(Refereed paper)

Form versus Function: A Study into Interactive Learning Process affecting the Implementation of Sustainability in Commercial Buildings.

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Owners and tenants of sustainable buildings are now realising the sustainable building that they own or occupy and also how they use the building have a significant impact on their work practices. These stakeholders are demanding sustainability outcomes such as improved occupant health and performance, lower energy and material consumption use as well as encouraging healthy ecosystem in their sustainable building. Clearly the level of user knowledge about a sustainable building and its technologies makes a difference about the actual behaviour towards sustainable buildings (Knott 2007; Stenberg 2007)

There remains two major challenge faced by sustainable building occupants: (i) addressing the gap between an occupant's expectations of sustainable building outcomes and what the building actually provides and (ii) overcoming the lack of user knowledge about sustainability design and operation for a particular with regards to performance (Jailani et. al, 2011). This is an innovative study designed to address these challenges. It uses a focus group approach to investigate the gap between (a) user expectations and (b) sustainable building performance, with reference to the relationship between interactive learning process and the level of implementation of sustainability in commercial buildings. The outcome from the study will provide a post-occupancy evaluation of the perception of occupants in sustainable buildings. Most importantly, this information can then assist architects and designers in private and government organisations to successfully develop future sustainable design and policy which can fully capitalise on the original intention when delivering sustainable buildings, as well as providing an innovative feedback mechanism between occupiers and architects.

Keywords: Sustainability, built environment, occupant satisfaction, office building design, interactive learning process.

1.0 Background

The continued adoption of sustainability in the built environment on a global scale continues to increase as more countries and organisations seek to establish standards and incentives to promote sustainable building practice. Whilst there is an established body of knowledge about the technical aspects of sustainable buildings, there has been relatively little research conducted into the relationship between the architects (i.e. form) and occupiers (i.e. function). Since social aspect is a major principle of sustainability, it is important to understand the occupiers' perceptions and expectations of sustainable building design and advance technology incorporated in buildings (Wilkinson, Reed & Jailani 2011).

Sustainability has broad and different definitions due to various perspectives in practice. However Kemp & Martens (2007) found that since different people and practices have different perspectives about sustainability that meet their own needs, therefore no right or wrong opinion in sustainability exists. While there have been some rather varied and complex definitions, the most common mainstream definition was by the Brundtland Commission Report (1987) which defined sustainability as development that meets the needs of the present without compromising the ability of future generation to meet their own needs.

Sustainability was further conceptualised and expanded by Elkington (2004) with the development of three overlapping sustainable development principles known as the 'triple bottom line'. Where principles of sustainability should be balanced and harmonised between the environment, the economy and the social values. The focus of this paper is on sustainability in the built environment with the primary focus on the effect of the human perceptions and expectations of sustainable commercial building in which sustainable buildings is one that improves occupant health and performance, using low energy and material consumption and encourage a healthy ecosystem.

Problems relating to inefficient energy and water usage, solid waste and black water management and also land use of conventional buildings are well documented. Compared to conventional building, a sustainable building promises environmental, economical and social benefits to the users. Since throughout the world more occupants are aware of the effect the conventional buildings have on health, safety and the environment, demands for building design and operation system for increased health and well being for the occupants, and improved environmental performance in a global market continue to escalate. In an Australian context, the increasing demand for sustainable buildings is demonstrated by the number of certified building in Australia from eight in 2004 to more than 200 in 2010. This demonstrates the considerable growth in demand of sustainable building from government, developers and owners in Australia (GBCA 2010). The Green Building Council Australia reports that in 2010 approximately 30% of the new building market in Australia are sustainable buildings with a combined value of $85 billion.

A sustainable building incorporates modern and sophisticated design and uses advanced and up to date technology for operational practices that substantially reduces or eliminates its negative impact on the environment and its occupants (Kohler 1999). However, there is limited discussion about human behavioural and social responses to the issue of sustainability in buildings, especially the relationship between technological advances in sustainable building and how occupants interact and behave with these buildings (Wener and Carmalt 2006). This research uses a qualitative design approach to investigate previous studies into sustainable buildings, with focus on the level of knowledge about sustainable building amongst occupants, and the interactive learning process through communication between the designer/architect and occupants about the human perceptions and expectations about sustainable commercial office buildings. This research will provide a better understanding about the relationship between occupants and the building, and the exchange of information to occupants of the objectives of the features of the sustainable buildings. This research will further develop the social element of sustainability in the built environment, and provide a stronger base for building design and policy related to occupation of sustainable buildings.

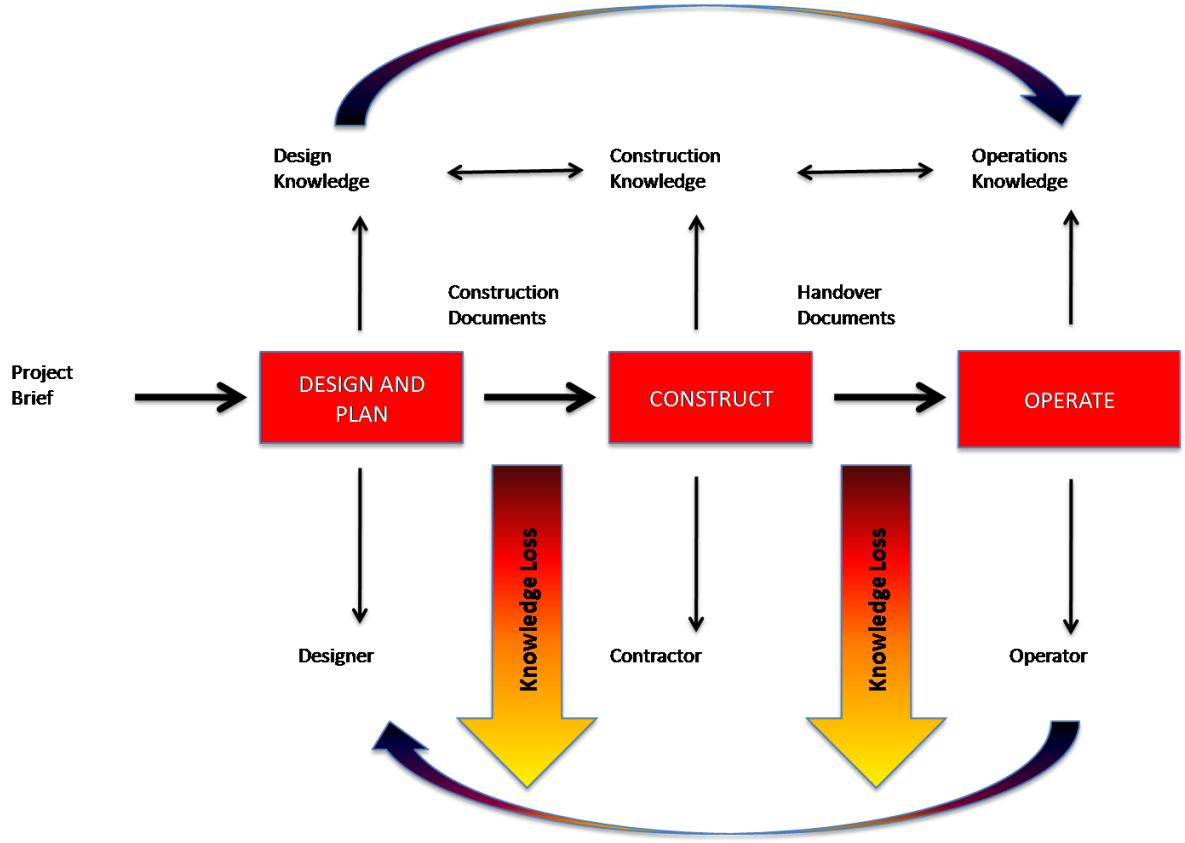
2.0 Architect versus Tenant: Interactive learning process

2.1 Knowledge Sharing

The rising level of awareness about the growing environmental consequences of conventional buildings has been a catalyst in the global market, including Australia, to increase sustainability in the built environment. However the skills required to achieve sustainable performance enhancements are decreasing in the industry. This skills shortage is compounded by a 'knowledge gap' which has occurred as critical knowledge of building design and operation as shown in Figure 2.1 which is lost between different stages of the building life cycle (Jones Lang LaSalle 2007). There are several ccommunication breakdowns between the people who are involved in the different phases of a building's lifecycle. This is especially evident between the architects and occupants with reduced knowledge transfer and knowledge sharing which restricts the sustainable building from being able to take full advantage of its sophisticated design and advanced building operation system.

