

## **Spatial Opportunity Structures for Resilient Social Networks – The Role of Architectural and Urban Form**

Kerstin Sailer and Xiaoming Li, The Bartlett School of Architecture, UCL

### **Abstract**

In this chapter we bring together research from the domains of social networks, resilience and spatial morphology to argue that the built environment is an often overlooked but increasingly recognised vector influencing the formation of ties in social networks. We define space on different scales – the urban and interior – as opportunity structures supporting or undermining network resilience, i.e., the way in which access to resources is enabled. A literature review identified five different spatial mechanisms with the power to inhibit resilience in social networks: proximity, correspondence, severance, access inequality and uniformity. Finally, we present empirical work that conceptualizes urban and architectural opportunity structures for the elderly in care homes in Nanjing, China. We close with a research agenda on socio-spatial resilience.

### **How to Cite**

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## Introduction

Social resilience and how it relates to network structures is an emerging field of research, drawing on the idea that in order to cope with, adapt to and transform society, actors rely on social capital (Keck & Sakdapolrak, 2013). Social resilience is also a topic in flux, and one, according to Keck and Sakdapolrak that requires taking context, feedback and connectedness of actors into account as they are embedded in wider environmental conditions. The context of tie formation has been defined in many ways over the decades – as social, organizational or spatial context.

Here we will consider context explicitly as the structural characteristics of architectural and urban form, i.e., the physical layout on an interior micro-scale, but also the larger morphology of whole cities or regions drawing on the network theory of space syntax (Hillier & Hanson, 1984). Space matters for social resilience as human actions are always embedded in a spatial situation. Considering the role of spatial structure in tie formation can look back on a long research tradition, going back to the 1950s Hawthorne bank wiring room studies (Doreian & Conti, 2012) and social relations between apartment inhabitants in a housing block (Festinger, Schachter, & Back, 1950).

Thus, bringing social networks, resilience, and spatial structure together, this chapter will proceed by asking whose access to which resources a resilient social network needs to balance. Then architectural and urban form will be discussed as two distinctive opportunity structures, initially leading to co-presence and interaction among actors, and consequentially to a series of desirable outcomes including health, welfare, cohesion, equality and innovation. Five spatial mechanisms inhibiting resilience in social networks will be identified. A case study of elderly care homes in Nanjing, China will exemplify the potential of architectural and urban form. Finally, the chapter closes with a research agenda sketching future directions for a socio-spatial understanding of resilience.

## Social Resilience – Whose Access to Which Resources?

In addition to the above-mentioned resilience definition focusing on coping, adaptation and transformation capacity, this chapter also draws on a more technical perspective of network resilience. Newman (2018) argued that a resilient network is one that does not break down as a whole when individual nodes fail, a process known as percolation. The internet is one example of such a resilient network, where a few non-functional routers do not jeopardize the overall performance of the network, i.e., the general accessibility of services. This is easily transferrable to social networks, for example considering an organizational network maintaining communication flow during high staff turnover (Krackhardt & Brass, 1994).

Newman used two opposing ideas of resiliency outcomes: firstly, a case in which resilience means unimpeded network flow and human actors retaining access to resources, as in the example of the internet or organizational network; and a second case, where resilience means that network flow is impeded, for example the epidemiological spread of a virus is contained. These two ideas of a resilient network, one which allows desirable flow and one which inhibits detrimental flow allows raising

the question who has access to what resources based on spatial conditions; and which outcomes might emerge from a specific network structure.

In a social context, desirable or detrimental flows are never fixed categories. What might be desirable for an individual is not necessarily beneficial to society as a whole and vice versa. In addition, the stability of a tie also varies in its desirability. The Covid-19 pandemic gives ample illustration, for example reducing personal contacts, i.e., severing ties might be painful for an individual yet desirable in order to protect public health (Stoddard et al., 2021).

## **Architectural and Urban Form as Opportunity Structures**

The geographer Edward Soja exemplified in his take on spatial justice how opportunities are unequally distributed in space:

*“Location in space will always have attached to it some degree of relative advantage or disadvantage. Some of this geographical differentiation will be of little consequence, but in other cases it can have deeply oppressive and exploitative effects, especially when maintained over long periods of time and rooted in persistent divisions in society such as those based on race, class, and gender.”* (Soja, 2010, p. 73)

Inequalities do not just happen in space; they are built into spatial forms. Spatial structures give rise to or constrain opportunities for access to (social) resources by mediating co-presence between actors, or in other words by the ability of space to bring people together or keep them apart (Hillier & Hanson, 1984). Co-present people were argued to act as raw material for community formation, a so called virtual community, which can be activated if needed (Hillier, 1996). Not every co-presence leads to interaction, let alone the formation of a relationship, as eloquently argued in the case of required conditions for community building in neighbourhoods (Völker, Flap, & Lindenberg, 2006). Still, fleeting encounters and acquaintances can play a significant role in allowing actors to activate resources following the strength of weak ties argument (Granovetter, 1973).

