

Pre-Occupancy Evaluation of the Physical Geography Building

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Abstract

This paper seeks to discuss a Pre-Occupancy Evaluation used to assess occupant well-being and understanding of net zero in the Physical Geography Building located on the St George Campus at the University of Toronto. A standardized building use survey evaluation method and the data pool includes the responses from 56 occupants of the building. Overall, through conducting a Pre-Occupancy Evaluation of the Physical Geography Building, this essay concludes that the PREOE methods used for this project are effective, current occupant well-being in the building is unsatisfactory especially for occupants who have permanent spaces in the building, and there is an overall lack of understanding on the concept of net zero.

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1. Introduction

The University of Toronto is one of the world's top research-intensive universities with a strong drive for innovation and invention. As the university continues to grow in population, the urgency to address environmental needs has become crucial to the long-term sustainability of the institution. One way in which environmental needs are being addressed is through the university's prioritization of city building as a part of their *Towards 2030* goals. In order to promote the importance of city building, the University of Toronto seeks to retrofit heritage buildings, design and construct new energy efficient buildings, to create gathering spaces for students, faculty, and community members (Facilities and Services, 2013).

Built in 1926, the Physical Geography Building (PGB) is a 3-storey building located on 45 St. George Street. In order to create a more sustainable environment for occupants of the PGB, a proposal has been suggested to transform the current building into a net zero or near zero energy building. Through this energy transformation, the building hopes to become a more sustainable center of well-being for its occupants. For the purposes of this study, the concept of a net zero energy building will be defined as a building that uses as much energy as it produces onsite. This can be done through the use of renewable energy sources such as: solar, wind, and geothermal. These sources of energy along with passive design strategies may be used in order to convert a fossil-fuel based building to a near or net zero energy one. Human well-being can be categorized into seven different categories; physical, occupational, environmental, social, emotional, intellectual, and spiritual. This study further analyzes how particular categories - physical, occupational, environmental, and social well-being had an effect on the occupants within the building.

2. Goals and Objectives

There are two main goals that this project seeks to achieve:

1) Complete a pre-occupancy evaluation to assess the current state of well-being in the building and how they may assist the building's expectations of the renovations.

- ❖ The objective of this goal is to understand occupants needs, wants and perspectives of the building in order to ensure that future renovations can optimize the well-being of occupants. Another objective of this goal is to determine whether the PREOE methods used in this project are useful and whether or not they can be replicated and reused for future projects. The methodology used for the PREOE will be further discussed in the *Methodology* section of this report.

2) Find out what building occupants know about the concept of “net zero”.

- ❖ The objective of this goal is twofold as it seeks to: assess whether occupants believe they understand the concept of net zero, and whether occupants relate the concept of ‘net zero’ to carbon or to energy.

3. Methodology

In order to collect data for this project, a Pre-Occupancy Evaluation that included a one-page four question survey along with a BUS (Building Use Study) survey were distributed to occupants throughout the PGB. The one-page four question survey was created by our group to determine occupant's understanding of sustainability, well-being, community and the concept of net zero energy. The questions asked were as follows:

- ❖ Is sustainability important to you?
- ❖ Does sustainability affect your well-being?
- ❖ Do you think a building plays a role in fostering a greater community?
- ❖ Do you know what a net zero is, and if yes explain.

The BUS survey, as provided to us by Sylvia Coleman, was chosen as our second method for data collection due to its standardized questions that collect both qualitative and quantitative data that may be used for comparison with previous BUS surveys conducted. Although there are three versions of the BUS survey that exist, only two versions of the survey were chosen for this PREOE: a short one-page survey and a long three-page survey. Once all the data was collected, it then was categorized within the seven dimensions of well-being, specifically: physical, occupational, environmental and social well-being. After a month of surveying, our group was able to collect a total of 39 short surveys and 15 long surveys.

Short Surveys

The purpose of the short surveys was to gather as much data as possible from the building's occupants within a short amount of time. In order to do this, our group created a two-page survey with our four initial questions on the front, and the short one-page BUS survey on the back. The initial questions were used to gather general data about how occupants view and understanding of sustainability, well-being, community and net zero. The short BUS survey was used to gain knowledge about: occupant background, and overall comfort, noise, lighting, productivity and health in the building. Questions on the BUS were structured using a Likert scale with an additional option of adding comments. These surveys were distributed to occupants by visiting the building during peak hours when teaching assistants were holding office hours, in order to gain data from a variety of infrequent occupants.

Long Survey and Semi-Structured Interviews

The purpose of the long surveys/semi-structured interviews were to gather comprehensive quantitative and qualitative data from the full-time and part-time occupants of the PGB. Since the short surveys lacked the depth of questions required to draw conclusive answers in regard to occupant well-being, a longer survey containing the four initial questions along with the long three-page BUS survey were combined and used as a guide for 30-minute semi-structured interviews. In order to do this, we conducted interviews with the building's two full-time occupants as well as the various part-time occupants in the building. Through the help of Lorraine Jung, a google poll was sent out to all math PhD students, post-docs and teaching assistants with offices located in the PGB for occupants to sign up for sit down interviews with one of our four group members. These longer surveys focused on all the short survey categories, along with a focus on: occupant's work requirements, comfort of the building in different seasons, personal control, occupant's response to building problems, effect on behaviour, occupation density and travel to work. Through the use of the long surveys and semi-structured interviews, we were able to interview occupants who have offices in the building. This allowed for an opportunity for in depth and comprehensive knowledge about occupant well-being.

