



**Indoor Environmental Quality + Workplace Environment  
DOA Minnesota State Capitol Building Interior Restoration  
St. Paul, MN**

**May 2019, Minneapolis, MN  
Sustainable Post-Occupancy Evaluation Survey (SPOES)  
B3 Guidelines**

**Caren S. Martin, PhD**  
(contact: [caren@mgdesignresearch.com](mailto:caren@mgdesignresearch.com))  
**Martin & Guerin Design Research, LLC**  
*Minneapolis, MN*

**Abimbola Asojo, PhD**  
([aasojo@umn.edu](mailto:aasojo@umn.edu))  
**Suyeon Bae, 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 and interior restoration of the DOA Minnesota State Capitol Building facility and occupants' satisfaction with their work environments located in the facility. This report communicates responses from employees about the overall facility and their workplace (WP). The facility was designed using the B3 Guidelines (formerly known as the Minnesota Sustainable Building Guidelines or MSBG), which were in effect at the time that the renovation and addition were funded. It was completed for occupancy in January 2017. The B3 Guidelines track specific state-funded, B3 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 their work environments. The Sustainable Post-Occupancy Evaluation Survey (SPOES) was developed to assess human outcomes in workplace, classroom, and residence hall settings in compliance with the B3 Guidelines project tracking requirements. This is a report of occupants' (hereafter called employees) responses from the survey conducted in December 2018.

This SPOES report focuses on employees' satisfaction with the physical environment as related to 26 indoor environmental quality (IEQ) criteria 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 also are included. Finally, a brief look at employees' commuting and physical activities within the building are 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). 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 (hindered) to 7 (enhanced).

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

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

- 1.00 - 3.50 dissatisfied (or hindered)
- 3.51 - 4.50 neither dissatisfied (or hindered) nor satisfied (or enhanced)
- 4.51 - 7.00 satisfied (or enhanced)

An IEQ Score is also calculated for employees' satisfaction with IEQ criteria in their primary workspaces. This is a statistical combination of all category-level (explained below) IEQ scores, which results in a single IEQ score for all respondents and is reported in an IEQ Scorecard.

## 2.1 Description of the Questionnaire

Employees first rate their level of satisfaction with the facility (site, building, and interior) 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 IEQ criteria from the B3 Guidelines. Additionally, employees' demographic, physical activity, and commuting practice data are collected to provide context for the study.

In the SPOES questionnaire, the 26 IEQ criteria listed below are evaluated. There are two levels of criteria, categories and attributes. As shown in the list, the 'overall' criteria are boldfaced and called 'categories' or 'category level' criteria. A category is broader or more general such as Overall View Conditions or Overall Indoor Air Quality. Some categories have 'attributes' or 'attribute level' criteria and provide greater detail about the category. For example, Overall Thermal Conditions is a category level question, and there are four attribute level questions related to thermal conditions such as adjustability, air velocity (draft), humidity, and temperature. Overall Acoustic Conditions is a category with attributes of employees' ability to hear desired sounds and their ability to limit undesired sounds. There are 12 category-level and 14 attribute level questions. Means are calculated and reported for all category and attribute-level criteria.

An IEQ Satisfaction Score is also calculated for employees' satisfaction with IEQ in their primary workspaces. This is a statistical combination of the 12 category-level criteria only and results in a single, mean IEQ Satisfaction Score for all employees' satisfaction with the physical conditions of their primary workspaces. Attribute-level criteria are not included in the IEQ Score because unequal weight would be given to criteria that have both category and attribute-level questions.

In the following list, **category (boldface)** criteria are listed in alphabetical order. If a category has attributes, they are listed with the category.