On the urban and architectural scale two different processes allow turning co-presence into interactions and resource-rich relations.

Cities can be seen as contact generating mechanisms, enabling meetings between strangers, where the culture of the street allows a peaceful co-existence of diverse and dense city populations (Hillier, 2009). In this sense, cities are ‘movement economies’ (Hillier, 1996), where the configuration of the urban grid distributes movement flows and creates encounter patterns and economic activity as its by-product. Centrally integrated spaces typically attract higher movement and encounter rates (Hillier, Penn, Hanson, Grajewski, & Xu, 1993), thus giving human actors access to more and potentially more diverse resources. On the other side of the coin, segregated space does not necessarily mean deprivation, as self-segregation by choice (for example in privileged gated communities) can provide pockets of similarity (Vaughan, 2018) and ample opportunities to activate social capital to resource-rich others to achieve goals.

Still, encounter does not equal a meaningful relation. The fleeting relations between strangers are of course very different from personal knowing and primary relationships, but the world is not just split into kin and close friends on the one hand, and strangers on the other. Humans know others in a variety of in-between ways, for example categorically by appearance or location. Through transitory sociability and repeated encounters (e.g. at the school gate, in local shops, etc.) strangers can turn into quasi-primary and intimate secondary relations that become emotionally charged (Lofland, 1973, 1998).

In contrast, interior space is less about encountering strangers in the first place due to the access control that buildings provide. Instead, architecture operates as a system of interfaces, orchestrating encounter patterns between both inhabitants of a building, those with social control and access rights, but also visitors with only temporary rights (Hillier & Hanson, 1984). Repeated habitual encounters and shared goals among building users particularly in buildings for work (offices, schools, hospitals, etc.) contribute to meaningful relationship formation; among other factors those arise from spatial opportunities of seeing and being seen or overlapping paths of movement and are thus 'built' into the physical fabric of architectural space.

The following section will take the concept of spatial opportunities further by focusing on concrete examples of resilience in social networks, linked to desirable outcomes.

## **Spaces, Social Networks, Resilience**

The three research fields of spatial structures, social networks and social resilience have to date flourished in rather distinct discourses.

The overlap between social networks and resilience is comprehensively represented in this book. Research bringing social networks and spatial structures together has grown over the last decades with three dedicated special issues in journals (adams, Faust, & Lovasi, 2012; De Benedictis, Vitale, & Wasserman, 2015; Ye & Liu, 2018) providing an overview of the field. Resilience of communities in relation to spatial features is equally emerging as a topic of interest, yet only very few studies address all three domains. A systematic review is also complicated by the fact that keywords such as resilience are not always used explicitly. Therefore, the state of the art sketched below does not claim any completeness.

Instead, we selected exemplary studies in order to highlight spatial mechanisms that inhibit resilience in social networks. We follow the example of a recent review on the effect of space on tie formation (Small & Adler, 2019), which highlighted features of physical space to structure the argument. Our review identified five mechanisms:

- Proximity
- Correspondence
- Access inequality
- Severance
- Uniformity.

## *Proximity*

Actors finding themselves in close proximity to others is the most straight forward and commonly studied factor in this field. Proximity is often also conceptualized in its opposite form as distance effects.

It might seem counterintuitive at first to think of proximity as an inhibitor to resilience, as the literature mostly associates proximity with opportunities for encounter and social network mobilization. Applying Newman's second case of detrimental network flow, proximity is a vector on both the urban and architectural scale that can propagate epidemiological spread.

Two studies exemplify this. On the urban scale, it was suggested that the spread of Covid-19 can be contained by using social networks related distancing strategies (Block et al., 2020). It was argued that society would be better able to cope with Covid by 'flattening the curve' of infections. Rather than applying a blanket reduction of all contacts different strategies were modelled based on 1) similarity such as geographic closeness or homophily; 2) triads and repeated contacts; or 3) communities. All three strategies were more effective in lowering infection risks than random or no contact reduction while allowing for the mitigation of the negative impact of social isolation associated with full lockdown, thus considering the health and wellbeing of society at large.

