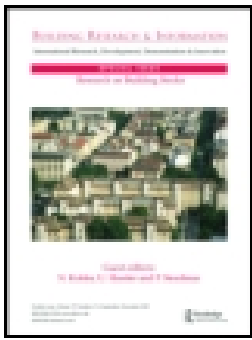# Relationship between the design characteristics of activity-based flexible offices and users' perceptions of privacy and social interactions

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Relationship between the design characteristics of activity-based flexible offices and users' perceptions of privacy and social interactions

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ABSTRACT

Activity-based flexible offices (AFOs) provide a variety of workspaces to meet the need for social interactions and privacy at work. This study investigates the relationship between the design characteristics of AFOs and users' perceptions of visual and acoustic privacy and social interactions. This case study is based on post-occupancy evaluations in three AFO layouts at a public service organization in Sweden. A mixed-method approach is adopted that combines questionnaires and layout analysis. In general, the results showed that while aesthetics received the highest satisfaction scores, office functionality, task support, storage and visual and acoustic privacy received the lowest ratings. Key design characteristics for AFOs were operationalized, observed and exemplified: zone diversity, proportion, readability, spatial enclosure, sharing ratios and functionality of furniture and tools. These insights may contribute to better-informed decisions about the design characteristics that influence privacy and social interactions in AFOs.

Introduction

Activity-based flexible offices (AFOs) are offices where users can choose where to work from a variety of non-assigned workspaces, according to the activity at hand or their preferences (Appel-Meulenbroek et al., 2011). This type of offices is typically planned for 70% occupancy (Bodin Danielsson & Bodin, 2008) and utilizes a desk-sharing policy to optimize space efficiency. AFOs have been designed to support two main categories of work: concentrated work that is often carried out alone and collaborative work performed in teams (Eismann et al., 2022; Wohlers & Hertel, 2017). These categories have had substantial implications for the design of AFOs (Bodin Danielsson & Bodin, 2008). Individual concentrated work has often been associated with the need for privacy and thus has been supported by enclosed workspaces that reduce distractions and disturbances (Bodin Danielsson & Bodin, 2008; Seddigh et al., 2014; Wohlers & Hertel, 2017). Collaborative work requires social interaction to facilitate communication and interaction. Collaborative work has often been supported by, for instance, enclosed meeting rooms for planned meetings, open group areas for informal communication, or coffee lounges for prompting spontaneous interactions (Davis et al., 2011; Haynes

et al., 2008; Wohlers et al., 2019). While literature shows consistent evidence that AFOs seem to support collaborative work, concentrative work seems to suffer in AFOs (see literature review by Engelen et al., 2019). This contradicts with the theoretical definition of AFOs that are to be designed to support different activities. It is therefore relevant to explore the relationships between (a) work conditions related to collaborative and concentrative work and (b) design characteristics of AFOs, rather than merely focusing on the outcomes.

Work conditions: needs for privacy and social interactions

Much of office work relies heavily on cognitive functions defined as the mental processes involved in information processing, which entail attention, memory, decision-making and learning (Kalakoski et al., 2020). Disruptions in the office environment create cognitive strain and harm performance (Jahncke et al., 2011; Venetjoki et al., 2006). Hence, a sense of control over environmental distractions, i.e. privacy, is an important factor in office design to support productivity. Visual and acoustic privacy have been differentiated in studies about offices. Weber (2018) described visual privacy as

the ability to not be observed (surveillance) and/or to isolate from visual distractions. Acoustic privacy has been described as the ability to have conversations without neighbours overhearing these conversations (Weber, 2018). The need for privacy has been shown to play an important role in users' satisfaction in AFO environments (Brunia et al., 2016), productivity (Jahncke & Hallman, 2020) and creativity (Yekanialibeiglou et al., 2021). However, AFOs have been found to impede users' privacy and thus concentration (see review by Engelen et al., 2019). In a study by Babapour Chafi et al. (2020), users' motives for choosing a workstation were based on the minimal presence of stimuli, among other reasons; however, this was not attainable when the provided workspaces were predominantly open (Babapour Chafi et al., 2020). It seems AFOs are designed with typical abundance of open zones and therefore impede concentration. However, AFOs can potentially support concentration if they were designed based on employees' needs and activities with balanced ratios of open and secluded workspaces.

Another essential part of office work is social interaction (Mathieu et al., 2014). Relocations to AFOs affect the nature of users' interactions through changes in proximity and visibility (Wohlers & Hertel, 2017). The layout design of offices, which includes the level of transparency and openness (e.g. cell office, shared space, open-plan office, flexible office, etc.), and proximity to others, influences the patterns of social interaction and thus shapes the social and relational aspects of work (Davis et al., 2011). While most studies report positive effects on communication and collaboration (Bodin Danielsson & Bodin, 2009; Engelen et al., 2019; Gerdenitsch et al., 2018; Kim et al., 2016; Robertson et al., 2008), others showed that after moving to an AFO, users' satisfaction with communication decreased over time due to their difficulties in finding colleagues (Haapakangas et al., 2019; Wohlers & Hertel, 2018).

Unfavourable work conditions in AFOs may result in negative consequences on individual and organizational levels. These consequences include decreased productivity and negative health outcomes, such as fatigue (Hodzic et al., 2021), burnout and engagement (Appel-Meulenbroek et al., 2020). Moreover, AFO design can lead to feelings of alienation and isolation (Hirst, 2011) which can have serious outcomes for the health and well-being of individuals, contradicting with social sustainability goals, specifically social development goal 3 in Agenda 2030 that concerns good health and well-being of individuals. This can negate the reductions in terms of energy consumption, costs and space usage that is achieved by implementing AFOs. The
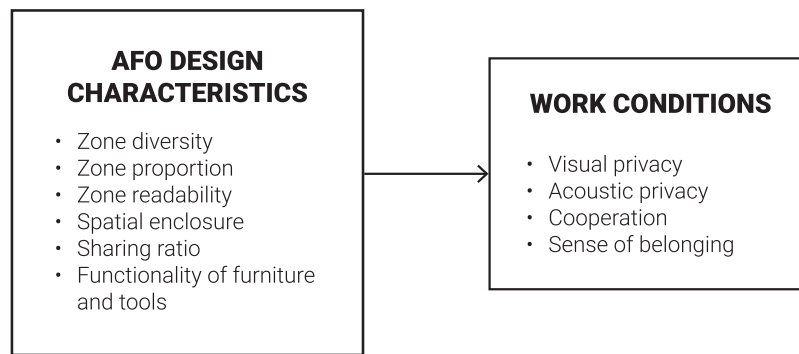
importance of addressing potential conflicts, synergies and trade-offs in relation to different sustainability goals have been highlighted in previous research (Weitz et al., 2018).

Design characteristics of AFOs

Although the basic functionalities of AFOs are similar, their layouts differ based on nuanced design characteristics, including the diversity, proportions and readability of zones, sharing ratios of workspaces, the level of spatial enclosure, or the functionality of the furniture and tools.