3.1 Defining Sustainability, Well-Being and Net Zero

Since there are varying definitions of sustainability, well-being and net zero, this project will define the concepts in the following ways:

- ❖ *Sustainability*: In Johnston et al. (2007), one of the holistic ways in which sustainability can be defined is: “Sustainability demands turning and charting a new course that will improve the quality of our lives and the lives of our children while restoring the gift of natural systems upon which our lives depend on.”
- ❖ *Well-being*: The seven dimensions of well-being will be used as the base framework for analyzing occupant's perspective. Here are the different dimensions of well-being and their definitions as described by Horton and Snyder (2009):
 - *Physical* well-being looks at how a person's lifestyle choices affects their physical health and bodily self. Lifestyle choices such as diet, sleep, exercise, personal hygiene, use of substances such as drugs and alcohol and decisions on how one spends their time and places that they go affect one's physical state.

- *Social* well-being is how a person can and will provide and receive support from others. Humans are social creatures and need to create connections with others where optimal social well-being is achieved through a balance between the pursuit of individual ambitions and gaining satisfaction from social interactions.
 - *Occupational* well-being is impacted by an individual's relationship with their job, and their ability to achieve and find purpose in their career. Individuals have diverse needs for their careers such as pay, hours, work environment, support networks and if the job aligns with personal values and goals.
 - *Environmental* well-being considers how the state of environmental preservation, conservation and acknowledgement can impact an individual's behaviour. Acting with the environment in mind means that future generations are considered in decision making which can encourage traits such empathy and taking responsibility for a wider purpose outside of an individual's needs and ambition.
 - *Emotional* well-being is dependent on an individual's ability to develop a strong sense of self identity and self-esteem. Developing emotional well-being is different for every person as the way individuals build self-esteem has to address the reason behind their lack of self-identity and lack of confidence.
 - *Intellectual* well-being at its optimal state is when individuals feel that they are engaged in meaningful and informed conversations on an ongoing basis. Individuals find meaning and enjoyment in broadening their knowledge and being stimulated by intellectual content that is engaging and interactive.
 - *Spiritual* well-being is tied to an individual's ability to look beyond their physical self and construct a deeper meaning and purpose of their life. Having strong spiritual well-being can create a sense of purpose and responsibility that one has for their time on earth.
- ❖ *Net Zero*: The term "net zero" is broad and can refer to either net zero energy or net zero carbon. According to Berry et al. (2014), net zero carbon buildings are "...buildings that over a year do not use energy that entails carbon dioxide emissions. Over the year, these buildings are carbon neutral or carbon positive in the term that they produce CO₂ free energy to supply themselves with energy. Net zero energy buildings on the other hands are, "...buildings that over a year are neutral, meaning that they deliver as much energy to the power grids as they use from the grids. Seen in these terms they do not need any

fossil fuel for heating, cooling, lighting or other energy uses although they sometimes draw energy from the grid.”

3.2 Literature Review on PREOE and Well-being

Workspace environment can affect the productivity, motivation, tiredness and distractibility of workers within a certain space (Lamb and Kwok, 2015). Through a study conducted by Sailen et al. (2010) that levels of satisfaction in workplaces are linked with company performance. In the US, only 43% of staff were satisfied with their workplaces, only 26% of staff in the UK felt satisfied in their respective country. These studies show that inadequate elements of Indoor Environmental Quality (IEQ) which includes lighting, thermal comfort and noise levels can hurt work performance and reduce cognitive performance by 2.4% to 5.8%. This study has also shown that poor IEQ can reduce performance by up to 14.8% in rare cases. This emphasizes the need for maintaining and understanding workspace environments to encourage productivity and effectiveness while supporting the mental health and reduction of stress levels in workers.

Conducting pre and post occupancy studies are helpful for planners, property managers and architects to reflect on occupant experience of workspaces (Sailer, K et al., 2010). This allows planners to better shape and create effective spaces for buildings in the future. It is important to make distinctions between different types of spaces and positionings due to the fact that some spaces are shared, denser or experience more human traffic than others. Since not all building spaces are used for the same activities and vary in levels of comfort, these aspects are able to be considered when completing an evaluation such as this. Occupants who completed the Physical Geography Building PREOE survey were represented by at least one respondent from each floor and corner of the building. Respondents were also from different office spaces such as: single offices, offices shared with only one other occupant, and office spaces shared with more than 5 people. The results found from this study therefore provide a holistic overview of well-being as experienced by diverse participants.

Since the Physical Geography Building aims to become a near zero energy building through a series of retrofitting projects, occupant well-being may be implicated both during and after the renovations. In a BUS survey conducted by Deuble and Dear (2012) in Sydney, the authors found that occupants tended to be more forgiving of discomfort if they knew that the

building they were in was of net or near zero energy. However, the reason for occupants being more forgiving was less due to the result of being in a “green” or environmental building, but because occupants could understand why irregularities in temperature persisted. Irrespective of the physical conditions, the study found that occupants were more forgiving if they felt that they had more control and understood how the building worked. Occupants who identified themselves as “environmentally conscious” had a slightly higher satisfaction rate of a “green” building compared to the average occupant.

