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Co-living for Ageing in Place: Mapping Privacy and Movement in a Long-Term Care Setting

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With a rapidly ageing population, Hong Kong is facing a multitude of challenges in providing suitable housing models for ageing in place. This leads to a high level of institutionalisation and many elders eventually have no choice but move into long-term care facilities long before they need to. The rise of co-living is increasingly seen as an alternative ageing in place model. The study proposes that co-living could also be conceptualised in a long-term care setting in order to transform care environments from institutional to domestic. Privacy, as a key design factor in various living conditions, has been investigated in relation to the movement of older residents in a long-term care setting in Hong Kong. Data were collected through an indoor location-tracking system. The results show three movement patterns — (1) residents regularly withdrew to their bedrooms; (2) residents mostly moved within in short-range distances and (3) residents travelled farthest from their bedroom in late afternoon or early morning – that carry implications for future co-living layout designs.

Keywords: co-living, long-term care facility, privacy, movement

1 TRACK THEME: DESIGN AND PEOPLE

While we are ageing at an historic rate, research has shown that the ageing processes are modifiable and that people are living longer without severe disability (Christensen, K. et al., 2009). The emerging life stage, the third age, is now considered by many to be the "golden years" of adulthood (Barnes, 2011). With increased life experiences, our aspirations for this life stage are undergoing deep transformations. We need a new approach to reflect upon the reality of the traditional 3-stage (education – work – retirement) life cycle. How do we keep healthy? How will we afford to live without income? How will we sustain relationships? (Gratton & Scott, 2016). How then can we use design to help people live better lives? A study by Langdon and Thimbleby (2010) pointed out that inclusive design, an approach that enables designers to relate to the realities of ageing users, has a key role in addressing these changes. In addition, Orpwood et al. (2008) suggested that in order to create a useful design that will support the needs of older adults with dementia, inter-disciplinary knowledge combining the fields of social science, architecture, mechanical engineering, and care and social services is indispensable.

Participatory design researchers have suggested that community engagement is the key to creating designs that bring meaningful experiences. For instance, a study conducted in Portugal indicated that by building relationships with the users, designers could inject

meanings into design (Branco et al., 2016). Dindler and Iversen (2014) suggested that nurturing relationships with the target groups has a critical impact on the design process and should be an object of design also. However, studies suggested that designers need to acquire skills to build relationships with the people they are designing for. Dankl (2017) pointed out that designers are mostly not trained, in comparison to, for example, healthcare professionals, in using a relational approach in the design process. Another study by Hendriks et al. (2018), stated that by learning about the person-cantered care adopted by care professionals, designers too could acquire the relational expertise when designing for and with people who have dementia. That said, Stevens et al. (2016) specified that when working with a single client, architects are familiar with ways to gather information and empathize with the client. Yet, when working with a group of different clients, it becomes more challenging for the designers to empathize with an abstract and undefined client. The study suggested that by engaging the users as a narrator, architects could overcome this obstacle.

This study proposes that, in the context of spatial design, indoor location-tracking technology offers a subtle and embedded method to engage the users. Although not a relational approach, ubiquitous data also has the potential to reveal how the elderly residents move and live. The system recorded the movement data of 50 residents in a field study for 31 days for analyses. The research sees digital technology as an alternative component in the co-design process in enabling designers to gather deeper insights and engage the participants in a more profound way.

2 RESEARCH FOCUS

Co-living is envisioned as an emerging housing model that could bridge the gap between domestic and institutional settings and support older adults to age in place. To facilitate the development of co-living spaces in Asia, the study aspires to understand the social behaviours of older adults in a shared living environment through a field study using indoor location-tracking technology. The focus of this research is to explain the residents' movement patterns through the spaces in a care facility in relation to their needs for privacy and social interaction.

