
# Indoor Environmental Quality + Workplace Environment
# UMTC Recreation and Wellness Center Expansion (UMTC-RWC)

**April 2016, Minneapolis, MN**
**Sustainable Post-Occupancy Evaluation Survey (SPOES)**
**B3 Guidelines**

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## 1.0 Overview

The purpose of this report is to examine the connection between sustainable design criteria used in the design of the University of Minnesota Twin Cities (UMTC) Recreation and Wellness Center Expansion (UMTC-RWC) facility and occupants' satisfaction with their work environments located in the facility. The UMTC-RWC facility was designed using the B3 Guidelines (formerly known as the Minnesota Sustainable Building Guidelines or MSBG) and completed for occupancy in July 2013. 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 February 2016.

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 (hinders) to 7 (enhances).

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

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 UMTC-RWC facility is located at 23 Harvard St. SE, Minneapolis, MN. The building (see Figure 1) is a six-story 163,820 square foot building that includes 14,193 square feet of private offices, shared enclosed offices, workstations, and open desk areas for employees. Only the overall facility and primary workspaces were included in this study. The building delivers the finest in university recreation and wellness opportunities and services to enrich the campus experience and encourage healthy lifestyles.

Figure 1. UMTC-RWC (Photo courtesy University of Minnesota)

## 3.2 Description of Respondents

This survey was administered to 178 full-time staff and part-time student employees with workspace in the facility during February 2016. The response rate to the questionnaire was approximately 46%. Of those responding, 45% were male and 55% were female. The mean age of respondents was 26 years, with a range from 18-68 years of age.

The UMTC-RWC was completed and ready for operation in July 2013. Since that time, 41% of respondents reported that they worked at the UMTC-RWC facility for over 2 years, 23% have worked at the facility for 1-2 years, and 36% of respondents have spent less than one year at this site. Relating to hours worked during a typical week at UMTC-RWC, 17% of employees reported they spend 40+ hours a

week in the facility; 20% spend 30-40 hours a week at UMTC-RWC; 15% spend 20-29 hours at UMTC-RWC, and 48% spend less than 20 hours a week there.

Relating to the time employees spend per week in their primary workspace, 26% of the employees reported they spend more than 75% of their weekly time in their primary workspace; 33% spend 51-75% of their time in their primary workspace; 15% spend 25-50% of their time in their primary workspace; and 26% 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.

UMTC-RWC is a workplace with private enclosed offices, shared enclosed offices, workstations (cubicles) with both low and high partitions, and desks in open office areas serving as primary workspaces. Employees indicated that 48% of their primary workspaces were located within 15 feet of an exterior window and 50% of the employees were not within 15 feet of an exterior window; 2% did not know the distance.

# 4.0 Findings and Discussion

## 4.1 UMTC-RWC Facility (Site, Building, and Interior): Overall Satisfaction, Work Performance, and Health

Employees responded to questions concerning the UMTC-RWC 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. UMTC-RWC - overall satisfaction, work performance, and health

| Overall | Mean | SD | N | Interpretation |
|---|---|---|---|---|
| Satisfaction | 6.16 | 0.90 | 77 | Satisfied |
| Work Performance | 5.77 | 0.98 | 77 | Enhanced |
| Health | 5.94 | 1.09 | 77 | Enhanced |