A similar argument was presented on the architectural scale before the Covid-19 pandemic focusing on the potential epidemic spread of acute respiratory diseases in workplaces (e.g., influenza). It was shown that research group membership, role, and shared projects were strongly predictive of contact patterns and that contact probability decreased with distance (Potter, Smieszek, & Sailer, 2015). Resilience was not explicitly mentioned, but evident in lower transmission risks and smaller outbreaks associated with the actual network including spatial distances compared to a random mixing model. This has implications for staff health but also for organizational continuity and productivity.

In this sense, distance can support social resilience while proximity can undermine it.

## *Correspondence*

Correspondence means a structural overlap between spatial closeness and homophily i.e., spatially close communities that also share other attributes (such as gender, ethnicity, background, preferences, etc) would be called correspondent (Hillier & Hanson, 1984)<sup>i</sup>. Therefore, it is a different form of distance measure, overlaid with a second strata of social similarity.

While non-correspondence has been termed a 'social insurance policy' (Peponis, 2001) that provides cohesion by bringing disparate groups of people together spatially, or bridging spatial distance by homophily, correspondence could be argued to inhibit social

resilience, especially in cases where inequalities of access on one level are exacerbated on another.

A pertinent example is provided on the urban scale in a study of Stockholm, where ethnic minorities were found clustered in outer suburbs (Rokem & Vaughan, 2019). The fragmented nature of the suburban fabric deprived these communities of opportunities to interact with mainstream society in the wider public space including transport. It was argued this might impact the building of trust and could result in deprivation and inequalities over time.

An architectural level application of correspondence investigated the degree to which staff in one team have opportunities to encounter staff in other teams based on seating plans and office layouts (Sailer & Thomas, 2019). Cases with high levels of correspondence created team silos, hindering organizational growth and innovative capacity.

These approaches highlight how social resilience can be undermined by correspondent structures.

### *Access inequality*

Another form of distance measure, access inequality describes spatial structures that deprive actors of access to resource rich centres within a spatial network<sup>ii</sup>. It is therefore related to Newman's first case of a desirable network flow being impeded.

On the urban scale, it was found that more deprived areas were less spatially central and accessible, and over the course of time this form of poverty was argued to 'stick' (Vaughan, Chatford Clark, Sahbaz, & Haklay, 2005). In a similar vein, overlapping network centralities on different urban scales from the local neighbourhood to larger agglomerations were found to provide resilient spatial morphologies by creating movement interfaces between locals and strangers over time (Vaughan, Dhanani, & Griffiths, 2013). Spatial network centrality was also shown to predict walkability in London to 92% accuracy if modelled alongside access to travel hubs, population density and land use diversity and intensity (Dhanani, Tarkhanyan, & Vaughan, 2017). Walkability is a crucial factor in population health and increasingly studied as an important variable in urban design. What these studies highlight is the fact that easy access to central places in a spatial network can be associated with social resilience, and the mobilization of social resources, but also positive outcomes of social welfare and health.

Access inequality is less pertinent on the architectural scale, possibly due to the fact that these are smaller spatial systems where differences in access or spatial centrality can be more easily overcome and have less impact on persistent inequalities.

## *Severance*

Severance refers to physical barriers in spatial network connections, which can be natural (mountains, rivers) but also man-made (railways, heavy traffic lanes, different floors in a building). Community severance has been argued to diminish social contacts and affect social networks (Mindell & Karlsen, 2012).

In a large comparative urban study in the US, it was found that cities segregated by railroads show persistent racial segregation and socio-economic inequality (Ananat, 2011). Adding a social network lens to the work of Ananat, a study of small towns in Hungary confirmed that geographical barriers reinforced the segregation of social networks, which lead to rising socio-economic inequalities over time (Tóth et al., 2021). In addition to looking at whole cities comparatively, smaller scale severance within urban structures for example through heavy traffic reduced walkability and active travel (Vaughan, Anciaes, & Mindell, 2020), highlighting again the link to health outcomes.

Severance on the architectural scale can be found in the split of organizations across different office floors. In a seminal study it was shown that workplace communication networks were severed with changes in floor on a dyadic level (Allen & Fustfeld, 1975). Further explorations of staff networks in 16 offices using E-I index calculations showed that 78% of face-to-face interaction remained within a floor, resulting in fragmented organizational networks (Sailer, Pomeroy, & Haslem, 2015). This builds on the previously discussed research on correspondence and team silos, which were argued to limit the innovative capacity of organizations. More generally speaking, disruptions in interaction networks due to severance reflects shrunk opportunity structures and points towards inhibitions to an organization's resilience to enable crucial access to information and social capital.