### **Overall Acoustic Quality**

- Ability to hear desired sounds
- Ability to limit undesired sounds

### **Overall Appearance (aesthetics)**

### **Overall Cleaning and Maintenance**

### **Overall Daylighting Conditions**

- Amount of daylighting
- Adjustability of daylighting

### **Overall Electric Lighting Conditions**

- Amount of electric lighting
- Adjustability of electric lighting
- Adjustability of task lighting

### **Overall Furnishings**

- Function of furnishings
- Adjustability of furnishings

### **Overall Indoor Air Quality**

### **Overall Privacy**

### **Overall Technology**

- Access to electric outlets

### **Overall Thermal Conditions**

- Adjustability of thermal conditions
- Air velocity (drafty/stagnant)
- Humidity (dry or moist)
- Temperature (hot or cold)

### **Overall Vibration and Movement**

### **Overall View Conditions**

## 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. This study is limited to employees' perceptions.

## 3.0 Sample Description

### 3.1 Description of Building

The Minnesota State Capitol Building facility resides at 75 Reverend Martin Luther King Jr. Boulevard, St. Paul, MN. The Minnesota State Capitol Building facility (see Figure 1) is a five-story, 378,825 square foot building. In addition to Senate, House of Representatives, and Court Chambers; public assembly spaces; conference rooms and a café, this building provides workspace (90,000 square feet) for elected and appointed officials and staff. Those with office space in the Capitol, represent the Governor's office, Minnesota Senate and the House of Representatives, Minnesota Attorney General, Minnesota Historical Society, and the Department of Administration. The workplace also includes conference and meeting space, and support areas.



Figure 1. Minnesota State Capitol Building (Photo courtesy of the Minnesota Historical Society)

### 3.2 Project Team

The relevant project team members to the SPOES process for Minnesota State Capitol Building was comprised of the owner, design team, and commissioning agent, and general contractor. They are identified below, relative to their capacity and involvement.

Owner	State of Minnesota
Architect	HGA
Mechanical Engineer	State of Minnesota
Electrical Engineer	HGA
Interior Designer	HGA
Lighting Designer	HGA
Landscape Architect	HGA
Commissioning Agent	Sebesta Blomberg
General Contractor	JE Dunn Construction Group, Inc.

### 3.3 Description of Respondents

This survey was administered to 92 employees with workspace in the facility in December 2018. The response rate to the questionnaire was approximately 42%. Of those responding, 62% were female and 38% were male. The mean age of respondents was 40 years, with a range from 22-61 years of age.

The Minnesota State Capitol Building restoration was completed and ready for operation in January 2017. Since that time, 54% of the respondents reported that they worked in Minnesota State Capitol Building facility for more than two years, 40% of the respondents reported that they worked at the Minnesota State Capitol Building facility for 1-2 years, and 6% of the respondents have spent less than one year at this facility. Relating to hours worked during a typical week at the Minnesota State Capitol Building, over 54% of the employees reported they spend 40+ hours a week in the facility, 17% spend 30-40 hours a week at the Minnesota State Capitol Building, nearly 9% spend 20-29 hours at the facility, and 20% work there less than 20 hours per week.

Relating to the time employees spend per week in their primary workspace, 47% of the employees reported they spend more than 75% of their weekly time in their primary workspace; over 38% spend 51-75% of their time in their primary workspace; nearly 12% spend 25-50% of their time in their primary workspace; and 3% spend less than 25% of their time in their primary workspace. These responses indicate the amount of time employees are exposed to IEQ conditions in their workplace environment.

The Minnesota State Capitol Building is a workplace with private offices; enclosed shared offices; cubicles with low partitions, cubicles with high partitions, and cubicles with both low and high partitions; and a desk in an open office without partitions, all serving as primary workspaces. Nearly 86% of employees indicated that their primary workspaces were located within 15 feet of an exterior window and over 14% of the employees were not within 15 feet of an exterior window.

## 4.0 Findings and Discussion

### 4.1 Minnesota State Capitol Building Facility (Site, Building, and Interior): Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning the Minnesota State Capitol Building 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 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 2 is a graph that shows the mean for each question, which is

identified with a blue mark. The standard deviation is shown by the green/red vertical bar with green representing satisfied (or enhanced) and red representing dissatisfaction (or hindered). Gray represents the 'neither/nor' range of responses. In cases where there were no dissatisfied responses, the bar may be all green or gray and green. This graph is simply a visual image of the findings from Table 1.