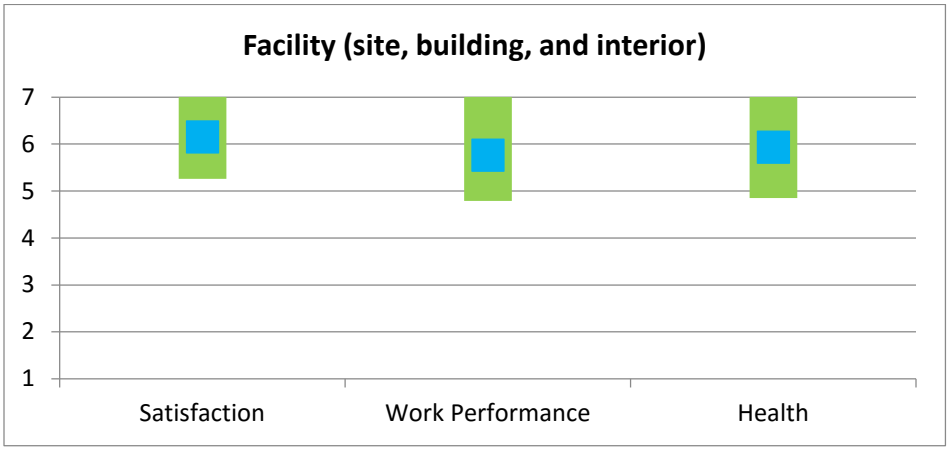

Figure 2. UMTC-RWC facility - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied** (**M = 6.16**) with the UMTC-RWC physical environment of the facility (building, site, and interior) and reported that their overall work performance was **enhanced** (**M = 5.77**) by the facility. Employees reported that their overall health was **enhanced** (**M = 5.94**) 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 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. UMTC-RWC primary workspace – overall satisfaction, work performance and health

| Overall | Mean | SD | N | Interpretation |
|---|---|---|---|---|
| Satisfaction | 5.74 | 1.12 | 72 | Satisfied |
| Work Performance | 5.41 | 1.29 | 73 | Enhanced |
| Health | 5.26 | 1.16 | 73 | Enhanced |

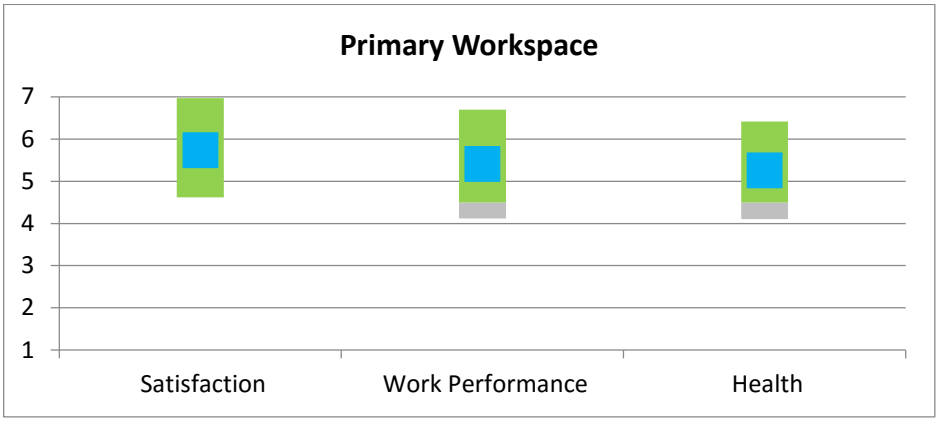

Figure 3. UMTC-RWC primary workspace - overall satisfaction, work performance, and health

Results indicate that employees were **satisfied (M = 5.74**) with their primary workspace, their overall work performance was **enhanced (M = 5.41)** by their primary workspace, and their overall health was **enhanced (M = 5.26)** 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. UMTC-RWC primary workspace - satisfaction with IEQ criteria

| # | **IEQ Criteria (1-26)** (Category level criteria are bold face) | **Mean** | **SD** | **N** | **Interpretation** (S = Satisfied) (D = Dissatisfied) |
|---|---|---|---|---|---|
| **1** | Amount of electric light | 5.97 | 1.11 | 68 | Satisfied |
| **2** | **Overall electric lighting conditions** | **5.96** | **1.14** | **68** | **Satisfied** |
| **3** | **Overall vibration and movement** | **5.86** | **1.18** | **69** | **Satisfied** |
| **4** | **Overall cleaning and maintenance** | **5.84** | **1.15** | **69** | **Satisfied** |
| 5 | Humidity (dry or moist) | 5.78 | 1.11 | 69 | Satisfied |
| **6** | Ability to hear desired sounds | 5.78 | 1.06 | 69 | Satisfied |
| **7** | **Overall technology** | **5.74** | **1.20** | **69** | **Satisfied** |
| **8** | **Overall appearance (aesthetics)** | **5.68** | **1.42** | **69** | **Satisfied** |
| **9** | **Overall indoor air quality** | **5.66** | **1.27** | **68** | **Satisfied** |
| **10** | Function of furnishings | 5.59 | 1.39 | 69 | Satisfied |
| 11 | Adjustability of task lighting | 5.51 | 1.33 | 69 | Satisfied |
| 12 | Amount of daylighting | 5.49 | 1.76 | 69 | Satisfied |
| **13** | **Overall daylighting conditions** | **5.48** | **1.61** | **69** | **Satisfied** |
| **14** | **Overall acoustic quality** | **5.45** | **1.38** | **69** | **Satisfied** |
| **15** | **Overall view conditions** | **5.45** | **1.75** | **69** | **Satisfied** |
| 16 | Access to electric outlets | 5.43 | 1.45 | 69 | Satisfied |
| **17** | **Overall furnishings** | **5.42** | **1.55** | **69** | **Satisfied** |
| **18** | Air velocity (drafty or stagnant) | 5.33 | 1.40 | 69 | Satisfied |
| **19** | Adjustability of task lighting | 5.28 | 1.61 | 69 | Satisfied |
| 20 | Adjustability of daylighting | 5.25 | 1.79 | 69 | Satisfied |
| 21 | Adjustability of furnishings | 5.23 | 1.63 | 69 | Satisfied |
| **22** | **Overall privacy (sound and visual privacy)** | **4.96** | **1.71** | **69** | **Satisfied** |
| **23** | **Overall thermal conditions** | **4.91** | **1.52** | **69** | **Satisfied** |
| 24 | Ability to limit undesired sounds | 4.84 | 1.68 | 69 | Satisfied |
| **25** | Temperature (hot or cold) | 4.72 | 1.62 | 69 | Satisfied |
| **26** | Adjustability of thermal conditions | 4.01 | 1.61 | 69 | Neither S or D |

