



# **Indoor Environment Quality + Residence Hall Pioneer Hall Renovation, University of Minnesota Minneapolis, MN**

**December 2021, Minneapolis, MN  
Sustainable Post-Occupancy Evaluation Survey (SPOES)  
B3 Guidelines**

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

**Elizabeth Kutschke  
([kutsc009@umn.edu](mailto:kutsc009@umn.edu))  
Center for Sustainable Building Research  
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 renovation of Pioneer Hall on the University of Minnesota Twin Cities Campus and residents' satisfaction with their living environment. The Pioneer Hall facility was designed using the B3 Guidelines (formerly known as the Minnesota Sustainability Guidelines or MSBG) and completed for occupancy in 2019. 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 building 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 residents' responses at 26 months post-occupancy. Due to the emergence of the COVID-19 pandemic in spring semester 2020, Pioneer Hall's occupancy rate was not at capacity. During the 2020-2021 academic year, the occupancy was between 64% - 59% (fall and spring semesters, respectively), which impacted the initial effort to survey the occupants. Therefore, the survey was conducted in late-October through early-November 2021.

This SPOES report focuses on residents' satisfaction with the physical environment as related to 23 indoor environment quality (IEQ) criteria such as lighting, thermal, and acoustic conditions in their primary living spaces. Residents' satisfaction with the facility (site, building, and interior) and the effect of the facility's physical environment on their perceptions of their academic performance and health also are included. Finally, a brief look at residents' commuting practices and physical activities within the building are reported. The report provides descriptive information about residents' perceptions of the IEQ of their resident hall environment (overall facility and primary living space). In addition, this information serves the broader development of knowledge regarding the influence of IEQ on individuals living in residence hall environments.

## 2.0 Method

SPOES consists of a self-administered, Internet-based, questionnaire submitted to and completed by residents. The SPOES questionnaire has been tested for **validity** (measures what it is intended to measure) and **reliability** (repeatability or replicability of findings). Residents 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 living spaces. They also rate the influence of their physical environment on their perception of their academic 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 residents' perceptions.

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 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:

- 1.00 - 3.50 dissatisfied (hinders)

- 3.51 - 4.50 neither satisfied (enhances) nor dissatisfied (hinders)
- 4.51 - 7.00 satisfied (enhances)

An IEQ Score is also calculated for residents’ satisfaction with IEQ in their primary living spaces. This is a statistical combination of category-level 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

Residents 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 academic performance and health. Then they respond to questions about their satisfaction with their primary living spaces in relation to IEQ criteria from the B3 Guidelines. Residents’ physical activities and commuting practices are also investigated.

In the SPOES questionnaire, the 25 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 residents’ ability to hear desired sounds and their ability to limit undesired sounds. There are 12 category-level and 13 attribute level questions. Means are calculated and reported for all category and attribute-level criteria.

An IEQ Satisfaction Score is also calculated for residents’ satisfaction with IEQ in their primary living spaces. This is a statistical combination of the 12 category-level criteria only and results in a single, mean IEQ Satisfaction Score for all residents’ satisfaction with the physical conditions of their primary living spaces. 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

### **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 Condition**

## 2.2 Limitations

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

## 3.0 Sample Description

### 3.1 Description of Building

Pioneer Hall is a living community, with Gender Open Housing as an option, serving students at the University of Minnesota. The building is located on the East Bank campus of the University of Minnesota at 615 Fulton Street SE, Minneapolis, Minnesota, adjacent to parking and campus transit provisions. The six-story facility includes five stories above grade for housing. Accommodations for 397 student housing rooms include 338 double-occupancy rooms (approximately 200 SF; 5 rooms share a bath), 48 single-occupancy rooms (the majority are approximately 168 square feet (SF) and 5 rooms share a bath; the remainder are approximately 264 SF with private bath); 11 triple-occupancy rooms (approximately 322 SF; 5 rooms share a bath), with larger ADA accessible rooms at the ends of the building's wings; and two professional staff apartments. Pioneer Hall provides single stall gender neutral restrooms. The building was intentionally designed to serve students' academic and Living Learning Communities needs with dedicated common and building lounges and study areas, dining hall, game room, ground floor community kitchen, mediation room, music practice rooms, tech lab, and a laundry room.



Figure 1. Pioneer Hall, University of Minnesota (Photo credit: University Relations)

### 3.2 Project Team

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

Owner	Regents of the University of Minnesota
Architect	TKDA (architect-of-record) with KWK Architects
Mechanical and Electrical Engineer	TKDA
Interior Designer	Studio Hive
Landscape Architect	TKDA
Commissioning Agent	University of Minnesota
General Contractor	McGough Construction (Construction Manager at Risk)

### 3.3 Description of Respondents

Pioneer Hall was designed to house up to 757 student residents. This survey was administered to approximately 745 students, and the response rate to the questionnaire was approximately 31%. Of those responding, 54% were female, 43% were male, and 3% were other. The mean age of respondents was over 18 years, with a range of 17 to 23 years. In terms of student status, 77% are freshmen, 17% are sophomores, 4% are juniors, and the remainder are seniors.

