Self-reported health and comfort of outpatient workers in six hospitals

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Abstract. As hospital workers are generally less satisfied with comfort than patients and limited information was available on health and comfort in outpatient areas, a PhD study was carried out on staff in outpatient areas. The study design, main conclusions and recommendations of this PhD study are discussed. To gain a more representative view of the occupants' perceptions, IEQ and social comfort were included. Social comfort was studied as a new construct, based on literature of privacy and crowding. A mixed methods approach was selected to justify the occupants' real-live experience of the physical environment. First, data were collected with building inspection of six hospitals and a questionnaire responded by 556 outpatient workers. Subsequently, a representative sample of them (17) was interviewed with photo elicitation. The survey was conducted before the COVID-19 pandemic, the interviews during the COVID-19 pandemic. Data were analysed with several techniques to describe comfort and health (descriptive statistics), determine associations of work and building-related aspects with comfort and health (regression analyses), to identify IEQ and social comfort profiles (Two-Step Cluster analysis) and to identify changes in preferences due to the COVID-19 pandemic (content analysis). The different analyses strengthened associations of contextual aspects, such as room types, with health and comfort. Also, the results indicate limited overlap of social comfort and IEQ. Therefore, it is recommended to include room types and social comfort aspects in future studies. Furthermore, as the results show differences in the occupants' preferences associated with differences in health (IEQ) and activities (social comfort) while their preferences can change in time, it is recommended to develop design strategies for an optimal fit beyond standardized solutions.

Keywords. comfort, hospitals, IEQ, COVID-19 pandemic, staff.
DOI: https://doi.org/10.34641/clima.2022.88

1. Introduction

Hospital workers spend most of their professional lives in hospitals, while patients stay relatively short in these buildings. Patients and their relatives are generally more satisfied with their comfort in hospitals than hospital workers [1-4], or occupants in office buildings [5]. For example, a study with 3811 hospital workers in Finland showed a higher percentage of occupants that was dissatisfied with the indoor air quality, noise, and glare than office workers [4]. Also, some building-related symptoms, such as irritated eyes or a dry skin, occurred more frequently among the hospital workers. While the pressure on hospital workers keeps growing [6], indoor environmental stressors, such as the presence of daylight, reverberation of noises, illumination, mould, and pollution from traffic, are related to work strain, health, and job satisfaction [7-11].

The characteristics of work in hospital departments, such as operating areas, inpatient, and outpatient areas, can vary largely. Due to differences in activities, needs for hygiene, and occupation hours, the perception of comfort may vary between hospital departments. Therefore, it is important to study hospital departments separately. Limited information was available on outpatient areas [3]. Taking these considerations into account, a PhD study was carried out on health and comfort of hospital workers in outpatient areas.

Within this study, comfort is approached as a multifactorial construct, including IEQ aspects (thermal, indoor air, acoustic, and visual) and social comfort aspects (privacy, interaction, crowding). The reason to include social comfort was because of the importance of both physical and social characteristics that can influence comfort. IEQ aspects as well as privacy and crowding can affect negative stress

reactions and dissatisfaction [12,13]. Also, personal aspects, such as age, sex, work strain, and diseases, may affect the perceptions of IEQ and building-related symptoms [14]. Building on previous studies that emphasized social and contextual aspects of comfort [15,16], the comfort perceptions and preferences of the occupants, as well as personal, work and building-related aspects, were included in this study to capture a broad view that justifies for the complexity of comfort perceptions and preferences of hospital workers.

To identify and explain relations of comfort and health of outpatient workers with personal, work, and building-related aspects, the following question was formulated: How are comfort and health in hospitals associated with personal, work, and building-related aspects? To answer this question, it was decomposed into four sub-questions: 1. How are the comfort and health of workers in outpatient areas of hospitals associated with work-related characteristics? 2. How do outpatient workers differ in their preferences and comfort perceptions? 3. How are dry eyes and headaches (the most prevalent building-related symptoms) associated with building-related aspects? 4. Which contextual aspects influence the preferences for comfort of outpatient workers?

