



Indoor Environment Quality + Workplace Environment Normandale Partnership Center (Report 1)

**April 2014, Bloomington, MN
Sustainable Post-Occupancy Evaluation Survey (SPOES)
B3 Guidelines**

Denise A. Guerin, PhD
(contact: dguerin@umn.edu)
Theresa Bauer, MA
Angelita Scott, MS
Abimbola Asojo, PhD
Hye Young Kim, PhD
College of Design
University of Minnesota

1.0 Overview

The purpose of this report is to examine the connection between sustainable design criteria used in the design of the Normandale Partnership Center Building (NPC) and employees' satisfaction with their work environments. The NPC facility was designed using the B3 Guidelines (formerly known as the Minnesota Sustainability Guidelines or MSBG) and completed for occupancy in January 2013. The B3 Guidelines track specific state-funded buildings as a means of demonstrating real outcomes aimed at the conservation of energy resources, creation and maintenance of healthy environments, and occupants' satisfaction with the physical environment. The Sustainable Post-Occupancy Evaluation Survey (SPOES) was developed to assess human outcomes in classroom and workplace settings in compliance with the project tracking requirements for the B3 Guidelines goals. This is the first of two required POE surveys and represents responses obtained at 14 months post-occupancy. The survey was conducted in April, 2014.

This SPOES report focuses on employees' satisfaction with the physical environment as related to 15 indoor environment quality (IEQ) criteria (hereafter called categories) such as lighting, thermal, and acoustic conditions in their primary workspaces, i.e., offices. Employees' satisfaction with the facility (site, building, and interior) and the effect of the facility's physical environment on their perceptions of their work performance and health are included. Finally, a brief look at employees' commuting and physical activities within the building are also reported. The report provides descriptive information about employees' perceptions of the IEQ of their work environments. In addition, this information serves the broader development of knowledge regarding the influence of IEQ on employees.

2.0 Method

SPOES consists of a self-administered, Internet-based, questionnaire submitted to and completed by employees. The SPOES questionnaire has been tested for **validity** (measures what it is intended to measure) and **reliability** (repeatability or replicability of findings) in studies involving similar facilities and employees. Employees rate their level of satisfaction on a **Likert-type scale** (measurement scale) from 1 (very dissatisfied) to 7 (very satisfied) with IEQ of the facility and their primary workspaces. They also rate the influence of their physical environment on their perception of their work performance and health on a scale from 1 (hinders) to 7 (enhances). There were no physical measurements taken of environmental conditions such as temperature or acoustic level. This study is limited to employees' perceptions.

The report provides a descriptive summary of the results stated as a **mean** (M) (average of all responses), **standard deviation** (SD) (how different scores are from each other and the mean), and **number of responses** (N) for questions analyzed. The mean for a 7-point scale is 4.00. Lower or higher means reflect stronger tendencies towards dissatisfaction/satisfaction and hinders/enhances. Means that are close to the center of the scale (4) are considered to be neither dissatisfied/hinders or satisfied/enhances.

When interpreting **mean** responses, the following labels were used:

- 1-3.99 dissatisfied (hinders)
- 4-4.49 neither satisfied (enhances) or dissatisfied (hinders)
- 4.5-7 satisfied (enhances)

An IEQ Satisfaction Score is also calculated for employees' satisfaction with IEQ in their primary workspaces. This is a statistical combination of all IEQ scores for each criterion, which results in a single IEQ Satisfaction Score for all employees on all IEQ criteria or variables and is reported in an IEQ Scorecard.

2.1 Description of the Questionnaire

Employees first rate their level of satisfaction with the facility and the influence of their physical environment on their perception of their work performance and health. Then they respond to questions about their satisfaction with their primary workspaces in relation to the IEQ criteria. The questionnaire uses IEQ criteria from the B3 Guidelines and relates each of them to employees' satisfaction with their physical environment.