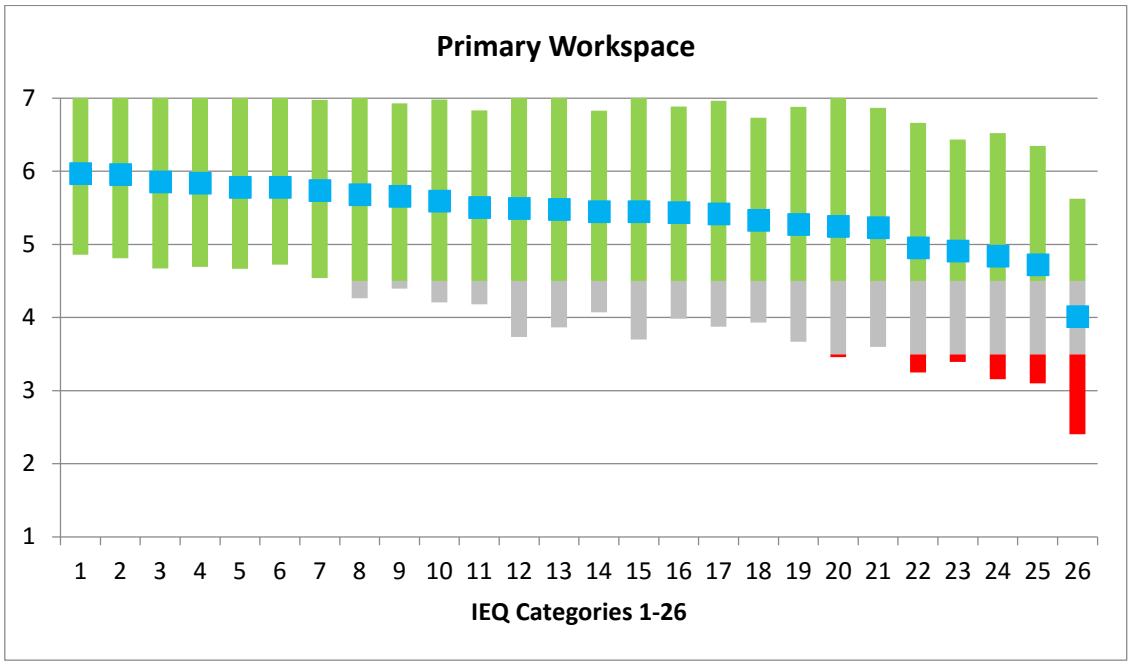

Figure 4. UMTC-RWC primary workspace - satisfaction with IEQ criteria (IEQ 1-26 refer to Table 3)

Results indicate that employees were **satisfied** with 25 of the IEQ criteria in their primary workspaces, i.e., means at or above 4.50. Employees were **neither satisfied nor dissatisfied** with only one of the IEQ criteria, adjustability of thermal conditions (4.01). That one criteria in the 'neutral' satisfaction range can be reviewed and 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 UMTC-RWC is **5.53**, which falls at the moderately high end of the satisfied range. The large number of criteria with scores near the high end of the satisfied range contribute to this high IEQ Score**.**

