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Social Practice Design As A Green Transition Tool For Sufficient Living

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51 Social Practice Design as a Green Transition Tool for Sufficient Living

Andre Sanchez Montoya, Matthew Burnett, Iddo Goren, and Maria Figueroa

Abstract

While cities must prepare to accommodate an increasing share of population growth in the coming decades, the increasing consumption of floor area is a prevalent and challenging trend in high-income Western countries that needs to be reversed in order to meet net zero carbon goals. A sustainability paradox emerges as housing demand within growing urban centres contrasts with the reality that the building sector is the fourth largest global carbon-emitting sector and is responsible for one of the highest levels of material resource consumption on the planet (Lamb et al. in Environ Res Lett 16:073005, 2022). Environmental Research Letters, 17(4), 049502 2021). Recent research supports the proposition that reductions in resource consumption are possible with the consideration of sufficiency measures and practices applicable to the building stock (Millward-Hopkins et al. in Glob Environ Chang 65:102168, 2020; Saheb in Buildings and Cities J, 2021). However, this research has not discussed how to advance or operationalise ideas and concepts like sufficiency or how innovative solutions can lead to achieving a reduction of floor area in the existing building stock. This research begins to address this gap by investigating whether a social practice methodology applied as an innovative tool can help decouple the overconsumption of floor area. This model re-assesses and elevates the existing housing stock as a strategic asset that can be densified.

Keywords

Sufficiency · Absolute sustainability · Social practice design · Practice-oriented design · Post-occupancy evaluation · Densification · Urban re-development · Housing transformation · Retrofits · Co-living · Compact living · Sustainable lifestyles

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51.1 Introduction

The building sector is one of the largest resource-consuming, waste generators, and carbon emitters globally, therefore reversing this trend is critical in order to meet net zero carbon climate goals by 2050 (IPCC 2022). Additionally, urbanisation and population growth could add another 2.5 billion people to urban areas by 2050

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(UN DESA 2020). A climate adaptation challenge emerges as cities will need to accommodate the growing demand for housing with solutions that can also meet ambitious climate targets (UN Habitat 2011).

Thus far, efforts to reduce carbon have concentrated on energy efficiency of operational systems and the carbon embodied in construction materials and processes (WGBC 2019). But despite this, "building sector emissions increased 2% from 2017 to 2018, to reach a record high". This growth was driven primarily by large expansions in floor area per capita and population increases (WGBC 2019). While efficiency improvements continue to be made, they have not yet been enough to outpace the sheer demand for floor space. As residential buildings are the largest source of demand for built space, accounting for over 70% per cent of final energy use within the building sector, spatial requirements for dwellings represent a key opportunity for change (WGBC 2019).

As a response to the interconnected problem of urban growth and its environmental impacts, researchers have drawn attention away from concepts of "efficiency" towards "sufficiency"—a state in which people's basic needs are met equitably while ecological limits are respected (Darby and Fawcett 2018). While sufficiency literature supports the proposition that radical reductions in building sector resource consumption are possible, it has not yet shed light into how these concepts can operationalise solutions or practices leading to an effective reduction of floor space per person in residential buildings through the densification of existing housing developments (Millward-Hopkins et al. 2020; Saheb 2021).

Simultaneously, building research has pointed at the lack of technologies for mapping and analysing occupant behaviour that can directly inform the design process for architects and designers. Traditional approaches to occupancy evaluations and data management are often labour intensive, difficult to scale, and lack socio-spatial granularity and digital frameworks capacities for flexible and efficient mappings of occupancy behaviour (Jørgensen et al 2020, pp. 251–253). Furthermore, there is little post-occupancy research systematically exploring how building residents' lifestyles are linked to space preferences (Bierwirth and Thomas 2019). This paper seeks to address these gaps by linking and developing theoretical conceptualisations related to sufficiency and social practice design, and by practically integrating these in a methodological digital tool (Make Room) with the ambition of gaining knowledge into reducing residential dwelling sizes and increasing the number of residents in multi-tenant residential buildings.

The research further tests the methodological tool within a case study in Copenhagen, Denmark. The ambition of the case study is to hypothetically transform and densify the case building using the quantifiable data and analysis from the Make Room (MR) tool, and to provide insights applicable to future building transformations, retrofits, and new building developments.

The proposed methodology could impact future climate adaptation strategies through effective urban densification, reducing land use change and influencing the housing practices of urban dwellers and other industry stakeholders at large.

51.2 Theoretical Framing Concepts

This section develops and explains how interrelated concepts to the notion of sufficiency can come together to facilitate a re-assessment of building occupancy and density of use. The first concept presented establishes the strategic lens described as a *sufficiency corridor* to gain insights into floor area per capita targets for housing. The second body of theoretical research outlines the theory behind the MR tool's empirical data collection process, which incorporates elements of social practice design. This research unfolds how social practices within dwellings can be construed as a unit of analysis for understanding behaviour relating to residents' floor area consumption and thus potential for reduction or reallocation of space for densification.

Furthermore, this body of work aligns with UN Sustainable Development Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable. Through the development of participatory data collection methods, as well as developing novel insights for sustainable urbanisation, the research engages primarily with Target 11.3 and Indicator 11.3.1. While it is difficult to forecast or impact population growth, it is extremely relevant to understand if there are further opportunities to densify within the existing building stock, and thus reduce the floor area consumption rate within Denmark's urban areas.

51.2.1 Establishing a Sufficiency Corridor for Residential Housing

Designing housing that considers the IPCC climate targets and the earth's ecological limits requires the creation of a sufficiency corridor for residential housing as a fundamental and strategic lens. The sufficiency corridor aims to reveal indexes where floor area per person can be reduced on a subjective level. This attempts to downscale the meta discussions on floor area regarding planetary boundaries, doughnut economics, and humans needs to the precedent that exists in current scientific research (Raworth 2017; Andersen et al. 2020; Röckstrom et al. 2015).

Research presented for the sufficiency corridor's ecological ceiling is informed by absolute sustainability assessments conducted for a mix of newly developed single stand-alone dwellings within the Danish regulatory framework (Andersen et al. 2020). The research underlined that a focus on a dwellings' energy efficiency, to assess if the building can remain within its share of the total safe operating space within assigned environmental boundaries, was too narrow of a focus and would need to be combined with other mechanisms to reach absolute sustainability (Andersen et al. 2020, p. 21). Among drastic cuts in environmental impacts from construction and energy consumption, living area per person would need to see a reduction by 60% (Andersen et al. 2020, p. 21). Simulating these drastic reductions resulted in floor area per person equating to 20 sqm, which the researchers state, "in Denmark is considered culturally challenging but physically possible" (Andersen et al. 2020, p. 22). The research simulates a scenario where construction related practices remain constant which pushes the living area to 6.4 sqm (Andersen et al. 2020, p. 22). While noting this assessment is specifically augmented for the construction of new stand-alone single-family-dwellings, it gives sqm per capita limitations that can give shape to the ecological ceiling and guide sufficiency-based approaches for decoupling the building industry from its current practice of building big (Sandberg 2018, p. 154). If living between 6.4 and 20 sqms per person can allow for Danish society, to exist ecologically within the planet's safe operating space, it is paramount to complement these findings with social policy and research to approximate a minimum social floor that respects the needs of individual residents (Fig. 51.1).

