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How design shapes space choice behaviors in public urban and shared indoor spaces- A review

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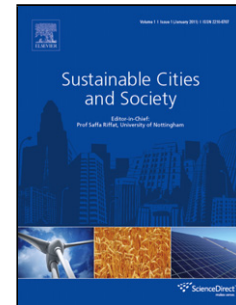
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How design shapes space choice behaviors in public urban and shared indoor spaces- A review

Abstract

This systematic literature review synthesizes the major physical and socio-physical determinants on space choice behaviors in open (i.e., non-defined uses) versus enclosed (i.e., specific uses defined) spaces. The purpose is to better understand the trade-offs between open and enclosed spaces and how opposing and complimentary design elements influence behavior and occupancy choices. Using the lens of space choice behaviors, we hypothesize that similar design challenges exists at both scales, and that analogous insights can be applied to both urban planning and building design.

We analyze the focus areas, research drivers, locations, and methods applied in the reviewed studies, and find overlapping similarities within research at both scales, particularly in the methods applied. The drivers for research into buildings tend to be more about optimizing space allocation, whereas lifestyles and well-being are more common in urban studies. We synthesize the content of the literature and find that challenges of successful public and common spaces in cities and buildings are similar in terms of trade-offs, barriers, and impacts on user activities. The implementation of diverse open spaces create more flexibility and adaptability to changing trends, attract different interest groups, and ultimately provide more synergistic benefits to the use of buildings and cities.

Keywords: Architectural Design, Public and Common Spaces, Space

Preferences, Health and Well-being.

1. Introduction

1.1. The effect of urban and building design on well-being

It has long been known that that human health and well-being is directly affected by our physical, built environment- both within the buildings in which we work, study and live; and though the urban fabric that connects these buildings. Public and shared spaces have a strong potential to facilitate the increasing diversity of functions, activities, and social needs within cities and buildings. Research suggests that social connections can be enhanced through urban planning that promotes interactive spaces [1]. Public investments into urban public spaces result in higher levels of physical activity [2], and increased sense of mental well-being and neighborhood satisfaction [3, 4]. This includes other civic needs that are functional to a community's well-being, including a resident's opportunity to actively engage in decisions, forming a collaborative governance of urban commons in order to innovative public interests, designs and solution, where public spaces become a common good with social access and existential exchanges [5]. Even still, local zoning, standards and benchmarks about functionality and sustainability in the built environment can often conflict with how space is used to support local activities [6]. This goes in line with literature, where top-down approaches in governing public spaces are typically criticized for lacking understanding of the contextual conditions and challenges deeply grounded in reality [5].

In a global context, studies show that urban residents are more sensitive to stress than people in rural areas. In Latin American and Asian countries, higher anxiety disorders are found in cities [7]. Moreover, higher rates of schizophrenia, mood disorders, and other diseases are found in large urban areas, within countries from Germany to China [7]. Loneliness, related to feeling isolated and disconnected, has become a major public health concern, affecting up to 47% of American adults [8]. In an experiment using functional magnetic resonance

imaging, [9] found that the brains of people that grew up and live in cities have increased amygdala activity (reduced capacity for regulating the amygdala[1]), leading to a reduced capacity for handling social stress processing. While these studies emphasize that causal links have not been established, nevertheless, correlations do exist between urban living and reduced physical and psychological health.

Factors like unattractiveness, long commuting distances, neglected maintenance and safety issues contribute to lower levels of neighborhood satisfaction and discourage the public from using outdoor spaces [1]. Green space standards, for example, have frequently informed policy acquisition but can be difficult to enact or enforce [10, 11]. A global city comparison on public green space finds the following allocations: Oslo (68%), Singapore (47%), and Sydney (46%) rank highest, while Istanbul (2.2%), Taipei (3.4%), and Bogota (4.9%) rank lowest [12]. In the US, still less than 25% of the 100 largest cities meet the UN-Habitat urban planning standard of devoting 15-20% of urban land in cities to public, open and green space [13]. Unfortunately, provisioning of common spaces often comes in conflict with the emphasis placed on cost-saving, with detrimental effects to the the well-being of urban residents. The access and quality of urban public spaces has previously suffered from the inability of public and private institutions to find governance structures that focus on the collective management of urban spaces. Here, principal decision-making structures lack efficiency due to their failure in reacting to local issues [5].

Regarding buildings, the trend toward more flexible and collaborative lifestyles and working approaches generate increased demand for more sophisticated configuration of workspaces and urban spaces. In learning environments, information and communication technology (ICT) led to increased autonomy and students are taking more responsibility for their own working processes and cre-

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[1]"*The one of the four basal ganglia in each cerebral hemisphere that is part of the limbic system and consists of an almond-shaped mass of gray matter in the anterior extremity of the temporal lobe*" (Merriam Webster)

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ating networking opportunities [14]. The same trend can be seen in the private industry, where organizations are adapting to work style changes through architectural and interior designs that aim to support different simultaneous task characteristics, such as spaces for private concentrated work, for creative work, and for collaborative work with others [15].

Opportunities for building managers to eliminate under-utilized workspaces to reduce costs result from generally low utilization rates in commercial office spaces worldwide; China has the lowest rates with 27% unutilized spaces, followed by Singapore (38%), US (41%), UK and Australia (both 40%) and Japan (46%) [16]. Such low utilization is finally being seen as wasteful from both cost and corporate social responsibility perspectives [17]. The US General Services Administration (2011) compares space allocations in the private and public sector, and links less space allocation (per person) in the private sector to more digital and flexible means of work. For offices, floor area is the second highest cost for an organization after human resources, and this is encouraging more flexible use of workplaces [10]. For this reason, building managers have successfully reduced the space-use ratio with help from wireless technologies, leading to significant reductions in operation and maintenance costs [18]. A similar trend can be seen in higher education facilities and libraries, where the initial purpose is not a direct economic outcome but to host paramount activities such as studying, research, socializing and networking [19].

As such, human health and well-being are beginning to be prioritized in the design of new workplaces and learning environments. Moreover, policy standards and certification benchmarks (e.g. LEED, DGNB, etc.) are increasingly addressing aspects of functionality and sustainability in the built environment [20]. Nevertheless, the strategy of minimizing building space has been of growing importance for several decades to achieve economic and environmental sustainability [17]. This can result in impaired functionality in buildings, where space densification has led to the over-utilization of spaces [10]. Each additional unit of space increases the environmental and economic costs, and yet, many indoor spaces are rarely used, if at all. Simultaneously, constantly crowded spaces have

unfavorable effects upon building users' health and well-being. Standards and benchmarks in higher education provide performance indicators with only little guidance for data collection strategies related to these indicators [21]. The validity of current benchmarks on space allocation is therefore widely questioned in literature, while architects and planners are challenged to find a balanced design solution for the complex interaction between spaces, occupants and their activities [22, 23]. Not enough is yet known, however, to achieve this well-balanced design solution [24]. Brown (2006), for instance, predict that the design of current and future workplaces will largely be determined by the balance of closed (i.e. private, semi-private) and open (i.e. public, common) spaces [25]. As our understanding on the relationship between building design and its effect on organizational and behavioral issues continues to grow, more interest is given to how these concepts can be harmonized.

1.2. Open versus enclosed spaces

Open spaces are common, flexible, and shared spaces that provide a certain diversity in space features as part of a 'community of regulars' [26]. Both on a building and urban scale, open spaces are publicly accessible, informal multipurpose spaces that are distributed across places and buildings, such as public squares or open parks in cities, or break-out spaces, often referred to as "in-between spaces", integrated into corridors inside buildings. Open public spaces comprise goods that are tangible, intangible and/or digital, in which "citizens and the administration, also through participatory and deliberative procedures, recognize to be functional to the individual and collective well-being, activating consequently towards them" [5, p. 424]. Ideally, these informal spaces support individuals and groups in conducting both work or social activities in the real and virtual worlds [27]. The activity types in open spaces are typically diverse, meaning their success depends on multiple user needs. On a city level, ownership and governance models of public spaces contribute to how they (miss-) align with local user needs when developing and maintaining public spaces as a common good[5]. Enclosed spaces, on the other hand, are characterized by predefined

design intentions for a specific set of activities (with limited variety). Enclosed spaces have, contrary to open spaces, a presumed activity and are not necessarily publicly accessible. For example, on the urban scale, this could be a football pitch or a parking lot. On the building scale, examples include offices, classrooms or collaborative spaces such as meeting rooms (e.g., with physical and visual privacy) that provide private space for an intended purpose of interaction.

1.3. Purpose

With respect to incorporating open spaces, i.e., public spaces into the urban landscape and common spaces into buildings, there are clear trade-offs between cost effectiveness on the one hand, and sustainability, functionality and human health and well-being on the other. In light of this, we hypothesize that a similar problematic exists at both scales, urban and building. Thus, the main purpose of this study is to investigate the benefits and drawbacks of common indoor and public outdoor spaces and compare the trade-offs between open and enclosed spaces, often stated as two opposing functions that exclude multi-purpose spaces and mono-purpose spaces from another. By doing so, we intend to identify analogous synergies between developers, planners, and urban residents on the one hand, and landowners, architects, and building occupants on the other. Moreover, we seek to identify insights that can be potentially applied across the different scales and elucidate mutual benefits of shared space in buildings and public urban spaces.