2.1 Ageing in place

As the older population continues to grow, it is critically important to consider where and how older adults will live (Bookman, 2008). Many older adults want to 'stay put' in their homes as they age. These experiences have been found to have significant effects on older adults' physical, cognitive, and social wellbeing (Burton et al., 2011), as well as supporting feelings of inclusion, security, dignity, identity, and choice (Chui, 2008; Wiles et al., 2012).

However, to support ageing adults to age in place, Hong Kong still has a number of hurdles to overcome. There are currently over 150,000 older people who live alone in domestic settings (13% of total ageing population) and over 94,000 elders (8.1%) live in long-term care facilities or non-domestic environments (Hong Kong Population Census, 2016). The wide gap in housing quality between the domestic and institutional settings, referred as "the slippery slope" by Sullivan (1998) is still valid in the situation in Hong Kong today. Figure 1 illustrates the current that there are limited options of housing units provided for the seniors in Hong Kong. What is a cause for concern is that institutionalized environments, especially those that are privately run, vary greatly in standards and quality of services (Chui, 2011).

Private facilities are commonly regarded as “dire”, even with the government’s recent proposal to tighten the regulations (Chiu, 2019a). However, with the long waiting list to a subsidised care home, many elders have no choice but turn to private facilities which are not subsidised (Chiu, 2019a). As reported by Social Welfare Department (2019), there are currently around 42,000 elders living in private nursing homes. A study on infection control in residential care homes indicated that the service in private homes are variable because they are only required to meet the minimum statutory standards (Wong et. al, 2019). Another news article reported that some rooms in private facilities are as small as 32 square feet in size, failing to meet the existing already-low requirement of 70 square feet (Chiu, 2019b).

Figure 1. The “slippery slope” is a gap where a diverse range of housing prototypes is needed (“star” represents shared units that are being phased out by government agencies).

Therefore, there is an urgent need for more attractive and inclusive housing options for a diverse group of third age adults who are single, widowed, empty nesters, downsizers, etc. (Battersby and Nicholson, 2014). In between the domestic and institutional settings, authorities in Hong Kong had resorted to some forms of communal living units. However, these initiatives did not deliver satisfactory results. These units are being phased out due to the low occupancy and high level of conflicts. Non-profit organizations have also introduced a number of housing schemes in hope to support the vision of ageing in place but were reported to face challenges of financial viability (Sing Tao Daily, 2014). With the gradual elimination of these specialized housing, elderly people will more likely end up living in a long-term care setting, even when they may not need to. Figure 2 indicates the different degrees of ownership older adults have in the available senior housing.

	Independent Living			The "slippery slope"		Institutionalized Setting		
	1 Public / Private Housing	2 ★ Shared / Subdivided Housing	3 Senior Housing 1	4 Senior Housing 2	5 ★ Elderly Hostel	6 Home for the Aged	7 Care and Attention Home	8 Nursing Home
Bedroom	Private	Private	Private	Private	Shared	Shared	Shared	Shared
Kitchen	Private	Shared	Private	Private	Shared	None	None	None
Bathroom	Private	Shared	Private	Private	Shared	Shared	Shared	Shared
Dining	Private	None	Private	Private	Shared	Shared	Shared	Shared
Living	Private	None	Private	Private	None	None	None	None
Communal	None	None	Shared	Shared	None	None	None	None

Figure 2. The degree of ownership that older adults have in the existing housing units ("star" represents shared units that are being phased out by government agencies).

2.2 Co-living as a new housing model

According to recent studies, a number of concepts towards elderly living have pointed to the importance of community living or co-living. As Rioux (2010) observed, some older adults choose to move into a residential care home at their own will, even without major health issues. The well-known architect, Matthias Hollwich advocated co-living as a key product for ageing in place (Frearson, 2017). The re-emergence of co-housing in Europe and the United States is seen to contribute to a sense of community (Cooper Markus, 2000) and encourages social interaction (Williams, 2005). In Asia, co-living is also embraced by Japan, who has abandoned the approach of building more long-term care facilities (Lee, 2018) and redirected its focus to "housing with services". These developments often adopt the model of intergenerational co-living, from households in Nagoya (Zhan, 2017) to the health- and work-integrated senior housing complex in Kashiwa (Urban Renaissance Agency, 2014). However, shared housing remains a major setback in Hong Kong. Reports on violent conflicts were common in the public housing units for seniors where bathroom and kitchen were shared. The recent promotion of "co-living" developments has also been hotly debated as repackaging the illegal subdivided units as "luxury apartments" (LinePost.hk, 2018). It would require a new housing model for ageing in place to happen in the form of co-living in Hong Kong.

