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Post-occupancy evaluation of sunshades and balconies' effects on luminous comfort through a questionnaire survey

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Abstract

To protect and improve the built environment, the Hong Kong government recommends sunshades and balconies as two daylighting green features to be incorporated into new buildings. A questionnaire survey was conducted to investigate the effects of these green features on subjective luminous comfort in housing units. The results showed that some practical functions decided the preferences of residents for tilted or horizontal sunshades and balconies with glass walls and parapets. Both features had direct effects on reducing glare and overheating problems, but at the same time they decreased daylight uniformity. Further, balconies provided poor privacy, which forced residents to use internal shading and artificial lighting more often. Based on the analysis, green features affected residents' luminous comfort indirectly by unconsciously affecting their feelings and behavior.

Practical application

These results may help the government to understand the status quo and establish appropriate guidelines and help researchers and architects improve green features that provide residents with better luminous environments. The data can be used for further studies that adopt the climate-based simulation to present the real luminous condition of the units whose residents were involved in this survey. The luminous comfort could then be quantified by some cumulative metrics and those metrics can be treated as the standard for the energy-efficient building design.

Keywords

Questionnaire survey, sunshades, balconies, residential buildings, luminous comfort

1. Introduction

Daylight is a valuable resource for both people's health and energy savings in buildings. To protect and improve the built environment, the Hong Kong government issued Joint Practice Notes[1], which explicitly recommend sunshades and balconies as two daylighting green features to be incorporated in building development. To assess the particular effects of and residents' feelings about these features, a personal questionnaire survey was then conducted, and non-parametric tests were used for statistical analysis of the collected questionnaire data.

1.1 Daylight and luminous comfort

Daylight is a limited resource that brings people close to nature, prevents diseases caused by vitamin D deficiency[2], and affects people's visual perception and mood[3], and enhances residents' satisfaction[4]. Greater exposure to daylight also improves people's productivity[5] and psychological health[6]. In recent years, there have been fruitful research findings about green building features.[7] The efficient use of daylight can reduce the energy consumption of both HAVC systems[8] and illumination systems[9]. Some researchers use a light shelf[10], light tube[11], atrium[12], or remote-source lighting systems[13] to bring daylight into rooms more intentionally while improving illuminance and comfort.

Increased consciousness concerning comfort has aroused people's attention to living conditions such as thermal, acoustic, and luminous comfort. Because a definition of the comfort of the luminous environment in a scientific sense has yet to be agreed upon, the term "luminous comfort" in this study is defined as satisfaction with the luminous environment (that created by both daylighting and artificial lighting) as subjectively evaluated by occupants.

The Hong Kong government has issued Joint Practice Notes[1] that explicitly recommend sunshades and balconies as two daylighting green features to be incorporated in building development, aiming to enhance the daylighting performance of the building with limited resources. Furthermore, upon application, sunshades and balconies may be subject to conditions that allow exemptions from site coverage and gross floor area calculations. The government believes these features can offer a better luminous environment and reduce the consumption of nonrenewable energy.

1.2 Daylighting green features - sunshades and balconies

Sunshades block the sun before it shines on the windows of a particular wall façade. A practical tool was developed by Jorge, Puigdomènech and Cusidó for sizing optimal shading devices to evaluate daylight performance.[14] An efficient motorized sunshade was then designed to follow the path of the sun and be controlled based on lighting requirements.[15] Shading and blocking of direct sunlight reduce the daylight entering rooms but also increase the load on the artificial lighting system. To balance the energy consumption of both air-conditioning systems and illumination systems, Yener[16] developed a method enabling the determination of an optimum solution for minimizing the total energy consumption. Further, considering thermal comfort, Charde and Gupta[17] found it possible to maximize solar heat gain in winter and reduce overheating in summer by using curved static sunshades, which would bring the temperature of indoor air into the comfort zone at the same time. To mitigate the obstruction of view, sunshades could still provide good views for occupants by adjusting the slat angle according to the solar angle at a particular time[18] and create visual comfort by controlling the natural inflow of light[19].