To accomplish this, we approach this problematic from a function-behavioral perspective, and review recent literature on human behavior, well-being and spatial allocation at both scales, urban and building. We first focus on how spatial choice behaviors are investigated to determine correlations between the scales of study and topics investigated, the methods used, and the drivers for the research. Next, we seek to understand the trade-offs between open and enclosed spaces, including an identification of socio-physical determinants on spatial choices and user outcomes. We then analyze and discuss the ways in which public urban spaces and common building spaces are analogous in terms

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of their benefits and drawbacks, their barriers, and their impact on social well-being. The following research questions guide the scope and content of this literature review:

1. What is the distribution of specific research topics within space allocation in buildings and urban environments? (quantitative)

2. What is the distribution of methods used to determine the benefits and drawbacks of shared and public space? (quantitative)

3. What is the distribution of the main drivers for research on human behavior in common indoor and public outdoor spaces? (quantitative)

4. What are the physical and socio-physical influences on space choice behaviors? (qualitative)

5. What are the various benefits and drawbacks for the implementation and use of shared and public space? (qualitative)

6. What are the trade-offs between open and enclosed environments and how can they be balanced? (qualitative)

2. Method

This systematic review is based on the guidelines and process outlined by [28] and [29]. Our approach was to first define the research purpose, define a protocol, execute a search, conduct a practical screen, appraise the quality of the publications, and finally extract specific data from the remaining publications.

Search terms were initially chosen from keywords stated in key papers that were pre-screened to get an initial understanding of the research topic. The stated keywords that were used were "Mental Well-being" (see e.g. [1]), "Physical Environment" and "Collaboration" (see e.g. [30]), "Work Performances" and "Workspace" (see e.g.[31]), "Space-Choice Behavior" (see e.g [32]) and "Space Design Attributes" (see e.g [32]).

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The initial list of search terms were supplemented with other keywords derived from landmark papers to make them more relevant to the above research questions. The main search terms used in this study were "Physical Environment", "Architectural Design", Space Preferences", and "Health and Well-being". To refine and hone the search to the research questions, three separate, iterative searches are conducted within Google Scholar, each of them adding disjunctive sub-terms to the search. Sub-terms were then obtained from titles and abstracts in documents obtained from the initial search. The first search focused on elaborations of the physical environment, adding often stated terms "Open", "Common", "Public", "Outdoor", "Indoor", "Private", "Enclosed", "Learning" and "Work" to the primary search terms. The second search focused on user output and behaviors, adding the terms "Social", "Space-Use", "Human Behavior", "Collaboration", and "Interaction" to the primary terms. Finally, the focus was set on the benefits, drawbacks, and trade-offs between common indoor and public outdoor spaces, using the terms "Benefits", "Barriers", "Investment", "Values", "Funding" and "Challenges" in combination to the overall search terms. This led to 489 documents.

For the practical screen to determine relevance, 'Harzing's Publish or Perish Software' was used to retrieve and analyze the literature found in Google Scholar. The software presents metrics of information (e.g. journals, total number of papers and total number of citations, average citations per paper, three variations of individual h-indices, etc.) to enable a more tailored screening of titles, literature sources, and research impact. First, the search was limited to papers published between 2015-2019 (inclusive). Second, studies from tangential research fields (e.g. energy sciences, agricultural and biological sciences, robotics, etc.) were excluded. Third, document types and titles were filtered according to this study's contextual relevance. Finally, the abstracts were screened for relevance to the research questions. The practical screen reduced the initial 489 documents down to 82.

Next, the quality of these 82 documents were appraised, using the following criteria:

- Quality of method: Is a method explicitly defined and applied; and is the method sound?

- Conclusions: Do the conclusions follow from the data, results, and/or analysis?

- Impact: Are the results meaningful / applicable on a larger scale?

- Overall recommendation: Based on the above criteria, should this publication be included in the literature review?

After the quality appraisal, 75 articles were left for data extraction. Before analyzing the qualitative content of the articles, a quantitative study research methods and focus areas of each of the article is given. For this, a detailed overview of the data extraction can be found in the Appendix, which includes the categorization of each finding according to the stated scale (urban, building, both); main focus areas (built environment, open spaces, public spaces, green spaces, learning spaces, work spaces, library, social spaces); research methods (surveys, interviews, observations, sensors, other); literature types (journal article, book chapter, white paper, report, thesis); and topical drivers (health and well being, changing lifestyles, work performances, space utilization, market competition).

3. Quantitative Findings

The quantitative study helps to consider contextual differences in the literature when focusing on space-use behaviors in common indoor and public outdoor spaces. This is done to establish that a comparison and synthesis of the literature from the urban and building scales is meaningful, i.e., to establish that they contain similar methodologies and have some degree of overlap in geography, topics, and drivers within the study.

Each study was therefore broken down into sub-categories that align with the research questions. For the qualitative analysis, a categorization scheme was

created in order to filter the differentiated findings of each article in relation to the physical and socio-physical influences on space choice behaviors in open and enclosed environments (question 4), the benefits and drawbacks in creating shared and public spaces (question 5), and the trade-offs between open and enclosed environments in public outdoor and common indoor spaces(question 6). This is exemplified by the Table in the Appendix ("Appendix A: The Categorization Scheme"), which gives an overview of the filtering approach of all included articles. Here, the X's represent a research finding in relation to the given sub-category. The qualitative data extraction involved summarizing each paper's findings within each of the subcategories, which are then synthesized in Section 4 (Analysis).

3.1. Focus Area

The number of studies addressing buildings versus the urban scale were 43 and 25, respectively, while only 7 studies combined these two scales. 15 of the reviewed studies do not indicate a geographic location, while 3 occurrences apply cross-cultural studies. The USA however is represented most with 18 conducted case studies, followed by Australia and the Netherlands both with 6 occurrences. Hong Kong, Germany, and Finland count 3 occurrences, followed by the UK, Turkey, China, Canada, and Australia (2 occurrences), and finally Sweden, Sri Lanka, Singapore, Spain, Poland, Malaysia, Iran, and Indonesia with 1 occurrence. Figure 1 highlights the proportional linkages between scales and focus areas, and it can be seen that learning spaces, libraries and workspaces dominate research at the building scale. Green spaces and the built environment (including plazas, streetscapes, among others) dominate research at the urban scale. Urban scale studies tend to be more diverse than building studies in terms of focus. Some urban studies touch on learning spaces, libraries, workspaces (the main focus for studies on buildings), whereas no building studies in our sample covered the topics healing spaces, green spaces or the built environment.

The studies that combine the two scales focus on learning and workspaces, while it is surprising that social spaces were only in the domain of building

studies. This suggests an opportunity for more research at the urban scale with this focus area. Likewise, there are opportunities for improving our understanding of the built environment and green spaces from the perspective of building studies.
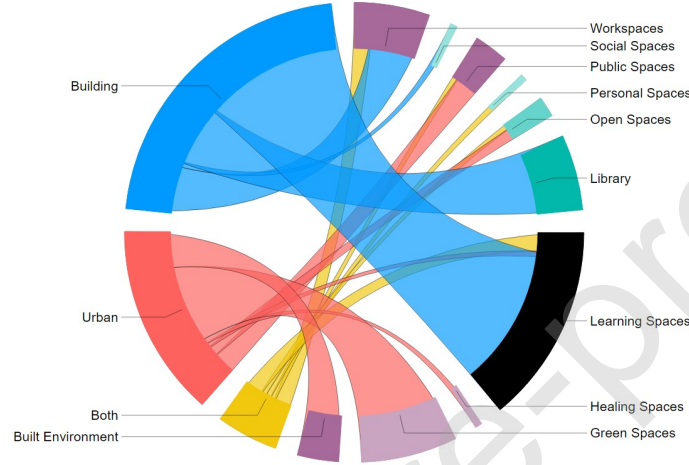
Figure 1: The distribution of focus areas within studies on buildings and urban areas, showing different and common focus on both scales.

3.2. Research Methods

The research methods used in the reviewed articles are surveys (n = 32), followed by literature reviews (n = 12), and interviews (n = 11). The remaining employed methods combined multiple means of data collection methods (n = 20).