## *Uniformity*

Uniformity highlights sameness in the provision of facilities or points of interest, as well as inequality in their distribution.

No studies were found on the architectural scale regarding uniformity. On the urban scale, high street diversity was considered a contributing factor to adaptability and thus the persistent vitality of town centres to support diverse forms of sociability (Griffiths, Vaughan, Haklay, & Jones, 2008). The study of Hungarian small towns already mentioned found that the spatial concentration of points of interest (such as cafés, cinemas, restaurants, pharmacies, etc.) was associated with social network fragmentation, which in turn related to socio-economic disadvantage and inequalities over time (Tóth et al., 2021).

Therefore, uniformity and distributional inequalities in the provision of points of interest can act as an impediment to social network resilience, depriving certain communities of resources and opportunities to mobilize social capital.

### *Social network resilience and spatial structure*

In summary, the above brief literature review sketched ways in which spatial structures inhibit social resilience, mediated by co-presence, encounter probabilities and opportunities for social capital mobilization. The five spatial features (proximity, correspondence, severance, access inequality, uniformity) were shown to undermine the ability of social networks to cope and adapt, leading to detrimental outcomes for health and welfare, but also economic prosperity at different scales.

The argument presented allows redefining social network resilience as spatially influenced following Newman's argument that resilience is derived from network structure – not just a social network structure but also the spatial network structure in which social networks find themselves embedded in. Conceptually, the resilience of interconnected social-ecological systems is closely related (see Barnes in this book).

How exactly this socio-spatial structuring of resilient networks comes into play will be explored further in a concrete example of care homes for the elderly in China.

## **Spaces for an Ageing Society**

Societal ageing has been recognized as a crucial issue, for example in Europe, but also in Asia with countries like Japan, South Korea and China affected according to the World Economic Forum<sup>iii</sup>.

Ageing has significant effects on social networks (see Ellwardt in this book), e.g., through retirement, illness and death-related network shrinkage which can result in loneliness and depression (Domènech-Abella et al., 2017; Glass, De Leon, Bassuk, & Berkman, 2006).

Ageing also has clear spatial implications, not just in the provision of care homes, and their architectural design, but also in how and where they are embedded within the urban fabric. The concept and policy of 'ageing in place' (Iecovich, 2014) is meant to support active healthy life in the community. This local community is crucial for the elderly. Older people are often less mobile with reduced distance ranges available and impaired spatial cognition; therefore, they are increasingly dependent on the immediate physical spaces they are surrounded by. Spending the majority of their time in the care home renders its architecture of utmost importance to inhabitants' abilities to connect with others in person. The immediate urban environment and what it offers in terms of surrounding facilities and points of interest, but also in its ease to be visited comes into play.

The high relevance of socio-spatial structures for the everyday life of the elderly makes it an ideal topic to study in this context.

## **Elderly Care Homes in Nanjing, China**

Nanjing is the capital city of one of the 'oldest' provinces in China with 23% of people aged 60 and over in 2017 (Jiangsu\_Provincial\_Government, 2018). We present a case study of all 147 care homes in Nanjing where we analyze their urban opportunity



structures. We also exemplify architectural opportunity structures for three selected cases with floor plan availability.

### *Urban Opportunity Structures*

We conceptualize urban opportunities as the accessibility potential arising from two related but distinct factors: 1) Ease of access within walkable distance for points of interest, measured as the number of amenities available within the immediate (<250m, straight line), ambient (<250m, 1-2 turns at street corner) and peripheral environment (250-500m, or 3+ turns) of care homes; using both distances as well as turns takes both physical and cognitive abilities of care home inhabitants into account. 2) Spatial network centrality of a care home location, measured as closeness and betweenness centrality of the street segment of the entrance within the spatial network using six distance thresholds of 250m, 500m, 800m, 1000m, 3000m and 5000m (for more details see: Li & Sailer, 2021); these serve as predictor for the intensity of movement flows in line with extant space syntax theory.

A principal component and k-means cluster analysis identified five distinct types of amenity access: strong (n=10), close (n=24), good (n=30), and weak access (n=18) as well as isolated cases (n=65).

The same approach found five distinct categories of network centrality: spatially integrated (n=22), globally isolated (n=31), globally integrated (n=10), locally integrated (n=56), and spatially isolated facilities (n=28).