To answer these questions a field study was conducted in two phases. The first phase was in the spring of 2019, before the COVID-19 pandemic, and the second phase in the autumn of 2020, during the COVID-19 pandemic. Contextual changes due to the pandemic were included in this study.

The main findings are presented and discussed in this paper.

2. Methods

2.1 study design

A mixed methods study was carried out to gain broad and in-depth insights into the occupants' perceptions and experiences. First, data were collected in a survey comprising a digital questionnaire for the outpatient workers, and a building inventory of the location, layout, building services, cleaning protocols and inspection of 127 rooms. The questionnaire comprised validated questions, based on OFFICAIR [17], a translated set of questions [12], and new questions. To test the new and translated questions, the questionnaire was piloted in a general hospital that did not participate in the final field study. The final questionnaire included questions on personal and work-related aspects, health, perceptions, and preferences for IEQ and social comfort.

Subsequently, the questions and sample for the follow-up phase were determined to build upon the results that needed more explanation. Therefore, data were collected with semi-structured interviews and photos. The interview guide comprised five main topics: work-related aspects, changes due to the COVID-19 pandemic, preferences for IEQ, preferences for social comfort, ranking of preferences. The interviews were tested with outpatient workers from hospitals that did not participate in the main study.

Before the interviews, the participants received instructions to take photos in their most frequently used rooms of IEQ and social comfort aspects that were important for them. They sent the photos before the interviews, digitally with e-mail, or prints by post. The interviews were conducted by telephone or videocalls, as the researcher could not visit the hospitals during the pandemic. All interviews were audio-taped with Microsoft Teams.

2.2 selection of the population and buildings

Only outpatient areas and workers were studied, because their comfort and health may vary from those in other hospital areas because of differences in duration of stay, activities, or building characteristics.

The hospitals varied in characteristics of the HVAC systems (e.g., type of heaters, type of heat recovery, replacement frequency of AHU filters, height of indoor air intake), individual control of the indoor environment, dimensions of building wings, possible outdoor pollutants, building year, cleaning protocol. Also, some building-related aspects varied within buildings, due to renovation period, room type or adjacency of the room to the façade.

2.3 ethical approval

Participation was voluntary. The participants could only participate after their approval of informed consent. The data were stored on a secured server. The study design was approved by the Ethics Committee of Delft University of Technology.

2.4 data analysis

Data from the questionnaire were imported from the Qualtrics XM platform to IBM SPSS Statistics 25. Data from building inspection were manually put into IBM SPSS Statistics 25. Building-related aspects were assigned to the respondents when the inspected variables were consistent. Consistency was identified with crosstabs of building-related aspects on different scale levels, such as organization, location, building-wing, room type, presence of a facade window, etc. The interviews were transcribed verbatim. Meaningful text fragments were manually put into Microsoft 365 Excel.

To answer the first sub-question descriptive statistics and logistic regression were used to identify differences in the perceptions of health and comfort between those in different room types (reception, consultation room, office, treatment room). The calculations were adjusted for personal aspects. Two-

Step Cluster analysis was used to identify profiles of outpatient workers, who differ in preferences and perceptions of comfort (sub-question 2). One set of six IEQ profiles and one set of three social comfort profiles were produced. To determine associations of headaches and dry eyes with building-related aspects, according to the third sub-question, multivariate logistic regression was used. Confounding variables were included. To answer the fourth sub-question, i.e., identification of changes in comfort due to the COVID-19 pandemic, inductive content analysis was carried out according to the steps defined by Gioia (2013) [18].

Detailed information on the study design and analysis can be found in [19-22].

3. Results and discussion

Three hospital organizations participated with two locations each. 556 outpatient workers responded to the questionnaire. Personal aspects, such as age or sex, did not vary between those working at the six locations.

3.1 IEQ and social comfort

Figure 1 shows (dis)satisfaction of the six IEQ aspects which the outpatient workers found most important. They selected three aspects from a list of 15. The figure represents the outpatient workers from the survey before the pandemic. The preferences of those who were dissatisfied vary from one of five (control of temperature) to one of two (sufficient daylight). The preferences of those who were satisfied vary from one of nine (no annoyance by noise) to one of two (control of temperature).