Figure 2 shows the horizontal connections between scale and methods employed in the studies. In general, there is a similar distribution in methods employed for studies on buildings and for studies on the urban scale, even if there are differences in research focus (1). On an urban scale, however, literature reviews are more commonly used to study public spaces, while surveys are the means to study behavioral patterns inside buildings. Research combining traditional data collection methods with digital means, i.e., interviews, surveys,

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or observations with sensors, mobile surveys or cameras, are marked black and only account for 9 studies.
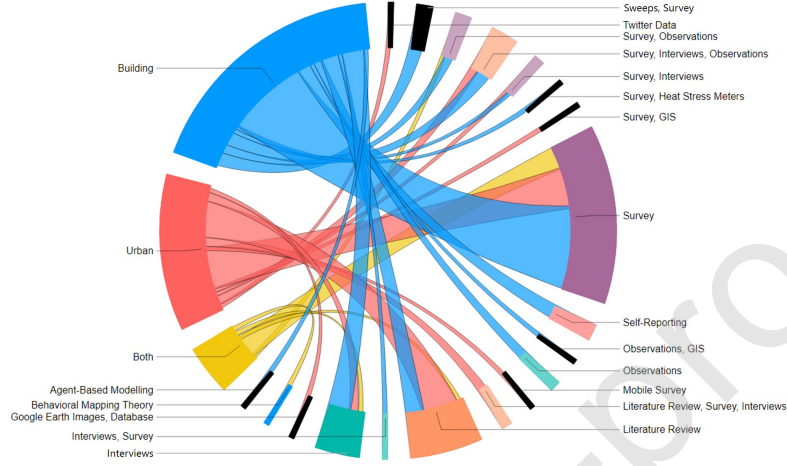
Figure 2: Distribution of research methods employed in studies on buildings and urban areas. Notably, digital data collection methods are marked black, only standing for 7 studies in total.

3.3. Main Drivers

Figure 3 gives an overview of the main drivers that are stated in the sampled publications as motivation for researching space use behaviors in public and common spaces.

At the urban scale, the most common stated intentions (main drivers) for conducting studies are generally associated with human-oriented fields, i.e., health and well-being (n = 14). In contrast, performance-based drivers, including space utilization, market competition, and work performance dominate studies at the building scale (n = 21), but increasingly also changing lifestyles (n = 12). The drive to optimize space utilization in buildings on the basis of increasing work performance has its origin in economic outcomes, while human drivers like health, well-being and changing lifestyles play a lesser role for motivating studies in building space allocation within the reviewed literature.

The literature included shows that there is a degree of overlap between the

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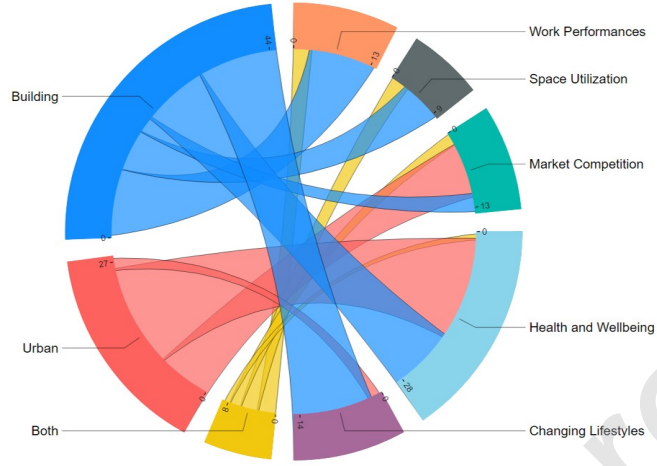
Figure 3: The distribution of main drivers within studies on buildings and urban areas gives insights on research motivation and purpose of given studies.

research at the different scales, particularly in terms of methodology. We find that there urban studies in our sample have a larger diversity of topics than building studies do, indicating an opportunity for urban studies to emphasize more the social spaces and space choices, and building studies to emphasize more green spaces and the built environment. Likewise, urban studies have more focus on well-being and lifestyles, and this is another opportunity for enriching building research.

4. Analysis

In this section, we explore the extracted information from the reviewed literature to address the qualitative research questions listed above. First, the physical determinants on space choices are analyzed and compared for both urban and building scales. Urban studies however tend to focus on abstract functional scales (green spaces, public spaces, parks, etc.), while socio-physical determinants of space choice behaviors are found mostly on a building scale but can be applied on both scales. The findings from Section 4 are therefore synthesized to highlight the various benefits and drawback of open and enclosed

spaces that can be applied to both an urban and building scale (see Figure 4).
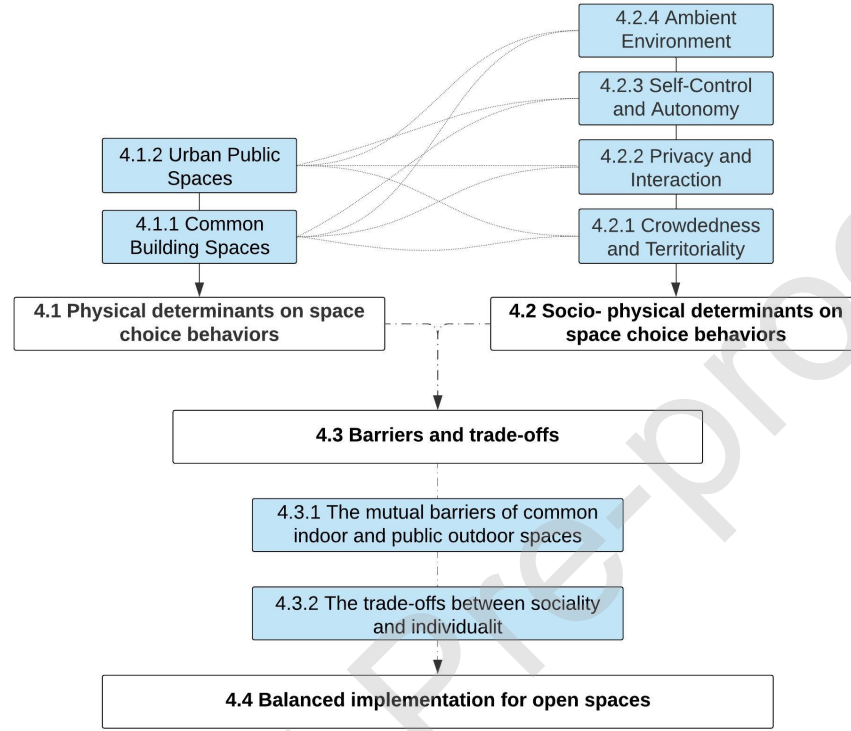
Figure 4: Analytical Framework Flowchart to demonstrate the literature synthesis.

4.1. Physical determinants on space choice behaviors

4.1.1. Urban public spaces

Research find that both in indoor and outdoor spaces, space preferences seem to depend on more than one spatial quality [31]. This is shown when preferred spaces for creativity-based activities ranged from open spaces in outdoor areas, enclosed indoor workspaces, and lounges, all being significantly different in terms of perceived loudness, privacy, and openness [31]. Compared to indoor spaces, natural outdoor environments were among the highly rated spaces for 'in-between' activities, such as taking a break or having lunch [31]. Study par-

ticipants also had similar perceptions of how distracting, private, and relaxing these spaces were [31].

Providing a single natural environment allows for a broad range of individual and group activities, while the provision of separate spaces for specific uses decreases the efficient utilization of that space. Nevertheless, as natural outdoor spaces are not universally perceived as suitable locations for all activities, additional support functions may offer increased spatial diversity to fulfil the needs and preferences of public space users. In public outdoor spaces, physical features influence the extent and character of outdoor activities, and the physical quality shows correlations with the frequency of social interaction, which can increase social ties between groups of people [33].

[34] and [35] found early evidence on that social activities are an indicator of successful spaces, as these activities tend to be optional. Next to environmental benefits, studies about outdoor spaces indicate that the perception of proximate green and social spaces, as opposed to impervious hardscapes, result in a greater sense of mental well-being and place-making [36, 1, 37, 38, 39, 40]. This goes in line with the degree of accessibility to outdoor spaces that may support or hinder user groups from pursuing activities nearby [36]. The perception of having green and social spaces with sitting opportunities also incorporated into the streetscape affects satisfaction levels as well as the frequency of use of such spaces [36, 41].

The actual physical availability of social and green spaces play a substantially larger role than just the perceived amount of green features in the spaces. The use of public outdoor spaces increases with the land-use diversity factor; functional diversity and higher density development and a well-connected street network around the public space increase its use [42]. Work activities in public outdoor spaces, for instance, were facilitated by the provision of small tables and chairs with desk attachments, and business travelers surveyed in both outdoor and indoor areas at an airport stated that they needed at least comfortable seating and a place for their laptop in order to work properly [43]. [43] found that workplaces embedded within another setting as in a public or semi-public place

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would need to *"consider the opportunities and the constraints of its surrounding physical and social environments"* [43, p. 215]. Environmental constraints like the shape, size and openness of a space influences space-choices, and determines frame conditions for the environmental quality of a space [44].

4.1.2. Common spaces within buildings

Similar to urban public spaces, there is consistent agreement in the literature that functional variety are needed to support a broad range of user preferences and activities within buildings. Architectural design elements such as layout and openness create the frame conditions for an interior setup of temporary elements with different shapes, sizes and orientations [45]. In terms of perceived importance, studies identify spaciousness, noise conditions, crowdedness, comfort and cleanliness as most important attributes [32]. This aligns with other studies suggesting that the visual comfort, noise levels and window views all had a statistically significant correlation to overall satisfaction [46, 15, 46]. In the context of work activities, studies indicate that satisfaction levels are more function-driven where aesthetic aspects only play a minor role [47].

