User Satisfaction in Sustainable Office Buildings: A Preliminary Study

17th PRRES Pacific Rim Real Estate Society Conference
Gold Coast, Australia 16-19th January 2011

Sara J. Wilkinson
Faculty of Business and Law
Deakin University Melbourne Australia
*Email: sara.wilkinson@deakin.edu.au

Professor Richard G. Reed
Faculty of Business and Law
Deakin University Melbourne Australia
*Email: richard.reed@deakin.edu.au

Junaidah Jailani
Faculty of Business and Law
Deakin University Melbourne Australia
*Email: jjailani@deakin.edu.au

Keywords: Tenant satisfaction, sustainability, office buildings, productivity.

Energy efficiency was first mandated for commercial buildings in 2006 in Part J of *The Building Code of Australia* (BCA) and regulators are already implementing increased measures in 2010 (ABCB 2010). Further increases will follow as part of the co-ordinated effort to reduce building related greenhouse gas emissions. The introduction of the Energy *Efficiency Disclosure Bill 2010* will establish a national scheme to promote the disclosure of information about the energy efficiency of office buildings as well as further highlighting the need for efficiency. Increased energy efficiency in the form of insulation, energy efficient light fittings, sophisticated Building Management Systems (BMS), micro-generation such as solar and wind turbines all result in measurable quantifiable reductions in operating costs for owners and tenants. However convincing all building owners about the sound business case for adopting sustainability measures has not been fully realised. To-date the adoption of cutting edge sustainable buildings in Australia is restricted to a few industry leaders, such as Investa and ISPT in Victoria for example. Sustainable building owners and tenants often benefit from reduced operating costs during the building lifecycle although the 'intangible' effect on businesses (e.g. employee productivity) is uncertain. This aspect has not been accurately quantified and has not been included as part of the measurement of sustainability in buildings.

This study will allow property stakeholders, including government policy-makers and investors/developers, to better understand the optimal type and level of sustainability to be incorporated into the built environment. In addition this knowledge will enable policy-makers to make more informed decisions with regards to the likely impact of the legislative measures they propose in respect of sustainability and buildings in *The Building Code of Australia* (BCA) and other relevant legislation.

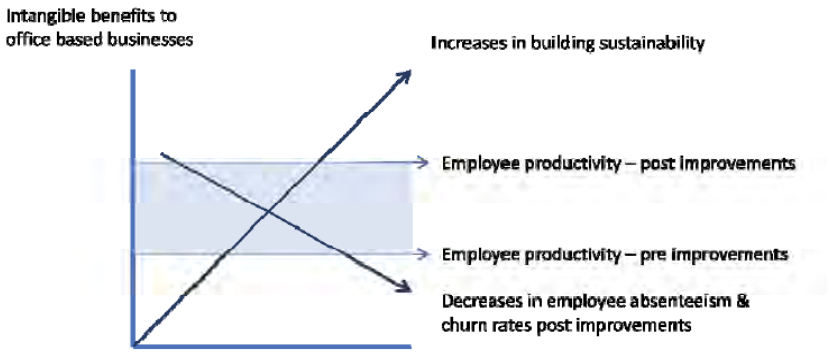
Introduction

This paper examines the case for sustainability in office buildings with reference to building user/tenant satisfaction levels and employee productivity. Incorporating sustainable attributes into buildings has been accepted widely as a positive measure from economic, environmental and social perspectives (Reed et al. 2005). Whilst the economic case primarily remains the key driver, the uptake of sustainability requires research to quantify the financial benefits that sustainability brings to business which are linked to user/tenant satisfaction levels and employee productivity (Ang et al. 2008). One example is the level of sustainability incorporated into new university buildings at the design phase with varying levels of user satisfaction in the occupancy phase.

In 2006 energy efficiency was mandated for commercial buildings in *The Building Code of Australia* (BCA) with regulators implementing increased measures in 2010 (ABCB 2010). It appears that further increases will follow in the future to reduce building related greenhouse gas emissions. Increased energy efficiency in the form of insulation, energy efficient light fittings, building management systems (BMS) and micro-generation (e.g. solar and wind turbines) results in measurable quantifiable reductions in operating costs for owners and tenants. However, convincing all owners about the benefits of the business case for sustainability has not been fully realised; to-date the adoption of sustainable buildings is generally restricted to a few industry leaders. Sustainable building owners and tenants benefit from reduced operating costs during the building lifecycle although the 'intangible' effect on businesses, such as productivity, is uncertain. This aspect has not been accurately quantified and is not part of the measurement of sustainability in buildings.

