# WANDERING MINDS, WANDERING SPACES

Unraveling Residents' Space Use Patterns in Long-Term Dementia Care

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UCL

**"I am afraid of looking at you and not knowing who you are."**
**"I think that even if you don't know who I am someday,**
**you will still know I love you."**

– Lisa Genova [1]

**"The notion of buildings that speak to us, places at the very center of our architectural conundrums the question of the values we want to live by, rather than merely of how we want things to look."**

– Alain de Botton [2]



University College London
Bartlett Faculty of the Built Environment

BARC0022
**Master Dissertation**
MSc Space Syntax: Architecture & Cities
Academic Year 2022-2023

The Bartlett School of Architecture

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Date of Submission: September 19, 2023

# Abstract

Amid a global dementia epidemic and the absence of a definitive cure, creating supportive environments that promote physical and social activity is paramount for slowing disease progression. Moreover, inconsistencies and ofttimes subjective metrics persist in the evidence base behind dementia-sensitive design.

This study, conducted in three long-term care facilities in Bavaria, Germany, employs ethnographic observations to investigate residents' space use patterns. For the first time, the comprehensive suite of space syntax techniques is tested for assessing the behavior of people with dementia. Results suggest that spatial configuration (visual integration) can effectively explain movement patterns ($r^2 \approx .5\text{-}.6$). Best correlations are found for wandering – despite potential somatosensory impairments. Purposeful behaviors are more conditioned by the institutional regime. Social activities are nuanced, influenced by care culture, persons involved, and cluster in the main common room (MCR). A novel computational tool, MCR step depth analysis, is introduced to illustrate the spatial dynamics of interactions. Comparative examination of special care units yields new insights – ample daylight and views appear as attractors to wandering, and strategic positioning of furniture may mitigate agitated behaviors.

The research emphasises the efficacy of space syntax as a qualitative, evaluative tool for care home designs, providing practical recommendations for architects, and advancing the discourse on dementia-sensitive design, ultimately seeking to enhance the well-being and quality of life for people with dementia in long-term care settings.



*Keywords*

*long-term care facility, dementia, post-occupancy evaluation, space syntax, spatial configuration, architecture, evidence-based design*


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# List of Abbreviations

| | |
|---|---|
| °C | degree Celsius |
| dB | decibels |
| EAT | Environmental Assessment Tool |
| DAT | Dementia Design Audit Tool |
| GDS | Global Deterioration Scale |
| GF | ground floor (excl. SCU if applicable) |
| LTCF | long-term care facility |
| MCR | main common room |
| non-SCU | traditional nursing unit (GF + SF) |
| r | resident |
| r+ | all resident interaction combined |
| r_a | agitated behavior |
| r-r | resident-to-resident(s) interaction |
| r-s | resident(s)-to-staff interaction |
| r-v | resident(s)-to-visitor(s) interaction |
| s | staff |
| SCU | special care unit |
| SF | standard floor |
| SPSS | Statistical Package for the Social Sciences |
| SS | space syntax |
| v | visitor |
| SCU | special care unit |
| QGIS | Quantum Geographic Information System (open-source software) |
| VGA | visual graph analysis |

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# 1. Introduction

## 1.1. The Global Dementia Epidemic

In response to global demographic change and the elicited aging of populations, the prevalence of dementia cases is projected to rise considerably in the forthcoming decades. According to the World Health Organisation, dementia is the seventh leading cause of death with currently more than 55 million people affected worldwide [3].
In many countries, figures are set to double over the next 30 years [4]. Illustratively in Germany, the tally of people necessitating care has surged by over three million within the last two decades (Figure 1). This trajectory is anticipated to continue with the number of dementia patients per 1,000 inhabitants escalating from 22 to approximately 35 by the year 2050 (Figure 2).
This dynamic engenders significant challenges for society, healthcare systems, and, given the growing reliance on inpatient care among seniors, for the provision of residential long-term care facilities (LTCFs) [5-6].

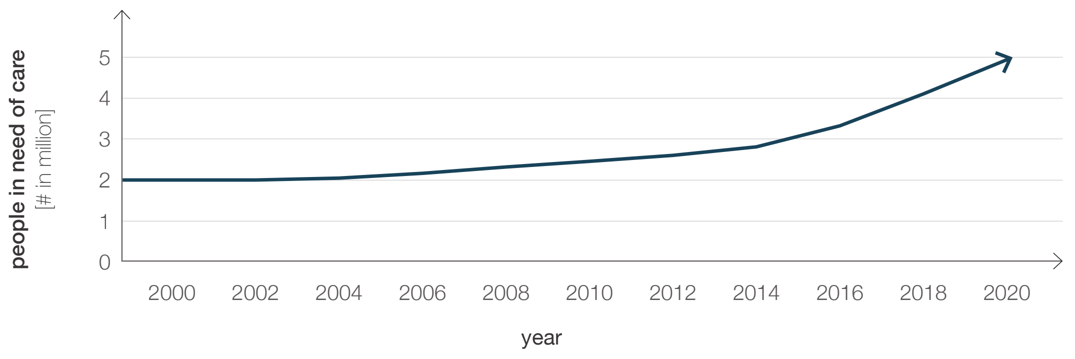



Figure 1. Evolution of care-dependent population in Germany, 2000-2020 (biennial data collection) [7].

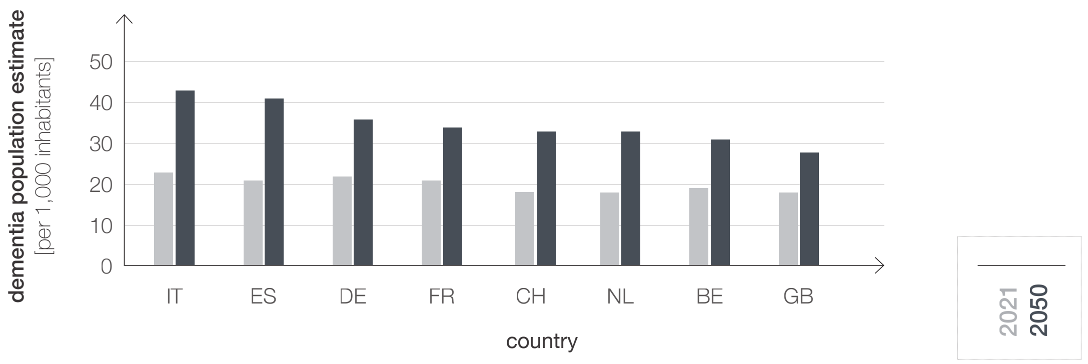



Figure 2. Europe is facing a dementia problem: estimated population with dementia in selected European countries per 1,000 inhabitants (2021) and forecast for 2050 [8].



## 1.2. A Brief History of Care Homes

Historically, elderly care in Germany was primarily the responsibility of families or ecclesiastical institutions. Severe cases were confined to lunatic asylums [9-10]. A pivotal breakthrough in understanding dementia as a neurological disease occurred in 1906 with the discovery of cerebral cortex 'plaques' by German physician Alois Alzheimer [11]. This finding coincided with other significant advances in hygiene and medicine, which were spurred alongside industrialisation. As the century progressed, many asylums were closed and replaced by nursing homes [12]. Following continuous efforts in advancing dementia care, special care units (SCUs) emerged in the 1980s and have flourished since with the aim of providing comprehensive and tailored care specifically designed for people with dementia [13]. Usually implemented as a separate area within nursing homes, SCUs offer an access-controlled, secure environment with trained staff who possess expertise in managing the unique challenges and needs associated with dementia, facilitating specialised activities, promoting comfort, and a higher quality of care [14].

## 1.3. Architecture as a Nexus of Health and Well-Being

Despite substantial scientific progress in unraveling the biochemical underpinnings of dementia, the quest for a pharmaceutical remedy remains elusive [15-16]. Contemporary medications primarily target the symptoms of dementia rather than its root cause [17]. Although recent advancements in the United States show promise for a drug that may slow down disease progression [18], as of now, there is no cure nor any certain way to prevent dementia [19].
It is in this context that architecture assumes an integral role within non-pharmacological therapeutic care, as creating supportive environments has shown efficacy in delaying the onset of the disease [20-22]. By facilitating independent wayfinding and fostering physical and social engagement architecture can wield a beneficial influence on both the well-being and health of individuals with dementia. Consequently, discerning the spatial variables that precipitate this effect has emerged as a paramount focus within research [23], an ongoing discourse to which this study hopes to contribute.

## 1.4. Knowledge Gap and Research Aims

At large, dementia-sensitive design can be grouped into two subcategories: architectural (e.g. spatial layout, visual sightlines) and environmental qualities (e.g. light, furniture, signage). While many thematic areas are well-researched, most existing studies rely on small sample sizes, highlighting the need for a more robust evidential foundation [24-25]. Comparative post-occupancy building analyses are imperative to ascertain residents' space use patterns (cf. 3.1. for details) [26-27].

In the pursuit of evaluating dementia-sensitive environments and deriving practical design recommendations for architects and care providers, the potential of space syntax techniques has garnered interest among scholars in recent years [28].
Space syntax, pioneered by the seminal work of Bill Hillier, constitutes a theoretical framework and suite of quantitative tools for examining spatial configurations* to understand their impact on human behavior, movement patterns, and social interactions [29-30]. It has been successfully applied in hospital designs for several decades [31-32]. However, its application within LTCFs remains notably understudied and the scarce existing body of literature has produced inconsistent findings (cf. 3.2. for details).

## 1.5. Research Questions and Hypotheses

**Examining residents' behavior in three long-term dementia care facilities,**

1. What discernible patterns of space use can be observed?
2. Are these patterns associated with the buildings' spatial configuration?
3. Which architectural qualities seem to promote physical and social activity?

It will be suggested, that SCUs and traditional nursing units (non-SCUs) adhere to distinct spatial behaviors **(1)**.
While spatial configuration and movement are associated, analogous evidence is not observed for social activity patterns **(2)**. Following, a novel computational tool (MCR step depth analysis) is introduced, showing promise in predicting the spatial dynamics of interactions among residents in LTCFs. In summary, space syntax emerges as a well-applicable and valuable tool for the assessment of dementia care environments.
Resident engagement can be stimulated by a range of architectural qualities, including, but not limited to, the provision of generous garden spaces, small-scale environments, simplified layouts, ample daylight and well-integrated common areas **(3)**. It is further implicated that strategic placement of furniture and emergency exits can mitigate agitation among people with dementia.
To examine the indicated hypotheses further, a summary of key findings including implications for practice and avenues for future research is provided at the end of the manuscript.

*In space syntax terms, spatial configuration is defined as relations taking into account other relations, or more precisely, the sum of all relations between the various spaces of a system (say, buildings or rooms).

**This pertains specifically to Alzheimer's (~65% of cases). If dementias are 'secondary' (~10%), indicating they arise from an underlying disease (e.g. alcohol poisoning), they can in some cases be curable. Nonetheless, the majority of dementias (~90%) are 'primary' and ultimately fatal.



# 2. What is dementia?

## 2.1. Etymology and Definition

Originating from the Latin word "demens", literally meaning "being out of one's mind" [33], the umbrella term "dementia" describes a set of neurological diseases characterised by a decline in cognitive, social, and emotional abilities. Common forms of dementia include Alzheimer's, which accounts for 60-70% of cases, vascular dementia, Parkinson's disease, and dementia with Lewy bodies, among others [34]. Notably, the boundaries between different types of dementia are indistinct, and mixed forms often co-exist [35]. Symptoms encompass memory loss, impaired language, orientation, and difficulty with performing daily activities [36-38].

## 2.2. Medical Explanation

Dementia entails the degeneration of neurons and their synaptic connections in the brain. Individuals with Alzheimer's experience an accumulation of amyloid protein, forming toxic plaques that damage brain cells and lead to physical atrophy [39]. This process typically originates in the hippocampus and progresses to other cerebral areas [40]. Vascular dementia, in contrast, is attributed to diminished blood flow to the brain, usually resulting from strokes [41]. Other forms of dementia, in turn, have other unique etiologies and manifest diverse symptomatology. Nevertheless, all types lead, over time, to progressive declines in individual autonomy and the need for full-time formal care [42-43].

While not an intrinsic aspect of natural aging, the likelihood of developing dementia rises with age. In Germany, the prevalence of dementia among individuals aged 65-70 is approximately 3%, escalating to one in three among those aged 90 and above [44]. Women are disproportionately affected due to their longer lifespan [45]. Moreover, depression, diabetes, hearing loss, hypertension, and obesity have been associated with an increased risk of dementia [46]. Nonetheless, the precise etiological factors triggering the pathological changes in the brain remain insufficiently researched [47].

## 2.3. Disease Progression

Over time, individuals with dementia gradually lose their capacity to function independently. The Global Deterioration Scale (GDS) developed by Dr. Barry Reißberg is commonly employed by medical practitioners to assess cognitive function [48]. It suggests seven progressive stages: **stage 1** signifies mental health, **stages 2-3** represent mild impairment (e.g. memory lapses), **stages 4-6** indicate moderate to severe decline (e.g. difficulty with daily activities, memory loss) while **stage 7** signifies very severe cognitive decline and loss of functionality. Depending on the time of diagnosis, dementia is fatal in three to ten years** [49].

## 2.4. Loss of Spatial Cognition

Age is directly linked to a near-linear decline in navigation ability from the early twenties [50]. Additively, people with dementia experience exacerbated visuospatial dysfunction as their capacity to recall cognitive maps rapidly erodes – an early characteristic of the disease [51-56]. This severe impairment of wayfinding capabilities causes disorientation, heightened stress levels, agitated behavior, and diminished sense of autonomy [57]. In fear of getting lost, many individuals adopt a sedentary lifestyle contributing to feelings of loneliness and isolation – factors known to expedite disease progression [58-61].

## 2.5. Supportive Environments

People with dementia are thus advised to reside in their familiar home settings for as long as possible [62]. However, as their condition worsens, often coupled with accidents happening at home, increased supervision and assistance are required, accompanied by relocation to LTCFs [63]. Research studies indicate an average decline of up to 23% in physical activity following this transition, highlighting a major concern [64].
Creating supportive environments can minimise this effect and enhance the residents' quality of life. To provide a finer understanding of the specific spatial characteristics conducive to this, the current evidence base is explored in the subsequent section.

# 3. Literature Review

A literature review was conducted to discern the research's broader academic debate, guide its methodology, and identify areas of research deficiency. The specific knowledge gaps addressed in this study are highlighted in the text below.
Studies were retrieved from the databases of UCL Explore and Google Scholar. The search was carried out in two phases.
**Part 3.1.** focuses on the relationship between built environment and dementia using the keywords '*dementia*' and '*residential care home*' or '*architecture*' or *'built environment'* or *'post-occupancy evaluation'* or *'evidence-based design'*. Two types of space use patterns are reviewed: physical (e.g. movement, wayfinding) and social abilities (e.g. engagement, interaction). **Part 3.2.** bridges the existing research to space syntax literature using the keywords *'dementia'* and *'space syntax'* or *'space configuration'* or *'VGA'*.
The literature was searched for articles published after 1980. Reference lists of review articles were hand-searched for further empirical literature. Titles and abstracts of articles were screened for relevance. If a clear decision on relevance could be made, articles were read at full length. Overall, 117 papers are included in the review.



## 3.1. The Evidence Base behind Dementia-Sensitive Design

### 3.1.1 Non-Spatial Factors

Institutional governance exerts a strong influence on space use within care environments, shaping operational policies, care philosophy, culture, and aspects like access control and visiting hours [65-67]. Additionally, the personality of both nursing and care staff, residents' demographic profiles, health conditions, and interpersonal dynamics must be taken into account [68].

### 3.1.2 Environmental Attributes

High noise levels and temperatures should generally be avoided as they constitute unhelpful stimulation for dementia patients, leading to detrimental effects on social abilities [69], agitated behavior [70-72], and contributing to disorientation [73]. Confusion in wayfinding can arise from repetitive elements and a lack of differentiation between different areas of the building [74]. People with dementia further have difficulty with crowding [75]. Disguising or hiding busy entrance doors was found to be effective in reducing overstimulation and controlling unsupervised exits [76-78].
The provision of homelike environments supports residents' engagement in daily activities and informal social interaction [79-81]. Factors such as the presence of equipment (e.g. handrails), accessibility (e.g. sufficient corridor width, no changes in level), and the aesthetics of the environment (e.g. artwork, windows, illumination) play important roles in influencing physical activity levels [82].
Orientation is aided by reducing the number of doors [83-85] and introducing landmarks [86-90]. Personal cues, such as written names and photographs of residents, have been found to enhance residents' ability to locate their own room [91-93], with one particular study reporting an increase of 45-50% in effectiveness [94]. Moreover, signposting is a valuable intervention to assist residents in navigating their surroundings [95], with text-based signage generally being better understood than icon-based signage [96-97].

### 3.1.3 Size of Residential Unit

Traditional nursing homes are conventionally designed to accommodate a substantial number of individuals, ranging from dozens to even hundreds. Small-scale environments such as SCUs offer an alternative, intimate model housing only a handful of residents, varying between 5-25 individuals, thereby emphasising familiarity, independence, and a sense of belonging by providing person-centered care [98].
Existing research predominantly reports a positive effect of SCUs on residents' mobility, social interaction, friendship formation, and communication skills [99-113]. Engagement in daily activities significantly increases by 44% [114-118]. However, four dissenting studies

indicate no significant relation between unit size and interaction behavior or even observed social withdrawal when compared to larger units [119-122]. Incidents of agitated behavior are unaffected by variations in unit size [123-124]. Proximity between living spaces and common areas has been associated with simplified wayfinding [125-127], although one study did not establish a clear correlation in this regard [128].

### 3.1.4 Social Density

Social density refers to the number of people per surface area or room. Its relationship to space use remains a subject of debate. While one study argues that residents in low-density environments exhibit higher engagement levels [129], other studies suggest it increases social withdrawal by providing fewer opportunities for interaction, even causing boredom [130-132]. One study found no relationship at all [133]. Social density and orientation are not associated [134].

### 3.1.5 Diversity of Spaces

Social interaction is furthermore affected by the number of different spaces and the diversity of activity programs provided [135-136]. Empirical validation regarding the advantages of outside space is sparse [137], nonetheless, extant evidence points towards beneficial outcomes for interactions between residents and staff [138].

### 3.1.6 Spatial Layout

Avoiding intersecting circulation routes improves navigability for individuals with dementia, as decision points can cause cognitive overload [139-143]. For instance, L-shaped environments are less disorientating compared to H-shaped configurations [144]. Additionally, research suggests that lengthy hallways have a detrimental effect on residents' awareness, orientation, and safety [145-146]. Therefore, clear and straight double-loaded corridors are most recommended in dementia care settings [147-148].

### 3.1.7 Visibility

Empirical evidence consistently suggests that enhanced visual connections between spaces play a pivotal role in facilitating social engagement and promoting orientation [149-155]. Establishing clear sightlines is particularly relevant between the individual's room, sanitary facilities, nursing station, communal and outdoor areas [156-160].



### 3.1.8 Reflections and Research Gaps

Design interventions in long-term care facilities demonstrate effectiveness in various outcomes regarding space use patterns of people with dementia (Figure 3).
Although by and large well-researched, conflicting findings are evident concerning the impact of unit size **(research gap 1)** and social density **(research gap 2)**. Studies also omit to delve into the practicality and cost-effectiveness of implementing small-scale environments. This could be further explored.
Environmental features are often investigated in a one-sided manner. The effect of camouflaging doors, for example, is tested only for exiting and agitated behavior. Potential adverse effects on confusion or increased wandering are not examined in the articles reviewed.
Terms frequently lack consistent definitions [161]. At times, *'homelike'* pertains to interior decorations and furnishings [162], while in other instances it relates to archetypical features (e.g. living room, laundry area) or the provision of family-like daily activities, such as housekeeping [163].
The negative impact of high noise levels and temperatures is discussed, but no specific thresholds are provided for at which these become problematic. One article introduces its own metric based on people density per room, while another defines noise as crying babies or patient screams. Incorporating quantitative data in future research, such as temperature in degree Celsius (°C) or noise in decibels (dB), would offer more precise design recommendations.

| design feature | social activity | orientation / movement |
|---|---|---|
| non-spatial factors | ■ ■ ■ ■ | |
| environmental attributes | ■ ■ ■ ▲ ▲ ▲ ▲ | ■ ■ ■ ■ ■ ■ ■ ■ ▲<br>■ ■ ■ ■ ■ ■ ■ ■ ▲ |
| unit size | ■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ○ ○<br>■ ■ ■ ■ ■ ■ ■ ■ ■ ▲ ○ ○ ○ | ■ ■ ■ ○ |
| social density | ■ ▲ ▲ ▲ ○ | ○ |
| diversity of spaces | ■ ■ ■ | |
| spatial layout | | ■ ■ ■ ■ ■<br>■ ■ ■ ■ ■ |
| visibility | ■ ■ ■ ■ ■ ■ | ■ ■ ■ ■ ■ ■ |

Figure 3. Consensus and disparities: the evidence base behind dementia-sensitive design. Each icon corresponds to a study identified in the literature review. Square icons denote a positive relationship, triangles indicate a negative relationship, and circles represent instances where no significant effect was found.

It should also be noted, that most research is based on small sample sizes and homogenous participant groups [164-165]. Therefore, more inquiry is generally required (particularly post-occupancy evaluations and comparative analysis of dementia care centers) to strengthen the evidence base **(research gap 3)** [166-167].
To facilitate the practical application of dementia-sensitive design criteria, various tools have been developed in recent years which allow an evaluation of LTCF performance – among the most common are the Dementia Design Audit Tool (DAT) and the Environmental Assessment Tool (EAT) [168-169].
However, given the inherent subjectivity of many metrics and deficiencies in the literature, this study turns to space syntax, a quantitative method for evaluating built environments that has garnered increasing interest in scholarly discourse [170].

## 3.2. Quantifying Human Behavior: The Potential of Space Syntax

Through the utilisation of graph mathematics and computerised representations of space, space syntax has advanced a measurable scale (from integration to segregation) that provides insight into the social functioning of built systems [171]. By quantifying the spatial configuration of a designated building layout, movement flow can be predicted ($r^2 \approx .5-.8$) [172-174]. Highly integrated areas attract to-movement and generate multiplier effects, such as social interaction [175].
In the 1990s, these methodologies were first applied within healthcare environments to analyse the behavior of both personnel and patients [176]. Among the earliest discoveries was the identification of integration values of hospital corridors as reliable predictors of the frequency of use in exploratory navigation by visitors unacquainted with the layout [177-178].

| space syntax | social activity | orientation / movement |
|---|---|---|
| axial integration | | ■ ▲ |
| visual integration | ■ ▲ ○ | |
| convexity | ○ ○ | |
| intelligibility | | ▲ |

Figure 4. Consensus and disparities: the space syntax evidence base pertaining to the behavior of people with dementia in care environments. Each icon corresponds to a study identified in the literature review. Square icons denote a positive relationship, triangles indicate a negative relationship, and circles represent instances where no significant effect was found.



Subsequent investigations revealed a comprehensive range of associations, linking spatial configuration to factors such as workflow efficiency, organisational performance, and quality of care [179-188]. This suggests that spatial configuration may hold greater significance than size or geometry in explaining space use patterns [189-190].

Curiously, the application of space syntax in long-term care settings remains little explored. Two articles apply its methods to quantify cross-cultural variation in long-term care layouts [191-192] and three studies examine the intrinsic spatial nature of LTCFs employing space syntax to suggest that nursing stations are intentionally placed in the integration core to prioritise control over residents [193-195]. Only six very recent publications discuss space syntax in the context of residents' space use patterns (Figure 4). Their results are outlined in more detail below.

### 3.2.1 Axial Integration

A negative correlation between axial integration (radius n) and wayfinding satisfaction is found ($p < .01$) [196]. Coevally, another study documents a positive relation to residents' active time [197], hinting at a trade-off between lengthened physical activity and wayfinding ease in highly integrated LTCFs.

### 3.2.2 Visual Integration

Three studies investigate the association between visual integration and social interaction. While one study about adult day-care facilities discovers a correlation [198], another article centered on LTCFs does not observe such a relationship [199]. The third study contends that it is the duration of conversations that plays a pivotal role: high-level interaction occurs in secluded spaces, whereas low-level interaction concentrates in integrated areas [200].

### 3.2.3 Convexity and Intelligibility

In a separate study involving 82 private homes, the impact of spatial layout convexity (defined as the ratio of convex spaces to building functions) on orientation abilities and functional independence in completing daily tasks among people with dementia is examined, revealing a negative influence.
No significant correlation is identified with intelligibility, a space syntax metric assessing the correlation between axial connectivity and axial global integration [201]. Social activity in adult day-care facilities also appears to be disjointed from floorplan intelligibility [202].

### 3.2.4 Reflections and Research Gaps

Reviewing the existing space syntax literature on long-term care environments reveals a significant lack of studies. Variations in care culture – from SCUs to non-SCUs – are not accounted for in the current evidence base **(research gap 4)**. Intriguingly, the scholarly discourse also leaves aside the pertinent question of who engages in the interactions observed **(research gap 5)**. Moreover, one article misinterprets intelligibility as synergy*, raising doubts about its applicability **(research gap 6)**.
The dissimilarity of space syntax techniques applied across studies underscores the need for a comprehensive comparison of methods to determine their suitability for dementia behavior analysis **(research gap 7)**. Some tools, incl. convex and step depth analysis, remain entirely unexplored **(research gap 8)**.
Furthermore, dementia prominently diminishes spatial reasoning and visuospatial abilities, distinctive alterations in cognition that elude assessment through syntactic metrics, such as space syntax. Consequently, the extent to which spatial configuration is pertinent to the design of dementia environments remains an open question **(research gap 9)**.
By providing insights and in-depth analysis this study aims to bridge the nine research gaps identified.

*Synergy is defined as the correlation between radius-3 and radius-n axial integration and assesses not navigational ease (intelligibility) but the relationship between the internal structure of an area and the larger-scale system.