Table 1 Minnesota State Capitol Building facility - overall satisfaction, work performance, and health

Overall	Mean	SD	N	Interpretation
Satisfaction	6.36	0.70	39	Satisfied
Work Performance	5.92	1.14	39	Enhanced
Health	5.26	1.26	39	Enhanced

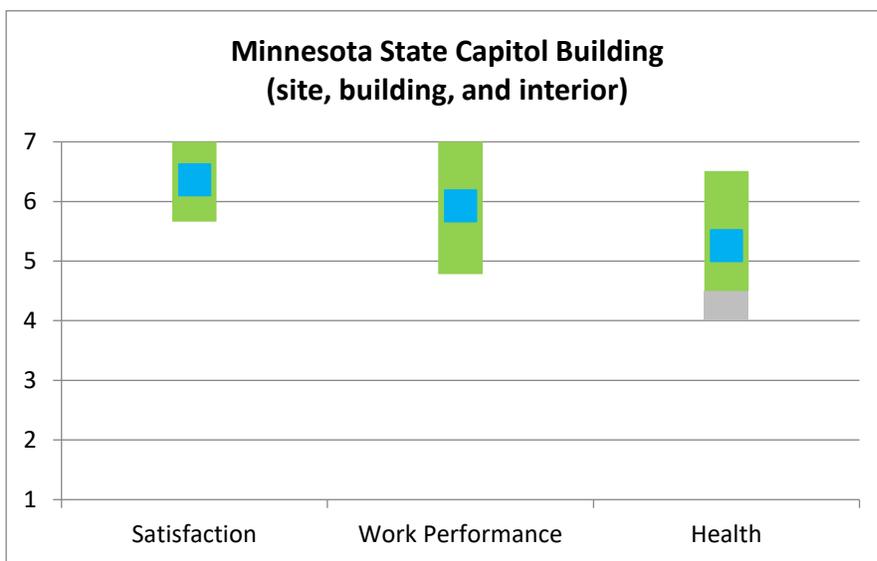


Figure 2. Minnesota State Capitol Building facility - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 6.36)** with the physical environment of the Minnesota State Capitol Building facility (building, site, and interior) and reported that their overall work performance was **enhanced (M = 5.92)** by the facility. Employees reported that their overall health was **enhanced (M = 5.26)** 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, shared office, or other primary workspace). Table 2 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 3 is a visual image of the findings from Table 2; an explanation of the graph was given for Figure 2.

Table 2. Minnesota State Capitol Building primary workspace – overall satisfaction, work performance and health

Overall	Mean	SD	N	Interpretation
Satisfaction	5.63	1.37	38	Satisfied
Work Performance	5.53	1.41	38	Enhanced
Health	4.97	1.16	38	Enhanced