Criteria include (in alphabetical order):

- | | |
|---------------------------------|---------------------------------------|
| 1. Acoustic Conditions | 9. Lighting Conditions |
| 2. Appearance | 10. Personal Adjustability Conditions |
| 3. Cleaning and Maintenance | 11. Privacy |
| 4. Daylighting Conditions | 12. Technology |
| 5. Electric Lighting Conditions | 13. Thermal Conditions |
| 6. Function | 14. Vibration and Movement |
| 7. Furnishings | 15. View Conditions |
| 8. Indoor Air Quality | |

However, there are 23 IEQ (see Table 3) questions that represent the IEQ criteria included in this study. Some of the criteria are broader such as Function or Indoor Air Quality, and there is only one 'overall' question about it to which employees respond. Other criteria have additional questions to provide greater detail about the condition. For example, Thermal Conditions has an 'overall' question and three other questions related to temperature, humidity, and air velocity (draft). Acoustic Conditions is also an 'overall' question with others related to employees' ability to hear desired sounds and ability to limit undesired sounds. Lighting Conditions has questions related to Daylighting Conditions and Electric Lighting Conditions and the quantity and control of each.

2.2 Limitations

Employees' participation is voluntary, and responses are self-reported. As is true with all survey research, the responses indicate employees' perceptions. There were no physical measurements, e.g., temperature, humidity, or lighting levels, of the environment taken.

3.0 Sample Description

3.1 Building Description of the Building

The NPC facility resides on the campus of Normandale Community College, a part of the Minnesota State Colleges and Universities system, and is located at 9700 France Avenue South in Bloomington, MN.

There are currently over 14,500 students in attendance at Normandale. The NPC facility (see Figure 1) is comprised of 27 classrooms, laboratories, faculty offices, and common student areas. These areas are distributed across three floors and 76,000 square feet. The facility provides offices for faculty and staff who work in business, accounting, hospitality, continuing education, and customized training.



Figure 1 Normandale Partnership Center Building (Photo credit: <https://normandale.ims.mnscu.edu/>)

3.2 Description of Respondents

The response rate to the questionnaire was approximately 28% with 16-18 total respondents. Of those responding, 37% were male and 63% were female. Relating to hours worked per week in NPC, 37.5% of the employees spend 51-75% of time in their primary workspace, 25% spend more than 75% of time in their primary workspace, 25% spend 25-50% of time in their primary workspace, and 12.5% spend less than 25% of time in their primary workspace. The majority (31.3%) of employees spend 30-40 hours per week at the NPC. The mean age of respondents was 53 years, with a range of 25 to 68 years.

NPC is a research facility with offices, laboratories, and classrooms serving as primary workspaces. The respondents indicated 58.8% work in enclosed offices shared with other people, 11.7% work in cubicles with both high and low partitions, 11.7% work in classrooms, 5.9% work in cubicles with high partitions, and 5.9% work in cubicles with low partitions. Results also indicated that 62.5% of the primary workspaces were located within 15 feet of an exterior window, 31.3% of the employees were not within 15 feet, and 6.3% were uncertain of the distance to an exterior window.

NPC completed in 2013. Employees identified that 63.4% have worked there for 1-2 years, 31.3% have worked there for less than 1 year, and 6.3% have worked there for 2-3 years. (Note: all percentages reported may not add to 100% due to rounding).

4.0 Findings and Discussion

4.1 NPC Facility (Site, Building, and Interior): Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning the NPC facility (site, building, and interior) and their overall satisfaction with the facility, overall perceptions of their work performance in relation to the facility, and their overall perception of their health in relation to the facility. Table 1 and Figure 2 show a summary and interpretation of their responses.

Table 1 Overall satisfaction, work performance, and health related to the NPCB facility

NPC Facility (site, building, and interior)	Mean (1-7)	SD	N	Interpretation
Overall satisfaction	6.65	.61	18	Satisfied
Overall work performance	6.35	.61	17	Enhances
Overall health	5.65	1.22	17	Enhances