AFOs are typically divided into three main zones – quiet, semi-quiet and collaboration. These zones include workstations, as well as backup spaces such as meeting spaces, phone booths and lounges to accommodate a range of work tasks and user needs. However, poor *zone diversity,* such as an absence of different speech levels, can lower motivation to change workspaces and increase physical and mental strain (Rolfö, 2018). The balance between individual workstations and team workspaces, i.e. *zone proportions* varies across different organizations (Appel-Meulenbroek et al., 2011) and can affect working conditions. In addition to diversity and proportion of zones, factors such as clarity of space organization, distinction between different functional areas, and effective use of visual cues and landmarks, known as *zone readability,* play a crucial role in creating functional, efficient and comprehensible environments. For instance, AFOs with visually similar or poorly designed zones can be confusing for users or placing furniture that encourages socialization in areas meant for individual work can cause distractions (Babapour Chafi et al., 2020).

AFO layouts often consist of a main area in an open floor plan and in addition provide a variety of enclosed, or semi-enclosed backup spaces (Bodin Danielsson & Bodin, 2008; De Been & Beijer, 2014). Enclosed workspaces are separated from adjacent workspaces and circulation areas by interior walls or glass partitions (from floor to ceiling) and a door (Hoendervanger et al., 2021). Open workspaces, in contrast, are not physically defined or separated from adjacent and circulation areas (Hoendervanger et al., 2021). The level of *spatial enclosure* influences perceptions of privacy. The highest level of privacy is perceived in cell offices where employees experience control over visual exposure and acoustic disturbances and can regulate their interactions with others (Elsbach & Pratt, 2007; Seddigh et al., 2014). In contrast, open-plan layouts are associated with a lack of a sense of control and reduced privacy (Bodin Danielsson & Bodin, 2008; Jahncke et al., 2011; Sailer

AFO DESIGN CHARACTERISTICS

- Zone diversity
- Zone proportion
- Zone readability
- Spatial enclosure
- Sharing ratio
- Functionality of furniture and tools

WORK CONDITIONS

- Visual privacy
- Acoustic privacy
- Cooperation
- Sense of belonging

Figure 1. Conceptual model of the study.

et al., 2021). The evidence about the suitable level of enclosure for better communication and cooperation has been mixed (De Croon et al., 2005). Some studies have shown that open and shared workspaces foster face-to-face communication based on physical proximity, visibility and lack of physical barriers (Davis et al., 2011; Sailer et al., 2021). However, other studies have reported cases where even less face-to-face communication has occurred in open workspaces (Bernstein & Turban, 2018; Brennan et al., 2002). The mixed evidence about the consequences of design choices on social aspects of work calls for studies to identify mechanisms that can explain these discrepancies (Figure 1).

Research has indicated that the number of employees per room, workstation or seat i.e. workspace *sharing ratio* in an AFO is important for its effectiveness (Wohlers & Hertel, 2017; World Green building Council, 2014). Too few workspaces can lead to frustration, longer search times, insufficient support for side-by-side work (Rolfö, 2018) and reduce the autonomy to use workspaces that are appropriate for the work tasks (van der Voordt, 2004). Therefore, high sharing ratios of workspaces can result in reduced privacy and potentially hinder collaboration.

Finally, the functional attributes of workspaces such as having dual screens, height-adjustable desks or proximity to copying can impact someone's preference for certain workspace in AFOs (Babapour Chafi et al., 2020). Kim et al. (2016) found that the impossibility to adjust furniture and tools hindered AFO users from satisfying their needs. Other studies link furniture adjustability to musculoskeletal disorders, sedentary behaviour and back pain (Amick III et al., 2005; Foley et al., 2016; Robertson et al., 2008). Thus, *furniture and tool functionality* in AFOs requires further study.

The findings from previous research highlight the importance of investigating the role of case-specific design characteristics within the broad category of AFOs. Despite this, studies on offices often overlook such nuanced design information. Insights into design

are therefore necessary for comparing cases and developing AFO solutions that promote positive experiences for users. This study therefore aims to explore the relationship between the design characteristics of AFOs and users' perceptions of visual and acoustic privacy and social interactions, in a case study.

Method

This case study is based on post-occupancy evaluations in two AFOs at one public service organization in Sweden. As shown in the systematic review by Engelen et al. (2019), this sector had been underrepresented in research on AFOs. Our study was reviewed and approved by the National Ethical Review Board in Sweden (No. 768-18). A mixed-method approach consisting of a questionnaire and floor plan analysis was used to collect data.

Case context

The study took place in 2019 in one of the 21 public service provinces responsible for healthcare, culture and transportation in Sweden. The cases were the first large-scale implementation of AFOs in the public sector in Sweden (Figure 2). The organization had recently launched two AFOs in two cities: (Case 1) a 6-floor building with approximately 400 employees that were brought together from 12 different office locations in 2018; and (Case 2): a 13-floor building that brought together 1500 employees from 15 locations in May-June 2019. Due to layout and size differences between different floors, Case 2 was divided into two sub-cases for analysis: (Case 2a) floors 1–4 with approximately 850 employees; and (Case 2b) floors 5–13 with approximately 550 employees (Figure 2). According to secondary data collected by the facility management, occupancy rates were approximately 50% in both cases. Prior to the relocation, 90% of employees in Case 1 and 40% in case 2 worked in cell-offices or shared

Figure 2. Representative floor plans of the cases and photographs of the office interiors.

Table 1. Percentages of employees from different office types that were relocated to the AFOs (*S: small OPOs for 4–9 p; M: medium OPOs for 10–24 p; L: large OPOs for more than 24 p) based on secondary organizational data.

Office types	Case 1	Case 2a	Case 2b
Cell-offices	65%	17%	19%
Shared rooms for 2–3 persons	25%	22%	21%
Open-plan offices with own workstations (OPO)	4% (S:3,5%; L: 0,5%)*	18% (S:7%; M:4%; L:7%)	25% (S:10%; M:9%; L:6%)
Open-plan offices without own workstations	2%	5%	6%
Activity-based offices	4%	37%	29%

rooms (Table 1). The different units within the organization were geographically dispersed before relocating to the new centrally located AFO buildings. The organization's goals behind relocation were to (1) create coherence and bring the different administrative entities together, (2) have more resource-efficient workplaces and (3) become an attractive public employer.

Data collection

The post-occupancy evaluation was based on an AFO-specific questionnaire developed by Rolfö (2018) consisting of 60 items. All employees were invited to participate in the questionnaires via email. The questionnaire was collected from each office building six months after the relocation and was distributed through a secure online service that only collected anonymous data.

The questionnaire was screened to identify and select questions that captured the outcomes associated with design characteristics of the AFOs. In total, 14 questions were included for analysis in this paper (Table 2).

