RAWC Thermal Comfort Survey

Summary

The University of Toronto Mississauga has decided to take steps in becoming not only environmentally friendly but also economically beneficial by coming upon the decision to retrofit the Heating and Ventilation Air Conditioning (HVAC) system. The RAWC Thermal Comfort Survey is essentially a project in which our group has been assigned to conduct research on whether or not there is a change in the level of comfort before and after the retrofitting of the Heating and Ventilation Air Conditioning (HVAC) system. This project acknowledges the fact that it is not only limited to the comfort of gym-goers alone but as well as the staff who tend to spend long amounts of time in the vicinity of the RAWC and students who tend to visit the area for non-gym purposes.

There were initially two parts of the survey that needed to be conducted, the first one being distributed before the installation of the HVAC system, and a similar survey distributed after the installation. However, given the time constraint, our group was only able to complete the pre-retrofit testing of the RAWC's thermal comfort levels.

The survey designed to come to a conclusion on the thermal comfort levels of the RAWC took into consideration what the participant's role was at the RAWC, the type of apparel the participant was wearing, the weather of the given day the participant was present at the RAWC, and the level of activity they were performing. The findings revealed that nearly three-quarters of the participants were there for gym purposes, the latter being staff. The type of clothes worn was mostly lightweight, allowing a more accurate response to how comfortable they were with the current HVAC system. The weather of the given days affected the level of comfort at the RAWC, warmer days meaning the RAWC was slightly less comfortable then cooler days, concluding the weather outside had minor impacts on the temperature indoors.

Upon observing these findings, there are a few possible recommendations that could be made to further enhance the conclusions. When creating the post-retrofitting survey, a few more detailed questions could be asked to analyze the specific thermal comfort levels of the individual in the gym. Furthermore, having situations which were not anticipated made our group come to the realization that surveys should be handed out much earlier in case of emergencies in which later on surveys would not get distributed in time.

Introduction

The University of Toronto Mississauga is making changes to the HVAC systems in the RAWC in an attempt to better improve the air quality in the area. The main goal is reducing greenhouse gas emissions, with the secondary objectives being to make it cost-efficient and more comfortable. A survey was created, conducted, and analyzed with the goal to find out how comfortable visitors and staff feel when at the RAWC. We have run into obstacles when carrying out the study, with primary issues being hearing from clients in a timely manner and school shutting down due to COVID-19. The findings show that there is a general discomfort in temperature at the gym, and the information gathered from surveys should be used in comparison to information gathered post-survey.

Background

The University of Toronto Mississauga wants to assess the thermal comfort of people in the RAWC to see if there has been a significant difference in thermal comfort before and after the retrofit. The RAWC at the University of Toronto Mississauga is mainly used as an athletic building where it can be accessed by anyone to exercise. What is being questioned would be if

the new system being added to the RAWC is going to make the building more comfortable for people to work in. The approach that was taken by the group was to conduct an electronic survey asking the concurrent users and visitors of the RAWC if they were comfortable with the temperature of the building.

Problem statement

The goal of our project is to get to know if there has been a significant difference in thermal comfort before and after retrofit. From knowing how people now feel about thermal comfort, we can give more detailed information about how the University of Toronto can improve thermal comfort. We conducted a survey to question people in the gym about what they wear and how they feel about the RAWC temperature and also the satisfaction level from 0 to 100. We totally collected 76 responses and overall the satisfaction level is around 68. The data showed that most people think the temperature is too hot and most students and staff were not fully satisfied with the conditions of the HVAC system in the RAWC.

From doing this research, we think we didn't collect enough responses due to the anticipated emergency. COVID -19 cut survey period short and we cannot efficiently collect quantified responses online. Therefore, the survey result might be kind of biased since we don't have enough data to support it.

Methods

The purpose of this project is to gather opinions from people who go to the RAWC building (to work in the gym, to work out or just visit) about their experience of the internal temperature of the building, before the retrofitting of the HVAC system. We used surveys as our

method of getting the data, it helps to collect people's experiences in the RAWC building about the thermal comfort level. In this project, we have made several questions in the survey to gain opinions from people.