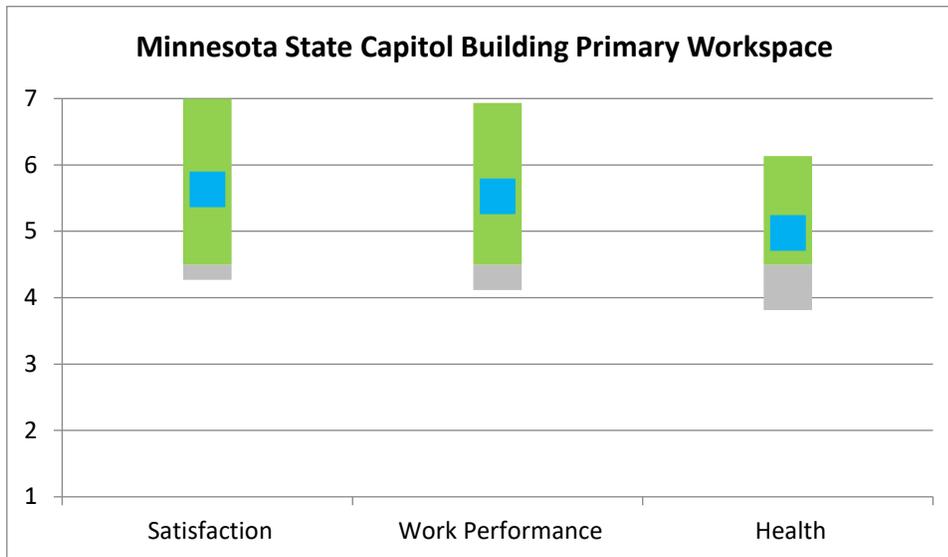


Figure 3. Minnesota State Capitol Building primary workspace - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 5.63)** with their primary workspace, their overall work performance was **enhanced (M = 5.53)** by their primary workspace, and their overall health was **enhanced (M = 4.97)** by their primary workspace.

#### 4.3 Primary Workspace: Satisfaction with Indoor Environmental 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 shows the means and standard deviations of their responses from highest to lowest mean, as well as how the responses are interpreted. Figure 4 is a visual image of the findings from Table 3; an explanation of the graph was given for Figure 2.

Table 3. Minnesota State Capitol Building primary workspace - satisfaction with IEQ criteria

#	IEQ Criteria (1-26) (Category level criteria are <b>bold face</b> )	Mean	SD	N	Interpretation (D = Dissatisfied) (S = Satisfied)
1	<b>Overall cleaning and maintenance</b>	<b>6.08</b>	<b>1.09</b>	<b>36</b>	<b>Satisfied</b>
2	<b>Overall appearance (aesthetics)</b>	<b>5.89</b>	<b>1.19</b>	<b>35</b>	<b>Satisfied</b>
3	<b>Overall furnishings</b>	<b>5.83</b>	<b>1.26</b>	<b>36</b>	<b>Satisfied</b>
4	<b>Overall technology</b>	<b>5.83</b>	<b>1.17</b>	<b>36</b>	<b>Satisfied</b>
5	Amount of electric light	5.67	1.33	36	Satisfied
6	<b>Overall indoor air quality</b>	<b>5.64</b>	<b>1.21</b>	<b>36</b>	<b>Satisfied</b>
7	Function of furnishings	5.64	1.18	36	Satisfied
8	Access to electric outlets	5.64	1.27	36	Satisfied
9	<b>Overall vibration and movement</b>	<b>5.56</b>	<b>1.28</b>	<b>36</b>	<b>Satisfied</b>
10	Humidity (dry or moist)	5.36	1.32	36	Satisfied
11	Adjustability of furnishings	5.35	1.43	34	Satisfied
12	<b>Overall electric lighting conditions</b>	<b>5.31</b>	<b>1.43</b>	<b>36</b>	<b>Satisfied</b>
13	Adjustability of task lighting	5.29	1.54	35	Satisfied
14	Adjustability of task lighting	5.23	1.44	35	Satisfied
15	Ability to hear desired sounds	5.19	1.13	36	Satisfied
16	Air velocity (drafty or stagnant)	5.08	1.36	36	Satisfied
17	<b>Overall view conditions</b>	<b>5.00</b>	<b>1.90</b>	<b>36</b>	<b>Satisfied</b>
18	Amount of daylighting	4.89	1.66	36	Satisfied
19	<b>Overall daylighting conditions</b>	<b>4.81</b>	<b>1.70</b>	<b>36</b>	<b>Satisfied</b>
20	<b>Overall acoustic quality</b>	<b>4.72</b>	<b>1.45</b>	<b>36</b>	<b>Satisfied</b>
21	<b>Overall privacy (sound and visual privacy)</b>	<b>4.61</b>	<b>1.60</b>	<b>36</b>	<b>Satisfied</b>
22	Adjustability of daylighting	4.42	1.92	36	Neither S or D
23	<b>Overall thermal conditions</b>	<b>4.33</b>	<b>1.45</b>	<b>36</b>	<b>Neither S or D</b>
24	Temperature (hot or cold)	3.89	1.58	36	Neither S or D
25	Ability to limit undesired sounds	3.86	1.65	36	Neither S or D
26	Adjustability of thermal conditions	3.75	1.61	36	Neither S or D