Figure 2 shows the (dis)satisfaction with the four most important social comfort preferences of the outpatient workers, that were selected from a list of 12 social comfort aspects. The preferences of those who were dissatisfied varied from four of ten (distraction by noise) to six of ten (contact with colleagues and patients and privacy of patients). The preferences of those who were satisfied varied from one of five (distraction by noise) to seven of ten (contact with colleagues and patients).

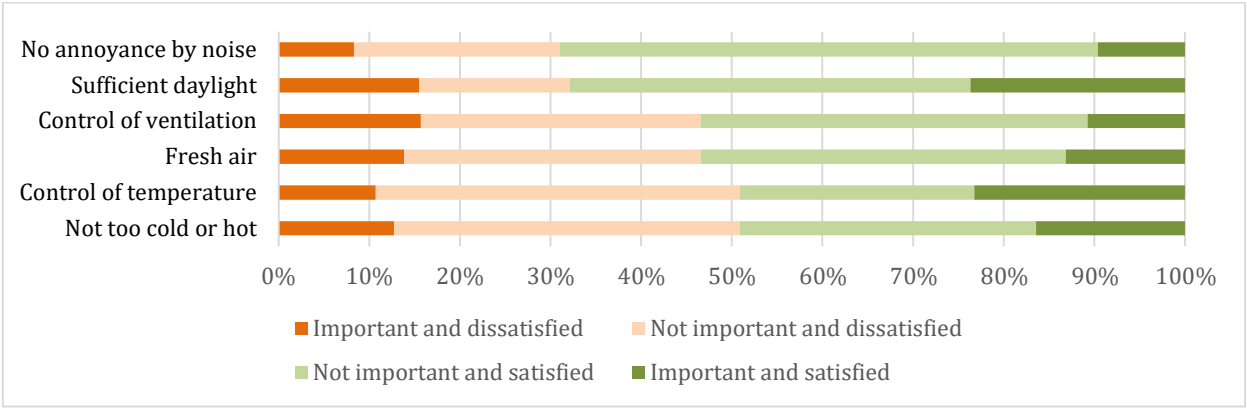

Fig. 1 – Importance and satisfaction of IEQ-aspects before the COVID-19 pandemic.

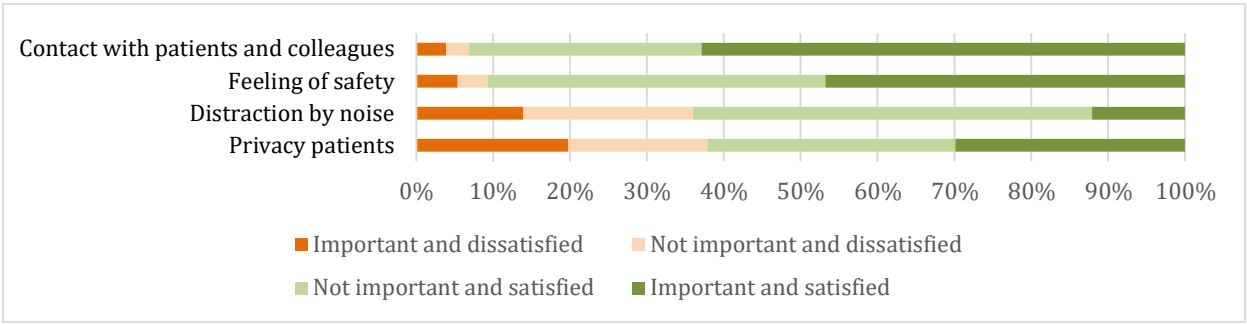

Fig. 2 – Importance and satisfaction of social comfort aspects before the COVID-19 pandemic.

The outpatient workers were more satisfied with social comfort aspects (Figure 1) than with IEQ-aspects before the pandemic (Figure 2). However, while only 7% of the outpatient workers was dissatisfied with contact with patients and colleagues, limited face-to-face contact with patients and colleagues was one of the main complaints during the pandemic [22]. The outpatient workers explained that interaction was important because it contributed highly to their work satisfaction and quality of care.