Unlike a sunshade, a balcony is an area with walls or parapets around it that projects from the building façade. It often exists for living rooms of residential flats in Hong Kong. Balconies can act as external sunshades that block undesirable summer sunlight[20], discomforting glare, and harmful ultraviolet rays[21] from a high angle. They thus can offer a substantial reduction in the cooling load and energy consumption in an air-conditioning system. With the use of the typical weather dataset for Hong Kong, Chan and Chow[22] presented results showing that a southwest-facing balcony and a clear-glass glazed window gave the highest savings percentage of 12.3% in annual air-conditioning consumption. Because of the glazed door dividing the balcony area from the living room, balconies can also offer an open space for viewing the outside and a large aperture for the entrance of natural light. A post-occupancy survey suggested that people living in rooms with projected balconies are more satisfied with their indoor environment than are those without such balconies.[23] Considering that environmental preference influences subsequent effect, behavior, and cognition, the preferences for the area and parapet of balconies may also significantly affect people's behavior patterns toward and satisfaction with the luminous environment.

The key functions of the buildings that were rated best for satisfaction on the users' perception scales should maximize daylighting and natural ventilation and minimize unwanted solar heat gains.[24] As daylighting green features, sunshades and balconies have a great integrated advantage in enhancing the indoor environment. They also have positive effects on natural ventilation[25,26] and noise reduction[27,28].

Based on our review of the literature, both of the daylighting green features recommended by the Hong Kong government are useful and effective in providing shade from the sun and energy savings. To assess their particular effects and residents' preferences, a personal questionnaire survey was conducted for this research. Yildirim, Akalin-Baskaya, and Celebi[29] adopted one-way and multivariate analysis of variance to investigate the effects of different variables on the perceptions of environmental conditions. Dahlan et al.[23] used linear regression and Friedman tests to assess the connection between physical indoor conditions and a vote on the overall perception of indoor comfort. Aries et al.[4] adopted Chi-square and path analyses to further explain the correlations between building designs and personal preferences. Mak and Lui[5] added Mann-Whitney U-tests to examine the differences in preferences between two populations when studying the indoor environment. In this study, with the research objects of static sunshades and balconies, several non-parametric tests were used for the statistical analysis of the questionnaire data.

1.3 Current situation and demands in Hong Kong

Hong Kong is situated just south of the Tropic of Cancer and receives a lot of sunshine. However, the exposure of housing units to daylight can differ sharply according to the floor level and distance between building blocks because Hong Kong has one of the world's densest urban environments, with over 7 million people living in only 6.8% of the whole territory, and the largest number of high-rise residential buildings in the world. Sunshades and balconies are now recommended by the government to enhance the current luminous environment of residential units. However, little is known about the changes for residents brought about by these features. This new investigation carried out in Hong Kong aimed to achieve the following specific goals:

1) to identify the difference in luminous comfort perceived by residents living in houses with different green features;

2) to investigate the effects of green features on residents' behavior patterns and feelings towards daylight; and

3) to collect people's preferences on configurations of features and identify the most relevant functions.

This in-depth analysis was conducted with non-parametric tests to achieve the aforementioned goals by using SPSS 19.0. The results will give policy-makers feedback on residents' feelings and preferences regarding sunshades and balconies. It will also help planners and architects to implement more effective daylighting green features to provide residents with better luminous environments.

2. Methodology

2.1 Sampling

Residential buildings in Hong Kong are currently categorized into two types: public and private housing. Public housing provides rental units in buildings or offers cheap houses for sale. However, in the last decade, most new residential developments have been private housing due to the temporary halt of public housing development by the Hong Kong government. In general, only some of the public housing developments have sunshades (Figure 1) outside their windows, whereas others have no green features. Balconies (Figure 1) only exist off the living rooms of some private housing. Other private housing may only have bay windows, which are not defined as a green feature by the Joint Practice Notes[1]. To identify the effects of the two features of sunshades and balconies, a survey was conducted in three residential estates situated in Tseung Kwan O, which is a newly developed district in Hong Kong. The three estates (one with sunshades, one with balconies, and one with no green features) were selected such that all of the buildings were over 40 stories, and the floor area of each unit was between 45–60 m^2.

2.2 Pilot study

A pilot study with a sample size of 47 was conducted before the main study to check the reliability of the questionnaire and further develop its questions. It also tested the feasibility of the statistical methods for analyzing the respondents' answers. Based on a preliminary analysis of the results and the respondents' comments, most of the items in the questionnaire were found to be clear and well organized. Several questions were modified to make them clearer and more reasonable, and two sunshade configurations were added in the modified questionnaire.