Pioneer Hall opened for occupancy in August of 2019; however, residency was interrupted by the COVID-19 pandemic, skewing occupancy duration to some extent. As a result, 96% of respondents have lived in Pioneer Hall for only the current semester, whereas under 4% have lived there for two or more semesters, and less than 1% have lived there for one-two semesters. Relating to the percentage of time (including sleep) residents spend in their primary living space, 12% of the respondents reported they spend more than 75% of their time during the week in their primary living space; 48% spend 51-75% of their time in their primary living space; 37% spend 25-50% of their time in their primary living space, and 3% spend less than 25% of their time in their primary living space.

Pioneer Hall has three types of primary living spaces available to students, some with shared and others with private baths. Results indicate that of students who participated in the survey, nearly 7% of the residents reside in a single room, 89% reside in a double room, and over 4% reside in a triple room.

## 4.0 Findings and Discussion

### 4.1 Pioneer Hall Facility (Site, Building, and Interior): Overall Satisfaction, Academic Performance, and Health

Residents responded to questions concerning the Pioneer Hall facility, (site, building, and interior) and their overall satisfaction with the facility, overall perceptions of their academic 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 as a blue mark. The standard deviation is shown by the vertical bar that runs from 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 will be all grey and green. This graph is simply a visual image of the findings from Table 1.

Table 1. Pioneer Hall Facility - overall satisfaction, academic performance, and health

Facility (site, building, and interior)	Mean (1-7)	SD	N	Interpretation
Satisfaction	6.09	0.98	232	Satisfied
Academic Performance	5.48	1.19	232	Enhances
Health	5.16	1.28	232	Enhances

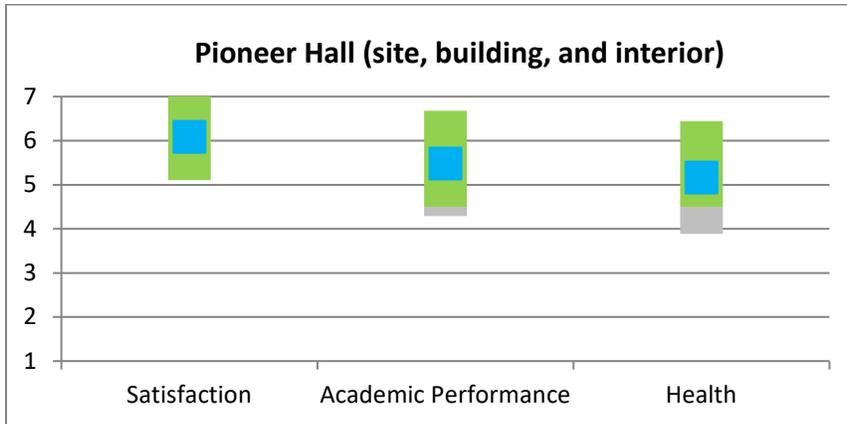


Figure 2. Pioneer Hall facility - overall satisfaction, academic performance, and health

Results indicate that respondents were **satisfied (M = 6.09)** with the Pioneer Hall facility (building, site, and interior). Further, they reported that their overall academic performance was **enhanced (M = 5.48)** and their overall health was **enhanced (M = 5.16)** by the facility.

#### 4.2 Pioneer Hall Facility Common Spaces (shared with all residents): Overall Satisfaction

Residents responded to questions concerning the Pioneer Hall facility (site, building, and interior) and their overall satisfaction with the shared common spaces located throughout the facility. 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.

Table 2. Pioneer Hall common spaces (main floor and lower level) - overall satisfaction

Pioneer Hall (site, building, and interior) Common Space				
Common Space	Mean	SD	N	Interpretation
Building Lounge	5.93	1.05	232	Satisfied
Community Lounge	5.87	1.10	232	Satisfied
Dining Hall	4.96	1.62	232	Satisfied
Game Room	5.58	1.20	229	Satisfied
Ground Floor Community Kitchen	5.54	1.28	230	Satisfied
Laundry Room	5.18	1.48	232	Satisfied
Meditation Room	5.28	1.34	220	Satisfied
Music Practice Rooms	5.42	1.39	221	Satisfied
Tech Lab	5.57	1.33	223	Satisfied