Satisfaction with IEQ was less likely to vary between those working in different room types than satisfaction with social comfort [19]. For example, only those who worked most frequently in consultation rooms were less likely to perceive dry

indoor air than those in treatment rooms or offices. While those in offices were more likely to be dissatisfied with privacy than those in consultation rooms and those in receptions more than those in offices, consultation, and treatment rooms.

To gain insights into differences in health, personal, work and building-related aspects between those with different preferences and satisfaction, six clusters for IEQ and three clusters for social comfort were found [20]. Both preferences and satisfaction were included, because there was no inter-collinearity between preferences and satisfaction. The preferences were stronger determinants for the profiles than satisfaction. The six main IEQ preferences (Fig. 1) and satisfaction with ten IEQ aspects, which were reduced with Principal Component Analysis (PCA), were included in the determination of IEQ clusters. The IEQ profiles, produced from comparisons between the IEQ clusters, were differentiated by the prevalence of building-related symptoms and sick leave. To determine the social comfort clusters the four main social comfort preferences (Fig. 2) and satisfaction with 11 social comfort aspects, also reduced with PCA, were included. The social comfort profiles were associated with activities. Both sets of profiles were associated with some personal, work, and building-related aspects. While over seventy comfort, personal, work or building-related aspects varied between the IEQ profiles or the social comfort profiles, only five aspects varied both between both the IEQ and social comfort profiles. These aspects were the preference for no annoyance by noise, dissatisfaction with natural light, room type, number of persons in the room, and the presence of a façade window.

Explanation of the profiles during the COVID-19 pandemic resulted in the finding that the main preferences can change and that the reason why IEQ and some social comfort aspects were important varied between the clusters [22]. While a comfort aspect, such as fresh indoor air, was for some related to dissatisfaction, others preferred it because of hedonic experiences, such as joy and feeling energized.

Tab. 1 – Associations of building-related aspects with profiles and building-related symptoms

Building-related aspect	Category	IEQ profiles	Social comfort profiles	Dry eyes	Headaches
Size outpatient area	<15.000m2 vs > 15.000m2		X		
Building year	1980-1999				
	2000-2009	X			
	2010-2018	X			
Façade window	Yes vs. no	X	X	X[a]	Y[a]
				X[b]	Y[b]
Corridor window	Yes vs. no	NA		X	Y
Control of heating	Manual vs. automatic	X			
Control of window view	Yes vs. no		X		
Direction of lighting	Direct vs. indirect + direct		X		
Cleaning protocol floors	Daily vs. weekly		X		
Cleaning protocol ventilation grills	Monthly vs. less frequent			Y	
Rotating heat exchanger	Yes vs. no			X	
Number of persons in the room[c]	1		X		
	(1 vs.) 2-4	X		X	Y
	1 (1 vs.) >4	X		X	Y
Room type[d]	Office		X		
	(Office vs.) reception	X			
	(Office vs.) consultation		X	X	X
	(Office vs.) treatment			Y	Y
Duration of stay	<4 hours vs. > 4 hours	X			

P-value of the clusters from Chi Square with Bonferroni correction
P-value of dry eyes and headaches from multivariate logistic regression
X=significant association (P-value<0.05)
Y= weak association (P-value<0.200)
NA= not applicable
[a] = façade window + corridor window
[b] = only façade window
[c] = changed during COVID-pandemic
[d] = varied also in satisfaction with IEQ and social comfort from univariate regression analysis including confounding variables

3.2 associations with building-related aspects

Table 1 shows associations of building-related aspects with the profiles and most prevalent building-related symptoms (dry eyes and headaches). The associations of the profiles were calculated with univariate analyses. The associations with dry eyes and headaches with multivariate analysis. The building-related aspects are part of the layout, HVAC systems, maintenance, and occupancy. Three building-related aspects are associated with both the profiles and building-related symptoms.