The contemporary understanding of minimum required floor area is an emerging body of research with evaluations being relative to geographical and cultural contexts. These institutional estimates range from 15 to 30 sqm per capita (Cohen 2020, p. 7; Bierwirth and Thomas 2019, p. 21), with references on minimum industry housing standards to sufficiency research that aims for buildings to exist within the ecologically and socially just space. Social floor sufficiency range estimates landing between 15 and 20 sqm per capita will be a challenging transition for residents and policymakers in high-income countries, such as Denmark, to reorient their demand and market preferences for dwellings with larger floor areas. Western nations boast the highest floor area consumption per capita, with Denmark averaging 52.8 sqm per capita (Ellsworth-Krebs 2019, p. 21). Consumption patterns from the past 10 years show that "the trend in average floor space per capita is still rising even in the wealthiest EU Member States" (Bierwirth and Thomas 2019, p. 15). This shift towards downsizing will need to challenge spatial values and behaviours regarding both the

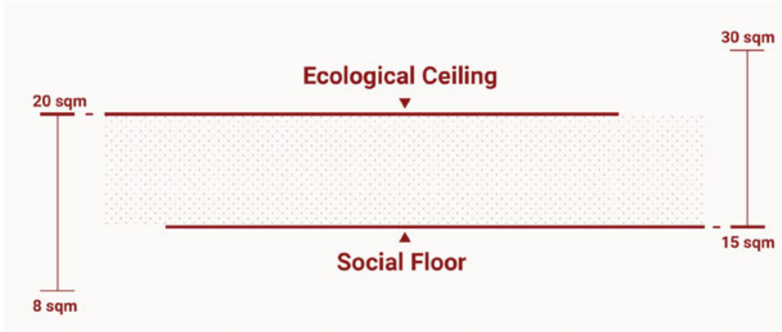


Fig. 51.1 Structuring the sufficiency corridor

industry and the dwellers themselves. A movement towards sufficiency will have to counter research that correlates social health and economic well-being of residents to larger floor areas (Silva and Wright 2009; Smith 2012).

As social floor determinants are driven by residents' lifestyles, spatial perception, and climatic and socio-cultural contexts, this methodology aims to systematically understand where spatial reduction potential in housing can stem from on a practice-by-practice basis.

51.2.2 Implementing Social Practice Design Principles

Social practice design provides designers a method for understanding how human behaviour can impact design interventions "to reduce product-related environmental impacts" (Lilley 2009). The rise of the social practice method is evident as designing for sustainability has leaned into understanding human behaviour within the past decade, specifically with a focus on how to address the social and systemic nature of consumption practices (Bakker and Scott 2011).

With the adoption of technology and data collecting devices into contemporary society, social practice design provides an opportunity to get closer to understanding existing user behaviour and the ethnographic data that it corresponds to. Designers that employ social practice as their methodology take the user's social practice as a unit of analysis to "distinguish between practice as a performance or the carrying out of a practice as an entity or nexus of activity" (Warde 2005). This unit of analysis is not meant to predict human behaviour, but it can be seen as a way to give shape to contexts that may elicit certain activities or practices. By directing attention to everyday activities or social practices, designers can start to understand in what ways their innovation can disrupt current practices in lieu of more sustainable ones.

Social practice methods have gained prominence as the starting point for many designers, "to understand the dynamics of consumption and to intervene in them to explore the potential to bring about reductions in resource use levels, with particular attention to what the space for action may be, given social arrangements for embedding ideas about boundless consumption and perpetual growth" (Pettersen 2014, p. 253). This convergence of using social practice theory to address behaviour change on an intimate level links social practice theory as a potential tool for industry wide climate adaptation strategies. Innovations in practices happen, "when existing links are broken and new links are created, new ideas, new products, and new procedures are introduced, or existing elements form new links" (Bakker and Scott 2011, p. 281) through data and user information gained from discursive and practical design methods.

51.3 Methods

51.3.1 Interdisciplinary Collaboration

To investigate how this research might shift architects towards a new paradigm of utilising the existing building stock, designing smaller housing footprints, while at the same time gathering fine-grain behavioural data required a multidisciplinary and co-evolutionary approach from the research team.

Creative design is characterised by a process of exploration of solution and problem, "constructed side-by-side" (Cross 2018, p. 379), through constant iteration of analysis, synthesis, and evaluation. Therefore, a design process can be seen as an interdependent development of problem and solution, with the ultimate goal for the designer to find a key concept that can act as a connecting "bridge" between them.

The researcher's process can be described as co-evolutionary according to Cross (2018), as the design and development of the MR tool were established on the basis of 17 discussions with experts across the building industry value chain, regular internal design workshops, and prototyping sessions (Fig. 51.2). The case study and data analysis process also co-evolved, primarily due to the influence of perspectives from multiple disciplines (an architect, an urbanist, and a strategic designer). Their academic and professional experiences in developing digital tools for architectural design processes, housing transformation, real estate development, and human-centred design approaches proved essential to frame the complexity of this body of research.

51.3.2 Digital Platform Structure and Creation

Understanding the spatial relationship between residents' practices and their floor space demands within a private dwelling requires aggregating both BIM data and behavioural data relating to residents' lifestyles. Therefore, the primary method for collecting the necessary data takes the shape of creation of a digital survey platform (Fig. 51.3).

The MR platform captures data concerning the building residents, the layout of the building, and the potential behaviour insights needed for floor area reduction. Building upon social practice theory and the proposed sufficiency corridor (Fig. 51.1), the prevailing hypothesis of the methodology of the MR tool is as follows:

(i) *An aggregation of social practices mapped across their space utilisation, satisfaction, and sharing preferences can provide a hypothetical amount of square metres where the building can be densified for new residents, bringing the building's avg. square metres per capita within the proposed sufficiency corridor.*

The digital platform was constructed specifically for a case study in Copenhagen, therefore the floor plans and other BIM data generated are