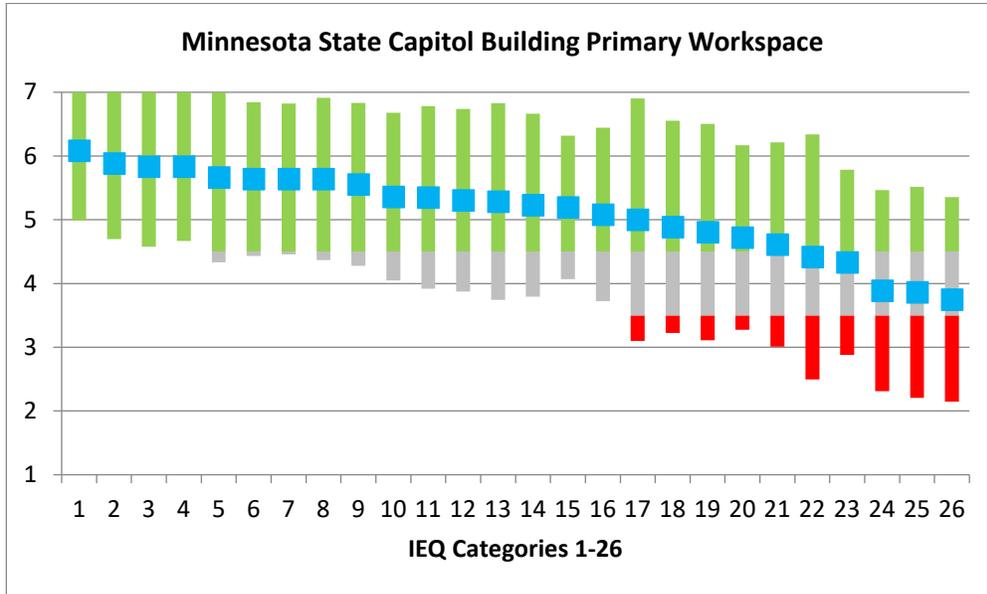


Figure 4. Minnesota State Capitol Building primary workspace - satisfaction with IEQ criteria (IEQ 1-26 refer to Table 3)

Results indicate that employees were **satisfied** with 21 of the 26 IEQ criteria in their primary workspaces, i.e., means at or above 4.50. Satisfied means ranged from **6.08** (Overall cleaning and maintenance) to **4.61** (Overall privacy, sound and visual privacy). Employees were **neither satisfied nor dissatisfied** with five (5) IEQ criteria, ranging from a mean of **4.42** (adjustability of daylighting) to **3.75** (adjustability of thermal conditions). The criteria in the 'neutral' satisfaction range should be considered for change. Potential for change will be addressed in Section 6.2 Recommendations. Further explanation of these scores also can be found in Appendix A. Open-Ended Responses.

#### 4.4 IEQ Satisfaction Scorecard

The IEQ Satisfaction Score is determined by calculating a mean of the 12 'Overall' category level IEQ criteria. At this time, criteria are weighted equally in this calculation as little evidence exists that provides rationale for weighting some criteria heavier than others. The IEQ mean is representative of a fair overall IEQ score and can serve as a benchmark of employees' satisfaction with the physical environment of their primary workspace. As shown in Figure 5, the **IEQ Satisfaction Score** for the Minnesota State Capitol Building is **5.30**, which falls in middle quadrant of the satisfied range, i.e., a moderately high IEQ Score.



Figure 5. Minnesota State Capitol Building primary workspace - IEQ Satisfaction Score

As shown in Table 3, satisfaction with Overall cleaning and maintenance, Overall appearance (aesthetics), Overall furnishings, Overall technology, Overall indoor air quality, and Overall vibration and movement were the six (6) categories with the highest satisfaction means (**5.56 or higher**), near the moderately high end of the satisfied range. In combination with the remaining five (5) satisfied scores ranging from **5.31** (Overall electric lighting conditions) to **4.61** (Overall privacy, sound and visual), they were unsuccessful in pulling the IEQ Satisfaction Score in a positive direction. Only one (1) of the 12 mean scores were in the neutral range, **4.33** (Overall thermal conditions). Please note that the IEQ Satisfaction Score only uses the category level criteria (those labeled 'Overall'; see section 2.1, paragraph 3 for explanation).