Users' knowledge on sustainable building and its technologies affects the actual behaviour towards sustainable building (Knott 2007; Stenberg 2008). Two main problems with the lack of a user's knowledge about sustainability design and operation with regards to performance are; (1) lack of occupants' knowledge about environmental control and operation of the buildings' systems affecting the energy efficiency of the building as targeted by architects and (2) occupants' poor understanding about why the building was designed in a particular manner and how to operate the appliances of the buildings which in turn impact on comfort and satisfaction with sustainable buildings. (Brown et al. 2009).

Figure 2.1: Critical knowledge of building design and operation



(Source: Jones Lang LaSalle, 2007)

2.2 User Interaction with Sustainable Building

Occupants are the end-user of the building and an important stakeholder in a building's lifecycle. They can comprise of several different types of people i.e. different demographic backgrounds and have their own personal demands or views. Therefore either they are feeling good, healthy and comfortable or alternatively are not when they are in a sustainable building depending on their personal needs (Edwards 2006; Roulet et al. 2006). Previous studies into sustainable buildings suggest a key aspect as a benchmark of sustainable building success is the occupants' satisfaction with the building design and performance (Edwards 2006; Abbaszadeh et al. 2006; Brown and Cole 2009; Hoffman and Henn 2008; Maver and Petric 2003; Zagreus et al. 2004; Peretti et al. 2010). Since occupants can be satisfied or dissatisfied with sustainable building attributes depends on their personal needs, it is essential their wishes and demands align with what the building can offer (Meir et al. 2009). Table 2.1 summarises some of the criteria influencing user satisfaction in a sustainable office building. The level of satisfaction by occupants of a sustainable building has a direct relationship with occupants' job performance. Occupants who are satisfied with their workplace environment are more productive and performed better on their work tasks and experienced stable state of mind and body compared to occupants who are dissatisfied with their workplace environment (De Croon et al. 2005)

Table 2.1: Criteria influencing user satisfaction in a sustainable office building

Criteria	Example	Researcher
1. Thermal comfort and air quality	too hot, cold and to stuffy or draughty	(Zagreus et al. 2004; Abbaszadeh et al. 2006; Roulet et al. 2006; Edwards 2006)
2. Aesthetically pleasing, well equipped facility and well maintained	modern attractive up to date appearance and equipment, with prompt repair and regular upkeep	(Zagreus et al. 2004; Edwards 2006)
3. Personal control over windows/blind/HVAC system	ability to vary surrounding environment	(Heerwagen 1998; Abbaszadeh et al. 2006; Edwards 2006; Zagreus et al. 2006; MacMillan 2006; Newsham 2009)
4. Lighting and acoustic	Excessive glare, inadequate lamination and poor sound transmission	(Zagreus et al. 2004; Abbaszadeh et al. 2006; Edwards 2006; Roulet et al. 2006; Newsham 2009)
5. Open space design and flexibility	Ability to reconfigure space to accommodate different space plan / user needs	(De Croon 2005; Edwards 2006; MacMillan 2006; Newsham 2003)

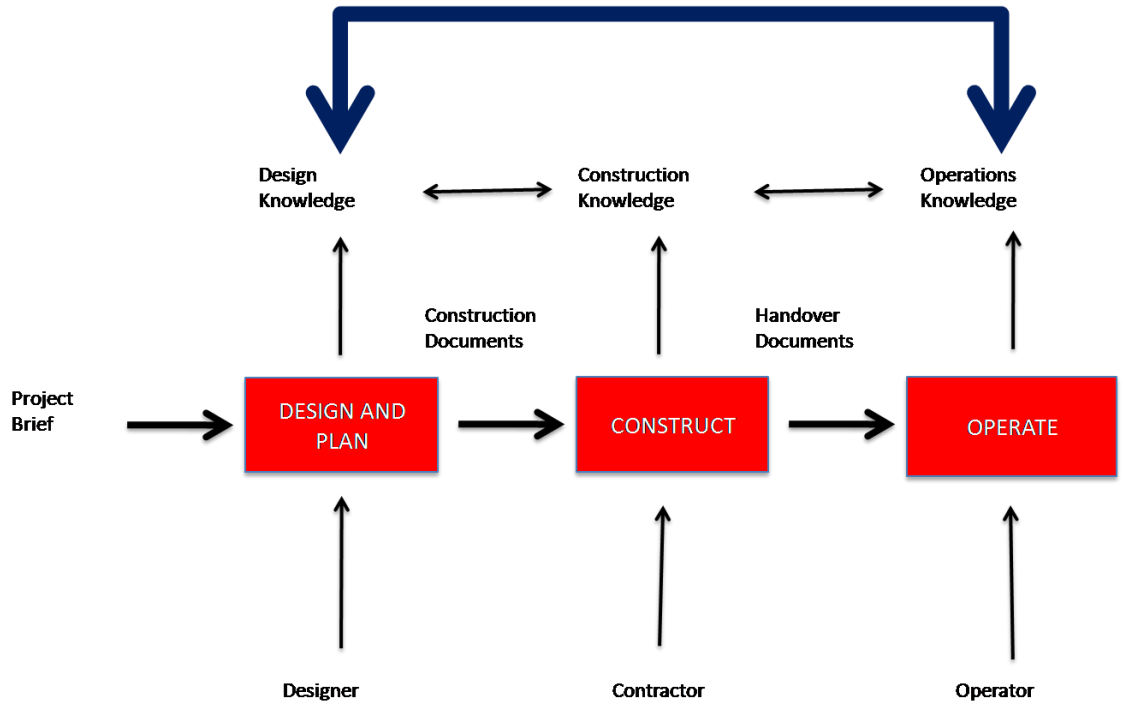
(Source: Wilkinson, Reed and Jailani, 2011)

The relationship between user satisfaction and a sustainable building depends on the interaction between architects and their building design philosophy around sustainable buildings and the occupants (Weiss et al. 2004). This interplay shapes the development of adaptation process between technology design and use. The success of the interaction processes are depends on communication of knowledge and experience as well as social learning process between designer and user practice (Rohracher and Ornetzeder 2002).

2.3 Communication

A vital component of a successful sustainable is the interaction and communication between the architects and occupants in order to communicate the intensions of the design, and how building works with the occupant to provide an enhanced workplace. However, at present there is a lack of communication between the designers and the occupants of sustainable buildings. As there are several phases separating designers from the occupants as shown in Figure 2.2 there is considerable information and knowledge loss from the design phase through the construction and operation phase and this has not yet reached the occupiers.

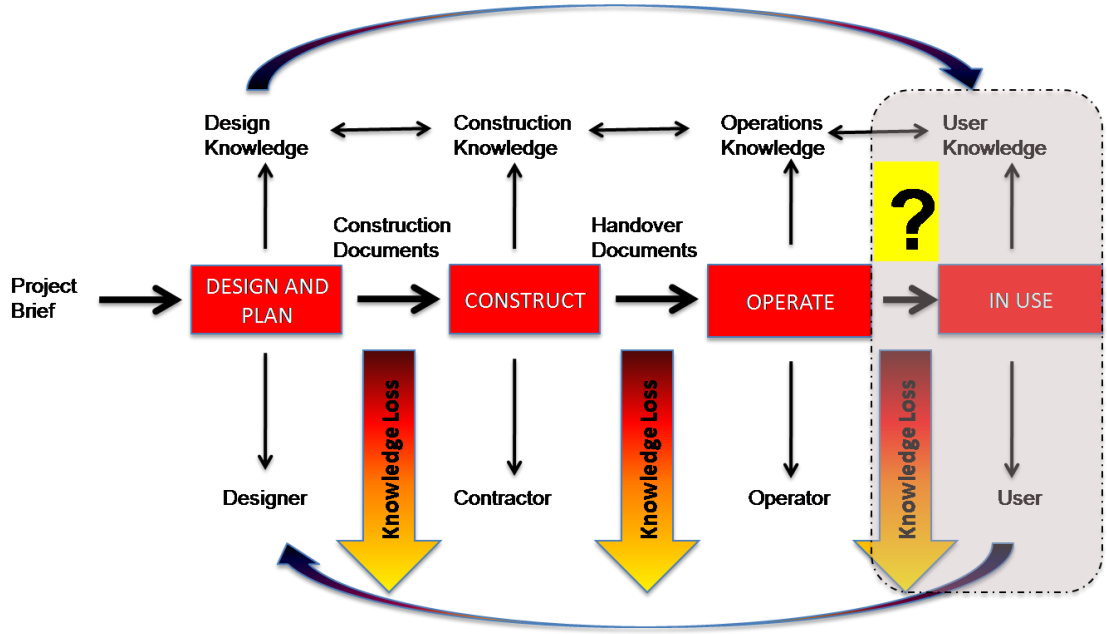
Figure 2.2 The Knowledge Life Cycle



(Source: Jones Lang LaSalle, 2007)

Occupiers are the fourth,\ and little discussed stakeholder in the knowledge cycle as shown in Figure 2.3. There has been a focus to date on the knowledge loss and the need to increase the communication and knowledge sharing between the design, construction and operational phases of sustainable development. However, there has been very acknowledgement of the occupier and their role in the communication and knowledge sharing process, which is vitally important as they are going to be the primary users of the building for the long term, and ultimately are the critics as to whether a sustainable building is considered a ‘success’ or not.