2.3 Questionnaire survey

The survey was conducted during November and December of 2013, and the participants were recruited via mail. Of the 1,782 questionnaires sent out, 464 were completed and returned to the authors through collection boxes, of which 340 questionnaires were valid for further analysis.

The questionnaire consists of six parts, which aimed to collect data on the residents' feelings, behavior, and luminous comfort in relation to different green features. The specific goals of this study mentioned in section 1.3 are shown in Figure 2, which illustrates the rationale of the questionnaire. Parts 1, 2, and 3, which collect data on individual factors, feelings towards daylight, and human behavior, respectively, contribute directly to the assessment of Part 5, luminous comfort, whereas Part 4 collects information about the green features that affect luminous comfort indirectly (dashed line) but which affect residents' feelings and behavior patterns directly (bold solid line).

The general structure of the questionnaire is shown in Figure 3. The survey items in each part were proposed with reference to previous studies by other researchers and survey-specific objectives. Part 1 involved the participants' background information, which follows the study of Wong, Mak and Xu[30]. Part

2 concerned the residents’ feelings toward daylight. Part 3 comprised questions about the residents’ light-related behavior, and these behavioral questions were based on the study of Cheung[31]. Part 4 investigated occupants’ preferred configuration and feelings as to the size of their green features. Nine functions were graded by the participants to study different items affecting their preferences. Most of these functions were selected from the items that affected occupants’ window preferences as reported by Dogrusoy and Tureyen[32]. In accordance with the different types of green features, Part 4 is designed for sunshades and balconies, respectively. In Part 5 of the questionnaire, the participants were invited to answer question regarding their luminous comfort. Participants’ opinions about the daylighting in residential buildings were solicited at the end of the questionnaire, in part 6. Residents could indicate the inadequacy of their buildings’ green features or provide suggestions to improve their luminous comfort.

Residents were asked to answer those scaled questions based on five-point scaled items instead of seven or nine-scaled ones. Too many options may lead confusion to the participants, and an important empirical study[33] found that items with five levels may produce slightly higher mean scores compared to those produced from the use of 10 levels, and there was very little difference among the scale formats in terms of variation about the skewness, mean and kurtosis.

2.4 Statistical analysis

The data were accurately coded and analyzed with SPSS 19.0. The statistical reliability was first tested to assess the overall consistency of the psychometric questions. Cronbach’s alpha coefficient was used to estimate the internal consistency of the functions of green features. To test whether the factors of gender, age, or types of green feature caused significant differences in terms of luminous comfort, a Chi-square test was used to show the bivariate associations. Kruskal-Wallis test is a non-parametric test of the null hypothesis that populations are the same (as opposed to an alternative hypothesis). Mann–Whitney U test is also a nonparametric test of the null hypothesis that two samples against an alternative hypothesis. This type of test has greater efficiency than the *t*-test for non-normal distributions and was therefore used to identify differences in mean scores of residents' behavior and feelings towards daylight among the different green features. The Pearson correlation coefficient is also a non-parametric test that assesses statistical dependence between two variables by describing the relation compared with monotonic function. Finally, the same correlation coefficient was applied to investigate the relation between the number of artificial lighting hours and luminous comfort.

3. Results

3.1 Reliability of the questions

In questionnaire analysis, the reliability of a psychometric test is commonly estimated first. The questions involving perceptual evaluations (excluding the objective physical environment) are tested by Cronbach's alpha. The reliability of the questions concerning feelings toward daylight (nine items), human behavior (four items), and functions of green features (nine items) are shown in Table 1.

The Cronbach's alpha coefficient estimates the internal consistency of the three scales, and the values are 0.753, 0.673, and 0.844, respectively. Both the item dimensionality and the number of test items affect the alpha values. The acceptable alpha value has been recommended as ranging from 0.60 to 0.95 in different studies.[29,34] The coefficients in this study are all above 0.60, indicating that the questions can thus be considered reliable.

3.2 Demographic characteristics of the participants

To determine whether green features affect residents' luminous comfort, bivariate associations between luminous comfort and green features are tested by a Chi-square test. The luminous comfort across genders and different age ranges is also tested, and the results of frequency distributions in the participants' demographic characteristics are presented in Table 2.