Locational accessibility to support facilities therefore may have increased space preferences of users in common spaces [48, 23]. Early attempts that embrace open and flexible office designs include the ability to rearrange tables and seating to support interaction and communication. Campuses also implemented amenities such as cafeterias and fitness centers to support inter-disciplinary and cross-departmental interaction [30]. On a larger scale, locational accessibility of common spaces to surrounding functions like food courts, fitness centers, copy rooms, offices and so forth play a significant role in space preferences and may illustrate users' considerations of whether the location is accessible and well-placed for the purpose of their activity [48, 23, 49]. Thus, common spaces become part of a network of support functions that may determine its success, as walking distances [50, 24] and the distance to entrances [22] are strongly related to spatial choices.

The physical infrastructure, including space availability and support struc-

tures like technology and communication infrastructure are commonly mentioned to be functional barriers for work [51]. This also accounts for the conditions of equipment and access to wireless connections and power outlets [23]. Equipment adequacy and the types and arrangements of equipment and the ability to rearrange and move equipment is stated to increase the flexibility and improve task efficiencies [23]. In a study by [50], participants strongly agreed with the statement that technology-enhanced classrooms increased collaboration over traditional classrooms. A mismatch between user needs and space conditions is highlighted by another study, where the laptop use is not appropriately considered in the design, resulting in low use rates in group study rooms, at computers, and carrels prioritized for laptop use [21].

Thus, designers of modern workplaces and learning environments are responding to changing life and work patterns. Digitization has dramatically changed the conceptualization of physical space in workplaces. The most common workplace outside the organizational workspace is the home, yet few studies have examined the physical design and characteristics of home offices [51]. [14] found that students prefer the home for individual study activities that require concentration, where open and noisy areas like atria, corridors and catering areas did not serve the purpose of concentrative work. Preferences to study at home, however, are stronger for individual activities than for collaborative activities, which may be reasoned by comfort factors, habits and the the possibility to retreat [52]. However, for collaborative work, quiet and enclosed learning spaces were perceived as more suitable, while 63% of the survey's respondents preferred face-to-face contact to virtual contact [14].

In addition, there has been a wave of criticism directed towards shared and open spaces, particularly at workplaces. The main critique is the negative effect they have on tasks that require privacy, concentration and focus. According to [53], *"rather than prompting increasingly vibrant face-to-face collaboration, open architecture appeared to trigger a natural human response to socially withdraw from office mates and interact instead over email and IM."*[53, p. 1]. Therefore, in order to activate common spaces, the provision of opportunities to choose

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from should facilitate autonomous and interactive engagement in the same space [30]. Thus, opening up does not necessarily result in increased interaction or a better physical adaptation to new working styles, but may only function in balance with surrounding support structures that are logically integrated into the daily processes of time-activity-user-space relationships [54, 55].

4.2. Socio-physical determinants on space choice behaviors

Both urban public spaces and common indoor spaces are influenced by physical and socio-physical factors that determine space-choice behaviors and space use qualities. The concepts described in this section are directly linked to physical constraints such as spaciousness, openness and ambient environmental conditions, and can be applied to both public outdoor and common indoor spaces.

4.2.1. Crowdedness and territoriality

Crowdedness and user territoriality are indicators that show different effects on space choices and perception [45]. [56] studied the effect of crowdedness on user behaviors in an open, unconfined space in a library during peak hours. The study found that a collective, crowded atmosphere under stable conditions can motivate and support users conducting individual, concentrated activities [56]. Users that benefit from stable, collective atmospheres experience negative effects with sudden changes in occupancy patterns, such as when people leave the space, which affects others who experience negative emotions caused by emptiness [56].

Studies indicate that spaciousness can reduce the risk of crowding and over-stimulation. The latter have a negative impact on user satisfaction and well-being [57, 10]. Crowding research has found lower use levels for those seeking stress relief- in such cases, social stimulus is less important [58], and others found higher preferences for enclosed workspaces than open workspaces [51]. [48] found that students deliberately withdraw themselves from noises and crowds in order to effectively do self-directed work and avoid disturbances. Students with the preference for privacy also preferred quiet learning spaces, which correlated with

circulation flow intensities and occupancy fluctuations in choosing their spaces to study [19]. This is supported by [59], who found that spaces most commonly associated with negatively perceived well-being effects are 'in-between' spaces, including corridors, pathways and stairwells.

4.2.2. Privacy and interaction

The earlier expressed dynamics of combinations between physical determinants imply that personal rules and norms about privacy and interaction vary according to space-use conditions. The issues of privacy and interaction intersect with the distinction between open and enclosed spaces. For example, [10] found that shared office environments are correlated with higher levels of uncooperative behavior and distrust between coworkers. Similar to earlier results, work performances of cognitive tasks can be impaired by distractions. As a result, many occupants reject socializing activities and desire privacy when working in public spaces [60]. Spaces that fulfil a broad range of requirements enable occupants to complete their tasks in common spaces and enhance their sense of place [61, 26]. The focus of new designs of flexible learning environments should therefore go beyond facilitating specific strategies such as collaboration and interaction, but rather focus on incorporating a broad range of design features such as breakout spaces, presentation spaces, outdoor learning areas, and others [30].

4.2.3. Self-control and autonomy

Social stimuli is a major source of distraction and closely related to the need for self-control and autonomy in common indoor and public outdoor spaces [32, 1]. The perceived effectiveness of well-designed spaces – meaning the ability to conduct a certain activity in an appropriate way – involves a high degree of autonomy and control [27], social distances [62], privacy and spaciousness [47], and flexibility and adjustability [26]. Flexible workers studied in modern public spaces with WIFI access have shown to maintain their control by not socializing with others when working, but interacting online instead [43]. Self-

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control and autonomy is also related to spatial privacy and personal space, which can further be broken down into the ability to visually and physically withdraw oneself from the dynamic processes taking place in common or public spaces [23, 32]. Other studies, however, found that students purposely choose common and public spaces to maintain their concentration even with other activities and social stimulation around them [56]. The relevance of flexibility and functionality is shown in successfully maintaining the equilibrium between stability and responsiveness to change [47, 27]

4.2.4. Ambient environmental conditions

The design and layout of spaces is closely related to ambient environmental conditions that may determine space-choice behavior. [51] found that noise, lighting, and circulation flows hinder flexible workers from working appropriately, since they have little control over the sources of noise. These unfavorable conditions lead users to reject a space in order to find more appropriate conditions for a planned activity [51].

Studies indicate that individual activities would pair with quiet, uncrowded spaces, while groups placed more importance to conversation privacy and interaction [32, 48]. Noise cannot be identified as beneficial for learning or working, but many young people and extroverts enjoy occupying spaces with higher levels of stimulation and noise [60]. Studies find that the soundscape may strongly influence cognitive and communicative tasks where intermittent noise is proven to be more disruptive than continuous noise [60].

Just like high levels of privacy and noise levels, lighting also becomes a dominant space attribute when choosing spaces. Certainly for work of high complexity, low lighting levels are negatively associated with positive emotions, flow and activity worthwhileness [63]. The luminance of artificial light, the directions of natural light, thermal comfort, air quality, and noise levels are all environmental factors that affect the space preferences and health [64, 65, 66, 15, 23].

It is shown that both physical and socio-physical influences on space choice

	Mutual effects on common indoor and public outdoor spaces
Flexibility and functional diversity	Flexibility, functional diversity, and support structures like technical equipment and seating opportunities would increase the use and purpose of public spaces - allowing for a broader range of user activities to fulfil the needs and preferences of public space users.
Proximity and Accessibility	The spatial form and layout of temporary design elements can respond to dynamic user behaviors and accessible, well-maintained support structures like technology, communication infrastructure, and power outlets are functional mediators to an increased activity diversity in common building spaces.
Ambient environmental conditions	Social stimuli is a major source of distraction and closely related to the need for self-control and autonomy; Clusters of semi-sheltered and spatially diverse spaces in an open space configuration attract more occupants than completely enclosed spaces.
Crowdedness and territoriality	Crowdedness and user territoriality are indicators that show different effects on space choices. Occupants reject socializing activities and desire privacy when working in public spaces. Personal rules and norms about privacy and interaction vary according to space-use conditions. Power and status determine the ability to control and demand privacy or interaction.
Self-control and autonomy	In common indoor spaces, space users have little control over the sources of undesired conditions that lead users to reject a space in order to find better conditions for both interactive and self-directed activities.
Privacy and interaction	Instead of focusing on specific strategies such as collaboration and interaction, public spaces can focus on incorporating a broad range of designs such as breakout spaces, presentation spaces, outdoor learning areas, and others.