The absence of a façade window was a risk factor for dry eyes and headaches [21] and varied between the profiles [20]. Also, the number of persons in the room was a risk factor for dry eyes, a weak risk factor for headaches and differentiated between the profiles. During the COVID-19 pandemic the number of persons in the rooms were reduced [22]. Room types were associated with the profiles, building-related symptoms and satisfaction.

3.3 limitations

The sample size of this study was sufficient for multivariate regression analyses and Two-Step cluster analysis. The events per variable (EPV) were calculated to check the sample size for the regression analysis. Peduzzi et al. (1996) [23] recommended an EPV of at least 10. The EPV in the current study varied between 11 and 20. Dolniçar et al. (2014) [24] recommended at least 40 participants per included variable for cluster analysis. The IEQ clusters included 58 participants per variable, the social comfort cluster 108 per variable. Nevertheless, for the determination of associations of building-related aspects per cluster, a larger sample size is required.

Validation of the profiles was complex due to the COVID-19 pandemic. The outpatient workers experienced differences in comfort due to the contextual changes. These changes might have influenced the explanation of the preferences and the clusters. However, the study design in two phases enabled to gain insights into changes of comfort due to the unforeseen pandemic.

3.4 recommendations for research

It is complex to improve comfort of individuals with different preferences, also because most outpatient workers do not have a fixed room and they work generally in rooms with other occupants. Therefore, they need to negotiate frequently with others or adapt (to) the conditions of a room. As the participants used different strategies, such as manual control, use of other rooms, compensation during breaks, it is important to further study the conditions which affect adaptation strategies of the outpatient workers.

The study built on existing sets of questions and checklists while new variables, such as room types, were included. As the differences in satisfaction, preferences, and health between room types imply that comfort and health can be influenced by different situations, inclusion of room types in further studies might be considered. The set of questions for social comfort was based on previous literature. A validated set of questions was not available. More studies of social comfort with focus groups can contribute to further validate the set of questions. The questions can be included in studies of other hospital areas to improve the understanding of comfort.

As preferences during the COVID-19 pandemic changed, it is important to gain insights into the stability of preferences. In their study on changeability of preferences Hoeffler and Ariely (1999) [25] suggested that the stability can be influenced by the strength of an experience. Further study of the conditions which contribute to the formation of stable preferences and whether these vary between occupants, could contribute to further explanation of preferences, in order to improve comfort.

3.5 recommendations for practice

The profiles show that “one size does not fit all.” Design strategies could be developed for design of an optimal fit with the specific function of rooms or areas, while the occupants’ perceptions within a room or area can vary and change. To increase insights into differences between occupants and raise awareness during design processes the profiles are visualized into two foldable paper cubes. One cube for IEQ (figure 3) and one for social comfort (figure 4).
The cubes show the differences between the profiles of preferences, perceptions, personal, work, and building-related aspects from the survey in the spring of 2019. Each profile has its own colour. The size of a rectangle represents the proportion of outpatient workers for an aspect. For example, in IEQ cluster 1 the preference for control of ventilation is a square,

because all outpatient workers in cluster 1 found it important. On the top of the cubes are the numbers of the clusters. The lines help to navigate between satisfaction, preferences, personal, work, and building-related aspects.