In this survey, 49% of the participants are male, and the number of participants' in each age range is shown in Table 2. Based on the Chi-square test, no statistical difference in gender occurs for feelings of luminous comfort (P > 0.05); however, there was a visible difference in satisfaction between different age groups (P < 0.05). The older residents tend to be more satisfied with the luminous environment because they gave higher ratings for luminous comfort, possibly because older people react more mildly toward dissatisfaction with their living environment compared with younger people, who express their discontent more actively. There is also a significant difference between the different housing groups, which has different green features (P < 0.05). From the statistical table, the residents living in houses with sunshades (128 people) or with no green features (110 people) have comfort degrees better than "just right," whereas those living in houses with balconies (102 people) show lower satisfaction with their luminous environment, partly because balconies block more light than they expected. The privacy problem may be another reason for this finding. To determine why different green features cause different levels of luminous comfort, the influences of green features on residents' behavior and feelings toward daylight must be studied.

3.3 Influences of green features on residents' behavior and feelings toward daylight

As hypothesized in Figure 2, behavior patterns and feelings towards daylight have a direct effect on residents' luminous comfort. Accordingly, it is critical to investigate whether green features affect certain items on residents' behavior and feelings toward daylight. Because the items of activity types and artificial lighting types collected in Part 3 are nominal data, the Kruskal-Wallis test is used for the following items with scale data. It aims to examine whether the null hypothesis, that the distribution of the test item is the same across the categories of green features, is retained (P > 0.05) or rejected (P < 0.05). The mean scores of each item in each group of green features marked by residents are shown in Table 3, which also shows the decisions determined by the test.

The effects of green features on residents' behavior and feelings toward daylight are clearly shown in Table 3. The null hypothesis decisions of abundance of daylight hours, expected sunlight hours, and fading problem were retained, indicates that the green features have no significant effect on these items.

Since the Kruskal-Wallis test has tested the difference among the three groups, it is very likely that the effects of sunshades and balconies are significant but close and the decision of a certain item tends to be "retain". In order to reveal the hidden difference, it is necessary to use Mann–Whitney U test to test the null hypothesis between two groups of participants. Table 4 shows the results of the two tests between sunshades and balconies compared with no features.

Compared with the flats without green features, those with sunshades have a worse condition of illuminance distribution. The sunshades offer the lowest uniformity because they block much light from a high angle and do not have as large an aperture for natural light as balconies. The residents in these flats also have relative short expected hours in both summer and winter. The direct sunlight increases the illuminance level near the window, so the uniformity will becomes worse.

The decisions in Table 4 and the mean scores of each item in Table 3 together show the fact that sunshades affect human behaviors insignificantly. However, balconies affect human behaviors and peoples' feelings significantly. Balconies provide longer sunlight hours in both summer and winter than did sunshades because of a larger aperture for natural light. But residents living in flats with balconies appear to use bigger internal shading area and it reduces the glare and overheating problems more efficiently. In this case, balconies cause the room lack of daylight hours and offer a lower level of uniformity. Residents have to use more artificial lighting to improve the indoor lighting condition.

To understand the reason why people living in houses with balconies like to use internal shading more often, the residents' preferences and the items affecting these preferences also require study.

3.4 Residents' preferences for green features and items affecting these preferences

This part of the questionnaire aimed to collect residents' subjective preferences for daylighting green features and then recognize the subjective ratings of different items affecting their preferences. The residents living in flats with sunshades or balconies were asked to choose the preferred configuration of these two types of green features, as shown in Tables 5 and 6, respectively. The results of all of the residents' preferred configurations are shown in Figure 4.

As can be seen from Figure 4 (a), a large number of people living with sunshades prefer the tilted or horizontal style, whereas fewer people prefer the other three styles. Figure 4 (b) shows that people prefer a balcony with a glass wall, half glass wall, or a half parapet, and balconies with a wall only seem out of fashion now. Nine related functions were then organized and graded by the residents to recognize the relation between people's preferences and the functions they valued, as shown in Figure 5.

As can be seen from Figure 5, sunshades receives a high mark for the functions of blocking rain, maintaining thermal comfort, and shading. This explains why residents preferred the tilted and horizontal sunshades. Similarly, because the functions of providing a good view, improving mood, strengthening natural ventilation, and providing spaciousness are thought to be important for balconies, residents prefer balconies with a half glass wall or a half ventilated parapet.