It is therefore important to fully understand the behavioural patterns of older adults in a shared living environment. By getting a better understanding on the behavioural patterns of the older adults in a shared living environment, we can further identify the reasons behind these behavioural patterns and develop motivation methods to alter the behaviours of the older adults to a more advantageous situation. Intrinsic and extrinsic motivations are the two important factors that drive the attitudes of older adults whether they are willing to accept, to adopt, to be active, and to put into action in daily living (Dacey et al, 2008). The self-determination theory is the research theory that puts design into factors that motivate intrinsically the mind of old adults into the first step of experience. Competence, autonomy and relatedness are the major design research parameters that could bring the concept of motivation into older adults, extract meaningful experience in co-living, and, essentially, the adoption of the living patterns and behaviours. The satisfaction comes from physical level of

safety and belonging, and then seek progressively higher in esteem and self-actualization (Thielke et al, 2011). It is also important to understand and consistently maintain the expectation of needs, which accumulate and becomes the personal living pattern of each individual older adult. By providing suitable “opportunity”, “encouragement” and “reward”, the living behaviours of the older adults in the scenario of co-living can be further shaped and designed.

The research chose a long-term care home in Hong Kong as a form of a co-living environment to investigate the residents’ movement patterns. Using indoor location-tracking technology, the study collected the location and time duration data on the study site for a period of 31 days. Altman’s privacy typology was adopted to explain how the design of the privacy affected the residents’ movements, which in turn shaped the territories for activities.

3 CONCEPTUAL FRAMEWORK

The aim of the study was to establish the connection between the design of privacy and residents’ movement patterns in a care facility setting. To achieve the goal, the research asked the following questions: (1) What privacy settings can be identified in a long-term care facility? (2) How does privacy affect the movement of the residents in relation to personal territories?

The research focuses on the investigation of privacy in relation to movement patterns. Privacy, often overlooked in many institutions for the ageing, is the subject of study. According to literature, by allowing adequate privacy, people are more likely to have control over space, i.e., territory and hence participate in activities (Proshansky et al., 1970). Altman’s privacy model (1975) suggested that privacy as a boundary regulation process where, just like a cell membrane, it can be closed or permeable depending on circumstances.

Along these lines, the field study examined the movement patterns of residents within a care home study site within different territories of privacy. This research categorized the spaces in a selected long-term care facility into territories where spaces were grouped based on the states of privacy as delineated by Westin (1967): seclusion, intimacy, anonymity and reserve. Applying these principles, four territory zones can be found on the study site to describe the different privacy conditions: secluded, intimate, anonymous and optional territory. Figure 3 illustrates these zonings on a typical floor plan. The four territory zones are defined as follows:

- **Secluded territory** is a single or cluster of rooms where residents can be most separated from fellow residents, i.e., bedroom and washroom.
- **Intimate territory** is a single or cluster of rooms where residents can participate in social activities with a small group of peers, i.e., peer’s bedroom.
- **Anonymous territory** is a single or cluster of rooms where residents can find “public privacy” and avoid intrusions, i.e., pantry and common room 1 (being monitored by care givers from staff room).
- **Optional territory**, as opposed to being in reserve, is defined as a single or cluster of rooms where residents are open to social interaction, i.e., common room 2, washroom 2, and peer’s bedroom in the adjacent unit, and the lift and reception area on ground floor.