# 4. Scope and Methodology

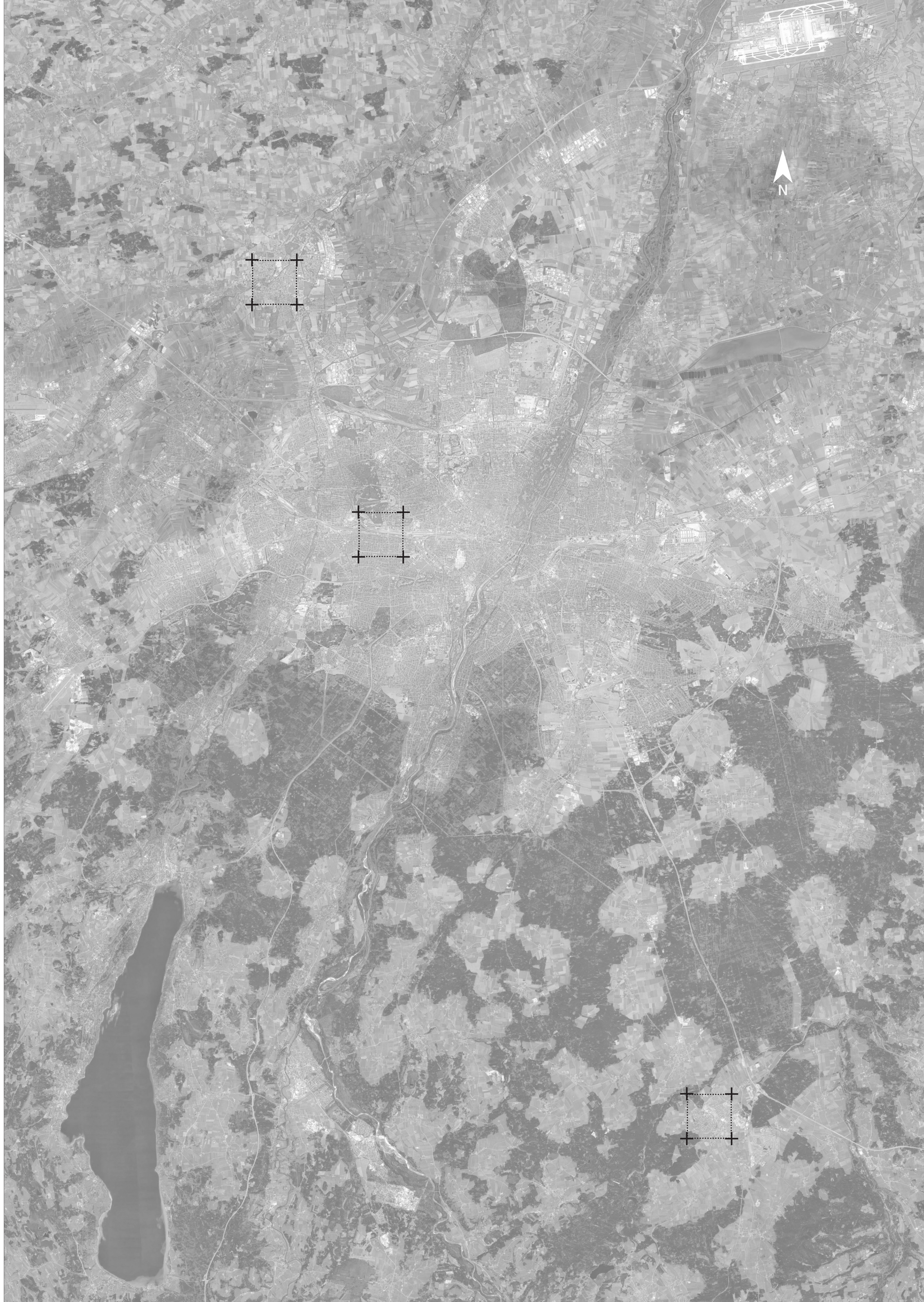
## 4.1. Case Studies

Three purpose-built LTCFs in Bavaria, Germany, are the subject of this dissertation. The case studies are located in **Dachau** ("House Marienstift"), **Holzkirchen** ("St. Anna House"), and **Munich** ("Dementia Competence Center") (Figure 5).

### 4.1.1 Cultural Context in Bavaria

As of 2023, Bavaria records 270,000 dementia cases with a significant projected increase [203]. Approximately two-thirds of these individuals receive care in their own homes [204]. Moreover, there are 1,520 long-term care facilities in operation [205], with an estimated 70% of residents living with dementia [206]. The majority of these nursing homes are either non-profit or municipally run, while 35% are privately owned [207].
Since 2013, the Bavarian Dementia Strategy has served as the primary policy document guiding the state's dementia care objectives and initiatives. Key goals are a change in society's attitude towards dementia (to counter stigmatisation) and upholding the dignity of those affected [208].

Figure 5. Location of case studies in Bavaria, Germany, in Munich (middle), with Dachau located north and Holzkirchen south of the state capital [209]. →



## DACHAU
U-shape

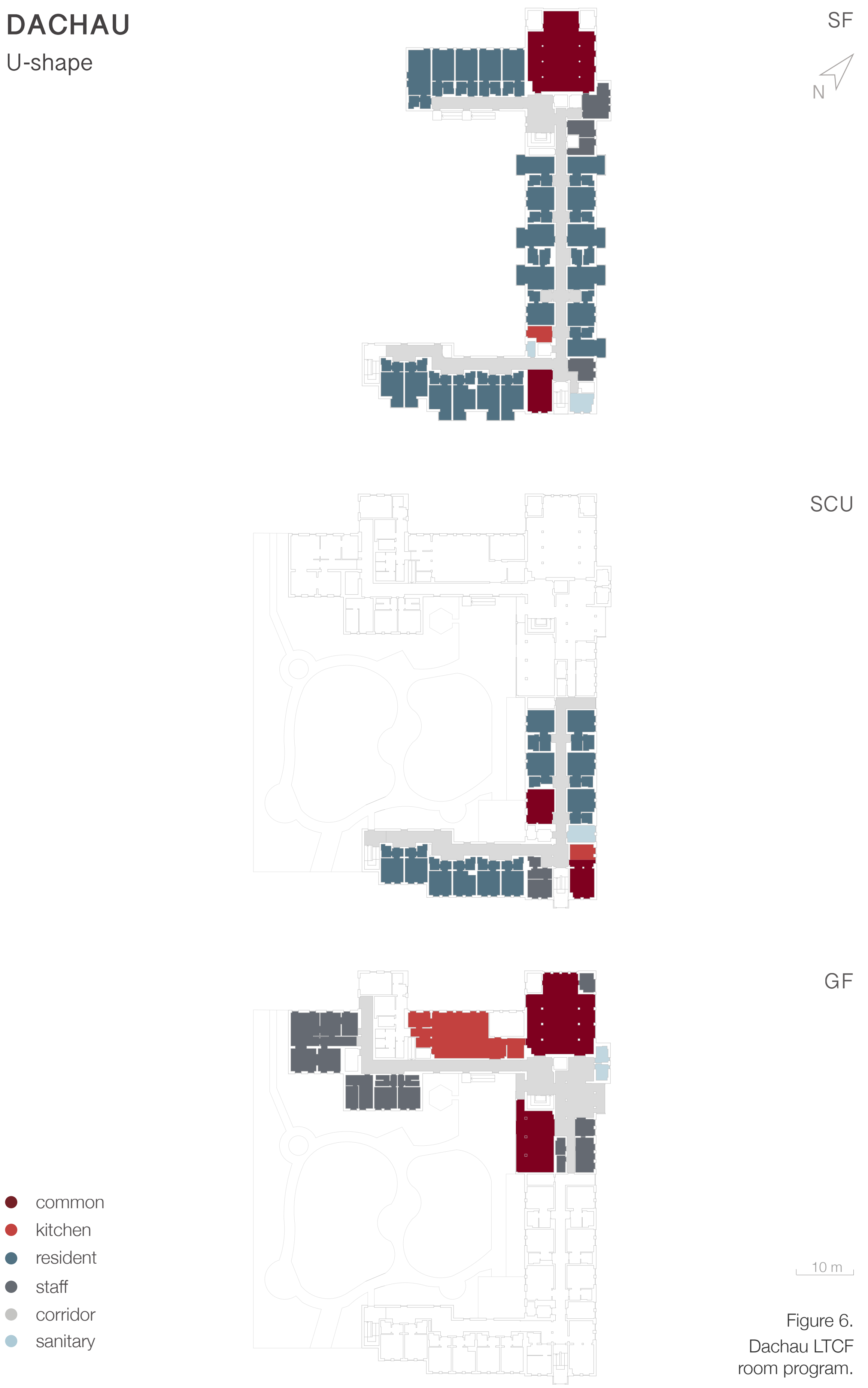



Figure 6.
Dachau LTCF
room program.



According to the World Alzheimer Report, Bavaria is among the very few places in the world, where dementia-sensitive design is essential in national plans [210]. It outlines minimum standards for accessible design and requires the provision of easily understandable, homely living units, as well as access to outdoor space [211].
People with dementia receive care allowance in Germany. The exact amount is determined following a point system. Care level 1 is the lowest level, defined as a minor impairment of independence (125 EUR/month), care level 5 is the highest level, defined as the most severe impairment of independence with special requirements (2,000 EUR/month) [212]. These amounts vary slightly depending on whether a patient is cared for on an outpatient, day-care, or inpatient basis. Bavaria additionally grants a federal supplementary allowance of +1,000 EUR /year for care level 2 and higher [213].
As care cultures vary widely around the world, the choice of case studies was carefully made to ensure a uniform context for further analysis.

### 4.1.2 Building Details and Room Program

All buildings comprise three upper floors. The ground floor serves various functions, housing foyer, reception area, administrative offices, a communal garden, and SCU (Figure 6-8). Holzkirchen is an exception to this with its SCU occupying the entire third floor. In Dachau, both the kitchen and laundry are situated on the ground floor, while in the other facilities, they are located in the basement. Living units are designed as double-loaded corridor structures. Entrance doors to en-suite residents' rooms incorporate cues such as name cards, resident pictures, personal decorations, or poems to aid in recognition. Each unit comprises two common rooms (main and minor), a small kitchen, a staff room, and a shared toilet. All three LTCFs include a chapel.
In Dachau and Holzkirchen, supplementary spaces known as the 'saloon' for special events (e.g. parties, concerts) plus a 'cafeteria' on the ground floor are available, where lunch is served for residents who are more able-bodied and do not require assistance with eating.

The buildings originate from different periods. While the Dachau care home was established in the 1960s, Holzkirchen's was built in the 1970s with a subsequent extension in the 1990s, and Munich's was completed as recently as 2016. Another notable distinction among the case studies are the floor layouts, covering U-shape (Dachau), L-shape (Holzkirchen), and racetrack (Munich) variants.

### 4.1.3 Schedules and Daily Routines

All institutions adhere to the same set of standards and similar daily schedules. Food is serviced in the MCR or, upon request, in the resident's private room. Breakfast begins around 8am, lunch follows at noon, coffee and cake at 2pm, and dinner is served at 6pm. Activities (in which participation is voluntary) are offered mid-morning (e.g. joint reading of the newspaper, piano matinée, cake baking, or church service on Sundays).

## HOLZKIRCHEN

L-shape


## MUNICH

Racetrack

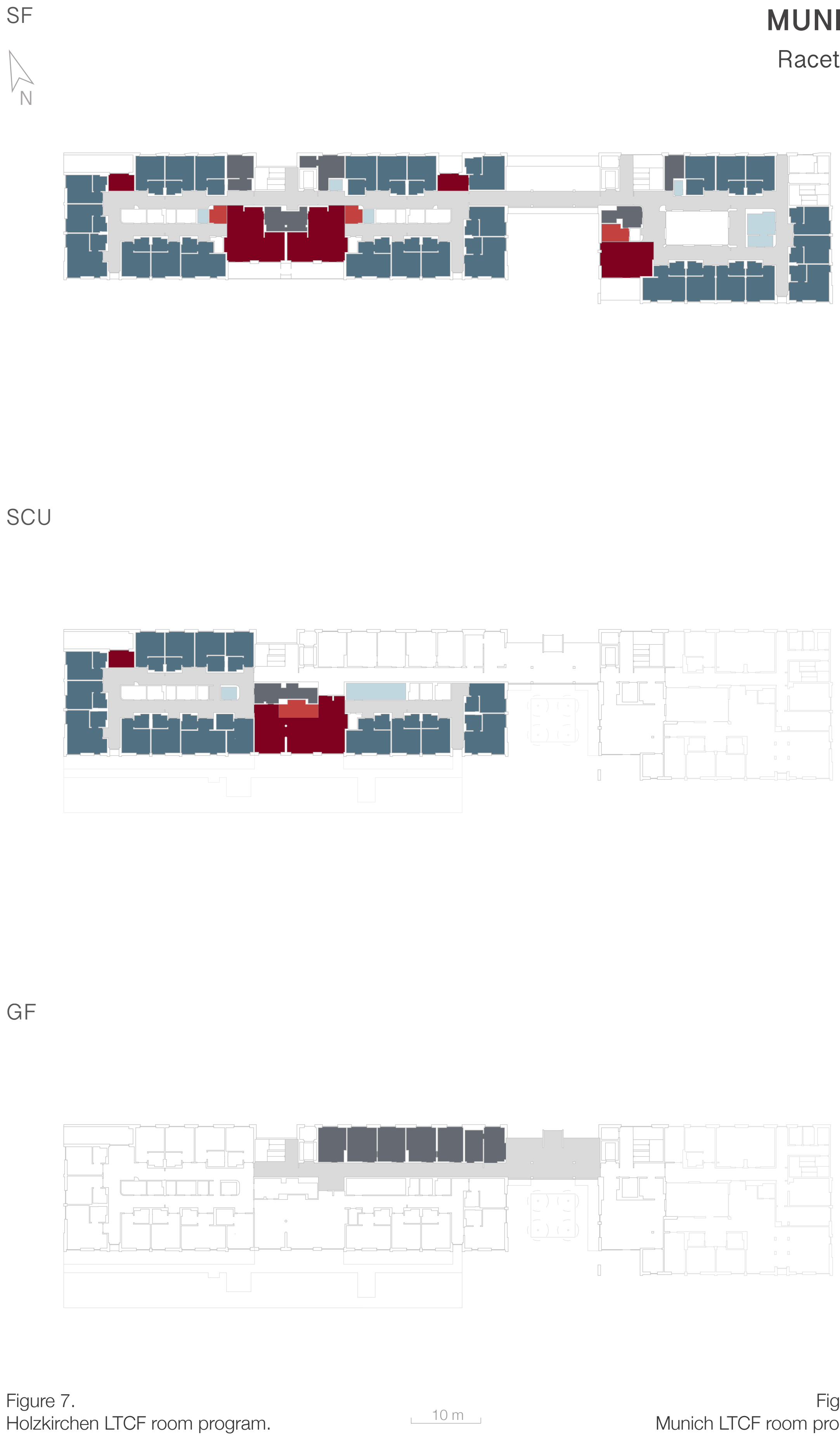



Figure 7.
Holzkirchen LTCF room program.

Figure 8.
Munich LTCF room program.

### 4.1.4 Free Movement and Accessibility

Residents can access all spaces and move freely between floors and the communal garden. However, to prevent residents from inadvertently exiting the building due to disorientation, they wear sensor-equipped wristbands. These trigger a notification to the responsible nurse when a resident leaves the premises. This system serves a dual purpose: it ensures the safety of residents while also mitigating stress levels among staff. The policy does not apply to residents living in SCUs, given that its entrance door is subject to strict access control. Only staff and authorised visitors are informed of the passcode.
Corridor widths range from 1.6 meters in Dachau to 2.4 meters in Holzkirchen. Uniform floor levels and wall-mounted handrails support ease of access and navigation.

### 4.1.5 People

Each LTCF provides accommodation for ~100 residents, with ~20 of them living in the SCU (Figure 9). Occupancy falls short of full capacity due to a prevailing shortage of caregivers. ~80% of residents are female. Many people move in wheelchairs, few are bedridden. Care level 2-4 is most common in Dachau and Holzkirchen (~70% dementia residents). Munich specialises exclusively in residents with dementia (100%) and shows slightly higher care levels of 3-4.

### 4.1.6 Rationale for Case Study Selection

The case studies are highly homogenous in terms of culture, room program, environmental features, daily routines, institutional governance, and resident population. Yet, they differ in floor layout (Figure 9).
As their contextual similarity coupled with diverse spatial configurations enhances hypothesis validation and strengthens the results' robustness, the case studies are found well-suited and were as such sensibly selected for the purposes of this research.

## 4.2. Observation and Data Collection

To systematically capture residents' behavior in LTCFs, two-day ethnographic field observations were conducted. Accounting for variations in visitor flow, observations spanned one weekday and one weekend day in each care center.
Ethical approval was obtained from the Research Ethics Committee of University College London, accompanied by a risk assessment. Consent to participation was gained from all facilities – cf. official documents in the appendices.



| | DACHAU | HOLZKIRCHEN | MUNICH |
|---|---|---|---|
| **GENERAL** | | | |
| address | Schillerstr. 40 | Krankenhausstr. 10 | Landsbergerstr. 367 |
| observation [2023] | | | |
| weekday | Jul 28 | Jul 24 | Jul 31 |
| weekend | Jul 30 | Jul 29 | Aug 6 |
| **BUILDING DETAILS** | | | |
| **year of construction** | **1962** | **1970 & 1998** (extension) | **2016** |
| architect | Manfred Danner | Langecker + Partner | Feddersen |
| upper floors [#] | 3 | 3 | 3 |
| floors observed | 0 & 2 | 0, 1 & 3 | 0 & 1 |
| special care unit | 0 | 3 | 0 |
| **floor layout** [shape] | **U** | **L** | **Racetrack** |
| corridor width [m] | 1.58 | 2.44 | 1.72 |
| **occupancy rate** | **89%** | **90%** | **100%** |
| **PEOPLE** | | | |
| care personnel [#] | 45 | 72 | 80 |
| **residents** [#] | **83** | **107** | **110** |
| female | 81% | 80% | 67% |
| male | 19% | 20% | 33% |
| level of care | | | |
| 1 | 4% | 5% | – |
| 2 | 18% | 29% | 7% |
| 3 | 35% | 35% | 42% |
| 4 | 32% | 19% | 44% |
| 5 | 11% | 12% | 7% |
| in wheelchair | 56% | 42% | 28% |
| bedridden | 14% | 2% | 6% |
| **with dementia** | **70%** | **70%** | **100%** |
| **special care unit** [#] | **16** | **25** | **20** |

Figure 9. Key data of case studies in comparison.

Before commencing the primary investigation, visits were made to all buildings, during which the nursing home director introduced the principal investigator to the premises as well as to staff members.
Ground floor (GF, incl. communal garden but excl. SCU if applicable), standard floor (SF), and SCU were observed. Floor plans were provided as .dwg-files by either the Bavarian Institute for Dementia-Sensitive Design or the responsible architects and refined in Archicad (Building Information Modelling software for architects) to ensure accuracy and uniformity in level of detail across all buildings. Space use patterns were recorded through manual observation, adhering to the Space Syntax Observation Manual [214], and utilising the techniques of static snapshots in conjunction with movement traces.

### 4.2.1 Static Snapshots

First, observation areas were subdivided into individual spaces to be visible in their entirety from a single vantage point. In Dachau, this resulted in a total of six spaces, in Munich and Holzkirchen in nine spaces. Second, zoomed-in floorplans of each space were printed on sheets of paper. Third, during the actual investigation, the observer moved from space to space, capturing snapshots (taking a mental photograph) of activities upon entering each space. The location of people was marked on the plan, with coding according to activity (sitting, standing, walking), gender (female or male), person type (resident, staff, visitor), whether they were interacting (denoted by drawing a circle around them), interaction type (talking, helping), and agitation – cf. Figure 10 for observation categories.

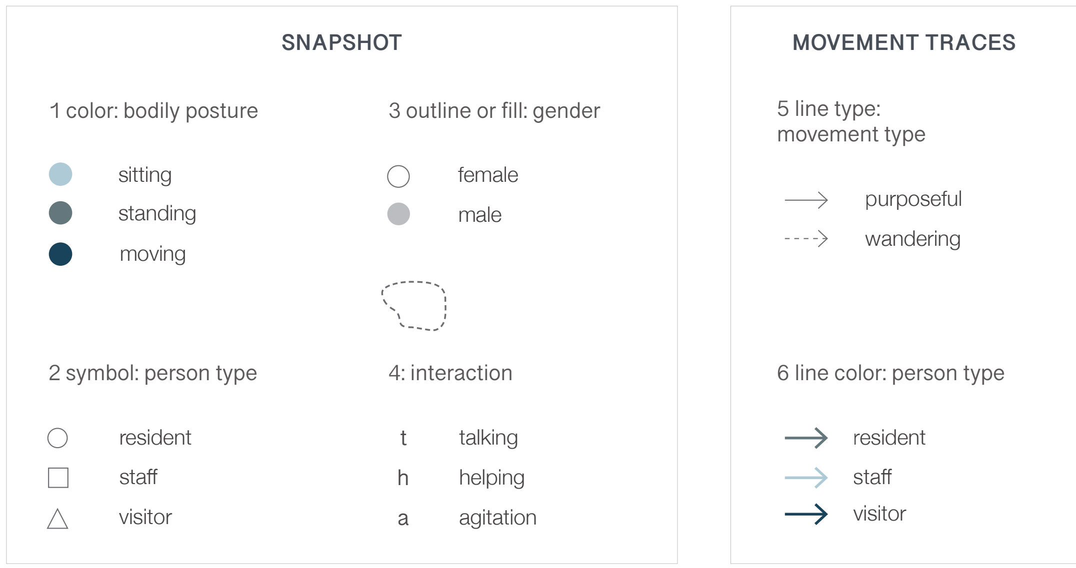



Figure 10. Observation categories.



| | | | | |
|---|---|---|---|---|
| **GROUND FLOOR** (GF) | Area 01 | snapshot<br>movement trace<br>change of location | 2 min<br>3 min<br>1min | 8:00 - 8:02<br>8:02 - 8:05<br>8:05 - 08:06 |
| | Area 02 | snapshot<br>movement trace<br>change of location | 2 min<br>3 min<br>1min | 8:06 - 8:08<br>8:08 - 8:11<br>8:11 - 8:12 |
| | Area 03 | " " | " " | 8:12 - 8:18 |
| | Area 04 | " " | " " | 8:18 - 8:24 |
| **STANDARD FLOOR** (SF) | Area 05 | " " | " " | 8:24 - 8:30 |
| | Area 06 | " " | " " | 8:30 - 8:36 |
| | Area 07 | " " | " " | 8:36 - 8:42 |
| **SPECIAL CARE UNIT** (SCU) | Area 08 | " " | " " | 8:42 - 8:48 |
| | Area 09 | " " | " " | 8:48 - 8:54 |
| | | | | 6min buffer |

Figure 11. Exemplary 1-hour observation cycle (case Holzkirchen).

### 4.2.2 Movement Traces

A similar process was adopted for recording movement traces, conducted immediately after each snapshot. The precise paths of movement observed were drawn with an arrow indicating the last point at which a person was seen. Codes were used to denote person type (resident, staff, visitor) and movement type (purposeful, wandering).
"Purposeful" hereby refers to independent mobility and self-propelled wheelchair use, while "wandering" is characterised by aimless or repetitive movement without a specific purpose or destination, a phenomenon associated with anxiety, agitation, and restlessness in people with dementia [215].

### 4.2.3 Additional Remarks

The behavior mapping took place during the summer months of late July and early August 2023 when outdoor activities occurred in favourable weather conditions. Information was documented for six minutes per observation space (comprising a 2-minute snapshot, 3-minute movement tracing, and 1-minute to change location) (Figure 11).

New observation cycles commenced each hour (10 cycles/day), spanning from 8am to 6.30pm with a 30-minute lunch break at 1pm, thereby covering the entire daily routine from breakfast to dinner.
Interaction was generally observed in all spaces, except bathrooms and storerooms. Even if doors to residents' rooms were closed, conversations inside were audibly perceptible from the corridor and were documented as occurrences of an interaction.
Movement traces were extended whenever possible, for example, if the observer walked from observation space 3 to 4 and found a resident doing the same, that person's trace was extended and counted as one. Movement behind closed resident doors was unobservable and consequently not analysed.
All data was captured anonymously and later filtered to examine behavior patterns specific to residents only. Across the three case studies, a total floor area of 20,884m² was observed involving the behavior of 185 residents which resulted in the recording of 649 movement traces and 693 resident interactions (Figure 12).

| | SCU | GF | SF | non-SCU | all |
|---|---|---|---|---|---|
| **OBSERVATION** | | | | | |
| floor area [m²] | 5,133 | 8,097 | 7,655 | 15,752 | **20,884** |
| # resident rooms | 50 | 24 | 86 | 110 | **160** |
| # residents | 61 | 26 | 98 | 124 | **185** |
| **MOVEMENT** | | | | | |
| traces [#] | 238 | 198 | 213 | 411 | **649** |
| wandering | 89% | 9% | 35% | 23% | **47%** |
| purposeful | 11% | 91% | 65% | 77% | **53%** |
| **INTERACTION** | | | | | |
| r+ [#] | 234 | 181 | 278 | 459 | **693** |
| talking | 77% | 88% | 76% | 80% | **79%** |
| helping | 23% | 12% | 24% | 20% | **21%** |
| **AGITATION** | | | | | |
| behavior [#] | 73 | 5 | 16 | 21 | **94** |

Figure 12. Understanding the numbers. Overview of the aggregated observation data considering variations in spatial distribution accross floors and care cultures, movement and interaction types.



## 4.3. Processing

The applied methodology aims to visually and statistically assess residents' space use patterns in LTCFs and test the applicability of space syntax in predicting the behavior of people with dementia.

### 4.3.1 Digitalisation of Observation Data in QGIS

Following the observation study, all data (totalling 960 pages) was digitised in QGIS (quantum geographic information system software).
Floor plans were imported from Archicad as .dxf-file. Shapefile* layers were created for each bodily posture (snapshot) and movement type (traces).

Each data point was then spatially mapped with key information on person type and gender being added to the attribute table. For interactions, the *'who-who'* was furthermore noted (r = resident, s = staff, v = visitor) – for example, an interaction between a caregiver reading to three residents would be described as 'rrrs'.

Ten specific layers were then created to simplify further analysis as follows:

**movement**
1. wandering,
2. purposeful,

**interactions**
3. resident-to-resident(s) = **r-r**,
4. resident(s)-to-staff = **r-s**,
5. resident(s)-to-visitor(s) = **r-v**,
6. total = **r+**,
7. talking,
8. helping,

**agitation**
9. type 1, and
10. type 2.

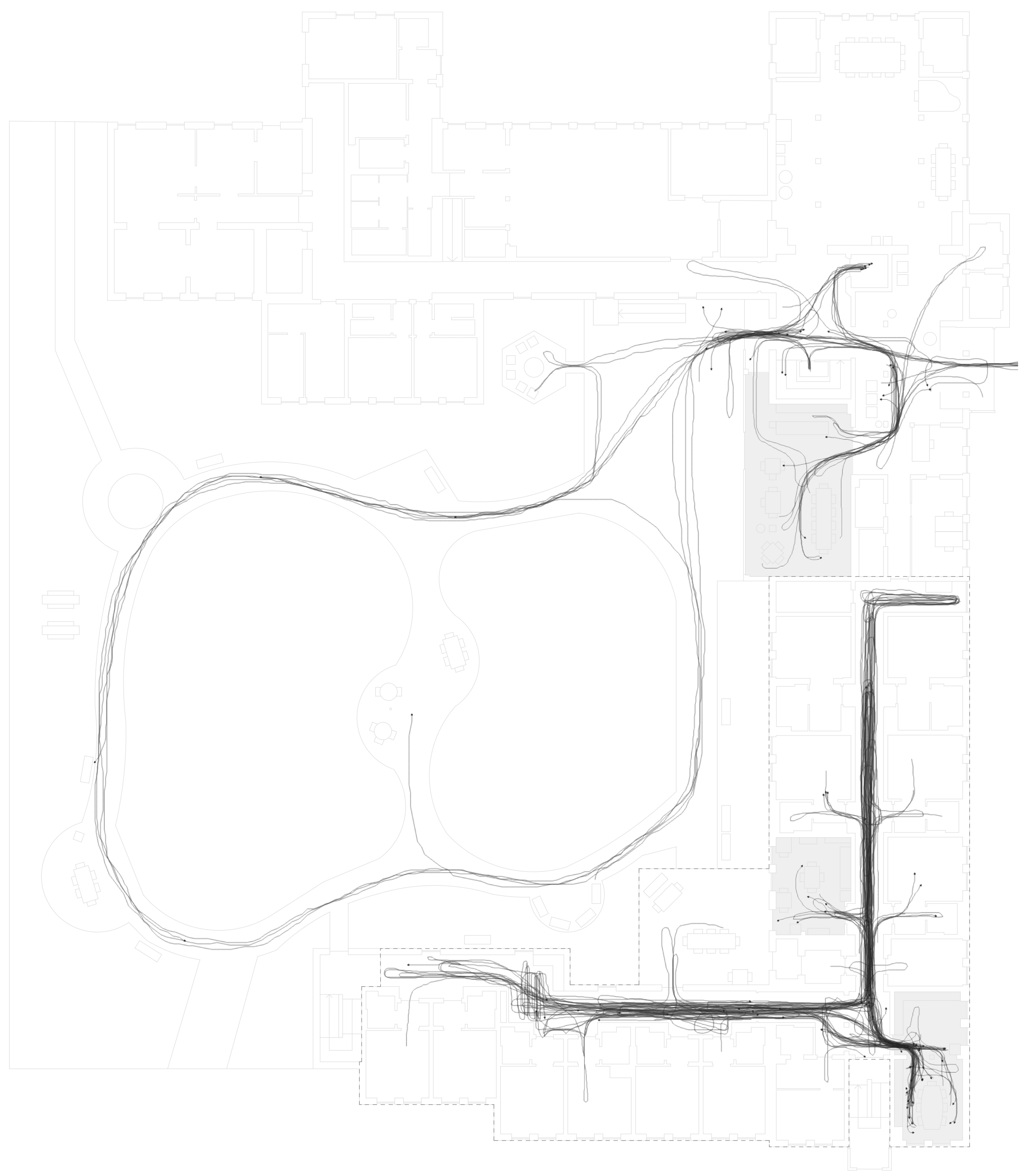
The date of observation, time of recording, and additional notes (if applicable) were also noted in the attribute table. Traces were drawn as polylines, snapshots as point geometries, and interactions as polygons. Layers were created individually for each case study. An overview of the observation data is presented on the following pages (Figures 13-19).