4. Main Findings

Overall Satisfaction of the building

Satisfaction of long and short surveys compared to the BUS database index can be seen in Figure 1 below.

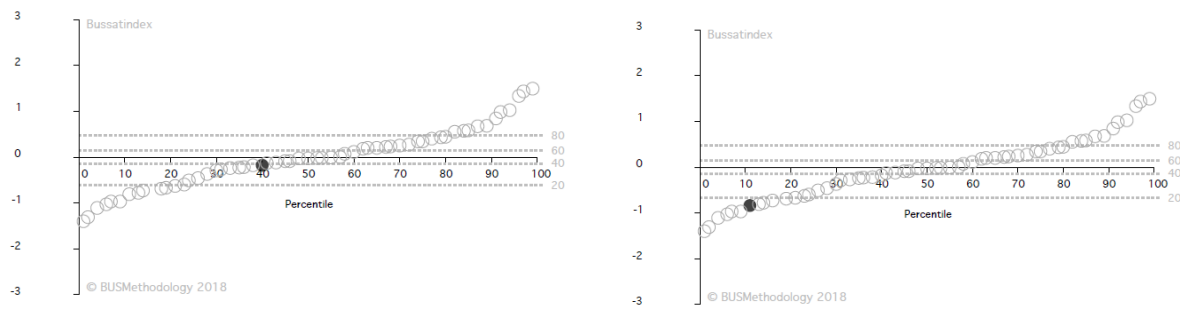


Fig 1 - Satisfaction Index of short (left) and long (right) surveys as benchmarked against other BUS evaluations

As can be seen in Figure 1, occupants who spent longer hours in the building were generally more dissatisfied with the building compared to occupants who stayed in the building for shorter amounts of time. While most respondents of the short survey were generally occupants who were in the building for one or two hours, long survey respondents were usually in the building for up to 8 hours a day. The rest of the findings found in this section will provide deeper insight into occupant dissatisfaction in the PGB.

4.1 Physical Well-being

The World Health Organization defines health as not as the absence of ill-health but as “state of complete physical, mental, and social well-being” (Stemmers, 2015). As per discussion earlier in the report, there are multiple dimensions and frameworks that make up human well-being. Each of these seven dimensions places an important role in overall well-being of occupants as well as reaching a net zero energy goal. Physical well-being is one of these dimensions that contribute to our holistic approach towards sustainability. Through data on: temperature, circulation and movement, and air as ways, physical well-being promotes proper care of our bodies for optimal health and function. The data collected for the PROE of the PGB was mixed between long semi structured interviews, and short structured surveys. This data was then used in analyzing the physical dimension of well-being, particularly looking at the overall temperature levels within the building. Of the occupants who participated in data collection, 91% of them reported that

they are unsatisfied with the overall temperature of the building. They feel that the building is inconsistent in temperature and found it was either “too hot” or “too cold” the majority of the time. Particularly, in the winter months it was reported that heating was inconsistent and “unbearable at times.” Another occupant stated, “The temperature is good at a certain point, after two weeks or so.” The PGB results compared to other buildings in the BUS database ranked PGB within the bottom sixth percentile. As can be seen in Figure 2 below, the PGB is located below the critically low region on the database. This data has made it apparent that the overall temperature in building does have an impact on individual’s well-being.

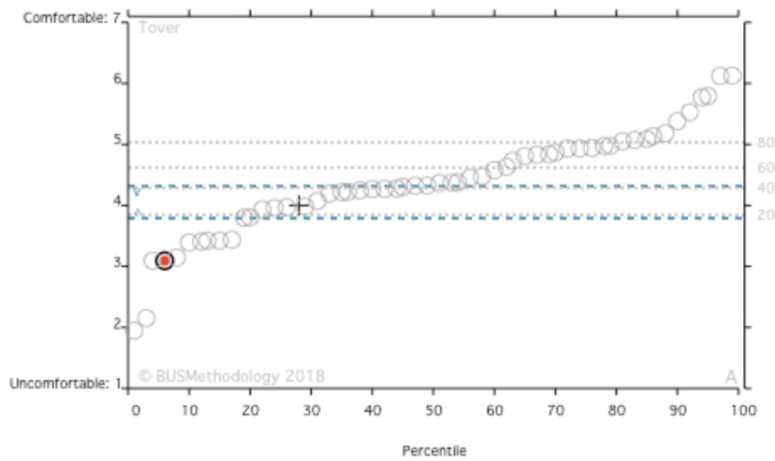


Fig 2 – Long Survey respondents rating on comfort as benchmarked against other BUS evaluations

From this data, we were able to analyze and address two areas in which were flagged as high priority.

1. Personal Control

Within the data it presented that 68% of the occupants agreed that it would be beneficial to have the ability to have personal control over their own temperature within their commons or office. By occupants having personal control over their own temperatures, their own thermal comfort needs would be most likely met.

2. Response to Problems

After interviewing the long-term occupants, it was apparent that 80% of them agreed and communicated that there was a clear issue in the management of PGB. Multiple occupants mentioned they have reported issues of the building in the past and it often took up between three to four weeks before they would hear anything back. One occupant

stated, “it took over 2 years for them to fix the heating and cooling issues, and clearly it still is not 100% fixed.”