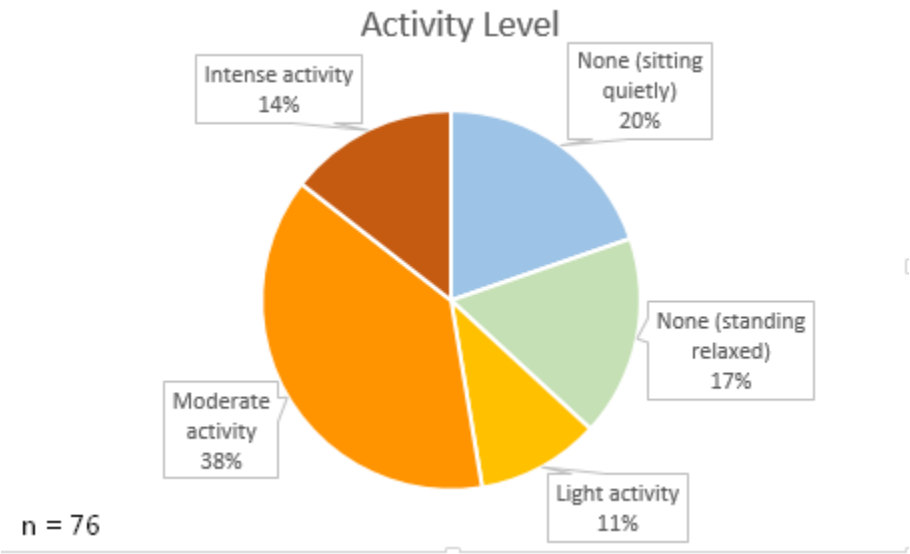
This survey includes questions of the purpose of visiting the RAWC, the clothes they have worn when they visit the building, the weather of the day, what exercise they have done in the gym and how they feel about the thermal level in the building, as well as their satisfaction on the temperature in the RAWC building. (See Appendix A for detailed survey)

We have spent a week's weekdays to do the survey and gather the results. We chose to do the survey in the afternoon to keep the survey in the same time period of the day. The survey we have created is online, we randomly asked people to do this survey, by asking them to scan the QR code of our survey. There were difficulties in collecting surveys since some people were having excuses and saying that they would do the survey later and we did not reach our goal of results that we expected.

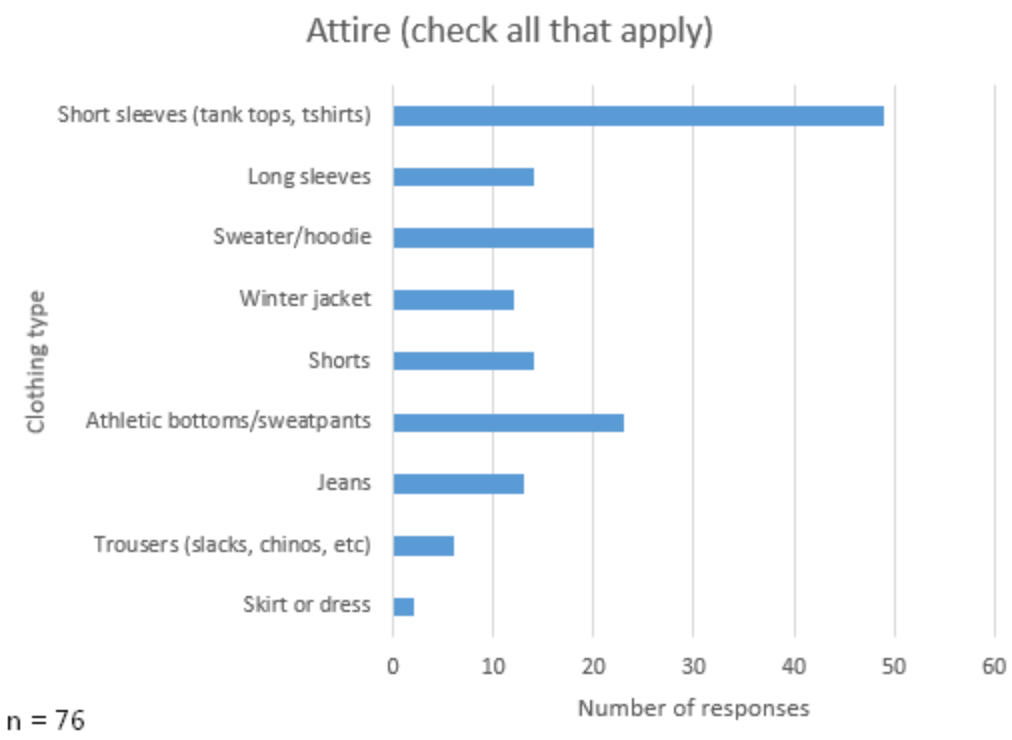
Findings

A total of 76 surveys were completed over the course of several days. It was our intention to survey a high portion of RAWC employees (comprising 13% of the sample population) due to the increased duration and frequency of experience with the RAWC's internal climate. Therefore, they might have been able to provide a generalized opinion on the building's ambient temperature. A number of RAWC employees unfortunately could not complete the survey due to restrictions on cellphone use during their shifts, but did offer feedback such as "it gets very stuffy in here, especially [in winter] because the heat is on"; "some areas are hotter than others, and some are even cold"; "the change rooms are the worst". The change rooms were noted by