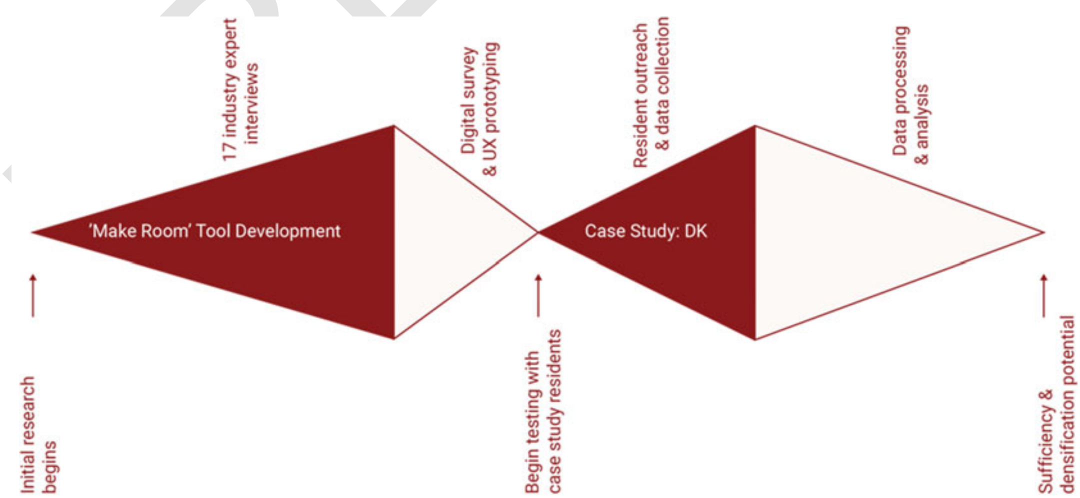


Fig. 51.2 Research and design process timeline

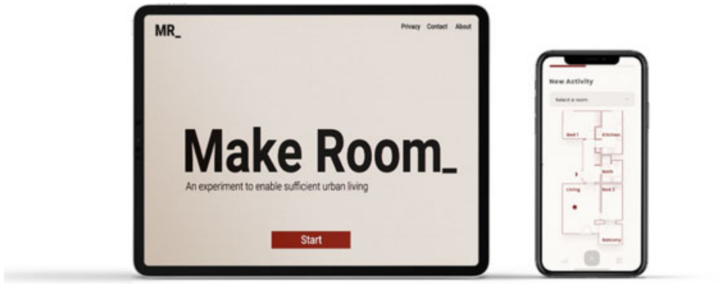


Fig. 51.3 MR user interface

associated with the address of each distinct user. This data allows for a fine-grain analysis of how the user's practices relate to their current spatial footprint. The building schematics were provided through close dialogue with the building's facility manager. The architectural floor plans and sqm analysis of the existing building were completed with ArchiCAD software.

The user experience (UX) and interface (UI) of the platform were prototyped in Figma—allowing rapid iteration of how questions would be sequenced and allowed for conditional follow-up questions to be asked (see Fig. 51.4). The iterative testing allowed for a curated experience to be designed that paired engaging language in addition to other design elements such as an intuitive interface. The UI, initially designed as a mobile application, was then developed for mobile and desktop use to ensure greater accessibility. The MR tool was hosted by the web platform Wix, which allowed for backend data collection and exporting to Excel for further analysis.

In order to adhere to GDPR guidelines, a unique and randomly generated user ID is used to associate all following data with and the user is given the ability to opt in or out of using the platform and a privacy policy is shown before collecting any data.

51.3.3 Empirical Data Selection

The data collection process considers the current practices of sufficiency evaluations conducted thus far in the building industry. Previous analyses of buildings have indicated that there is a lack of data availability when making sufficiency assessments. In a European context, missing indicators include time utilisation of dwellings/rooms, spatial satisfaction of the building, room syntax, and hybridisation of rooms (Bierwirth and Thomas 2019, p. 147). These are components structured into the tool.

Following the sign-up page, the data collection aims to capture demographic data that can analyse trends for sufficiency strategies along indicators such as age range, household size, household type, and duration of occupancy. Assessing the user's current overall satisfaction with their dwelling is surveyed in relation to corresponding environmental variables such as light, space, public space, and neighbours. These baseline indicators can help give a foundational context for the user and potentially any initial spatial preferences they might inhabit.

Collecting data regarding residents' practices required a variety of qualitative survey questions and corresponding spatial data. The spatial data derived through BIM allowed for a specific allocation of square metres per person per practice, as the resident can select in what room of their apartment the activity was taking place (see Fig. 51.5). By asking residents the type of activity, the room, duration, time of day, people involved, and frequency, the data can be analysed according to these metrics (see Fig. 51.6). Users were also asked their satisfaction with the size of the space for that given activity (herein referred to as "spatial satisfaction").

Data on users' sharing preferences was also gathered. This included information on the preferred group size and type of people residents would be willing to share with for any given