Figure 5. UMTC-RWC primary workspace - IEQ Satisfaction Score

As shown in Table 3, all 12 of the overall scores ranked in the moderately to moderately high satisfaction range. Satisfaction with Overall electric lighting conditions (5.96), Overall vibration and movement (5.86), and Overall cleaning and maintenance (5.84) were the criteria with the highest satisfaction means and pulled the IEQ Satisfaction Score in a positive direction. In addition, another seven of the remaining overall criteria scores were moderately high (5.74-5.42). The remaining two overall scores, Overall privacy (4.96) and Overall thermal conditions (4.91) ranked a bit lower, though still in the satisfied range. 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 UMTC-RWC (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 UMTC-RWC facility

| UMTC-RWC facility (site, building, and interior) | Mean | SD | N | Interpretation |
|---|---|---|---|---|
| Overall physical activity (walking, stair use, etc.) | 6.30 | 0.76 | 66 | Enhanced |

Results indicate that employees felt that UMTC-RWC **enhanced** (**M = 6.30**) their physical activities (walking, stair use, etc.) to a high degree.

## 5.2 Commuting Practices

UMTC-RWC is located on the Minneapolis East Bank campus of the University of Minnesota (UMN) in the Twin Cities, southwest of University Avenue and adjacent to the UMN Aquatic Center. The facility can be reached via bus, light rail, bike-friendly roads (with bike-racks available), or by walking. Parking is available in various surface lots and parking ramps.

Table 5 provides results on employees' primary mode of transportation; Table 6 summarizes commuting distances between home and the UMTC-RWC facility; and Table 7 summarizes employees' ability to commute using alternative choices (walk, public transit, bike, van, or carpool, 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 – UMTC-RWC Primary mode of transportation

| **Primary mode of transportation** (N=66) | **Drive Alone (or w/children <16)** | **Van or Carpool** | **Public** | **Bicycle** | **Walk** |
|---|---|---|---|---|---|
| Commuting to UMTC-RWC | 23% | 5% | 14% | 5% | 55% |

Related to primary modes of transportation, 55% of employees walk and 23% drive alone (or with children under 16), followed by 14% who use public transportation, and 5% each who use van or carpool or bike to work. (Note that percentages have been rounded to the nearest percentage point, so the total does not add up to 100%.)

Table 6. Commuting Practices – UMTC-RWC Commuting distance traveled

| **Miles Traveled** (N=66) | **0-5 miles** | **6-15 miles** | **16-30 miles** | **31-45 miles** |
|---|---|---|---|---|
| Home-to-UMTC-RWC (One-way) | 71% | 18% | 6% | 5% |

Results indicate that 71% of employees commute 0-5 miles one-way between home and the UMTC-RWC, followed by 18% who commute 6-15 miles, 6% commute between 16-30 miles, and 5% commute 31-45 miles to the UMTC-RWC. All of these are one-way miles.

Table 7. Commuting practices – UMTC-RWC location and alternative commuting behaviors

| **Alternative Commuting** | **Mean** | **SD** | **N** |
|---|---|---|---|
| Ability to commute in alternative ways | 5.59 | 1.32 | 66 |

Results indicate that location of the UMTC-RWC **enhances** (M = 5.59) 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 UMTC-RWC at approximately 31 months after it was first occupied. This UMTC-RWC is used as a recreation and wellness center that offers a myriad of recreation, fitness, and wellness programs and opportunities. This survey reports responses

from employees and their satisfaction with the physical environment of the facility and their primary workspace. Results indicate that 63% of employees spend less than 30 hours per week in the UMTC-RWC facility, likely reflecting the high number of student employees who work part-time. The remaining employees (37%) spend 30 – 40+ hours per week in the UMTC-RWC facility. Hours spent in employees' primary workspace ranged fairly equally between less than 25% of their time (26%) to more than 75% of their time (26%), with 33% of employees spending 51-75% of their time at UMTC-RWC 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 = 6.16)**; they found the facility **enhanced** their work performance (**M = 5.77)** and **enhanced** their health (**M = 5.94**). In addition, similar results were reported when employees were asked these same questions about their primary workspaces (private office, shared office, cubicles, or desk in an open office). They reported **satisfaction** (**M = 5.74**) with their primary workspaces, that their work performance was **enhanced** (**M = 5.41**), and their health was **enhanced** (**M = 5.26**) by their primary workspace. As the range of scores was from 1-7, scores showed a moderately high level of satisfaction and enhancement.