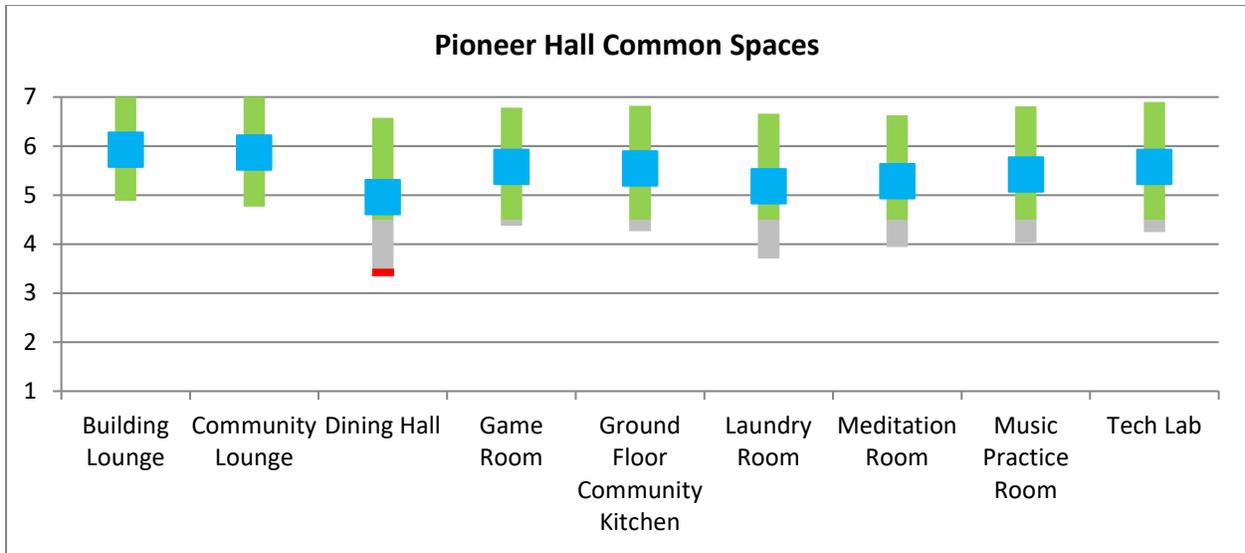


Figure 3. Pioneer Hall common space - overall satisfaction

Results indicate that residents were **satisfied** with the building lounge (**M = 5.93**), community lounge (**M = 5.87**), game room (**M = 5.58**), tech lab (**M = 5.57**), ground floor community kitchen (**M = 5.54**), music practice rooms (**M = 5.42**), meditation room (**M = 5.28**), laundry room (**M = 5.18**), and the dining hall (**M = 4.96**) at Pioneer Hall.

#### 4.3 Primary Living Space: Overall Satisfaction, Academic Performance, and Health

Residents responded to questions concerning their overall satisfaction and overall perceptions of their academic performance and health as related to their primary living space (e.g., single, double, or triple rooms with or without a bath). Table 3 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 4 is a visual image of the findings from Table 3.

Table 3. Primary living space - overall satisfaction, academic performance, and health

Overall	Mean	SD	N	Interpretation
Satisfaction	5.73	1.16	230	Satisfied
Academic Performance	5.21	1.26	230	Enhances
Health	5.13	1.28	230	Enhances

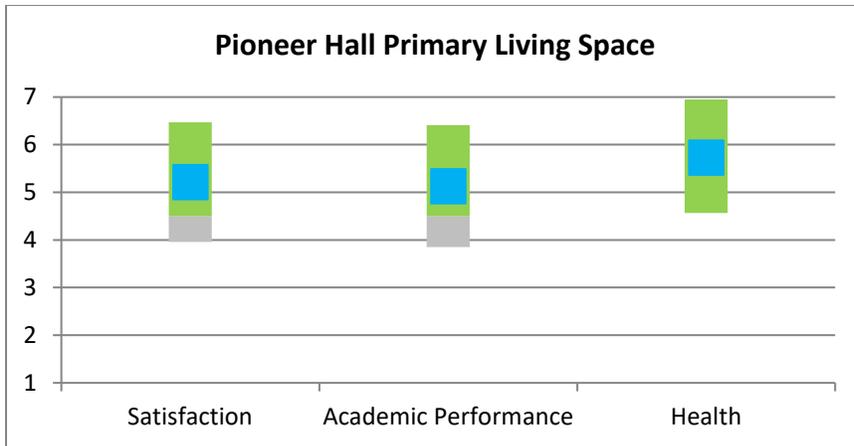


Figure 4. Primary living space - overall satisfaction, academic performance, and health

Results indicate that residents were **satisfied** ( $M = 5.73$ ) with their primary living space and reported that their overall academic performance ( $M = 5.21$ ) and overall health ( $M = 5.13$ ) were **enhanced** by their primary living space.