Figure 2.3 The Knowledge Cycle – Communication and Knowledge Sharing



(Source: After Jones Lang Lasalle, 2011)

Communication between architects and occupants is imperative for the exchange of important information and knowledge sharing between these two groups in order to achieve occupant satisfaction during their occupation and use of the sustainable building. This requirement for an interactive learning process allows the architects to explain the motives of specific design or system applied on a sustainable building to the users. The users have the opportunity to provide the architects with information about their expectations and what they experienced with a sustainable building. It is necessary for a feedback loop and knowledge sharing process to be advocated between designers/architects and users/tenants as shown in Figure 2.3. This will improve communications and discussions between the designers, building operation management and users, consequently this style of feedback communication and discussion would most likely improve the performance of sustainable building by increasing the understandings of the building design and style of occupation required for the building

3.0 Research methodology

Based on the literature review and the conceptual model presented in Figure 2.3 about communication and knowledge loss between the different actors within the sustainable building design, construction, operation and occupation, the aims of this study are:

i. To identify the gap (if any) between users' expectations and users' experience with five key criteria influencing user satisfaction in a sustainable building; and

ii. To examine relationship between users' expectations and users' experience with sustainable building performance and interactive learning process of architects and occupants of sustainable building

iii. To identify the effective medium for interactive learning process of architects and occupants of sustainable building

The findings reported in this paper are based on series of focus group sessions. The focus group sessions consisted of two sections: (i) completion of a questionnaire and (ii) group interview. The focus group session is using to determine the level of satisfaction and expectations of sustainable building occupants' with their workplace. This study was also designed to understand the relationship between the level of knowledge about sustainable building design and operating systems among occupants and the behaviour of, and impacts, on sustainable building occupants.

The focus group session participated by randomly selected occupants of 8 buildings located in the Melbourne Central Business District (Melbourne CBD) area. The buildings were divided into five (5) categories: (i) premium building (Premium), (ii) design as a "sustainable building" (DFS), (iii) 4 Star Green Star Rating (4 Star), (iv) 5 Star Green Star Rating (5 Star) and (v) 6 Star Green Star Rating (6 Star) and classified as office use. Table 3.1 list characteristics of buildings being examined.

The questionnaire was divided into four sections with questions about demographics asked in section one. In section two and three respondents were asked to identify their perception and experience about interior aspects of their office building design, operation and appearance based on five key categories grouped as follows: thermal comfort and air quality; aesthetics, level of amenity and maintenance; personal control over windows, blinds HVAC; lighting and acoustics and finally, open space design and flexibility for a range of uses. A five point likert scale was used to rank the levels of satisfaction and expectation from 1 (strongly agree) to 5 (strongly disagree) based on five key categories. Section four contained questions on knowledge sharing and communication where the respondents were asked to rate their opinion whether their knowledge on office building design, operation and appearance have effects on their satisfaction with sustainable building performance. The participants who completed the questionnaire then participated in a group interview to describe their views of the user/s and the sustainable performance of the building.

Table 3.1 Properties of Buildings

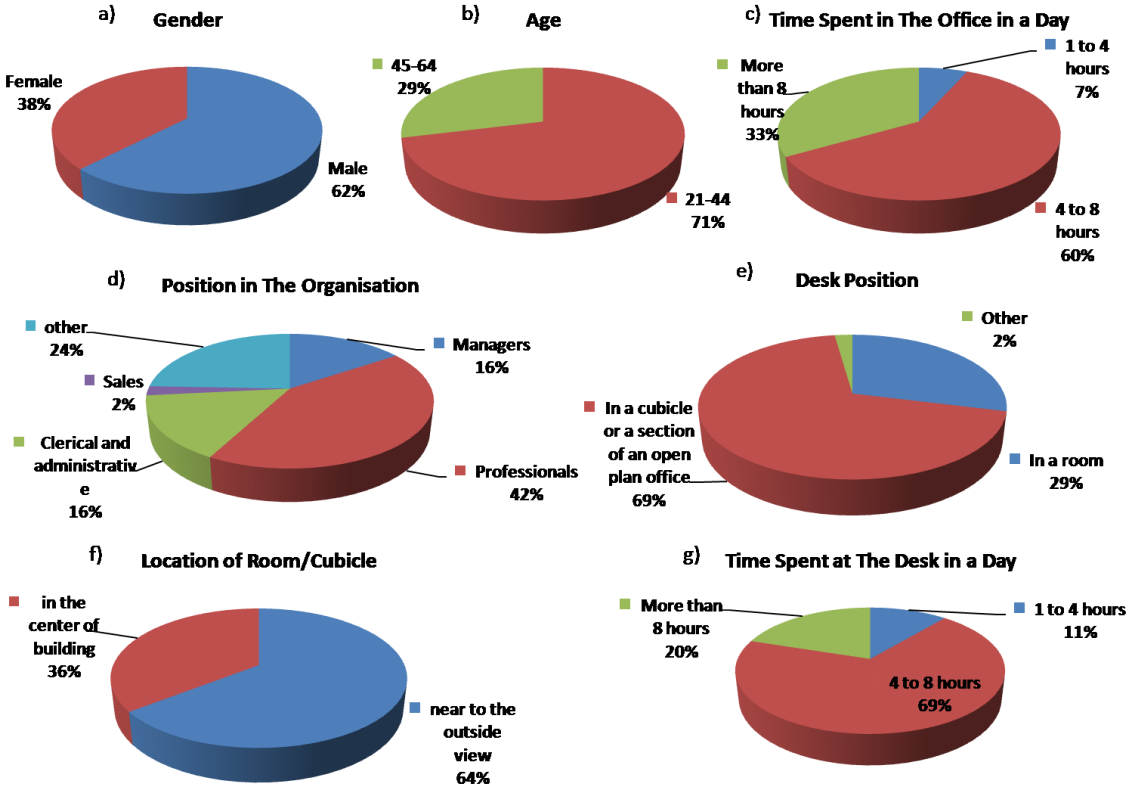
	Premium	6 Star	5 Star	4 Star	DFS
Building Properties					
Tenant	Private Officer	Government Officer	Government Officer Private Officer	Government Officer Private Officer	Student Academician
Type of Building	Office	Office	Office	Office	Office Educational Facilities
Year of Completion	< Year 2004	2006	2008	2005	2002
Size	> 1300 m2	12536 m2	25600 m2	52000 m2	19000 m2
No. of Floors	>26	10	19	34	5
Floor Design	Open Plan	Open Plan	Open Plan	Open Plan	Room
HVAC SYSTEM					
Heating System	Air Conditioner	Thermal Mass	Air Conditioner	Air Conditioner	Air Conditioner
Cooling System	Heater	Thermal Mass	Heater	Heater	Heater
Ventilation	Mechanical Ventilation	Natural Ventilation	Mechanical Ventilation	Mechanical Ventilation	Natural Ventilation
Personal Control					
Window	No Opening	Control Opening	No Opening	No Opening	No Opening
Blinds	No Blinds	Control Blinds	No Blinds	No Blinds	Manual Blinds
HVAC	Centralised Control	Personal Control Fresh Air Vent	Centralised Control	Centralised Control	Centralised Control

4.0 Analysis and Discussion

4.1 Demographic characteristics

In section one of the focus group participants were asked about their background. Demographic results show that 62.0% of the samples were male and 38.0% were female. Most respondents were adults aged 21 to 44 years (71.0%), with few over 45s (29.0%) and no users aged 20 and under. Most respondents are professionals. More than half of the respondents shared their office with others (66.7%). The percentage of respondents who are working in the middle of the building without outside view (36.0%) lower than respondents who are working near to the window (64.0%). Most of the respondents (69.0%) spent 8 hours in the building. Characteristics of the focus group participants are illustrated in figure 4.1.

Figure 4.1. Focus Group Participants Characteristic.