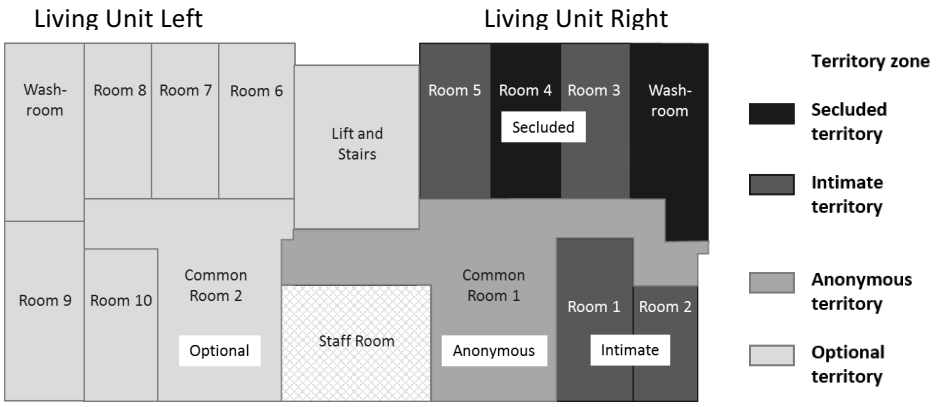

Figure 3. The four territory zones on a typical floor plan of the study site

4 METHODS

4.1 Design of Field study: Using Sensor Technologies

An indoor location-tracking system using Bluetooth Low Energy (BLE) technology was set up on the study site. The system was set up as permanent installations in the facility for the purposes of monitoring in case of falls. Each participating resident is assigned a smartwatch that communicates with the sensors by receiving signals sent out by the sensors. When an elderly resident is in the indoor environment, within the range of the signals, her/his location can be tracked by the beacons that were installed on the walls. The system collected continuous location data for the entire month in March, 2017 when the weather is found to be the most pleasant in Hong Kong.

Although BLE technology is growing in popularity due to the ease of installation and affordability of the components, the technology still faces a number of challenges in accurately tracking the locations of participants in relation to the issues of signal fluctuations and refractions in the physical space (Cantón Paterna, 2017). That said, it is advantageous in its non-intrusive method of monitoring and its capability in continuously tracking elderly residents' movement data make it a new method to gather numeric data in evaluating person-environment relationships. The system leverages on collecting quantitative data that have the following characteristics in order to retrieve deeper insights in terms of spatial design and social interaction: (1) Ubiquitous location data – residents' movements were recorded in all the spaces of the study site - bedroom, washroom, common area, pantry and reception area - at random timeslots. (2) Continuous time data - residents' time duration data at each location were recorded randomly from 0 to 23 hour for 31 days, which were calculated into mean values by the hour in a day. (3) Personal tags – the system had the advantage of collecting the time and location data in a multi-user environment, permitting the identification of each elderly participant which was essential for observing individual movement patterns.

4.2 Study Sites and participants

A care facility of 200 residents was selected for this study. The care facility consists six floors in a building that was built in the 1990's. The ground floor contains the reception area and a workshop space for group activities. Residents lived between the first floor and fifth floor. Each floor has two living units that are connected by the staff station and pantry. Each unit, approximately 2000 square feet, accommodated 20 residents. Female and male residents

lived separately on different floors. The residents were able to go between the six floors in a lift and to exit the building through the main gate that was next to the reception area. The two units were in a symmetrical spatial layout and were connected in the middle by the pantry and staff room (restricted area).

In total, 50 participants (female, n=26 and male, n=24) were recruited for the experiment. The sampling criteria for the pilot study included two items; a balanced proportion of female (n=26) and male (n=24) residents, and higher functional abilities in terms motor and cognitive skills for the carrying out of the activities of daily living (ADL). Around 20% of the residents participated from each living unit on each floor. Each resident was assigned with a smartwatch which allowed the location data to be recorded by the beacons throughout the day. A one-day training was conducted on site for both the residents and the care staff in using and charging the wristbands.