The questionnaires included additional open-ended questions asking the respondents to comment on their office environment functionality, visual and acoustic privacy, and social interaction aspects. A total of approximately 1700 comments were derived from open-ended questions (including comments related to satisfaction with spatial seclusion, cooperation, furniture and office functionality), providing a significant amount of qualitative data for analysis.

The respondents reported gender, age and position (Table 3). The gender distribution among the respondents represented the organization at large, since the organization mainly provided public services where

Table 2. Questionnaire parameters.

Theme	Parameters	Question	Scale
General	Office functionality	How does working in the new office function?	1 = Completely Disagree 7 = Completely agree
	Task support	The office design matches your work tasks optimally.	1 = Completely Disagree 7 = Completely agree
Design characteristics	Storage	How satisfied are you with storage opportunities?	1 = Very dissatisfied 7 = Very satisfied
	Aesthetics	How satisfied are you with aesthetics of the workplace?	1 = Very dissatisfied 7 = Very satisfied
	Furniture functionality	How satisfied are you with functionality of the furniture (chairs, tables, drawers …)?	1 = Very dissatisfied 7 = Very satisfied
	Furniture adjustability	How satisfied are you with the possibility to adjust the furniture to meet your individual needs (chairs, tables, drawers)?	1 = Very dissatisfied 7 = Very satisfied
Privacy	Noise level	How satisfied are you with the speech volume level you can hear from your workstation?	1 = Very dissatisfied 7 = Very satisfied
	Workstation seclusion	How satisfied are you with the degree of privacy with walls, separation panels and furnishings around your workplace?	1 = Very dissatisfied 7 = Very satisfied
	Visual privacy	How satisfied are you with the visual privacy at your workstation (capacity to not be observed)?	1 = Very dissatisfied 7 = Very satisfied
	Acoustic privacy	How satisfied are you with the acoustic privacy at your desk (possibility to engage in conversations without your neighbours hearing)?	1 = Very dissatisfied 7 = Very satisfied
Social interactions	Within-team cooperation	How does within-team cooperation work?	1 = Very bad 7 = Very good
	Between-team cooperation	How does between-team cooperation work?	1 = Very bad 7 = Very good
	Working atmosphere	Is there a good atmosphere between you and your colleagues?	1 = Very bad 7 = Very good
	Sense of belonging	Do you feel part of a community at your place of work?	1 = Very bad 7 = Very good

Table 3. Overall demographics of the respondents.

	Case 1	Case 2a	Case 2b
Number of employees	395	842	562
Response rate, %	72.2	71.3	
Gender			
Female, %	61	63	67
Male, %	36	32	37
Age, M (SD)	49 (10.9)	47 (10.7)	47 (11.3)
Managerial position, %	10.5	9.2	11.1

women were overrepresented both across healthcare and administrative professionals.

Data analysis

Survey data

The questionnaire was analysed with descriptive statistics using SPSS 26. The 1700 comments were analysed to identify major themes in respondents' feedback about their AFOs. The qualitative data coding was done in four phases (Table 4). In phase one, comments were analysed for first-order coding, which resulted in summaries of core statements. In phase two, the categories were further coded based on AFO design characteristics outlined in the presented conceptual model (Figure 1). These characteristics were zone diversity, zone proportions, zone readability, spatial enclosure, sharing ratios of workspaces, as well as functionality of furniture

and tools. Consequences mentioned in comments were extracted in a parallel coding process (step 4). In the final phase, categories were grouped into broader themes as (i) general positive comments about the AFO, (ii) general negative comments, (iii) furniture and tools, (iv) privacy and distractions and (v) social interaction, connecting the concepts that emerged from the data. The first and last author discussed coding and thematic relevance of the identified categories and reporting strategy.

Layout analysis

Architectural drawings and photos of the facilities were used to compare the architectural and functional features as well as the intended activities. This section provides an account of similarities, space types and detailed design information about the spaces, while the visual material is presented in the result section to facilitate interpretation of the survey data.

The AFO solutions offered a variety of non-assigned activity settings, divided into three types of zones: (i) strictly quiet zones were (semi-)enclosed spaces for concentrative work; (ii) semi-quiet zones were open workspaces that allowed for short interactions and (iii) collaboration zones were open and enclosed spaces to be used for meetings and breaks. Both buildings had

Table 4. Overview of different steps of coding of qualitative data.

Step 4: Overarching theme	Step 3: Perceived consequences	Step 2: Design characteristics	Step1: Perceptions of AFOs	Quote
General negative	Physical discomfort	Zone proportions	Too few workstations	Far too few workstations. Remove armchairs, poufs, bar table and sofas in favour of desks with screens (C2b-199).
Lack of privacy and exposure to distractions	Decreased productivity	Spatial enclosure	Too much spatial openness and transparency	Having visual and audio side effects all the time is hugely tiring. This goes beyond efficiency but also beyond one's own energy (C1-180).

**Table 5.** Space typologies, architectural features and intended activities.

Space type	Architectural and functional features	Intended activities
Single room	Enclosed room with one fully equipped workstation*, often including an extra chair for a visitor and windows.	Individual work
Shared room 2p	Enclosed room with one or two side by side fully equipped workstations with windows.	Individual work and/or side by side work
Small open plan room 4-8p	Semi-enclosed room with individual fully equipped workstations shared by 4 to 8 persons and with windows.	Individual work and/or side by side work
Phonebooth	Enclosed room or glass box with a table and a chair; includes glass door or partitions.	Phone and/or online calls
Open work area 10-16p	Open areas with no strict spatial definition with workstation shared by 10 to 16 persons.	Individual work and/or side by side work
Meeting room	Enclosed rooms with a table and chairs, large screen and a table with or without video conferencing equipment.	Online and/or in person meetings
Open group work area	Open areas; without any strict spatial definition and with a table and chairs for groups.	Socializing; informal meetings; individual or collaborative work
Lounge	Open areas; informal furniture	Socializing; informal discussions; individual or collaborative work

*Fully equipped workstations refer to workstations that contain an office chair, a desk, a docking station and one or two screens.

Table 6. Design characteristics for each case. Zone proportion refer to percentage of areas dedicated to each respective zone. Sharing ratio refers to the number of employees per room, workstation or seat.