Overlapping those two potential structures, amenity access and network centrality (see figure 1) draws a complex picture of access inequality. A total of 17 care homes are both distant from amenities and spatially isolated. This means inhabitants will be deprived of opportunities to go out and connect with other people but are also less likely to be visited due to the segregated location of the care home. The opposite case of a highly central care home embedded in a rich network of surrounding amenities applies to only five care homes in the sample. Inhabitants in these homes are more easily connected to vibrant urban life and are hypothesized to enjoy better opportunities to maintain ties within the community. The remaining large bulk of care homes (n=125) find themselves in a mixed situation with varying opportunities available to inhabitants.

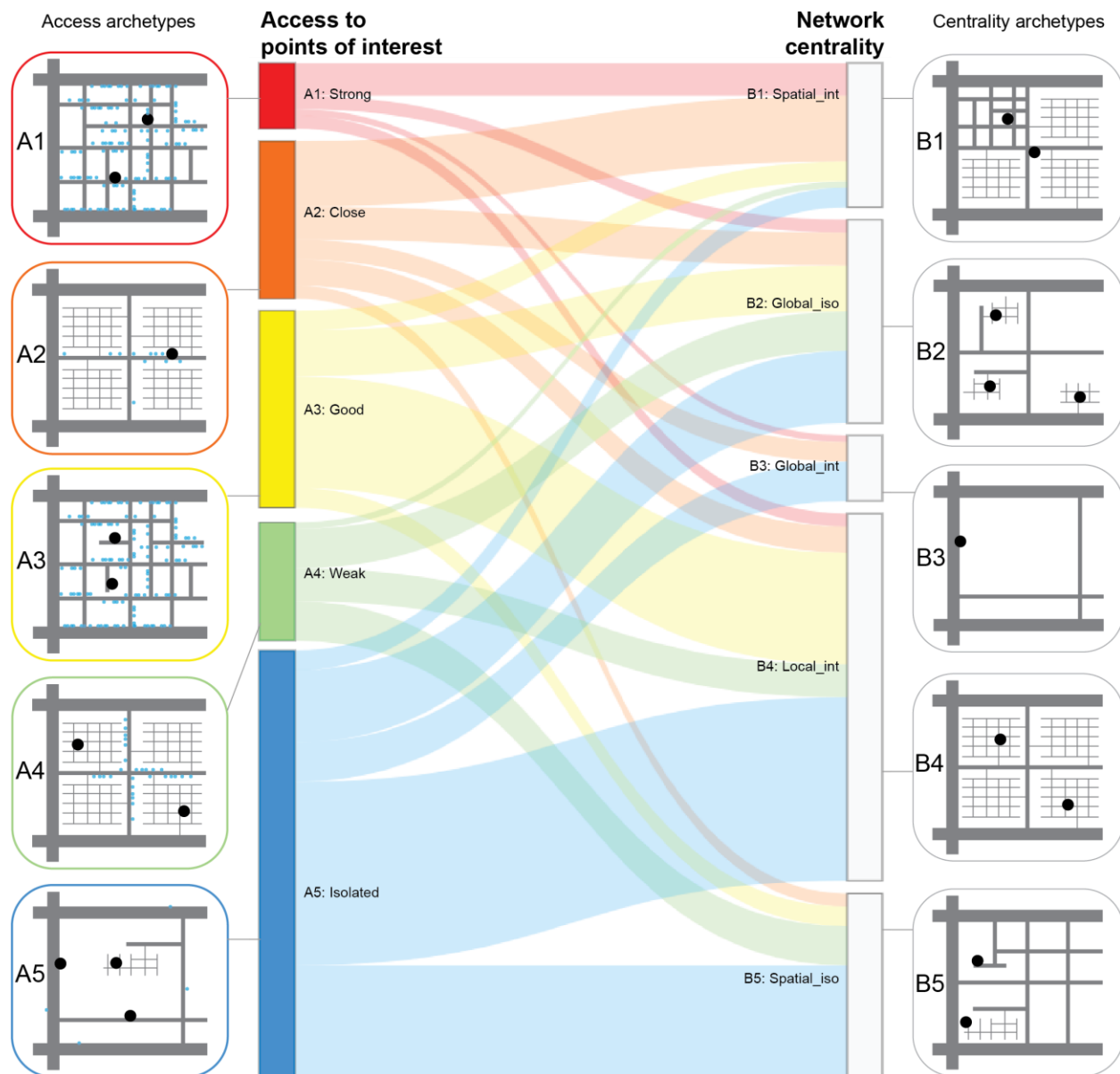


Figure 1: Overlapping opportunity structures arising from both points of interest (left) and spatial network structures (right)

### *Architectural Opportunity Structures*

Differential opportunities for sociability also emanate from the detailed interior floor plan layout of care homes. Three factors are worth mentioning.