The comparison between these two green features shows that sunshades obtained a higher mark. This result suggests that sunshades could be more useful than balconies in the functions of shading, blocking rain, and providing privacy. Likewise, balconies have an advantage in providing a good view, improving mood, strengthening natural ventilation, providing spaciousness, and enabling noise control. From these results, it can be concluded that balconies have a disadvantage in protecting privacy, which makes the residents living in houses with balconies use internal shading and artificial lighting more often. From an overall perspective, balconies have a great integrated advantage in enhancing the indoor environment, but as a daylighting feature they do not work as well as expected.

3.5 Residents' comments or suggestions regarding the use of daylighting in buildings

At the end of the questionnaire, all of the participants were invited to provide additional comments or suggestions on what they thought about the daylighting features in their residential buildings. The following is a synopsis of some of these valuable comments.

Point 1: Some of the participants commented on the criteria of building regulations. They thought that the distance between buildings is too small, which causes privacy problems for residents and makes them use curtains and turn on lights. The nearby opposite building also blocks the sunlight and sometimes brings an uncomfortable reflected glare

Point 2: Some of the participants mentioned that windows are a key factor for daylighting. The current small windows lead to poor uniformity in the distribution of illuminance in a living room. The participants hoped to have a larger window such as a French window or the ability to open a second window on another wall if possible. They thought that the top of the window could have been designed a little higher, so that light could shine more deeply into the living room.

Point 3: Some of the participants hoped that the sunshades could be designed more efficiently. They stated that the sunshades only block direct sunlight for a while on a summer’s day, so they should be designed to be a little longer and to change their orientation. Some residents suggested that the sunshades could be tilted upward so that they would not obscure the view too much but still block the sunlight.

Point 4: Some of the participants thought that many people have to work outside and seldom stay at home in the daytime, so the government should develop more parks and country parks for citizens to get close to nature and sunlight.

4. Discussion

The 340 questionnaires with valid responses allow this survey to provide a group of reasonable results concerning the preferences and effects of daylighting green features of high-rise residential buildings in Hong Kong. The results show that residents living in houses with different green features have their own preferences and levels of luminous comfort. Although the whole study focuses on the differences that green features brought, one question remains to be settled: why do residents living in houses with balconies experience lower luminous comfort?

Green features do not have a direct influence on luminous comfort, but they can affect residents’ behavior patterns and feelings toward daylight, which do have close relations with luminous comfort. From the results analyzed above, a process is drawn to reveal the correlations, as shown in Figure 6.

Residents living in houses with balconies in Hong Kong may have a higher standard of privacy than others. Although there is no scientific evidence to show that they care more about privacy, the results in section 3.4 indicate that these residents are not satisfied with the privacy provided by balconies. It is then possible that residents use internal shading more often to protect their privacy. Table 3 shows that abundant daylight hours and uniformity of illuminance both decrease with the use of balconies, compared with houses without this green feature. This result echoes the finding of a study conducted by Kim and Kim[35], who found that balconies block more skylight and that illuminance level and distribution are strongly dependent on the depth of the balcony floor. Considering the aspects of both internal shading and poor illuminance, residents would be more likely to turn on artificial lighting more often, as shown in the result in Table 3.

An earlier study found that artificial lighting time (by number of hours) was the most relevant behavior influencing luminous comfort.[36] The Pearson coefficient between them is -0.455, which means that the correlation is negative and linear. This result indicates that the overuse of artificial lighting during the day decreases luminous comfort. Summing up all of the analyses, the question of why residents living in houses with balconies experience lower luminous comfort seems to have a reasonable explanation.

5. Conclusion

The Hong Kong government recommends sunshades and balconies as two daylighting green features to be incorporated in building development. A questionnaire survey was conducted to study the effects of these green features in Hong Kong. Based on the analysis of the data, the following conclusions can be drawn.

1) In general, residents prefer tilted and horizontal sunshades because they can block rain and solar heat,

and provide shade. Similarly, residents prefer balconies with a parapet and glass wall because they provide a good view, improve mood, strengthen natural ventilation, and provide spaciousness.