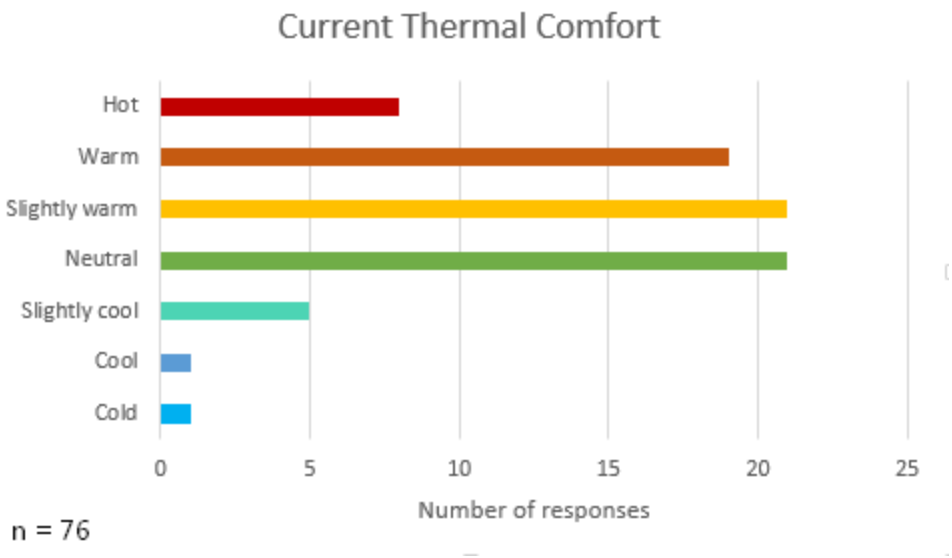
our team to be extremely hot and uncomfortable, but again, due to restrictions on cellphone use, no surveys could be administered in these areas. 75% of respondents cited their reason for being in the RAWC was to use the gym and workout equipment. Unsurprisingly, well over two-thirds of respondents recorded partaking in some level of physical activity (high, medium, or low intensity) immediately prior to taking the survey (see figure 1). Increased activity raises an individual's body temperature, making them feel warmer in their environment than their environment may actually be, and increased respiration rates can raise the temperature in an enclosed space. It is for these reasons such variables were accounted for during our survey.



The most common type of shirt was short sleeves (including t-shirts and tank tops), and the most common bottom was sweatpants or other full-length athletic wear (see figure 2). Both types of apparel are considered lightweight and breathable (making them suitable for physical activity), so we can comfortably assume our results were not skewed by an overdressed and overheated sample.



The most common temperature ratings were “neutral” and “warm” (tied with 21 response each), followed by “warm” close behind, then “hot” (see figure 3). Roughly 11% of responses found the RAWC on the cool side (“slightly cool” or lower), but this group was outnumbered by people who responded “hot”. The average satisfaction rating, when given a sliding scale, was 68 points out of 100; with 0 out of 100 being the worst possible score and 100 out of 100 being the best



Due to limitations in our online survey platform, individual sets of responses could not be viewed, and there was no way to determine if individuals who responded one way to a given question also responded to different questions the same way. Our platform also could only display the first 40 responses to be collected. This limitation ultimately proved to be a strength. The first 40 responses happened to be collected primarily on sunny days, and the later 36 responses were collected primarily overcast/inclement days with no instances of sun. Therefore, by dividing the data in this way, inferences could ultimately be drawn about the impact of weather on the RAWC's thermal comfort conditions. Weather was considered an important variable to account for as much of the RAWC's walls are made of glass. Much like a greenhouse, the glass was thought to have potential to trap incoming sunlight and warm the building.

The first 40 responses, referred to henceforth as Group A, were recorded under clear or partly cloudy conditions 95% of the time. The last 36 responses, henceforth Group B, had 50% reports of partial cloud and 50% reports of complete cloud cover and/or rain, with zero instances

of clear skies. While we acknowledge the division between the groups could have been much clearer, were extremely limited in what could be done with the data and so this will have to suffice.

To quantify the average temperature rating in each group, each descriptor was given a point value from 3 to -3 based on overall intensity; 'hot' was rated a 3, 'cold' was rated a -3, and neutral was 0. Within Group A, the number of responses in each category was multiplied by the respective point value, the sum of each category's points was then divided by the number of responses to give an average score, and the process was repeated for Group B and the sample as a whole. The average scores were then be compared amongst each other, and reinterpreted with a temperature rating along the 3 to -3 scale. Similar methods were also applied to activity levels and the weight of clothing, which were ranked based on their relative impacts on perceived heat; only the results of the temperature comparison appear in table 1 below.