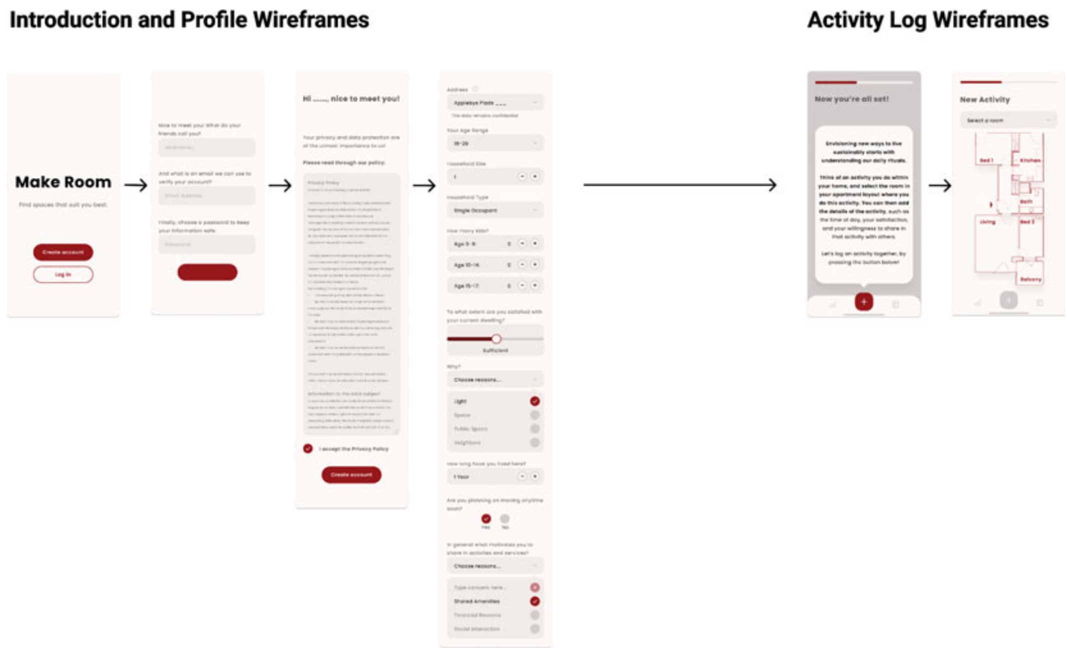


Fig. 51.4 Early UX wireframe, Figma

Fig. 51.5 Activity map screen

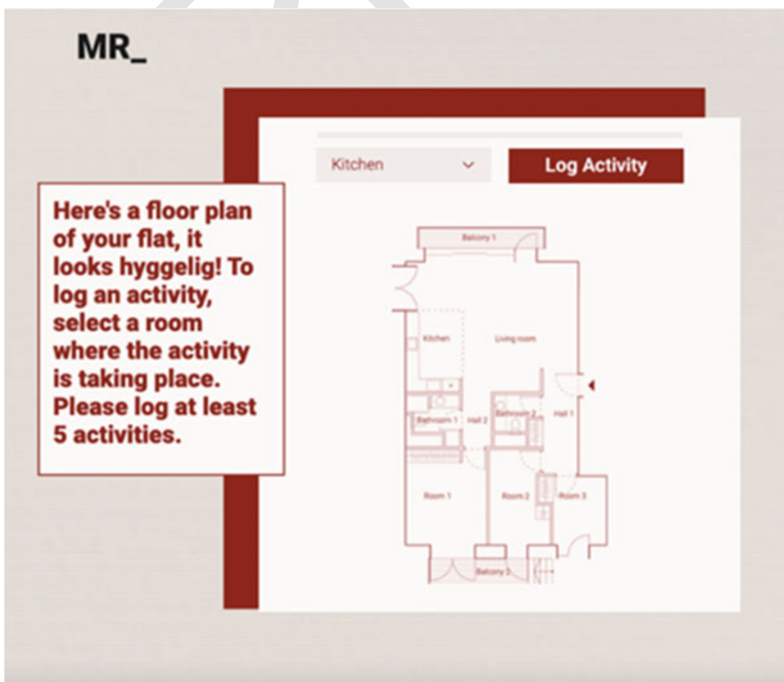
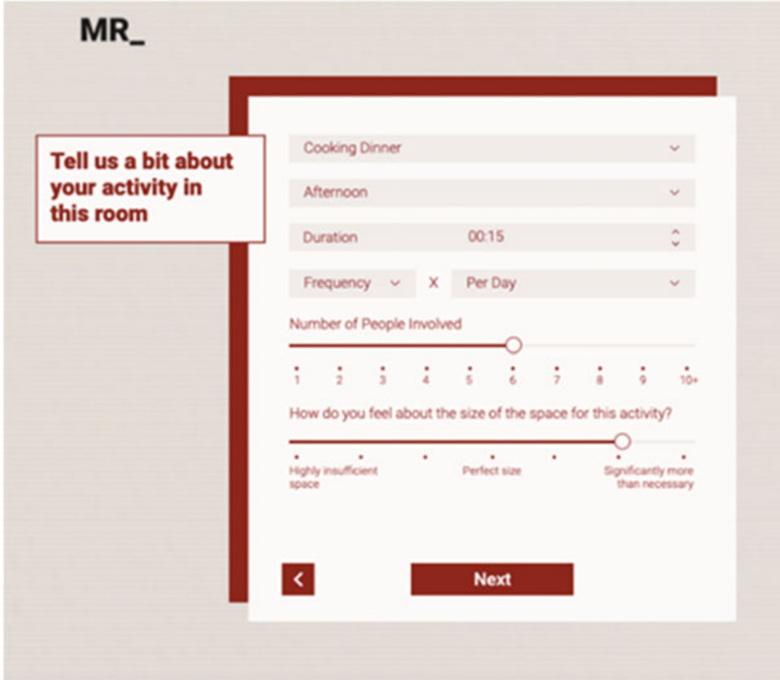


Fig. 51.6 Activity log screen



practice. Conditional questions related to sharing behaviour, such as motivations or concerns around sharing can help further segment user data so similar profiles can be matched (Fig. 51.7).

The final questions included services that residents might suggest to live with less space at home, and what activities residents dreamed of having access to (Fig. 51.8). These were identified as potential opportunities to increase access to shared amenities and offset the negative social impacts of private floor space reductions.

51.3.4 Spatial Reduction Design Framework

The fidelity that MR's data provides aided in the development of a design framework to assist the team's designers in understanding spatial consumption patterns and potential approaches for achieving floor space reductions.

Building upon the metrics outlined by sufficiency researchers Bierwirth and Thomas (2019, p. 12), the spatial reduction framework is split into three design categories: *less, flexible, and shared* (Fig. 51.9). Each category contains corresponding data points drawn from the MR platform that were identified as useful in organising a user's responses into potential areas for spatial reduction or reallocation:

- *Less*. Explores the potential for spatial reduction and/or redistribution through smaller room sizes where unnecessary, as well as where spaces are under-utilised. This can arise as a design solution for sufficiency when the resident has indicated that they have more space than necessary to conduct their activities, or when they log unused rooms.
- *Flexible*. Creating flexible or polyvalent space solutions which can be used for more functions than they do currently requires an extensive overview of room time utilisation across users, their spatial satisfaction, ideal group sizes, and motivations and concerns for engaging in shared activities in a hybridised space.
- *Shared*. Occurring when residents select that they are willing to share in their practices with

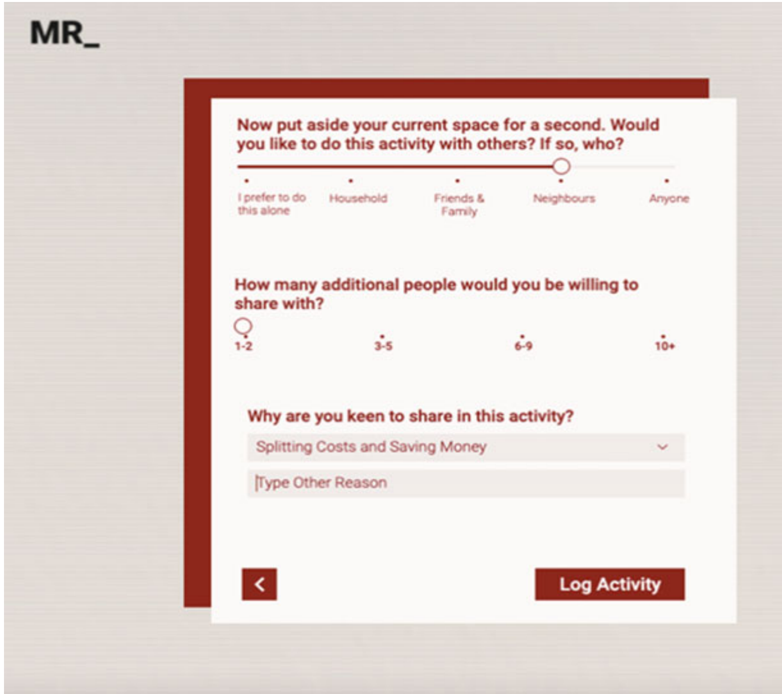


Fig. 51.7 Sharing preferences screen

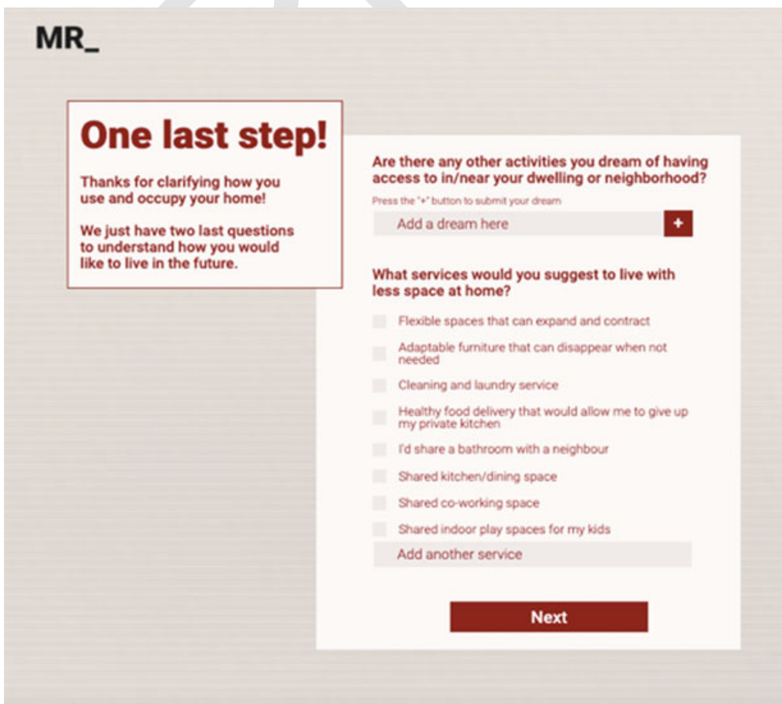


Fig. 51.8 Additional questions screen

Fig. 51.9 Spatial reduction design framework

others, sharing as a design solution for overall spatial reduction requires a network mapping of residents willing to participate in a similar sharing fidelity that corresponds with preferred group sizes, sharing types, and motivations.