4.3 Data Analysis

The study first examined residents' movements on all floors for particular trends. It then focused on the data recorded on the fourth and fifth floor where the highest numbers of female (n=13) and male (n=9) participants lived.

Before the analyses, the data were screened according to a set of criteria to ensure greater validity. Since BLE signals travel through walls and floor slabs, it sometimes results in duplicate or inaccurate location data in the indoor environment. Therefore, the data were filtered out in the following conditions: (1) when a resident was found back and forth in one room and the adjacent during the same hour (e.g., living/dining room right and room 1), (2) when a resident was found in other rooms that are directly above or below (e.g., a resident in room 9 on 4th floor was found in room 9 on 5th floor), and (3) when a resident was found in a location for under 3 minutes, which was observed on site to be the time required for signals to stabilize.

The analyses focused on how residents used spaces in relation to time and location, and what movement patterns were discovered in relation to privacy territory. Figure 5 illustrates a resident's access model to other rooms in the care facility and her/his movements through the four territory zones. Based on this model, the analyses explored the collective movements of all the residents in search of a general tendency.

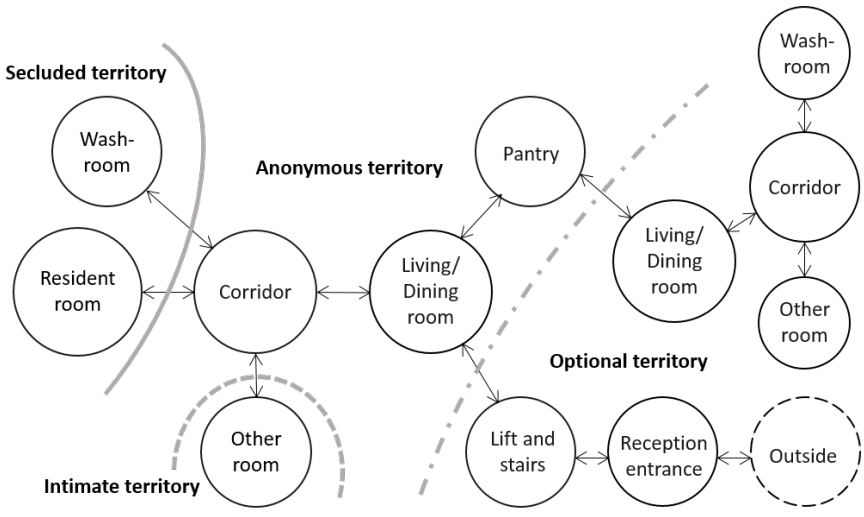

Figure 4. Access model to four territory zones from a resident's bedroom

4.3.1 Space use

Time duration results suggested a number of ways in which the residents use the spaces (figure 6). Analyses indicated that residents spent 92% of the day (around 22 hours) inside the boundary of their own living units (53% in the more private spaces of bedroom, washroom and peer room; 39% in the more public setting of common room 1 and pantry). A small portion of time was spent in visiting common room in the opposite living quarter (4%) and a significantly low amount of time was spent on the ground floor where the entrance was located (0.2%). No residents were found to have travelled to the living units of different floors.