Table 1: Mutual effects of socio-physical determinants on common indoor and public outdoor spaces

behaviors differ between open and enclosed environments: On an urban scale, literature reveals that the availability, access and provision of public spaces play a larger than the perceived amount of present design features such as natural elements or furniture types. The use of public outdoor spaces however increase

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with functional diversity and spatial connection, which indicates that public outdoor spaces - similar to common indoor spaces - depend on a combination of support functions in order to live up to the needs and preferences of public space users. On a building scale, studies also highlight the importance of an integrated physical infrastructure (i.e. space availability, locational accessibility, and support structures like technology and communication infrastructure), and common spaces become part of a network of support functions that may determine its success. This also involves crowdedness, territoriality, privacy, self-control and autonomy, which in combination create an ambient environment that facilitates and balances autonomous and interactive engagement within the same space. Table 1 summarizes the findings from the previous subsections that can be applied to both public outdoor and common indoor spaces, as shown in Fig-ure 4. In the following, however, the authors focus on the mutual barriers and trade-offs between of implementing and maintaining common indoor and public outdoor spaces.

4.3. Barriers and trade-offs

This section addresses the mutual challenges and barriers for implementing and maintaining common indoor and public outdoor spaces. This includes the economic, legal, infrastructural, spatial, and environmental influences on the overall existence of common and public spaces. Trade-offs related to the use of these spaces, most commonly associated to opposing space requirements for individual and group activities, will thereafter be outlined to clarify biases for user activities.

4.3.1. The mutual barriers of common indoor and public outdoor spaces

As with common indoor spaces, public outdoor spaces have a variety of intended purposes, though primarily recreational and environmental [27]. [36] shows a direct relation between the use frequency of green and social spaces and the positive impacts of social interaction and community ties on mental well-being. Despite the comprehensive documentation in literature about the

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positive effects of high quality, well-designed public open spaces, a broad range of barriers constrain their implementation into the urban fabric [67].

The ever-increasing pressure to optimize operational costs is often in opposition to aligning spaces to the actual needs of users. On a building level, the combination of processes between people and building functions can determine to some degree whether an organization's missions and goals are satisfied, as it provides the means by which users can adapt the environment to their needs [30]. On a city level, physical barriers are often related to property rights and spatial planning failures, such as busy roads or railroads separating the public spaces from their users. In terms of attractiveness, barriers for public outdoor spaces are related to specific equipment and management rules, and just as common indoor spaces, noise and other nuisances in the surroundings dissuade people from occupying these spaces [6].

High density-developments are commonly noted to increase the pressure on the existence of public outdoor spaces [43]. Studies have consistently demonstrated that funding of public spaces is an ongoing challenge for local governments, and private investment decreases as the scale of a given common space increases [27]. In terms of urban green spaces, barriers to their availability are often related to conflicting interests of many different stakeholders, which are further exacerbated by legal and governmental planning [6]. The lack of general appreciation towards public spaces can be exemplified by the lack of investment into informal public spaces, especially when local zoning plans do not consider the benefits of these spaces.

Perceived accessibility is one of the most commonly measured factors when it comes to urban neighborhood studies [68]. Concerning urban green spaces, perceived barriers that affect neighborhood satisfaction or frequency of use include unattractiveness, low maintenance, lack of walkability, long distances and safety-related issues [43]. Study results show that being surrounded by built structures with major roads and limited natural elements negatively affect the sense of mental well-being [69]. There is a growing understanding about the differences in restorative potentials when it comes to built, mixed-built, and

natural environments [36, 11].

The demands on public spaces reflect the diversity of public life and behaviors embedded in a complex set of forms and functions. Accordingly, they are accessible to the public realm and provide space for various user needs and activities [3]. Health and well-being is a common stated benefit of public spaces that in form of occupancy preferences for a given activity in an appropriate environment relates to the layout and interiors of spaces (e.g. [17, 53]), their environmental quality (e.g. [63, 70], and connectedness to surrounding support functions (e.g.[23, 30, 71]). Basic activities such as walking, stopping, sitting and meeting others are related to building social relations and enhancing community identity [1]. On a larger scale, public spaces can be interrelated with other economic and recreational activities that contribute to the culture of a place [72, 73]. As such, emerging consensus among researchers indicate that public spaces need to be diversified in function to facilitate flexibly a range of current and future uses [74][27].

Table 2 summarizes comparable barriers with the implementation and maintenance of common indoor spaces and public outdoor spaces. The barriers with their usage go hand in hand with the trade-offs between open and enclosed spaces, which will be discussed in section 4.4.

4.3.2. Trade-offs between sociality and individuality

The growing diversity of spaces with similar characteristics to public spaces are observed throughout industries and sectors. In many new designs of learning environments, traditional spaces have been replaced with informal learning spaces to support contemporary and flexible working styles. A similar trend is seen in workplaces, where traditional enclosed offices have been transformed to open-plan spaces. Meanwhile, issues of crowdedness and related noise generation is often referred to as the consequence of open confined spaces, which can hinder individual activities that require concentration and focus.

In addition, health and well-being aspects may be one of the major driving forces in discussions about spaces that serve both social and individual needs,

Barriers	Common Indoor spaces	Public Outdoor spaces
Economic prioritization	Operation and maintenance costs, impaired functionality	Low maintenance, privatization and commercialization
Policy constraints & benchmarks	Standards and benchmarks, legal and regulatory barriers	Lack of valuation and data collection methods
Equipment & support structures	Support structures, equipment, ICT, catering services, furniture	Specific equipment and management rules
Densification & space-efficiency	Utilization rates, existing building configurations	Urban densification, land use patterns and future trends
Environmental discomfort	Overstimulation, noise, crowdedness, privacy, ambiance	Noise and other nuistances, privacy, ambiance
Locational accessibility	Locational accessibility, distances and support facilities	Perceived accessibility, long distances

Table 2: The mutual barriers of implementing and maintaining common indoor and public outdoor spaces.

but empirical studies are contentious and mixed. Therefore, research tend to suggest a profound balance between open and enclosed spaces. In terms of social and recreational activities, findings from literature suggest that building users appreciate informal spaces that can meet their social and recreational needs without disturbing others [27]. The challenge of balancing the trade-offs between open and enclosed spaces is frequently mentioned in the reviewed literature (see e.g. [75, 76, 30, 77]). In addition to common spaces being encapsulated by surrounding functions, spaces with physical and visual privacy are getting increased attention to counteract or compensate the disadvantages of open spaces.

With a broad consistency throughout workplaces, learning environments or libraries, studies often show use preferences for enclosed spaces when it comes to both collaborative and individual working activities (e.g. [78, 14, 60]. In terms of social and recreational activities on the other hand, findings from literature suggest that building users appreciate informal, common spaces (e.g. [14]). Under certain conditions, common spaces have shown to support both individual and collaborative work. Examples in literature include:

- Common spaces can generate a collective atmosphere, and concentration

that is vulnerable to changing crowdedness and density conditions [66].

- The degree of enclosure is highlighted to determine spatial choices and supports previous statements of preferences for secure visual privacy while being willing to share a common atmosphere with peers [30].

- Common spaces may attract a certain target group. A moderating effect of an appropriate use of common spaces is found on work related outcomes, meaning that those who are more likely to use common spaces can take advantage of spatial opportunities, resulting in increased well-being and favorable attitudes [30].

- Occupied and noisy spaces can be associated with an individuals' perceived conversational privacy when choosing a space for collaborating or socializing [60].

- The frequencies and duration of possible space uses may be an important indicator on the successful utilization of common spaces. For frequent users, acoustically conflicting activities such as group work activities were the main reason to come to a library, while for for non-frequent users, socializing activities were the main reasons to occupy the space [56].

- Within common spaces, flexibility and functions that maintain the equilibrium between stability and responsiveness to change, determine the degree of self-control, autonomy, privacy and adjustability [30].

The trade-offs described in the literature suggests that the access to a variety of spaces comprised of different spatial qualities is perceived as particularly important and cannot be limited to physical factors. Considerations about the comprehensiveness of socio-physical and personal factors are therefore essential in understanding how occupants use different building functions [79]. Here, cultural and contextual user experience is important to base the understanding of how spaces are perceived [80, 81]. Table 3 synthesizes the findings in order to clarify the benefits and drawbacks of open and common spaces. The empowering

means of digitalization led to an increased demand for flexibility in everyday life [30], which may be the primary opportunity of common indoor spaces.

	Open	Enclosed
Personal Control and Privacy	No	Yes
Crowdedness and Vitality	Yes	No
Collective Atmosphere	Yes	No
Adjustability and Adaptability	Yes	No
Cognitive Performances	No	Yes
Collaboration and Social Support	Yes	No

Table 3: Trade-offs between open and enclosed spaces.

Given the mutual barriers that public urban spaces and common building spaces share, as well as the trade-offs between sociality and individuality, we derive the benefits and drawbacks of open spaces in both urban and building settings. Using these, we address our final research question: to identify the trade-offs between open and enclosed environments for a balanced implementation and use of shared and public space. Here, providing flexible and adjustable environments that dynamically respond to changing user activities positively influences spatial choices for not only recreational and social activities, but also for working activities that require self-direction and concentration (e.g. [14, 53]).

