A Qualitative Study on Daylight Design Parameters in High Rise High Density Residential Buildings in Hong Kong

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ABSTRACT

Daylight is an essential element in architecture and human life. Daylight is not only enhancing the quality of spaces and defining the character of interior, but also providing a significant impact on energy consumption in terms of lighting and thermal issue. In addition, it is widely accepted that daylight could do more than that, in both physical and psychological aspects.

There are many different lighting guidelines for both natural and artificial lighting provision, either statutory or non-legislative. In Hong Kong, daylight provision is not only affecting the design of window, but also the building bulk and disposition. The current regulation on daylight provision is based on a prescriptive quantitative approach. Although it is understood that human response to daylight is always related to previous experiences, for which climatic effects, socio-cultural factors and life-styles are all affecting daylight perception and acceptance, the design process has rarely taken these into consideration. Furthermore, due to the lack on knowledge of the qualitative studies of the human response to daylight, the inter-relationship between on the quantitative and qualitative studies is not known. Therefore, the design process should integrate both quantitative and qualitative parameters, in order to formulate a meaningful design solution.

The authors conducted a survey in 2005 to study the user response to the daylight provision in their living spaces, which focused the qualitative aspect. The survey also investigated the users’ expectations on living conditions, life-style, living habits and space usage, which set up a preliminary framework for future study. The author believes that there is relationship among these above parameters and the daylight perception and acceptance of the occupants. In order to provide a better living environmental to the occupants, the above parameters should be taken into account as design guidelines.

KEYWORDS: daylight, regulations, POE, user response, life style, high rise, high density, residential building.

1. INTRODUCTION

Daylight is an important element in architectural design and daily activities. It gives the quality of spaces, and character of the interior. “Light is form giver” (Lam 1986) shows the significant impact of light in Architecture. Besides aesthetic spatial enhancement of architecture, the effect of daylight is also affecting in the energy issues in lighting and thermal aspects. The above aspects have been focused as the major studies in the world over years. Apart from that, it is widely accepted that daylight could do more in both physical and psychological aspects. Human response to daylight has also been studied for many years (Boyce1981) and many researchers attempted to link the psychological and physical aspects. Even the findings were always negative to provide a reasonable explanation for the linkage, they strongly believed that psychological sensations do matter.

Many design guidelines and regulation on daylight provision are based on prescriptive quantitative approach but human response to daylight is always related to previous experiences, for
which climatic effects, socio-cultural factors and life-styles are all affecting daylight perception and acceptance. Due to the lack on knowledge of the qualitative studies of daylight and human response, the inter-relationship between quantitative and qualitative studies is not fully analyzed and studied. Yet, the authors believe that by means of Post User Occuoccupant Evaluation (POE) would offer the qualitative parameters to formulate a design framework for better living environment.

Hong Kong is famous for her unique high-rise and high density urban context for both residential and office buildings, because of her special historical, political and geographical position. Because of land scarcity, population growth and economic boom, Hong Kong has reached the density of about 46,000 persons per sq. km., and up to 80 storeys for residential buildings now. The Hong Kong high-density and high-rise living environment has challenged by the unexpected outbreak of Severe Acute Respiratory Syndrome (SARS) in March 2003, which also gave the significant impact to some of the world’s densely populated cities, such as Beijing, Singapore and Toronto. Hence, a review of the desirability and environmental performance of high-rise residences is necessary with the joint participation of building control authorities, developers, and designers to evaluate the high-rise domestic tower blocks. The review revealed an insufficiency of daylight and ventilation for kitchen and bathroom as an apparent problem in prevailing building design, typically in eight number home-units in a centrally serviced point block, the cruciform. Suggestions were made to upgrade statutory requirements for daylight in kitchens. However, the review and reform has taken the user evaluation into consideration.

Fig. 1 Typical plan of a private residential building

Since 1850’s, Hong Kong became British Colony and thus the building codes were also inherited from the U.K. which guarantee a minimum standard of hygiene and safety for building occupants. Over the years, some characteristic criteria related to domestic building were made in the Hong Kong building codes in order to response to the rapid urbanization and the construction boom.

The first criteria was all the habitable spaces, namely as kitchens, bathrooms, living rooms, dining rooms, and bedrooms, are mandated to be provided with windows (HK B.(P.)R.). The areas of windows, both fixed and operable windows, are directly related to the areas of the corresponding rooms. Currently, windowless bathrooms were allowed if the prescribed requirement of mechanical ventilation and artificial lighting were fulfilled.