### 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 Minnesota State Capitol Building (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.

Table 4. Overall physical activity (walking, stair use, etc.) affected by the Minnesota State Capitol Building facility

Minnesota State Capitol Building (site, building, and interior)	Mean	SD	N	Interpretation
Overall physical activity (walking, stair use, etc.)	5.79	1.16	34	Enhanced

Results indicate that employees felt that Minnesota State Capitol Building **enhanced (M = 5.79)** their physical activities (walking, stair use, etc.).

## 5.2 Commuting Practices

The Minnesota State Capitol Building facility resides in the center of the Capitol Complex grounds. It is accessible via highways 94 to the south and 35E to the east and the Green Line light rail on University Avenue to the north. There are also multiple public transportation bus stops located nearby. Vehicle parking is available at surface lots, parking ramps, and on-street locations, including disability parking available throughout. In addition, bicycle racks and EV charging stations are located near the Minnesota State Capitol Building. Note that the overall percentages presented below may not total 100%, due to rounding.

Table 5 provides results on employees' primary mode of transportation; Table 6 summarizes commuting distances between home and the Minnesota State Capitol Building facility; and Table 7 summarizes employees' ability to commute using alternative choices (walk, public transit, bike, van or carpool, motorcycle/moped, etc.). 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. Commuting Practices – Minnesota State Capitol Building Primary mode of transportation

Primary Mode of Transportation (N=35)	Drive Alone (or w/children <16)	Public Transit	Walk	Other
Commuting to Minnesota State Capitol Building	86%	6%	3%	6%

Related to primary modes of transportation, nearly 86% of employees drive alone (or with children under 16), nearly 6% of employees use public transportation, and nearly 3% walk. Of the occupants, nearly 6% use modes of transportation other than those listed. No employees used a carpool or vanpool or a motorcycle or moped to get to work and none telecommute.

Table 6. Commuting Practices – Minnesota State Capitol Building Commuting distance traveled

Miles Traveled (N=35)	0-5	6-15	16-30	31-45	>45
Home-to-Minnesota State Capitol Building (One-way)	43%	23%	31%	3%	0%

Results indicate that 43% of employees commute 0-15 miles one-way between home and the Minnesota State Capitol Building, followed by 23% who commute 6-15 miles, 31% who commute 16-30 miles, and 3% who commute 31-45 miles. No one commutes more than 45 miles. These are one-way miles.

Table 7. Commuting practices – Minnesota State Capitol Building location and alternative commuting behaviors

Alternative Commuting	Mean	SD	N
Ability to commute in alternative ways	4.49	1.59	35

Results indicate that location of the Minnesota State Capitol Building **neither hindered nor enhanced (M = 4.49)** employees' ability to commute to work in alternative ways, e.g., walk, bicycle, public transit, van or carpool, etc.

## 6.0 Conclusions

### 6.1 Summary

A post-occupancy evaluation was conducted of employees of the Minnesota State Capitol Building at approximately 23 months after it was first occupied. About 42% of faculty and staff responded to the survey, reporting their satisfaction with the physical environment of the facility and their primary workspace. Results indicate that over 71% of employees spend more than 30 hours per week in the Minnesota State Capitol Building facility, and over 85% of employees spend more than 50% of their time at the Minnesota State Capitol Building in their primary work space.

The survey included questions related to employees' satisfaction with the facility (site, building, and interior) and influence of the facility on their work performance and health. Employees were **satisfied** with the facility (**M = 6.36**); they found the facility **enhanced** their work performance (**M = 5.92**) and **enhanced** their health (**M = 5.26**). In addition, similar results were reported when employees were asked these same questions about their primary workspaces (private office, shared office, workstations, etc.). They reported **satisfaction (M = 5.63)** with their primary workspaces, that their work performance was **enhanced (M = 5.53)**, and their health was **enhanced (M = 4.97)** by their primary workspace. As the range of scores was from 1-7, the scores showed a moderately high level of satisfaction with the facility and the primary workspace. (The satisfaction/enhancement range is 4.51-7.00).