Owners and researchers argue there are many benefits from sustainable buildings including increased productivity, less absenteeism and less churn rates than non-sustainable buildings (Clements-Croome 2006). Given that employee salary and on-costs equate to approximately 85% of a typical business, quantifying the levels of employee productivity, absenteeism and churn in sustainable buildings could have significant financial benefits to businesses - (figure 1). The central questions are: (a) *how many benefits arise from increasing the level of sustainability in a building* and (b) *how can we measure the indirect effect of sustainability for a building user and tenant?* This research seeks to measure and quantify these intangible aspects to add evidence to the business case for sustainability to owners; it will assist regulators and policy-makers to determine the financial impact on business of increased sustainability in the BCA.

Figure 1. Relationship between intangible benefits of sustainability in buildings pre and post-adaptation.



Model of the perceived intangible benefits to business of sustainability in buildings

(Source: authors)

User and tenant issues in sustainable office buildings

Financial benefits, a longer building life-cycle and a healthy environment for occupants are some of the attributes commonly promoted as positive characteristics of a sustainable building (Ang et al. 2008). A modern design, state of the art services and new technology are incorporated to ensure the building meets recognised sustainability criteria, however the most important factor as a benchmark of a building's success in meeting the design objectives is the level of user satisfaction (Abbaszadeh, Zagreus, Lehrer, & Huizenga 2006; Brown & Cole 2009; Edwards 2006; Hoffman & Henn 2008; Maver & Petric 2003; Peretti, Schiavon, Goins, Arens, & De Carli 2010; Zagreus, Huizenga, Arens, & Lehrer 2004).

Previous studies from the perspective of building users distinguished between the emphasis on occupants' well-being and health. Collectively these two factors constitute user satisfaction and are a measure of building performance (Roulet et al. 2006). In summary, occupants either feel good, healthy and comfortable or not when they are in the sustainable building (Edwards 2006; Roulet et al. 2006). Meir et al. (2009) argued that building users may be either satisfied or dissatisfied with a sustainable building. Since designers of sustainable buildings incorporate three main components namely economic, environmental and social sustainability, it is important to determine an acceptable balance between designer creativity and utility (Meir, Garb, Jiao, & Cicelsky 2009).

Abbaszadeh et al. (2006) and Edwards (2006) proposed that to identify the building user satisfaction gaps, the task is to evaluate user satisfaction on aspects such as Internal Environmental Quality (IEQ); in this example the focus is placed on office layout, office furnishings, thermal comfort, air quality, lighting, acoustic qualities, cleaning and maintenance in the workplace. The relationship between user satisfaction and building's IEQ categories is where high levels of satisfaction towards the building's IEQ categories can be positively correlated with better building performance. It has been demonstrated that user satisfaction is dependent on IEQ and office design as shown in table 1 (Zagreus et al. 2004; Roulet et al. 2006; De Croon et al. 2005; Newsham 2009).

Table 1. Criteria influencing user satisfaction in office buildings.

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

Sustainability criteria for offices

The criteria for sustainability in office buildings are well documented (Wilkinson et al. 2009; GBCA 2010). The underlying goal of increasing the level of sustainability in buildings is to reduce the environmental impact of the building throughout the whole building lifecycle from design and construction, through the operational phase which includes adaptations and to the end of the lifecycle when deconstruction and recycling can be undertaken (Reed et al. 2005; Wilkinson 2009). Many building owners and designers seek to confirm their sustainable credentials through adoption of green ratings such as *Green Star* in Australia, *BREEAM* in the UK and Canada or *LEED* in the US (Reed et al. 2009).