The second one was that such windows must directly face a clearance area in order to guarantee air and day light passage. This is known as the “prescribed rectangle horizontal plane” (RHP) regulation (HK B. (P.)R.). The windows are also required to face onto a vertically unobstructed space where the dimension of the unobstructed space is in relation to the height of the building, and the distance from the site boundary. This was a very essential criterion which affected the floor plan configuration and the disposition of building arrangement.

2. PROBLEM & RESEARCH

2.1 Problem

Most of the daylight studies are focus in office building or schools and concerning for the effectiveness of productivity and learning sensitivity. Also, Post Occupancy Evaluation (POE) was rarely carried out on daylight quality. In addition, there was also lack of qualitative studies on the relationship between daylight and human response, socio-cultural factor, life style and behaviour.
This paper would investigate the qualitative aspects of daylight design parameters in high-rise high density residential buildings in Hong Kong, which includes the studies of the socio-cultural factors affecting the occupants’ daylight perception.

2.2 Current Daylight Studies
The human response to lighting has been a subject of study for many years (Boyce1981). Heerwagen (1984) also observed that many researchers attempted to integrate the psychological (qualitative) and physical (quantitative) aspects which ended up with mixed results in the past. Though there were still not positive findings to prove the inter-relationship to the above matters, many researchers believed that the sensations do affect the human response. The author suspected the negative results of those studies might be due to measurement of wrong variables.

2.3 Current POE Studies
Post Occupancy Evaluation (POE) is accepted a useful means to gather information from users, both subjective and objective issues (Presier 2005). Presier traced that initial studies were focusing in the building performance on health, safety and security, which has been adopted and developed into energy issues, building materials performance and life cycle costing, and more recently, psychological, social and cultural aspects. Therefore, most of the POEs done were about energy saving and rare on the qualitative aspect of daylight.

3. RESEARCH METHODOLOGY
Survey by means of standardized questionnaires would be conducted on the daylight aspect, focusing on the perceptual and acceptance aspects. The criteria of targeted sample should be those who live in private residential buildings, where the design and construction adhere to current statutory control.

Generally, the data is measured in different levels, or scale, of measurement of variables, where the variables must be mutually exclusive and exhaustive. Among the four common statistic levels of measurements variables, namely Nominal, Ordinal, Interval and Ratio, questionnaires designed were based on the Nominal and Ordinal scales in this paper. Nominal scale is of no ordering of variables such as gender, location and occupation. Ordinal scale can provide ranking of variables. The authors did not carry out personal interviews in this study.

4. FINDINGS & DISCUSSION

4.1 The POE survey and Background Information
The authors conducted a survey in September 2005 in Hong Kong, which collected views from users towards the living conditions. Questions were classified into four major areas namely Background Information, Expectations on Living Condition, Life Style and living habits & Space usage. 120 questionnaires were sent out with 99 sets returned. Only 86 sets of the questionnaires were selected to analyze who live in private residential buildings. Those who live in public housing were not selected as they are exempted from the Building codes. The analysis is thus reflected a better relevance to the statutory controls of residential buildings, and users’ perception and acceptance. The interviewees are mainly from the age 21 to 40 (87%) and most of their family sizes are four people, or less than four (75%). Most of them are living at above 20 storeys (68%).

4.2 Expectation on Living Condition
In order to investigate how the users evaluate the criteria of the living condition, they were asked to prioritize the consideration of buying new flat. The major consideration is the price, and the next criterion is the location. It is expected that the affordability of buying flat is the primary concern. However, it is surprising to note that the surrounding environment and view are not as important as...
expected, which are of lower priority to location. When the question is more focused to the living environment, 76% of interviewees prioritized their preferences of living in high-rise residential buildings are related to windows, which is in the order of view, daylighting and ventilation.

It is interesting to note that the location is more important than the surrounding environment. Because it affects the travelling time from home to work, and also the facilities and condition available nearby. 90% of the interviewed families agreed that convenient transportation is a major consideration for their choice of residence location. It is because the Hong Kong working environment, employees always suffer from prolonged stressful working hours. Hence, minimizing the time spent becomes essential consideration. (Lau & Li 2006). Also, the availability of daily supporting facilities is also important as Hong Kong people seeks a convenient living style that avoids excessive time spent in any activities, which is contrasting to the Americans, that their homes are always far from the places of work and shopping centres. The socio-cultural factor, which is the time use pattern (way of working) of people in this case, is actually influencing both the life style and physical setting.