		ALL RESPONSES (n=76)		**GROUP A (n_A=40)**		**GROUP B (n_B=36)**	
TEMP RATING	POINT VALUE	Responses	Score	Responses	Score	Responses	Score
Hot	3	8	24	5	15	3	9
Warm	2	19	38	11	22	8	16
Slightly warm	1	21	21	8	8	13	13
Neutral	0	21	0	13	0	8	0
Slightly cool	-1	5	-5	1	-1	4	-4
Cool	-2	1	-2	1	-2	0	0
Cold	-3	1	-3	1	-3	0	0
		Sum of scores/n:	**0.96**	**Sum of scores/n_A:**	**0.975**	**Sum of scores/n_B:**	**0.944**

Sunny day responses had warmer temperature ratings than cloudy/overcast/ inclement days, despite slightly lower activity levels and comparably light clothing. From this, an assumption can be made that outdoor conditions have a small impact on the RAWC's internal

climate. Thermal satisfaction differed by a negligible amount between the sunny and cloudy/inclement conditions; 67 points and 70 points, respectively. The average satisfaction rating for the whole group was 68 out of 100.

Recommendations

The data collected through the use of a survey showed an average of 68 out of 100 as the satisfaction level. This shows that most students and staff were not fully satisfied with the conditions of the HVAC system in the RAWC during the completion of the survey. The survey results were not quantifiable and there was room for interpretation between survey takers. This might have resulted in slightly skewed answers than previously hypothesized. In response to this finding, the post-retrofitting survey is recommended to have one or more of the following questions to further clarify the issues.

- What year of study are you in at the moment?
- Were you present at the RAWC during the pre-retrofitting period (before March 2020)?
- Have you completed a pre-retrofitting survey? If so have you felt an improvement with the HVAC system conditions in the RAWC?
- How often do you visit the RAWC?

Any of these additional questions could provide insight into which people can make a more accurate comparison between the pre and post- retrofitting. In addition to these questions, gathering a larger number of responses to more accurately portray the student's and staff's opinion is recommended.

Within our period of completing this assignment, our group came across a few issues that might occur again;

- Finding a site that provided an easy and accessible way to deliver surveys to students was hard to find (the one used was Survey Monkey).
- COVID-19 cut the survey period short. (Some other issue might shorten the survey time that was previously allocated).
- Communication with members and clients were more time consuming and slower due to COVID-19.

The solutions to these issues are to start surveying as soon as possible and to receive aid from the RAWC gym staff to promote the survey. This would allow for larger sample size and further variety in responses.

Conclusion

Based on what we have talked about in previous sections, the University of Toronto is making changes to the HVAC system in the RAWC. A survey was conducted to find the pre-retrofitting thermal comfort within the RAWC through the use of 6 questions (Appendices A) on 76 people. The data showed an average comfort level of 68%. The COVID-19 outbreak has resulted in a reduction of survey responses and a slowdown of the project completion. Some added questions could be added to the post-retrofitting survey to make a more accurate comparison.

Appendices

Appendix A: Pre-retrofitting survey

Why are you visiting the RAWC?

☐ Gym (working out) ☐ Work (in gym) ☐ Sports

☐ Work (at desk) ☐ Swimming ☐ Other: _____

Clothing: Please place a check mark by the articles of clothing that you are wearing:

Top	**Bottom**
☐ Short Sleeve Shirt	☐ Pants
☐ Long Sleeve Shirt	☐ Skirt/dress
☐ Sweater	☐ Shorts
☐ Athletic Sweat Top	☐ Athletic Sweat Pants
☐ T-shirt	☐ Jeans
☐ Winter Jacket	☐ swim wear

How would you describe your activity level just prior to completing this survey?

☐ Sedentary ☐ Light Activity

☐ Medium Activity ☐ High Activity

How would you describe the weather outside today?

☐Clear skies / sunny ☐Very cloudy ☐ Partly cloudy ☐Inclement Weather

What is your current thermal comfort:

1. ☐ Hot
2. ☐ Warm
3. ☐ Slightly Warm
4. ☐ Neutral
5. ☐ Slightly Cool
6. ☐ Cool
7. ☐ Cold

How satisfied are you with the temperature in the RAWC today?

Very Satisfied ☐ ☐ ☐ ☐ ☐ ☐ ☐ Very Dissatisfied