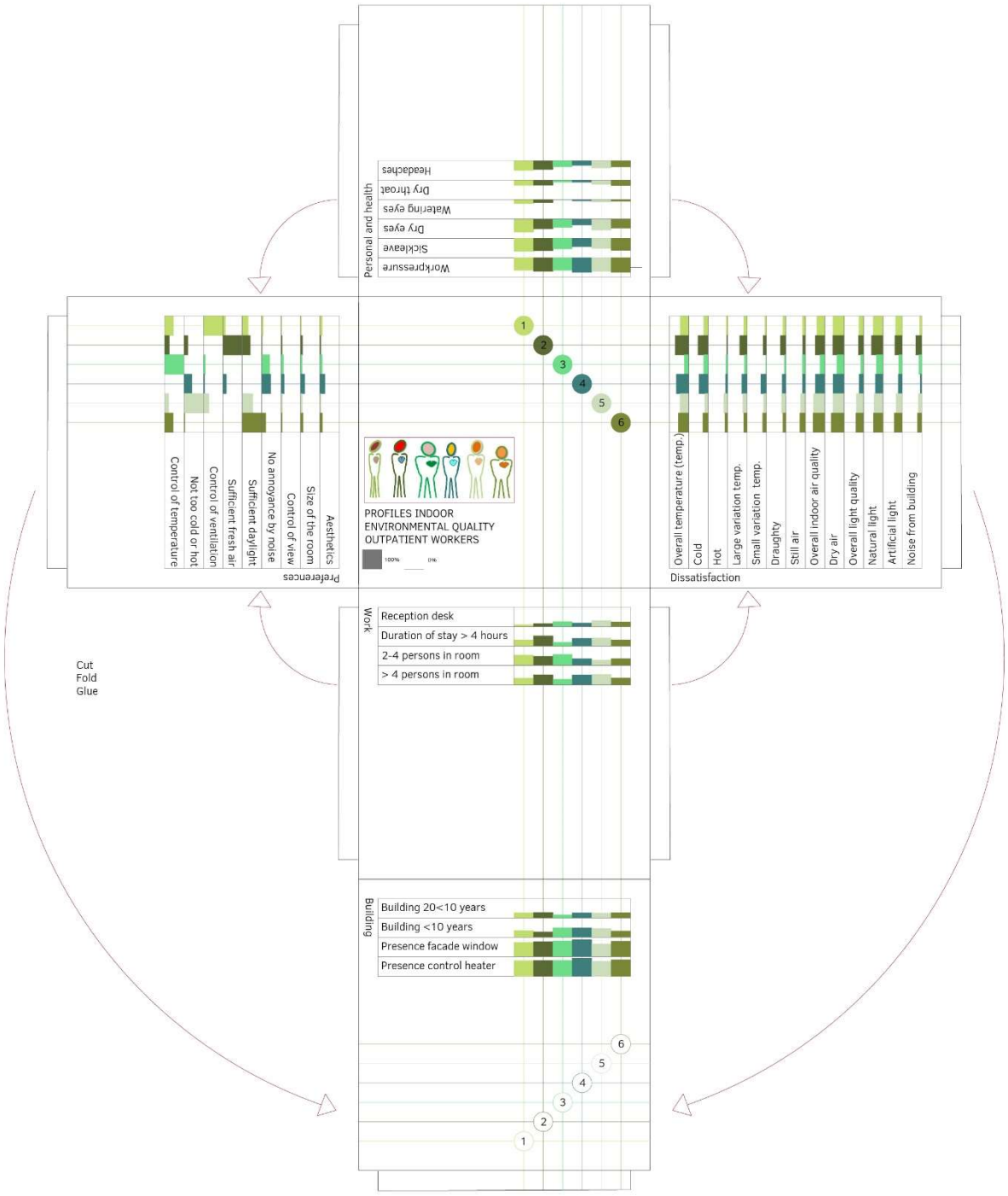

Fig. 3 – Cube of the IEQ profiles

The cubes show the differences between the profiles of preferences, perceptions, personal, work, and building-related aspects from the survey in the spring of 2019. Each profile has its own colour. The size of a rectangle represents the proportion of outpatient workers for an aspect. For example, in IEQ cluster 1 the preference for control of ventilation is a square, because all outpatient workers in cluster 1 found it important. On the top of the cubes are the numbers of the clusters. The lines help to navigate between satisfaction, preferences, personal, work, and building-related aspects.

4. Conclusion

This study shows relations of preferences and satisfaction of IEQ and social comfort of outpatient workers in hospitals with other aspects. Preferences for comfort can change due to contextual changes. The profiles suggest that those with different preferences can vary in health (IEQ) and activities (social comfort). As IEQ and social comfort have limited overlap, it might be useful to study both simultaneously in further studies. The broad type of building-related aspects that are associated with comfort and health show the importance of integrated design processes, including design of HVAC-systems, layout, façade and building maintenance.