To explore potential quantitative reductions in floor area per capita using this framework, experimental approaches were tested with user's spatial satisfaction responses. In Table 51.1, a numerical weight was assigned to the corresponding survey responses, and a hypothetical room size adjustment factor, to determine how much more space can be reduced per resident per practice to match their room size preference. These estimates were conducted through architectural simulations and sketch room layouts that accounted for the different room size reduction factors.

51.3.5 Case Study Site Selection

Denmark retains the largest spatial footprint per capita in Northern Europe and is one of the largest in the world (Bierwirth and Thomas 2019). Copenhagen municipality data shows that most urban neighbourhoods exceed 35 sqm per capita, such as Christianshavn with an average close to 45 sqm per capita (Denmark Statbank, BOL103). The test site for this model is a multi-tenant residential building located in the neighbourhood Christianshavn. This neighbourhood was selected as it has the highest floor space per person on average for every single household size when compared to other Copenhagen neighbourhoods (Denmark Statbank BOL103).

The residential block for this case study contains 152 apartments, 40 unique apartment layouts, totalling 13,572 sqm of living space. While the exact count of residents for the 152 apartments is unknown, a weighted average was calculated based on demographic data (Denmark StatBank) using an assumption about the number of people per apartment per bedroom. This estimates a total number of residents to 328, and a weighted average of 41 sqm floor space per person. Therefore, the residents within this case site exceed the ecological ceiling proposed by this paper's sufficiency corridor by 21 sqm per person. These residents also exceed the highest estimates for a social floor by 11 sqm per person—underscoring opportunities for sufficiency-based design interventions.

51.3.6 Determining Sufficiency Targets

The research presented for a sufficiency corridor's ecological ceiling is informed by LCAs for newly developed stand-alone dwellings. Therefore, the 20 sqm ceiling determined by DTU's

Table 51.1 Determining sqm adjustments by user's spatial satisfaction scores

Survey text	Spatial satisfaction score	Spatial satisfaction adjustment by practice*
Significantly more than necessary	+3	Reduce room sqm by 45%
Moderately more than necessary	+2	Reduce room sqm by 30%
Slightly more than necessary	+1	Reduce room sqm by 15%
Perfect match for my activity	0	No spatial adjustments
Slightly insufficient space	−1	Increase room sqm by 15%
Moderately insufficient space	−2	Increase room sqm by 30%
Significantly insufficient space	−3	Increase room sqm by 45%

Note The survey text was, "How do you feel about the size of the space for this activity?"

study is not a direct 1:1 correlation to the case site, as the existing building already retains embodied carbon, avoiding the new emissions factored into DTU's LCA.

Acknowledging that floor area reduction would need to be taken incrementally to distil spatial and cultural norms, the sufficiency corridor was developed around three floor area targets. The most extreme target would follow the 20 sqm recommendation by DTU's study and is understood as culturally challenging yet ecologically necessary. The second design scenario meets the 30 sqm sufficiency standard outlined by researchers in social policy. The final design scenario and smallest reduction in floor area aim to marginally reduce floor area per capita levels to 35 sqm. This final scenario does not fall within sufficiency parameters yet, any reduction in floor area can be seen as a step towards recalibrating social perceptions of necessary space for private dwellings.

51.3.7 Data Collection and Residential Engagement

Connecting with the residents of the case study site was staggered into three separate outreach tactics. The primary mode of disseminating the survey platform was through residential social media groups, i.e. Facebook. Announcements of the project, the intent of the research, and technical support were facilitated through this digital group. Print media such as informational posters were hung in the building's corridors. Mail flyers were dropped in resident's mailboxes. Both the flyers and posters contained a QR code that linked directly to the platform's landing page, in addition to listing the URL itself and participatory instructions.

51.4 Results

The data collection phase resulted in 24 unique user profiles and 117 practices recorded, yielding almost 3,000 unique data points for analysis. The ensuing analysis assessed whether the MR tool was able to collect the missing level of granularity cited by sufficiency researchers to begin understanding what data is needed to redesign existing residential buildings for sufficiency targets.

Figure 51.10 outlines the way in which the research team applied the *less, flexible, and shared* spatial reduction framework to assess resident profiles and create an experimental methodology for hypothetical floor area reductions that incorporate some of the key data provided by the MR tool.

This resulting methodology enabled a quali-quantitative development of the design framework adapted from Bierwirth and Thomas (2019, p. 12) and incorporated some of the missing data points cited by Jørgensen and Bierwirth and Thomas. We also unfolded that practice data as it relates to sharing and group sizes was an

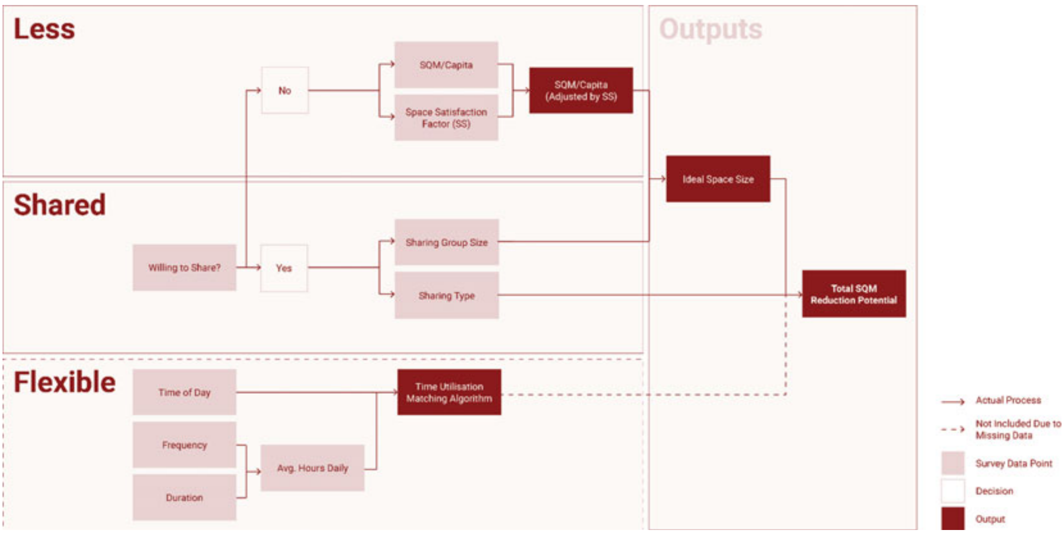


Fig. 51.10 Data analysis approach

essential behavioural metric to capture in order to facilitate sufficiency-based reductions according to the design framework.

51.4.1 Social Practice-Based Sufficiency Estimations

Scaling up this incomplete dataset to the estimated 328 residents of the case site proved to be difficult for the metrics used to determine *flexible* spaces within the design framework. The initial data set lacked enough time utilisation data across residents in order to understand how much of the liveable floor area of the building could become polyvalent or flexible in use. Therefore, the research team proceeded to conduct quantitative sufficiency reductions or reallocations only within the *less* or *shared* design framework categories.