4.4. Balanced implementation for open spaces

A sensitive approach for designing and integrating common spaces is needed to solve complaints within open environments, which have been linked to higher levels of uncooperative behavior and distrust between space users. Table 4 presents the main benefits and drawbacks of public outdoor spaces found in literature. It is found that natural design elements can be integrated into public outdoor spaces. Compared to indoor spaces, these can provide environmental benefits on a larger scale in order to improve a greater sense of mental well-being [36]. The provision of social and green spaces increases optional and 'in-between' activities, which can affect the probability of spontaneous interaction and can improve community ties [33]. For working activities, public outdoor

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spaces show less suitability due to increased levels of distraction and physical and visual overexposure. In order to increase the range of activities in public outdoor spaces, research indicates that functional diversity and the strategic placement of physical design elements would have the potential to increase uses that go beyond optional and in-between activities. The provision of technical equipment such as power-plugs, for instance, is still limited in public outdoor spaces while having the potential to increase satisfaction and use levels for both leisure and work-related activities [43].

Benefits	Drawbacks
The use of Public outdoor spaces have shown to increase with the land-use diversity factor, which means that functional diversity and higher density development and a well-connected street network support the use of public spaces.	Public outdoor spaces are surrounded by physical and social environments. The extent and character of public spaces however often not reflect these local needs and contexts.
Public Outdoor Spaces are among the highly rated spaces for 'in-between' activities, such as taking a break or having lunch, which tends to increase spontaneous and planned social interaction and ties between people.	Public Outdoor Spaces are vulnerable to perceptions of distraction, lack of privacy, and stress symptoms due to high noise levels and visual overexposure.
Studies about public outdoor spaces indicate that the perception of proximate green and social spaces, as opposed to impervious hardscapes, result in a greater sense of mental well-being and place-making	Public outdoor spaces are not universally perceived as suitable locations for all sorts of activities, additional support functions may offer increased spatial diversity to fulfil the needs and preferences of public space users.

Table 4: Benefits and Drawbacks of Public Outdoor Spaces.

Table 5 presents the benefits and drawbacks of common indoor spaces found in literature. Opportunities of common indoor spaces involve changing lifestyles and working approaches towards more autonomy. Increased knowledge of organizational costs related to human and personal needs of building users can

support strategic choices of interior design elements such as furniture and other temporary elements to counteract the effects of noise and privacy issues. Moreover, the provision of functional support to perform the basic activities in common spaces with minimal assistance and flexibility can be critical to work related outcomes, which the provision of opportunities to choose from may facilitate autonomous and interactive engagement [82][83]. A successful integration of common spaces into the general building configuration can help support and maintain social relationships and collaboration, which is seen to support psychological aspects such as managing emotions and reactions, and facilitate self-efficacy through a sense of coherence and control.

Benefits	Drawbacks
Common indoor spaces can help to provide flexibility and functionality in maintaining the equilibrium between stability and responsiveness to change.	Common indoor spaces are perceived unsuitable for many working activities due to distractions and other disturbances.
Common indoor spaces can have positive impacts of social interaction and organizational ties on mental well-being and comfort.	Noise and human circulation are major sources of distraction and can closely be related to the need of self-control and autonomy in common and public spaces.
Spaciousness can show reductions in negatively associated risks of crowding and overstimulation on user satisfaction and well-being.	Common space users withdraw themselves from noises and crowds in order to effectively do self-directed work and not be disturbed.
Common spaces attract certain target groups and can shape and improve inner-organizational processes and philosophies.	Noise, lighting, and circulation flows hinder flexible workers from working appropriately, since they only have little control over environmental conditions.

Table 5: Benefits and Drawbacks of Common Indoor Spaces.

5. Discussion and Conclusions

Common spaces have become popular throughout industries to respond to the dynamic requirements of modern workplaces and working behaviors. Workplaces are among the most common types of physical environments that people inhabit in their daily lives and are standing under a radical change towards more flexibility and commonality. Literature reveals parallels between undervaluing public space in cities and undervaluing common space in buildings. Public urban spaces and common spaces in buildings share common characteristics in that they serve as physical link between building and city functions, and provide multi-purpose space for a diverse range of user activities. While many workplaces and learning environments particularly focus on facilitating collaborative and social activities, literature discloses the lack of sufficient spaces for retreat and concentration. The shift towards collaborative and flexible work approaches will continue to grow, which goes hand in hand with an increased need for quiet informal spaces in future workplaces and learning environments. The literature suggests that flexibility not only favors interaction and collaboration, but also individual activities that require a high level of focus. Being dependent on too few spatial qualities would stand in contrast to the dynamic nature of spatial choice behaviors. Optimal space conditions that balance opposing concepts depend on the integration of multiple spatial qualities in a common space that effectively promote a variety of activities [84].

The mutual barriers of common spaces include economic prioritization, policy constraints and benchmarks, equipment and support structures, densification and crowdedness, environmental comfort, and locational accessibility. These barriers are analogous between common buildings spaces and public urban spaces, particularly when it comes to the initial challenges of implementation and operation. However, such barriers may be perceived differently by different users, and this diversity of needs creates a challenge in functionally balancing space provisions within common indoor and public outdoor spaces. The benefits and drawbacks of informal open spaces depend on their alignment

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to dynamic user needs, yet conclusions about the potential of common spaces to support collaborative and interactive processes within an organization are still not clear. The behavioral approach taken in this research, with its implicit aim to distinguish the user values of open and enclosed spaces, can help to understand the policies that govern them. Research suggests that a collaborative governance structure could help to include all relevant stakeholders in the decision making of investments into common goods such as public spaces. Previous policies tend to take individual preferences as given, and social needs deviate from economic rationality. Instead, public policies for urban commons should be based on cooperation and collaboration, in order to understand the diversity and irrationality of decisions that do not focus on individual and collective well-being [5].

When it comes to physical determinants of common and public spaces, studies reveal layout and design quality, ambient environmental conditions and support structures as the main determinants on spatial choices. Moreover, the atmosphere and character of a space is more important for optional activities, while furnishing played a larger role for work activities. Common spaces are not universally perceived as suitable locations for all sorts of activities and highly depend on additional support functions. Spaciousness and support structures like technology and communication infrastructure are common functional barriers for work. Locational accessibility and functionality is highly praised in the literature to counteract the negative effects of common and public spaces on spatial choices. Aesthetic appearance showed significant relation to satisfaction but less on occupancy preferences. The combination of traditional and modern types of functions may facilitate work or learning outcomes most efficiently, but the direct differentiation of health and well-being effects in open and enclosed spaces is rarely targeted in the reviewed literature. Indirectly, the literature still reveals a clear distinction between the two space typologies, both in terms of space choice behaviors, health and well-being, and work product outcomes.

The concepts of perception, cognition and behavior dominate the assessment of human responses to the built environment. Common spaces should support

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psychological aspects, facilitate self-efficacy, enable the development and maintenance of social relationships with others, and provide functional support to perform the basic activities with minimal assistance. Crowdedness and territoriality, privacy and interaction, and self-control and autonomy have been identified as main categories of socio-physical determinants on spatial choices. In the literature, these stand in strong contrast with enclosed spaces, as open and common spaces often do not serve individual needs such as privacy and territoriality. Contrarily, examples can be found where the stimulation of a collective atmosphere even within noisy and crowded spaces seem to motivate and support space users in working together and alone. At the same time, crowding research has also linked low use levels when seeking stress relief (when social stimuli are less important).

The literature considers issues of privacy and interaction on the one hand, and open and enclosed spaces on the other often in isolation. However, we find that successful common spaces have the potential to increase interaction among a broad range of users, user groups and activities. Demographic diversity and democratic and inclusive processes may occur, comprising important social factors for common and public spaces. Flexibility and adjustability are perceived positively by users and highlight the facilitating role of the physical space to stimulate user attitudes, motivation, engagement and well-being. The literature further implies the potential of increased autonomy in common spaces with providing a variety of choices that support aspects of self-regulation, collaboration and interaction. Sociality and commonality is a major source of distraction and can be closely related to the need of self-control and autonomy in common and public spaces. The negative implications of common and public spaces on spatial choices could be interpreted as the high inter-dependency between changing psycho-social needs and appropriate diversity. This reflects the relevance of flexibility and functionality in maintaining the equilibrium between stability and responsiveness to change. The perceived effectiveness of well-designed spaces involves a high degree of autonomy and control, privacy and spaciousness, and adjustability. In terms of ambient environmental condi-

tions, the luminance of artificial light, the directions of natural light, thermal comfort, air quality, and noise levels are all environmental performances that affect the decision on spaces for a users' intention. Crowdedness and noise levels are the most important factors in both perception and satisfaction, indicating that these space attributes are salient for users when they make space choices. Contrary to these findings, some others reported components of perceived suitability and well-being were greater in spaces with lower background noise levels, but with more user-generated sound. Just like high levels of privacy, noise levels become a dominant space attribute when choosing which space to reject. Conversely, low levels of noise would not attract space users, but other users that form a certain collective quality would, in combination, determine spatial choices and thereby attract users.