The main criterion linked to energy conservation is the relationship with greenhouse gas emissions as well as with climate change and global warming. In Australia water conservation is a high priority because of a long term lack of rainfall. Nevertheless through office building design it is possible to reduce energy consumption through the orientation of the building and the sizing and placement of windows to reduce excessive solar gain during summer months and heat loss during the winter months. Operational energy consumption is extremely important because an office building can stand for many years before adaptation occurs, where operational energy can exceed construction energy and embodied energy levels substantially. Attention is also paid to the specification of building materials which have low embodied energy and do not include deleterious materials such as volatile organic compounds (VOCs) or formaldehydes. It has been shown these particular building materials can affect human health adversely through allergic reactions to eyes and skin and respiratory problems (Douglas, 2006). During the operational phase of the office building it is important that attention is paid to maintenance practices to ensure principles of sustainability are adopted. Finally, transport-related emissions need to be also considered. For example transport emissions typically account for one-quarter of Australia's total greenhouse gas emissions and therefore any reduction in emissions is a useful overall contribution to Australia's total emission levels (Davis Langdon, 2008). For office buildings to encourage occupants to use public transit systems such as train, tube, trams or buses as credited under the rating tools, buildings must incorporate amenities such as showers and bike racks for cyclists.

Due to the relationship with energy consumption, building services and IEQ are important aspects of sustainable office buildings; for example there has been increased importance placed on adopting natural ventilation over air conditioning systems. An important theme in

the uptake of sustainability in office buildings is to maintain and increase sustainability whilst maintain and enhancing comfort levels of users in office buildings.

Benefits of incorporating sustainability in office building

Given the criteria for sustainable buildings, it can be asked: *what are the benefits of incorporating sustainability into office buildings?* There are obvious economic, environmental and social benefits which advantage owners and occupiers. For example, owners are said to benefit from lower running costs, higher rental and capital values (Reed et al. 2005). Depending on the actual lease structure, lessees benefit from lower running costs, less employee absenteeism due to reduced building-related illnesses and improved occupant health. Another study found that employers experienced lower employee turnover or churn rate of staff in sustainable buildings (Clements-Croome 2006). The same studies also concluded there were higher levels of productivity observed and lower employee absenteeism in sustainable office buildings (Clements-Croome, 2006).

Research method

This research examines the satisfaction levels and expectations of sustainable building users about their workplace. In addition this is a pilot study to establish benchmark data in terms of user satisfaction and expectations of the workplace. The questionnaire survey was designed in line with best practice principles (Moser & Kalton 1971) and was divided into three sections. The questions were derived from the literature review and comprised five key categories grouped as follows:

1. thermal comfort and air quality;
2. aesthetics, level of amenity and maintenance;
3. personal control over windows, blinds HVAC;
4. lighting and acoustics; and
5. open space design and flexibility for a range of uses.

Section one in the survey asked respondents about their levels of satisfaction with their office building. A seven point likert scale was used to rank the levels of satisfaction from 1 (extremely unsatisfactory) to 7 (extremely satisfactory). Section two contained identical questions to section one however respondents were asked to rank their expectations about their sustainable office building. Two relatively new sustainable office buildings were selected for the survey which were both constructed since 2005. Both buildings are located at

the Burwood Campus and were designed and promoted as ‘sustainable buildings’. Both buildings are primarily occupied by staff (approximately 85% of net lettable area allocated to office space), although both have a small number of tutorial rooms on the ground floor of each building. Both buildings are low rise; one being three stories high and the other four stories. Both buildings are rectangular in design with long elevations facing north, with each building having a central atria with offices located either side of the central open space.

All staff located in the two buildings was invited to participate in the anonymous surveys. A total of 51 completed surveys were returned equating to a response rate of 34%. The results are deemed statistically reliable and robust for the research population. Most importantly, the buildings are classified as for office use which this will ensure the results of this survey are applicable to other office buildings.

The research question is: ‘*What are the links between user satisfaction criteria for productivity in office environments, absenteeism and churn rates and sustainability?*’

The research aims are to:

1. Identify core measures of user satisfaction in offices.
2. Establish benchmarks for user satisfaction in offices.
3. Using sustainable office buildings in a case study and apply measurement criteria to determine user satisfaction and expectations.
4. Conduct user surveys in sustainable buildings to determine satisfaction and expectation levels.

Results and interpretation

The results from the questionnaires are presented in five sections based on the criteria influencing user satisfaction outlined in table 1. Four questions were posed for each section with an identical question for users’ level of satisfaction and expectations. Clearly there is a problem where expectations are not met and satisfaction is less than the expectation for any given item.