Layout analysis	Case 1	Case 2a	Case 2b
General			
Square metres per person	14.6	14.9	16.7
No. of office floors/total number of floors	5/6	4/14	9/14
No. of equipped workstations	279	397	235
No. of provided seats	764	1275	696
Total square metres	6103	12571	9423
Zone diversity and proportion	Quiet zone (4±5%): small open	Quiet zone (9%): shared office room; small open plan room; phone room	Quiet zone (12%): shared office room; small open plan room; phone room
	Semi-quiet zone (31%): open workstation area	Semi-quiet zone (25%): open workstation area	Semi-quiet zone (32%): open workstation area
	Collaboration zone (60± 5%): meeting room; lounge; open group area; open workstation area; small open plan room	Collaboration zone (66%): meeting room; lounge; open group area	Collaboration zone (56%): meeting room; lounge; open group area
Zone readability	Ambiguities zone differentiation	Clear zone differentiation	
Spatial enclosure	Two central atriums	Corridor layout	Corridor layout across three building blocks
Sharing ratios			
Workstation sharing ratio in single room	84	0	80.3
Workstation sharing ratio in shared rooms (2p)	10	20.5	28.1
Workstation sharing ratio in open plan rooms	3.3	11.1	10.4
Workstation sharing ratio in open work areas	4.0	3.0	3.5
Total workstation sharing ratio	1.5	2.1	2.4
Small meeting room sharing ratio (2-6p)	2.9	24.8	22.5
Large meeting room sharing ratio (7-25)	3.8	26.3	35.1
Special meeting room sharing ratio	9.8	52.6	70.1
Lounge seat sharing ratio	3.1	9	7.8
Seat sharing ratio in open group work area	5.0	9	12.5
Phonebooth/room sharing ratio	79	32	17.6
Functionality of furniture and tools	Fully equipped workstations were adjustable. Meeting rooms, phone rooms and lounges were not adjustable.		
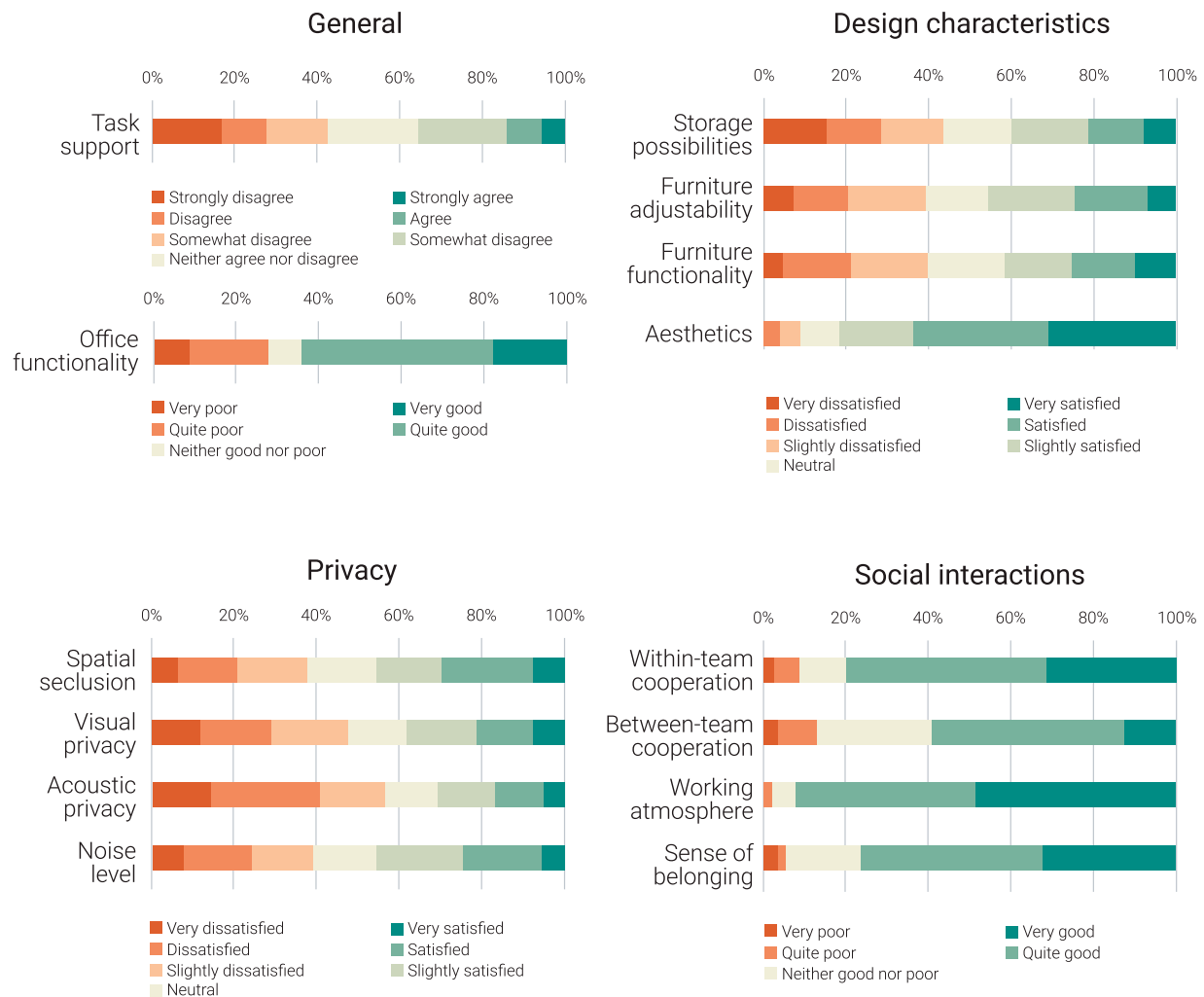
Figure 3. Survey responses from Case 1.

centralized restaurants and coffee areas for all the employees. Smaller coffee corners were provided on each floor. For larger meetings with external visitors, both offices included a conference area. Codes of conduct and guidelines for the effective use of these different work zones were communicated to the employees via brochures, emails and signs posted at the entrance of or in different settings. For every workstation, employees were asked to clean their desks when leaving to make the desk available for the next user (clean-desk policy). Almost all employees had non-assigned workstations, except a few employees with particular needs who received assigned desks.

The AFOs shared several similar design characteristics: (i) the same space types were provided, (ii) all office users were provided with personal storage of the same size; (iii) the same types of furniture were used, with some new and some re-used furniture from the previous offices; (iv) height-adjustable desks and adjustable office chairs were provided at the individual

workstations and (v) similar colour schemes, artworks and greenery were used. The space types used in the study were categorized based on the work by Bodin Danielsson and Bodin (2008); categories included single rooms, shared rooms and open-plan rooms (Table 5). To complement the original list, several other space types, such as phonebooths, open work areas, meeting rooms, group areas and lounges, were included in the categorization.

Case 1 had two central atriums, Case 2a had three building blocks with a corridor layout and Case 2b had a corridor layout in a single building (Figure 2). While the space types were almost identical in the studied AFOs, the number of workspaces allocated for individual workstation area, meeting area and breakout area were different. Therefore, we used the number of employees that would be sharing one room, workstations or seat as a measure to signify 'sharing ratio'. For instance, workstation-sharing ratio of 2.1 means that every two employees share one workstation.

Table 7. Main themes and sub-themes in responses from open ended questions in Case 1.