On physical safety in the building, occupants who completed the long survey provided high ratings about how they felt about their personal safety with most (80%) rating it at 6 or 7 on the Likert scale as seen in Figure 3 on the next page. No occupants gave personal safety a rating of 1 or 2 showing that most people are personally satisfied with the building’s facilities. There were comments made by different respondents about the building being inaccessible “The building is not accessible. This building is historical and does not allow a ramp to be built.” and that “If you sprain your ankle, you cannot work here” as well as there could be health issues with dust “...also the construction dust, making it a breathing hazard.” However, even though these comments were made, occupants do not feel that these issues affect their personal safety in a significant way.

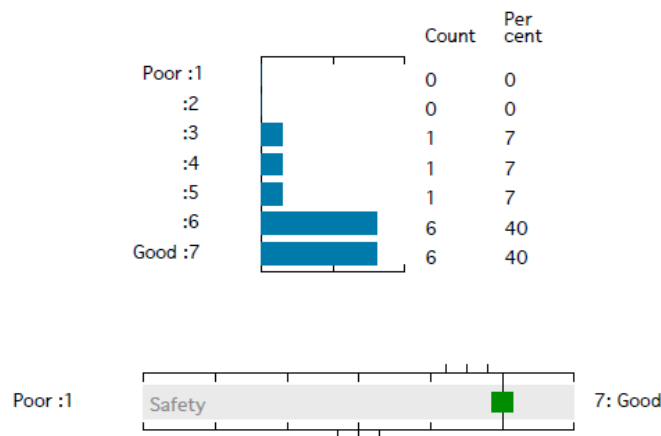


Fig 3 – Long survey respondents rating on personal safety

Conclusively the physical well-being of an occupant within the PGB is being affected mostly through the building’s temperature levels. Therefore, the PGB should incorporate features that will improve occupant well-being and productivity through use of ranges of thermal comfort levels and the increase of personal control on environmental conditions. Additionally, physical and occupational well-being coincide together. Over 40% of occupants who complained about temperature reported that they would rather work at another location on or even at home due to thermal discomfort levels that created a lack of work productivity.

4.2 Occupational Well-Being

Thatcher and Milner (2012), believe that ‘green’ buildings are more comfortable, healthier, and produce overall higher levels of productivity than conventional buildings. In a study conducted by the authors, occupants of multiple green building averaged an increase of 10% in productivity levels, with some buildings increasing up to 28%. Since productivity plays such a large role in the effects of green building, the data collected regarding productivity will play an essential role in determining the occupational well-being of an individual.

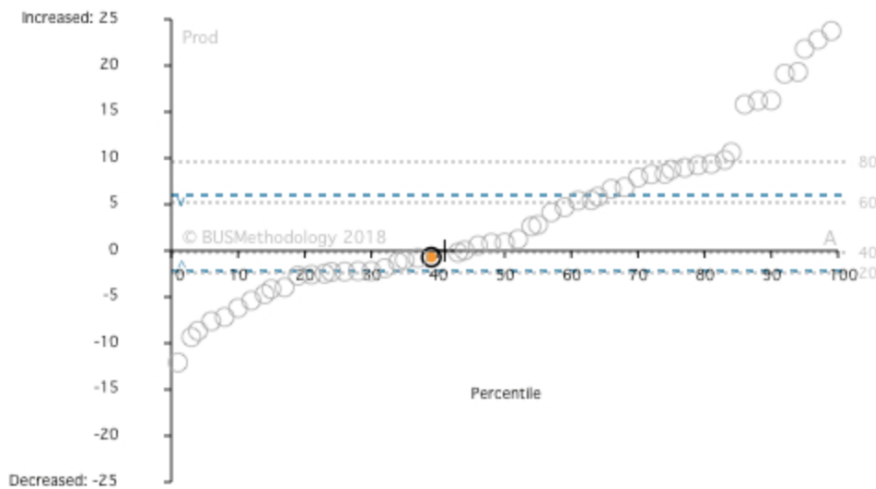


Fig 4 – Long survey respondents rating on productivity as benchmarked against other BUS evaluations

As signified in Figure 4 above, the PGB is found in the 39th percentile for its overall productivity levels. In contrast to the BUS database that places PGB just above the critical low region of the graph. Overall 72% of the occupants reported that they do not feel any more productive within PGB. Yet, 41% of the 72% feel that they are being less productive in the building. The direct correlation that the built environment is becoming substantial clearer. We need to ensure our designs be responsive to the occupants needs, behaviors and requirements which will allow them a freedom of choice and control over their environment while stay sustainable to our environment.

A further analysis of this data drew a concise conclusion of the productivity levels within the building. Of the occupants who feel that they are more productive, or they feel doesn't make them anymore productive are occupants who spend on average less than four hours a week in PGB. As for the opposite of that you have occupants who spend more than four hours a week

within PGB who actually feel less productive. This allows us to draw a conclusion that the occupants spending more time in the building have different perspectives and outlook, than those who are there for a short amount of time. Therefore, when evaluating future PROE and POE, it's important to ensure that the sample of data collection is a mixed source of occupant types. Physical and occupational well-being both play a fundamental in evaluating how an individual's well-being can be affected by buildings, specifically PGB. By looking at the connection between thermal comfort levels, as well as unproductivity it is deceptive that in order to each a net zero energy building along with increase occupant's well-being, changes must be made.