#### 4.4 Primary Living Space and Common (shared) Spaces: Overall Satisfaction

Pioneer Hall provides several common or shared spaces on each floor for use by the student residents. Residents responded to questions concerning the common (shared) spaces selected for this study (living room/lounge and the associated bathroom) and their primary living (sleeping) space. Table 4 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 5 is a visual image of the findings from Table 4.

Table 4. Primary living space and common (shared) spaces - overall satisfaction

Shared Common Spaces	Mean (1-7)	SD	N	Interpretation
Primary Living Space	5.73	1.28	230	Satisfied
Living Room/Lounge	5.64	1.30	230	Satisfied
Associated Bathroom Area	5.18	1.55	229	Satisfied

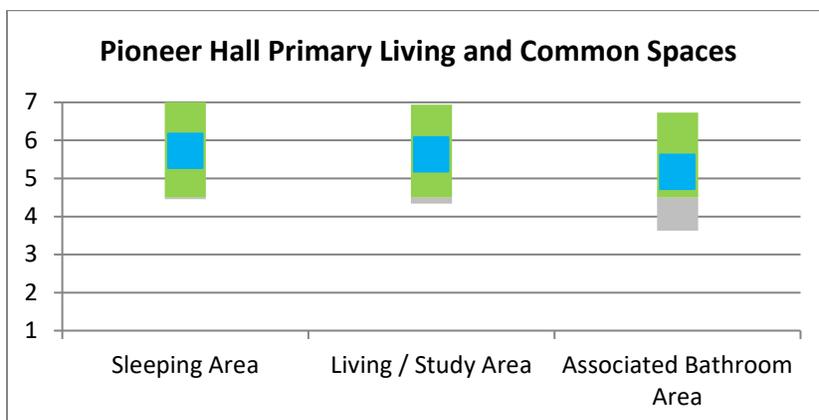


Figure 5. Primary living space and common (shared) spaces - overall satisfaction

Results indicate that respondents were **satisfied (M = 5.73)** with their primary living space, **satisfied (M = 5.64)** with the living room/lounge associated with their primary living space and **satisfied (M = 5.18)** with the bathroom area associated with their primary living space.

#### 4.5 Primary Living space: Satisfaction with Indoor Environment Quality (IEQ)

Residents responded to questions concerning their satisfaction with IEQ criteria (thermal conditions, indoor air quality, acoustic conditions, etc.) related to their primary living space (e.g., single, double, or triple occupancy spaces with or without bathrooms). Table 5 shows the means and standard deviations of their responses as well as how the responses are interpreted. Figure 6 is a visual image of the findings from Table 5.

Table 5. Primary living space - satisfaction with IEQ conditions

#	IEQ Criteria (1-25) (Category level criteria are <b>bold face</b> )	Mean	SD	N	Interpretation (D = Dissatisfied) (S = Satisfied)
1	Function of furnishings	5.75	1.18	217	Satisfied
2	Amount of electric light	5.72	1.30	218	Satisfied
3	Ability to hear desired sounds	5.65	1.16	218	Satisfied
4	<b>Overall furnishings</b>	<b>5.65</b>	<b>1.20</b>	<b>217</b>	<b>Satisfied</b>
5	<b>Overall electric lighting conditions</b>	<b>5.63</b>	<b>1.40</b>	<b>215</b>	<b>Satisfied</b>
6	<b>Overall appearance (aesthetics)</b>	<b>5.61</b>	<b>1.29</b>	<b>218</b>	<b>Satisfied</b>
7	<b>Overall technology conditions</b>	<b>5.61</b>	<b>1.36</b>	<b>217</b>	<b>Satisfied</b>
8	<b>Overall daylighting</b>	<b>5.54</b>	<b>1.47</b>	<b>218</b>	<b>Satisfied</b>
9	<b>Overall vibration and movement</b>	<b>5.43</b>	<b>1.41</b>	<b>214</b>	<b>Satisfied</b>
10	<b>Overall indoor air quality</b>	<b>5.43</b>	<b>1.46</b>	<b>218</b>	<b>Satisfied</b>
11	Air velocity (drafty or stagnant)	5.42	1.37	214	Satisfied
12	Amount of daylighting	5.40	1.55	218	Satisfied
13	<b>Overall cleaning and maintenance</b>	<b>5.33</b>	<b>1.46</b>	<b>218</b>	<b>Satisfied</b>
14	Adjustability of daylighting	5.31	1.55	217	Satisfied
15	Adjustability of task lighting	5.31	1.40	216	Satisfied
16	Humidity (dry or moist)	5.27	1.69	216	Satisfied
17	Temperature (hot or cold)	5.23	1.53	217	Satisfied
18	<b>Overall view conditions</b>	<b>5.17</b>	<b>1.66</b>	<b>218</b>	<b>Satisfied</b>
19	<b>Overall privacy (sound and visual privacy) conditions</b>	<b>5.15</b>	<b>1.56</b>	<b>218</b>	<b>Satisfied</b>
20	<b>Overall thermal conditions</b>	<b>5.14</b>	<b>1.59</b>	<b>218</b>	<b>Satisfied</b>
21	Access to electric outlets	5.02	1.66	218	Satisfied
22	Ability to adjust electric lighting	4.94	1.61	216	Satisfied
23	<b>Overall acoustic quality</b>	<b>4.68</b>	<b>1.67</b>	<b>217</b>	<b>Satisfied</b>
24	Adjustability of thermal conditions	4.67	1.89	217	Satisfied
25	Ability to limit undesired sounds	4.13	1.78	217	Neither S/D

