INTERIOR LAYOUT DESIGN PARAMETERS AFFECTING USER COMFORT IN ENERGY EFFICIENT BUILDINGS

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Abstract - Interior layout design is the last but not the least phase of architectural design. Previous studies claim that interior layout design has direct association with user comfort and convenience. Although previous studies have investigated the association between interior layout design and user comfort, a comprehensive review on interior layout design parameters and sub-parameters affecting user comfort in energy efficient buildings has not been yet established. In this purpose, this research aimed to establish the interior layout design parameters and involved sub-parameters by conducting a systematic literature review. Searching all relevant literature on mentioned keywords via internet academic sources come up different journal papers, conference proceeding, and project reports. This involved in the Web of Science Citation Database, Proquest, Sciencedirect, Scopus, Pub Med and Medline. Then, content analysis of collecting literature was conducted. The systematic review resulted with three (3) Building Aspects parameters and thirty (33) involved sub-parameters, and three (4) User Aspects and twelve (13) involved sub-parameters. The finding aid professionals in architecture, building design and interior designed to enhance the energy efficiency of buildings considering user comfort.

INTRODUCTION

Layout design refers to “the process of determining the sizes and positions of the visual objects that are part of an information presentation (Lok, and Feiner, 2001). Interior layout design is the ultimate phase of architectural design that corresponds directly to user comfort. The previous research demonstrated that besides physical and visual qualities of building layouts, the physiological and psychological aspects of users arise human comfort. In addition, well-designed interior layout design is able appropriately dealing with cost considerations to reduce the energy usage and energy consumption of different types of buildings. Energy efficiency can be defined as the ratio of useful energy output to energy input (P’erez-Lombard et al., 2010). The Major contribution of improved energy efficiency is increased savings, not less energy usage (Patterson, 1996; Haas, 1997; Herring, 2006). Based on MS 1525: 2007, energy efficiency program in building is to “…reduce the use of energy without constraining creativity in design, building function and the comfort or productivity of the occupants”.

In building design assessment field of research, the ‘interior layout design’ was interpreted to ‘Indoor Environment Quality’ (IEQ). According to...
Choi (2011), the IEQ involves parameters directly affect building’s users comfort, including, thermal comfort, Indoor Air Quality (IAQ), acoustics, lightings, privacy, air velocity, humidity, and furnishings. These parameters have been also considered in the Interior layout design. Indeed, the ‘real’ interior layout design deals with geometric shapes and their arrangements, while, user’s satisfaction and preferences about that environment have to be taken into account as well. The ‘building user’ is in the focus of microcosm architecture which considers the parameters generating comfort and wellbeing of users (Gratia and Herde, 2011). Building design assessment studies have developed numbers of models to capture the architectural interior design phases (Mitchell, 1990). These models have been mainly used to obtain schematic geometric arrangements, rather than detailed layout design parameters. There was not yet yielded any comprehensive list of interior layout design parameters with one used practically by architects (Stiny, 2006).

Problems with Comfort Measurement in Energy Efficient Buildings

Indeed, knowledge of design and specification of interior layout design and IEQ can provide indoor designers with the ability to improve simultaneously the comfort and health of building users (Garnys, 2007), and healthy physically and psychologically feedback of environment to building users (Bonda and Sosnowchik, 2007). This issue has been considered by building rating systems as well. To data, Energy and Environmental Design (LEED), Green Star, Hong Kong Building Assessment Method (HK-BEAM), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) and Sustainable Building Tool (SBTool) have considered the association between building indoor design and users’ comfort. These building rating systems attempt to evaluate the correlation between indoor environment design and users’ comfort in the perspective of energy efficiency. Researchers on energy efficient building rating systems state that building user’s behave like a trade-off between comfort and energy saving. However, these rating systems have not yet identified the parameters and sub-parameters of indoor layout design corresponding to users’ comfort and energy efficiency in details.

On the other side, there are numbers of comfort measurement methods. One of the most famous comfort measurement methods is ‘Post Occupancy Evaluation’ (POE) which evaluates the effectiveness of the designed environments from human user perspective (Zimring and Reizenstein, 1980). POE provides building designers with comprehensive and accurate information regarding the performance of their designs, and also, provides building users with guidelines to achieve the best environments from their existing resources (RIBA, 1991). Whereas, the POE and other existing comfort measurement methods have not also considered the indoor layout design parameters corresponding to user comfort and energy efficiency in details. Furthermore, a few guidelines and standards have been established and practically used for the building interior layout design process (Alexander et al., 1977; Susanka, 2001; Jacobson et al., 2005), specifically, in optimizing energy consumption and energy usage.

Interior Layout Design Parameters Associated with User Comfort

According to the ANSI/ASHRAE Standard 55, if 80% of the building users are satisfied with a condition of the indoor environment at any given time, then, the condition of that environment is considered reasonably comfortable. This standard specifies ‘building-based indoor environmental parameters’ and ‘user-based parameters’ that establish comfort acceptable to a majority of users within the space (Clements-Croome and Baizhan, 2000; Nasrollahi et al., 2008). In energy efficient building design studies, the adaptive responses of users can be determined in terms of technological, personal, psychological and Physical adaptations (Liu et al., 2012). The following present diverse user’s adaptations for comfort provision within building indoor environment:

- Technological adaptation, mainly reflects by the adjustment of two environmental. It is in purpose to adjust the thermal and/or lightening condition in the building. It includes adjustments on window , sun-shading devices, heating units (e.g. fan heater), cooling, fan, air conditioner.
- Personal adaptation, refers to adjustment in personal physical situation. It is in response to thermal and/ or lightening environment changes. It is a kind of typical personal adaptation; such as, cloth adjustment, place adjustment.
- Psychological adaptation, in the context of