In this article, a structured literature review is applied in order to collect information from a broad range of sources, with the aim to increase transparency and replicability of an unbiased literature research. A systematic approach aids a rigorous synthesis across disciplinary themes, which reflects the versatile nature of the proposed research questions in section 1.

Shortcomings with structured literature reviews include the limitation in creativity and intuition when searching for literature, as this approach does not allow high flexibility in manually tailoring and pinpointing search directions. In addition, SLRs highly depend on the quality of titles and abstracts of the search findings. The limited flexibility of SLRs can be seen in the lack of sophisticated findings about scalable benefits of the different space typologies. In terms of economic prioritization, we find that a well-balanced design between open and enclosed spaces at both scales could synergistically benefit economic and social aspects in minimizing operation costs in tandem with improved health and wellbeing. However, our study highlights clear similarities between the barriers and important physical and social determinants of common indoor and public outdoor spaces. The trade-offs between open and enclosed indoor spaces highlight the importance of understanding the use and purpose of spaces, the opposing and complimentary design elements and behaviors that reveal promising direc-

tions for future research when it comes to promoting a balanced use of common and public spaces. A commonly referred answer on the trade-offs between spaces and their suitability for various user needs directed towards common indoor and public outdoor spaces is system thinking. Here it is about the provision of possibilities for users to choose and adapt spaces to their needs, that we think of buildings as combinations of functions, and make them visible. Facing space scarcity means that modesty is a desirable behavior, and that applies to one's personal surroundings as well. For this, traditional spaces will not fit into the development, which means that there are completely new dimensions of tasks and challenges in which common spaces may play a vital role both on a building and urban scale. In our case, many learning environments and workplaces were subjects of enquiry inside buildings, while green spaces dominate studies on an urban scale. The methods used on both scales are rather unilateral; surveys and literature reviews were mainly used to assess urban phenomena, and inside buildings, surveys were by far the most used method, with issues of context-dependency and lack of scalability. For example, studies using digital means like sensors, seating sweeps, cameras or wearable devices to investigate human behavior in physical settings are poorly represented in the search findings. The lack of methodological diversity within this field may have several reasons, including lack of funding for digital data collection tools, routines in research procedures, time limitations, and the dynamic nature of human behavior itself, where technological advancements and new data sources reflect a strong opportunity for future research.

Drawing on the findings of this SLR, common spaces may play an important role in mitigating emerging problems with existing building and city configurations, ranging from underutilized spaces and poorly balanced organizational functionality, to the unsuitability of traditional spaces to today's user behaviors. With the increasing flexible and overlapping uses of spaces, and the desire for increased compatibility of spaces to user activities, common and public spaces face the unique opportunity to encourage the collective power of stakeholders in order to contribute to the larger community with providing synergistic benefits

to the operation, and most importantly, the use of buildings and cities.

6. Funding acknowledgement statement

7. Appendix A: The Filtering Scheme

# Ref.	Scale	Focus Area	Authors	Title	Types	Drivers	Methods	Physical and socio-physical influences on space choice behaviors	Benefits and drawbacks for the implementation and use of shared and public space	Trade-offs between open and enclosed environments and the balance between user needs
1	Urban	Built Environment	Hadavi (2017)	Direct and indirect effects of the physical aspects of the environment on mental well-being	Journal Article	Health and Wellbeing	Survey	X	X	X
2	Urban	Built Environment	Hadavi (2015)	Nearby Nature and Mental Wellbeing: A Designer's Perspective.	Journal Article	Health and Wellbeing	Survey, Interviews	X	X	X
3	Urban	Built Environment	Gatersleben Griffin (2017)	Environmental stress	Journal Article	Health and Wellbeing	Literature Review	X		X
4	Urban	Built Environment	Hadavi, et al. (2018)	How does perception of nearby nature affect multiple aspects of neighbourhood satisfaction and use patterns?	Journal Article	Market Competition	Survey	X		X
5	Urban	Built Environment	Turton (2016)	Defining residential place attachment and exploring its contribution to community and personal environmental actions.	Thesis	Health and Wellbeing	Literature Review, Survey, Interviews	X		
6	Urban	Green Spaces	Shanahan, et al. (2016)	The benefits of natural environments for physical activity	Journal Article	Health and Wellbeing	Literature Review		X	X
7	Urban	Green Spaces	Loret de Mola, et al. (2017)	On the use of hedonic price indices to understand ecosystem service provision from urban green space in five Latin American megacities	Journal Article	Market Competition	Google Earth Images, Database		X	X
8	Urban	Green Spaces	Toutakhane (2018)	Influencing factors on performance of social behavior settings at parks and green spaces of Chelvir	Journal Article	Changing Lifestyles	Survey	X		X
9	Building	Learning Spaces	Cogswell Goudsward (2018)	Building Demand and Reaching for Capacity	Journal Article	Market Competition	Survey	X	X	
10	Building	Learning Spaces	Beckers, et al. (2016)	Why do they study three? Diary research into what students' learning space choices in higher education	Journal Article	Changing Lifestyles	Self-Reporting	X		X
11	Building	Learning Spaces	Yuan, et al. (2017)	An Investigation of University Students' Classroom Seating Choices	Journal Article	Work Performances	Survey	X	X	X
12	Building	Learning Spaces	Van der Voordt (2016)	Study place preferences: quiet please	Journal Article	Changing Lifestyles	Literature Review	X	X	X
13	Urban	Learning Spaces	Marcella Kesoumssari (2017)	Students' sitting preferences at plaza in educational institution	Journal Article	Changing Lifestyles	Survey, Interviews, Observation	X	X	
14	Building	Learning Spaces	Mantooth (2017)	Learning Spaces and Self-Efficacy in Undergraduate Statistics	Thesis	Work Performances	Survey	X		X
15	Building	Learning Spaces	Goodnight Jettnee (2016)	Sending out an SOS: Being mindful of students' need for quiet study spaces	Journal Article	Changing Lifestyles	Survey	X	X	
16	Building	Library	Hristov (2018)	Space Preference at Oakman Library: What Students Value and Activities They Engage in	Thesis	Health and Wellbeing	Interviews	X	X	X
17	Both	Personal Spaces	Sorokowska, et al. (2017)	Preferred interpersonal distances: a global comparison	Journal Article	Health and Wellbeing	Survey	X		
18	Urban	Public Spaces	Hadavi Kaplan (2016)	Neighborhood satisfaction and use patterns in urban public outdoor spaces: Multidimensionality and two-way relationships	Research Paper	Market Competition	Survey	X		X
19	Urban	Public Spaces	Gharanpeor, et al. (2019)	Theory of Place in Public Space	Journal Article	Market Competition	Survey	X	X	
20	Both	Work Spaces	Mangone, et al. (2017)	Bringing nature to work: Preferences and perceptions of constructed indoor and natural outdoor workspaces	Journal Article	Work Performances	Survey	X	X	X
21	Building	Work Spaces	Wolkers, et al. (2019)	The relation between activity-based work environments and office workers' job attitudes and vitality	Journal Article	Work Performances	Survey	X	X	X
22	Both	Work Spaces	Özguner (2017)	The influence of space characteristics on the preference of codes as workplaces	Journal Article	Work Performances	Survey, Observation	X		
23	Both	Work Spaces	Ng (2016)	Behavioral mapping and tracking	Journal Article	Space Utilization	Behavioral Mapping Theory	X		
24	Urban	Green Spaces	Arabregér Eiler (2015)	Are urban visitors' general preferences for green-spaces similar to their preferences when seeking stress relief?	Journal Article	Health and Wellbeing	Survey			X
25	Urban	Green Spaces	Jennings, et al. (2016)	Advancing sustainability through urban green space: cultural ecosystem services, equity, and social determinants of health	Journal Article	Health and Wellbeing	Literature Review			X
26	Urban	Green Spaces	Biernacka Kronenberg (2018)	Classification of institutional barriers affecting the availability, accessibility and attractiveness of urban green spaces	Journal Article	Market Competition	Literature Review		X	X
27	Urban	Green Spaces	Park (2019)	Park and Neighborhood Attributes Associated With Park Use: An Observational Study Using Unmanned Aerial Vehicles	Journal Article	Market Competition	Survey	X		
28	Urban	Green Spaces	Bouhon, et al. (2018)	Factors shaping urban greenspace provision: A systematic review of the literature	Journal Article	Market Competition	Literature Review		X	X
29	Both	Learning Spaces	Beckers, et al. (2016)	Learning space preferences of higher education students	Journal Article	Work Performances	Survey	X	X	X
30	Building	Learning Spaces	Mikkola Hofftensten (2016)	Developing a conceptual framework for participatory design of psychosocial and physical learning environments	Journal Article	Health and Wellbeing	Survey	X	X	
31	Building	Learning Spaces	Yuan, et al. (2017)	An Investigation of University Students' Classroom Seating Choices	Journal Article	Work Performances	Survey	X		
32	Building	Learning Spaces	Beckers (2016)	Higher education learning space design: form follows function?	Journal Article	Work Performances	Survey		X	
33	Building	Learning Spaces	Zeivots Schuck (2018)	Needs and expectations of a new learning space: Research students' perspectives	Journal Article	Health and Wellbeing	Interviews, Survey	X	X	
34	Building	Learning Spaces	Duraehpour (2018)	Value Generation in Higher Education Space Management Through User-Centric Data Analytics	Thesis	Market Competition	Survey, Observation	X	X	X
35	Building	Learning Spaces	Turpin, et al. (2016)	What makes an informal learning space?	Book	Changing Lifestyles	Sweeps Survey	X	X	
36	Building	Learning Spaces	Lowe, et al. (2008)	Commuter Campus in Transition: Meeting the Changing Needs of Students through Mixed-Methods Assessment	Thesis	Changing Lifestyles	Survey, Interviews, Observation	X		X
37	Building	Library	Nemchr (2017)	First-generation Undergraduate Library Users: Experiences and Perceptions of the Library as Place	Thesis	Health and Wellbeing	Self-Reporting	X		X