2) Although balconies have a great integrated advantage in enhancing the indoor environment, residents living in flats with balconies have a lower luminous comfort than others. The analysis shows that balconies affect the luminous comfort stealthily through a logical process that involves residents' feelings and behavior patterns.

3) Sunshades and balconies have direct effects on residents' behavior and feelings toward daylight. Both reduce glare and overheating problems, but they decrease the illuminance uniformity at the same time. Further, balconies force residents to use internal shading and artificial lighting more often because balconies provide poor conditions of privacy.

4) The participants provided valuable comments and suggestions related to the criteria of building regulations, window design, and green features design, and the better use of daylighting in residential buildings. Combined with the results of this analysis, any improvements in design should be based on a good intake of daylight.

This study shows the effects of daylighting green features, and the results may help government to understand the status quo and establish appropriate guidelines and standards and can also help researchers and architects to understand how to improve design features and provide residents with better luminous environments. The limitation of this work is the 5 scaled questions. Though five ordered response levels are widely used and could generate good results, many psychometricians advocate using seven or nine levels as they could obtain more accurate data for better statistical analysis. In further studies, the climate-based simulation will be adopted to present the real luminous condition of the units whose residents were involved in this survey. Then the luminous comfort could be quantified by some cumulative metrics obtained from the simulation and those metrics can be treated as the recommendation or standard for the energy-efficient building design.

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Tables & Figures Captions

Table 1. Reliability of the dependent variables

Scale items	Cronbach's Alpha	Scale items	Cronbach's Alpha
Part 2 - Feelings toward daylight	0.753	Part 4 - Functions of green features	0.844
Abundance of daylight hours		Shade	
Satisfaction with uniformity		Block rain	
Problems sunlight brings (3 items)		Good view	
Sunlight access hours (summer and winter)		Improve mood	
Expected sunlight hours (summer and winter)		Natural ventilation	
Part 3 - Human behavior	0.673	Provide privacy	
Kinds of activities		Spaciousness	
Internal shading		Thermal comfort	
Artificial lighting hours		Noise control	
Artificial lighting types			

Table 2. Cross-tabulation of luminous comfort with green features, gender, and age

		Satisfaction with the luminous environment					Total	Pearson Chi-square
		Strongly disagree	Disagree	Just right	Agree	Strongly agree		
Gender	Male	1	14	67	67	17	166	0.725
	Female	2	10	64	80	18	174	
Age	≤25	0	6	13	25	1	45	0.031
	26~35	2	6	28	21	5	62	
	36~45	0	5	37	34	9	85	
	45~55	0	5	30	23	10	68	
	≥56	1	2	23	44	10	80	
Green features	Sunshades	1	8	44	63	12	128	0.000
	None	1	11	22	59	17	110	
	Balconies	1	5	65	25	6	102	
Total		3	24	131	147	35	340	

Table 3. Hypothesis test and mean scores of each item with different green features

Items		Mean scores			Kruskal-Wallis test	
		None	Sunshades	Balconies	Sig.	Decision
Abundance of daylight hours		4.118	3.875	3.902	0.112	Retain
Satisfaction with uniformity		3.721	3.398	3.506	0.013	Reject
Problems sunlight brings	Glare	3.578	3.436	3.157	0.002	Reject
	Overheating	3.391	3.383	2.873	0.000	Reject
	Fading	3.523	3.300	3.274	0.070	Retain
Sunlight access hours	Summer	3.211	3.018	3.706	0.002	Reject
	Winter	2.991	2.617	3.657	0.000	Reject
Expected sunlight hours	Summer	3.727	3.561	3.620	0.123	Retain
	Winter	4.055	3.881	3.980	0.137	Retain
Internal shading area (1 full off – 5 full open)		4.000	3.961	3.451	0.000	Reject
Artificial lighting hours		2.064	2.066	2.569	0.000	Reject

Asymptotic significances are displayed. The significance level is 0.05.