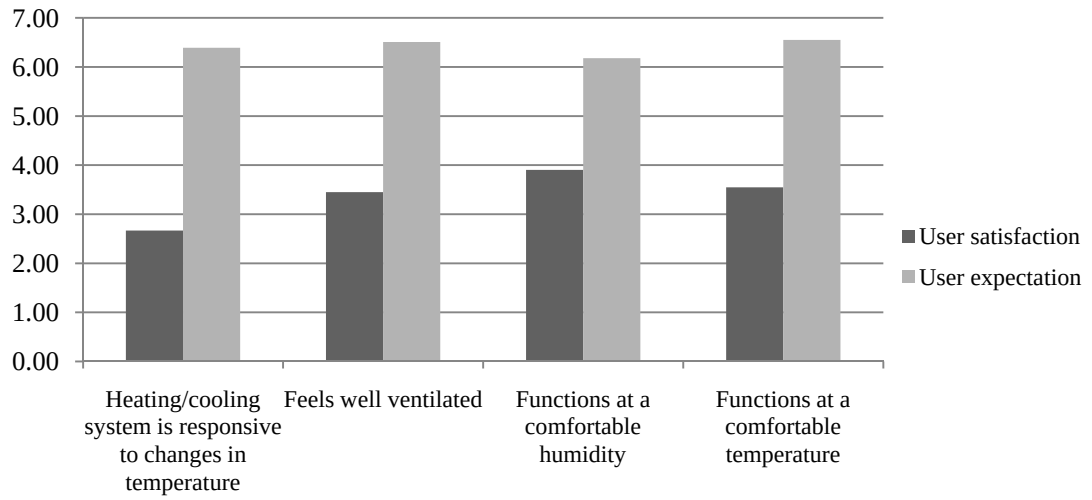
In total 51 completed surveys were returned. Most users were aged 31 to 60 years (78.43%) with some respondents over 60 years (5.88%). No building users were aged 20 years and under (table 2). All respondents were mature age individuals with over half (50.98%) identified as academics, with 23.5% of respondents being researchers or research students, 13.72% were administrative staff and 9.8% classed as ‘other’. Most respondents had individual office space (56.86%) followed by 35.26% occupying large open plan space. Fewer than 4% of respondents shared an office with another person. There is a acceptable

variance of responses covering experiences of single person and multiple person office space. 56.86% of respondents had worked for the University for 2 years or less. 82.35% of respondents had worked in the case study buildings for 2 years or less the same proportion had worked at the current desk space for 2 years or less. This finding is unsurprising given the buildings were constructed within the last 5 and 7 years.

Thermal comfort and air quality

The questions about thermal comfort and air quality were my office (a) has a heating/cooling system that is responsive to changes in temperature (b) feels well ventilated (c) functions at a comfortable humidity or (d) functions at a comfortable temperature. The results show that in all instances the expectations of the user were not met by the level of satisfaction expressed (figure 2). One respondent claimed the office was *'a freezing office with a ridiculously hot breezeway'* whilst another respondent claimed *'air flow (exchange) in internal offices is poor and stuffy on warmer day'*.

Figure 2. User satisfaction and expectations of thermal comfort and air quality criteria