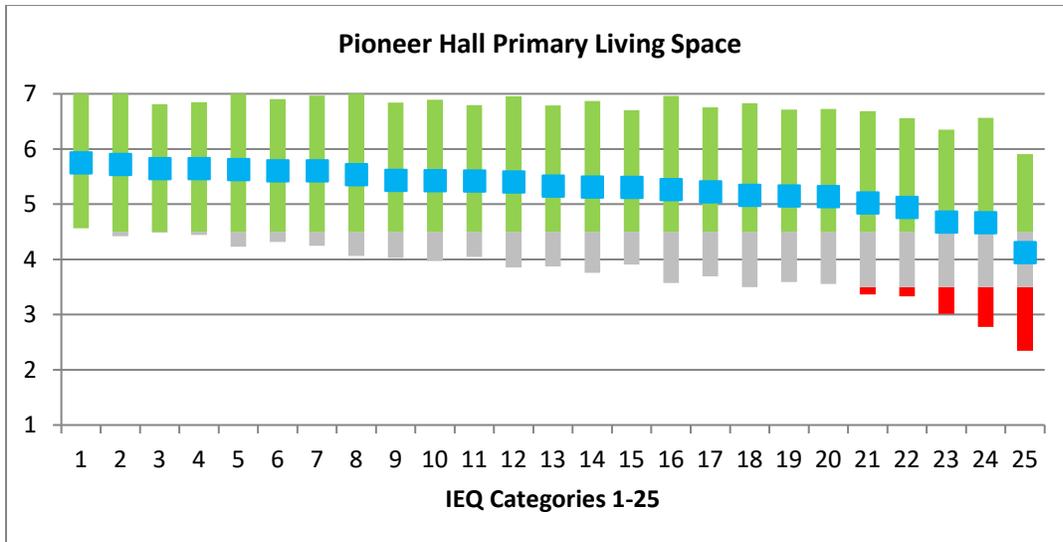


Figure 6. Primary living space - satisfaction with IEQ conditions (IEQ 1-25 are listed in Table 5 above)

Results indicate that residents were satisfied with 24 of the IEQ criteria in their primary living spaces (i.e., means at or above 4.50). They were neither satisfied nor dissatisfied with one IEQ criterion, their ability to limit undesired sounds (M = 4.13) (i.e., means between 3.51 - 4.50). The mean satisfaction scores are at the moderate to high levels, however, there is still room for improvement of residents' satisfaction with their primary living spaces and 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 all overall category level IEQ criteria. At this time, all variables are weighted equally in this calculation as little evidence exists that provides rationale for weighting some variables heavier than others. The IEQ mean is representative of a fair overall IEQ score and can serve as a benchmark of residents' satisfaction with the physical environment of their primary living space. As shown in Figure 7, the **IEQ Satisfaction Score** for primary living spaces at Pioneer Hall is **5.36**.



Figure 7. Primary living space - IEQ Satisfaction Score

Overall, the residents showed a moderately high level of satisfaction with IEQ as indicated by the mean score of **5.36**. As shown in Table 5, satisfaction with overall furnishings (M = 5.65), overall electric lighting conditions (M = 5.63), overall appearance (aesthetics) (M = 5.61), overall technology conditions (M = 5.61), and overall daylighting (M = 5.54) were the criteria with the highest satisfaction (all over 5.5) and pulled the IEQ Satisfaction Score in a positive direction. The lowest rated criterion, overall acoustic quality (M = 4.68) although still positive, pulled the IEQ Score down just a bit. Any of the IEQ criteria can be addressed by building management to increase residents' satisfaction. Recommendations to assist with this process are noted in Section 6.2 Recommendations. 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, residents responded to questions regarding their overall physical activity while at the Pioneer Hall facility (site, building, and interior) and their commuting practices.