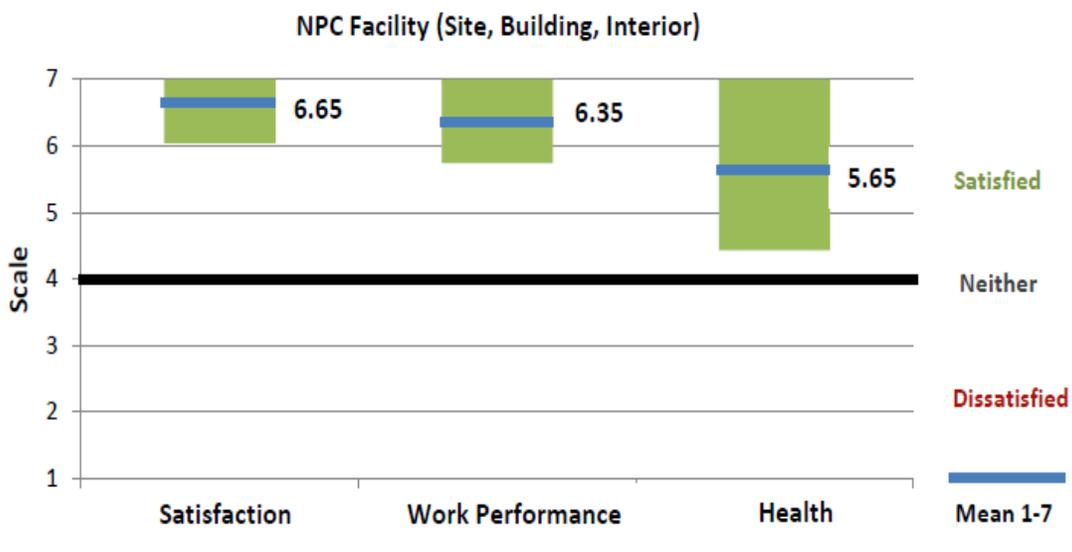


Figure 2 Overall satisfaction, work performance, and health related to the NPC facility

Results indicated that employees were satisfied ($M = 6.65$) with the NPC facility (building, site, and interior) and reported that their overall work performance was enhanced ($M = 6.35$) by the facility. Employees reported that their overall health was enhanced ($M = 5.65$) by the facility.

4.2 Primary Workspace: Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning their overall satisfaction and overall perceptions of their work performance and health as related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 2 and Figure 3 show a summary and interpretation of their responses.

Table 2 Overall satisfaction, work performance, and health related to primary workspace

Primary Workspace	Mean (1-7)	SD	N	Interpretation
Overall satisfaction	6.52	.62	17	Satisfied

Overall work performance	6.29	.77	17	Enhances
Overall health	5.65	1.17	17	Enhances

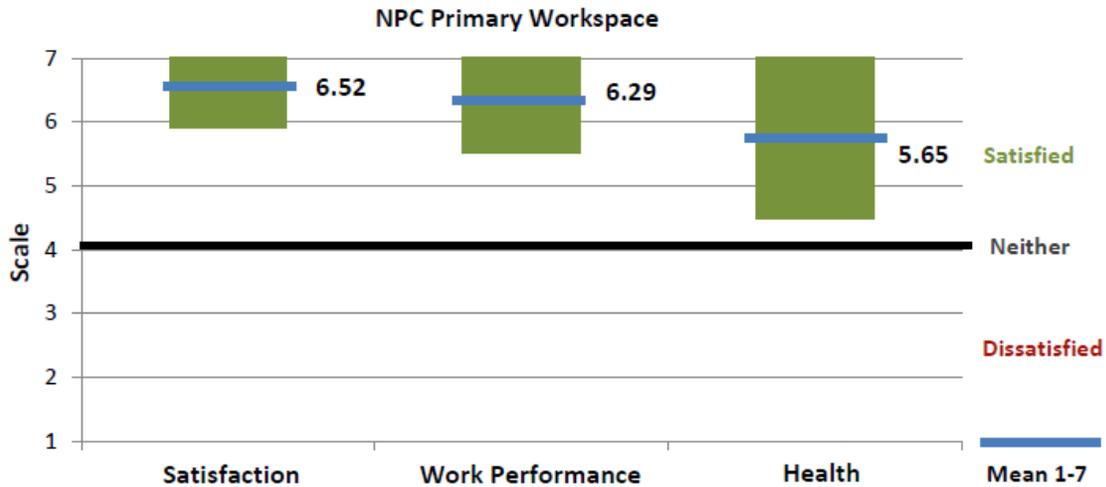


Figure 3 Overall satisfaction, work performance, and health related to primary workspace

Results indicated that employees were satisfied ($M = 6.52$) with their primary workspace, their overall work performance was enhanced ($M = 6.29$) by their primary workspace, and their overall health was enhanced ($M = 5.65$) by their primary workspace.