*Shapefile is a vector data format (.shp) that stores the location, shape, and attributes of geographic features.

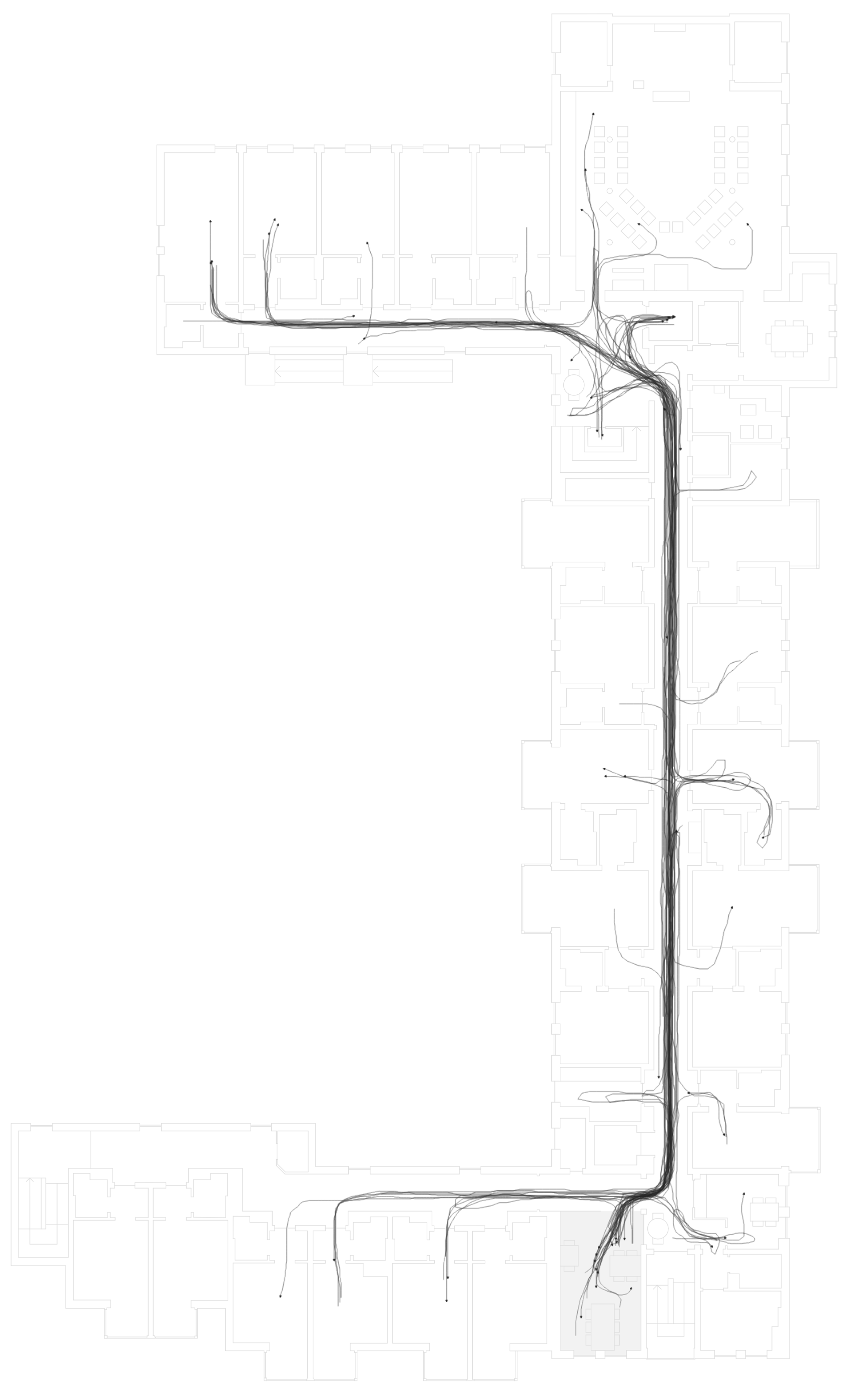
# DACHAU

U-shape

GF incl. SCU



SF



N

movement trace of resident

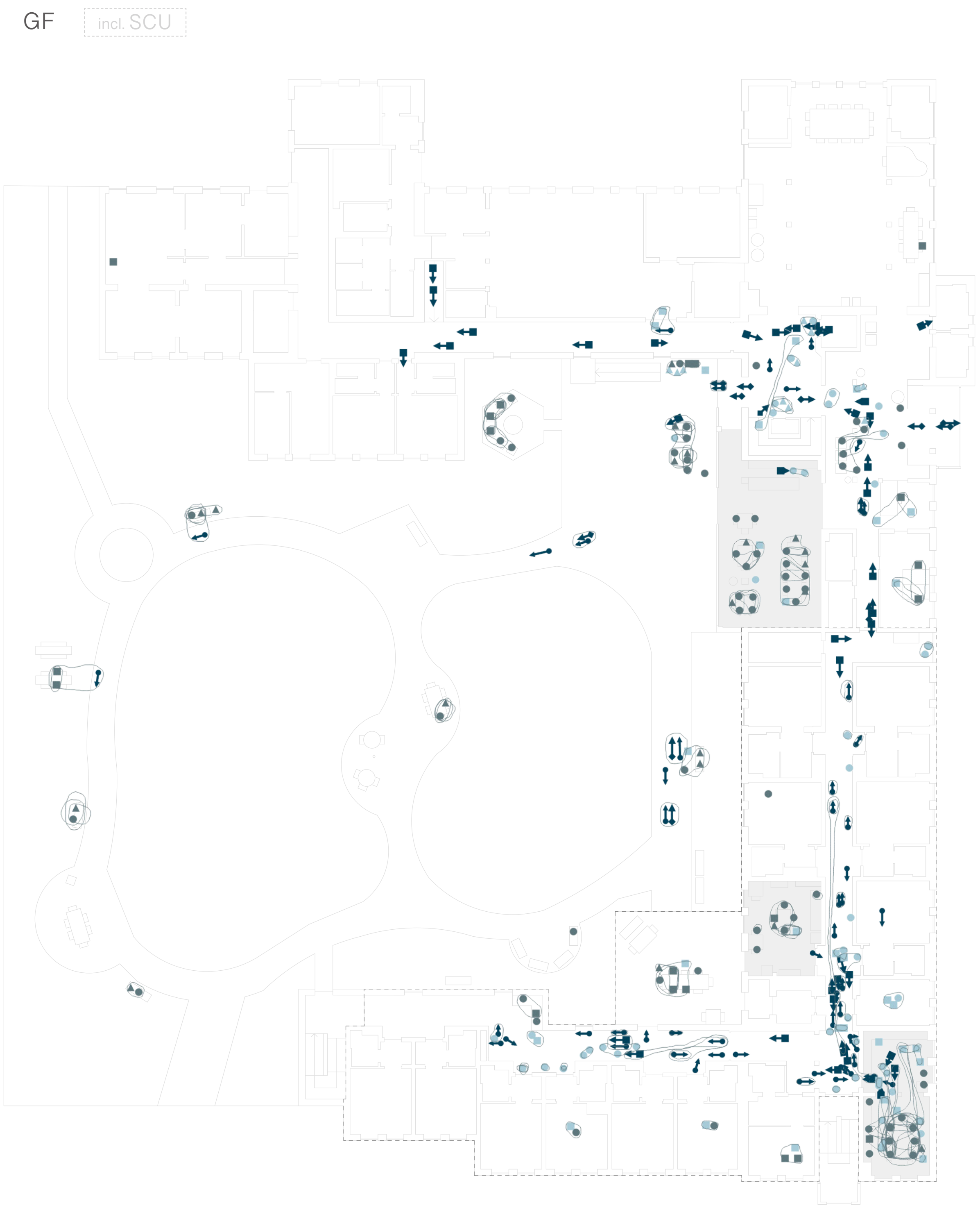
common room (food is served)

Figure 13. Dachau - movement traces.

10 m

# DACHAU

U-shape



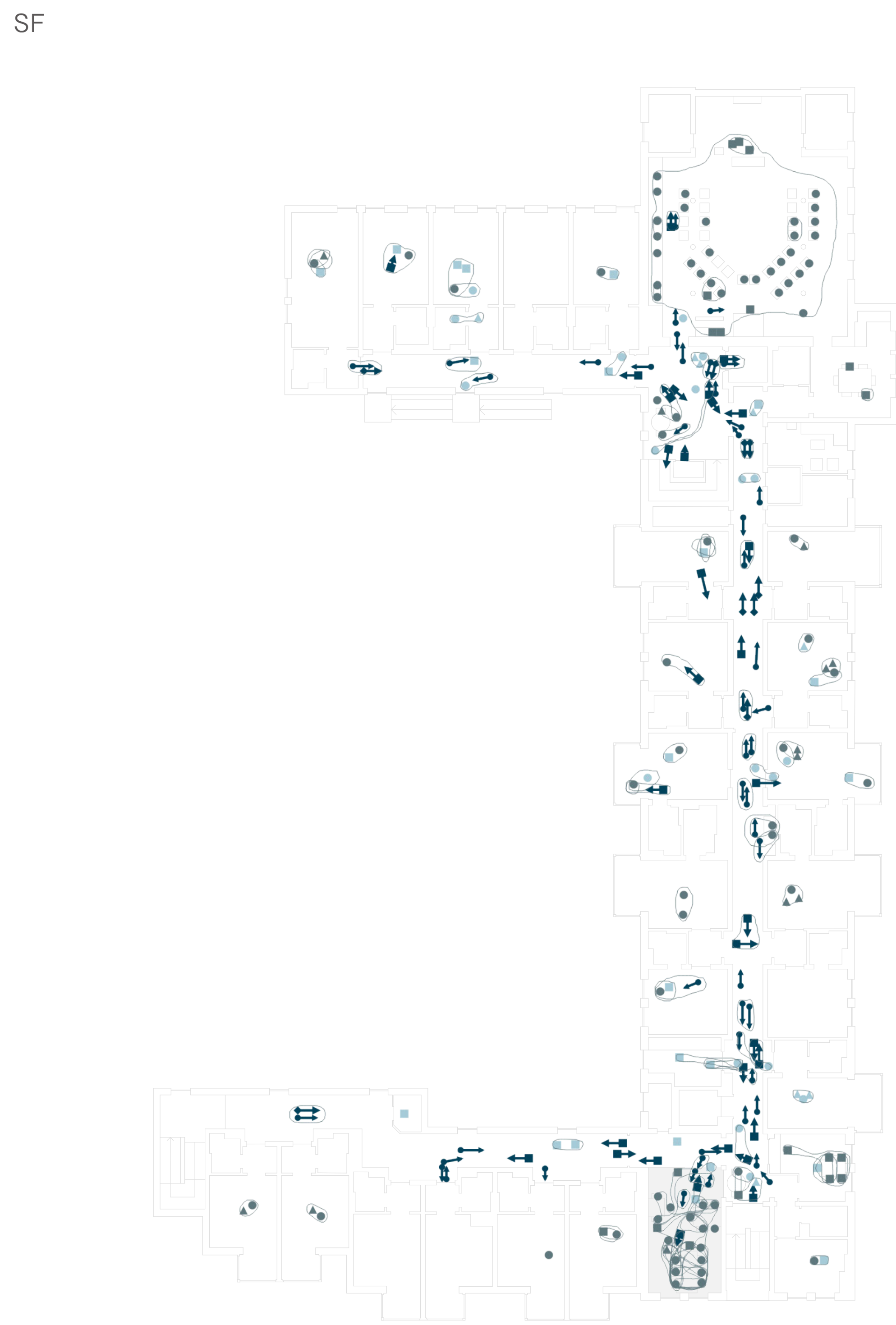






Figure 14. Dachau - snapshot.

10 m

GF

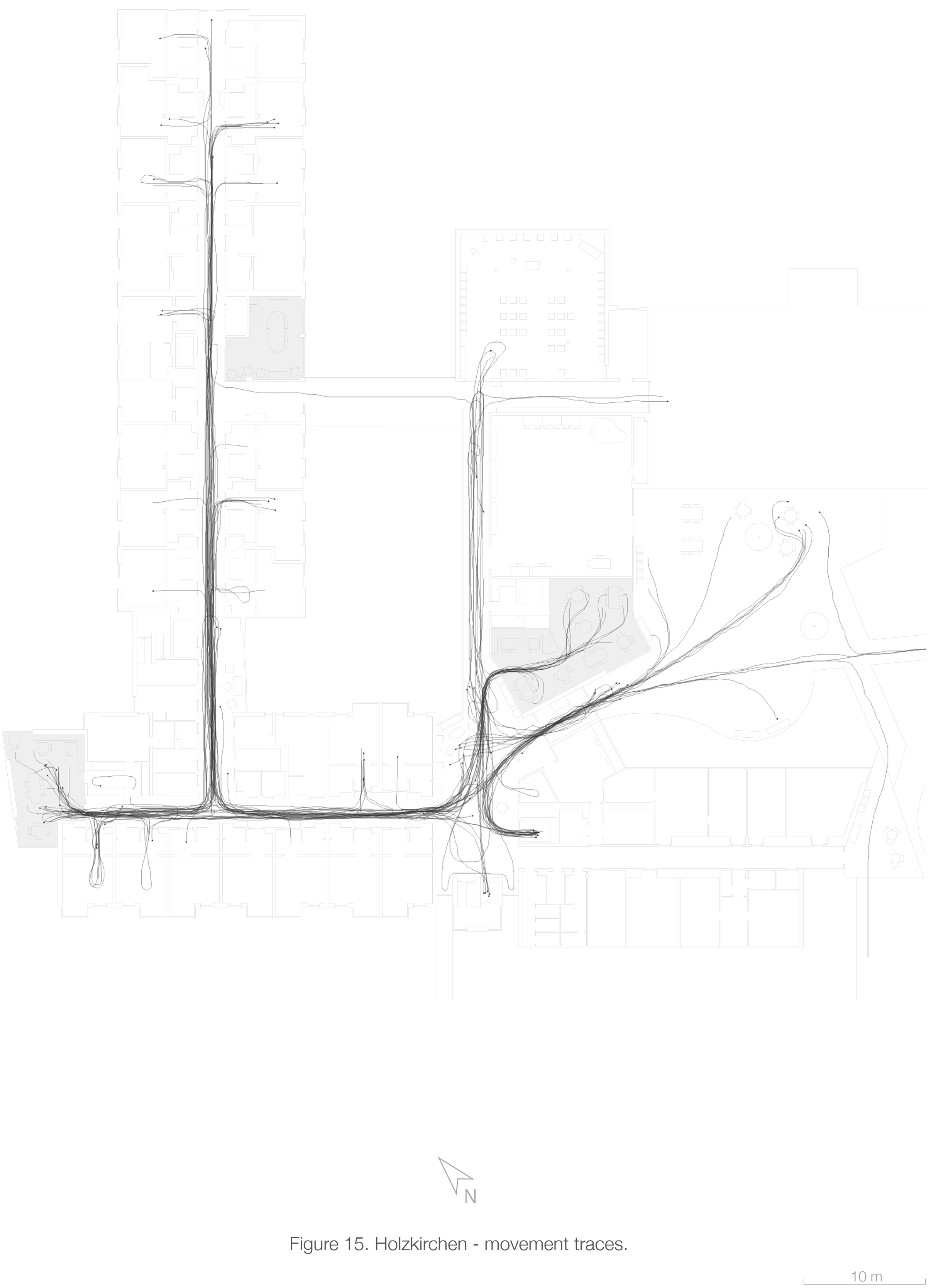


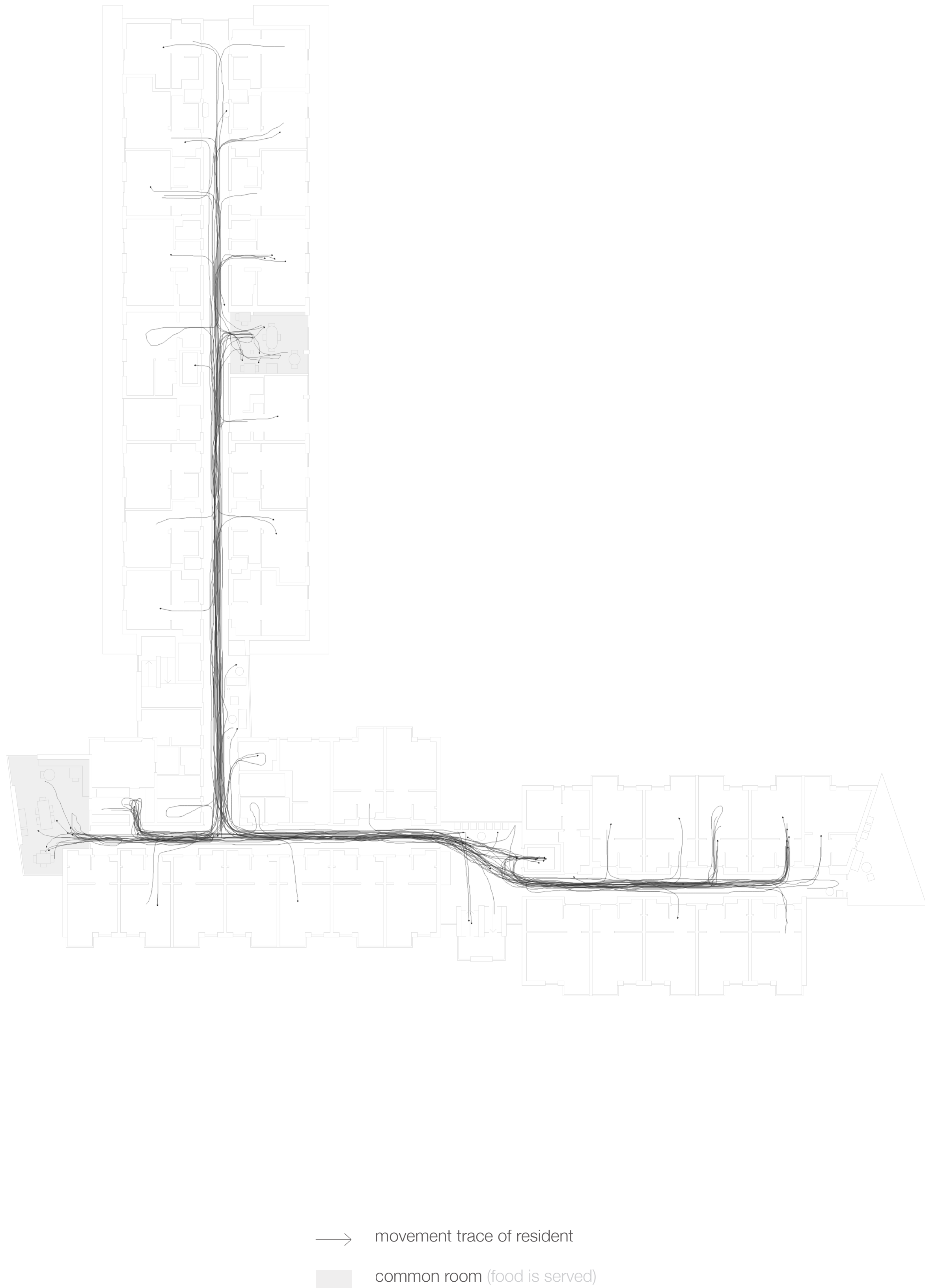

Figure 15. Holzkirchen - movement traces.



# HOLZKIRCHEN

L-shape

SF



GF

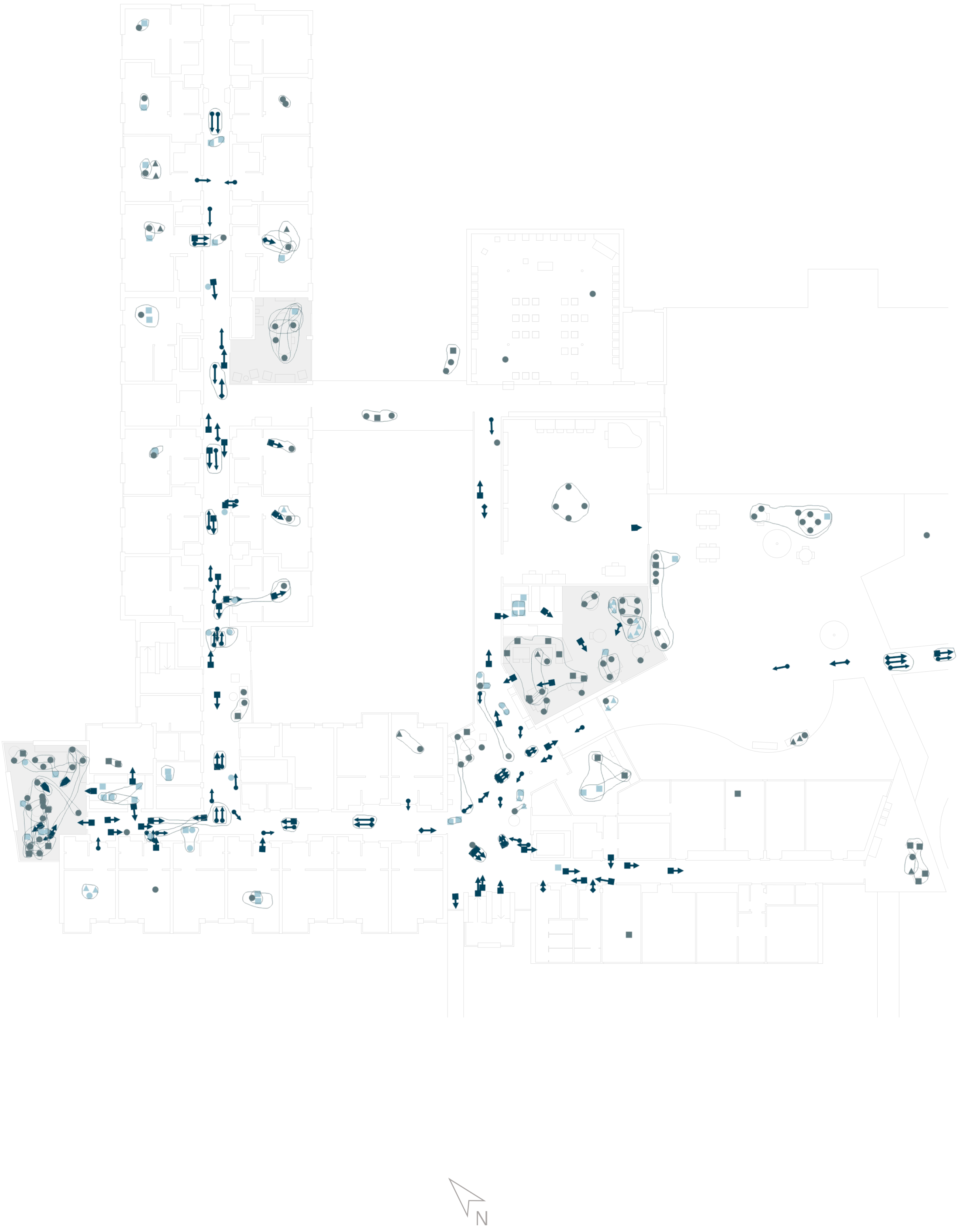



Figure 16. Holzkirchen - snapshot.