The data points shown in Table 51.2 show all logged practices with the total sqms of the rooms where the practices are occurring, the spatial satisfaction adjustment estimations, and the total number of people involved. The researchers calculated the difference between the Sum of Room SQM for that logged room versus the Sum of Room SQM adjusted by the average spatial satisfaction. This resulted in the potential to reduce the space required for all practices across all apartments by a total of 5.19% of the building's total sqm.

Table 51.3 applies the estimated spatial reduction percentage between the practices logged to the entire liveable floor area of the building, resulting in an estimated 704.6 sqm that could be reduced through a scaled-up analysis by using 5.19% as an average reduction factor across all residents. The densification possibilities based on this reduction show a larger impact potential in pushing the site's average floor area per capita towards the outlined sufficiency targets but remain above the corridor.

Table 51.4 applies the same analysis used in Table 51.2, estimating a hypothetical floor area reduction based on the spatial satisfaction adjustments for all practices that could be shared. This sum equates to 7.13% floor area reductions from sharing practices between users. These calculations show that optimising floor area to resident sharing preferences results in a slightly higher percentage of sqm reallocation, but falls short of sufficiency targets.

When taking the sum of "Total SQM Reduction Potential" from both reduction scenarios from Tables 51.3 and 51.4 there is a

Table 51.2 Space satisfaction reduction potential (less), all practices

Row labels	Sum of room SQM	Sum of room SQM (adjusted by spatial satisfaction)	Sum of people involved
Using the bathroom	6	5.1	1
Personal hygiene	6	4.2	1
Making lunch	11	12.65	1
Smoking	12	11.85	6
Laundry	16	14.5	3
Making breakfast	22	18.7	3
Yoga	24	16.8	2
Getting dressed	29	22.4	5
Showering	30	25.5	5
Studying	32	24.8	2
Playing with kids	40	37	8
Listening to music	40	34	4
Using phone/social media	43	34.45	3
Playing an instrument	44	36.8	4
Reading	61	54.4	4
Relaxing/lounging	75	72	6
Watching TV/movies	100	101.05	10
Art/craft/creative	106	97.45	6
Cooking dinner	127	120.55	20
Sleeping	136	139.15	20
Exercising	137	144.2	10
Socilalising/chatting	140	134.45	27
Working from home	149	144.95	11
Eating/dining	155	141.2	25
Grand total	1592	1509.35	216

Table 51.3 Densification from less spatial reduction scenario, all qualifying practices

Spatial satisfaction reduction percentage	5.19%	
Total internal floor area	13,572	
Total SQM reduction potential	704.6016332	
Hypothetical floor area per capita for new building resident/s	Number of new potential residents	Avg. floor area per capita
20 sqm	35	37.86
30 sqm	23	39.12
35 sqm	20	39.50

Table 51.4 Densification from shared spatial reduction scenario, all qualifying practices

Spatial satisfaction reduction percentage	7.13%	
Total internal floor area	13,572	
Total SQM reduction potential	967.57	
Hypothetical floor area per capita for new building resident/s	Number of new potential residents	Avg. floor area per capita
20 sqm	48	36.53
30 sqm	32	38.17
35 sqm	28	38.66

Table 51.5 Densification from shared and less spatial reduction scenario, all qualifying practices

Spatial satisfaction reduction percentage total	12.32%	
Total internal floor area	13,572	
Total SQM reduction potential	1672.17	
Hypothetical floor area per capita for new building resident/s	Number of additional people	Avg. floor area per capita
20 sqm	83	29.18
30 sqm	55	31.05
35 sqm	47	31.63

potential for an estimated reallocation of 12.32% of the total building's sqm. Table 51.5 outlines the combined estimations and reveals that the reallocation of the 1672.17 sqm taken from both *less* and *shared* reduction scenarios across all practices results in the floor area per capita falling either within or just outside the target of 30sqm. This data illuminates a path towards the sufficiency corridor and an ability to avoid the new development of housing for 47–83 new occupants. This hypothetical densification of the case site would however require an architectural design process to effectively meet these targets and does not consider building regulations or the limitations of the building's structural and mechanical layout.

51.5 Discussion

51.5.1 Applying the Make Room Tool within an Architectural Design Process

The preceding case study has indicated that a social practice-based examination of a multi-tenant building illuminates opportunities for the reduction of floor space per person and potential for densification of the existing housing stock. Beyond the initial quali-quantitative methodological approach to assess the sufficiency potential of the building, the platform's data outputs provided the architectural insights to hypothetically transform the case study building.

A key component of the MR tool that enabled sufficiency insights consists of a visual data dashboard building upon the *less, flexible and shared* spatial reduction framework. Figures 51.11, 51.12, 51.13, and 51.14 depict the visualisations and mappings that can assist the architects in establishing sufficient room sizes, organisation of apartment layouts, and degrees of sharing throughout the building. These outputs allow for the architectural translation of the data from Table 51.5 into a hypothetical densification of one of the building's cores (Fig. 51.15).

Aggregate data concerning practice-based spatial perceptions were one useful output for the team to identify opportunities to reduce (and, when necessary, increase) the floor space per person. As can be seen in the box and whisker plot in Fig. 51.11, some activities such as using the bathroom, yoga, and getting dressed were always cited as being "more than necessary" for residents. These represent opportunities where the proposed architectural layout was adapted with smaller spaces for these practices. The majority of practices have mixed spatial perceptions, for example, sleeping and eating. This suggests that these rooms should be designed with more variation in size or flexibility across the building that might result in a net reduction in space per capita.

Time utilisation data mapped across the building layouts were also an effective method for identifying areas that were used very little or not at all and therefore represented opportunities to reduce the effective dwelling space (see spaces marked in dark red in Fig. 51.12). The majority of these rooms included unusable corridor or entry spaces, guest rooms, and balconies. In the final architectural layout (see Fig. 51.15), corridor spaces were minimised and minimal guest rooms were proposed to be shared across multiple households.

Data on users' sharing preferences allowed the research team to effectively re-organise the shared spaces within the new layout. Practices that were preferred in significantly larger group sizes in Fig. 51.13 (e.g. partying, socialising, eating, dining, and laundry) became larger shared spaces to be housed within one whole floor of the proposed transformation (see floor 3 in Fig. 51.15). In addition, by identifying residents' concerns or motivations for each practice (see Fig. 51.14), the design could alleviate those concerns which might negatively impact resident well-being. In the case of the architectural