4.3 Primary Workspace: Satisfaction with Indoor Environment Quality (IEQ)

Employees responded to questions concerning their satisfaction with IEQ categories (thermal conditions, indoor air quality, acoustic conditions, etc.) related to their primary workspace (e.g., private office, workstation, or other primary workspace). Table 3 and Figure 4 show a summary of the means, the standard deviations, and interpretation of their responses.

Table 3 Satisfaction with IEQ related to primary workspace

	Primary Workspace	Mean (1-7)	SD	N	Interpretation
1	Indoor air quality	6.71	.59	17	Satisfied
2	Humidity	6.41	.87	17	Satisfied
3	Vibration and movements	6.35	.93	17	Satisfied
4	Cleaning and maintenance	6.35	.99	17	Satisfied
5	Air velocity	6.29	1.26	17	Satisfied
6	Ability to hear desired sounds	6.19	1.11	16	Satisfied
7	Furnishings	6.19	1.17	17	Satisfied
8	View conditions	6.18	1.81	17	Satisfied
9	Appearance (aesthetics)	6.18	1.24	17	Satisfied
10	Function	6.12	1.17	17	Satisfied
11	Electric lighting conditions	6.12	1.32	17	Satisfied
12	Lighting conditions	6.06	1.40	17	Satisfied
13	Privacy	6.00	1.00	17	Satisfied
14	Adjustability of electric lighting	6.00	1.54	17	Satisfied
15	Amount of daylight	5.94	1.89	17	Satisfied

16	Technology	5.82	1.18	17	Satisfied
17	Temperature	5.82	1.59	17	Satisfied
18	Thermal conditions	5.82	1.59	17	Satisfied
19	Acoustic quality	5.76	1.39	17	Satisfied
20	Ability to limit undesired sounds	5.70	1.61	17	Satisfied
21	Adjustability of task lighting	5.35	1.87	17	Satisfied
22	Adjustability of daylighting	5.29	2.14	17	Satisfied
23	Adjustability of thermal conditions	4.75	1.95	24	Satisfied

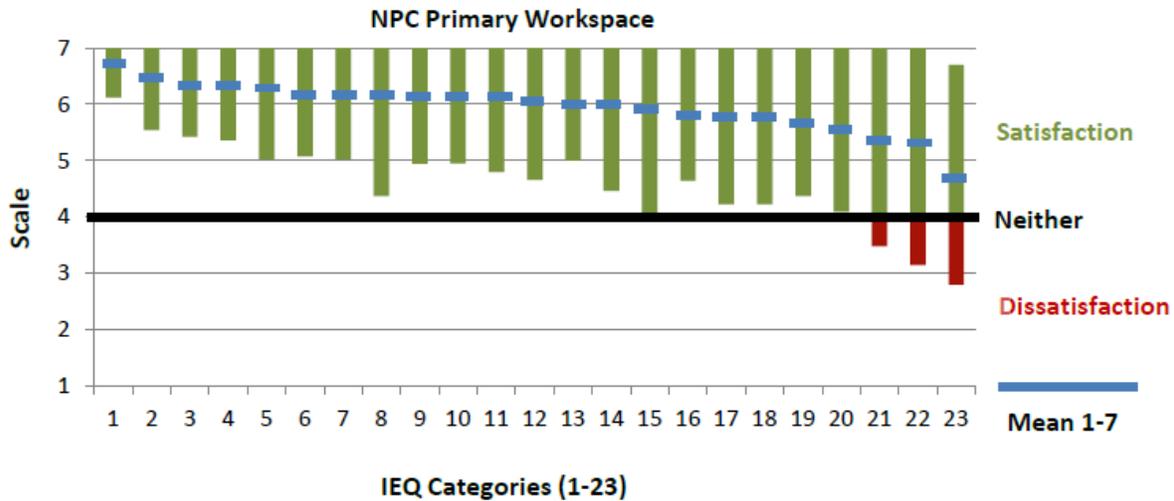


Figure 4 Satisfaction with IEQ related to primary workspace (IEQ criteria 1-23 are included in Table 3)