Table 4. Mann–Whitney U test of each item between different green features and no feature

Items		Sunshades		Balconies	
		Sig.	Decision	Sig.	Decision
Abundance of daylight hours		0.117	Retain	0.048	Reject
Satisfaction with uniformity		0.006	Reject	0.042	Reject
Problems sunlight brings	Glare	0.255	Retain	0.023	Reject
	Overheating	0.485	Retain	0.000	Reject
	Fading	0.106	Retain	0.802	Retain
Sunlight access hours	Summer	0.387	Retain	0.001	Reject
	Winter	0.051	Retain	0.000	Reject
Expected sunlight hours	Summer	0.001	Reject	0.002	Reject
	Winter	0.001	Reject	0.028	Reject
Internal shading area (1 full off – 5 full open)		0.928	Retain	0.000	Reject
Artificial lighting hours		0.947	Retain	0.000	Reject

Asymptotic significances are displayed. The significance level is 0.05.

Table 5. Sunshade configurations

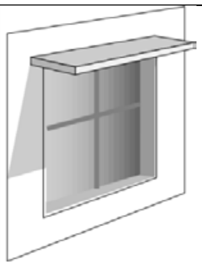
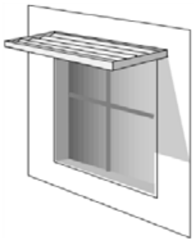
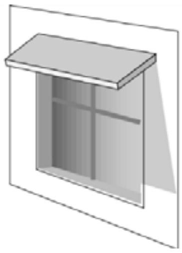
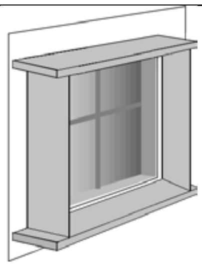
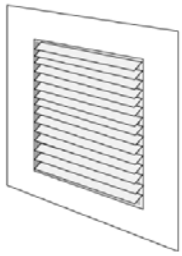
Horizontal	Horizontal louvered	Tilted	Surrounded	Louvered
				

Table 6. Balcony configurations

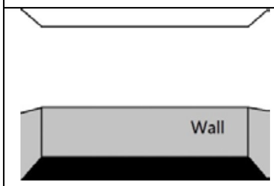
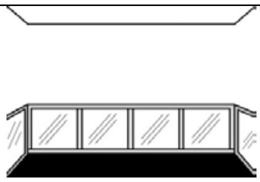
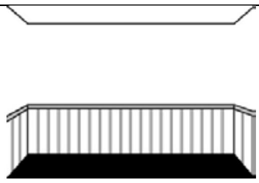
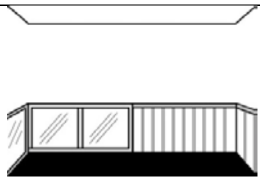
Wall	Glass wall	Parapet	Parapet and glass wall
			

Figure 1. Sunshades and balconies in Hong Kong residential buildings (Source: Photograph by the authors)

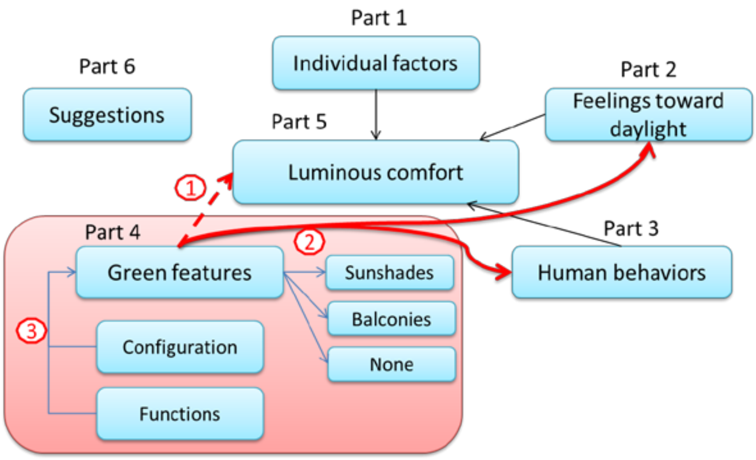


Figure 2. Rationale of the questionnaire and the three specific goals (circled numbers) of this study