4.2 Users Satisfaction and Users' Expectations

4.2.1 Users' Satisfaction and Users' Expectations with Sustainable Building Key Categories

In the Section 1 of the questionnaire, the focus group participants were asked to rate their satisfaction level with twenty (20) sustainable building characteristics on a scale from 1 to 5. The characteristics were separated into five key criteria:

i. thermal comfort and air quality;

ii. aesthetics, level of amenity and maintenance;

iii. personal control over windows, blinds and HVAC;

iv. lighting and acoustics and

v. open space design and flexibility.

The results in Figure 4.2. show that in all instances the expectations of the user/s were not met by their satisfaction expressed. Key criteria of sustainable building that have the biggest gap between users' satisfactions and users' expectations is personal control over windows, blinds and HVAC system (34.2% difference). Criteria lighting and acoustics showed a 25.8% difference between users' experiences and users' expectations, closely followed by thermal comfort and air quality (25.6% difference) and criteria design and flexibility (17.8% difference). The smallest difference was between users' satisfactions and users' expectations with the sustainable building key criteria of aesthetic

pleasing, well equipped and well maintained (14.0%). Table 4.2 lists the rank order of the issues experienced by the occupants with regards to twenty (20) sustainable building characteristics. The occupants have ranked personal control over the ventilation and temperature in the office as the top issues they have experienced. Tidiness ranked as the least issue they have experienced.

Figure 4.2 The Gap between Overall Users' Satisfactions and Users' Expectations with Key Criteria of Sustainable Building

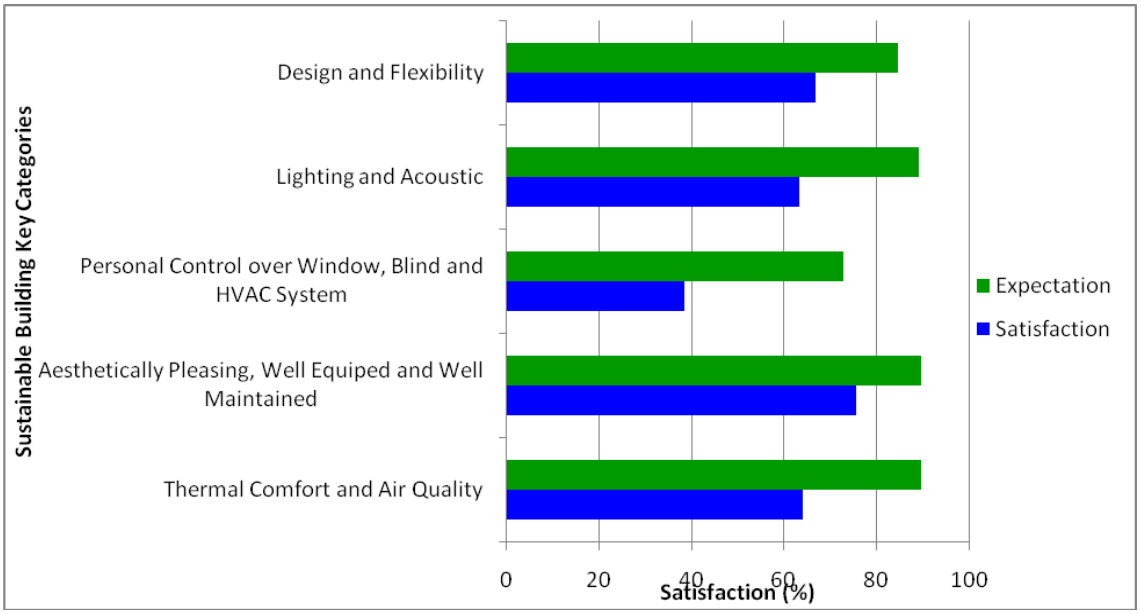


Table 4.2 Ranking of Issues Concern by Occupants with Regards to Sustainable Building Characteristic

Sustainable Building Characteristic	Rank
Control over the ventilation in the office	1
Control over the temperature in the office	2
Conversation privacy in the office	3
Control the opening of external windows in the office	4
Visual privacy in the office	5
Functions at a comfortable temperature	6
Control over the natural lighting in the office	7
Feels well ventilated	8
Heating/cooling system that is responsive in temperature change	9
Functions at a comfortable level of humidity	10
Adequate natural lighting	11
Good acoustic quality with acceptable noise level	12
Flexible enough to accommodate changes in different employee teams	13
Visually appealing	14
Contains up-to- date IT/Telecommunication services	15
Layout/design that facilitates movement within the building	16
Good common amenities (e.g. toilets / kitchen facilities)	17
Adequate artificial lighting in the office	18
Facilitate collaboration/ interaction with other colleagues	19
Tidy in appearance	20

4.2.2 Users' Satisfactions and Users' Expectations with Sustainable Building Key Criteria

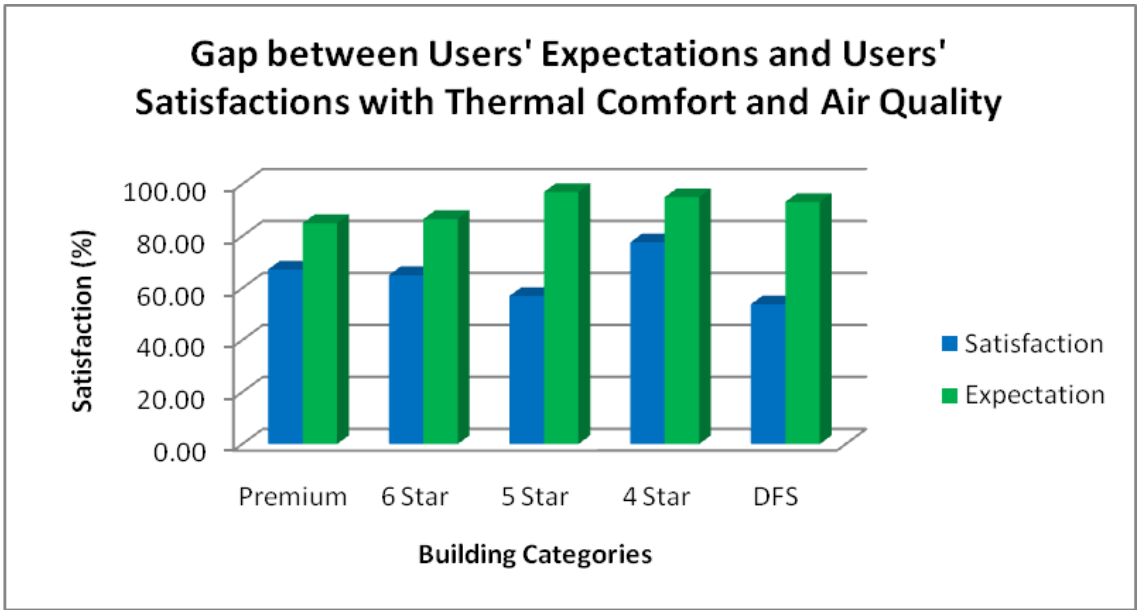
Criteria 1: Thermal Comfort and Air Quality

Figure 4.3 shows the gap between users' satisfactions and users' expectations with thermal comfort and air quality according to five building categories: Premium, DFS, 6 Star, 5 Star and 4 Star. When the questions related to thermal comfort and air quality are examined, occupants working in 5 Star rated building have the lowest satisfaction level (57.0%) with thermal comfort and air quality compare to occupants in other four building categories. Occupants working in 5 Star rated building also have the highest expectation level (97.0%) with thermal comfort and air quality compare to occupants in other four building categories. The difference between users' satisfactions and users' expectations for 5 star building occupants is 40.0%. The largest difference between users' satisfactions and users' experiences with thermal comfort and air quality revealed a similar response profile by occupants working in DFS building (39.4%). Occupants working in Premium and 4 Star buildings were the most satisfy with thermal comfort and air quality with only a 17.8% and 17.4% difference between satisfaction and expectation levels respectively.

When the questions related to thermal comfort and air quality are examined in a 5 Star building, one respondent claimed the office was *'pretty well satisfied apart from the heating'* and of the respondent from DFS building said ' *I've actually got a little thermometer and humidifier reading on my desk and*

the temperature stays quite constant now as in over winter/summer it sort of varies from around about 20 degrees up to about 24, I think is the hottest I've seen but the humidity in this building goes anywhere from about 30% up to over 80% and once the humidity gets up around that, in that 70s, 80s, I don't know, it becomes very hard to concentrate and it becomes very easy to drift and the productivity, it might be just me, but I've just noticed that when it gets up to there, I'm starting to think I'm going home or if I can. I'm looking for other places. It just becomes uncomfortable.'