Results indicate that employees were satisfied with all of the IEQ criteria in their primary workspaces (mean at or above 4.49). Several IEQ criteria had mean scores above 6.0 and with Indoor air quality with the highest level of satisfaction (**M = 6.71**) and adjustability of thermal conditions (**M = 4.75**) with the lowest level of satisfaction.

4.4 Primary Workspace: IEQ Satisfaction Scorecard

The IEQ Satisfaction Score is determined by developing weighted factors of all categories, which is more representative of a fair overall IEQ score. For example, it might be more important for an employee to have satisfying thermal conditions than to have satisfying indoor air quality. Thus, if the employee gives a high thermal satisfaction score and a lower indoor air quality satisfaction score, the overall IEQ satisfaction will be scored much higher than one with the inverse statistics. Unfortunately there were not enough responses necessary to run analysis of the IEQ satisfaction score.

5.0 Physical Activity Engagement and Commuting Practices

In the final section of the survey, employees responded to questions regarding their overall physical activity while at NPC (site, building, and interior) and their commuting practices.

5.1 Physical Activity Engagement

Providing employees with opportunities for alternative paths of travel around the workplace, e.g., taking stairs as opposed to the elevator provides opportunities to engage in additional types of physical activities. Engaging in physical travel throughout the work environment can be associated with healthier lifestyles. Results indicated that employees felt that NPC enhanced (**M = 5.88**) their physical activities (walking, stair use, etc.).

Table 4 Overall physical activity (walking, stair use, etc.) affected by the NPC facility

NPCB facility (site, building, and interior)	Mean (1-7)	SD	N	Interpretation
Overall physical activity (walking, stair use, etc.)	5.88	1.02	16	Enhances

5.2 Commuting Practices

NPC is a facility within Normandale Community College in Bloomington, MN. The institution resides on a 90-acre wooded lot, 1.5 miles south of a major highway that runs through the Minneapolis/St. Paul Metro area. The campus is convenient to public transportation and bicycle trails.

Table 5 provides results on employees' commuting mode of transportation. These results, although not related to IEQ, do offer insight into employees' commuting behaviors and opinions. These data can provide important information about commuting practices that can reduce transportation energy consumption.

Table 5 NPC Primary mode of transportation

Commuting Practices	Drive alone (or with children < 16)	Carpool or van	Public transit	Bicycle	Walk
Primary mode of transportation	100 %	0%	0%	0%	0%

The most frequent mode of transportation to NPC was driving alone (or with children under 16) at 100%. Employees did not use any other form of transportation for their daily commute even though 43.8% responded that the NPC enhances their ability to commute to work in an alternative way.

6.0 Conclusions

6.1 Summary

A post-occupancy evaluation was conducted of employees of NPC at approximately 9 months after it was first occupied. About 28% of the employees responded to the survey, although the total number of responses was too low to generate an IEQ Score. The survey included questions related to employees' overall satisfaction with the facility (site, building, and interior) and influence of the facility on their overall work performance and health.

Employees were highly satisfied with the facility (**M = 6.65**); they found the facility enhances their overall work performance (**M = 6.35**) and enhances their overall health (**M = 5.65**). In addition, similar results were reported when employees were asked these same questions about their primary workspaces (private office, shared office, laboratory, etc.). They reported overall satisfaction (**M = 6.52**) with their primary workspaces, and that their overall work performance (**M = 6.29**) and their overall health (**M =**

5.65) was enhanced. As the range of scores was from 1-7, these scores that showed a high level of satisfaction with all aspects of the facility.