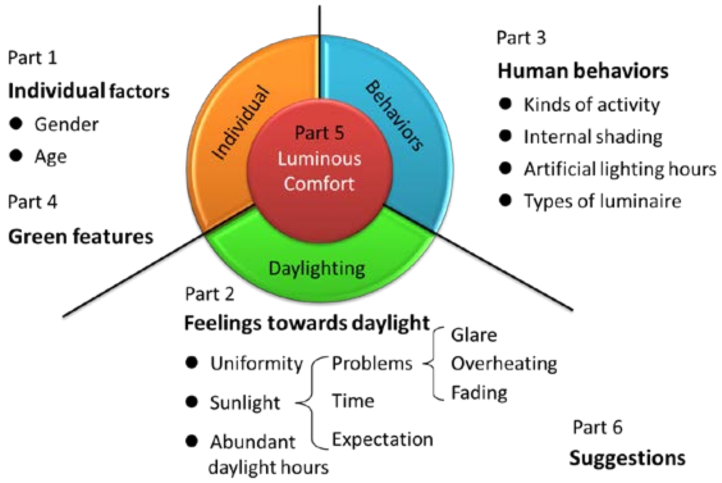


Figure 3. General structure of the questionnaire

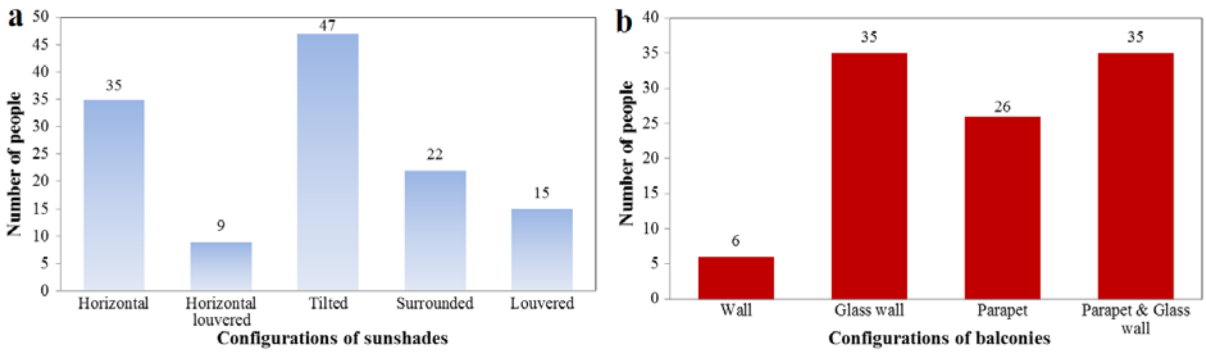


Figure 4. Residents' preferred configurations of (a) sunshades and (b) balconies

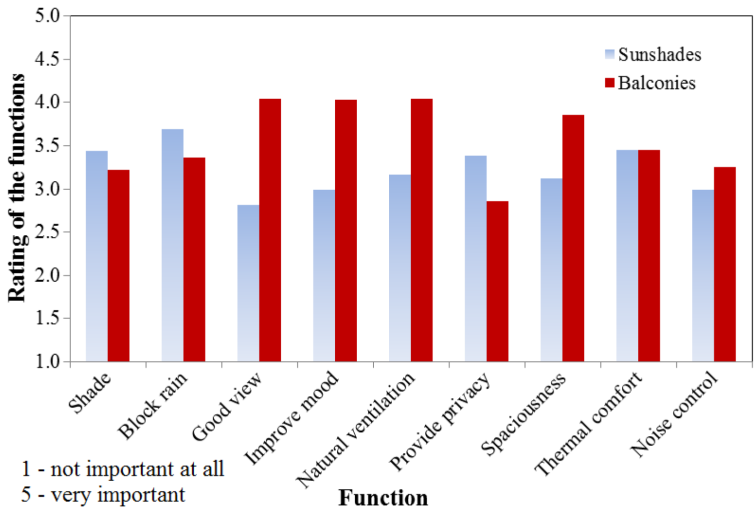


Figure 5. Subjective ratings of residents concerning the functions of sunshades and balconies

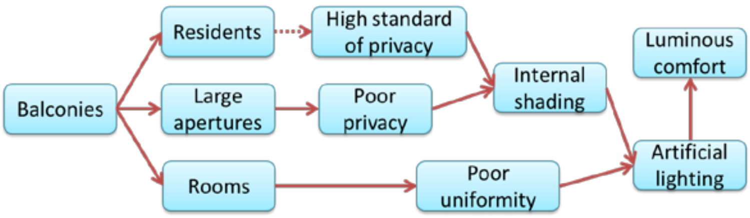


Figure 6. Process by which balconies affect luminous comfort