Most of the survey questions related to employees' satisfaction with the IEQ criteria in their primary workspaces (private office, shared office, cubicles, or desk in an open office). Employees' responses showed they were **satisfied** with 25 of 26 IEQ criteria. The mean satisfaction scores ranged from **4.72** (temperature, hot or cold) to **5.97** (amount of electric light). Again, this shows a moderately high level of **satisfaction**. Employees responded **neither dissatisfied nor satisfied** to only one IEQ criteria, adjustability of thermal conditions (4.01).

From employees' responses, an IEQ Score was developed and shows respondents' satisfaction with the IEQ of all category level criteria. For UMTC-RWC, the IEQ Satisfaction Score was **5.53**. This score reflects a moderately high satisfaction level with all categories. Finally, employees reported that UMTC-RWC **enhances (6.30)** their physical activity to a high level, which is one of the sustainable design criteria that influences occupant behavior.

Even though satisfaction and enhancement scores were reported for all categories and nearly all criteria, employees' satisfaction can be improved by addressing the one criteria that had a 'neither dissatisfied nor satisfied' score. Also, note that the attribute that received the lowest satisfied score was for temperature (hot or cold) (4.72), which is related to the one 'neutral' criteria, adjustability of thermal conditions (4.01). The following recommendations can help address change in this 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 moderate 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

The vast majority of IEQ criteria satisfaction scores are in the positive direction, however, improvement on the 'neutral' 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 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 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 ASHRAE Standard 55-2004 or *Human Factors Design Handbook* (see B3 Guidelines).

## 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. UMTC-RWC employees raised specific concerns about the following themes: furnishings and equipment, lighting conditions, privacy conditions, technology, and thermal conditions. Though these qualitative responses overall appear as if the employees are dissatisfied; it does not mean they represent the overall sentiment from employees as indicated by the positive scores previously discussed. However, the comments do give insight into specific issues that should be addressed by building management, especially relative to thermal conditions. Generally, the comments are in the employees words, below.

### General Comments

- I have a really great work environment - my wife makes over twice as much money as I do and has a much worse environment.
- The work space and physical spaces could not be better!
- I think music or TVs would be helpful. And Kleenex in the winter months.
- There are not many outlets and zero windows.
- It can get crowded during peak hours.
- It's hard to see windows unless you're in an upper level office.
- I also think that websites like office.com, drive.google.com, etc. should not be blocked so we can do homework at work without bringing our laptops. Being able to do homework during downtime at work is the main reason I applied for this job, and it's absurd that we can't do our homework online, which, unless you're an engineering or math student, is where all of our homework is done.

### Furnishings and Equipment

- There is a need for new chairs behind the desk.
- The computer's monitor angle is poor and the keyboard under the desk with the sliding drawer.
- Not always set up the best, but remodeling the equipment has gotten better.

### Lighting Conditions

- The sun comes right into our office in the afternoon, and when we work on our laptops it creates a terrible glare. There aren't blinds in our office. This is where the students work.
- Also lighting and environment of these spaces are hard to alter to desired settings.
- The fluorescent lights giving me a headache.
- Shop is at basement level daylight questions don't apply.

### Privacy Conditions

- I am fortunate to have a fantastic office to work in. The only issue that I have with it is the audio privacy, as the work spaces do not seem very sound proof. This can be an issue with confidential discussions.
- It would be nice if the Fitworks office had blinds or translucent glass to decrease glare on really sunny days and add a little sense of privacy.

## Technology

- The sounds system in the multipurpose spaces always seems to have troubles. Music will drown out the mic.

## Thermal Conditions

- Any of the offices (most on the 4th floor) are very, very cold and inconsistent. This has been reported time after time. Some staff need to wear jackets and coats to work comfortably. Often an office will be warm in the morning, only to gradually get colder and colder. At times, the outside temperature is bitterly cold, and yet cold air is blowing from the ceiling vent. For a new facility, the lack of comfortable and consistent air temperature should be much better. Aggravating.
- It gets really cold in the winter especially when lots of people are coming in at the same time and the cold air drifts to the front desk.
- It has been very drafty and very cold in the lobby and front desk areas. With the doors opening so frequently there is almost constantly a draft of cold air and the temperature is below a comfortable level.
- Often times a draft coming in causing the workspace to be very cold in the winter.
- No concerns other than it being very cold in the winter at the front desk.
- The building is still being adjusted for temperature. We have no control at this point of any of the office spaces or larger spaces in our building
- Really cold at front desk b/c we're by the doors-not sure if there is much that can be fixed here.

## 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).