Most of the survey questions related to employees' satisfaction with the IEQ categories in their primary workspaces (private office, laboratory, etc.). Employees' responses showed they were **satisfied** with the all of the IEQ categories. The mean satisfaction scores ranged from the lowest of 4.75 (**Adjustability of thermal conditions**) to the highest 6.71 (**Overall indoor air quality**). Again, this shows a **moderate to high level of satisfaction**. Finally, employees reported that NPC **enhances** their physical activity, which is one of the sustainable design criteria that influence occupant behavior.

6.2 Recommendations

The satisfaction scores are certainly in the positive direction, however, improvement may be possible. For IEQ categories that have physical measurement possible, e.g., thermal, acoustic, and lighting, it is recommended that these measurements be taken in both overall workspaces and primary, individual workspaces. Recommendations follow that will help management stay ahead of any IEQ problems.

There are several strategies that can be used as a follow-up to this survey that will help dig deeper into the criteria that showed low satisfaction or dissatisfaction. They include the following:

- Determine if any task areas differ now from original intent.
- Identify employees' specific concerns via focus groups
- Log complaints and sort into areas of concern that can be acted upon. For any criteria/complaints that are measurable, e.g., thermal conditions, lighting conditions, conduct onsite measurements using Illuminating Engineering Society standards for employees' tasks.

Acoustic Conditions

- Identify acoustic criteria for overall requirements.
- Determine if any task areas differ now from original intent.
- Develop any additional special acoustical performance requirements to support functional programming of building, e.g., sources of recurrent noise that need to be controlled, special user populations that may have distinct auditory performance limitations, or multiple uses of building spaces that may have different acoustic criteria. Investigate and choose appropriate acoustics modeling software for the project.
- Measure acoustic performance onsite with full systems running. Log noise and other sonic environment complaints.

Lighting Conditions

- Identify performance criteria that are to be met to achieve goals.
- Develop additional quality lighting criteria as needed for special facility issues such as employees' ages, duration of task, influence of daylight quality or quantity.

Personal Adjustability

- Determine if adjustability issues arise with temperature, lighting, or furnishings via focus group.
- Identify personal, individual problem areas and relate to other IEQ issues via log of complaints.
- Provide education to employees about adjustability of any applicable adjustment options, e.g., furnishings, air diffusers, lighting, temperature control, etc.

Privacy Conditions

- Consider adding noise masking equipment and/or visual screening depending on nature of complaints.
- Compare acoustic privacy problem areas with acoustic measurements to pinpoint specific problem areas.

Thermal Conditions

- Determine special thermal comfort requirements or problems that may be encountered in the building due to work activities, sitting, or design considerations.
- Determine if any task areas differ now from original intent.
- Review conditions that affect thermal comfort using ASHRAE Standard 55-2004 or Human Factors Design Handbook.
- Log complaints related to thermal conditions.

It seems obvious that employees' satisfaction can be improved by addressing the categories that had lower levels of satisfaction. The above recommendations can help address change in these categories. The area employees were least satisfied with was the adjustability of thermal condition. Exploring this area in more detail and making adjustments may increase overall satisfaction with the primary workspace.

This study investigated employees' satisfaction with the facility and primary workspaces. IEQ satisfaction is individual, but the results of the survey show a central tendency of high satisfaction with the facility and most of the IEQ categories. The results can be used as a diagnostic tool to aid in improving IEQ conditions for employees and to set the benchmarks from which improvement can be measured in the future.

Appendix A. Open-Ended Responses

Employees had the opportunity to raise specific concerns about the overall facility and their primary workspaces. Important information can be gleaned from these open-ended responses. NPC employees raised specific concerns about the following themes: thermal conditions, lighting, acoustics, furnishings, cleaning and maintenance, privacy, wayfinding, and technology. There were positive comments as well, which included an overall satisfaction with the building, and the building services amenities. Though these qualitative responses overall appear as the employees are dissatisfied; it does not mean they represent the overall sentiment from employees. However, thermal conditions including temperature and adjustment were reflected also in the responses above as areas that had the most concerns. The following are open-ended comments to the above noted themes.