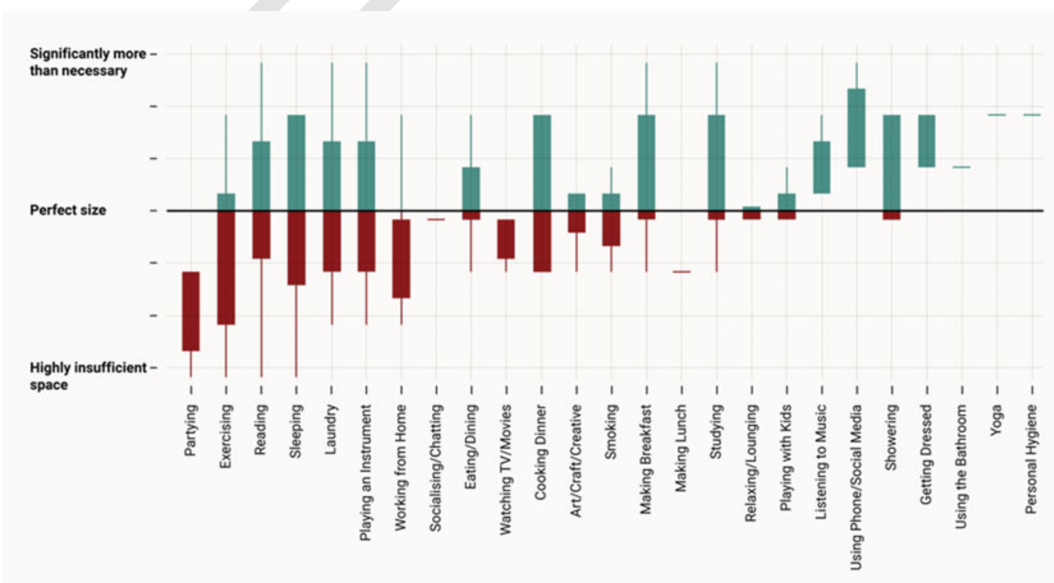


Fig. 51.11 Spatial satisfaction visualisation, by practice

Fig. 51.12 Under-utilised room mapping, automated across apartment layouts

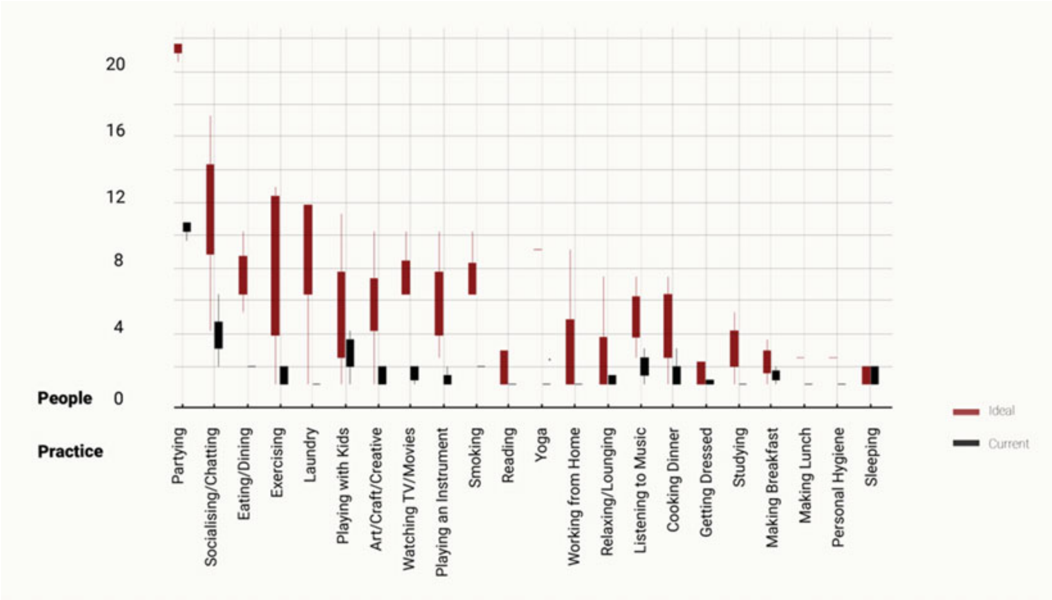


Fig. 51.13 Current versus ideal group sizes, by practice

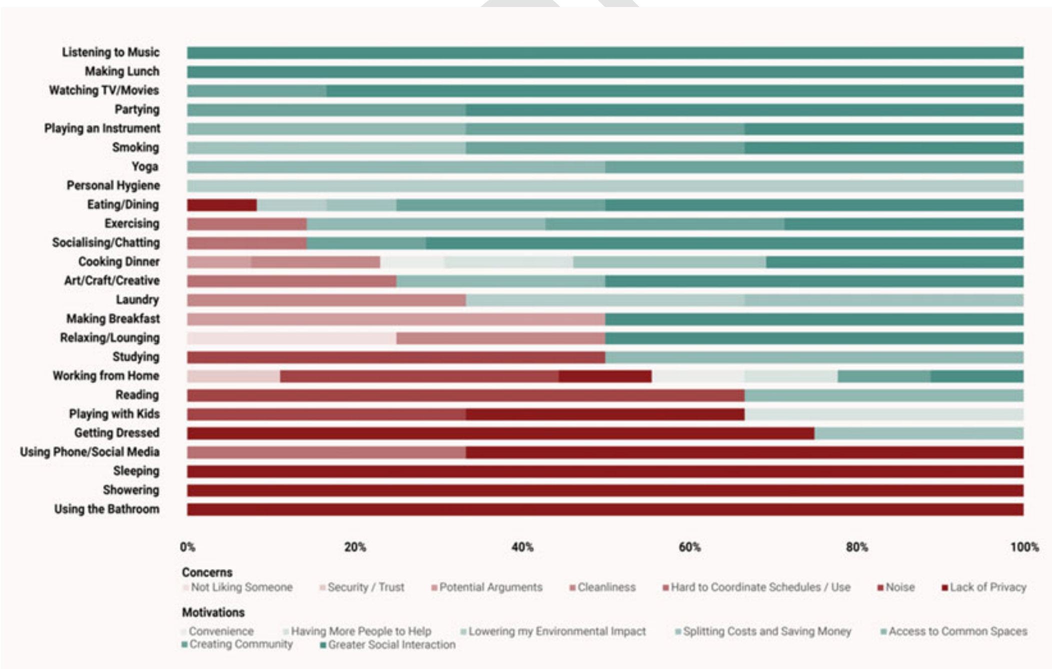


Fig. 51.14 Sharing motivations and concerns visualisation, by practice

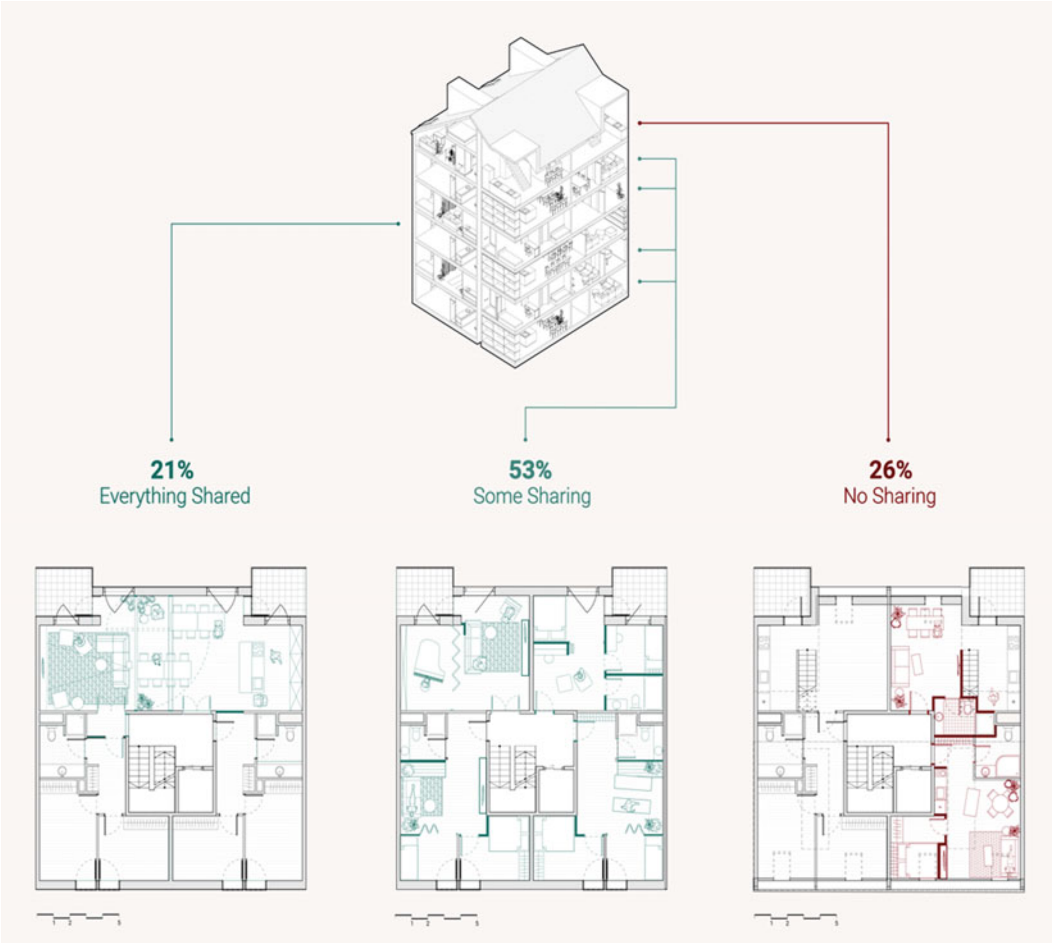


Fig. 51.15 Hypothetical architectural solution

proposal, spaces where there was a concern for noise were located far from bedrooms and quiet spaces, and spaces with privacy concerns were fitted with flexible or rotating partitions for selective control of interactions with others.

When analysing all practices more broadly (Fig. 51.16), a general trend can be observed that sharing a practice with just one other person allowed for a significant reduction in space use per capita and that the benefits diminish as practices are shared by more people. Therefore, creating shared spaces for sharing one or more practices and strategically targeting sole occupant or small households can be an additional path towards sufficiency-based housing developments.

51.5.2 Potential Value in Scaling on a Strategic Level

This research provokes a dialogue around downsizing spatial norms across residential planning, whether that is applied to adaptive re-use projects or new developments. This would require a strategic approach to the stewardship of the existing building stock where architects could influence the reallocation of sqms informed by indexed residential behaviour data based on lifestyle practices and corresponding BIM information.

A data-driven understanding of what a contextual minimum floor area per capita is could lend to shifting patterns and perceptions of how

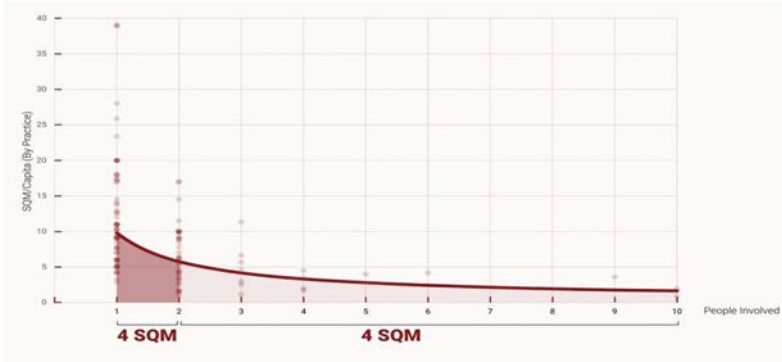


Fig. 51.16 Sharing efficiency curve, mapping all analysed practices

much floor area is needed on a per capita basis. A combination of rather immediate resource reductions through smaller household sizes and correlated energy use could find itself as a key foundation for urban planning strategies needed to keep global actors on par with IPCC carbon reduction targets. Urban planning strategies focussed on data informed sufficiency measures present the dual opportunity to shift the living behaviour of residents towards a more sufficient consumption of floor area while bringing elements of the sharing economy forward that could spur higher levels of conviviality, urban togetherness, and well-being. (Natale et al. 2015; Sekulova 2016; Jarvis 2017; Palm et al 2019).

A deeper industry wide qualitative study to verify this hypothesis on social floor metrics (quality of life, subjective residential well-being) in relation to an ecological ceiling is needed to advance this opportunity as a holistic climate adaptation strategy. Researchers have pointed towards contemporary case studies (Sandberg 2018; Cohen 2020) where new developments have engaged in smaller spatial footprints that aim to exist within a contextual sustainable consumption corridor. These case studies ranging from new builds in Finland to the United States point out different spatial models for co-living. However, post-occupancy evaluations of residents within these more sufficient units need to be undertaken to gain insights as to whether smaller living spaces can provide a high quality of life in the long term and can further operationalise a scalable sufficiency-based planning model. More data is also needed to compare sufficient living approaches in relation to existing health and well-being research that correlates smaller floor area with negative impacts on social health (Smith 2012).