Figure 4.3 The Gap between Users' Expectations and Users' Experiences with Thermal Comfort and Air Quality Criteria According to Five Building Categories

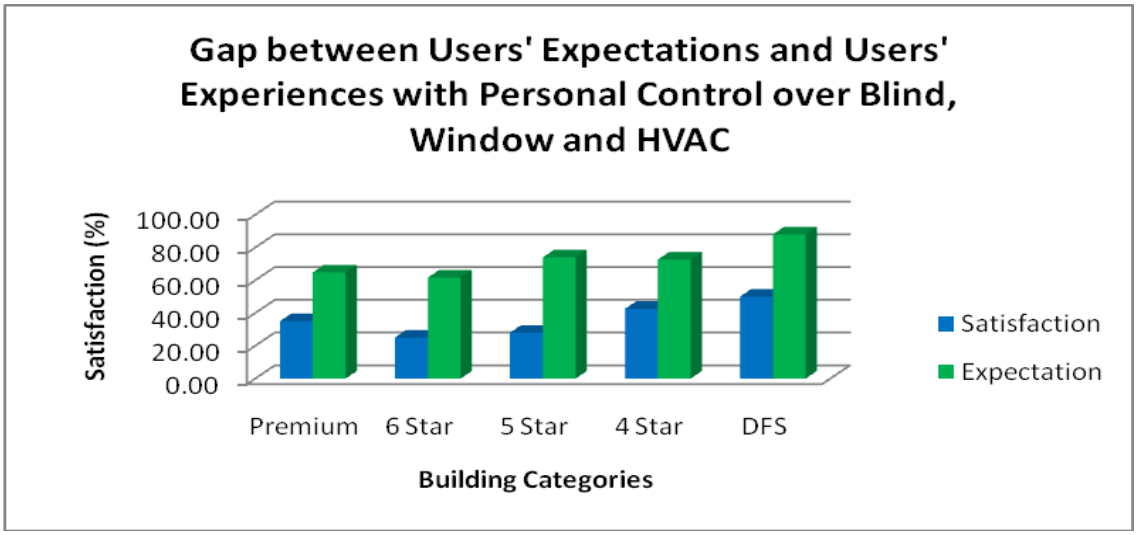


Criteria 2: Personal Control over Windows, Blind and HVAC System

Figure 4.4 explains that all users in five building categories experienced high level of dissatisfaction with personal control over windows, blind and HVAC system compare to what they expected. There were not so much different on percentage of difference of users' satisfactions and users' expectations with personal control over windows, blind and HVAC system between five building categories – Premium, 6 Star, 5 Star, 4 Star and DFS. Almost all buildings have more than 30% differences between level of satisfaction and expectation. The differences are 29.8%, 36.6%, 46.0%, 30% and 38% respectively. These show that, users in five building categories were dissatisfied with personal control over windows, blinds and HVAC system of their offices. The highest difference is experienced by users in 5 Star building with almost 50% differences between level of satisfaction and expectations.

When the questions related to personal control over windows, blinds and HVAC are examined in 5 Star building, one respondent claimed '*There's not a lot of control and I suppose it is important to the, you know, to your perception of the building how much control you get so I think I said to you earlier, while we were sitting outside, you know, it doesn't feel like a green star rated building in some ways. I wouldn't think of the building as a whole was a particularly green building. Out here, it's pretty green within this building but it's kind of minimal stuff, double glazing, black water treatment'*

Figure 4.4 The Gap between Users' Expectations and Users' Experiences with Personal Control over Windows, Blind and HVAC System Criteria According to Five Building Categories

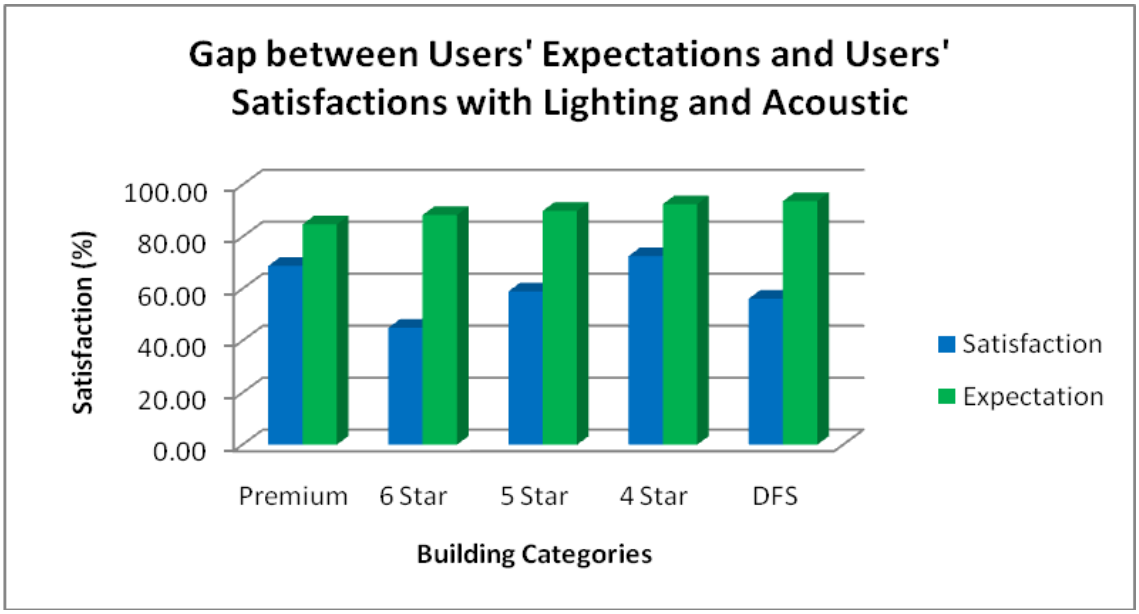


Criteria 3: Lighting and Acoustic

Occupant satisfaction and expectations with lighting and acoustic conditions revealed a similar response profile for 6 Star, 5 Star and DFS buildings. Figure 4.5 shows that in these buildings there are huge differences between level of satisfaction and expectation of occupants with lighting and acoustic (43.4%, 31% and 37.6% respectively). The percentage of differences is more than 30% for all three building categories. This shows that users in these three building categories were not happy with lighting and acoustic criteria of their offices. The highest level of occupants' satisfaction with lighting and acoustics conditions was experienced by occupants in a Premium building (16.0%).

One of the respondent in a 6 Star building claimed that *"I find this building very dark and it is a little bit frustrating that all the columns seem to have been placed in front of windows and I also find this building quite noisy... lacking in total privacy. There's nowhere where you can go unless you go outside if you're having a private conversation and so you can't do that unless you've got a mobile phone"*.

Figure 4.5 The Gap between Users' Expectations and Users' Experiences with Acoustic and Lighting Criteria According to Five Building Categories

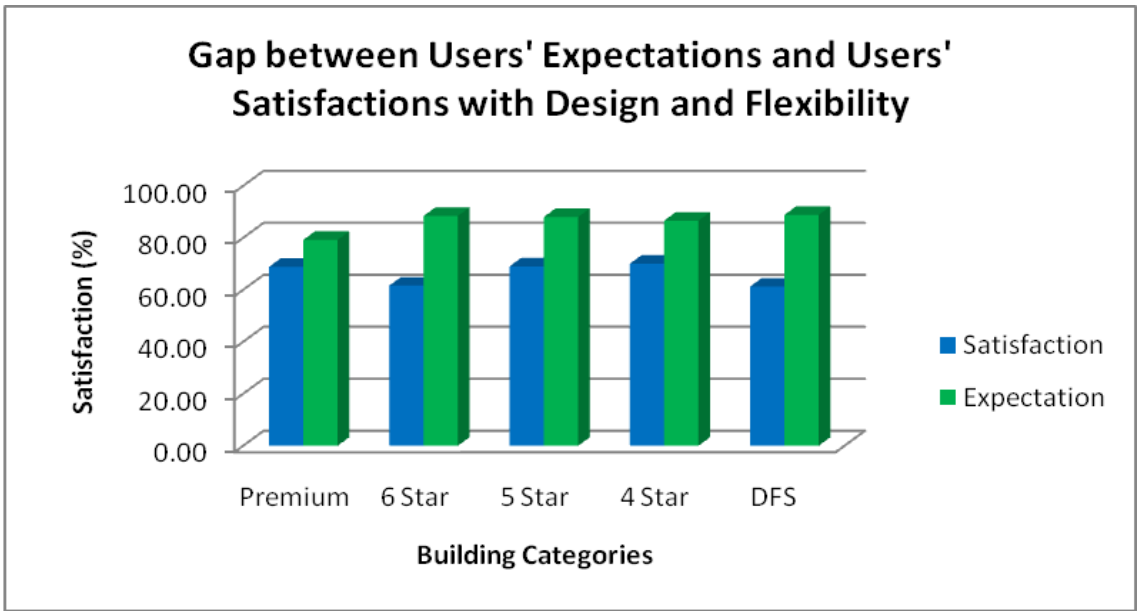


Criteria 4: Design and Flexibility

Users in all five building categories were satisfied with design and flexibility criteria of their building. Figure 4.6 shows only small differences between level of users' satisfactions and users' expectations of this criteria for Premium, 6 Star, 5 Star, 4 Star and DFS buildings. The percentage of differences are less then 30% for all buildings. The differences between level of users' satisfaction and users' expectation with design and flexibility criteria for Premium, 6 Star, 5 Star, 4 Star and DFS are 10.4%, 26.8%, 19.0%, 16.6% and 27.6% respectively