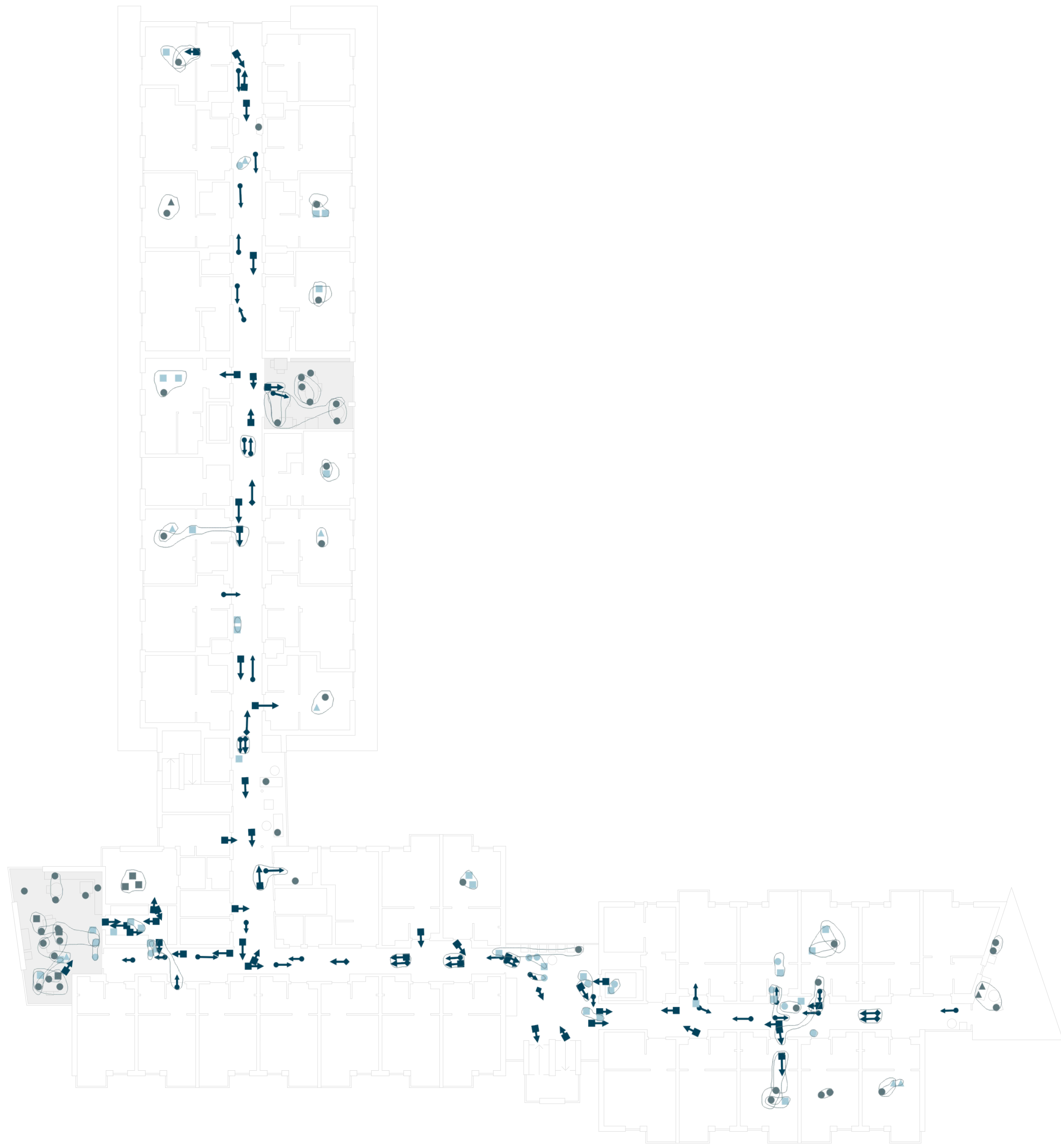
10 m



# HOLZKIRCHEN

L-shape

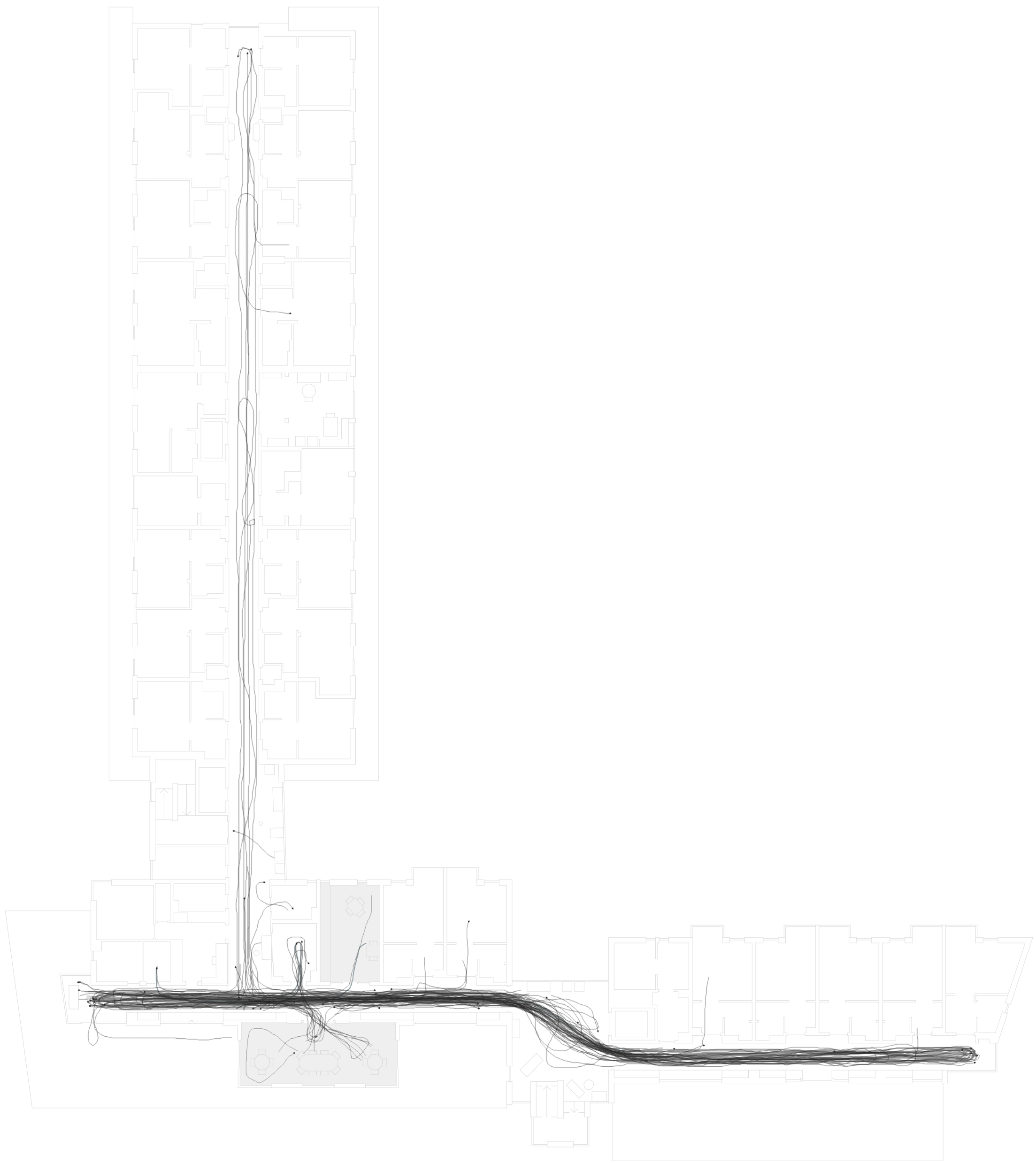
SF



r s v sitting standing moving r+

common room (food is served)

SCU



N

Figure 17. Holzkirchen SCU - movement traces and snapshot.

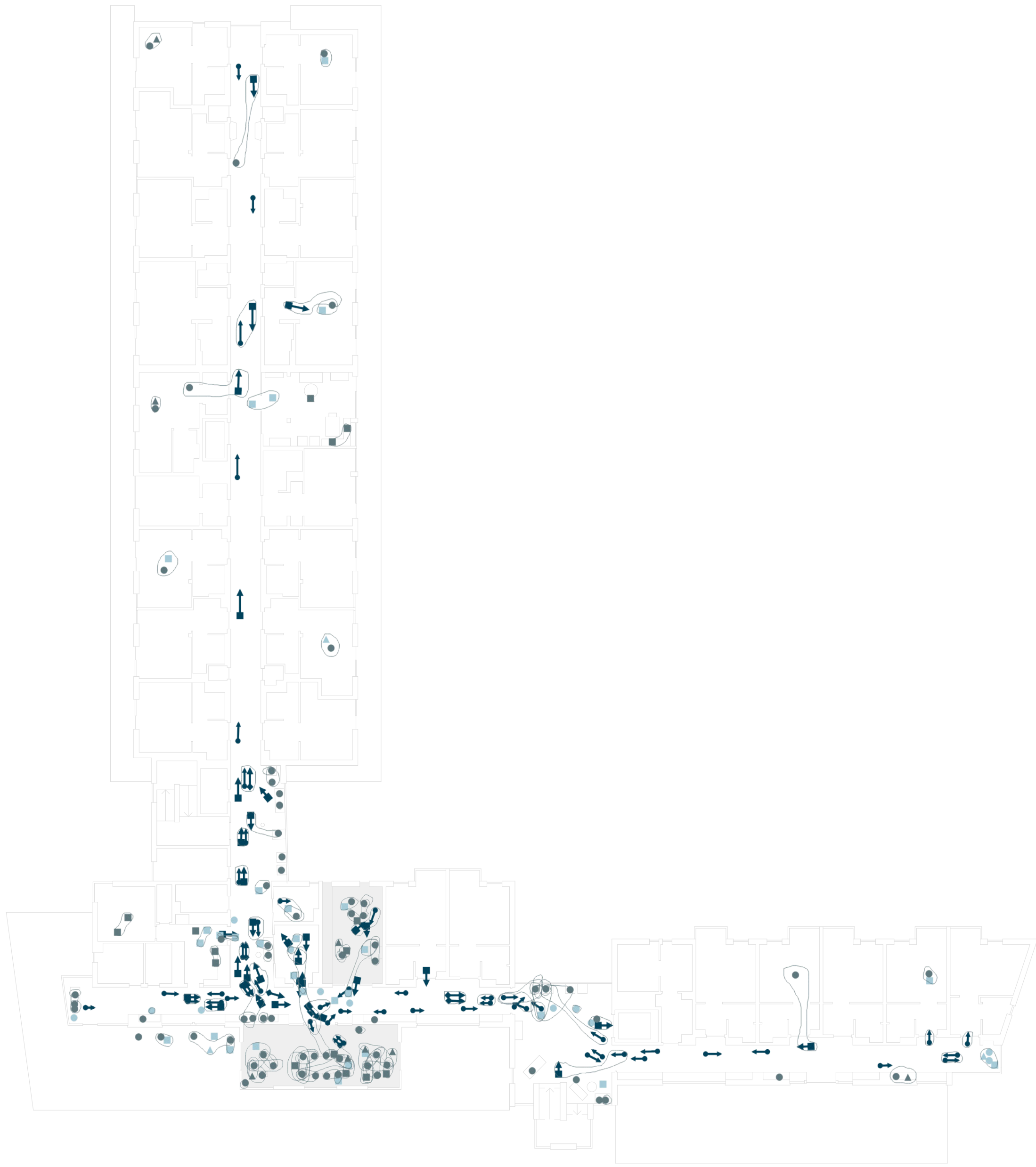
10 m



# HOLZKIRCHEN

## L-shape

SCU



movement trace of resident

r s v sitting standing moving r+

common room (food is served)

# MUNICH

Racetrack

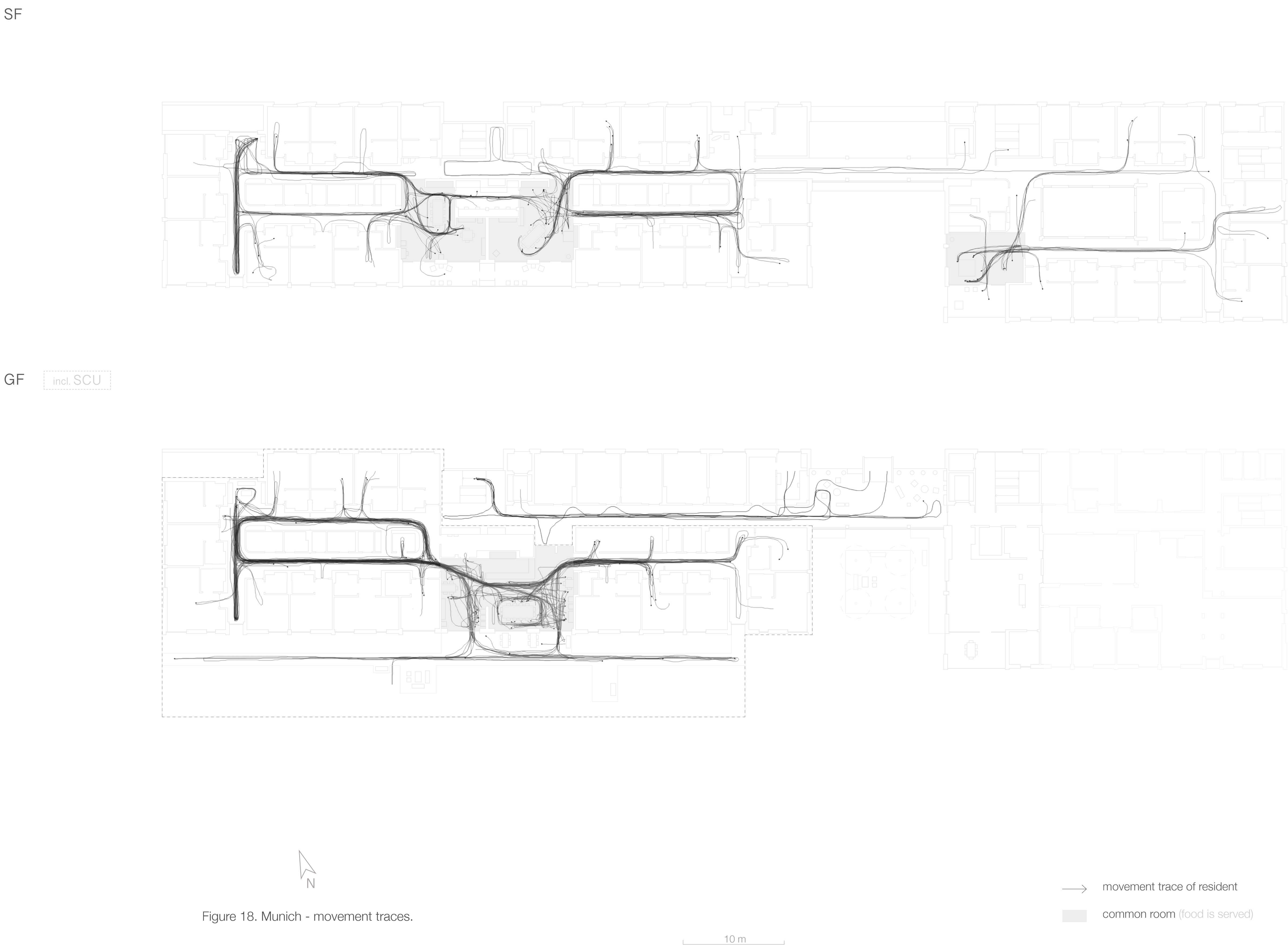



Figure 18. Munich - movement traces.

**MUNICH**
Racetrack

SF

GF incl. SCU

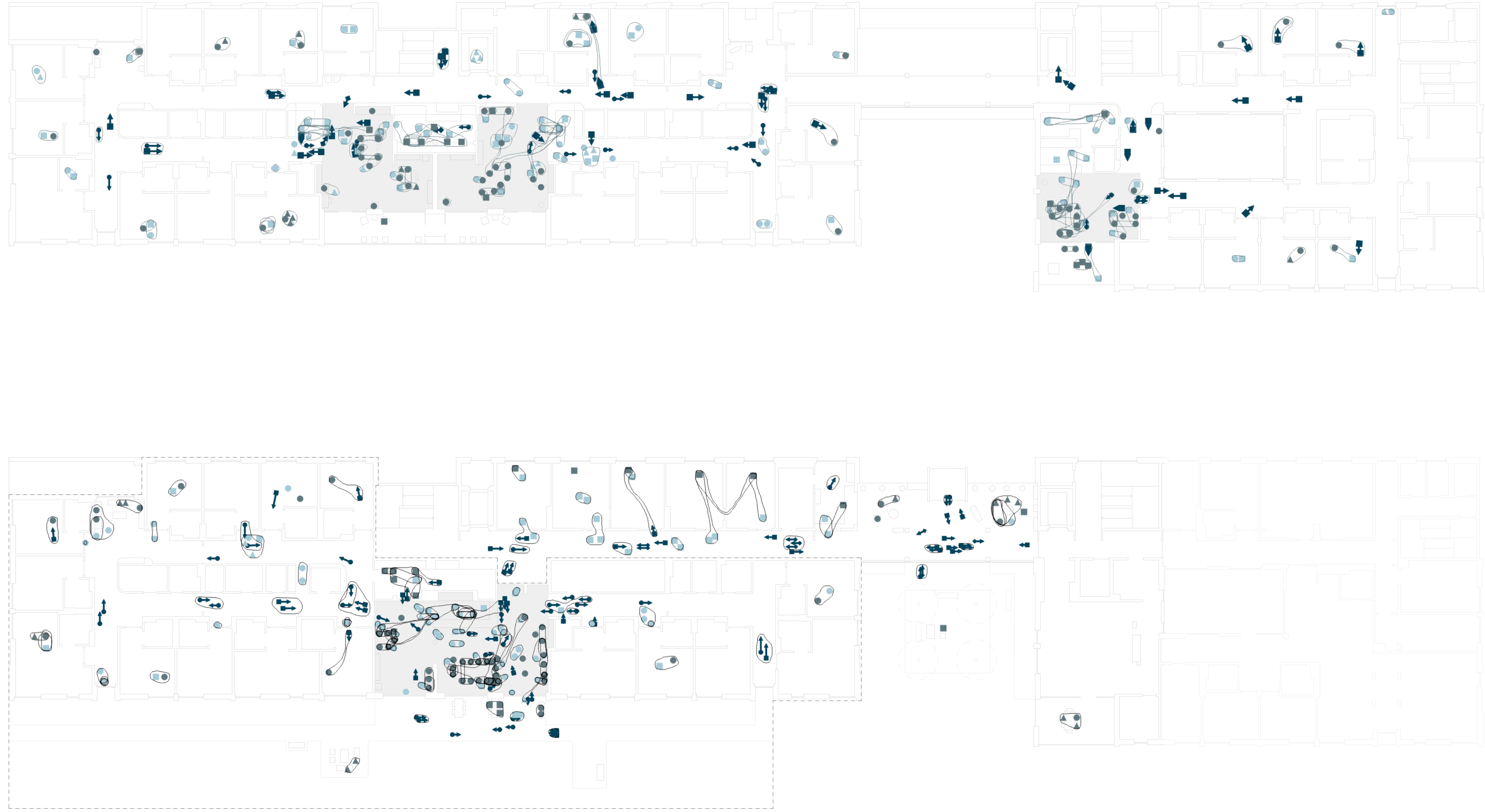



Figure 19. Munich - snapshot.


10 m

### 4.3.2 Excel Analysis

In order to investigate the discernible patterns of residents' space use in LTCFs **(research question 1)**, the dataset was analysed in Excel*. Percentage shares of subcategories (wandering, purposeful, talking, helping) compared to totals were identified. Movement quota (traces/mobile resident) and interaction quota (r-r interaction/resident) were calculated.

### 4.3.3 Data Classification

To address possible deviations across care cultures, all data was generally processed for SCU-only, GF, SF, non-SCU areas (GF+SF), and all floors combined.

### 4.3.4 Space Syntax Analysis

Space syntax offers a broad suite of numerical measures to describe the spatial configuration of buildings, including step depth analysis, boundary analysis, convex analysis, axial analysis, and visual graph analysis (VGA) for both eye and knee level.

To test the applicability of space syntax for the assessment of LTCFs **(research question 2)**, a pilot analysis was undertaken applying all of the above-mentioned methods for the case study Munich. Munich was chosen as the primary example because it is the only LTCF with 100% dementia residents at full occupancy. The results of this initial inquiry highlighted most potential for boundary analysis and integration measures of convex analysis and VGA eye level. For this reason, those methods were chosen for further investigation in this paper**.

SCUs were principally regarded as a separate complex, while the remaining spaces were 'linked' across floors where there are stairs and elevators to reflect residents' lived experience.

**Two scenarios were investigated:** one encompassing all spaces (Scenario A), while the other scenario includes shared spaces only (Scenario B = common and staff rooms + circulation areas + garden). This dual approach accounts for the aforementioned limitation of not observing movement behind closed doors and aims to clarify whether results diverge between scenarios.

*Excel is a spreadsheet program enabling the organisation and calculation of data using graphing tools, pivot tables, and formulas.

**In contrast, axial analysis, VGA knee level, and the measures connectivity, control, and choice generally performed more poorly, meaning they showed no/weaker statistical correlation with residents' space use patterns and are thus excluded from further analysis. As a component of future research, the pilot study could be expanded to encompass all three case studies.



Step Depth Analysis

The spatial depth for each space was quantified, with the entrance serving as the initial node (base). Additionally, to illustrate the concept of depth distribution, justified graphs were drawn for SCUs with nodes for each space aligned horizontally to represent the number of syntactic steps taken from the base [216].

Boundary Analysis

According to Bill Hillier's influential work 'Space is the Machine', spaces were classified into four topological types, each affecting movement and occupation based on their boundary characteristics [217].

**A-type** spaces are dead-ends, exclusively designed for occupation.
**B-type** spaces lie along paths to dead-end spaces, resembling tree-like structures. They imply through-movement and impose a high measure of control as return movement necessitates passing through the same space (highly programmed).
**C-type** spaces are found along single rings, featuring an equal number of links as spaces. Cutting a link converts the ring into tree-like segments.
**D-type** spaces span at least two rings, providing route choices in both directions and resulting in less programmed and more contingent movement within the spatial complex.

While a- and d-type spaces create integration, b- and c-type spaces foster **segregation**. **Integration** is a measure that describes relativized asymmetry in the graph network, revealing how deep or shallow a space is in relation to all other spaces [218]. Highly integrated spaces are indicative of rates of social encounter and act as wayfinding anchors in cognitive maps [219-220].

Convex Analysis

In a convex space, every pair of points is interconnected, i.e. no straight line can be drawn between two points that runs outside the space [221]. Convex maps were drawn in DepthmapX, with terraces and the communal garden treated as individual convex spaces, and analysis run (radius n) as specified in the space syntax methodology manual [222].

Visual Graph Analysis

Increased visual proximity is thought to be supportive of higher levels of interaction and has been used as a proxy to understand spatial behaviors [223-225]. VGA characterises the intervisibility of points in a spatial system based on isovists [226-227]. An isovist is defined as the directly visible area (360° degrees) from a specific point [228]. By overlaying a given floorplan with a human-scale grid spacing, VGA constructs an isovist from each pixel's center point to calculate different measures [229]. This study focuses on integration values.

To represent the residents' spatial experience at eye level, floor plans were modified in Archicad. This involved removing furniture, doors, and glass walls, with the building boundary serving as the analysis perimeter. Terraces were incorporated, while the communal garden areas were excluded from VGA analysis due to their significantly large size which could potentially distort the results.
The revised floor plans were imported to DepthmapX (.dxf), visibility graphs were constructed and VGA was performed (radius n).

### 4.3.5 Spatial Join in QGIS

It was decided that convex spaces would constitute the spatial unit of comparative analysis, as they best represent the spatio-functional layout in LTCFs. Therefore, convex maps for all case studies were drawn in Archicad, imported to QGIS, and each polygon was linked 'by location' (count) to the aggregated nine observation layers.

Space syntax results were appended to the same attribute table. Space types were entered manually. Convex and visual integration analysis were imported as .mif to QGIS and geographically 'translated' (to be precisely located/overlay the existing mapping). Convex integration was then linked 'by location', and visual integration was averaged (max, mean) for each space using the 'join by location (summary)' tool.
Ultimately, a master file was created combining the data for all three case studies.

### 4.3.6 Statistical Evaluation in SPSS

Resultant attribute tables were exported for each case study and the master file as .csv and statistically evaluated in SPSS, a statistical software platform, using correlation (Pearson) and linear regression analysis.

### 4.3.7 Comparative Analysis of Special Care Units

An initial data review unveiled that space use patterns are most pronounced in SCUs that exclusively house people with dementia. This finding prompted a focused, comparative examination of the three sample cases in order to explore which architectural qualities positively influence resident activity **(research question 3)**.
Decision points were charted and daytime of wandering was considered. To gauge layout complexity, the space syntax measure intelligibility was employed. Axial maps were created for all three SCUs, analysed in DepthmapX, and evaluated in SPSS. An axial map is the set of fewest and longest lines of sight in a predefined spatial system [230]. It focuses on the number of direction changes required to travel through a building rather than metric



distance [231-232]. Additionally, the number of convex spaces/m$^2$ and /axial line was calculated. Finally, movement within SCU communal gardens was examined, quantifying its utilisation. Isovists for the MCR were created in DepthmapX, using the center point of each convex space as the origin. Social density was calculated and the diversity of spaces counted for each SCU. Agitated behavior was mapped, distinguishing between residents opening doors in a state of confusion (type 1) and other behaviors such as screaming or talking to themselves (type 2).

# 5. Results

## What discernible patterns of space use can be observed?

Results obtained through Excel analysis indicate that agitated behavior and wandering predominantly occur within SCUs (~90%). Purposeful movement is primarily observed in non-SCUs. The majority of interactions involve residents engaging in conversations, with helping behaviors accounting for only 20%. These trends are consistent across all case studies, with one minor exception being in Munich, where wandering also occurs regularly on standard floors. This is likely because Munich, even in non-SCU areas, exclusively houses residents diagnosed with dementia who are prone to wandering behaviors. Perhaps, this is also why movement per resident is highest in the racetrack layout, followed by the U-shape and L-shape configurations (Figure 20).

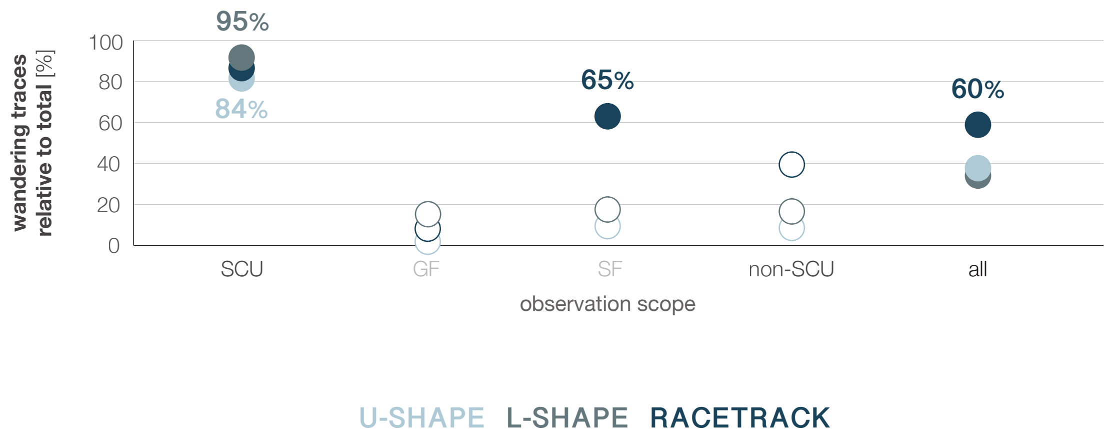



Figure 20. Wandering traces relative to total movement observed - comparison across configurations.

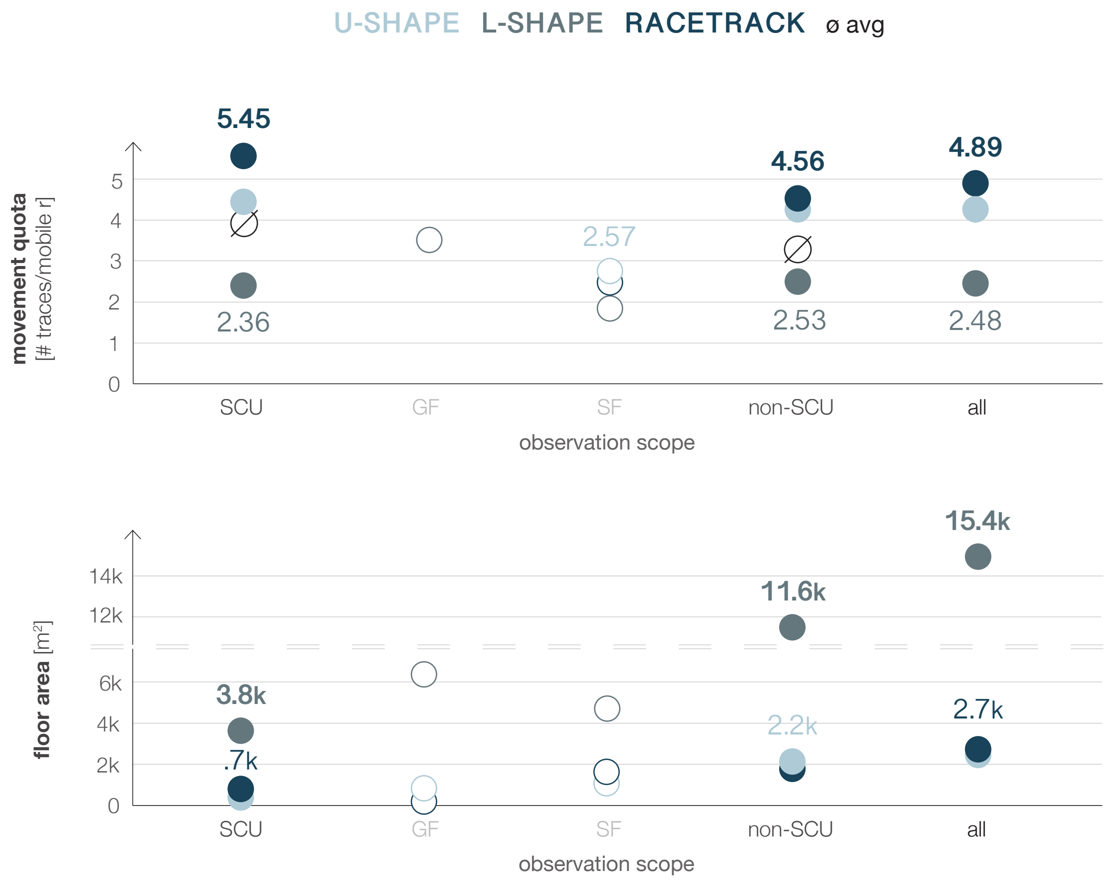



Figure 21. Movement quota and floor area - comparison across configurations.

