resident survey. Moreover, balconies highlighted their relevance for residents' well-being as semi-private outdoor spaces that provided functional adaptability potential, recreation, and safe connections to nature and the neighbourhood community. (Lehtinen et al. 2022, 37, 45.) The combined analyses highlight that the same apartment properties might work well from one perspective, or poorly if other aspects of housing quality and design solutions are prioritised.

Discussion: Room for improvement

The furnishability of dwellings is affected by several interconnected factors, such as effective usage area, openings (windows and doors), daylight, fixed furniture and circulation areas and connections to other spaces. In terms of daylight, one of the key findings was the determining role of the balcony, which obstructed especially the main (and often sole) window in a typical studio apartment. In these apartments decreasing the width of the balcony so that it would not cover all of the window or offsetting it from the main window without compromising neighbouring units' privacy, would clearly improve daylight access. However, this is not always possible with narrow-shaped studio apartments without compromising the usability of the balcony as appreciated by the residents (Lehtinen et al. 2022 37, 101). Glassed, transparent balcony railings and walls also allow for better daylight conditions. If placing the main window behind a balcony, it should be significantly larger than without the balcony. Similar balcony considerations apply where a balcony obstructs the main or sole window to larger apartments' living spaces (as was often the case) or bedrooms (not as common). Both case study buildings had deep building masses (16–18 meters) whereas the other studied ten case buildings varied between 9 to around 18 meters, where the deepest plans make good access to daylight difficult. Deep building masses have been observed to be increasingly common and problematic in current Finnish housing production (e.g., Pelsmakers et al. 2021, Saarimaa & Pelsmakers 2020). Deep buildings typically lead to deep apartments with a large amount of naturally unlit spaces. Making slimmer buildings would significantly improve daylight conditions and visual connections to outside, both in support of residents' well-being (Lehtinen et al. 2022, 43, 144). Further, by adding several orientations (either through the building mass, or by creating L-shaped apartments or spaces), the number of windows can be increased in the external walls (see e.g., Saarimaa and Pelsmakers 2020).

In terms of circulation and furnishability, design strategies should focus on overlapping different circulation areas and placing them into darker parts of the apartment (as is done e.g., with wet rooms and storage areas), supporting the interrelation between sufficient daylight and furnishability qualities. Circulation and usage areas should be carefully designed as essential passages, supporting the functionality of the apartment. One design solution for good furnishability of habitable rooms is to avoid a living room thoroughfare with central circulation areas that provide entrances to all rooms. This layout type was not commonly used in the studied housing stock. The placement of kitchen fixtures so that their usage area overlaps with other circulation areas provides spatial efficiency in small apartments. On the other hand, the usual solution for this overlapping is a kitchen located in a living room as a thoroughfare (Vainio et al. 2021), reducing possibilities for separating the kitchen area from other rooms. This was observed in the studied example, and increasingly in the current Finnish housing production (Vainio et al. 2021).

The ability to place (necessary and additional) furniture in more than one location is also important and strongly hindered by the fragmentation of the furnishable

floor area. This difficulty was also pointed out in the resident survey responses (Lehtinen et al. 2022, 38). While generally the studio apartments had effective circulation areas, their actual usable and furnishable zones did not usually allow for different furnishability (see also Pelsmakers et al. 2021). While passages through the room affect its furnishability, there is also a direct impact on the privacy level of the room, which should be considered in the design.

Residents need the ability to adjust the level of privacy in their homes through controlling their visual and physical connections, e.g., by opening or closing rooms by doors. Providing several doors or openings can create multipaths into the apartments, thus providing optional and adaptable connections, privacy levels and passages between rooms inside an apartment. While multipath designs affect furnishability (and can increase circulation zones if all their potential is in use), residents can simply choose to place furniture in front of an unused door.

Finally, the studied characteristics affect an apartment's adaptability potential, referring to the use of space in multiple configurations without needing to change load-bearing elements as a strategy to respond to the changing needs of residents over their lifetime (Saarimaa & Pelsmakers 2020), or to the needs of different residents over the lifetime of the apartment. An example of adaptability potential, which is connected to the possibility to adjust the level of privacy in the apartment, is the kitchen area and the ability to separate it from the other communal living spaces. In our studied sample there were not many instances where this would be possible due to the kitchen then being without a window and thus having no daylight. Different adaptability strategies in the apartment should be included in the design phase so that apartments can better support residents' daily lives and changing needs, safeguarding also the longevity of the building.

Conclusion

There is room for improvement to create more resilient living environments: the amount of daylight was below good practice, especially where balconies obstructed the main living space or the depth of the room kept daylight from reaching the back parts; ineffective (yet essential) circulation areas reduced and fragmented the furnishable area.