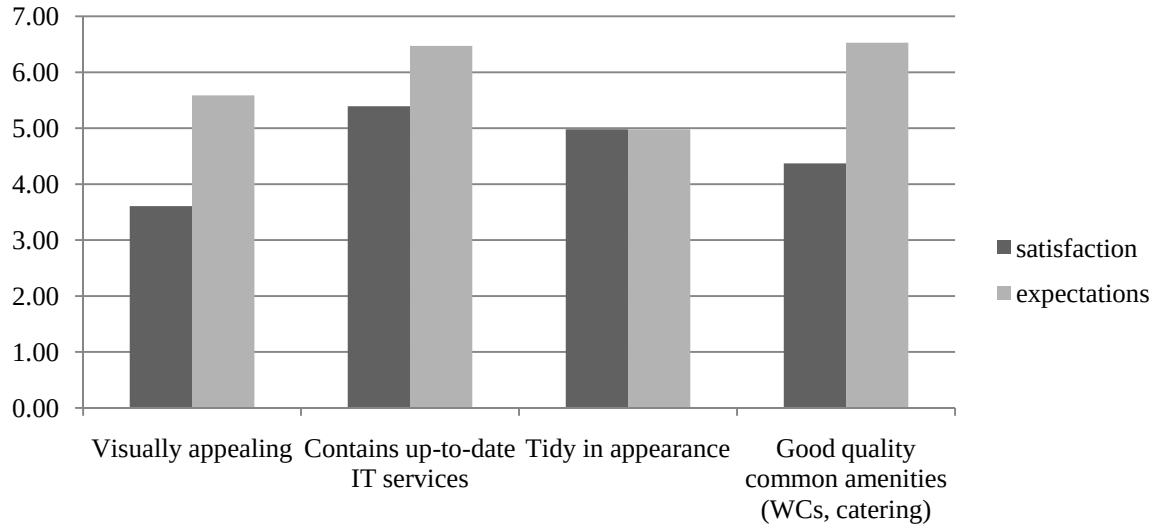


Aesthetics, amenity and upkeep

When responses to questions related to aesthetics, amenity and upkeep were examined there was less dissatisfaction with these criteria than the thermal comfort criteria (figure 3). The four questions related to the office being (a) visually appealing (b) containing up-to-date IT services (c) tidy in appearance and (d) having good quality common amenities. Responses confirmed the gap between the expectations and satisfaction was narrower than thermal

comfort criteria. The tidiness of the offices has the best outcome between satisfaction and expectations being fully met. The largest gap was between the satisfaction and expectation of the level of amenities provided such as staff rooms, toilets and kitchens; as one respondent said *'This building also lacks facilities for staff and students with disability'*. This was followed by a wide gap regarding the visual appeal of the buildings.

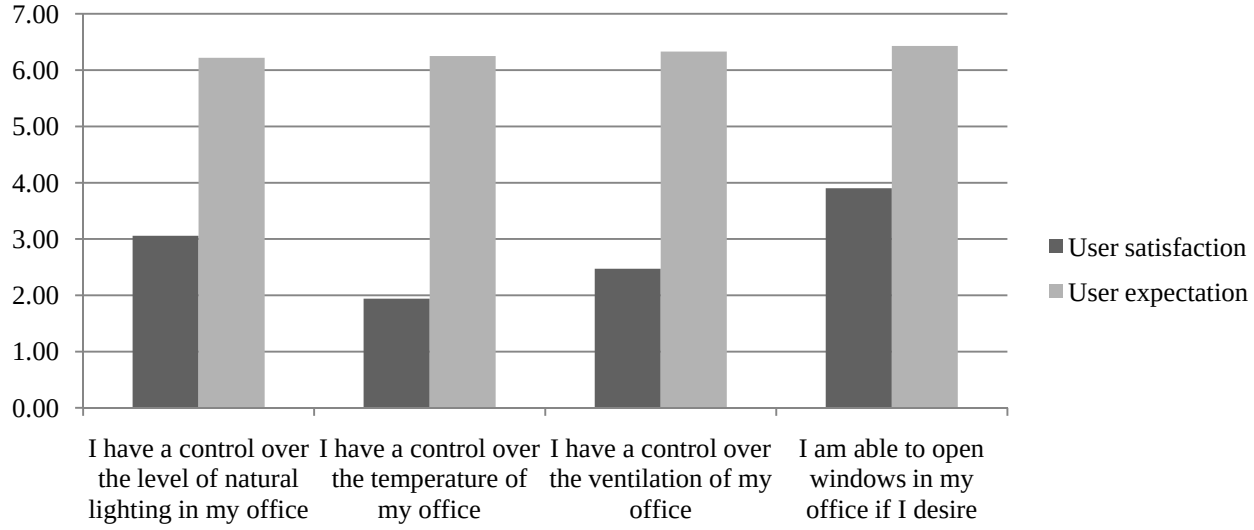
Figure 3. User satisfaction and expectations of aesthetics, amenity and maintenance criteria



Personal control over window, blinds, HVAC system

The survey included questions related to how much control users have over their environment in key areas such as temperature, lighting and ventilation. Responses highlighted very high levels of disparity between levels of satisfaction and expectations (figure 4). The largest gap lies in control over temperature, followed by ventilation, followed by lighting and lastly the ability to open a window for natural ventilation. These criteria are critical to office user comfort and satisfaction where the sustainable office buildings perform very poorly in this respect. It is clear that expectations are consistently high for the four criteria but the experience of the building users is consistently below expectations.