An opportunity to mobilise on this strategic level currently presents itself as the European Commission has launched “The Renovation Wave” as part of the European Green New Deal. There is a spotlight on optimising the existing build stock to aid the continent’s climate mitigations (Interreg Europe 2021). If EU nations can optimise energy efficiency and simultaneously densify residential spaces through mediating a sufficient floor area per person, this can promote sufficiency strategies to quell the urbanisation climate paradox, while significantly reducing resources used for the development of new buildings. This type of strategic asset management of the existing building stock can combine the efforts of energy efficiency while concurrently giving the building more dynamic use and value among a higher number of occupants.

This approach could open up new opportunities for architects to design and transform dwellings with sufficiency targets in mind. This would align with policy tactics that have recently been published by the European Environmental Bureau’s report on sufficiency measures. These policy recommendations stress that “sufficiency measures will encourage repurposing existing buildings to avoid constructing new ones –

avoiding the need for cement and steel – the two most carbon intensive materials used in buildings", while "pressure for greenfield construction and biodiversity losses will also be reduced leading to more preservation of nature and fertile agriculture land" (EEB 2021, p. 11). With this in mind, can this dual approach achieve this strategic shift while still providing key residential infrastructure through adaptative re-use of existing buildings—potentially slowing the resource consumption and carbon emissions for new developments?

51.6 Conclusion

The major ambition of the paper's research is to hypothetically transform and densify a multi-tenant residential building using the quantifiable data and analysis from the MR tool and to provide new knowledge applicable to future building transformations, retrofit projects, and new building developments.

To operationalise this hypothesis, the research components needed to address particular gaps present in building occupant behaviour studies and attempted to do so by linking and developing theoretical conceptualisations related to sufficiency and social practice design. By practically integrating these in a methodological digital platform, the MR tool was able to facilitate user engagement at the level of residents' activities and routines. This granular data collection opened a communicative opportunity for a practical revision between floor area consumption and their linked social practices.

This convergence of design and theoretical approaches highlights the opportunities in gaining new knowledge into reducing residential dwelling sizes and increasing the number of residents in multi-tenant residential buildings. The findings illuminate an embryonic opportunity for architects and other building sector stakeholders to re-configure and re-contextualise the existing housing stock as a strategic asset that can be densified by informed residential practice data.

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