When questions about design and flexibility about their building were asked, one of the building respondents said *"I've heard one story that these ceilings were designed by the lighting engineers to do all their work based on a white ceiling...And when we, of course when we moved in and it's a grey wall so you don't have the paint surface interfering with the heat transfer, it is a completely different effect than what they modelled."* Another respondent also claimed *"when it was designed (the building) they've not looked at the practicalities of if it..just looks beautiful to look at"*

Figure 4.6 The Gap between Users' Expectations and Users' Experiences with Design and Flexibility Criteria According to Five Building Categories



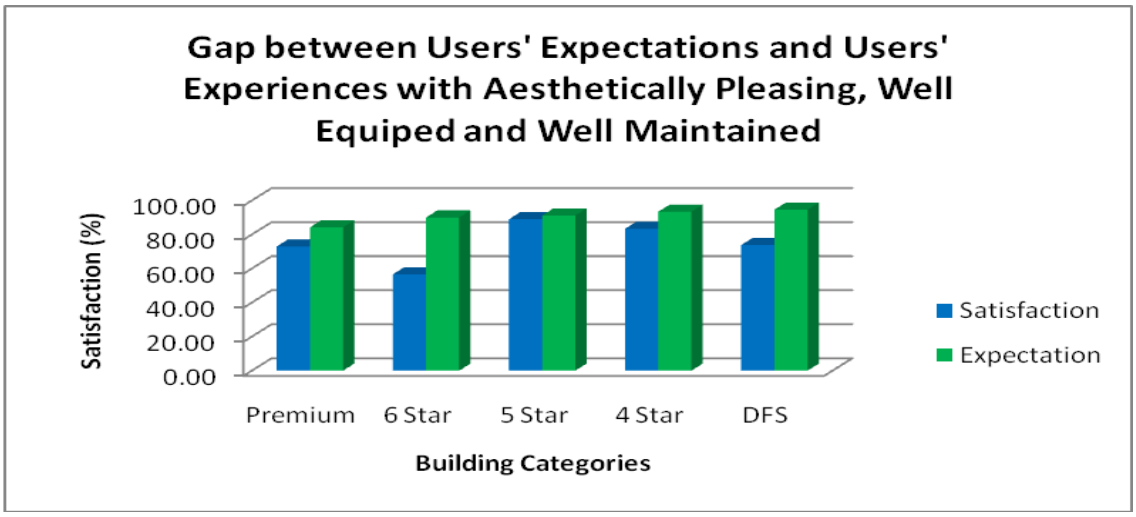
Criteria 5: Aesthetically Pleasing, Well Equiped and Well Maintained

The result in figure 4.7 shows that most users were happy with aesthetically pleasing, well equiped and well maintained criteria of their building except for users in a 6 Star building. The difference in level of users' satisfactions and users' expectations with aesthetically pleasing, well equipped and well maintained criteria of 6 Star building is the highest compared to other four building categories (33.40%). The percentage of difference of level of users' satisfactions and users' expectations with aesthetically pleasing, well equiped and well maintained criteria of four other building categories are very small only 11.0% for Premium, 2.2% for 5 Star, 10.0% for 4 Star and 10.8% for DFS.

One of the respondent's comments on aesthetically pleasing, well equipped and well maintained was *"you know, a maintenance issue with bearings and getting them to work and-and the wind, because I think they were being made out of steel, they were probably too heavy, so a combination of things just*

made them, they weren't ever going to operate as designed or as how it's thought out so we've locked them down"

Figure 4.7 The Gap between Users' Expectations and Users' Experiences with Aesthetically Pleasing, Well Equiped and Well Maintained Criteria According to Five Building Categories



4.2.3 The difference between Users' Satisfations and Users' Expectations with Sustainable Building Criteria

The results in Figure 4.8 shows the differences between level of users' satisfaction and users' expectations with sustainable building key criteria for five building categories. Occupants in a Premium and 4 Star building were more satisfied with their office with regards to sustainable building key criteria compared to three other building categories. The differences between level of users' satisfaction and users' expectations for both premium and 4 Star buildings are less than 30% for all sustainable building key criteria. Occupants in a Premium and 4 Star building were satisfied with almost all sustainable building key categories in their building except for personal control over windows, blinds and HVAC system.

The highest difference between the level of users' satisfaction and users' expectations with sustainable building key criteria is for 6 Star building followed by a 5 Star building. The graph shows level of difference between users' satisfactions and users' expectations with sustainable building key criteria revealed a similar trend for DFS building and both 6 Star and 5 Star buildings. Occupants in 6 Star and 5 Star buildings were most dissatisfied with two sustainable key building categories: personal control over windows, blinds and HVAC system and lighting and acoustic. The difference between levels of users' satisfactions and users' expectations for these two categories almost reached 50% differences.

The results in Figure 4.8 also shows that the difference level between users' satisfactions and users' expectations with all sustainable building key criteria for 6 Star building were higher than for a Premium building. This prove that occupants are less satisfied with building with too much complicated technology and sustainable elements incorporated in the building such as in 6 Star building and more prefer a 'simple ready to use' building such as Premier building. Table 4.3 explains the rank of most important sustainable building characteristic preferred by the occupants in a building.

Figure 4.8 Users' Satisfactions and Users' Expectations with Sustainable Building Criteria According to Building Categories

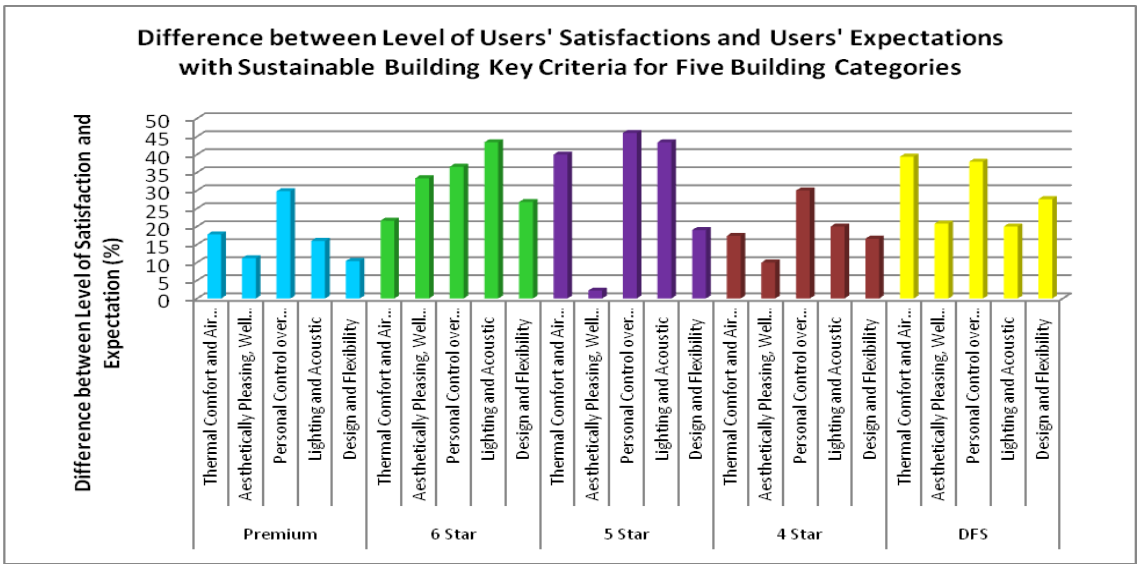


Table 4.3 Ranking of The Importance of Building Characteristics

Sustainable Building Characteristic	Mean	Std. Deviation
Adequate natural lighting	4.80	.405
Feels well ventilated	4.64	.484
Contains up-to- date IT/Telecomunication services	4.60	.539
Good common amenities (e.g. toilets / kitchen facilities)	4.58	.543
Function at a comfortable level of humidity	4.52	.505
Functions at a comfortable temperature	4.51	.661
Adequate artificial lighting in their office	4.47	.661
Flexible enough to accommodate changes in different employee teams	4.44	.659
Good acoustic quality with acceptable noise level	4.44	.546
Visually appealing	4.43	.625
Facilitate collaboration/ interaction with other colleagues	4.42	.621
Layout/design that facilitates movement within the building	4.40	.618
Tidy in appearance	4.36	.679
Heating/cooling system that responsive in temperature change	4.33	.707
Conversation privacy in the office	4.11	.745
Control over the natural lighting in the office	4.04	.796
Control over the ventilation in the office	3.80	1.079
Visual privacy in the office	3.67	.929
Control over the temperature in the office	3.47	1.179
Control the opening of external windows in the office	3.27	1.156