# Ref.	Scale	Focus Area	Authors	Title	Types	Drivers	Methods	Physical and socio-physical influences on space choice behaviors	Benefits and drawbacks for the implementation and use of shared and public space	Trade-offs between open and enclosed environments and the balance between user needs
38	Building	Library	Olyvira (2016)	Space preference at James White Library: What students really want	Journal Article	Health and Wellbeing	Survey, Interviews, Observations	X	X	X
39	Building	Library	Gulliksen Meyer (2016)	Collecting space use data to improve the UX of Library space	Journal Article	Changing Lifestyles	Sweeps, Survey	X	X	
40	Building	Library	Hillman, et al. (2017)	User-focused, user-led: space assessment to transform a small academic library	Journal Article	Space Utilization	Sweeps, Survey	X	X	
41	Building	Library	Given Archibald (2015)	Visual traffic sweeps (VTS): a research method for mapping user activities in the library space	Journal Article	Space Utilization	Observations, GIS	X	X	
42	Building	Library	Kim (2017)	User perception and use of the academic library: A Correlation Analysis	Journal Article	Work Performances	Survey		X	
43	Building	Library	Mehta Cox (2019)	At home in the academic library? A study of student feelings of "homeness"	Journal Article	Changing Lifestyles	Observations	X	X	
44	Building	Work Spaces	Perera, et al. (2019)	Adaptability of the shared workspace concept, for office buildings in Sri Lanka	Journal Article	Changing Lifestyles	Interviews	X	X	
45	Building	Work Spaces	Wohlers, et al. (2019)	The relation between activity-based work environments and office workers' job attitude and vitality	Journal Article	Work Performances	Survey		X	X
46	Building	Work Spaces	Ozgluer (2017)	The influence of space characteristics on the preference of cafes as workplaces	Thesis	Work Performances	Survey	X	X	
47	Both	Learning Spaces	Kim, et al. (2018)	Space choice, rejection and satisfaction in university campus	Journal Article	Space Utilization	Survey	X	X	
48	Building	Learning Spaces	Andrews (2016)	High school Learning Spaces: investigating Year 6 students' imaginings and representations	Thesi	Work Performances	Interviews	X	X	
49	Building	Library	Cha Kim (2018)	The role of space attributes in space-choice behaviour and satisfaction in an academic library	Journal Article	Space Utilization	Survey	X	X	
50	Building	Library	Cha Kim (2015)	A conceptual framework of an agent-based space-use prediction similar to system	Journal Article	Market Competition	Agent-Based Modelling		X	
51	Building	Library	Cho, et al. (2017)	Modelling building users' space preferences for group work: a discrete-choice experiment	Journal Article	Space Utilization	Observations	X	X	
52	Urban	Built Environment	Bittencourt, et al. (2015)	The Usability of Architectural Spaces: Objective and Subjective Qualities of Built Environment as Multidisciplinary Construction	Journal Article	Health and Wellbeing	Literature Review	X	X	
53	Urban	Green Spaces	Pietilä, et al. (2015)	Relationships between exposure to urban green spaces, physical activity and self-rated health	Journal Article	Health and Wellbeing	Survey, GIS	X		X
54	Urban	Green Spaces	Wan, et al. (2018)	The moderating effect of subjective norm in predicting intention to use urban green spaces: A study of Hong Kong	Journal Article	Health and Wellbeing	Mobile Survey	X		
55	Urban	Green Spaces	Hernandez, et al. (2018)	Urban green spaces as a component of an ecosystem function, services, users, community involvement, initiatives and actions	Journal Article	Market Competition	Survey	X	X	X
56	Urban	Green Spaces	McFarland (2017)	The relationship between the use of green spaces and public gardens in the work place on mental well-being, quality of life, and job satisfaction for employees and ...	Journal Article	Market Competition	Survey	X		X
57	Urban	Healing Spaces	DuBose, et al. (2018)	Exploring the concept of healing spaces	Journal Article	Health and Wellbeing	Literature Review	X		X
58	Building	Learning Spaces	Van Merrinboer, et al. (2017)	Aligning pedagogy with physicalLearning Spaces	Journal Article	Changing Lifestyles	Literature Review		X	X
59	Building	Learning Spaces	Kariippanon, et al. (2018)	Perceived interplay between flexibleLearning Spaces and teaching, learning and student wellbeing	Journal Article	Changing Lifestyles	Interviews	X	X	X
60	Building	Learning Spaces	Ray (2015)	Design for mental health: integrating daylight and nature into campus spaces	Thesis	Health and Wellbeing	Survey, Interviews	X		X
61	Building	Learning Spaces	Liu, et al. (2019)	A comparative study of thermal comfort inLearning Spaces using three different ventilation strategies on a tropical university campus	Journal Article	Health and Wellbeing	Survey, Heat Stress Meters	X		
62	Building	Learning Spaces	Hughes, et al. (2016)	High School Spaces and Student Transitioning: Designing for Student Wellbeing. Research Report for Queensland Department of Education and Training	Report	Health and Wellbeing	Interviews	X	X	X
63	Building	Learning Spaces	Skiler (2015)	Ideal Learning Spaces: The student perspective	Thesis	Changing Lifestyles	Survey, Interviews, Observations	X	X	
64	Building	Learning Spaces	Loxsk (2018)	Key design elements of self-regulation spaces within inclusive elementary school classrooms	Thesis	Changing Lifestyles	Literature Review	X	X	
65	Building	Learning Spaces	Frankiewicz Kim (2015)	The Relationship Between Noise and Privacy in UBC Students' Study Spaces and Reported Stress Levels	Report	Health and Wellbeing	Survey	X	X	X
66	Building	Learning Spaces	Scamoli, et al. (2016)	The role of acoustics in the perceived suitability of, and well-being in, index-null Learning Spaces	Journal Article	Health and Wellbeing	Survey	X	X	
67	Urban	Open Spaces	Völker, et al. (2016)	Determining urban open spaces for health-related appropriations: a qualitative analysis on the significance of blue space	Journal Article	Health and Wellbeing	Interviews	X		
68	Urban	Open Spaces	Musacu Yilmaz (2016)	Seating Furniture in Open Spaces and Their Contribution to the Social Life	Journal Article	Health and Wellbeing	Literature Review	X	X	X
69	Both	Public Spaces	Ng (2016)	Public spaces as workplaces for mobile knowledge workers	Journal Article	Market Competition	Literature Review	X	X	X
70	Urban	Public Spaces	Aljawabra Nikolopoulou (2018)	Thermal comfort in urban spaces: a cross-cultural study in the hot and arid climate	Journal Article	Health and Wellbeing	Survey, Interviews, Observations	X		
71	Building	Social Spaces	Annni Ford, et al. (2015)	Preference on Social Spaces in High Density Condominiums in Malaysia	Journal Article	Space Utilization	Survey	X		X
72	Building	Work Spaces	Morrison Macky (2017)	The demands and resources arising from shared office spaces	Journal Article	Work Performances	Survey	X		
73	Building	Work Spaces	Mateos-Cecilia Navarro-Escudero (2018)	Creating Office Spaces in the Mediterranean. The importance of well-being, health and performance of office users	Journal Article	Work Performances	Self-Reporting	X		X
74	Building	Work Spaces	Nummerdmaa, et al. (2015)	Towards Playful Office Culture: Final Report of the OASIS Playful Spaces for Learning and Collaboration at Work (2014-2015) research project	Report	Space Utilization	Survey	X		X
75	Building	Work Spaces	Gordstadtel, et al. (2016)	Coworking spaces: A source of social support for independent professionals	Journal Article	Health and Wellbeing	Survey	X	X	

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