Floor areas were compared to movement quotas, however, no relationship is found. Holzkirchen's L-shape configuration exhibits the longest corridors, yet residents are the least active (Figure 21).

Interactions are most likely with staff (r-s = 51%) or other residents (r-r = 39%), while interactions with visitors (r-v) are less frequent and mainly occur on weekends (Figure 22). Common rooms are the primary space for social activities, accommodating more than half of all interactions observed. This finding is consistent in both care cultures. Dachau performs best in fostering social engagement, Holzkirchen the least.

SCUs generally exhibit an average movement quota of 3,9 (non-SCUs: 3,3) and an interaction quota of 1,9 (non-SCUs: 1,3).



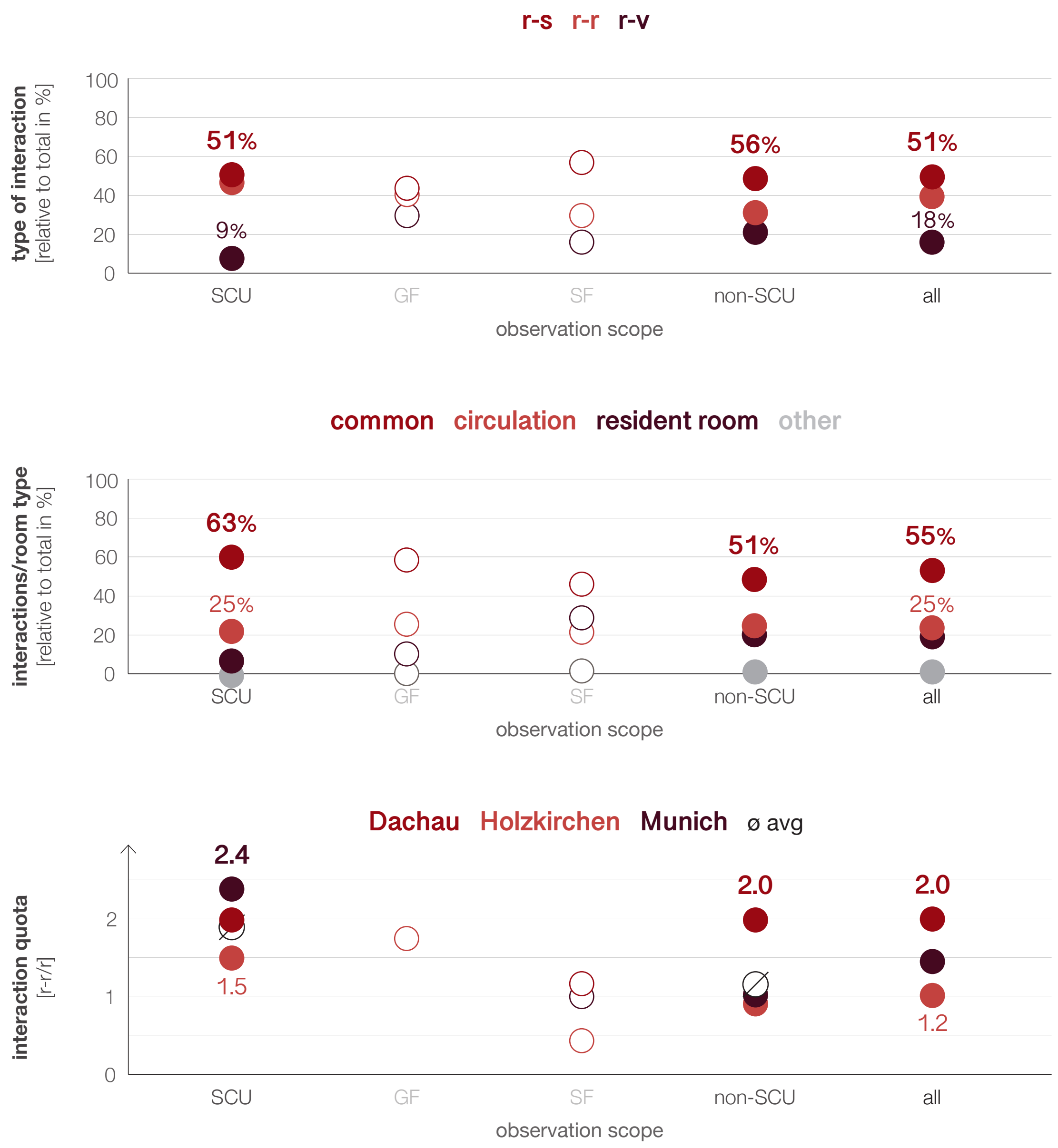



Figure 22. Spatial distribution of interactions - considering who-who, room types and case study variations.

## Justified Graphs
Special Care Units

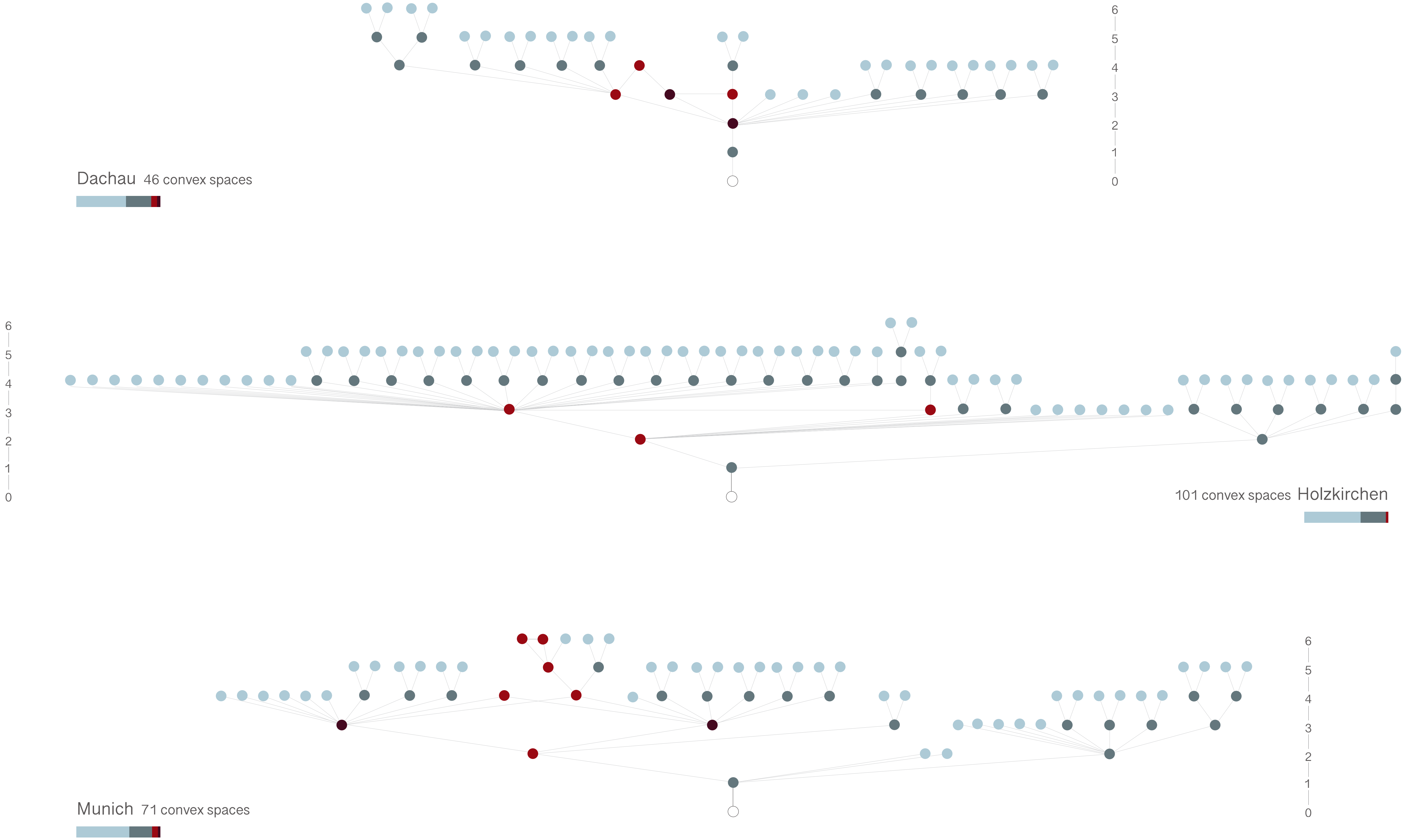



Figure 23. Justified graphs – SCUs in comparison.

a-type b-type c-type d-type

## Are these patterns associated with the buildings' spatial configuration?

Examination of the **justified graphs** (Figure 23) underscores notable similarities regarding spatial depth distribution among SCUs. All graphs exhibit shallow structures spanning six steps from the base.

**Step depth** analysis yields no relation to space use patterns.

By contrast, **boundary analysis** appears as a useful tool for understanding resident behavior. Space types are distributed similarly across case studies. SCUs tend to have slightly more a- and b-type spaces due to their smaller unit size (Figure 24).
In non-SCUs, wandering mainly occurs in c-type spaces, while purposeful movement tends to concentrate within d-type spaces. In SCUs however, movement clusters in a- to c-type spaces and is much more controlled.
Interactions cluster in a-type spaces, aligning with Bill Hillier's assertion that these are particularly conducive to occupation. This is most distinct for r-v, whereas r-r and r-s interactions are more evenly distributed (Figure 25).
Statistical analysis reveals a significant correlation ($p < .01$) between residents' physical activity patterns and space types for wandering (SCU **r =.458**) and purposeful movement (non-SCU **r =.468**) (Figure 26).

To illustrate Scenarios A and B, convex and visual graph analysis, the results for all three SCUs are presented on the following pages (Figures 27-30).

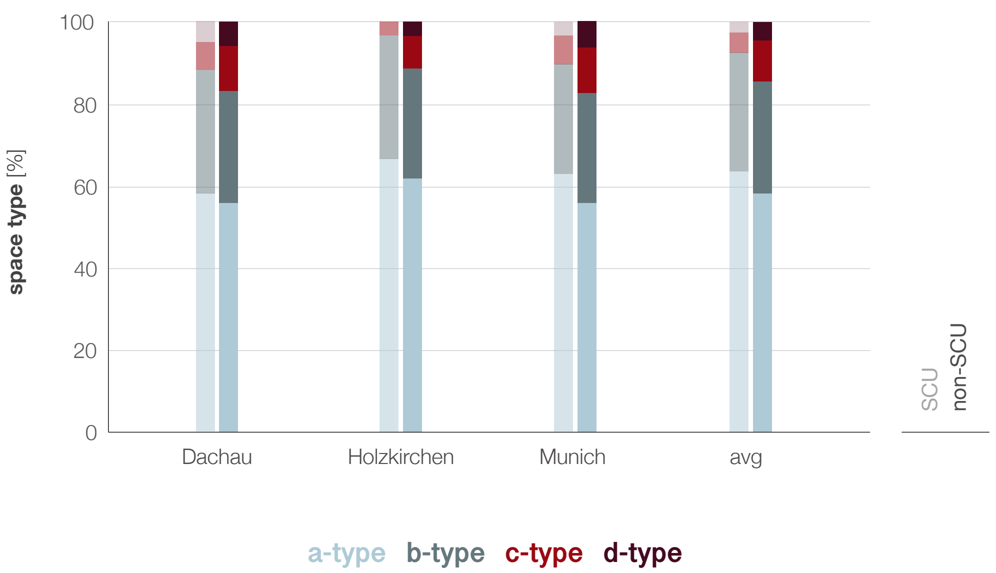



Figure 24. Space type distribution across case studies.

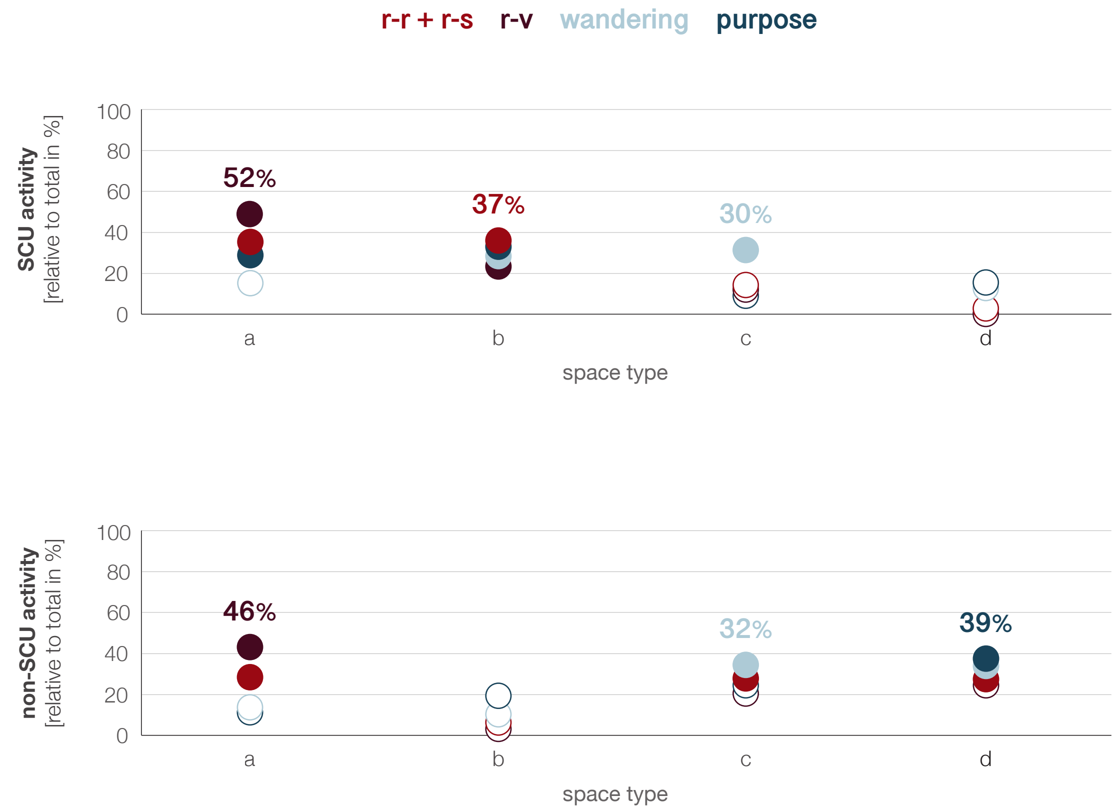



Figure 25. Boundary analysis results - SCU vs. non-SCU.

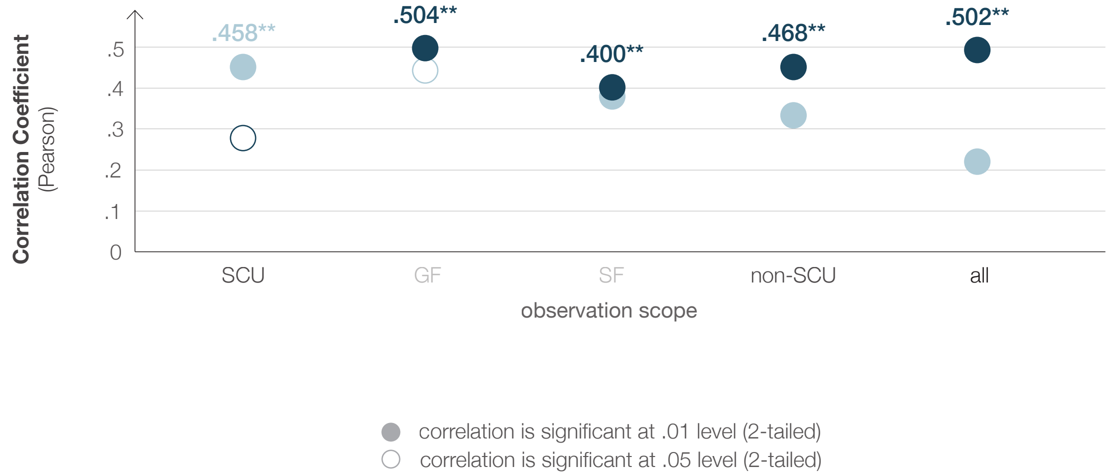



Figure 26. R of a Pearson correlation for the spatial distribution of wandering and purposeful movement traces to space types (a=1, b=2, c=3, d=4), considering the combined data of all LTCFs observed.

## Convex Analysis
Scenario A

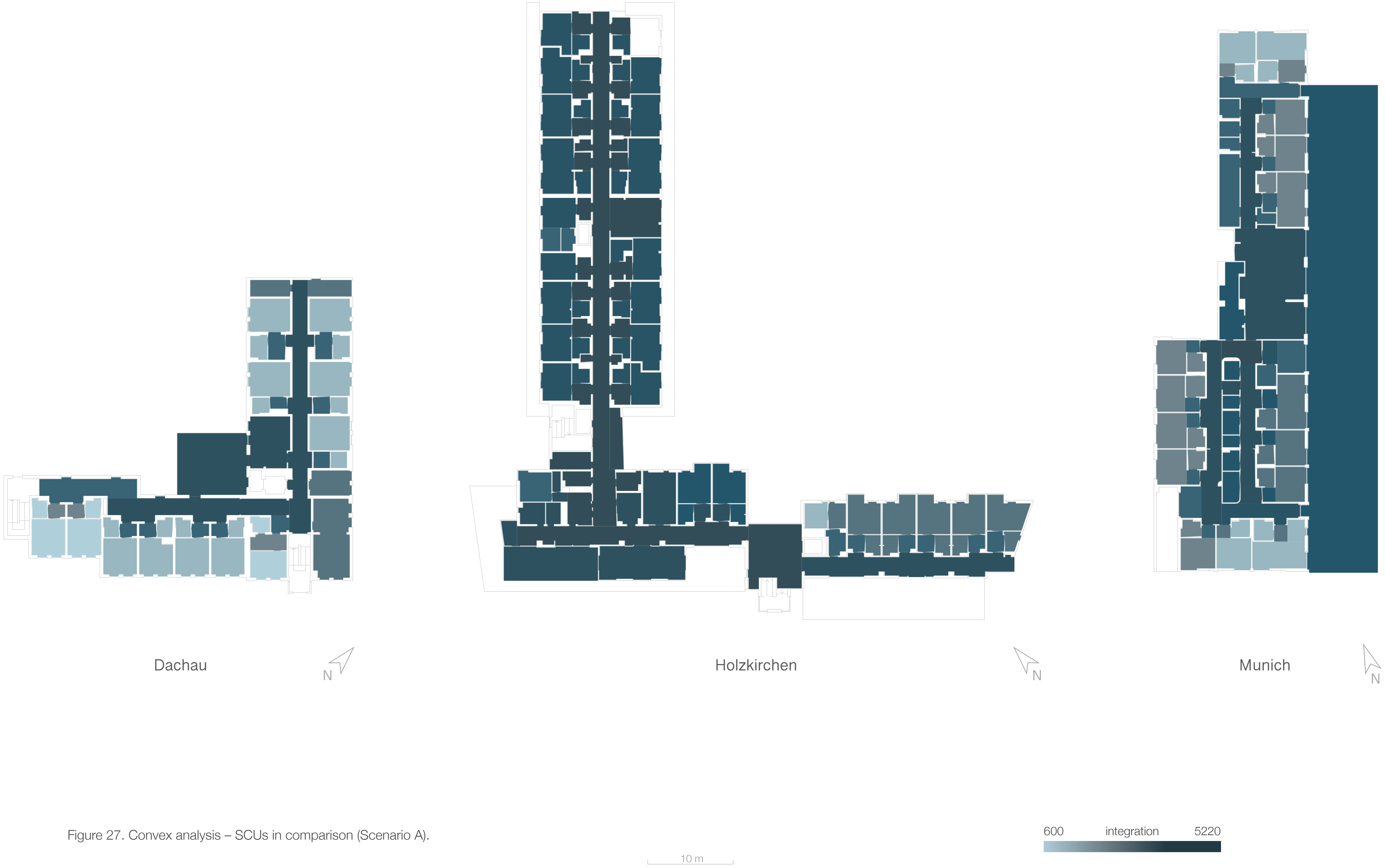



Figure 27. Convex analysis – SCUs in comparison (Scenario A).

## Convex Analysis
Scenario B

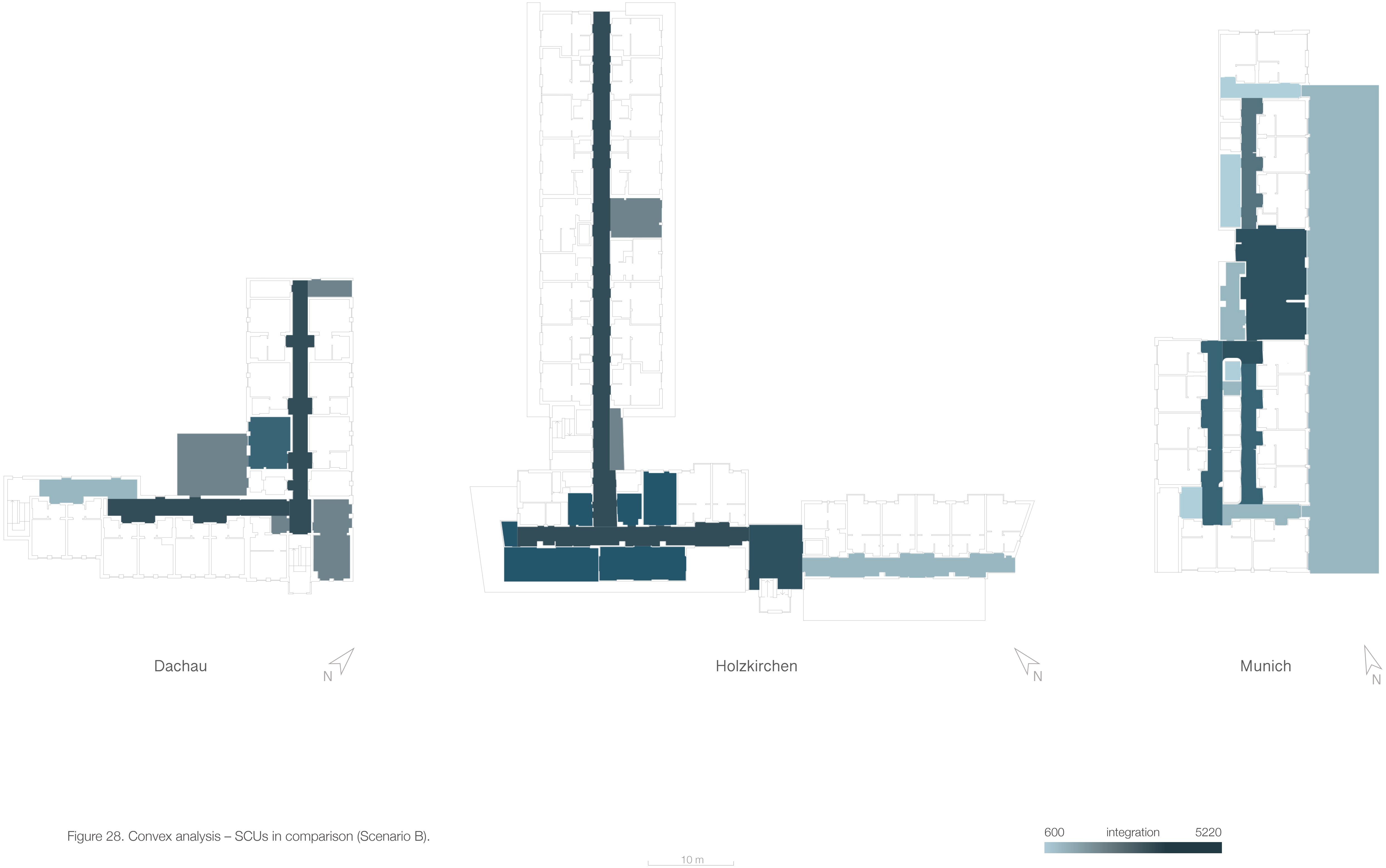



Figure 28. Convex analysis – SCUs in comparison (Scenario B).

## Visual Graph Analysis (eye level)

Scenario A

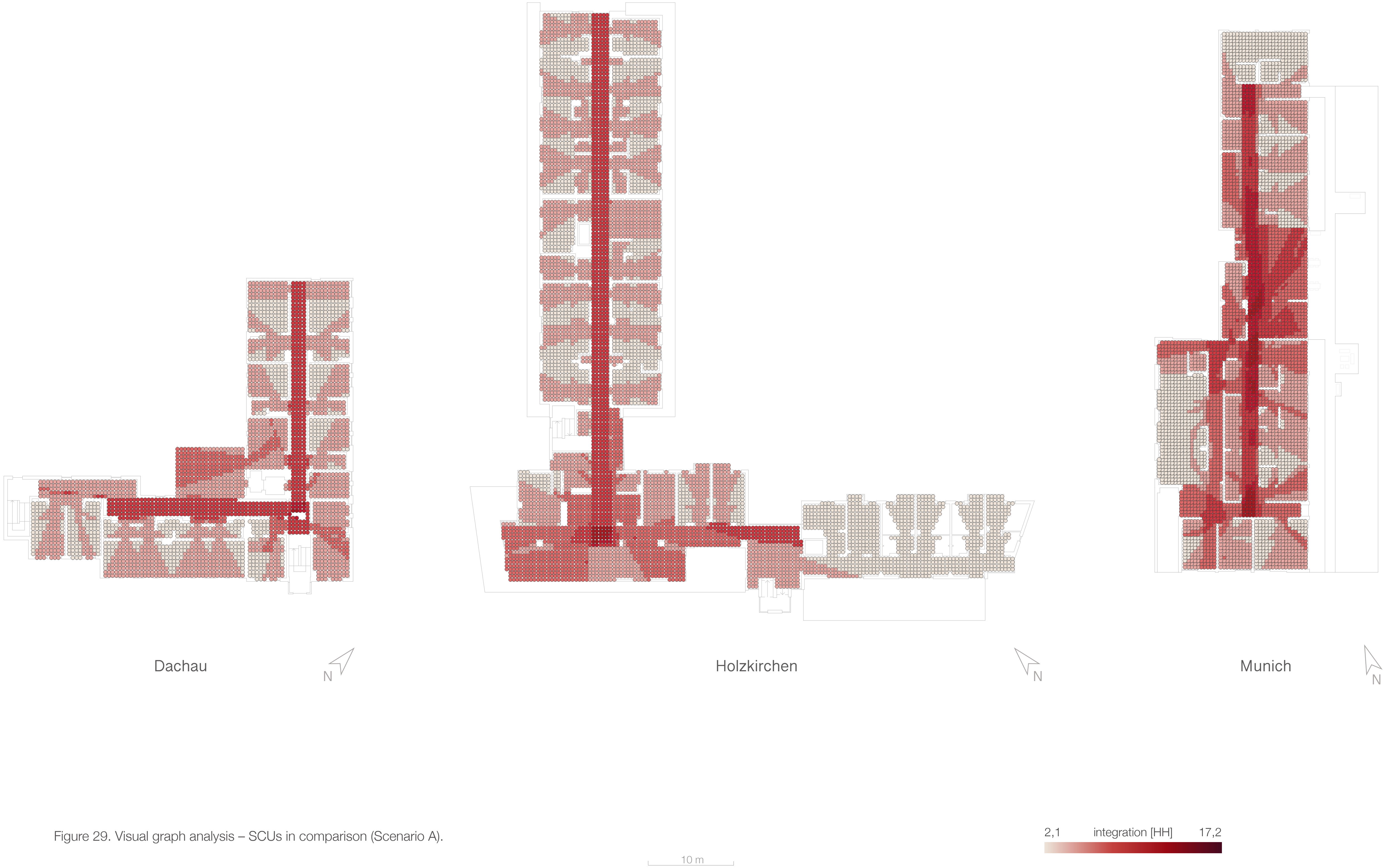



Figure 29. Visual graph analysis – SCUs in comparison (Scenario A).