### 5.1 Physical Activity Engagement

Providing residents with opportunities for alternative paths of travel around the residence hall facility, 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 residence hall can be associated with healthier lifestyles.

Table 6. Overall physical activity (walking, stair use, etc.) affected by Pioneer Hall

Pioneer Hall	Mean (1-7)	SD	N
Overall physical activity (walking, stair use, etc.)	5.44	1.11	219

Results indicate that residents felt that the Pioneer Hall facility moderately **enhanced (M = 5.44)** their physical activities (walking, stair use, etc.).

### 5.2 Commuting Practices

Pioneer Hall is located within the Super Block neighborhood of the East Bank of the University of Minnesota. Transportation options include the Metro Transit light rail and bus to free campus shuttles and the Gopher Way, an extensive tunnel and skyway system that connects many of the buildings on campus is also available, especially in poor weather. Also, Metropolitan Council Metro Mobility and University of Minnesota Paratransit are available. The University also provides several parking facilities, bike paths, and sidewalks throughout the campus and adjacent to Pioneer Hall.

Table 7 provides results on residents' primary mode of transportation. These results, although not related to IEQ, do offer the University insight into residents' commuting behaviors and opinions. These data can provide important information about commuting practices that can reduce transportation energy consumption.

Table 7. Commuting Practices – Primary mode of transportation

Pioneer Hall Facility	Walk	Bicycle	Public Transit	Other
Primary mode of transportation on campus	90%	6%	3%	2%

Related to primary modes of transportation, 90% of the student residents walk, 6% ride a bicycle, 3% use public transit (bus or light rail), and 2% use other means to commute.

## 6.0 Conclusions

### 6.1 Summary

A post-occupancy evaluation was conducted of residents of Pioneer Hall 26 months after it was first occupied in August 2019 due to the reduction in housing capacity caused by the COVID-19 pandemic beginning spring 2020 and continuing until fall 2021. About 31% of the residents responded to the survey.

The survey included questions related to residents’ overall satisfaction with the facility (site, building, and interior) and influence of the facility on their overall academic performance and health. Residents were **satisfied** with the facility (**M = 6.09**); they found the facility **enhances** their overall academic performance (**M = 5.48**) and **enhances** their overall health (**M = 5.16**). In addition, similar but somewhat lower results were reported when residents were asked these same questions about their primary living spaces. They reported overall **satisfaction** (**M = 5.73**) with their primary living spaces and that their overall academic performance was **enhanced** (**M = 5.21**) by their primary living spaces. Additionally, their overall health was **enhanced** (**M = 5.13**) by their primary living space. As the range of scores was from 1-7, scores that showed satisfaction are in the moderately high positive satisfaction.

Most of the survey questions related to residents’ satisfaction with the IEQ criteria in their primary living spaces). Residents’ responses showed they were **satisfied** with all except one of the IEQ criteria. The mean satisfaction scores ranged from **4.67** (adjustability of thermal conditions) to **5.75** (function of furnishings). Again, this shows moderate to moderately positive levels of **satisfaction**. Residents responded **neither satisfied nor dissatisfied** to only one criterion, ability to limit undesired sounds (**M = 4.13**).

From the residents’ responses, an IEQ Score was developed and shows respondents’ satisfaction with the IEQ of all category level criteria. For Pioneer Hall, the IEQ Satisfaction Score was **5.36**. This score reflects a moderately high satisfaction level. Finally, residents reported that Pioneer Hall **enhances** their physical activity, which is one of the sustainable design criteria that influences occupant behavior.

### 6.2 Recommendations

The satisfaction scores are certainly in the positive direction; however, improvement may be possible. For example, two of the three criteria with the lowest mean satisfaction scores relate to acoustics and acoustic privacy and the second lowest relates to thermal conditions. 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 living spaces. 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 (study rooms adjacent to noisy spaces).
- Develop specialized acoustical performance requirements to support functional programming residents' 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, air conditioning; HVAC) running.
- Identify residents' privacy concerns via focus groups and/or log complaints relative to acoustical conditions for further evaluation.
- Consider residents' tasks within shared spaces to determine if spatial layout changes can be made for increased acoustic control.

### **Lighting Conditions**

- Identify residents' lighting performance criteria that are to be met to achieve goals by conducting onsite measurements of existing illumination and compare them to standards for residents' tasks as identified by the Illuminating Engineering Society (IES).
- Determine if any task areas differ now from original intent to be sure illumination quantity and quality 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 if 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 log of complaints relative to adjustability.
- Provide education to residents about any existing/achievable adjustment options, e.g., furnishings, air diffusers, lighting, temperature control, etc.

### **Privacy Conditions**

- Identify residents' 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 residents' task areas differ now from original layout to determine if air flow is meeting systems design intent.
- Review conditions that affect thermal comfort using ASHRAE Standard 55-2004 or *Human Factors Design Handbook* (see B3 Guidelines).