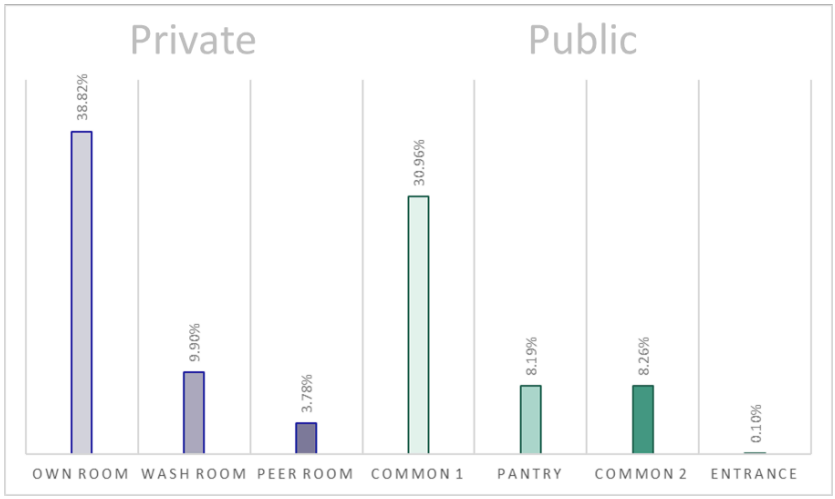

Figure 5. Percentage of time duration in each space

Residents spent around 9 hours of the day in the anonymous territory between 7 a.m. to 9 p.m. Participants generally spent under 2 hours in the optional territory usually between 3 – 5 p.m. Residents were found briefly in the intimate zone, spending time in peer's room. An hourly colour scale of duration (figure 7) indicates that residents' activities concentrated in the secluded territory throughout the day. The activity pattern in the secluded territory was characterized with irregular and brief movements while the activities in the anonymous territory were frequent and long. There was little activity in the optional territory near the entrance on ground floor.

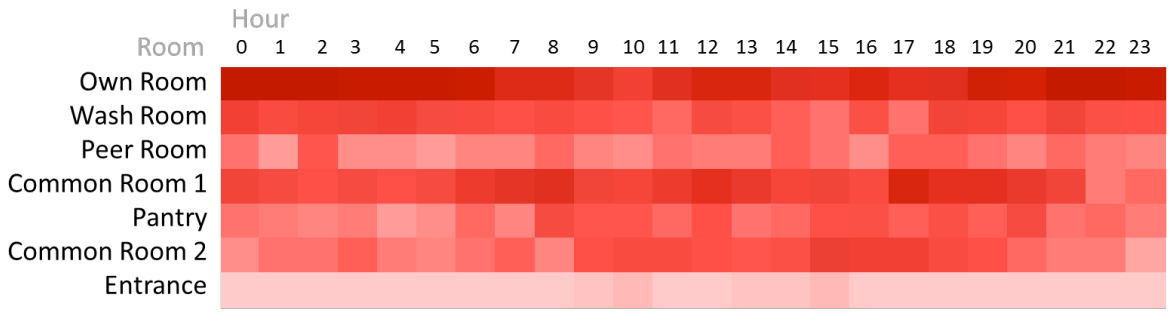

Figure 6. Percentage of time duration in each space

4.3.2 Movement patterns

Although each floor had its unique movement patterns, there was a regularity in the general patterns. Results showed that 80% of the residents travelled short range distances throughout the day. Long-ranged travels commonly took place at around 3-4 p.m., but

sometimes in the middle of the night. Longer range walks to the ground floor entrance usually happened at around 9 - 11 a.m. and 1-3 p.m.