4.2 Relationship between Users' Expectations and Users' Experience with Sustainable Building Performance and Interactive Learning Process of Architects and Occupants of Sustainable Building

4.2.1 *The impact of knowledge on Occupants' Interaction with Sustainable Office Building*

This research investigates the effect of users' knowledge about sustainability with their level of satisfaction and expectation with sustainable building criteria. Most respondents were aware about sustainable building and about their workplace. 88.9% of the total respondents answered correctly to the question about sustainable building characteristic and 71.1% respondents answered correctly about their office buildings. A correlation analysis is applied in order to examine whether there is correlation between users' satisfaction and users' expectations with five key criteria of sustainable building and occupants' knowledge about sustainability and their workplace. The results in Table 4.4 and Table 4.5 indicate there was no significant difference between users' satisfaction and users' expectations with five key criteria of sustainable building and their knowledge about sustainability and their workplace with all test score $p > 0.05$.

Table 4.4 Correlations between Users' Knowledge and Users' Satisfaction with Sustainable Building Characteristics

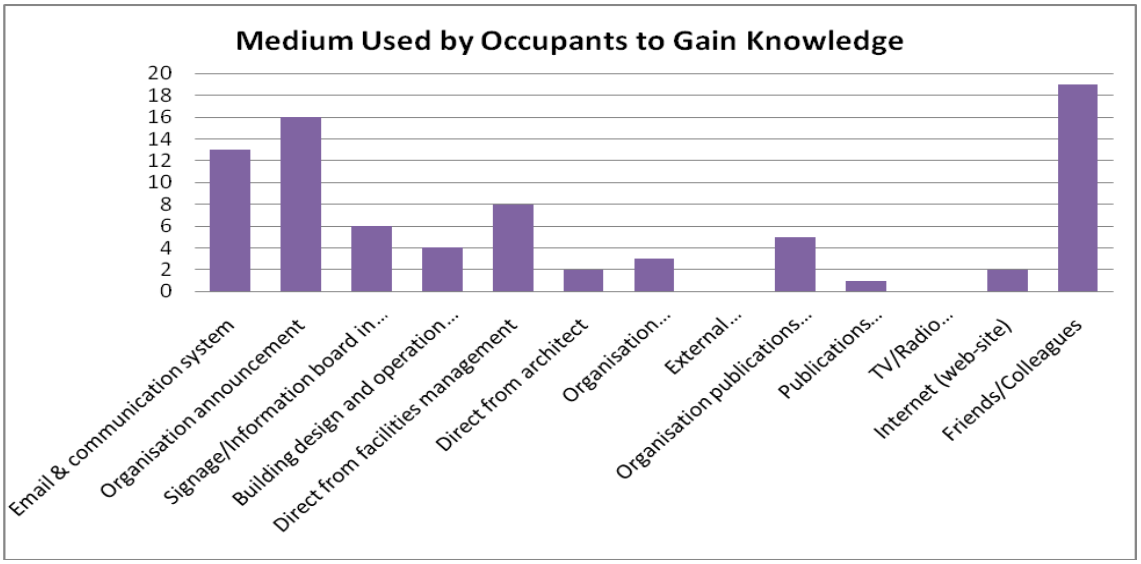
		Thermal Comfort & Air Quality	Aesthetically Pleasing	Personal Control over Windows, Blinds & HVAc	Lighting & Acoustic	Open Space Design & Flexibility
Knowledge about Sustainability	Pearson Correlation	.159	.083	-.113	.099	.003
	Sig. (2-tailed)	.297	.590	.459	.519	.983
Knowledge About the Building Design & Operation	Pearson Correlation	.133	.108	.075	.081	.042
	Sig. (2-tailed)	.384	.482	.624	.597	.785

Table 4.5 Correlations between Users' Knowledge and Users' Expectation with Sustainable Building Characteristics

		Thermal Comfort & Air Quality	Aesthetically Pleasing	Personal Control over Windows, Blinds & HVAc	Lighting & Acoustic	Open Space Design & Flexibility
Knowledge about Sustainability	Pearson Correlation	.004	.088	.046	-.005	.012
	Sig. (2-tailed)	.978	.569	.765	.976	.936
Knowledge About the Building Design & Operation	Pearson Correlation	.008	-.029	.083	-.048	-.183
	Sig. (2-tailed)	.958	.851	.589	.755	.230

Occupants who are aware about sustainable building and their wokplace were asked to identify the medium for the source or originator who provided information about sustainable building and their office building. The results in Figure 4.9 explain that occupants received information about the building they were working in mostly from friends and colleagues, and email and communication. Signage or information boards and organisation announcement were next frequently the medium for the user to receive information. Architects directly or indirectly (i.e. building design and operation) were less preferred by the occupants as a medium to receive information about their building.

Figure 4.9 Medium used by user to gain knowledge



4.2.2 *Communication*

When respondents were asked to chose between the human resource department of their organisation, facility manager of the building they work in and architects who designed their building about who they would prefer to contact regarding their problem with the sustainable building design and operations system, Figure 4.10 shows that 58% of respondents prefered to contact human resource or facilities manager of their organisation and 36% prefered to contact facilities manager of their building. Architects who designed the building were not preferred by any of the respondents.

Figure 4.10 Occupant's Preferred Personnel

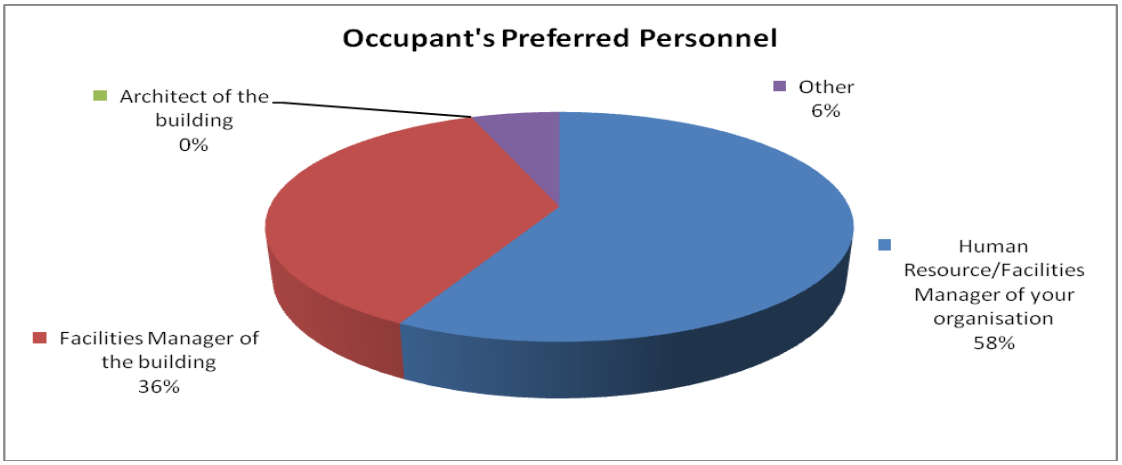
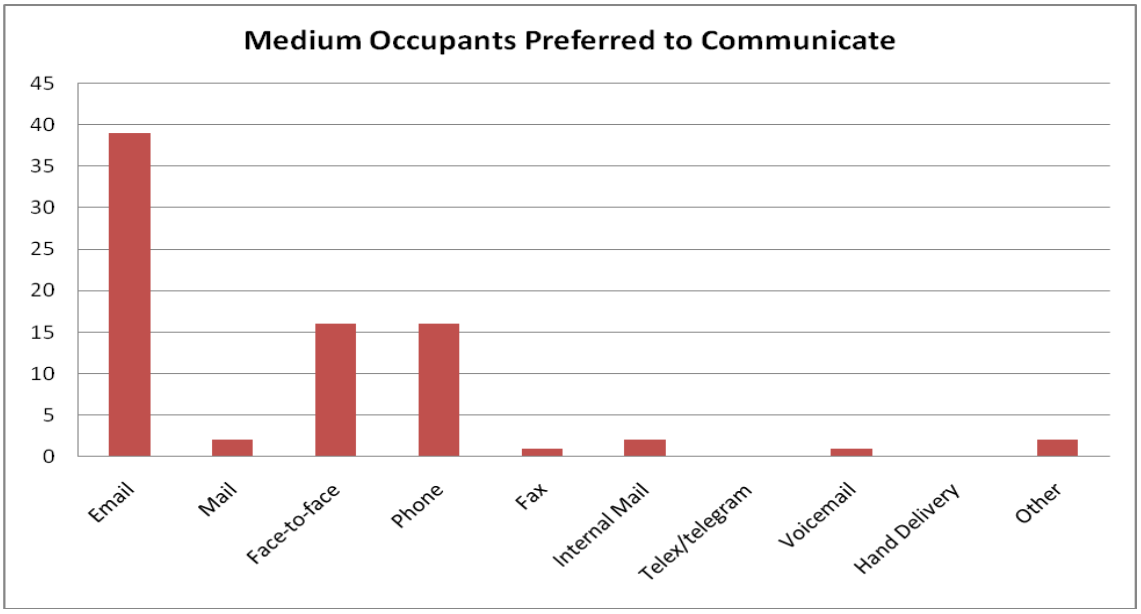