Most of the survey questions related to employees' satisfaction with the IEQ criteria in their primary workspaces (private office, workstations, etc.). Employees' responses showed they were **satisfied** with 21 of the 26 IEQ criteria. The mean satisfaction scores ranged from **6.08** (Overall cleaning and maintenance) to **4.61** (Overall privacy, sound and visual). Again, this shows a positive level of **satisfaction**. Employees responded **neither dissatisfied nor satisfied** to five (5) IEQ criteria, with mean satisfaction scores ranging from **4.42** (adjustability of daylighting) to **3.75** (adjustability of thermal conditions).

From employees' responses, an IEQ Score was developed and shows respondents' moderately high level of satisfaction with the majority of all IEQ category level criteria. For the Minnesota State Capitol Building, the IEQ Satisfaction Score was **5.30**. This score reflects the influence of the moderate high satisfaction level of 11 of the 12 categories and the neither dissatisfied nor satisfied level of one (1) of the 12 IEQ categories. Finally, employees reported that the Minnesota State Capitol Building **enhanced (5.79)** their physical activity, which is one of the sustainable design criteria that influences occupant behavior.

It seems obvious that employees' satisfaction can be improved by addressing the categories that had 'neither dissatisfied nor satisfied' scores. However, it is possible that the rest of the criteria would benefit from some attention as well. The following recommendations can help address change in these criteria to further improve employees' satisfaction. Exploring these areas in more detail and making adjustments may increase overall satisfaction at the primary workspace. It must be noted that the

expense of building and operating a facility is second only to employee-related expenses over the life of the building. Therefore, maintaining or improving employees' satisfaction is a sound investment, which, in turn affects their performance and their health.

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 moderately lower 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.

## **6.2 Recommendations**

Several IEQ criteria satisfaction scores are in the positive direction, however, improvement on the 'neutral' and 'dissatisfied' criteria may be possible. For IEQ categories that can be physically measured (e.g., thermal, acoustic, and lighting), it is recommended that these measurements be taken in the primary workspaces. Specific recommendations for the most common areas of occupants' concern follow:

### **Acoustic Conditions**

- Identify acoustic criteria for overall requirements.
- Determine if any task areas differ now from their original spatial layout/use (i.e., collaborative work spaces now located adjacent to focused work areas, individual workstations).
- Develop specialized acoustical performance requirements to support functional programming employees' tasks (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). Identify and apply appropriate acoustics modeling software for the project.
- Measure acoustic performance onsite with full building systems (heating, ventilation, and air conditioning) running.
- Identify employees' privacy concerns via focus groups and/or log complaints relative to acoustical conditions for further evaluation.
- Consider employees' tasks within shared spaces to determine if spatial layout changes can be made for increased acoustic control.

### **Lighting Conditions**

- Identify employees' lighting performance criteria that are to be met to achieve goals by conducting onsite measurements of existing illumination and compare them to standards for employees' tasks as identified by the Illuminating Engineering Society (IES).
- Determine if any task areas differ now from original intent to be sure illumination level and quality of lighting are not impeded by physical changes to the space (i.e., walls, ceilings, furnishings, fixtures, or equipment).
- Develop additional quality lighting criteria as needed for special facility (e.g., influence of daylight quality or quantity) or employee (e.g., age, task duration) issues.
- Log complaints related to lighting conditions for further evaluation.
- Identify poor lighting conditions in the workspace caused by a lack of control over daylighting, which can cause glare and eyestrain.

### **Personal Adjustability**

- Determine what adjustability issues arise with temperature, lighting, or furnishings via a focus group.
- Identify personal, individual problem areas and relate them to other IEQ issues via a log of complaints relative to adjustability.
- Provide education to employees about any existing/achievable adjustment options (e.g., furnishings, air diffusers, lighting, temperature control, etc.)