The Hong Kong people get used to the high-rise environment and there is a tendency to live as high as possible. This is mainly because of the view preference (Lau 2002, Lau & Li 2006) which can be reflected by the selling price of the flat in upper storey is always higher than the lower storey for that same building. This survey gave the explanation to choosing high-rise living by three major reasons, which are the view (30%), ventilation (25%) and daylight provision (21%). This reflects the importance of windows in the users’ mind where daylight is actually not a fundamental concern for window. The actual performance and acceptance of daylight provision that follows the prescriptive quantitative guidelines are questionable.

4.3 Life Style and Living Habits

The survey show the interviewees’ home are always unoccupied in day time, as 27% of their homes are unoccupied more than 8 hours. Similar phenomenon is found in the Western countries which also accounts for the little research of daylight and residential building. (Lau & Li 2006)

The situation of long period of unoccupied home affects their dinning behaviour, where the result shows most of them are not taking breakfast and lunch at home, even there is 28% of them never cook at home. Only 22% of interviewees have daily cooking during weekdays, which is contrasting to their counterpart in the public housing, or in the 1970’s. This phenomenon requires the qualitative study on the socio-cultural aspect of the occupants and which is challenging the traditional residential spatial arrangement and design. The current design parameters of residential spaces may not march the users’ requirement.

The above result of users’ perception and expectation towards the window and daylight in Hong Kong, but the life-style and behaviour is showing an interesting story. The survey shows more than half of interviewees do not stay at home for more than 5 hours a day (daytime). This is a common phenomenon in Hong Kong and Shanghai that not working class always has a long work hour in the daytime (Lau & Li 2006, Lau & Gou 2006). Then the actual daylight in both quantitative and qualitative performance, or to what extend, is appreciated by the users is being in question. Then, the function of window to those residents may not be daylight, and in other words, the window does something else other than daylight provision to them. Also, whether the daylight provision is sufficient or enjoyed by the occupants are not known.

4.4 Spaces Usage

The importance of different domestic spaces and the associated considerations were studied. The result shows that 65% of studied sample ranks living room as the most important space, and 33% ranks the bedroom, where no people place kitchen as the most important space. The low importance of kitchen is expected in the Chinese society, but this is contrasting to the UK society if consider daylight provision is a parameter of measuring the importance of a living space. Because in UK, kitchen is required daylight factor of 2% and only 1.5% for living room, which implied the need for daylight in kitchen is highest in among different space in a residential unit. This is because the British formulate the building regulation taking the consideration of the duration of staying as the design criteria.
Compared to this survey, 78% of the interviewee spent less than 30 minutes and 44% less than 15 minutes inside kitchen.

The functions of kitchen were ranked in terms of importance, namely cooking, boiling and drinking water, laundry and storage separately. The results show that 57% interviewees agree cooking as very important function and there are about 26% of people treat the cooking from neutral to very unimportant, which supports the result of similar percentage of interviewees not cook at home throughout a week. The role of kitchen and dinning habits of the interviewee, and the inter-relationship are also studied. The result show that 28% of interviewees never cook at home. The cooking function of kitchen has diminished over the years. Outside dining becomes a common life style for many families (Lau & Li 2006). Then, this challenges the design criterion of kitchen window based on daylight provision, as the quantitative measurement is apparently irrelevant to the users is actual usage. Therefore, the qualitative study of user acceptance is necessary to link this gap.

The survey also investigates how occupants rate the different functions of window in the different family spaces. For main spaces like living rooms, dining rooms and bedroom, both view out and natural ventilation provision play a very important role in users’ mind. However, in general the daylight provision is not the most important function of window. This contrasts to most of the current window design guidelines, or regulations, where the design of windows is always deprived from the daylight provision, or daylight factor. The daylight becomes the most essential quantity and parameters in formulating process of windows. For secondary spaces like kitchen and bathroom, ventilation becomes the most essential criteria. The result reflects that people perceived window as sole functional element in the secondary spaces while it does more than that in that main spaces. Finally, 46% of interviewees have found no problem to their windows, while the major complaints from the rest interviewees are the poor ventilation and daylight provision, due to the smallness of window size. Apart from that, an interesting point is that only 5% of the interviewees complain of overheating because of the large window. The result shows the occupants do not concern much on thermal and energy issue through windows, which have been widely studied by many researchers and engineers, especially in the Western and European countries.