Main themes	Frequency	Sub-themes	Perceived consequences
General positive responses	4.7% (16/337)	• More flexibility [ZD] • Low occupancy [ZP] [SR] • Nice look and colours	• Positive experience with clean desk
General negative responses	16% (54/337)	• Not enough workstations [SR] [ZP]	• Increased stress level • Uncertainty about finding a suitable workspace • Loss of time setting up a workspace and packing up
Substandard furniture and tools	30% (103/337)	• Lack of adjustable desks and chairs in video conferencing rooms [FT] • Meeting rooms with uncomfortable armchairs and backless chairs [FT] • Lack of fully equipped workstations in collaboration zone [ZD][FT] • Insufficient personal storage space [FT] • Lacking double screens [FT] • Lacking large screens in 2-person shared rooms [FT]	• Physical discomfort • Decreased productivity
Lack of privacy and exposure to distractions	34.7% (117/337)	• -Lack of panels between workstations [FT] • Too much spatial openness and transparency [SE] • Quiet and semi-quiet zones not being as quiet as expected [ZR]	Decreased productivity
Negative social experiences	5% (20/337)	• Difficulty finding colleagues [SR] [ZP]	• Feelings of isolation and loneliness • Lack of sense of belonging

Note: Design characteristics of AFOs: zone diversity [ZD], zone proportions [ZP], zone readability [ZR], spatial enclosure [SE], sharing ratios [SR] of workspaces, as well as functionality of furniture and tools [FT].

Moreover, the zone proportions were calculated based on the percentage of the zone area to the total area of the workspace. The detailed information of the cases is presented in Table 6.

## Results

Case 1: atrium layout

The survey results from Case 1 are illustrated in Figure 3. The results showed that more than 40% of respondents were dissatisfied with how the AFO supported their tasks. Moreover, over 60% of respondents rated the functionality of the office negatively. Aesthetics ratings were most positive (more than 80%) and acoustic privacy was rated lowest (68% dissatisfied), of which 32.4% were very dissatisfied. Responses from open-ended questions provided insights on usage preferences, work tasks and design characteristics (Table 7). Respondents whose tasks involved frequent phone calls and online meetings chose the semi-quiet zones due to (i) substandard furniture in the video conferencing rooms and (ii) poor zone diversity that is lack of fully equipped workstations in the collaboration zone. As a result, the semi-quiet zones, which were mainly open, became more crowded, with perceived high noise levels and disturbances leading to deficient zone readability. In terms of social interactions, work atmosphere and

within-team cooperation were rated the highest, with 80% and 92.4% satisfaction, respectively. That said, the comments indicated difficulty finding colleagues in the building leading to feelings of isolation and loneliness.

While few respondents left positive comments about the increased flexibility and clean desk policy, it was indicated that the low occupancy of the spaces facilitated activity-based work. On the other hand, respondents reported difficulties in setting up workstations and cleaning them up.

Case 2a: tri-corridor layout

More than 60% of the respondents were satisfied with the functionality and task support in the AFO (Figure 4). While aesthetics ratings were the most positive (84%), ratings of storage (48%) acoustic and visual privacy (56% and 47%, respectively) were the most negative. The respondents' comments reflected dissatisfaction with functionality of furniture, that is the size of the storages, as they did not provide space for work materials, outdoor/winter clothing and equipment. In addition, respondents reported feelings of crowding due to high occupancy (Table 8). Others raised concerns about varying interpretations of acceptable noise levels in semi-quiet and open/collaboration zones, causing difficulties in reading and understanding the boundaries of each zone. In terms of social interaction, ratings of
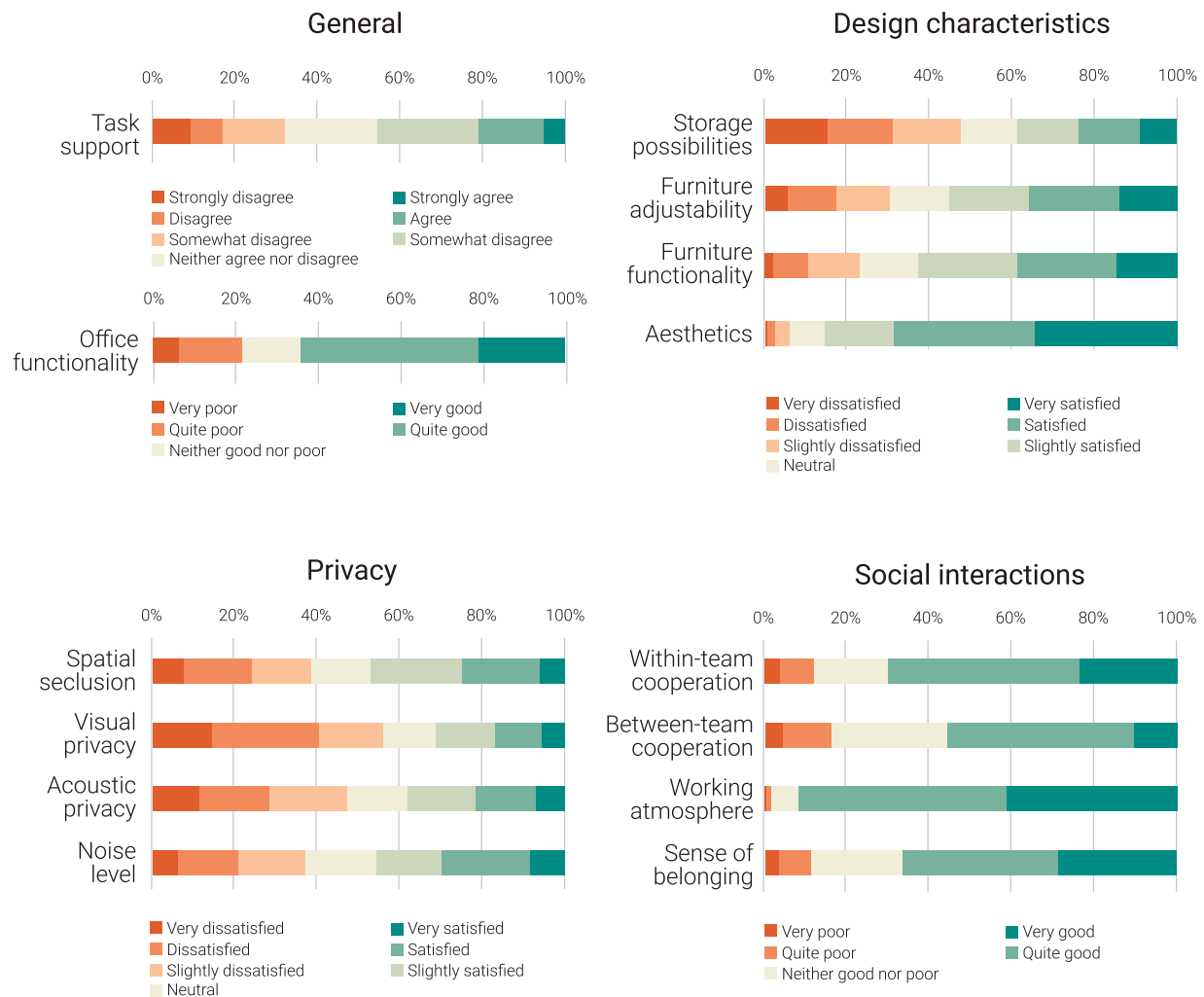
Figure 4. Survey responses from Case 2a.

working atmosphere were most positive (91%). While over 60% of respondents rated cooperation and sense of belonging positively, nearly 12% of the ratings were negative. In the comments, respondents attributed several hinders to productivity loss and a sense of isolation: (i) difficulty in finding colleagues and (ii) inadequate diversity in the collaboration zone, with a lack of fully equipped workstations in the collaboration zone for side-by-side cooperation and a sense of belonging.