It seems obvious that residents' satisfaction can be improved by addressing the criterion that had a 'neither dissatisfied nor satisfied' score. The above recommendations can help address change in this one criterion reported by respondents. However, addressing some of the other criteria before they become an issue is recommended and can further improve residents' satisfaction. Exploring these areas in more detail and making adjustments may increase overall satisfaction at the primary living space. It is a good investment to improve residents' satisfaction, which, in turn affects their academic performance and their health.

This study investigated residents' satisfaction with the facility and primary living spaces of Pioneer Hall. IEQ satisfaction is individual, but the results of the survey show a central tendency of moderately high satisfaction with the facility and most of the IEQ criteria at the living space level. The results can be used as a diagnostic tool to aid in improving IEQ conditions for residents and to set the benchmarks from which improvement can be measured in the future.

## Appendix A. Open-Ended Responses

Residents had the opportunity to raise specific concerns on the overall facility and their primary living spaces. Important information can be gleaned from the open-ended responses. Students in Pioneer Hall raised a wide variety of concerns, in addition to positive comments, related to acoustics and privacy, furnishings, indoor air quality (IAQ)/ventilation, operations and cleaning/maintenance, safety and security, spatial layout, study rooms, technology/electrical, and thermal conditions and control. Generally, the comments are shown exactly as written.

### Open Ended Comments

#### Overall Positive/Negative

- I LOVE living in Pioneer.
- Great residence hall.
- Great building
- Great dorm.
- I love Pioneer Hall and my room. Everything is so modern, clean, and accessible. The dining hall is also conveniently downstairs. I lived here for the past 2 years and hope to stay for the rest of my time here at UMTC. Thanks for the amazing living experience!
- I like pretty much everything about the living space here! People are nice and the building is beautiful since the renovation. I really like living here.
- I absolutely love the new renovations done to Pioneer. I couldn't be more grateful! I feel like everything I need and every resource is right at my fingertips and very close by, whether that be in the building itself or the surrounding area.
- I think I am feeling very satisfied with pretty much everything, no complaints here.
- I really appreciate the overall atmosphere of the building in my room.
- The halls are very huge (very nice) the bathrooms are very private and nice, well kept. The bedrooms are very big with nice lighting. Overall amazing dorm!
- Overall, I really love living in Pioneer. I think it is a wonderful building that is accommodating for many. Pioneer is also one of the cleanest and most visually appealing residence halls here at the U of M. I don't think I would live in any other building on campus other than Pioneer.
- Being next to the hospital you can hear the helicopters roar as it passes by the dorm. You can also hear random noises from the hospital.
- I would like it if the pianos in the music room were tuned. They are pretty off.
- Music room, having two music rooms are nice but having them right next to each other defeats the purpose since the sound goes through.
- It's much easier to be in other places rather than the dorm for anything like hanging out, studying, or anything other than just sleeping or resting.
- The view sucks.
- Sucks that the windows can't actually open.

#### Acoustics and Privacy

- As far as noises go, the main thing I notice are how loud the doors close, especially the bathroom doors.
- The walls are very thin which makes it difficult to sleep when neighbors are listening to music or people are talking or yelling loudly in the hallways late at night which they do most weekend nights.

- For some reason the vent in my room allows me to hear directly into a room 2 doors over. So, noises are very loud sometimes.
- 3rd floor is insanely loud at night.
- Sometimes it is very hard for me to be able to sleep because students play music that basically vibrates the walls. I can't tell where the source is coming from sometimes, but the music will play well past midnight.
- Everything is pretty good, but these doors are very loud. I will hear multiple doors slam shut within the span of a few minutes as I'm trying to fall asleep.
- I wish the walls were thicker because you can hear your neighbors if they talk at a normal level.
- I can hear my neighbors' entire conversations and the third floor is extremely loud late into the night. My neighbors blast music at 1 in the morning and are screaming in the hallways at 12, waking me up from my sleep.
- Can hear the toilets flush from my room but it's not a big deal.

### **Furniture/Furnishings**

- The chairs in the dorms are very a very awkward height for me.
- I don't appreciate that my desk is significantly smaller than other desks I've had in Pioneer (apparently, it's just the 5th floor desks that are smaller?).
- The blinds in the rooms are not very functional. Very cheap, break easily, barely keep out light.

### **Indoor Air Quality/Ventilation**

- Smells seem to be very easily carried from other rooms, perhaps through the vent system.
- This is very bothersome, and a large complaint to me.