The survey shows that the living room is the most important and the bathroom is the most unimportant space in the ranking of different family spaces. The interviewees rated the importance of spaces were based on the duration of staying and the area of that space. The duration of staying implies that the atmosphere and environment of living room should be the best among all the spaces. Windows, as the sources of daylight, thermal, views and noise penetration directly affect the atmosphere of the space, which need more understanding on how users expectation and acceptance.

The study also gave the result of how interviewees rate the functions of windows for ventilation, daylight, view and drying clothes in different family spaces. It shows that views and ventilation are the most important function of window in the main spaces, where daylight provision is only limited to about 20% of interviewees who considered it important. Even for the secondary spaces (kitchen and bathroom), most of the interviewees agrees that ventilation is the most important function of windows, where daylight is still the next preferred. And, view-out of kitchen and bathroom is no longer being the consideration due to privacy concern. This is contrasting with to the western world like the UK, where the 2% daylight factor is recommend for kitchen and is the highest requirement among all spaces in a residential unit (Boyce 1981). Therefore, the existing statutory control of kitchen window using daylight quantity to formulate the design guideline may be out of the context. The qualitative study of human response toward window is necessary to be taken into account in formulating a design.

Finally, an interesting finding is that nearly half of the interviewees have found no problem to their windows provision at home, which is unlike what the building professionals such as designers, architects, engineers and planners have expected that the performance of existing window are inadequate and even needed a new regulation, especially after the outbreak of SARS in 2003 (Lau & Li 2006). The actual complaint on poor daylight provision and ventilation is 18% and 19% respectively due to the smallness of windows. The sole quantitative measurement in formulating the regulation is not sufficient to provide a better quality of living spaces in the high-rise high density Hong Kong. A comprehensive Post occupancy evaluation study is necessary to provide adequate
information from the users’ points of views showing their actual needs. Otherwise it is meaningless to review the building controls without taking the users’ evaluation into account.

5. CONCLUSION

Daylight is not only contributing lighting and thermal provision to the habitable spaces, but also imposing impact to the users in both physical and psychological aspects. However, most studies were focusing in the energy aspects or physical measurable parameters. The actual acceptance and perception of daylight provision is rarely investigated. For most cities, the design of windows is always governed by their local regulations where the regulations again formulated by prescriptive quantitative parameters, such as in relation to the floor area, height of windows and the obstruction angle of the windows. The daylight provision of residential building in Hong Kong is also based on prescriptive quantitative approach. However, the study showed the human response to daylight perception and acceptance would be affected by previous experiences, for which climatic effects, socio-cultural factors and life-styles. The linkage between quantitative and qualitative is important in order provide the occupants a healthy living environment.

The Post Occupancy Evaluation (POE) is a very useful tool to gather the occupants’ response on all the qualitative parameters, through the questionnaires and interviews. The author conducted this survey to collect the occupants’ views to the daylight provision in the unique high rise high density Hong Kong environment.

Linking the relationship between the daylight quality and occupants’ view is actually providing a better living environmental to the occupants, where the findings should be taken into account as design guidelines for the residential buildings.

REFERENCES

Burnett J., 2004, Indoor Environments in Hong Kong's High-rise Residential Buildings: International Housing Conference, Hong Kong
Lau, S.S.Y. and P.K. Li, 2002, A Survey of User Response on High-rise Living in Hong Kong, Hong Kong: University of Hong Kong [unpublished report]
Lau, S. S.Y., Guo, F., Li, F. M., Baharuddin and D. Song, the Planning of Kitchens and Perception of Day-lighting Effects in High-rise Residential Developments in Metropolitan Shanghai: Journal for Building Appraisal [accepted]
Li, F. M., 2005, The Planning of Kitchens in High-rise Domestic Buildings in Hong Kong: Second Conference - Architectural Design and Technologies for Pan Sub-tropical Climates, Guangzhou, China
Preiser, W.F.E., 2005, Building Performance Assessment – From POE to BPE, A Personal Perspective: Architectural science review, vol.48, pp201-204