Firstly, contact among inhabitants derives from the arrangement of beds, which serve as main private area and elementary carriers of elderly people's everyday live. Figure 2 shows the layout of three different homes A, B and C alongside the intervisibility network between beds, highlighting distinctive solidarities emerging in clusters and dyads, where the presence of others can potentially act as stimuli for interaction or leading to overloading and withdrawal. It is easy to imagine how occupying one bed

versus another or living in one care home versus another would result in different opportunities and constraints to connect with others.

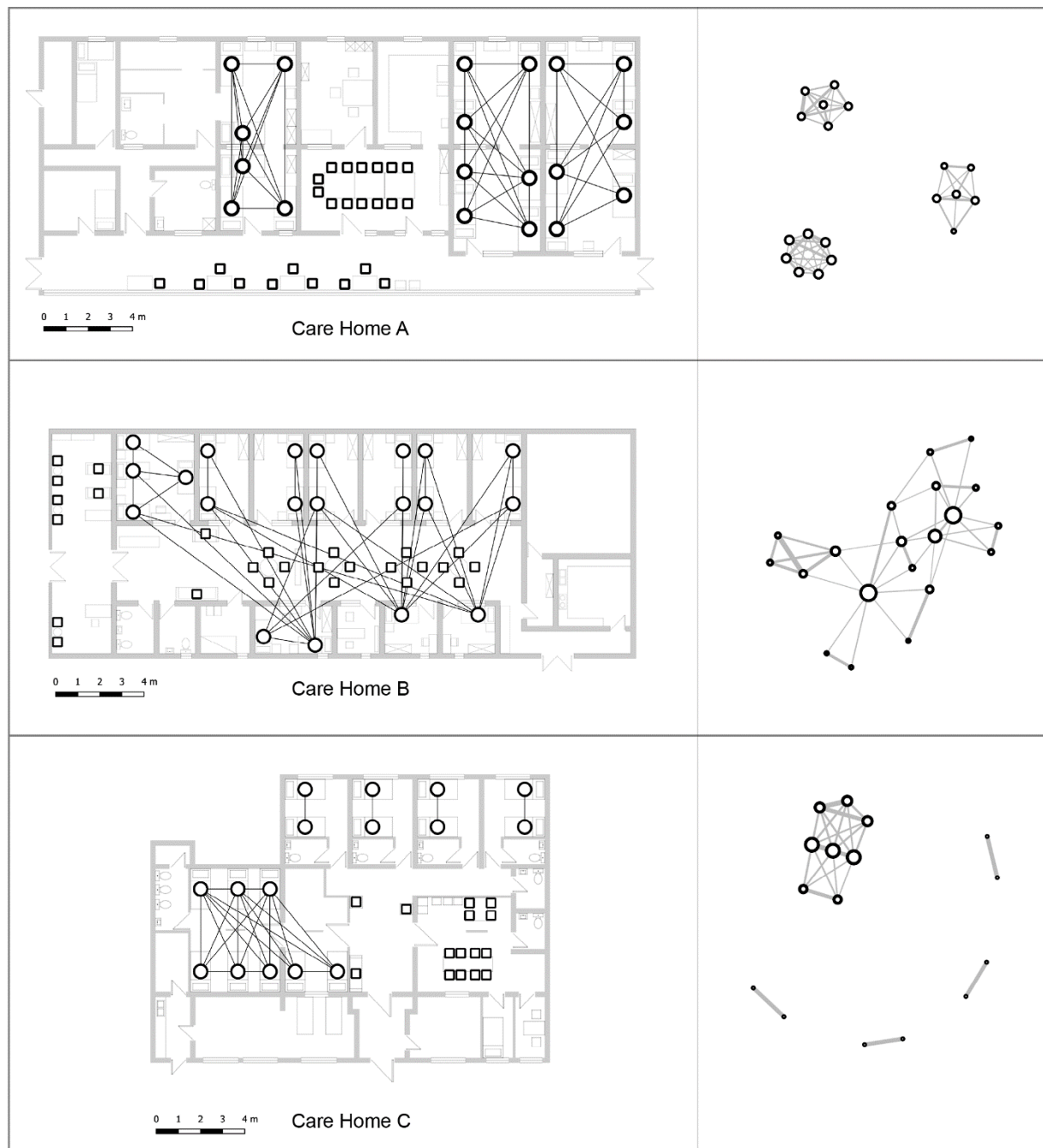
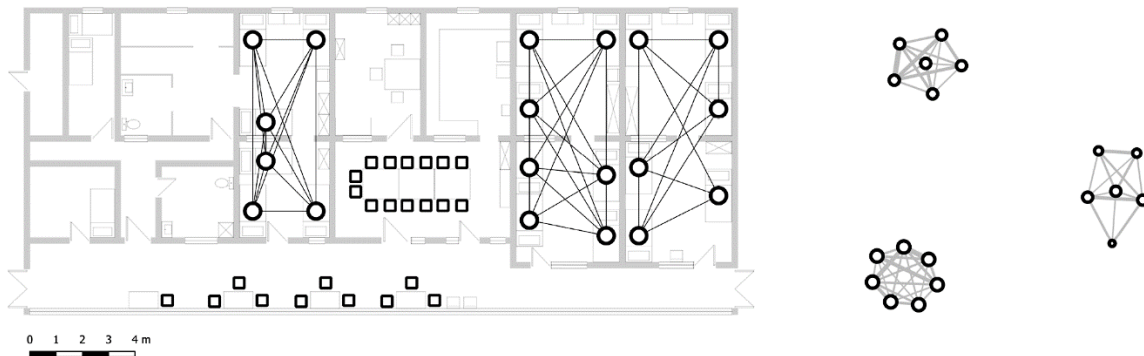