### **Operations and Cleaning/Maintenance**

- The main issues are less about the physical building/spaces and more about the level of cleaning and care.
- The bathrooms are never clean.
- The bathrooms need to be checked for soap.
- The sinks, and the lounges in general, smell extremely bad because there is food inside of the sink pipes.
- Maybe add a drain to the women's shower areas on East wing floor 4? There are always puddles because there isn't anywhere for the water to go.
- The individual unisex bathrooms usually have excessive water pooling after someone takes a shower and the sinks are not cleaned as well as they probably should be. They're usually not very clean.
- The only thing that is a little unsatisfactory is the cleanliness of the bathrooms. Students are a huge cause of this but even when the bathroom is clean it never looks clean.
- Conditions of the bathrooms are not great. The women's bathroom by my primary living area kept running out of toilet paper for a week.
- The bathrooms are very dirty. I don't know if anything can be done about that but sometimes, they are almost unusable. People make the bathrooms nasty and don't clean up after themselves.
- It doesn't seem like the bathrooms are cleaned on a specific schedule (it seems like it is cleaned irregularly).
- There was a strange odor by the door to the stairs on the third floor for a few days, which wasn't pleasant.

- The laundry machines are absolutely revolting!!! The amount of mold and other things in the machines is extremely concerning. There needs to be something done to make them cleaner! I don't ever want to wash my cloths in them again, however, it is my only option. I bring my bedsheets home to wash them there because these machines are so moldy.
- The stairwells could be better maintained/cleaned. I've seen used condoms sitting on the stairwell for weeks, moldy bananas smushed on the floor, and oranges thrown against the walls.
- There is food residue in the sinks and on the ground quite frequently.
- I wish that the floor lounges were cleaned more often because I go there to wash dishes and there is food and water everywhere.
- The third floor of Pioneer in the west wing currently smells like vomit and it is not pleasant.
- For some reason, when we run out of toilet paper on the weekends, we are never replenished. I have gone three days without toilet paper and it was disgusting.
- The water pressure in the bathroom is never constant. In one of the bathrooms, it is WAY TO HIGH. It is bad to the point where it is unusable

### **Safety/Security**

- In terms of my physical space itself (the room), I don't like that it doesn't have a true deadbolt which makes me feel less 'safe'. Additionally, I don't like that the door closes so slowly. If the U card scanner worked, it wouldn't be as big of a deal.
- Our door lock has been finicky.
- Why is there a camera pointed directly at my window? Haven't opened the shades since welcome week because of it.

### **Space Planning**

- My room is small compared to others.
- The layout of my room on the fifth floor is almost unlivable for two people, with the slanted roofs above our heads.
- We have a random pillar literally in the middle of our room which isn't that big of a deal it's just a bit weird.
- I still don't know why the laundry room is such a weird shape. It has a very narrow chokepoint to reach the 3 washers at the end.

### **Technology/Electrical**

- The outlets in the study/lounge spaces don't actually hold charging blocks and you can't charge a Mac/iPhone without setting up a chair or something to keep it held to the wall. Can be frustrating/inefficient when trying to do homework on a laptop that requires charging.
- There should be more electrical outlets in the room.
- All of our outlets are upside down. There's probably a reason for this and it's not a big deal, but it is definitely an ever-present annoyance.
- One of our ethernet outlets does not work.
- WiFi's really good.
- The [WiFi] reception in my room is never good.

### **Thermal Conditions and Control**

- Temperature regulation does not work very effectively.
- The only issues I have with the hall are that it is extremely dry and my roommate and I had to get a humidifier for our room. It has auto settings and can detect the room humidity levels and it is running so often we have to continuously refill it.
- Allow the thermostats to have more adjustability and to open the windows to open more.
- I wish that I could set the temperature to lower than 68 degrees, and that it actually held the temperature that I have it set at.
- It's pretty dry in our room.
- The air is really dry in the rooms, which started to affect my health to the point I had to take countermeasures.
- Vents are impossible to turn off, the air temperature rarely matches the temperature set on the thermostat. I believe that because of the position of the vents and little space in the room to move my bed, I got sick several times. Because vents rarely turn off, the air in the room is extremely dry and also contributed to several instances of cold that I had.
- Only real downside that has an effect on me is that it is always hot in the room.
- Temperature of the corridor is very cold.

### **Kitchen**

- I love the kitchen!
- The only complaint I have about Pioneer Hall is the shared lounge kitchen sinks. All of the students use those for doing dishes and there aren't any garbage disposals. Even the sink on the main floor kitchen doesn't have a garbage disposal.

### **Study Rooms**

- Study rooms that are on my floor have good sound proofing, good layout, and the lack of visual noise in them (both on my floor only have a chair table and whiteboard) makes it very easy to focus. Also, very helpful to have a white board.
- Studying wise, the study rooms are convenient for winter, but you might as well go to the library to not be disturbed by other students.

## 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 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, 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).