This research investigated how the housing design qualities of a Finnish social housing provider supported residents' every-day life and well-being. Ten case-study buildings from a total of 142 rental and right-of-occupancy apartment blocks in the Tampere and Turku regions in Finland were selected for analysis and two representative housing blocks were used to illustrate housing design qualities in more detail. Based on a 1,315 resident home use and housing quality survey in 2020 (Lehtinen et al. 2022), the investigated housing qualities in this paper were daylight, circulation and furnishability, and spatial connections and privacy levels. The first research question was: '*How do apartments and some living environment qualities support residents' daily lives and their possibilities to adapt to changing situations?'.* For this, the research confirmed prior research (e.g., Pelsmakers et al. 2021, Saarimaa & Pelsmakers 2020) that there appears little capacity for urban housing to accommodate changing needs, potentially impacting on residents' well-being (Jusan & Sulaiman 2005). In the studied sample, the apartments had less than optimal levels of daylight, affecting the usability of the rooms, with likely resident well-being implications. Moreover, because essential circulation zones covered (on average) 40% of the floor area, furnishability options in the remaining floor area were reduced. The studied apartments had a rather similar spatial configuration to one another, providing few different privacy levels inside apartments. In addition, adaptability options were poor in the studied cases, yet the need for adaptability was reflected in the resident survey: the majority of residents wished to make changes to their apartment, though special wishes concerning spatial adaptation remained mainly unidentified (Lehtinen et al. 2022).

Concerning the second interconnected research question of '*where is there room for improvement to support residents' daily lives?*', findings highlighted that there is room for improvement to create more resilient living environments: the amount of daylight was below good practice, especially where balconies obstructed the

main living space or the depth of the room kept daylight from reaching the back parts; ineffective (yet essential) circulation areas reduced and fragmented the furnishable area. Only 27% of all habitable floor area was both sufficiently daylit and furnishable. Potential improvements include redesign of the balcony locations, slimmer building blocks and apartment depths, and creating more dual-aspect apartments (i.e., facing more than one orientation). An overlapping of different circulation and usage areas was shown to improve furnishability. Likewise, circulation areas should be located in the darker parts of the apartment to enable the best daylit zones to be used for good furnishability and enabling different furnishing options. Designing passages through rooms affects both furnishability and privacy of the room and this should be carefully considered as part of the apartment design phase. Consideration of multipaths i.e., creating multiple routes inside the apartment, would enable the residents to adjust their levels of privacy as and when needed. Enabling the opening and closing (or connection and separation) of rooms would also enable residents to control levels of privacy and to control visual connections. However, this option was found to be rarely present in the studied sample and needs to be supported by window locations that support good daylight conditions in separated and combined spaces.

Limitations and further research

The research was undertaken during the covid-19 pandemic and apartments could not be visited in-situ. This affected the researchers' ability to observe the actual use of the homes, take daylight readings, and study how the qualitative factors appeared (and were perceived by residents) in reality. The studied ten housing blocks are representative of the wider YH Kodit Housing Association housing stock, and the two illustrative cases are representative of more recent production. However, this studied sample had a larger proportion of one-bedroom units (58%, compared to 30% as found in a recent study by Pelsmakers et al. (2021) of recent Finnish housing production), hence the block plans may not be fully representative of the current Finnish housing production. However, the key identified trends and solutions for improvement for individual apartments are sufficiently generic to be highly relevant to the design and adaptation of living environments and residents' well-being in similar contexts.

Moreover, the research methods used are transferable to the study of other housing blocks. While the studied criteria were based on background literature and transformed into spatial zones, ultimately, the zones were theoretical and simplified models of the qualitative factors studied, which were transparently reported. Finally, the individual and combined spatial zoning method created in this study can be applied to other housing design qualities and would enable an increased understanding of the living environment more holistically.

All of the studied perspectives and their connections would deserve further research. One of these factors is daylight, which has an indisputable impact on residents' delight and well-being (Baker & Steemers 2019). This research concentrated on simplified assumptions of the amount of daylight, but further research on the impact of the window design on the heat gains, heat losses, views to outside, different balcony locations and indoor comfort circumstances should be conducted, not just theoretically but also in the field. Even though daylight factor (DF) has been acknowledged to be suitable to use in the study of daylight in the Finnish latitudes, it has also been criticised about its suitability to different kinds of geographical locations (DeKay 2010). More detailed illuminance studies should include orientation, apartment location, surface materials as well as external and internal obstructions, such as neighbourhood buildings, vegetation, furniture and curtains.

Furthermore, housing design is not only concerned with the internal spaces but includes the housing block and surrounding living environment and neighbourhood. Hence, a further study of the physical and visual connections and qualities between the apartment, neighbourhood and the shared and transitional spaces is needed.

Finally, housing needs are dynamic, and so must be our knowledge acquisition; this was evidenced for example by the global covid-19 pandemic. The future needs are uncertain and some trends and needs witnessed during the pandemic may be long-term shifts. This further prioritises the need to understand how we can achieve adaptable and more resilient housing designs and transformations in reality. To this end, studies using and combining different methods (e.g., spatial zoning and meeting residents in their home environments, but also real estate economics and housing management practices and decision-making processes) are needed. Finally, the wider phenomena – such as the importance of the home and its internal qualities, but also the immediate living environment – needs to be studied from different perspectives.

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