Figure 2: Differentiated visual connections and network structures in the bed-to-bed network of three different care homes.

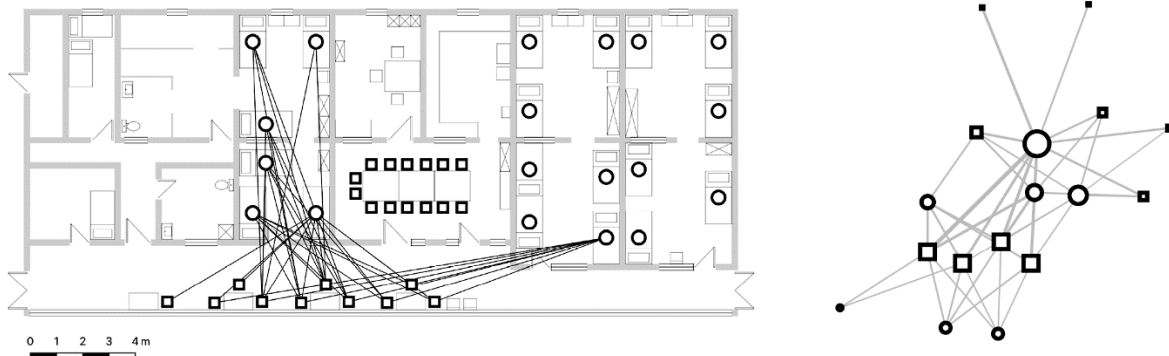
Secondly, in addition to the bed-to-bed network giving rise to inhabitant solidarities, the interfaces between inhabitants and visitors emerging from the relational positioning of

beds and public seats, but also the visitor-visitor interface (seat to seat) influence the way in which interior layouts enable or constrain sociability. Care homes in China tend to offer a variety of community related services to visitors, e.g., catering, entertainment, and training, hence all of these three interfaces are relevant, as illustrated in figure 3 for Care Home A as an exemplar. Again, a differential picture presents itself depending on the allocation of beds and the frequentation of seats.

**A** Bed to bed relations in Care Home A



**B** Bed to seat relations in Care Home A



**C** Seat to seat relations in Care Home A

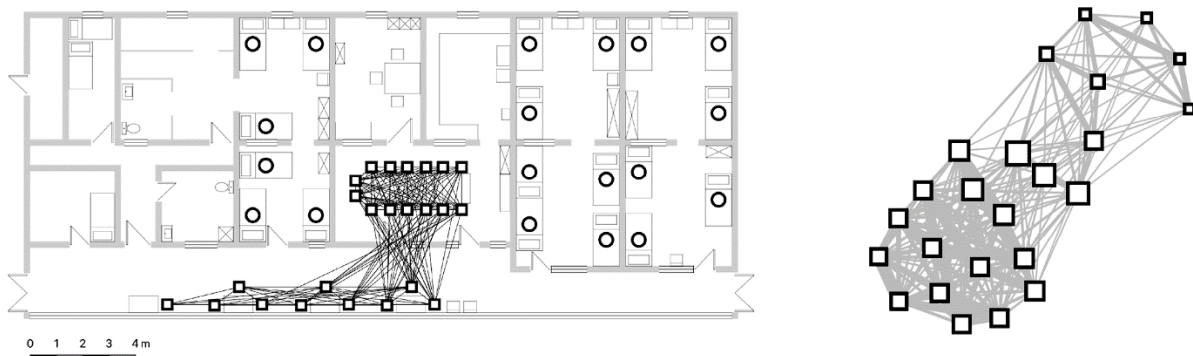


Figure 3: Differentiated visual connections and network structures in the bed-to-bed (A), bed-to-seat (B) and seat-to-seat networks (C) of Care Home A.