## Visual Graph Analysis (eye level)

Scenario B


Figure 30. Visual graph analysis – SCUs in comparison (Scenario B).

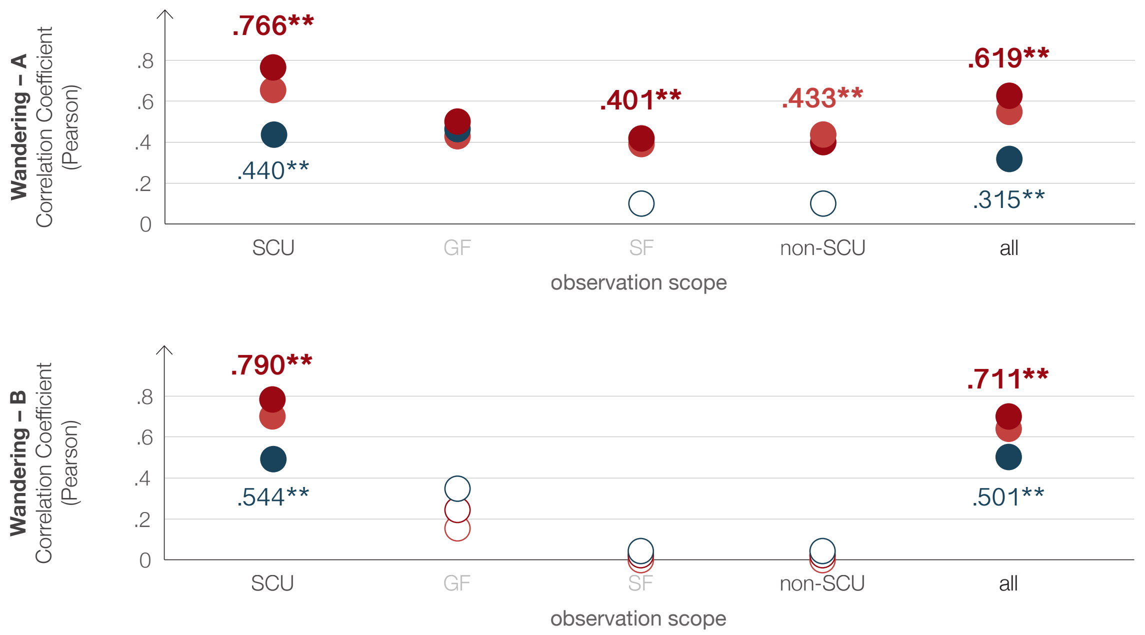



Figure 31. R of a Pearson correlation for the spatial distribution of wandering traces to convex and visual integration (max, mean), considering Scenarios A and B.


Figure 32. R of a Pearson correlation for the spatial distribution of purposeful movement traces to convex and visual integration (max, mean), considering Scenarios A and B.



**VGA eye level** appears as the best-performing method to predict movement flows.

Wandering, particularly in SCUs, evinces significant positive correlations ($p < .01$) with max. visual integration for Scenario A (**r =.766, $r^2$ =.586**) and Scenario B (**r =.790, $r^2$ =.624**) (Figure 31). **Convex** integration performs similarly but with less accuracy. Notably, Scenario B exhibits no correlations for wandering in non-SCUs.
For purposeful movement, correlations are most pronounced on the ground floor, where mean visual integration reveals significant positive correlations ($p < .01$) for Scenario A (**r =.699, $r^2$ =.488**) (Figure 32). In Scenario B convex integration outperforms visibility.

Interaction patterns cannot be apprehended via visual or convex integration (Figure 33). The analysis yields only a weak correlation for Scenario A (r =.376, $r^2$ =.141) and Scenario B (r =.217, $r^2$ =.068).

**visual integration max and mean  convex integration**

● correlation is significant at .01 level (2-tailed)
○ correlation is significant at .05 level (2-tailed)

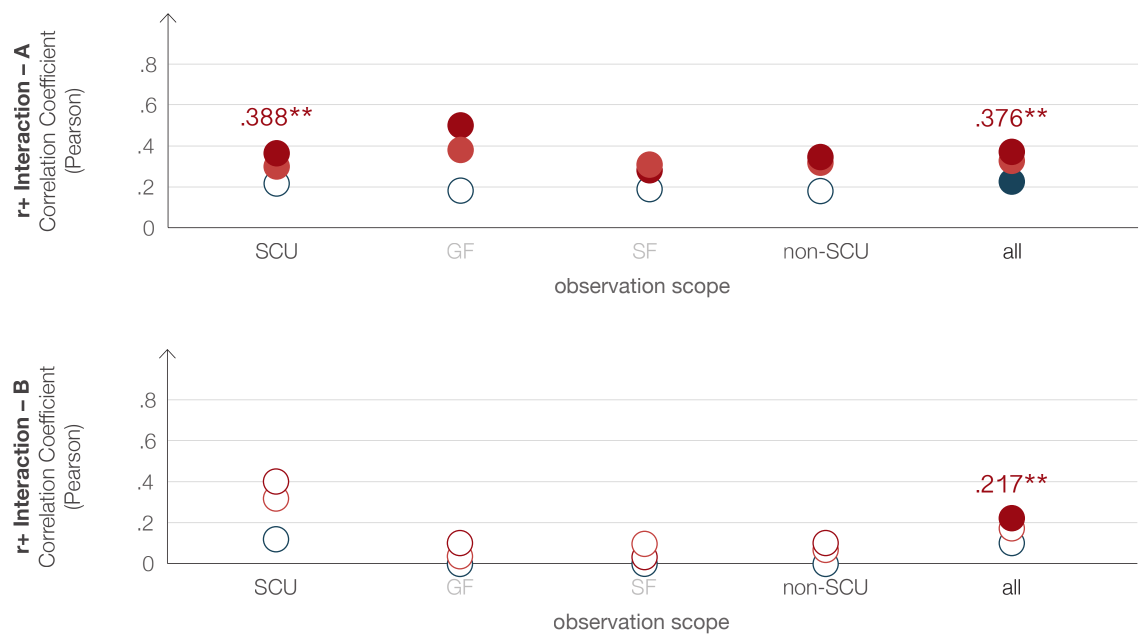
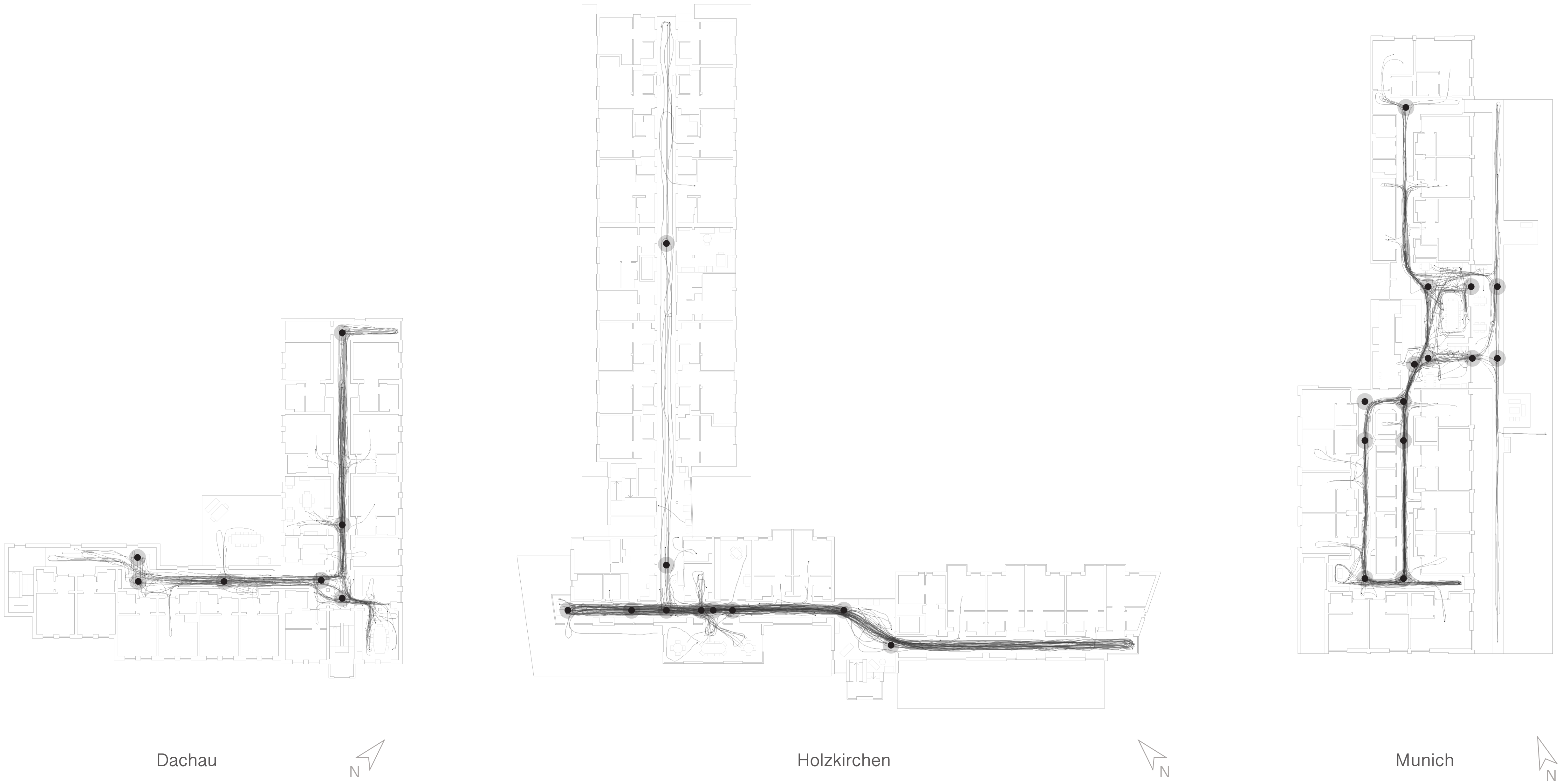



Figure 33. R of a Pearson correlation for the spatial distribution of resident interaction (r+) traces to convex and visual integration (max, mean), considering Scenarios A and B.

## Physical Activity

Special Care Units in Comparison




decision point
turn in corridor or to room with no or opened door

wandering trace of resident

Figure 34. Physical activity - SCUs in comparison.

10 m

## Which architectural qualities seem to promote physical and social activity?

Each SCU features a distinct floor layout – Dachau is L-shaped, Holzkirchen T-shaped, and Munich a racetrack. Corridors are generally double-loaded, however, Holzkirchen's and Dachau's SCUs comprise a single-loaded corridor as well.
Examining Holzkirchen more closely reveals that approximately 80% of physical activities occur in this specific corridor, which is very well-illuminated due to its location on the top floor (Figure 34). By contrast, movement in Dachau's darker, more enclosed SCU, situated on the ground floor, is evenly distributed throughout the space. This suggests that daylight and/or views might act as an attractor to wandering.

Purposeful movement occurs most frequently in the L-shaped floor plan, indicating best navigation. Within the racetrack, it is most often seen that residents cannot find their rooms. Floorplan intelligibility relates to purposeful movement quotas. Layout complexity measures appear indicative of increased wandering and possibly wayfinding confusion. The quantity of decision points along routes does not correlate with wayfinding, contradicting previous research (cf. 3.1.). There is a notion that residents bypass decision points continuing straight until they encounter an obstruction (e.g. a wall), at which point they change direction, execute a 180° turn, or attempt to open a window or door. Munich is unique in offering a large communal garden, in which much physical activity occurs (Figure 35).

Interactions accumulate in the MCR. Its spatial qualities were thus examined in more detail. Dachau's is the smallest (39m$^2$) contrasted by Holzkirchen's spacious 135m$^2$ MCR with an isovist almost double the size (253m$^2$). Yet, it is Munich that documents most interactions among residents. MCRs' floor and isovist areas are therefore unrelated to social engagement. Diversity of spaces and social density equally show no correlation with interaction patterns. Munich's MCR, a b-type space (contrasting the other two a-type MCR samples) shows the highest interaction quota.

Most agitated behavior is seen in Dachau and least in Holzkirchen. Interestingly, the opening of doors in a state of confusion (type 1 agitation) occurs almost exclusively at the end of corridors (dead-ends) when there is no seating possibility (e.g. couch). Other forms of agitation (type 2) assemble in proximity to the MCR (Figure 36).



| | L-SHAPE | T-SHAPE | RACETRACK |
|---|---|---|---|
| **MOVEMENT** | | | |
| mobile residents | 16 | 24 | 20 |
| **purposeful traces** [#] | 11 | 3 | 11 |
| **quota** | **.69** | **.15** | **.55** |
| **wandering** [#] | 58 | 56 | 98 |
| **quota** | **3.63** | **2.33** | **4.9** |
| before 1pm | 40% | 46% | 30% |
| after 1pm | 60% | 53% | 70% |
| note | equally distributed in both corridors | **80% in lower corridor** | 40% of wandering in racetrack |
| **garden** | small terrace only | small terrace only | **yes** |
| wandering [#] | 3 | 2 | 25 |
| **quota** | **.19** | **.08** | **1.25** |
| **LAYOUT COMPLEXITY** | | | |
| decision points [#] | 7 | 10 | 14 |
| #convex spaces/m$^2$ | **.09** | **.03** | **.10** |
| #convex spaces/axial line | **3.10** | **2.85** | **3.78** |
| **intelligibility** | .837** | .507** | .645** |
| **MCR** | | | |
| floor area [m$^2$] | 39.3 | 135.0 | 96.0 |
| isovist area [m$^2$] | 44.2 | 252.9 | 112.9 |
| space type | **a** | **a** | **b** |
| convex integration | .956 | 1.625 | 1.690 |
| visual integration (mean) | 4.1 | 4.3 | 6.1 |
| **interactions** [#] | 30 | 32 | 63 |
| **quota** | **1.9** | **1.3** | **3.2** |
| visual sightlines from MCR | **1** | **5** | **6** |
| **UNIT** | | | |
| **unit size** [m$^2$] | **540.4** | **3,868.4** | **723.7** |
| residents | 16 | 25 | 20 |
| **social density** [m$^2$/r] | **33.8** | **154.7** | **36.2** |
| **interactions** [#] | 55 | 90 | 89 |
| **quota** | **3.4** | **3.6** | **4.5** |
| diversity of common spaces | **3** | **4** | **3** |
| **AGITATION** | | | |
| **type 1** [#] | **4** | **3** | **12** |
| **type 2** [#] | **30** | **15** | **9** |

Figure 35. Key data - physical and social activity across configurations.

## Agitation

Special Care Units in Comparison

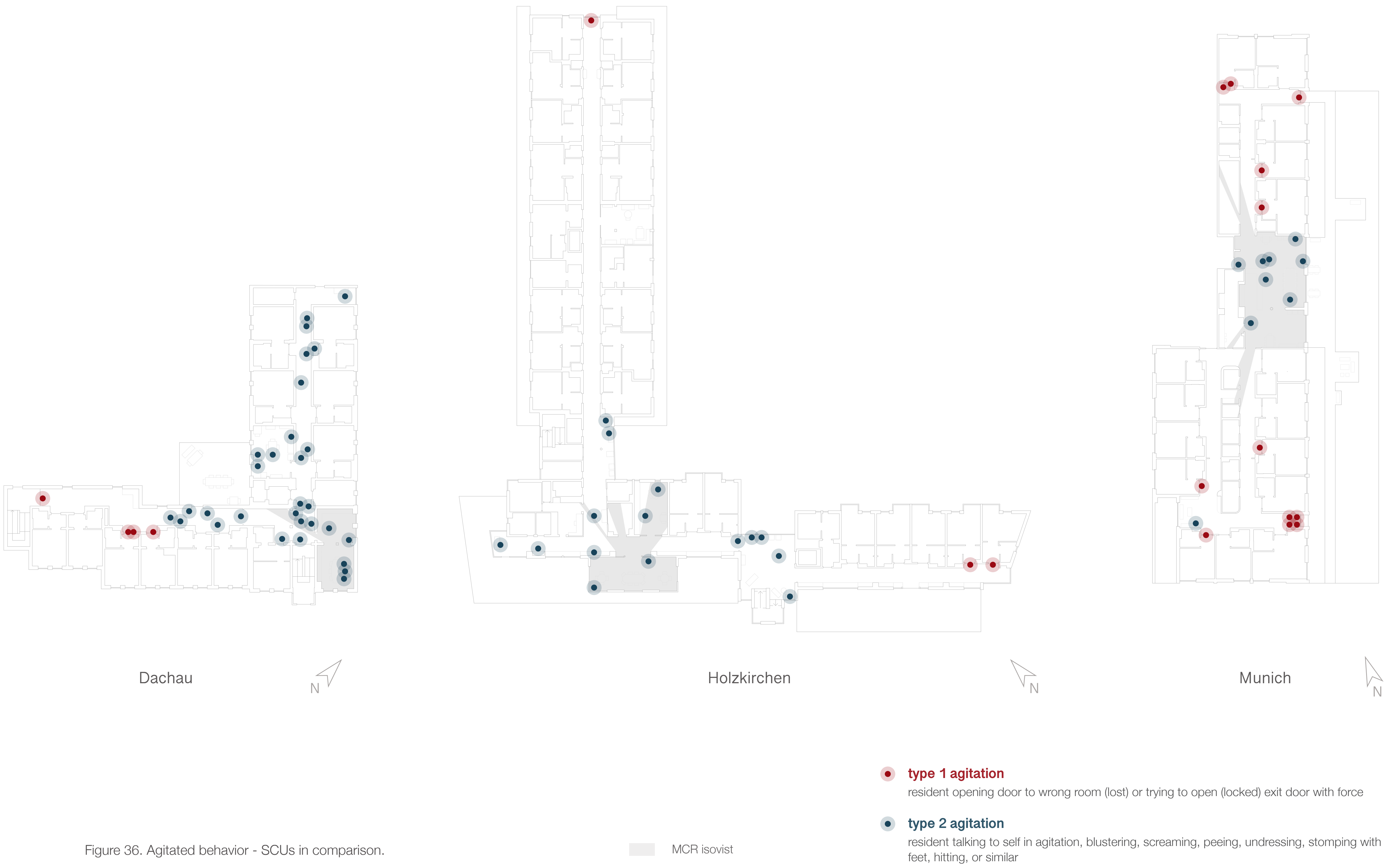



Figure 36. Agitated behavior - SCUs in comparison.

# 6. Discussion

Results indicate that the prevailing care culture strongly influences space use. In SCUs, both wandering and agitated behaviors are common. This is correlative to disease progression and symptomatology. As their cognitive ability declines, people with dementia ultimately require higher care levels and are transferred to SCUs. Concurrently, the implementation of person-centered care demonstrates efficacy, as evidenced by higher levels of both physical and social activity in SCUs compared to non-SCUs. Disparities across care cultures are also reflected in the results of the space syntax analysis. Therefore, it is advisable for future spatial behavior research in LTCFs to independently investigate care cultures in order to ensure comprehensive and nuanced findings **(response to research gap 4)**.

Who is involved in interactions plays a significant role in determining the spatial distribution of social activity patterns **(response to research gap 5)**.
R-r and r-s cluster in the MCR (e.g. conversations over meals, daily activities). Contrary, r-v occur primarily in private resident rooms or on the ground floor – in the foyer, cafeteria, or, if weather conditions allow, the communal garden. Only in SCUs where the ability of residents with late-stage dementia to engage in meaningful conversations is often severely impaired, visitors tend to join daily activities. In summary, r-v interactions exhibit distinct spatial behaviors and should as such be understood in their own right.

The examination of all tools within the space syntax suite reveals that space-types (boundary analysis) and visual integration (VGA eye level) perform as best proxies in explaining the behavior of residents with dementia **(response to research gap 7)**. In comparison, convex analysis, axial analysis, VGA knee level, as well as the metrics of connectivity, control, and choice demonstrate weaker correlations. No relationship is found for step depth analysis using the entrance as initial node **(response to research gap 8)**.

Movement patterns of residents in LTCFs are well-predicted by spatial configuration ($r^2 \approx .5$-$.6$). This is an interesting finding for two key reasons.

Firstly, space syntax, as a theoretical framework, postulates the syntactic reading of the environment [233]. It suggests that analogously to how languages employ words and syntax to derive meaning, human behavior and encounter is constituted by spatial configuration [234-235]. By examining its relations and interrelations, insight into how people perceive and use space can be gained [236]. However, space syntax views the body as a generic entity in a material world and does not account for intricacies in human experience.

Secondly, dementia disease is associated with a decline in spatial reasoning, involving both egocentric (self-to-object), and predominantly allocentric (object-to-object) faculties [237-



-239]. As dementia advances, individuals lose their ability to recall cognitive maps (“I do not remember having been here.”), while simultaneously constructing new, non-existing, and at times even hallucinatory links (“I have been here before.”) [240]. Neuroscientific research finds that the mechanical functioning of the vision system is severely impaired [241-242]. When dementia patients move along a path, instead of actively scanning the environment, their eyes remain fixed in position [243-246]. This suggests that dementia once spread to the somatosensory and premotor cortex, could be affecting the performance of the preconscious brain in directing saccades (eye movement). With limited information being received (“All I see is grey.”), spatial conception is profoundly restricted and entirely unique from one person with dementia to the next [247].

Both somatosensory and syntactic readings of the environment drive the lived experience. Given the significant alterations in how people with dementia perceive the world, there is an open question as to whether syntactic metrics, such as space syntax, are at all suited for dementia-related behavior research.
Intriguingly, the results of this work suggest that when examining movement patterns, space syntax analysis is not less, but rather more applicable to people with dementia **(response to research gap 9).** Of all parameters tested, it is residents’ wandering behavior that demonstrates the greatest correlation with space configuration – despite the expected impacts of somatosensory impairment. Note, however, that this finding may be accentuated considering that purposeful movement is conditioned more strongly by the institutional regime (e.g. time and place of mealtimes or activities) and the location of common spaces, whereas wandering occurs more or less arbitrarily.
These discoveries parallel a recent eye-tracking study, which found that Alzheimer’s patients fixate mainly on architectural features during navigation [248]. This suggests that spatial configuration may hold greater significance than salient visual cues for wayfinding in individuals with dementia.

Conversely, interaction patterns do not exhibit a discernible correlation to spatial configuration. This nuance is of particular interest to space syntax theory which generally posits that increased visibility leads to greater social encounter. Previous literature hypothesised that this may be due to excessive institutional control or differences in interaction levels in long-term care settings. Contrary, this paper introduces a novel perspective by arguing that space syntax analysis falls short in delineating patterns of social space use because r-v interaction differentiates in spatial distribution according to care culture, plus r-r and r-s concentrate in the MCR, irrespective of its integration score. This conception hasn’t been considered in the current evidence base and may account for the aforementioned inconsistency in academic debate (cf. 3.2.).

## MCR Step Depth Analysis

Special Care Units in Comparison

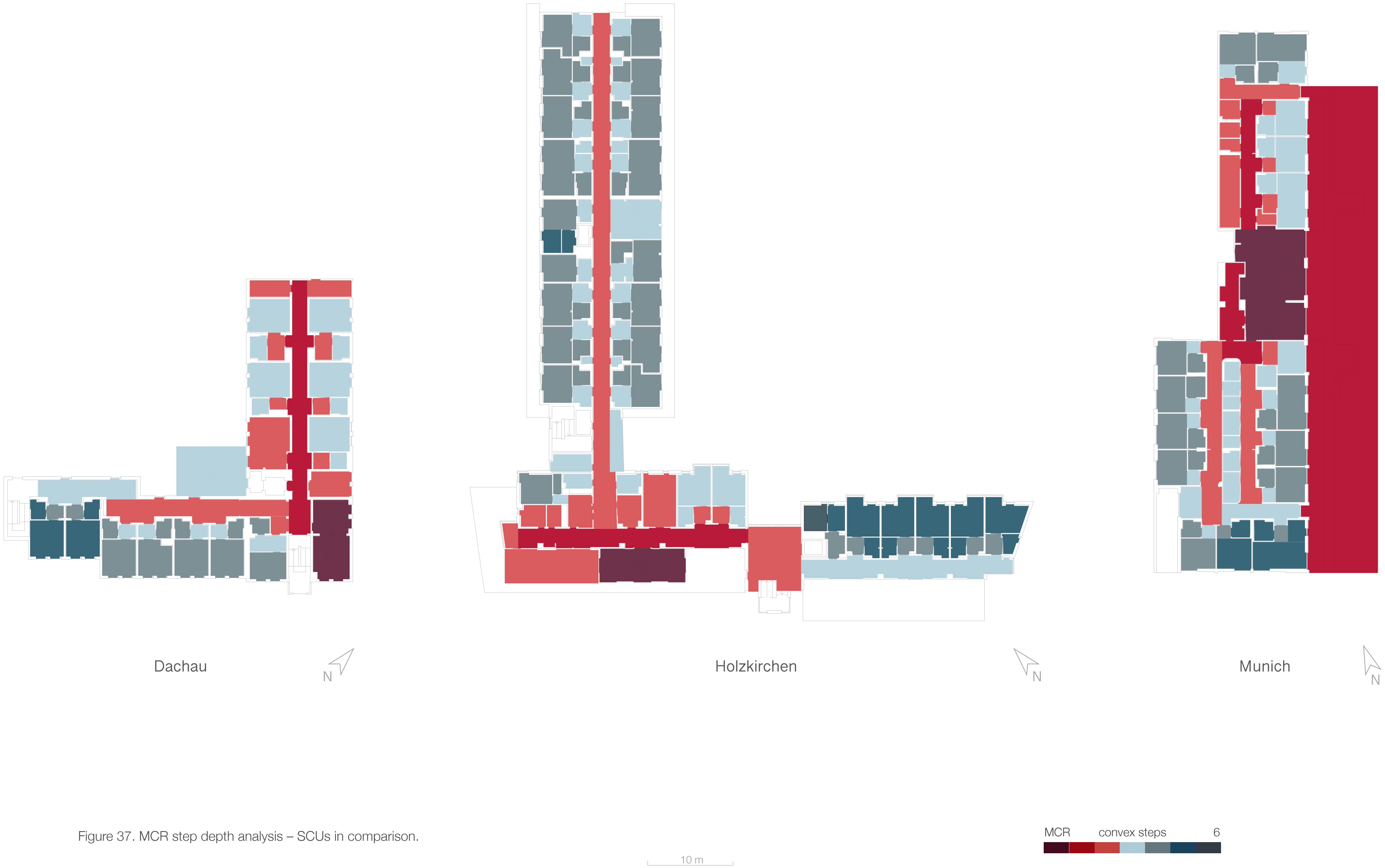



Figure 37. MCR step depth analysis – SCUs in comparison.