Figure 4.11 demonstrates the communications medium chosen by the respondents for knowledge sharing. Most respondents preferred to communicate about their issues with sustainable building design and operation system by email. Phone calls were the second most popular before face-to-face communication.

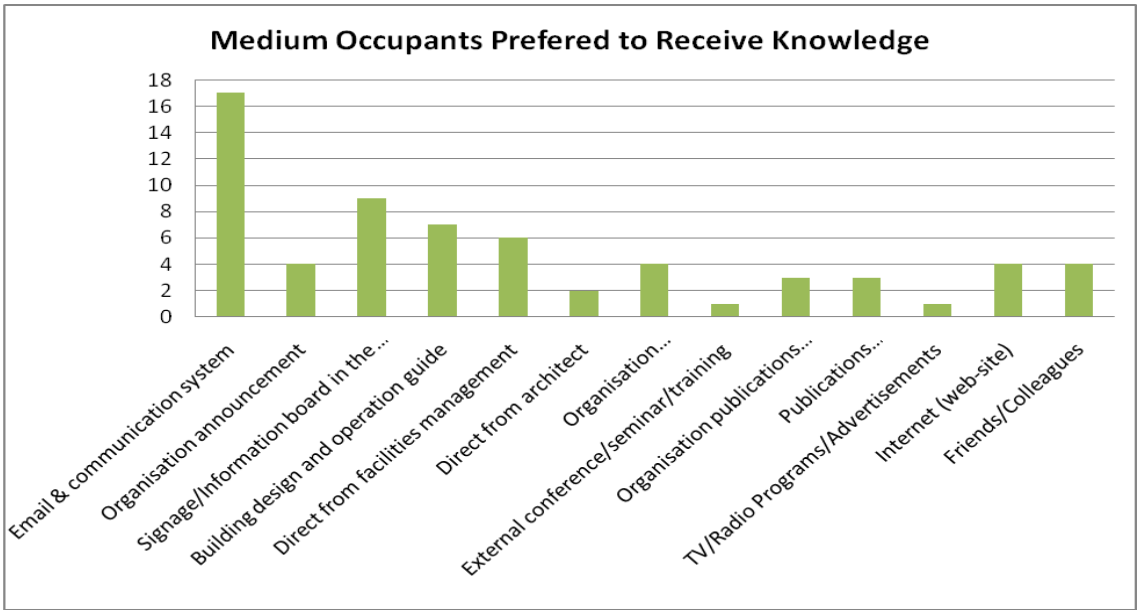
Figure 4.11 Medium for Communication



The proportions of respondents who were interested or alternatively not interested to be involved in sustainable building learning process were about the same. 51.1% responded with 'yes" and 48.9% responded with "no" when they were asked *"would you like to know more about your building design and operation?"*. Reasons given to why they were not interested to know more about their building included too busy, the information about the building is too complicated, and it is not their responsible to know about the building - the building should functions well and comfort. The respondents who were interested to know more about their building gave reasons relating to feeling a sense of responsibility for their workplace, environment and future generations. They were also believed information about their workplace will help them to understand about their workplace design and operation system. This perhaps will increase their satisfaction level with the building performance.

Respondents who were interested to know more about their building then were asked to indicate mediums that they preferred to receive and share knowledge about their sustainable building. Figure 4.12 proved the most preferred medium for interactive learning process is via the email and communication system. Internal organisation conference, seminar and training, and internet were also popular medium among occupants for knowledge sharing and knowledge transfer.

Figure 4.12 Medium for Knowledge Sharing



5.0 Conclusion and Recommendation

This research investigated the gap between (a) user expectations and (b) sustainable building performance, with reference to the relationship between interactive learning process and the level of implementation of sustainability in commercial buildings. To provide the conclusions of this study the aims of this study are restated and discussed respectively:

i. To identify the gap (if any) between users' expectations and users' experience with five key criteria influencing user satisfaction in a sustainable building

ii. To examine effect users' expectations and users' experience with sustainable building performance and interactive learning process of architects and occupants of sustainable building; and

iii. To identify the effective medium for interactive learning process of architects and occupants of sustainable building

The results of the focus group confirm there is a large gap between user expectations and user experiences with five key criteria of sustainable buildings. All criteria examined also showed the user experienced differed from what they believed and expected the sustainable building to provide in terms of a workplace in a sustainably designed and operated building. Personal control over window, blind and HVAC system is the major problem faces by the occupants. The results presented in this study showed that users in 6 Star and 5 Star buildings have the lowest satisfaction level with sustainable building key characteristics compared to Premium and 4 Star buildings. Occupants working in a 5 Star and 6 Star rated building also have the highest expectation levels of sustainable building key characteristics compared to Premium and 4 Star buildings. The occupants in 6 Star building were only satisfied with the design and flexibility of their building. Aesthetically pleasing, well equipped and well maintained is the criteria that occupants in 5 Star building were satisfied with. The big difference between users' satisfaction and users' experience in both 6 Star and 5 Star buildings with sustainable building key characteristics revealed a similar response profile by occupants who are working in a DFS building. Occupants in Premium and 4 Star buildings were more

satisfied with sustainable building characteristic in their offices. The result from this study proved that modern and sophisticated design and advanced building operation system in highly rated sustainable buildings were not performing as anticipated. Generally the occupants preferred to work in moderate and less complicated buildings. With regards to the initial research aim, this paper has identified the gap between users' expectations and users' experience with five key criteria influencing user satisfaction in a sustainable building.

This study identified that there is no significant relationship between users' expectations and users' experience of sustainable building performance and users' knowledge about sustainability and the building they were worked in. There is no effect on the level of sustainable building occupants' expectations and satisfaction about sustainable building attributes whether they know about sustainable building characteristic and about their workplace or not. Interestingly the majority of the occupants were interested to learn more about their sustainable workplace and to be involved in the interactive learning process especially to improve their knowledge about their sustainable workplace and to discuss their issues about the sustainable workplace. However, the architects were the least person preferred by the occupants to discuss about issues regarding their sustainable building.

The most effective medium for knowledge sharing and communication about sustainable building design and operation system is email. This finding suggests that any information and complaints regarding sustainable building design and operation were best distributed to the occupants via email. However, the concerns are on a large proportion of information received by the occupants was secondary information (colleagues and friends) rather than from a direct source architects and organisations).

Further research is required to complement this study by identifying;

i. How to reduce the gap between users' expectations and users' experience with sustainable building performance:

ii. The knowledge about sustainable building design and operation which is important to the occupants; and

iii. The extent of any relationship between this knowledge and user satisfaction with sustainable building performance.

Findings from this paper will be used in the development of further investigative work to analyse the initial research objectives and the above mentioned areas for further research. It is therefore hoped the current and proposed research will assist the uptake of sustainability in the built environment and provide a strong base for future policy and building design.

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