### **Privacy Conditions**

- Identify employees' privacy concerns via focus groups or log complaints relative to privacy to determine if visual or audio privacy is most affected.
- Determine if any task areas or responsibilities differ from original intent and develop alternatives or modifications.
- Consider adding noise masking equipment and/or visual screening depending on the nature of the complaints.
- Document and compare acoustic privacy problem areas with acoustic measurements to pinpoint specific problem areas.

### **Thermal Conditions**

- Measure thermal performance conditions on site.
- Log complaints related to thermal conditions for further evaluation.
- Determine special thermal comfort requirements or problems that may be encountered in the building due to physicality of work activities, duration of sitting, or design/layout considerations. Focus groups can be useful in identifying problem locations.
- Determine if any employees' task areas differ now from original layout to determine if air flow is meeting systems design intent.
- Review conditions that affect thermal comfort using the applicable version of ASHRAE Standard 55, or Human Factors Design Handbook (see B3 Guidelines). For additional information, consider reviewing Human Factors and Ergonomics Design Handbook, Third Edition (2016), by Barry Tillman, published by McGraw-Hill, NY.

## **Appendix A. Open-Ended Responses**

Employees had the opportunity to raise specific concerns on the overall facility and their primary workspaces. Important information can be gleaned from the open-ended survey responses. The Minnesota State Capitol Building employees raised many general and very specific concerns and positive comments related to acoustics and privacy, electric lighting and lighting controls, operations, site, spatial layout, technology/electrical, and thermal conditions and control. Generally, the comments are shown exactly as written.

### **Overall Positive/Negative**

- Thank you!
- The building, as refurbished, is beautiful.
- The Capitol courtroom is stunning, and I love the days that I get to work over there. I am proud to work there.
- For a historic space, the overall conditions are to be expected.
- The overall accessibility of the building is an ongoing concern.

### **Acoustic Quality and Privacy**

- Even with six-foot high cubicles, every sound and conversation can be heard in the office space. For supervisors, this makes it difficult to have private conversations. The poor acoustics also makes work difficult due to the distractions.

### **Electric Lighting and Lighting Controls**

- Computerized timers for interior lights turn the lights off right at the proposed time the building closes, so visitors who need to find their way to the exits have to do so in the dark. This is very hazardous, especially for elderly visitors we have in the building.

### **Operations**

- Power-assists on the main front doors make it very difficult to open the front doors, many visitors have complained about this, especially the elderly visitors we have.
- My most significant concern is the weight of the doors in our office and the exterior doors of the Capitol as well as hearing room doors. They are heavy and due to air pressure issues often difficult to open which does not seem welcoming to the public.
- When we call about the temperature it always gets fixed within a day or so.

### **Site**

- It takes me 9 minutes to drive and it takes an hour on public transit to get here. Also, there is no incentive to take public transit a couple days a week when I already have to pay for my monthly parking. Why isn't there any incentive to not drive every single day?! And why don't buses come here?!
- My primary work space is across the street at the Minnesota Judicial Center. I like the days that I am working at the Capitol for court hearings or other court events, as it gets me out from behind my desk and gets me walking through the tunnel to the Capitol Courtroom. Round trip is about 2,000 steps = 1 mile, but it never feels like a long walk and it goes quickly.

### **Spatial Layout**

- Office is essentially a coat closet.

### **Technology/Electrical**

- There are frequent electrical outages at the Capitol (I think during off hours), this interrupts the settings on our audio and video recording equipment. It has been hard to deal with because we leave the room on one day and everything is working fine and come back the next day and everything is haywire - we usually find out later that there was a power outage during the evening.

### **Thermal Conditions and Control**

- It is freezing all year round.
- My desk is in an open room just off the front doors. In winter when people come and go the draft can be uncomfortable.
- It is always cold. I am not a person who is usually cold, but I am in this office.
- The temperature has been pretty consistent and good lately, but sometimes we have streaks where the room is incredibly cold, downright icy.
- The ability to control for temperature is incredibly varied throughout our office and very often cold.

## 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.

### **Frequency**

A descriptive statistic that provides information about how many of a particular response or measurement is 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, or a single question, 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).