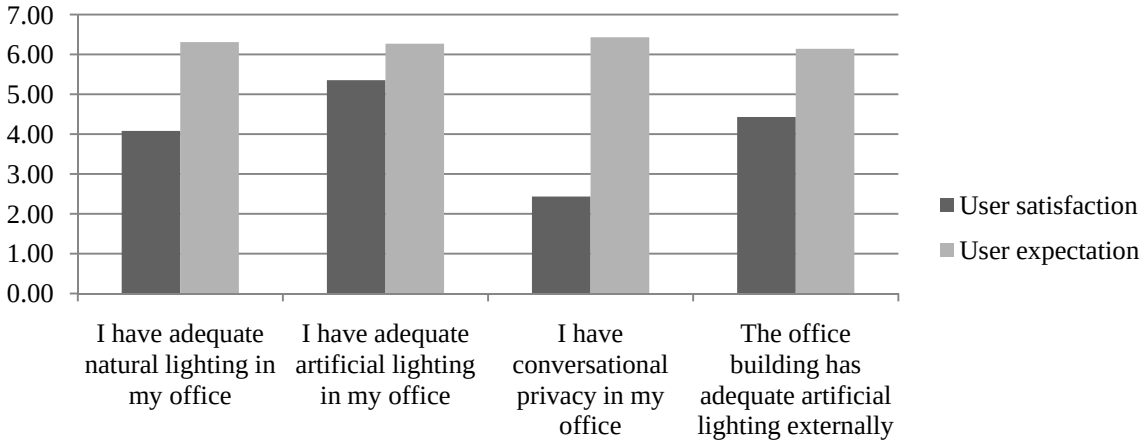
Figure 4. User satisfaction and expectations of individual control of environmental criteria



Lighting and acoustics

The survey responses indicated high expectations from the users and lower levels of satisfaction (figure 5). Overall the lighting levels, both artificial and natural, scored reasonably well although some users experienced high levels of dissatisfaction. For example one respondent said: *'I'm unhappy with my office artificial lighting though'*. High levels of dissatisfaction are related to the area of privacy within the offices with more than one respondent noting: *'lack of privacy in office [is the] biggest problem'* and *'critical problem - lack of privacy'*. The overall level of satisfaction was very low for privacy. It should be noted that lack of privacy is closely related to the poor acoustic performance and high rates of sound transmission from office to office and corridor to offices. Accordingly it was noted there is *'too much noise from printer, copiers, glass trays dragged along brick floors, hallway conversation'*. *'The only serious reservation I have regarding my office is the glass door & windows facing the corridor (lack of privacy) I have got used to this however it is still problematic when you want to have a private conversation (in person or on phone). Also noise travels very freely along the corridor.'*

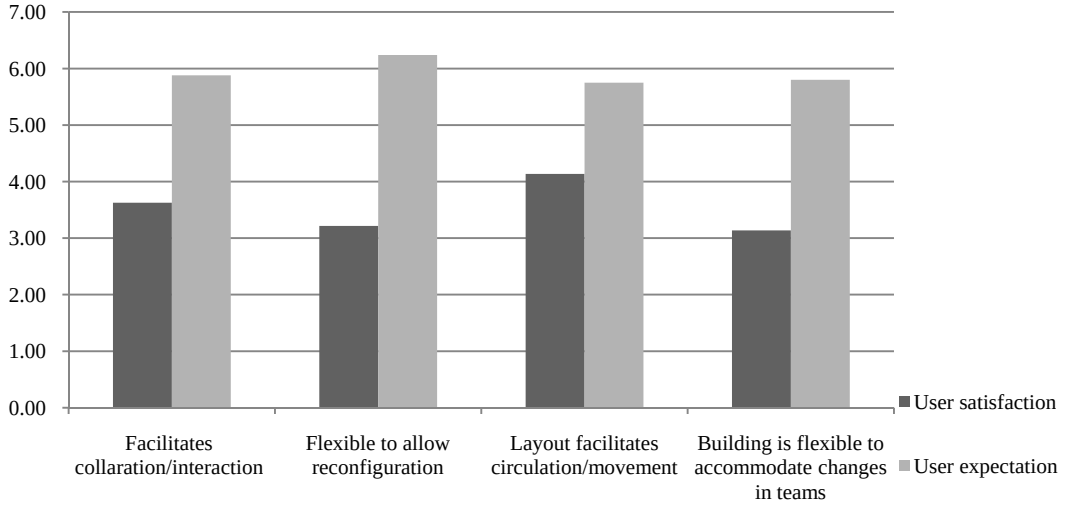
Figure 5. User satisfaction and expectations of lighting and acoustic criteria