4.3 Social Well-being

In order to create a strong sense of belonging of the occupants to the building they are working in, it is very important to foster a positive community and increase the ease of communication between occupants. In addition, previous research studies on understanding the issues in workplace have demonstrated that being socially-connected at work could help reduce stress (Kamarulzaman et al., 2011). Apart from that, social connections in the workplace are essential in promoting productivity. When employees feel distant from the others, they would become less engaged, and thus, less productive at work (Lorsch & Abdou, 1995).

After interviewing with the long-term occupants regarding to their social well-being in the Physical Geography Building (PGB), it was discovered that the current state of PGB could not fully fulfill their social needs and the idea of fostering community was not widely promoted. This is important since 84% of the surveyed occupants believed that the idea of fostering community is important to them. According to the American Psychologist Abraham Maslow, his famous work on the hierarchy of needs suggested that any successful social community must be supported by the community members' sense of belonging. Using his work as a foundation, a successful community must at least fulfill four social needs to promote sense of belonging, they are communication, connection, contribution and creation. First of all, communication is defined as the ability for the community to easily share with others and to support their esteem needs. Similarly, connection is defined as how the community find others to make connections that contribute to fulfilling the needs in belonging. In terms of contribution and creation, it means to provide help for one another and the ability to effectively facilitate collaboration within the

community respectively (Forrester Research, 2010). Therefore, the social needs in the PGB is assessed by these criteria.

Judging by these criteria, it is considered that the PGB does not offer an encouraging structure that allow for easy communication and establishing connections. Looking at the data from the long PREOE, it was found that 60% of the occupants were not satisfied and consider that there were not enough meeting rooms and common spaces in the PGB. As signified in Figure 5 below, the PGB is found in the 1st percentile for its overall satisfaction regarding to the availability of meeting rooms. Since most of the interviewed occupants were Math TAs and they have their office hours in the building, the lack of meeting rooms contributed to the inconvenience in having private conversations. Furthermore, having no proper meeting rooms might affect their work since they are not able to meet with the professors, preventing them from gathering and discussing updates on work matters. Therefore, it is important for the PGB to have sufficient amount of meeting rooms and common spaces that encourage effective communication system, and provides suitable space and time for social connection.

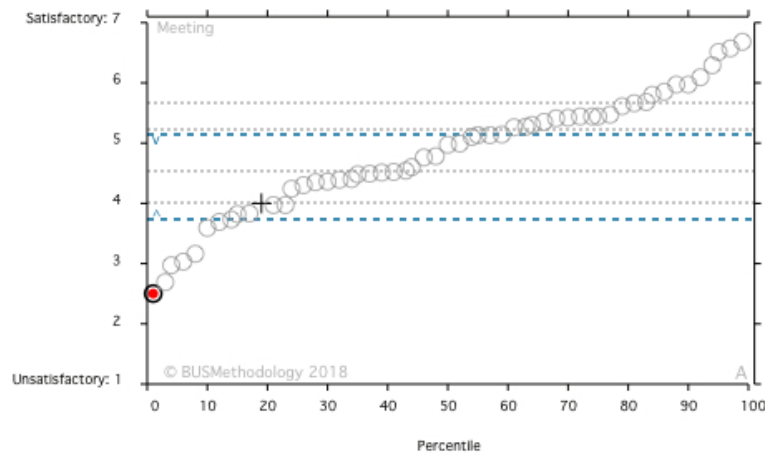


Fig 5 – Long survey respondents rating the availability and conditions of meeting rooms as benchmarked against other BUS evaluations

Apart from the lack of meeting rooms, the office rooms were claimed to be too small to carry out their daily work which includes communicating with fellow students. Since they have appointments with their fellow students inside their offices, more than half of the interviewed Math TAs expressed the concern that the size of their office restricts them to meet with all the students in need. It is estimated that the average size of the office rooms in the PGB is 15 x15 square feet. Considering that a typical 15 x 15 square feet classroom, the estimated maximum attendees should only be 9 persons. One of the interviewed TAs said that during his office hours,

there could be up to 10 students in his office, therefore it is evident that the maximum occupancy of the office has been reached. Thus, there is a need to expand the size of the office rooms. Moreover, the math aid center located on the first floor of the building that is available for all first-year students where Math TAs can provide assistance in their studies, was claimed to be too small to accommodate the demand for the students dropping-in. All these factors together might have an impact on the relationship between the TAs and their fellow students by hindering their chances to meet, and also affecting the learning quality of the students. Hence, it is essential for the PGB to have larger rooms for working and learning that can accommodate the needs for TAs and students and foster their communication with each other.

The accessibility of a building also plays a role in promoting social cohesion. Accessibility implies having amenities and features that are usable by all people and being socially and emotionally accessible. According to the University of Toronto accessibility service website, over 2,000 students are registered with disabilities and required accessibility services. Given there being no access to ramps and elevators in the building, the building is not friendly to people who requires accessibility services. On the other hand, washrooms and drinking fountains are only available on the second floor of the building, which is inconvenient for occupants not working on the second floor and possibly having an impact on their working and learning performances.