Other themes identified in the respondents' comments were too few fully equipped workstations, uniform look on every floor, and a large, crowded lunchroom. Few respondents left positive comments about increased flexibility, nice look and increased opportunities for collaboration within and between teams.

Case 2b: single-corridor layout

Aesthetics ratings were the most positive (74%) while ratings of acoustic privacy were the most negative

(74%) (Figure 5). Moreover, more than 40% of respondents rated spatial seclusion, visual privacy and noise levels negatively. In the open-ended questions, respondent reported high noise levels in semi-quiet zones and feelings of disturbance. The mentioned reasons were included insufficient diversity in the collaboration zone with a lack of fully equipped workstations, colleagues disregarding speech rules and causing confusion about zone boundaries, and sound spreading from collaboration zone into semi-quiet zones (Table 9).

In terms of social interaction parameters, 93% of respondents rated work atmosphere positively. While over 60% of respondents reported satisfaction with within-team cooperation and sense of belonging, 18% and 15% of ratings were negative. The comments indicated difficulty locating team members in the building or lack of available workstations close to team members and the subsequent feelings of loneliness and lack of sense of belonging.

Table 8. Main themes and sub-themes in responses from open ended questions in Case 2a.

Main themes	Frequency	Sub-themes	Perceived consequences
General positive responses	5.4 (40/735)	• More flexibility [ZD] • Nice look and colours	• Positive experience with clean desk
General negative responses	16.4 (121/735)	• Not enough workstations [ZP][SR] • Difficulty carrying around work tools and material	• Increased stress level • Uncertainty about finding a suitable workspace • Decreased productivity and loss of time/difficulty setting up a workspace and packing up
Substandard furniture and tools	32.7% (241/735)	• Uncomfortable seats in collaboration zone [FT] • Too many varieties of chairs [FT] • Lack of fully equipped workstations in collaboration zone [FT] [ZD] • Insufficient personal storage space [FT] • Lacking dual screens [FT] • Poor reception in phone rooms	• Physical discomfort • Increased stress • Decreased productivity
Lack of privacy and exposure to distractions	26.1% (192/735)	• Lack of panels between desks [FT] • Too much spatial openness and transparency [SE] • Quiet and semi-quiet zones not being as quiet as expected; colleagues not respecting speech rules; sound spreading from collaboration zones [ZR]	• Increased stress • Disturbance • Decreased productivity
Negative social experiences	17.2 (127/735)	• Difficulty finding colleagues [SR] [ZP] • Cannot find a workstation close to one's team [SR] [ZP]	• Feelings of isolation and loneliness • Lack of sense of belonging
Positive social experiences	1.9% (14/735)	• Opportunity to get to know nonteam colleagues [SR] [ZP] • Opportunity to sit with ones' team [SR] [ZP]	• Improved within and between team cooperation
Other	5.4% (40/735)	• Loud and crowded lunchroom [ZP][SR] • Uniform look on all floors [ZR]	• Headache and disturbance • Difficulty in orientation

Note: Design characteristics of AFOs: zone diversity [ZD], zone proportions [ZP], zone readability [ZR], spatial enclosure [SE], sharing ratios [SR] of workspaces, as well as functionality of furniture and tools [FT].

Respondents also commented that the mainly open layout of AFO was suitable for social interaction but at the cost of privacy and concentration. Other reported musculoskeletal pain due to uncomfortable furniture, headaches due to crowded and loud lunchroom, and difficulties in orientation due to the monotonous look on all floors (Table 9).

Relationship between perceptions of AFOs and design characteristics

In this section, similarities and differences between the employees' perceptions and design characteristics of the three cases are compared qualitatively in relation to our conceptual model that was revised based on the results (Figure 6).

In terms of privacy and distraction, more than 45% of the respondents were dissatisfied in all cases. Respondents' comments indicated that the AFOs did not achieve the three intended speech levels in quiet, semi-quiet and collaboration zones leading to poor zone diversity. This also led to difficulties understanding the boundaries (zone readability) and expected behaviour in different zones. Comments indicated three types of activities requiring privacy: (i) individual (focused) work, (ii) video conferencing or online meetings and (iii) face-to-face teamwork. Each of these activities required different workspaces, furniture, tools and spatial seclusion, which was not always provided.

In terms of social interactions, more than 60% of the respondents were satisfied with within-team cooperation. However, the comments revealed difficulty of finding colleagues, a lack of opportunities for side-by-side work caused by high sharing ratios of workstations in quiet and semi-quiet zones as well as poor zone diversity. Consequently, some respondents experienced hindered cooperation and a lack of a sense of belonging. That said, the layout analysis showed rather high proportions of collaboration zones in all cases (Table 6).