Thirdly, people resting on beds or seats are exposed to movement flows of others passing by within the space. Figure 4 illustrates which opportunities for sociability are available in Care Home A as a bed or seat can visually access certain viewsheds immediately. Following the work of Ossmann et al. (2019) not just the size of viewsheds matter, but also qualities of the visible areas, whether they are exposed or hidden, hence potentially more busy or quiet. Bed A for instance can not only see a large area, but this area is also likely busier and more easily accessible than for bed B. Likewise, seat B is exposed immediately to a potentially much busier area of the plan.

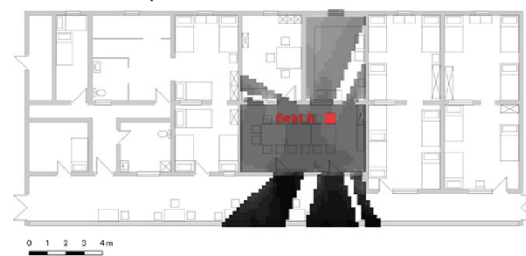
**A** Local visibility graph exemplifying exposure



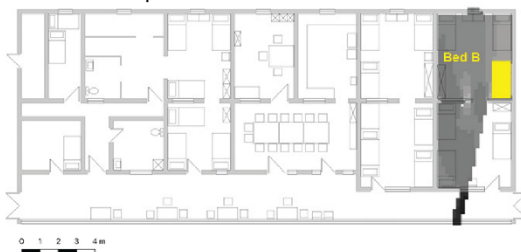
**B** Visual exposure of bed A



**D** Visual exposure of seat A



**C** Visual exposure of bed B



**E** Visual exposure of seat B



Figure 4: From overall exposure (A) embedded in the layout of Care Home A to localised degrees of exposure for two single beds (B, C) and two seats (D, E).

### *Learning from Care Homes: Socio-spatial Resilience*

The analysis of Nanjing care homes shows how the spatial structure both on the urban and architectural scale offers a variety of opportunities to build, maintain and extend social networks for the elderly. Being deprived of opportunities to encounter others may also mean being deprived of building meaningful everyday relations, resulting in an increased risk of loneliness. In this way, the Care Homes analysis showcases how the two spatial mechanisms of access inequality and uniformity of amenity distribution might undermine the social resilience of elderly people.<sup>iv</sup>

## **Future Challenges and Research Agenda**

Many scholars agree that space matters for social relations. However, we are only at the beginning of uncovering the detailed mechanisms of how spatial structures affect social outcomes. A considerable lack of empirical data and rigorously conducted studies impedes our understanding. While the link between spatial structures and patterns of co-presence and encounter are reasonably well understood, how, when and why encounters turn into commitment thus creating meaningful relations including desirable outcomes such as health, prosperity and welfare is less well conceived.

This leads to the following research agenda:

1. Integrate spatial thinking into network studies of social resilience, particularly exploiting the opportunities arising from multi-level and multi-modal social network analysis methods, where spatial characteristics can be included systematically, e.g., teams operating in silos due to office floor severance, or co-presence of people in specific places.
2. Include desirable outcomes into the theorizing and empirical study of the relationship between spatial structures and social relations.
3. Incorporate spatial models across scales, from the architectural to the urban, also covering the intermediary interface of how building activities extend into the urban realm, and vice versa.

The study of spatial antecedents of resilience has important policy implications. Once designed and built, spatial structures are persistent and influence opportunities for decades if not centuries. At the same time, spatial interventions might have unintended consequences. This leads to a final research agenda point:

4. Run intervention studies tracking the impact of deliberate spatial design interventions on social network structures over time.

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## Notes

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<sup>i</sup> The authors did not refer to homophily explicitly, but rather to conceptual closeness, or 'transpatial' solidarity, i.e., bonding mechanisms that traverse spatial boundaries.

<sup>ii</sup> Network centrality in spatial terms can be thought of as the equivalent of brokerage in a social network.

<sup>iii</sup> Source: <https://www.weforum.org/agenda/2020/02/ageing-global-population/>

<sup>iv</sup> Exploring actual solidarities and network relations among the elderly users of care homes in Nanjing is part of an ongoing research project.