4.4 Environmental Well-being

Environmental well-being looks at one's awareness of how the environment can benefit them as well as the way a person's behavior can impact the environment. Other aspects of environmental well-being focus on the awareness of the short-lived impact of material consumption on happiness and openness to lifestyle changes and sustainability innovations (Bahl et al., 2016).

When asked "is sustainability important to you?" 96% of occupants answered yes, with only 4% answering no. Since a large portion of respondents said that sustainability is important to them, we could conclude that regardless of whether people understand what sustainability is, they think that it should be important. This question could be biased but it shows that even if people have varying ideas of what the concept of sustainability is, they still believe that it should matter. Knowing this, occupants of the building would be onboard with the proposed renovations

of the building to become a net zero building.

When asked “does sustainability affect your well-being” we found that only 64% of people said yes while 36% of people said no. Furthermore, 7 out of 10 long survey respondents discussed the importance of sustainability in reference to “caring about the environment”. For occupants who responded no to sustainability influencing their well-being, respondents justified their answers through relating sustainability to the environment and how their current well-being has not been impacted by the environment. These findings are significant as it shows that there is a disconnect between the environment in relation to well-being, and the lack of knowledge surrounding the social aspect of sustainability. This information will be useful in assisting with building renovations as in order to increase well-being, occupants must understand the idea of sustainability and how it connects with their personal wellness.

BUS survey findings

Overall lighting satisfaction was high for long survey participants as 79% of respondents rated overall lighting at 6 or 7 on the Likert scale where 7 is satisfactory. Respondents felt that artificial lighting and natural lighting was fine where the average score for these factors were “4” which meant that lighting wasn’t too much or too little. Some comments revealed that a couple of offices do not need artificial light during work hours in the day. This shows that some occupants have been saving energy in the building by not using artificial lights helping the energy use footprint of the building to remain smaller which is aligned to the PBG building’s aims of becoming net zero energy. For participants of the short survey, most respondents felt neutral about the building’s lighting as most (75%) provided a rating of “3” or “4” on the likert scale. This rating is still leaning towards a more unsatisfactory result as seen in Figure 6.

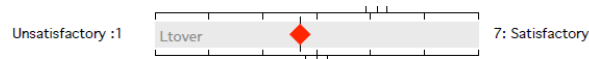


Fig 6 – Long survey respondents on lighting

It is evident to see that heating is an issue in the building where the average rating for long survey respondents on overall satisfaction of temperature was “2.5” on the Likert scale where the maximum score was a “5”. 6 out of 10 of respondents who provided comments on overall comfort of the building mentioned temperature and heating issues where it gets too hot in summer or winter.

There were even comments about how it got so hot in the winter that occupants would open windows to regulate the air temperature. The building is probably using too much energy on heating judging from how occupants said that it gets too hot in the winter time as seen in Figure 7.

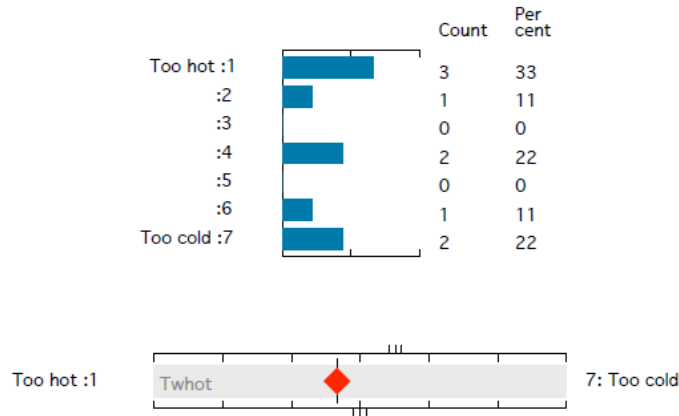


Fig 7 – Long survey respondent’s view on temperature as benchmarked against other BUS evaluations

This provides an opportunity as the building could invest in smart thermostat systems so that the heating can be controlled and distributed in a manner that keeps occupants comfortable and productive. Once heating in the building is optimized, the building will end up using less electricity and save on energy costs and reduce the need to generate a larger amount of energy onsite in the coming years when the building is achieving net zero status. Occupants also lack control over adjusting heating in the building meaning that they lack control and cannot be empowered to act environmentally. The average rating for satisfaction over overall control of building adjustments to do with lighting, noise and temperature was unsatisfactory with a numerical rating of 1.53.

Net Zero

When it comes to whether an environmental building or workplace is beneficial to occupant’s well-being, research has shown that it is beneficial if it promotes community understanding and aligns with the ambitions and views of occupants. (Helene and Smith, 2016) For this project to be successful, it is important to communicate about building plans and updates while involving occupants in anyway. This will make occupants more engaged with the project and feel a sense of accomplishment when the project is completed, contributing to increased well-being.

One of the objectives of this evaluation was to understand how building occupants felt about the concept of net zero energy. The findings show that a majority of occupants did not know what net zero meant where only 27% of occupants said they knew. This 27% represents 11 occupants where 10 of them associated “net zero” with energy consumption and generation. The other 1 occupant associated “net zero” with CO2 reductions. This shows that occupants who said they knew about the concept understood that it had to do with energy consumption. However, for the remaining 44 occupants, it would be good if they knew about net zero energy and understood that that’s what the building is aiming for so that they could have a better appreciation of the space and achieve a higher level of well-being. Occupants need to understand how the building works and functions better so that they can have a sense of security and rationalization when issues in the building arises.