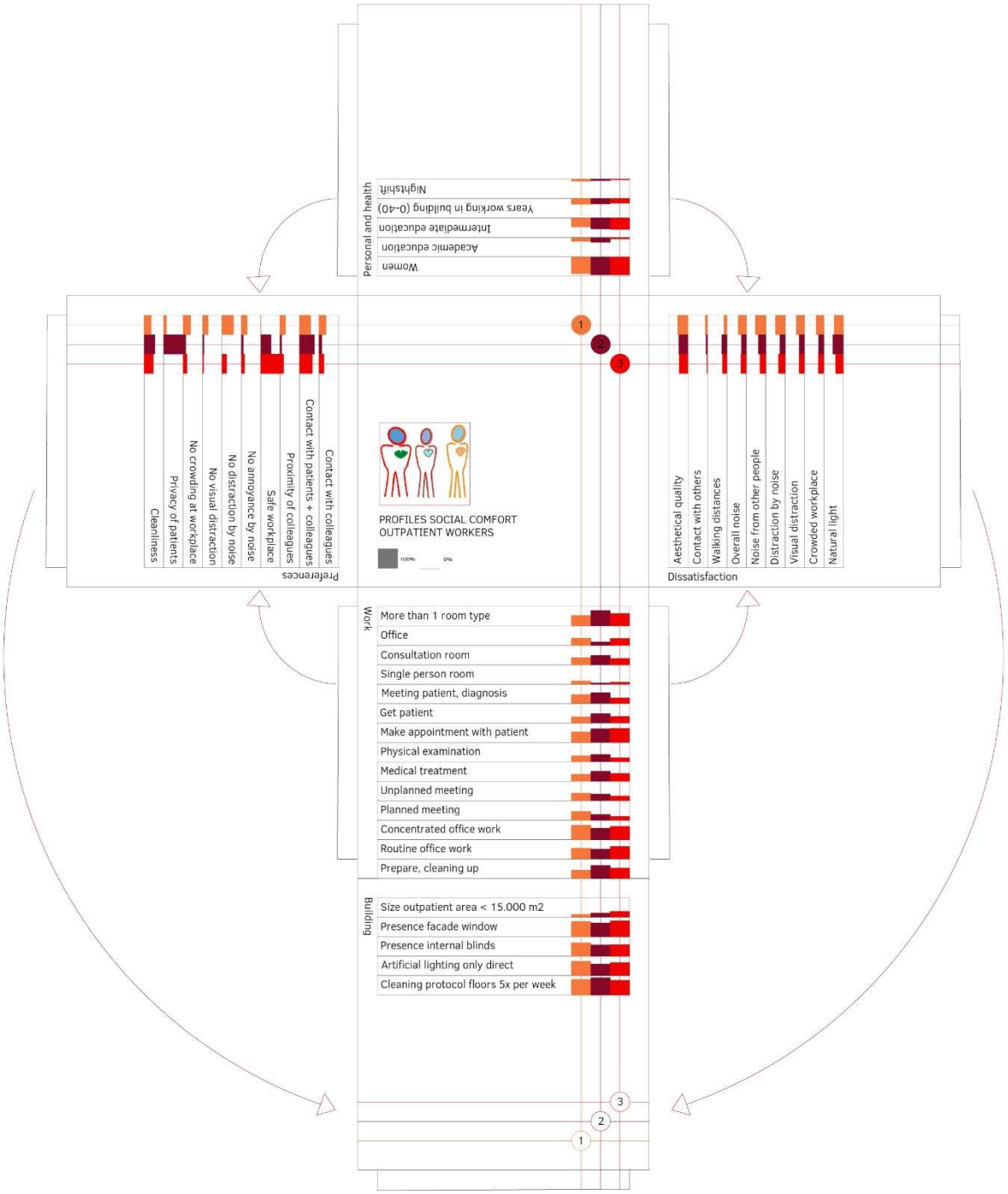

Fig. 4 – Cube of the social comfort profiles

5. Acknowledgement

This PhD study was supported by Daikin Netherlands and EGM architects and conducted at the Faculty of Architecture and the Built Environment at the Chair of Indoor Environment.

Data availability statement

The dataset is not publicely available because of personal information of the participants. The authors can be contacted for information.

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