Expanding upon this finding, the idea emerged to conduct a pilot study modifying the prior step depth analysis by using not the entrance but instead the MCR as the initial node (Figure 37). Substantiated by examination of the available dataset, notable correlations are discerned (SCU **r =–.625**, non-SCU **r =–.524**) (Figure 38). The probability of social encounter diminishes gradually in a spatial continuum, emanating from the MCR, proceeding through corridors and other shared spaces, and ultimately being least likely in residents' private rooms.

To summarise, space syntax methodology provides valuable tools to quantitatively evaluate resident space use in long-term care environments.

In Munich (SF), for example, much through-movement occurs within the highly integrated nursing room. While some staff members appreciate the heightened level of control it offers, others experience disruptions in their daily tasks, such as filing documents or writing reports, leading to difficulties in maintaining focus. One potential solution could involve the provision of two distinct staff rooms – one integrated and one segregated – to accommodate varying working conditions. Visual graph analysis offers a means to assess layout performance, predict the spatial distribution of both purposeful and wandering behaviors, and provide tailored recommendations to clients.

Furthermore, MCR step depth analysis holds promise in unraveling the spatial distribution of social activities. If validated with additional data, this method could offer guidance on furniture placement and inform future design proposals.

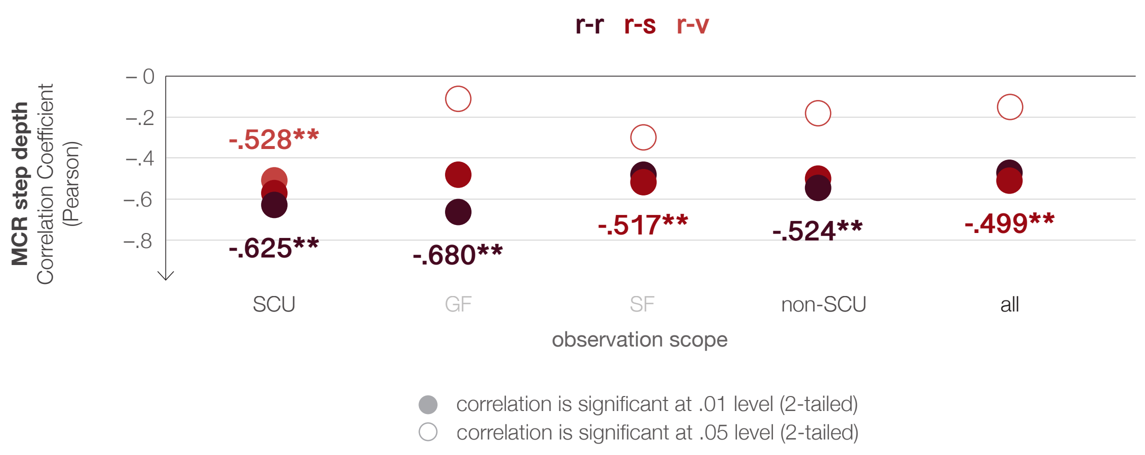



Figure 38. R of a Pearson correlation for the spatial distribution of resident interactions to step depth analysis with the main common room as the initial node.



Comparative post-occupancy assessment of three SCUs yields insights into which architectural qualities are supportive of physical and social activity. The findings largely confirm, partly contradict the existing evidence-base, and introduce some discoveries **(response to research gap 3)**.

Simplified floor layout and small unit size enhance wayfinding **(response to research gap 1)**. Racetrack configuration heightens navigation challenges and confusion. Views and/or daylight emerge as positive factors in minimising agitation and attracting movement. Locating SCUs on higher floors and emphasising the access to sunlight, potentially through larger window sizes, is advisable. Lengthy corridors have an adverse effect on residents' active time and should be avoided. Spacious communal garden areas promote physical activity.
Intelligibility appears indicative of wayfinding **(response to research gap 6)**. Decreased number of convex spaces/$m^2$ or /axial line – indicative of layout complexity – is related to improved orientation capabilities. The explored metrics present interesting prospects for assessing ease of navigation, yet warrant deeper investigation as the current sample number is insufficient.

Parameters such as MCR floor and isovist area, diversity of spaces, and social density are not linked to interaction patterns, partially contradicting previous research **(response to research gap 2)**.

In Munich (SCU), a considerable amount of wandering activity is observed in the MCR, accounting for 30% of all traces. This may be influenced by its central location, effectively connecting two opposing corridors (b-type space). Its spatial configuration conveniently directs wandering residents into the shared space, which may also account for Munich's high interaction rate. Consequently, it may be prudent for future LTCF designs to strategically position common spaces either between or at the terminus of corridors, rather than (as in Dachau and Holzkirchen) alongside them.
Greater visual and convex integration of the MCR, as well as planning for multiple lines of sight to other functional areas is found to promote social activity.

Observations regarding agitated behavior propose that placing seating furniture at the end of corridors, as exemplified in Holzkirchen, leads to a notable reduction in agitated incidents of type 1 (door opening in confusion). Additionally, emergency exits, frequently located at dead-ends, are better positioned along straight routes or, if feasible, entirely outside the main paths of wandering.

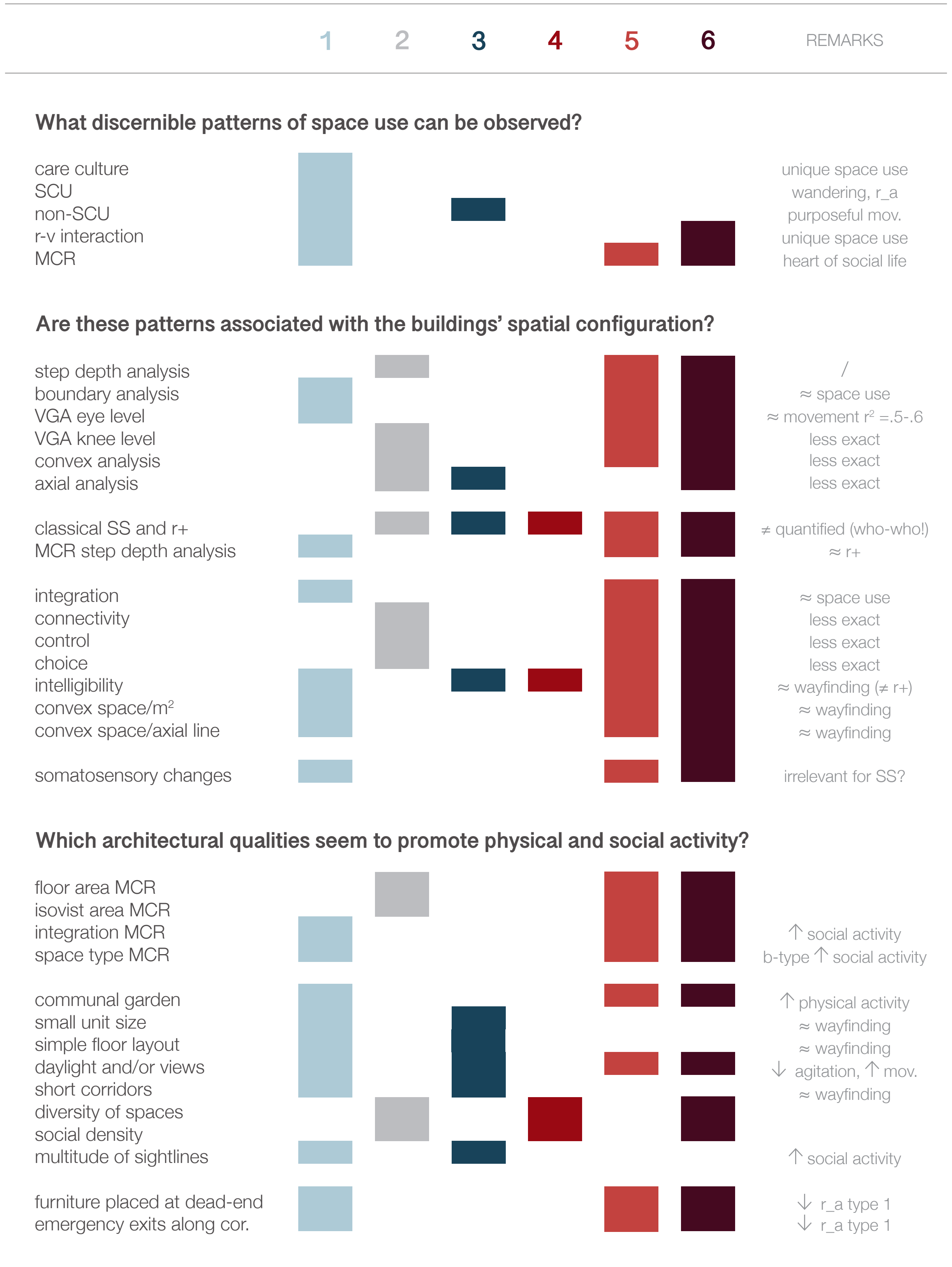



Figure 39. Summary of key findings.



# 7. Implications for Practice

Figure 39 encapsulates the key findings of this study, offering practical implications and outlining avenues for future research.

Incorporating garden spaces conducive to strolling extends residents' active time and contributes to a healthier and more enjoyable environment for all occupants. Small-scale environments with simplified floor layouts facilitate clear navigation and reduce stress in daily activities. Implementing person-centered care in strategically positioned common areas fosters social engagement. The MCR, being the heart of social life, warrants special attention in planning and design, ideally planned with direct garden access. Abundant natural light, avoidance of dead-end corridors, thoughtful positioning of emergency exits and furniture can mitigate agitation.

When employing space syntax to evaluate architectural LTCF layouts, visual graph analysis (eye level, integration) can effectively predict residents' movement flows. Space syntax metrics such as intelligibility and layout complexity may offer insights into wayfinding ease. Interaction patterns are best illustrated by MCR step depth analysis.

While in general additional research is advised to strengthen the evidence base on dementia-sensitive design, particular emphasis should be placed on the underexplored areas of space syntax application and the relevance of somatosensory changes to perception. Additionally, it is pertinent to re-examine the extent to which daylight and/or views attract wandering and the effectiveness of furniture placement at the end of corridors – two novel findings of this study.

**1 relevant to dementia-sensitive design 2 not applicable**
**3 confirms evidence base 4 opposes evidence base 5 novel finding**
**6 future research advised**

# 8. Limitations and Future Research

The observational study addresses various aspects of social activity but does not distinguish between low- and high-level conversations. Exploring encounter durations alongside participant characteristics (who-who) could offer deeper insights into spatial dynamics in long-term care settings.

When documenting space use in residents' rooms, it was assumed that interactions recorded through closed doors occurred in the main space (and not in the bathroom). Achieving a more precise location would necessitate intrusive observations, raising privacy concerns and potential biases. This paper addresses this challenge by examining Scenarios A and B, which yield similar outcomes, supporting the validity of the applied observation method for testing the applicability of space syntax.

Occupancy in the case studies is not entirely exclusive to dementia residents, resulting in a degree of generalisation in the combined analysis. To account for variability, figures present results for both 'all' and each case study independently.

Another constraint is the Modifiable Area Unit Problem pertaining to the aggregation of spatial units, which, if delineated, can lead to different statistical outcomes. In this study, convex spaces are chosen for data standardisation as most space syntax computation relies on them (boundary, step depth, and convex analysis). However, an alternative approach aligning units with room functions could be explored.

In general, more comprehensive data would strengthen the study. Particularly, remarks based on the comparison of three SCUs should be interpreted with caution due to the very small sample size. However, as their examination primarily aims to scrutinise the existing evidence base, the samples stand not for themselves but enhance the ongoing scholarly debate.

VGA emphasises quantitative measures of space configuration. Qualitative elements like shadows, reflections, or floor patterns, known to influence dementia-related behavior, introduce complexities beyond VGA's scope. For example, mirrors are sometimes misconceived as passageways, leading individuals to attempt to navigate through them, or shadows are misinterpreted as ground obstacles, causing movement halts [249-250]. This highlights the need for complementary and interdisciplinary approaches, as space syntax alone cannot explain all spatial phenomena.



Isolating single environmental factors poses heuristic challenges [251]. For instance, this paper discusses wayfinding without analysing the potential impacts of signage or landmarks. Incorporating such features, i.e. as computational weight in space syntax analysis, could enhance future research accuracy.

Dementia medication can indirectly affect residents' physical and social abilities. Pharmacological interventions may improve motor skills and cognitive function (navigation, more meaningful conversations), or reduce agitation, but can also entail side effects like nausea, dizziness, or muscle weakness [252-256]. Considering the variation in symptoms, drug dosage, and individual responses, the comprehensive assessment of medication impacts on space use patterns remains challenging.

Every brain is different, and the distortion caused by dementia, as well as symptomatology, are thus highly idiosyncratic [257-258].
Architectural qualities may influence individuals differently depending on their specific diagnosis, stage, and dementia type [259]. Future research could place greater emphasis on this heterogeneity and advance more inclusive methods addressing dementia's intricate complexities.

Research on dementia-related visual dysfunction is still in its nascent stages. Many questions are unanswered and the subject is largely under-recognised in today's dementia-sensitive design evidence base [260]. Understanding how people with dementia perceive their surroundings is crucial, yet challenging. Especially for Alzheimer's, scientific studies face difficulties, as language abilities decline before visual impairment sets in, making verbatim reporting of symptoms and perception by patients impossible [261-262]. This study suggests that movement patterns may be unaffected by somatosensory changes, but future research should delve further into this aspect.

Country-specific factors, such as local building regulations, social services, policies, and public attitudes significantly shape dementia care [263-264]. For example, Ireland's strong family ties increase demand for dementia day-care, contrasting Germany's prevalence of elderly loneliness and long-term residential care [265-266]. These contextual nuances must be considered when comparing the results of this study.

# 9. Conclusion

Is dementia a natural part of the aging process, or can we actively address it as our understanding grows? Over the past century, there has been a transformative shift from regarding dementia as a pathological variant of normal aging to recognising it as a distinct and rapidly proliferating disease of global public health concern [267-268].

With the absence of a definitive cure for dementia and a growing population in need of long-term institutional care, creating supportive environments that can decelerate disease progression is imperative. Thoughtful design choices that facilitate physical and social activity serve as a catalyst for enhancing the quality of life, benefitting not only individuals with dementia but also the broader society [269]. Furthermore, optimised building performance enhances resident independence, resulting in more efficient staff allocation and, consequently, significant time and cost savings.

For the first time, the comprehensive suite of space syntax techniques is tested for their applicability in assessing resident behavior in LTCFs. The results affirm the ability of spatial configuration to accurately predict movement patterns. Additionally, MCR step depth analysis is introduced, a novel computational method capturing the spatial distribution of interactions in LTCFs. Thus, space syntax emerges as a valuable tool to quantitatively evaluate both design performance and social function of future care home designs.

The findings of this study aim to enrich the existing knowledge base, guide non-pharmacological care, emphasise the universal advantages of dementia-sensitive environments, and encourage architects, care providers, and policymakers to embrace universal design that fosters the well-being and quality of life of people irrespective of their health status or cognitive abilities.

Good design for people with dementia is, in essence, good design for all.

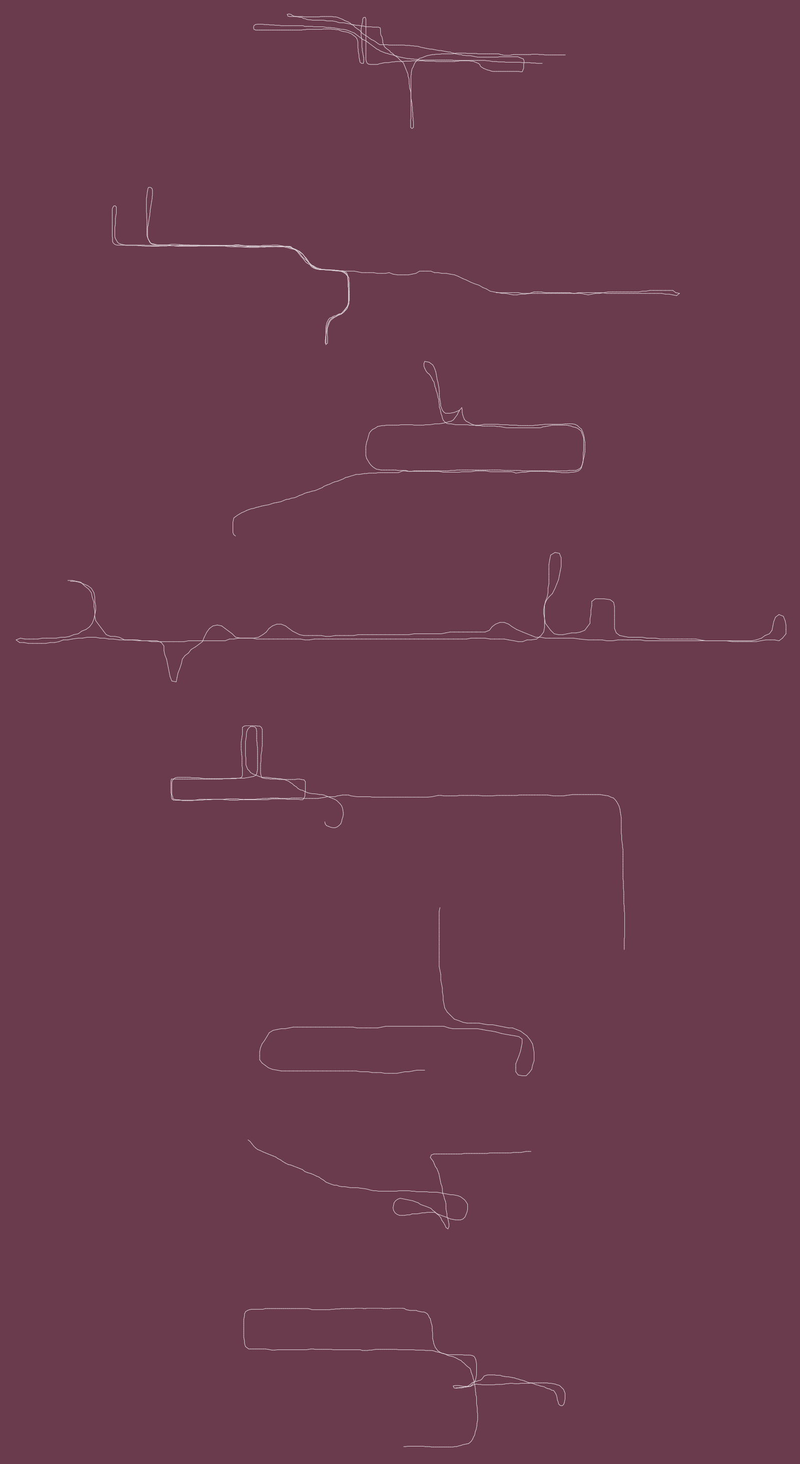


Figure 40. Sampled wandering traces of residents.

# 10. Acknowledgement

The author thanks **Alan Penn**, who served as a supervisor to this project, for his continuous support and insightful feedback that greatly contributed to the improvement of this work. Moreover, the report was enriched by the following individuals who generously shared their time, thoughts, and expertise in neuroscience, dementia-sensitive architecture, and space syntax: **Nick Tyler** (Chadwick Chair of Civil Engineering, UCL and member of Ecological Brain DTP), **Niall McLaughlin** (Prof Architectural Practice UCL, 'Losing Myself' project), **Kerstin Sailer** (Prof Sociology of Architecture, UCL), **Kimon Krenz** (Research Fellow, Bartlett Faculty), **Rosica Pachilova** (Foster+Partners and Researcher Spatial Quality of Care Environments, UCL), **Sam McElhinney** (Prof Architecture, UCA), **Chenyang Li** and **Kayvan Karimi** (Director of the MSc Space Syntax Program, UCL).

Special thanks go to **Birgit Dietz**, who recently published her wonderful book 'Dementia-sensitive Architecture' (de. *'Demenzsensible Architektur - Planen und Gestalten für alle Sinne'*), for her instrumental role in facilitating this project and for her recommendation that led to the collaboration with Dachau's and Holzkirchen's LTCFs. The author is equally grateful to her grandmother, **Kathinka Schreiner**, and **Sabine Sittinger** for arranging a visit to the Munich care home which ultimately led to the cooperation.

Appreciation is extended to **Stefan Drees** (Feddersen Architekten) and **Tanja Dieter** (BIfadA, Bavarian Institute for Age and Dementia-Sensitive Architecture) who kindly shared key datasets and building floorplans.

Thanks are given to **Christine Bauer**, **Cornelia Müller**, and **Ramona Auermeier**, representatives of the three care homes studied, for guiding me through the building, their participation and support in the project.

To **Aleksander Geisler**, **Gina Zuth**, **Alicia Hergerdt**, and **Youssef Elassaly**, the author expresses heartfelt gratitude for their endless support and cherished friendship. Thank you also to **Karin and Wolfgang Amann** for their tireless efforts in printing and transporting the 980 sheets of paper necessary for the observations, as well as for their unconditional love.

This work is dedicated to **Sigi Sittinger**, the author's great-uncle, who resides in the Munich Dementia Competence Center.

The research was supported by a fellowship of the German Academic Exchange Service (DAAD).

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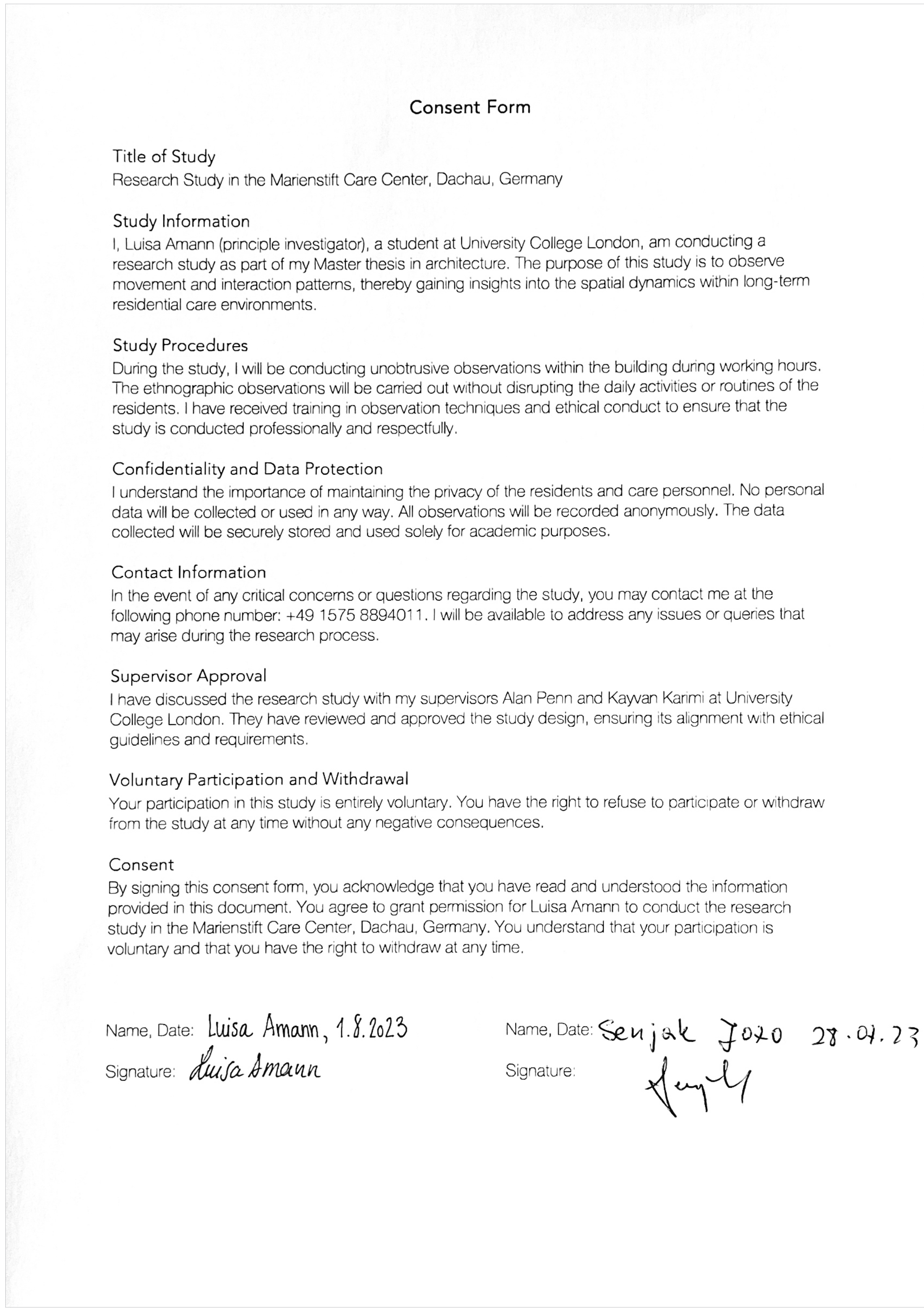
# 12. Appendices

## Additional Notes

All graphics are produced and designed by the author. Visuals which were informed by other sources are referenced.
The dataset compiled and created in this dissertation cannot be disseminated publicly, however, interested parties may obtain it upon request by contacting the author.
Front and back cover show collaged movement traces of residents with dementia wandering.



## Consent Form Dachau 'Marienstift House'



Consent Form

Title of Study
Research Study in the Marienstift Care Center, Dachau, Germany

Study Information
I, Luisa Amann (principle investigator), a student at University College London, am conducting a research study as part of my Master thesis in architecture. The purpose of this study is to observe movement and interaction patterns, thereby gaining insights into the spatial dynamics within long-term residential care environments.

Study Procedures
During the study, I will be conducting unobtrusive observations within the building during working hours. The ethnographic observations will be carried out without disrupting the daily activities or routines of the residents. I have received training in observation techniques and ethical conduct to ensure that the study is conducted professionally and respectfully.

Confidentiality and Data Protection
I understand the importance of maintaining the privacy of the residents and care personnel. No personal data will be collected or used in any way. All observations will be recorded anonymously. The data collected will be securely stored and used solely for academic purposes.

Contact Information
In the event of any critical concerns or questions regarding the study, you may contact me at the following phone number: +49 1575 8894011. I will be available to address any issues or queries that may arise during the research process.

Supervisor Approval
I have discussed the research study with my supervisors Alan Penn and Kayvan Karimi at University College London. They have reviewed and approved the study design, ensuring its alignment with ethical guidelines and requirements.

Voluntary Participation and Withdrawal
Your participation in this study is entirely voluntary. You have the right to refuse to participate or withdraw from the study at any time without any negative consequences.

Consent
By signing this consent form, you acknowledge that you have read and understood the information provided in this document. You agree to grant permission for Luisa Amann to conduct the research study in the Marienstift Care Center, Dachau, Germany. You understand that your participation is voluntary and that you have the right to withdraw at any time.

Name, Date: Luisa Amann, 1.8.2023    Name, Date: Senjak Jozo 28.07.23
Signature: Luisa Amann    Signature:

# Consent Form Holzkirchen ‘St. Anna House’

## Consent Form

**Title of Study**
Research Study in the St. Anna Care Center, Holzkirchen, Germany

**Study Information**
I, Luisa Amann (principle investigator), a student at University College London, am conducting a research study as part of my Master thesis in architecture. The purpose of this study is to observe movement and interaction patterns, thereby gaining insights into the spatial dynamics within long-term residential care environments.

**Study Procedures**
During the study, I will be conducting unobtrusive observations within the building during working hours. The ethnographic observations will be carried out without disrupting the daily activities or routines of the residents. I have received training in observation techniques and ethical conduct to ensure that the study is conducted professionally and respectfully.

**Confidentiality and Data Protection**
I understand the importance of maintaining the privacy of the residents and care personnel. No personal data will be collected or used in any way. All observations will be recorded anonymously. The data collected will be securely stored and used solely for academic purposes.