5. Limitations

Although our findings are a good indication of the differences in data obtained from short surveys versus long surveys, there are some limitations that we will address with these findings. First off, our sample size is quite limited as we were only able to obtain data from a total of 54 individuals. One of the reasons this data set is relatively small is due to the limited access we had to contact the building's contacts. Due to this limitation, we were unable to interview people from the geography department which may have biased our data to simply math occupants. Another limitation of this project is the ways in which occupants understand the concept of sustainability. Although most occupants circled yes when asked if they believe sustainability is important to them, the ways in which occupants defined sustainability is unknown therefore the data in regard to this question may not be reflective to the understanding of sustainability that we are trying to promote in this project. Moreover, due to time constraints, all four group members of this project conducted interviews throughout the duration of the evaluation in order to obtain the most amount data. As a result of having four different interviewers, occupant answers may be biased due to potential leading questions by interviewers, as well as the different ways in which interviewers interpreted questions. Lastly, the biggest limitation of this project surrounds the lack of specificity on future occupants of the PGB. In order for a PREOE to be effective, individuals interviewed should be the same occupants who will be using the building. This ensures that findings and recommendations from the PREOE will be relevant to the views and perspective of the actual occupants who will be using the newly retrofitted space.

6. Recommendations

Through conducting a PREOE for the Physical Geography building, there are a number of recommendations that may be implemented by future building evaluators, the building management team, as well as the building renovation team. These recommendations include: creating an easily-accessible database with all occupant contact and building use information, giving occupants personal control over temperature in individual rooms, allocating building rooms according to occupant needs, increasing accessibility, promoting the concepts of net zero and sustainability, better response to building problems, and making renovations according to occupant needs.

Database with Occupant Contact and Building Use Information

One of the major challenges that this group faced during the occupancy evaluation was determining the building's occupants. Initially we were told that the building's occupants were all staff from the math department, however we were later on told that there were a few geography occupants in the building as well. Moreover, only through a semi-structured interview with one of the math department postdocs did our group discover that there is a lab in the PGB used by geography students for basic chemical tests. If the PREOE methods used in this project were replicated in the future, the recommendation we have is creating an easily accessible database containing all occupant contact information as well as building use would be useful for future surveyors. This would ensure that interviewers are able to contact all building occupants to ensure that the data obtained by the PREOE are able to represent diverse occupant beliefs.

Personal Control Over Room Temperature

Through our main findings on physical and occupational well-being, it is clear that the biggest issue affecting occupant well-being is the temperature in the building. Due to rooms being too hot or too cold, many occupants felt physically uncomfortable and less productive during the time they spent in the building. To resolve this issue, rooms in the PGB should have individual temperature controls that allow occupants to adjust their room temperature according to their personal needs. The building could also install a smart thermostat that can better track and adjust the temperature of the building while providing control for occupants. This would increase physical well-being as occupants would be comfortable in their office space instead of constantly freezing or sweating. As a result, productivity would also increase as occupants would not have

to avoid working in the PGB or work in an uncomfortable environment. Providing occupants with control over room temperature can help the building save energy as well, so that energy isn't being wasted blasting heat during the winter for some offices.

Proper Allocation of Building Space

In terms of increasing social well-being, the recommendation that our group proposes is to allocate building space according to occupant use and needs. As previously stated, occupants of the PGB perceived the building as antisocial due to the lack of meeting rooms available and the randomness of room assignments. Due to the lack of common spaces in the building, TAs were forced to hold office hours in their shared office spaces which many occupants found disruptive. To resolve this issue, building space must be allocated according to occupant use, such as a designated room that allows TAs to book and hold office hours. This will increase social well-being as building space used for their intended purposes will ensure that occupants are not disrupting others and creating social tensions within shared office spaces. Furthermore, office spaces should be allocated according to specific research and work interests to allow colleagues to discuss and formulate ideas with one another if they wish.

Increase Accessibility

To increase sustainability and promote a sense of community and belonging, the building must not limit occupants to only those without accessible needs. Currently, the PGB has no ramps or elevators, making it increasingly difficult for those with accessibility needs to enter and navigate throughout the building. To increase accessibility, not only are ramps and elevators needed but so are wider doorways, aisles and handrails on the steps outside the building.

Promote Sustainability and Net Zero

Through the results obtained by the four initial questions created by this group, it was clear that people did not understand the concepts of sustainability or net zero but still felt that sustainability was an important concept. In order for this building to achieve its goal of becoming net zero and more sustainable, it is important for occupants to understand what these concepts are and how they relate to one's well-being. Through properly understanding the concepts of sustainability and net zero, occupants will begin to think in a more ecological manner both in and out of the building. Ways to increase the promotion and awareness surrounding these concepts can be done

through e-newsletters, posters, meetings, and social media. Ultimately, the success of a net zero energy building relies on occupant actions as much as it relies on the retrofit.

Better Response to Building Problems

Aside from complaints about temperature and lack of social spaces, another issue that occupants had about the building was in regard to the lack of response received from building managers when complaints were issued. In order to better respond to building problems, a more robust system must be put in place to ensure that building managers are accountable for their action. This can be done through a more systemic complaint process that allows occupants to contact different individuals if they feel their needs are being unmet in the building. With a more systemic complaint process, this increases the accountability of building managers to address and fix issues in an efficient, effective and timely manner.