Design and flexibility

The questions focused on the flexibility of the spaces to accommodate change and other alternative uses. Building users had lower expectations for this group of criteria compared to thermal comfort for example (figure 6). Furthermore the responses highlighted that the differences between satisfaction and expectations levels were smaller. The largest gap existed between the ability of the office being sufficiently flexible to allow reconfiguration of the workspace. Typically most offices in these sustainable buildings are relatively small especially by Australian standards with most being between 10 to 15 square metres in area. Overall the respondents were not too dissatisfied with the circulation of the building. An exception to this trend was noted by one respondent who noted they were '*very happy with my space'*. However a typical response was that the office provided *'a wholly inadequate office inappropriate for a professor and director*'.

Figure 6. User satisfaction and expectations of design and flexibility criteria



A total of twenty questions were examined which could be grouped into five distinct categories; these categories represent a range of criteria which are linked to building user satisfaction in offices. For each criterion a mean score was calculated and a table identifying the rank order of each criterion was produced (table 2).

Table 2. Ranking of user satisfaction criteria

Criteria	Description
1	Control over the temperature of my office
2	Conversational privacy in my office
3	Control over the ventilation of my office
4	My office has heating/cooling system responsive to changes in temperature
5	Control over the level of natural lighting in my office
6	My office feels well ventilated
7	My office is flexible enough to allow me to reconfigure my workspace
8	My office functions at a comfortable temperature
9	The office building is flexible enough to accommodate changes in teams
10	I am able to open windows in my office if I desire
11	My office functions at a comfortable humidity
12	My office facilitates collaboration/interaction with colleagues
13	I have adequate natural lighting in my office
14	The office has good quality common amenities (toilets, catering facilities)
15	My office is visually appealing
16	The office building has adequate artificial lighting externally
17	The office building has a layout that facilitates circulation/movement
18	My office contains up-to-date IT/telecommunication services
19	I have adequate artificial lighting in my office
20	The office building is tidy in appearance

Discussion

The survey questionnaires referred to criteria discussed earlier in the literature which were being important for office user comfort (Clements-Croome 2004, Zagreus et. al 2004,

Abbaszadeh et. al 2006, Roulet et. al 2006; Edwards 2006). It should be noted many of these issues have become important when incorporating increasing levels of sustainability into office buildings. Temperature, ventilation, heating/cooling and lighting which ranked in the top five problem areas are all connected to building related energy consumption and greenhouse gas emissions. Furthermore many of the criteria are linked to occupant productivity and building-related illnesses. For example, poor ventilation and uncomfortable temperature levels are linked with respiratory complaints which lead to employee absenteeism. On this issue one respondent stated: *'I now work mostly from home as I need [an] outside view and a quiet place due to an adverse reaction when I work from this building.'*

Alarmingly all criteria examined showed that user expectations exceeded satisfaction even in these sustainable offices. There was a clear gap observed. The claims made for sustainable buildings are that they perform better than their non-sustainable counterparts and are healthier for users. However the results presented here challenge this claim. A limitation of the research was that a control building (i.e. with no sustainable features) was not used to benchmark the results. However a control building will be used in the next survey which will replicates the survey in a non-sustainable office building.

Conclusion

With regards to the stated research aims, this preliminary study has identified the core measures of user satisfaction in offices by conducting a survey of sustainable office building users based on the review of the literature. The survey has established benchmarks for user satisfaction in respect of the twenty criteria assessed in the questionnaire. A case study approach was used based on two office buildings promoted as sustainable which are located on a university campus. Respondents in both buildings provided an insight into user satisfaction and expectations. The research question: '*What are the links between user satisfaction criteria for productivity in office environments, absenteeism and churn rates and sustainability?*' has been answered. The link between user productivity, absenteeism and churn is linked to levels of satisfaction, particularly with regards to thermal comfort and lighting criteria.