**Contact Information**
In the event of any critical concerns or questions regarding the study, you may contact me at the following phone number: +49 1575 8894011. I will be available to address any issues or queries that may arise during the research process.

**Supervisor Approval**
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**Voluntary Participation and Withdrawal**
Your participation in this study is entirely voluntary. You have the right to refuse to participate or withdraw from the study at any time without any negative consequences.

**Consent**
By signing this consent form, you acknowledge that you have read and understood the information provided in this document. You agree to grant permission for Luisa Amann to conduct the research study in the St. Anna Care Center, Holzkirchen, Germany. You understand that your participation is voluntary and that you have the right to withdraw at any time.

Name, Date: Amann, Luisa, 24.07.23
Signature: Luisa Amann

Name, Date: Müller, Cornelia 24.07.2023
Signature:

caritas
Krankenhausstraße 10
83607 Holzkirchen
Telefon 08024/99770 Fax 99773
Lebensgestaltung und Pflege für alte Mensc

# Consent Form Munich ‘Dementia Competence Center’

## Consent Form

**Title of Study**
Research Study in the Competence Centre for Dementia, Munich, Germany

**Study Information**
I, Luisa Amann (principle investigator), a student at University College London, am conducting a research study as part of my Master thesis in architecture. The purpose of this study is to observe movement and interaction patterns, thereby gaining insights into the spatial dynamics within long-term residential care environments.

**Study Procedures**
During the study, I will be conducting unobtrusive observations within the building during working hours. The ethnographic observations will be carried out without disrupting the daily activities or routines of the residents. I have received training in observation techniques and ethical conduct to ensure that the study is conducted professionally and respectfully.

**Confidentiality and Data Protection**
I understand the importance of maintaining the privacy of the residents and care personnel. No personal data will be collected or used in any way. All observations will be recorded anonymously. The data collected will be securely stored and used solely for academic purposes.

**Contact Information**
In the event of any critical concerns or questions regarding the study, you may contact me at the following phone number: +49 1575 8894011. I will be available to address any issues or queries that may arise during the research process.

**Supervisor Approval**
I have discussed the research study with my supervisors Alan Penn and Kayvan Karimi at University College London. They have reviewed and approved the study design, ensuring its alignment with ethical guidelines and requirements.

**Voluntary Participation and Withdrawal**
Your participation in this study is entirely voluntary. You have the right to refuse to participate or withdraw from the study at any time without any negative consequences.

**Consent**
By signing this consent form, you acknowledge that you have read and understood the information provided in this document. You agree to grant permission for Luisa Amann to conduct the research study in the Competence Centre for Dementia, Munich, Germany. You understand that your participation is voluntary and that you have the right to withdraw at any time.

Name, Date: Luisa Amann, 1.8.2023
Signature: Luisa Amann

Name, Date: Ramona Ammeier, 1.8.2023
Signature: R.

# Ethical Approval

LONDON'S GLOBAL UNIVERSITY

UCL

**2022-23 MSc Space Syntax: Architecture and Cities LOW RISK ETHICS FORM**

**This form is adapted from the UCL Research Ethics Committee application**

**Step 1: You MUST read the UCL Ethics Research page PDF in the folder before you fill in this form.**

You are also encouraged to refer to guidance in the **Practicing Ethics Website**, which contains many good examples of methods/approaches: www.practicingethics.org

| **Section A: Your Details** | |
|---|---|
| **Title of Project** | The Relationship between Spatial Configuration, Movement and Social Interaction of Residents with Dementia in Long-Term Care Settings: Investigating two Case Studies in Germany |
| **Proposed data collection start date** | **24.7.2023** |
| **Proposed data collection end date** | **4.8.2023** |
| **Your Name (Principal Investigator)** | Luisa Amann |
| **Faculty/Department** | BARTLETT SCHOOL OF ARCHITECTURE |
| **Course Title** | MSc Space Syntax |

| | |
|---|---|
| Supervisor Name | Alan Penn |

**Section B: Project details**

**1** **200-word Project abstract, including its intended aims.**

Around the world, demographic change and a generally aging population give rise to a dementia epidemic.

As part of my master thesis I am researching how the spatial configuration (using Space Syntax methods of analysis) of care centers affects wayfinding and social interaction of dementia patients/residents. Understanding the potential architecture holds in relation to these is important, as it can positively influence and slow down the course of the disease.

To develop the study successfully, visiting exemplary buildings is key. Three German care centers – Caritas Marienstift in Dachau, St. Anna House in Holzkirchen and Kompetenzzentrum Munich – have agreed for me to conduct observational studies mapping occupancy and activities.

The study could make a significant contribution in informing future construction projects, evaluating the relevance of Space Syntax to dementia design, promoting spatially efficient care home architectures and resident's well-being.

**2** **Methodology & Methods** (tick all that apply)

- ☐ Interviews*
- ☐ Focus groups*
- ☐ Questionnaires (including oral questions)*
- ☐ Action Research
- ☒ Observation

Ethnographic Observation

- ☐ Documentary analysis (including use of personal records)
- ☐ Audio/visual recordings (including photographs)
- ☐ Collection/use of sensor or locational data
- ☐ Controlled Trial
- ☐ Intervention study (including changing environments)
- ☐ Systematic review
- ☐ Secondary data analysis – ***(See Section D)***
- ☐ Advisory/consultation groups
- ☐ Other, give details: Making a collaborative zine

**Attach copies to application (see below).*

**3** **Overview of the project – in lay person's language:** focusing on your methodology and including information on what data/samples will be taken (including a description of the topics/questions to be asked), how data collection will occur and what (if relevant) participants will be asked to do. **(300 words max)**

Ethnographic observations will be conducted for two days in each of the three care centres (staff and resident space occupancy, movement and interaction). These will be unobtrusive and not interrupt normal care activities. I will only go around the building with a notebook during normal working hours. All data will be anonymous.
Essentially, I will document movement traces (from/to/where do people walk) and the location of social interaction (taking 'snapshots' of conversations). I will have floorplans of the buildings with me (printed) and draw 'into' them. Observations will first be conducted between July 24th and August 4th.

The traces and snapshots will later on be digitalised and compared to Space Syntax analysis of the building (axial analysis, VGA, isovist).

**4** **Attachments**

/

**Location of Research**

**5** **Please indicate where this research is taking place.**

- ☐ UK only (Skip to 'location of fieldwork')
- ☒ Overseas only
- ☐ UK & overseas

**6** **State the location(s) where the research will be conducted and data collected. For example public spaces, schools, private company, using online methods, postal mail or telephone communications.**

Observations will be conducted in the following three care centers:

1. Caritas Altenheim Marienstift Dachau
   address: Schillerstraße 40, 85221 Dachau, Germany
2. Caritas Altenheim St. Anna Haus
   address: Krankenhausstraße 10, 83607 Holzkirchen, Germany
3. Kompetenzzentrum Demenz
   address: Landsbergerstraße 367, 80687 Munich, Germany

**Section C: Details of Participants**

In this form 'participants' means human participants and their data (including sensor/locational data, observational notes/images).

**7** **Does the project involve the recruitment of participants?**

**Yes** ☐ Complete all parts of this Section.

**No** ☒ Move to Section D.

| | | |
|---|---|---|
| **Participant Details** | | |
| **8** | Approximate maximum number of participants required: / <br> Approximate upper age limit: / Lower age limit: / <br> Justification for the age range and sample size: | |
| **Recruitment/Sampling** | | |
| **9** | Describe how potential participants will be recruited into the study. | |
| **Informed Consent** | | |
| **10** | Describe the process you will use when seeking to obtain consent, e.g. in an email text, and also with the participant form. | |

| | |
|---|---|
| **11** | How will the results be disseminated (including communication of results with participants)? |

**Section D: Accessing/Using Pre-collected Data**

| | |
|---|---|
| **Access to data** | |
| **12** | If you are using data or information held by third party, please explain how you will obtain this. You should confirm that the information has been obtained in accordance with the General Data Protection Regulation 2018. <br> I will only be using my own data, collected as part of the study. |

| | |
|---|---|
| **Accessing pre-collected data** | |
| **13** | **Does your study involve the use of previously collected data?** <br> **No** ☒ Move to Section E. <br> **Yes** ☐ Complete all parts of this Section. **Note:** If you ticked any boxes with an asterisk (*),ensure further details are provided in Section E: Ethical Issues. |

| | | |
|---|---|---|
| **14** | **Name of dataset/s:** | |
| **15** | **Owner of dataset/s (if applicable): name of archives** | |
| **16** | **Is the data in the public domain?** Yes ☐ No ☐ <br> **If not,** do you have the owner's permission/license? Yes ☐ No* ☐ | |
| **17** | **Is the data anonymised?** Yes ☐ No ☐ <br> **If not:** <br> i. Do you plan to anonymise the data? Yes ☐ No* ☐ <br> ii. Do you plan to use individual level data? Yes* ☐ No ☐ <br> iii. Will you be linking data to individuals? Yes* ☐ No ☐ <br> See here for guidance on this question: https://www.ucl.ac.uk/bartlett/sites/bartlett/files/bartlett_ethics_guidance_2_sept_2020.pdf | |
| **18** | Is the data sensitive? | Yes* ☐ <br> No ☐ |



| | | |
|---|---|---|
| **19** | Will you be conducting analysis within the remit it was originally collected for? | Yes ☐ <br> No* ☐ |
| **20** | If not, was consent gained from participants for subsequent/future analysis? | N/A Yes ☐ <br> No* ☐ |

**Section E: Ethical Issues**

| | |
|---|---|
| **Ethical Issues** | |
| **21** | Please address clearly any ethical issues that may arise in the course of this research and how they will be addressed (e.g. your conduct in contacting the interviewees – also see risk assessment for cultural issues that you should be aware of in interviewing). <br> Dementia patients/residents are vulnerable groups. No personal data or identification will be gathered and/or used in my research. <br> To familiarize myself with both building estate directors, staff and residents beforehand, I have visited the care centres in advance of the observations (June 2023). This gave me an opportunity to discuss my methodology with the personnel and understand how I can optimise the ethnographic observations taking into consideration daily activities (unobtrusive). |

| | |
|---|---|
| **Risks & Benefits** | |
| **22** | Please state any *risks* to participants and how these risks will be managed. <br> / |
| **23** | Please state any *risks* to you or your research team and how these risks will be managed. <br> / |

**Section F: Data Storage & Security**

Please ensure that you answer each question and include all hard and electronic data.

| | |
|---|---|
| **24** | **Will the research involve the collection and/or use of personal data?** <br> Yes ☐ No ☒ <br> ***Personal data*** *is data which relates to a living individual who can be identified from that data OR from the data and other information that is either currently held, or will be held by the data controller (the researcher).* <br> *This includes:* <br> – *any expression of opinion about the individual and any intentions of the data controller or any other person toward the individual.* <br> – *sensor, location or visual data which may reveal information that enables the identification of a face, address, etc (some postcodes cover only one property).* <br> – *combinations of data which may reveal identifiable data, such as names, email/postal addresses, date of birth, ethnicity, descriptions of health diagnosis or conditions, computer IP address (if relating to a device with a single user).* |
| **25** | **Is the research collecting or using** <br> – sensitive personal data as defined by the General Data Protection Regulation (racial or ethnic origin / political opinions / religious beliefs / trade union membership / physical or mental health / sexual life / commission of offences or alleged offences), and/or <br> – data which might be considered sensitive in some countries, cultures or contexts. <br> **If yes,** state whether explicit consent will be sought for its use and what data management measures are in place to adequate manage and protect the data. |

| | |
|---|---|
| | No. |

**During the project** *(including the write up and dissemination period)*

**26** **State what types of data will be generated from this project** (i.e. transcripts, videos, photos, audio tapes, field notes, etc).

Mappings of movement traces (lines) and location of interaction (cross) on printed floorplans.

**How will data be stored, including where and for how long?** This includes all hard copy and electronic data on laptops, share drives, usb/mobile devices.

The data will be digitalised after finishing the observational studies and stored with the researcher, that is me, Luisa Amann, in form of a .pdf on my personal computer for the period of the study.

**Who will have access to the data, including advisory groups and during transcription?**

In its raw format, only the principal investigator.

**27** **Do you confirm that all personal data will be stored and processed in compliance with the General Data Protection Regulation (GDPR 2018).**

**Yes** ☐ No ☐

Not applicable.

**28** **Will personal data be processed or be sent outside of the European Economic Area (EEA)?***

Yes ☐ No ☐

**If yes,** please confirm that there are adequate levels of protection in compliance with the GDPR 2018 and state what the arrangements are below.

*Please note that if you store your research data containing identifiable data on UCL systems or equipment (including by using your UCL email account to transfer data), or otherwise carry out work on your research in the UK, the processing will take place in keeping with the previous EEA standards, and will be captured by UK Data Protection legislation.

Not applicable.

**After the project**

**29** **What data will be stored and how will you keep it secure?**

The data will be stored securely in a one-drive format and password protected drive.

**Where will the data be stored and who will have access?**

Only the principal investigator has access to the data.

**30** **Will the data be archived for use by other researchers?** Yes ☐ No ☒



| | |
|---|---|
| | **If yes,** please provide further details including whether researchers outside the European Economic Area will be given access. |

**Section G: Declaration**

**I confirm that the information in this form is accurate to the best of my knowledge.**

| | |
|---|---|
| Student name and signature | Luisa Amann |
| Date | 25.6.2023 |

**I have met with and advised the student on the ethical aspects of this project design.**

Supervisor Name and signature Alan Penn.

| | |
|---|---|
| Date: | 5/7/23 |

**Signature of Programme Director**

**Part A**

I have read the 'criteria of minimal risk' as defined on page 3 of the Guidelines (http://ethics.grad.ucl.ac.uk/forms/guidelines.pdf) and I recommend that this application be considered by the Chair of the UCL REC.

Yes ☐ No ☐

**Part B**

**I have discussed this project with the principal researcher who is suitably qualified to carry out this research and I approve it. I am satisfied that** (highlight as appropriate):**

1. **Data Protection registration:**
   - has been satisfactorily completed
   - has been initiated
2. **A risk assessment:**
   - has been satisfactorily completed
   - has been initiated
3. **Appropriate insurance arrangements are in place and appropriate sponsorship [funding] has been approved and is in place to complete the study.**

Yes ☐ No ☐

| | |
|---|---|
| Name and signature: | Kayvan Karimi |
| Date: 11/07/2023 | |

## Risk Assessment

**MSc Space Syntax Programme 2022-23**

**MSC SPACE SYNTAX RISK ASSESSMENT TEMPLATE**

**Hazards**
**The safety information in this risk assessment covers the following hazards which may be associated with MSc Space Syntax research:**

1) Hazards associated with lone working
2) Hazards associated with dealing with other people
3) Hazards associated with different environments
4) Hazards linked to general health and fitness

**Please complete this form, by reading and considering carefully all potential risks and control measures and putting a tick in the column on the right-hand side - not for each (sub)category of risks/control measures but each individual one (line).**

**Then discuss the form and issues arising with your supervisor, and submit the signed document to your supervisor and the Programme Director (Kayvan Karimi). Forms can be submitted electronically, with the student's and supervisor's names typed in as signatures, *providing* that the form is sent by the supervisor, from their UCL email.**

**IF YOU HAVE NOT OBTAINED YOUR SUPERVISOR'S FORMAL APPROVAL FOR YOUR RISK ASSESSMENT YOU ARE NOT AUTHORISED TO UNDERTAKE ANY FIELD RESEARCH.**

**Safety Information**
*Please indicate which Hazards, Risks and control measures are appropriate to your project by placing a tick next to the line in question, in the final column.*

**1) Hazards associated with *Lone Working***
Lone working is defined as working out of the eye-sight of other colleagues. These hazards apply to much generic fieldwork where you carry out interviews or questionnaires alone, as well as travelling to and from the research site alone. Many of the control measures are common sense and apply to everyday life as well as research, but are important to observe.

| Hazard | Risk | Control Measures | Insert an x against all that apply |
|---|---|---|---|
| ***Lone Working-* Miscellaneous Hazards** | **Difficulties in summoning help when required**; risk of abuse/attack | • Where possible carry a radio or mobile phone.<br>• Leave details of the field site and a work plan (include contact name and address) with colleagues in the department or at home prior to any trip.<br>• Specify dates and times of departure and return. If your plans change, inform someone as soon as possible.<br>• Do not carry valuables or large sums of money unless you need to.<br>• Carry a personal alarm (This advice is directed to males as well as females - all are equally vulnerable when alone!)<br>• Instigate a "check-in" system with a colleague or supervisor - Phone in at regular intervals. If you do not phone or return at a certain time arrange for suitable action to be taken.<br>• Trust your intuition - If you feel scared or uneasy, do not ignore it. | X<br>X<br><br>X<br><br>X<br><br><br><br>X |
| ***Lone Working-* Travelling alone** | **On foot** - risks of personal attack/abuse | • Whenever possible avoid walking alone at night.<br>• Keep to busy, well lit roads.<br>• Avoid poorly lit or rarely used underpasses.<br>• Walk facing on-coming traffic to avoid kerb-crawlers.<br>• Do not use a personal stereo - you will be unable to hear anyone approaching from behind.<br>• Plan your journey in advance - tell someone which route you mean to take and estimated time of arrival at your destination.<br>• Walk with confidence and purpose - try not to look as if you are not sure of where you are going.<br>• Make sure wallets, cameras, jewellery and expensive watches and other valuables are not on display.<br>• Dress appropriately - try to fit in without attracting attention. | |
| | **By Car or other transport.** | • Make sure the vehicle is in good working order before setting off.<br>• Make sure you have change for a telephone in an emergency.<br>• Plan your journey in advance - tell someone which route you mean to take and estimated time of arrival at your destination.<br>• Do not leave valuables visible in the car - even when you are in it. Keep bags etc. out of reach of open windows.<br>• When parking in daylight, consider what the area will be like after dark.<br>• When returning to the vehicle, quickly look around it to make sure there is no one waiting for you.<br>• If you are forced to stop by another car, stay in the car, lock the doors and speak through a slightly open window.<br>• Make sure you know what to do if the car breaks down. (i.e. who to phone; where to phone from etc.) | |
| ***Lone Working-* Staying in Hotels** | **risks to personal safety** | • At reception, try to avoid letting other people overhear your name and room number.<br>• Do not go into other people's rooms unless you know it is absolutely safe.<br>• Do not allow people into your room unless you know who they are.<br>• If you hear a disturbance, stay in your room and phone for help. | |

**2) Hazards associated with D*ealing with Other People***
Geographical research often involves dealing with other people. Most research is carried out without problems, but it is important to be aware of the guidelines for good practice in dealing with the public, and especially entering other people's homes.

| Hazard | Risk | Control Measures | |
|---|---|---|---|
| ***Dealing With People* - Other Peoples Homes** | **Associated Risks** | • See also *Lone working.* | |
| | **Risk of personal attack/abuse** | • Do not enter the house if the appropriate person is not available.<br>• Wait to be invited in or at least ask to enter.<br>• Acknowledge that it is their territory; let them lead the way.<br>• If the person is drunk or aggressive, do not enter.<br>• Ensure you can get out quickly if necessary.<br>• If you feel threatened at any point, make an excuse to leave. | |
| | **Causing offence, leading to abuse/attack** | • Try not to react to dirty or smelly surroundings.<br>• Do not spread your belongings around.<br>• Take care with documents you may not want them to see, but avoid being "secretive".<br>• Let them know how much of their time you will need. | |
| ***Dealing With People* - Unexpecte** | **Risk of personal attack/abuse**/misunderstanding | • Be aware of any delicate issues involved with discussions or interviews e.g. before asking a farmer questions regarding his land management, explain why you need to know. | X |

| | | | |
|---|---|---|---|
| d **Behaviour** | of nature of work. | • Ensure landowners and their employees know who you are and what you are doing. | |
| | **Aggressive Behaviour** | • Do not underestimate the importance of body language.<br>• Talk yourself out of problems; placate rather than provoke.<br>• Do not turn your back on someone who is behaving aggressively.<br>• Stay Calm, speak gently and slowly.<br>• Do not be enticed into an argument.<br>• Avoid an aggressive stance. Crossed arms, hands on hips or raised hands will challenge and confront.<br>• Keep your distance.<br>• Never try to touch someone who is angry -this will not calm the situation.<br>• Keep your eye on potential escape routes | X<br>X<br>X<br>X<br>X<br>X<br>X<br>X<br>X |
| | **Physical attack** | • Try to get away as quickly as possible. Move towards a place where you know there will be other people.<br>• Carry a personal alarm - set it off as close to the aggressor's ear as possible and then throw it out of reach.<br>• Shout and scream - shout something practical like "call the police!" or "Fire!" - people rarely react to cries of "help!" or "rape!"<br>• If grabbed and unable to break free - pretend to vomit. This will often have the desired effect! | X<br>X<br>X |
| *Dealing With People* - Dealing with Strangers | **Causing offence**, leading to abuse/attack | • Seek training in good interview techniques.<br>• Where possible "vet" interviewees first over the phone.<br>• Conduct interviews at neutral locations or public spaces or where neither party could be at risk.<br>• Where possible conduct any interviews with an observer.<br>• Seek advice and support from local groups.<br>• Do not wear clothes that might cause offence. | |
| ***Dealing With People*** **- Public Places** | **Causing offence**, leading to abuse/attack | • Do not stand in places where you will be causing an obstruction.<br>• Always carry your ID card and be prepared to identify yourself.<br>• Seek training in good interview techniques.<br>• Consider your dress carefully - is it suitable for the location.<br>• Make sure you have sought permission from relevant authorities to work in your chosen location. | X<br>X<br>X<br>X |

**3) Hazards associated with different *Environments***
Different environments will involve different hazards, and it is important to plan for these.

| Hazards | Risk | Control Measures | |
|---|---|---|---|
| ***Environment* –Location** | Risk of causing offence /personal attack/abuse. | • Respect must be paid to local customs and problems, and advice taken from local contacts, embassies etc.<br>• Dress appropriately.<br>• Consult Foreign Office for advice before travelling overseas | |
| | **Working within other establishments,** | • Ensure establishment has their own safety guidelines in place.<br>• Whilst on the premises follow their guidelines. | X<br>X |
| *Environment* – District | Risk of attack/abuse and personal injury | • Avoid areas known to be "unpleasant"<br>• Seek information on areas before setting out.<br>• Consult Local Community groups, Local Authorities, Police etc. for information and possible contact names before setting out.<br>• Do not enter unfamiliar neighbourhoods alone.<br>• Walk with confidence and purpose - try not to look as if you are not sure of where you are going.<br>• Do not carry more money than you need to.<br>• Dress appropriately - try to fit in without attracting attention. | |



| | | | |
|---|---|---|---|
| | **Risk of getting lost** - high risk areas. | • Study maps of the area before setting out.<br>• Plan your route carefully. Ensure you know of a second route should the first be impassable.<br>• Ensure you have a means of raising alarm if you are lost. | |

**4) Hazards linked to *General Health and Fitness***
There are additional hazards to do with general health associated with working in the field, accidents and problems with allergies are most common in unfamiliar environments. The following should be used as a guideline.

| Hazard | Risk | Control Measures | |
|---|---|---|---|
| *Health* – **Accidents** | **Risk of injury** | • For joint projects in remote areas ensure that one of the fieldwork team is trained in First Aid, and carry a First Aid kit<br>• Be aware of where medical Supplies or treatment can be bought or received if there is an accident<br>• Have plans of action and be aware of where help can be sought should an accident occur in a remote location.<br>• *Remember that it is essential to fill out an accident report and return it to the Departmental Safety Officer on return. It may help to make notes as soon after the incident as is possible.* | |
| *Health* - **Medical Conditions and General Fitness** | **Risk of illness whilst in the field** | • Ensure any necessary medication is carried at all times<br>• Ensure someone else is aware of the medical conditions and will recognise signs and symptoms. They should also be informed of the location of medication.<br>• Diabetics should ensure sufficient food is carried in case there is a delay in returning. | |
| | **Fatigue lack of concentration, accidents and risk of injury** | • Do not try to do too much in one day, especially if the work is to be followed by a long drive home<br>• Lack of sleep can lead to accidents - ensure sufficient rest is taken. | |
| | **Lack of Physical Fitness leading to risk of personal injury/illness** | • Know your limitations - do not be forced to over-stretch your limit.<br>• Do not be afraid to tell someone if you feel unwell or cannot carry on with a task.<br>• Plan your work within your limits.<br>• If you feel unwell - stop. | X<br>X<br>X |
| *Health* – **Allergies** | **Inset bites and some plant material may cause allergic reactions -** | • If aware of an allergy, carry any necessary medication. Be aware that some forms of anti-histamine can cause drowsiness. If affected do not continue with fieldwork.<br>• Be cautious of the first signs of allergic reaction and DO NOT ignore them.<br>• Seek medical attention immediately for suspected anaphylactic shock. | |
| | **Alcohol** - dehydration; inability to work | • Avoid drinking excessive amounts of alcohol on the evening before going into the field.<br>• Avoid drinking alcohol during fieldwork<br>• Be aware that alcohol can impair judgement and will remain in the system for several hours after consumption. | |
| | **Miscellaneous Risks** -Food poisoning, dehydration, allergies | • In remote/overseas locations - Be wary of accepting ice in drinks.<br>• In remote/overseas locations be careful of eating food prepared by other people - particularly meats or fish and salads.<br>• Try not to drink contaminated water<br>• Caffeinated drinks (coffee, Cola etc.) can enhance dehydration - avoid drinking them in hot weather<br>• Be cautious of the first signs of allergic reaction and DO NOT ignore them. | |

**Project Details**

**Name(s) of Researcher(s):** Luisa Amann

**Title of Project**: The Relationship between Spatial Configuration, Movement and Social Interaction of Residents with Dementia in Long-Term Care Settings: Investigating three Case Studies in Germany

**Brief description of work to be undertaken:**
**Working method, location, plan of dates and travel or arrangements. Research questions/focus/aims.**

Ethnographic observations (staff and resident space occupancy, movement and interaction) will be conducted in three German dementia care centres (two days each). These will be taking place during normal working hours and not interrupt normal care activities (unobtrusive and anonymous). I will document patterns of space use by drawing into printed floorplans of the buildings that I carry with me.

Observations will be conducted between July 24th and August 4th.
Consent forms are undertaken and completed beforehand.

I hereby confirm that I have undertaken a full review of the locations and circumstances for conducting the field work. I have visited each care home in advance of the observations, met with the care personnel and building estate director.

Sites:
Caritas Altenheim Marienstift Dachau (address: Schillerstraße 40, 85221 Dachau, Germany)
Caritas Altenheim St. Anna Haus (address: Krankenhausstraße 10, 83607 Holzkirchen, Germany)
Kompetenzzentrum Demenz (address: Landsbergerstraße 367, 80687 Munich, Germany)

**Declaration:**

**We have reviewed and assessed the possible hazards that might arise from the work planned for the project detailed above. All persons carrying out this work declare that they have read, understood and agree to abide by the safety instructions and control measures in the generic risk assessment. This assessment will be reviewed if there is a significant change to the project, and annually for projects of over one year's duration. A full project specific risk assessment will be carried out if the project extends beyond this generic risk assessment.**

Supervisor signature and statement of support:

I have reviewed Luisa's research plan. Care homes are relatively benign environments with high levels of staff supervision in all spaces. Luisa has the institutions' agreement to conduct her ethnographic observations. She will be conducting these in three buildings for two days each during working hours. Her review of potential risks is thorough, and her contingency plans are clear. I fully support the work which is important and likely to lead to a contribution to knowledge about how to design for old age and dementia.

Date: 11 July 2023 Alan Penn