7. Conclusion

Overall, through conducting a Pre-Occupancy Evaluation of the Physical Geography Building, this essay concludes that the PREOE methods used for this project are effective, current occupant well-being in the building is unsatisfactory, and there is an overall lack of understanding on the concept of net zero. First off, the PREOE methods used in this project were found to be effective as the data gained from the surveys and interviews were comprehensive and allowed for different insights to be gained. Specifically, short surveys allowed for an increased data set whereas long surveys allowed for deeper insight into specific building issues. In terms of occupant well-being, it is clear that occupants are overall unsatisfied with the current state of the PGB. Due to temperature problems, occupants felt physically uncomfortable as it was always too hot or too cold in the building. This led to decreased occupational well-being because occupants felt so physically impacted by the temperature that they would rather work at home than at their office in the building. Moreover, due to improper allocation of building space, the PGB left occupants feeling unhappy due to lack of social interaction. The lack of accessibility in and around the building further added to the PGB being a socially exclusive environment. Lastly, through the analysis of environmental well-being, it is clear that there is a lack of knowledge surrounding the concepts of net zero and sustainability.

At the completion of this project, a post occupancy study should be held to evaluate the impacts the net zero building changes have on occupant well-being. It is beneficial for occupants to understand what a net zero building is so that they can have a sense of how the building is operating and provide them with a stronger feeling of control and certainty.

8. Citations

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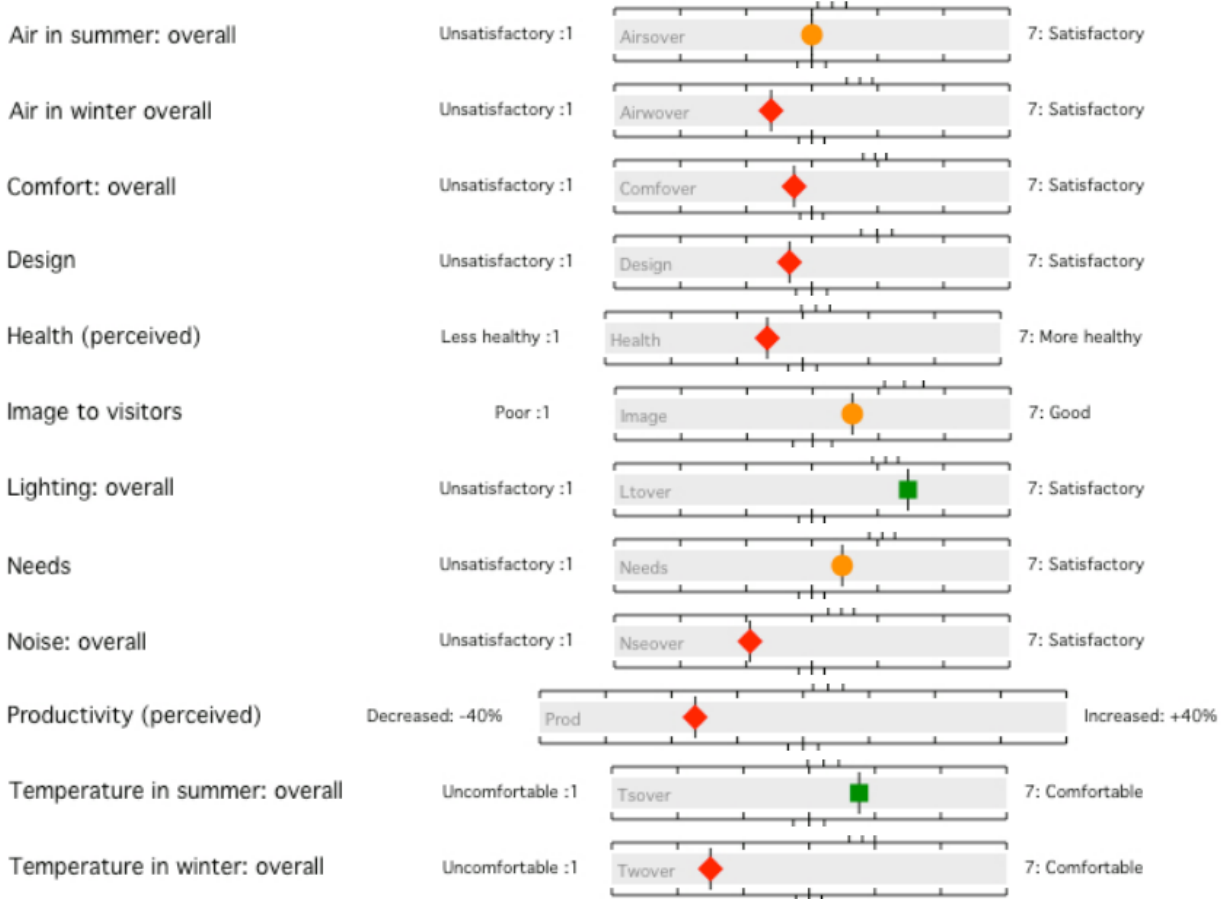
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8. Appendices

Overall summary charts for long survey/interviews - N=14



Overall summary charts for short surveys - n = 39