Additional research is needed in this area from the perspective of user satisfaction. Further research is required to: (a) model the optimal level of sustainable attributes with relation to

employee productivity and (b) model the economic impact of large scale adoption of sustainable refurbishment on the Melbourne CBD office stock and these 'intangible' aspects. Whilst there is an increasing emphasis placed in increasing the level of sustainability in office buildings, there is a need to assess the optimal level of sustainability. Further research will be able to address questions such as:

1. *What is the relationship between office employees in sustainable and non sustainable office buildings?*
2. *What are effects of more sustainability on employee productivity, absenteeism and churn rates?*
3. *What is an optimum level of sustainability in office environments to maximise employee productivity, minimise absenteeism and churn?*

This paper has provided an insight into an important area; the users of a sustainable office building. The findings from this preliminary study show that property stakeholders, including government policy-makers and investors/developers need to develop a better understanding of the optimal type and level of sustainability incorporated into the office buildings. Further research is required to supplement this knowledge to assist policy-makers in the longer term to make more informed decisions with regards to the likely impact of the legislative measures they propose in respect of sustainability and buildings.

Reference List

Abbaszadeh, S., Zagreus, L., Lehrer, D., & Huizenga, C. (2006). *Occupant satisfaction with indoor environmental quality in green buildings*.

Ang, S., & Wilkinson, S. (2008). Is the social agenda driving sustainable property development in Melbourne, Australia? *Property Management, 26*(5), 331-343.

Bilos, A. Reed, R. Schulte, K.W, & Wilkinson, S. (2009)

Brown, Z., & Cole, R. J. (2009). Influence of occupants' knowledge on comfort expectations and behaviour. [Article]. *Building Research & Information, 37*(3), 227-245.

Clements-Croome, (2006) 2nd Ed. Creating the Productive Workplace. Spon, UK.

Clements-Croome, (2004) Environment & Health in Buildings. Spon, UK.

Edwards, B. (2006). Benefits of green offices in the UK: analysis from examples built in the 1990s. [Article]. *Sustainable Development, 14*(3), 190-204.

Davis Langdon, (2008)

Douglas, J . (2006). Building Adaptation. Butterworth Heineman.

Green Building Council of Australia (GBCA) (2010) accessed September 23rd 2010.

Hoffman, A. J., & Henn, R. (2008). Overcoming the Social and Psychological Barriers to Green Building. [Article]. *Organization & Environment, 21*(4), 390-419.

Maver, T. W., & Petric, J. (2003). Sustainability: real and/or virtual? [Article]. *Journal Automation in Construction, 12*, 641-648.

Meir, I. A., Garb, Y., Jiao, D., & Cicelsky, A. (2009). Post-occupancy evaluation: An inevitable step toward sustainability. *Advances in Building Energy Research, 3*(1), 189-220.

Moser, C. A. and G. Kalton (1971). Survey Methods in Social Investigations.

Peretti, C., Schiavon, S., Goins, J., Arens, E., & De Carli, M. (2010). Evaluation of Indoor Environment Quality with a Web-based Occupant Satisfaction Survey: a Case Study in Northern Italy.

Reed, R., Bilos, A., Wilkinson, S.J. & Schulte, K.W. 2009. International Comparison of Sustainable Rating Tools Journal of Sustainable Real Estate. Vol 1 issue 1. ISSN 1949 8276

Reed, R. G. & Wilkinson, S. J., 2005. The increasing importance of sustainability for building ownership. Journal of Corporate Real Estate. December Issue 4 Vol 7 pp 339 – 350. ISSN 1463-001X.

Reed, R. & Wilkinson, S. 2007. Office buildings and the environment – the increasing role of facility managers. Facilities Management Association of Australia (FMA) Conference May 2007, Sydney, Australia.

Roulet, C.-A., Johner, N., Foradini, F., Bluyssen, P., Cox, C., De Oliveira Fernandes, E., et al. (2006). Perceived health and comfort in relation to energy use and building characteristics. [Article]. *Building Research & Information, 34*(5), 467-474.

Wilkinson, S. James, K. & Reed, R. 2009. Using building adaptation to deliver sustainability in Australia. Structural Survey Journal ISSN 0263-080X. Issue 1 Vol. 27

Wilkinson S. J. and Reed R. 2006. Office building characteristics and the links with carbon emissions. Structural Survey. August Issue 3 Vol 24. pp 240-251. ISSN 0263-080X.

Wilkinson, S., James, K., & Reed, R 2009. Delivering sustainability through the adaptive reuse of commercial buildings: the Melbourne CBD challenge. Pacific Rim Real Estate Conference, Jan 19h-21st 2009. Sydney, Australia.

Zagreus, L., Huizenga, C., Arens, E., & Lehrer, D. (2004). Listening to the occupants: a Web-based indoor environmental quality survey. *Indoor Air, 14*(8), 65-74.