Layout analysis showed that approximately 30% of total provided seats were fully equipped and adjustable, while furniture in meeting rooms, phone rooms and
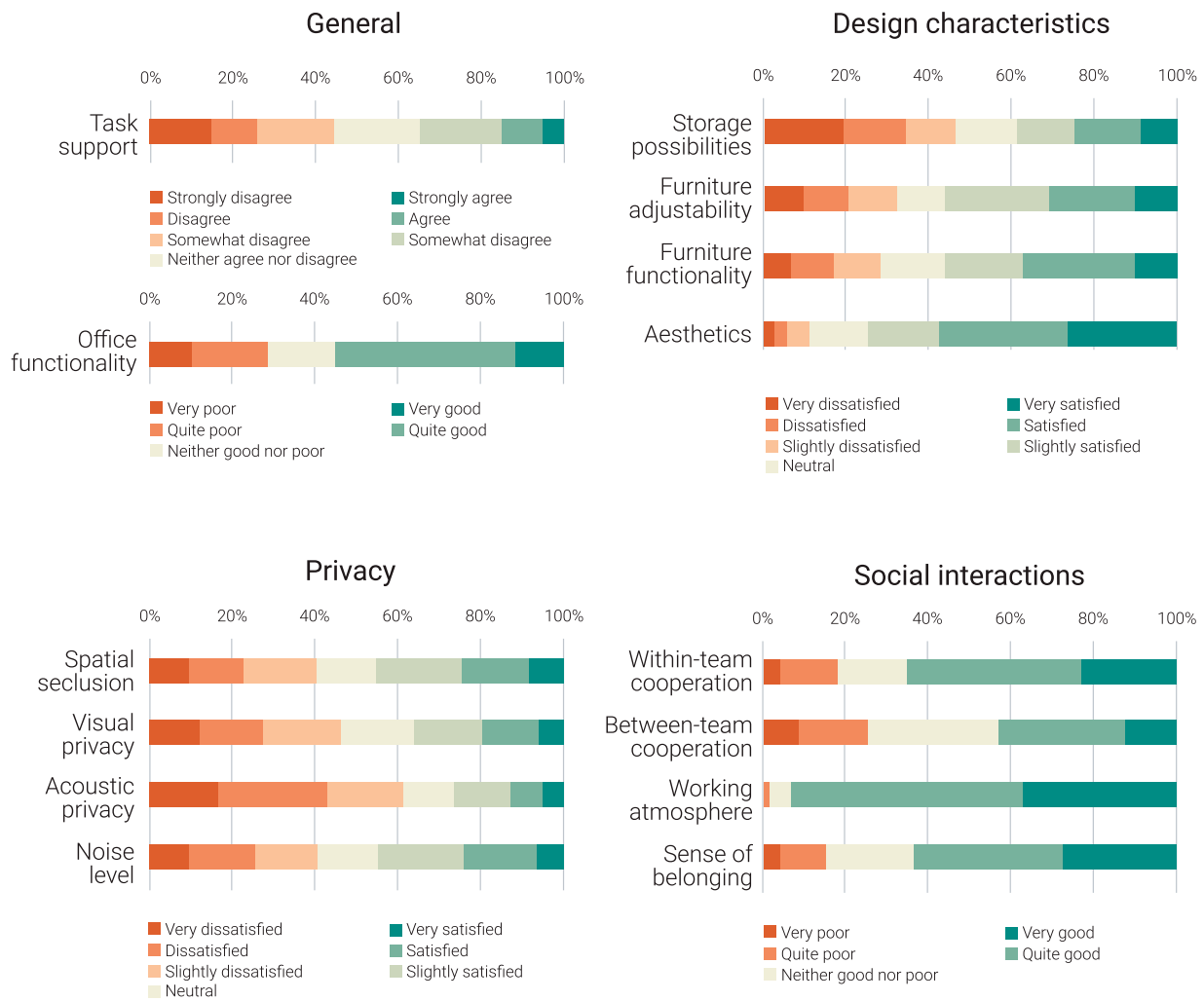
Figure 5. Survey responses from Case 2b.

lounges were non-adjustable (Table 6). As a result, respondents in all cases commented on difficulties finding adjustable and fully equipped workstations in preferred zones. The proportions of workstations in different zones did not seem to match respondents' needs and preferences. These shortcomings seemed to have an impact on perceived productivity and physical discomfort.

Layout analysis showed major design differences among cases regarding spatial enclosure, zone proportions and readability. While the number of workstations per person in enclosed rooms was the highest in Case 1 (Table 6), the respondents had the most negative responses regarding noise and privacy. The two central atriums and lowest proportions of quiet zones in Case 1 seemed to impact these perceptions as opposed to Cases 2a and 2b which had corridor-layouts (Figure 2). Moreover, zone readability in Case 1 did not follow any specific design language, i.e. a workspace such as an open workstation area,

could be a quiet zone on one floor and a semi-quiet zone on another floor. In Cases 2a and 2b, zones were differentiated by their spatial enclosure, i.e. quiet zones were enclosed, and semi-quiet zones and collaborative zones were open. These design characteristics could explain the slightly more negative perceptions of privacy in Case 1.

Discussion and conclusion

This study aimed to explore the relationship between the design characteristics of AFOs and users' perception of privacy and social interactions.

In general, the results showed that while aesthetics received the highest satisfaction scores, office functionality, task support, storage and visual and acoustic privacy received the lowest ratings. Key design characteristics for AFOs were operationalized in our conceptual model and observed, exemplified and

Table 9. Main themes and sub-themes in responses from open ended questions in Case 2b.

| Main themes	Frequency	Sub-themes	Perceived consequences
General positive responses	3.9% (25/639)	• More flexibility [ZD] • Nice look and colours	• Positive experience with clean desk
General negative responses	24.1% (154/639)	• Not enough workstations [ZD] [SR] • Difficulty carrying around work tools and material	• Increased stress level • Uncertainty about finding a suitable workspace • Decreased productivity and Loss of time/difficulty setting up a workspace and packing up
Substandard furniture and tools	26% (166/639)	• Uncomfortable seats in collaboration zone [FT] • Too much variety of chairs [FT] • Insufficient personal storage space [FT] • Lacking dual screens in workstations [FT] • Poor reception in phone rooms	• Physical discomfort • Decreased productivity
Lack of privacy and exposure to distractions	19.7% (126/639)	• Lack of panels between desks [FT] • Quiet and semi-quiet zones not being as quiet as expected; colleagues not respecting speech rules; sound spreading from collaboration zones [ZD] • Lack of quiet zones in one floor [ZD]	Decreased productivity
Negative social experiences	19% (122/639)	• Difficulty finding colleagues [ZP][SR]	• Feelings of isolation and loneliness • Lack of sense of belonging
Positive social experiences	1.8% (12/639)	• Opportunity to get an overview of nonteam colleagues • Cooperation works well if there are opportunities to sit with ones' team	
Other	7.1% (46/639)	• Crowded and loud lunchroom [ZP][SR] • Automated shading system and poor daylight [FT] • Uniform look on all floors [ZD]	• Headache • Feelings of loneliness • Difficulty in orientation

Note: Design characteristics of AFOs: zone diversity [ZD], zone proportions [ZP], zone readability [ZR], spatial enclosure [SE], sharing ratios [SR] of workspaces, as well as functionality of furniture and tools [FT].

compared in three case studies. These were zone diversity, proportion, readability, spatial enclosure, sharing ratios and functionality of furniture and tools. Our results show an interrelation between all of these characteristics and privacy.

While previous research has indicated that enclosed rooms make for improved productivity and privacy and fewer distractions (Brunia et al., 2016; Jahncke & Hallman, 2020), our results address deficient zoning, i.e. disproportionate allocation of different types of zones and workstations, and high level of spatial openness and transparency. This deficiency leads to difficulties in zone readability, i.e. users cannot interpret and distinguish the intended use of spaces and behaviours to adopt in the different zones (Søiland, 2021). These shortcomings led to a failure in providing the zone variation that is otherwise the essence of activity-based offices. The identified differences between our cases show that clear design cues, spatial seclusion and soundproofing may help create a comprehensible environment in which users are able to easily read and understand the function of workspaces.