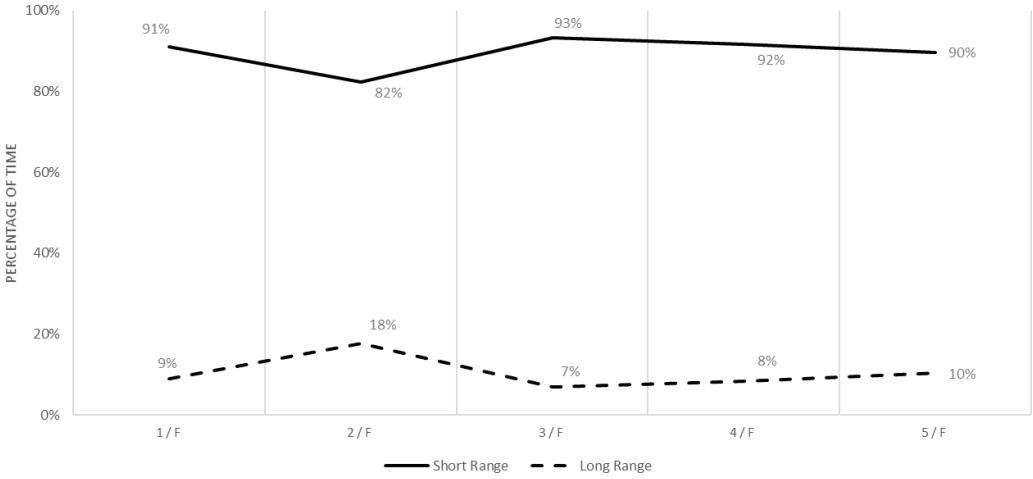

Figure 7. Short range and long range travels on each floor

In addition to the characteristic short-ranged travels, residents were also seen returning to their own rooms on an hourly basis. Figure 10 demonstrates the changes in the distances outside the bedroom in a time sequence. Depending on the location of the bedroom, results indicated that residents started the day moving within secluded territories near their bedrooms. The boundary of the territory expanded further at around 1 p.m. and the farthest at around 4 p.m.

5 DISCUSSIONS

The results suggested that privacy is not a linear experience, stretching from public, semi-public, semi-private and private. Rather the residents' movement was closely linked to the four privacy conditions (seclusion, intimate, anonymous or optional) depicted in the access model. In another word, residents would move around different rooms during different time of the day to find the desired privacy. For example, "seclusion" could be found in one's own room at 4 p.m. (when most people were seen out of the bedroom) or in the public common area at 2 a.m. (when most people were in their own rooms). Although privacy can be determined by metric distances, it is more to do with its temporal attribute and what activities the rooms enabled residents to do. Thus having the capability to access different privacy settings in one particular space is significant in a co-living environment.

Three movement patterns were synthesized below to discuss the impact of privacy design.

5.1 Pattern 1: withdrawal to bedrooms

Results show that the residents withdrew to their bedrooms on an hourly basis where they had more privacy. It suggests that having a higher level of privacy was often important for the elderly residents. However, this observation also indicates that the high use of bedrooms was due to the lack of privacy found between the bedroom (secluded territory) and the common area (anonymous territory). It is implied that incorporating other privacy experiences could encourage the residents to spend more time outside of the bedroom.

5.2 Pattern 2: short-range travels

Results show that the residents mostly stayed in areas that are within short distances from the bedroom. More specifically, a large part of the residents' day was spent in the common area and pantry (anonymous territory) with a small portion of the time in peers' rooms (intimate territory). It is fair to assume that the residents carried out most of the daily activities within the boundary of their living unit where only three types of privacy experiences were found. This movement pattern implies that the space mainly induced group activities offering little opportunities for personal or small group activities.

5.3 Pattern 3: Long-range travels

Results show that the residents spent very little time in the adjacent living unit or on the ground floor (i.e. optional territory). Therefore, this pattern is likely to suggest a change in daily routines. Residents were mostly located in the optional territory in late afternoon or just after midnight. It indicates that enabling this specific privacy setting would potentially encourage the residents to leave their own living unit. This pattern is worth noting as it implies that the residents travelled to a less familiar environment and were more likely to participate in different types of social activities.

6 CONCLUSIONS

The paper concludes that different privacy settings – secluded, intimate, anonymous and optional – have an effect on the movement patterns of elderly residents. Results show that three movement patterns carry the implications for the design of privacy for future co-living layout. It is also concluded that ubiquitous data could better inform designers and researchers in what ways the physical environment affects behaviour. In terms of methods, the indoor location-tracking system used in the field study provided 80% accuracy in collecting location and duration data. The study recommends that more research using the big data approach is needed to better explore the relationship between movement and architecture inside other long term care facilities.

Although current preliminary results only focus on the influences that physical designs have on mobility patterns in a nursing home, it is acknowledged that other factors such as daily activities and friendships will also affect how the elders move. In order to further explain the motivations behind the movement patterns, qualitative analyses such as focus group interviews will be conducted in the next phase to examine the interplay between privacy design and residents' social networks. Temporal dimensions will also be incorporated to investigate to what degree the weekday and weekend activities affected how elders moved.

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