Thermal Conditions

- My office is regularly cold, so that I use a space heater a couple of times a week.

Lighting

- I would like the ability to set my lighting at a default level.
- The green lighting required is unhealthy. We need softer, yellow light.

Acoustics / Thermal

- The noise level outside my office is very disruptive, but when I close my door it gets very warm in my office.
- The biggest issue is the force of air blowing down and the consistently cold temperature in my office.

Furnishings / Technology

- I would have preferred a rounded corner where my computer sits. I have very little access to outlets. One outlet under my desk in which everything must go, so I have to have a power strip which gets in the way of my feet. Cords are very difficult to guide behind the desk. There is NO access to the back wall, so I have no idea if there is an outlet there. The only other outlet I have access to is in the middle of open space, so cords must be strung across office to reach them.
- Cubical needs one additional chair for students who visit faculty.
- Ergonomics are a minor concern - the placement of my keyboard is a bit unnatural, making it tough to keep my arms and wrists at a comfortable angle.
- Part of my workspace was installed upside down and has not been fixed.

Cleaning and Maintenance

- I do think a better job could be done to actually sanitize things like the doors to the bathrooms and other chrome finishes which show fingerprints and are NEVER even wiped down. Also, there are a lot of surfaces, such as along the lower part of the stairs and the window ledges in the LINK, that get very dirty and dusty.
- Lack of paper towels in the bathroom is extremely bothersome. There is no way to protect your hand from germs on the door handle as you leave the bathroom. Additionally, the dryers are awkward and take a long time to dry hands for high velocity dryers, unless you shake a bunch of water off before.

Privacy

- Cubicles will be great as long as we don't have to share them with other faculty.

Wayfinding

- Only negative is the difficulty students and guests seem to have in finding the 3rd floor (labeled 2nd floor) because of the lack of clearly visible stairways and the unusual numbering convention (Ground, first, and 2nd floor instead of the more intuitive 1st, 2nd and 3rd floor).

Overall Positive

- The 6s [rating] are only due to the fact that I will need a change to summer to see how the heat issue has been resolved. Right now everything seems fine, although the weather conditions are currently moderate.
- The place is fabulous, and we are lucky to have it.
- The overall building is so very pleasurable. It's a joy to be there.
- Overall, these are minor things compared to how spoiled I feel most of the time to work in such a beautiful building.

Building Services

- Very pleased with the lighting, aesthetics and climate control.
- Overall however, I'm thrilled with the Partnership Center environment.

Appendix B. Glossary

Descriptive statistics

Statistics used to summarize large sets of data (i.e., means, frequencies, medians). Descriptive statistics describe only the sample under consideration and are not intended to infer results to the larger population.

Factor analysis

A multivariate statistical procedure that is used to identify and group together general dimensions or factors that underlie a large number of variables in a set of data. The procedure transforms the variables

into new principal components or orthogonal factors. Variables within each factor are related to each other but have no relationship to variables in other factors.

Frequency

A descriptive statistic that provides information about how many of a particular response or measurement are observed.

Likert-type scale

A measurement technique, employed in questionnaires and interviews, that utilizes a range of standardized response categories such as strongly agree, agree, etc.

Mean

The average score of a set of data calculated by adding all scores together, then dividing by the number of scores.

N

The number of subjects or participants responding to the questions in the study

Reliability

The repeatability or replicability of findings; the same results are produced each time. Instruments and procedures should produce the same results when applied to similar people in similar situations, or on a second occasion.

Standard deviation

A statistic used to measure the variability of a group of scores (how different scores are from each other and the mean). For example, if the range of scores is 1-7 and the mean (average) is 5.0 with a standard deviation of 1.0, then the scores are closely clustered around the mean, i.e., there is one unit of variation among all scores. If the mean was 5.0 and the SD was 3.0, there is a broader range of variation among the scores...a smaller SD means the scores are similar and the mean score is likely to be more accurate and more useful (this is better!).

Validity

The extent to which an instrument or procedure measures what it is intended to measure (internal validity). The generalizability of results to another population (external validity).