In general, perceptions of social interactions were positive among the majority of the respondents. Studies

on the impact of AFOs on social interactions (i.e. cooperation and communication) have shown mixed results, with some studies reporting positive results (Bodin Danielsson & Bodin, 2009; Engelen et al., 2019; Gerdenitsch et al., 2018; Kim et al., 2016; Robertson et al., 2008). Similar to the findings of Wohlers and Hertel (2018), respondents in our study reported better between-team cooperation than within-team cooperation. Wohlers and Hertel (2018) provided an explanation for this result, arguing that while desk-sharing and spatial openness in AFOs promote team interaction and communication, they can also scatter team members over multiple levels, increasing physical separation and restricting access to team members. While the layout analysis showed rather high proportions of collaboration zones in all cases, the findings showed other factors including furniture and tools, the degree of spatial enclosure, diversity of collaboration workspaces play an important role in supporting cooperation in AFOs. In this study, we used floor areas to calculate zone proportions. Future research may benefit from investigating other indicators for zone proportions and ways to balance out proportions of quiet, semi-quiet and collaboration zones according to employees' needs and preferences.
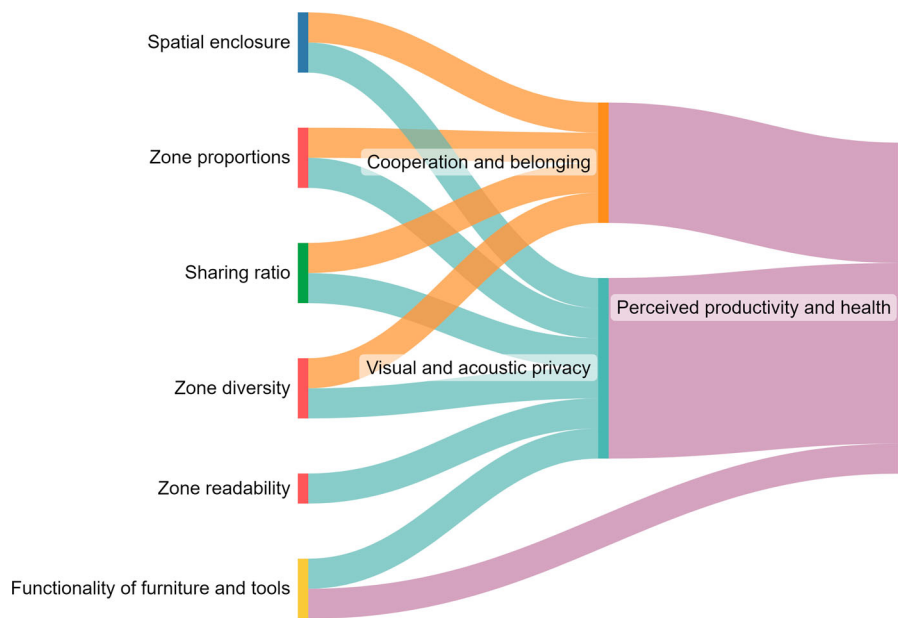
Figure 6. Schematic diagram illustrating relationships between design characteristics of AFOs and work conditions.

Previous studies of offices have not addressed the sense of community and belonging in relation to office density and size. Studies in psychology have shown that perceived crowded conditions lead to a feeling of alienation and a negative mood and (lack of) a sense of belonging as shown in the review by Heerwagen et al. (1995). Similarly, our results suggest that the drift from the community may be related to increased demands on employees caused by high spatial density. Feelings of social isolation and loneliness were recurrent themes in the respondents' comments in our study. Recent longitudinal studies on AFOs have suggested that negative social interaction outcomes are a result of desk sharing and the subsequent difficulties in locating team partners in a building (Haapakangas et al., 2019; Wohlers & Hertel, 2018). This challenge may be a major drawback in AFO design, leading to alienation and less meaningful work environments. Future research can benefit from exploring opportunities to strengthen a sense of belonging through spatial design in AFOs.

Our result also suggests that other aspects than openness and transparency of workspaces that explain the results. First, the proportions of workspaces for promoting privacy (quiet zone) and social interactions (collaboration zone) did not correspond to employees' *activity profiles*. Functionalities such as storage and adjustability of the workspaces did not satisfy a large number of respondents. The respondents expected functional and adjustable furniture in different zones (in both enclosed

and open spaces), while merely half of the workspaces were adjustable. The importance of adjustable furniture for productivity has been highlighted by other studies (Hameed & Amjad, 2009; van den Berg et al., 2020). While Eismann et al. (2022) argued for equal distribution between open and enclosed workspaces in AFOs, Soriano et al. (2020) argued for the importance of considering activity profiles when planning open and enclosed workspaces. Our study supports the latter. Second, users' *previous office types* seem to influence perceptions of privacy. Our findings showed the same effect observed by Sirola et al. (2021): when users move from shared or open-plan offices to an AFO, their perceptions are more positive (Arundell et al., 2018; Gerdenitsch et al., 2018; Robertson et al., 2008; van der Voordt, 2004), while users who move from private offices are more likely to perceive the AFOs more negatively (Haapakangas et al., 2019; Morrison & Stahlmann-Brown, 2020; van der Voordt, 2004). Hence, organizations should consider users' previous office type to facilitate smooth transitions from enclosed spaces to mainly open workspaces in AFOs. This may be achieved by allocating a higher proportion of enclosed rooms for users who relocate from cell offices than those from open-plan offices.

Limitations

As illustrated in this study, layout design is embedded in the local context of organizations; thus, our results are

limited to the studied context and can be generalized neither to other cases nor to a wider population. In addition, our data was collected prior to the outbreak of COVID-19 and should be interpreted with the knowledge that most employees worked at the offices and may experience the facilities differently with an increased extent of remote work after the pandemic restrictions. Nonetheless, the study offered new insights into the layout design of AFOs and introduced indicators to analyse AFO layouts. The mixed-method approach combining questionnaires with layout analysis was found to be valuable, as the design of AFO layouts has often been understudied, and a lack of objective measures has been observed in AFO studies (Engelen et al., 2019). Several improvements can be made in future studies. Occupancy and space use can be studied in relation to intended occupancy and use to identify potential differences. In addition, the questionnaires addressed general design characteristics of the office as a whole. It is recommended that questionnaires be developed to specifically investigate perceptions of specific workspaces and their design characteristics within large-scale AFOs.

Practical implications

With the increased level of remote work after COVID-19 and a drive to achieve global sustainability goals, more employers seem to consider shifting towards flexible and activity-based office solutions (Barath & Schmidt, 2022; Norton et al., 2021). This trend may be more prominent in the public service sector due to budget limitations. Our main recommendations based on this case study of a public service organization are: (i) making design choices such as proportion of different zones and adjustable workstations to match employees' activity profiles; (ii) considering office type before relocation and designing a smooth transition for employees who move from cell-offices; (iii) provision of zone diversity by means of well-functioning design cues, placement, clear rules and spatial enclosure. It is also relevant to consider new and emergent needs of employees in hybrid work settings, such as hybrid meeting rooms and an additional need for individual teleconferencing rooms as highlighted in (Babapour Chafi et al., 2020). These considerations require understanding employees' needs, preferences and work activities, and carrying out a user-centered design and planning process.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Authors contributions

Babapour led the planning and data collection. Forooraghi analyzed the data and wrote the paper with Babapour. Miedema, Ryd and Wallbaum provided comments on the early versions of the article.

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