Cooling the YIH food court

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Abstract

We propose a solution to the problem of high temperatures and humidity in the open-air food court area at Yusof Ishak House.

Contents

Introduction

According the Meteorological Service Singapore, over the past decade, there are 11.6 more warm days in every year, on average.[3] In light of the numerous complaints regarding the open-air food court at Yusof Ishak House, it is clear that some mistakes have been made in the design process of the food court.

1 Assessment

This section addresses Question 1.
After some preliminary research, we have narrowed down on four options.

Solution 1. Install 1× giant ceiling fan.

Solution 2. Install 30× regular-sized ceiling fans, equidistant from each other.

Solution 3. Install 40× regular standing fans, equidistant from each other.

Solution 4. Install air-conditioning.

1.1 Priorities and considerations

In selecting the best solution, we have settled on the top three most important considerations, listed in decreasing order of importance.

Consideration 1. Comfort.
We prioritise the comfort of our students and staff, as a more comfortable environment improves productivity and reduces stress.

Consideration 2. Cost efficiency.
Rather than going with the cheapest option, we prioritise "bang for the buck", the solution selected should be worth what it costs.

Consideration 3. Aesthetic appeal.
The solution must look nice and fit in the architectural design of the existing ambience of Yusof Ishak House.

1.2 Comparison of solutions

For Consideration 1, we judge each solution based on the perceived temperature.

Definition 1.2.1. The **perceived temperature** of a solution is defined as the actual temperature subtracted by expected improvements from airflow circulation, temperature control or humidity control.

We assume here that the actual daily temperature is around 30 °C on a warm day. We also assume that each level of improvement of airflow circulation and humidity control corresponds to a 1 °C drop in the perceived temperature. The estimated perceived temperatures of each solution are tabulated in Table 1.1.

For Consideration 2 we consider the cost of each solution over 15 years.

	Solution 1	Solution 2	Solution 3	Solution 4
Actual temp. (°C)	28.5	28	30	24
Humidity control	2	1	0	3
Airflow circulation	3	1	2	1
Perceived temp. (°C)	23.5	26	28	20

Table 1.1: Expected temperature characteristics

	Solution 1	Solution 2	Solution 3	Solution 4
Perceived temp. (°C)	23.5	26	28	20
Long-term cost ($)	75860	57495	49206	1707500
Aesthetic appeal	✡✡✡✡✡	✡✡	✡	✡✡✡✡

Table 1.2: Summary of solutions

Definition 1.2.2. The estimated **long-term cost** of solution i is the sum of its cost of purchasing, installation and the power consumption over 15 years, the expected lifespan of this installation.

The cost is computed by the following formula,

$$c = \pi + \iota + 33.93 \cdot \omega$$

where π denotes the cost of purchasing, ι the cost of installation, and ω the power consumption in Watts. The constant term 33.93 reflects the cost of using 1 Watt of power over 15 years, extrapolated from current electricity tariffs.[1]

For Consideration 3 we rate each solution aesthetically out of 5 ✡s. In particular, Solution 1 minimally affects the current aesthetics, while Solutions 2 and 3 are considered unsightly. Solution 4 is largely favourable with a caveat – the food court will be arbitrarily divided into two halves, both air-conditioned.

The solutions are summarised in Table 1.2.

1.3 Choice of solution

With reference to Table 1.2, it is clear that **Solution 1** emerges as the best choice. Having a long-term cost two orders of magnitude lower than that of Solution 4, it provides comparable performance, greatly surpassing that of Solution 2 and Solution 3. In addition, it is also the most aesthetically appealing.

2 Evaluation

This section addresses Question 2.

2.1 Potential risks

The solution chosen allows for dust to accumulate and dust mites to gather. This could pose hygiene and air quality issues for our students and staff, especially those with respiratory conditions such as asthma. An unclean fan blows dust and dust mites around the environment, posing as a health risk especially for people with allergic reactions.[4] It is therefore important for the giant ceiling fan to be kept clean in order to maintain the air quality and the health of our students and staff.

2.2 Mitigation strategies

To mitigate this potential risk attributed to Solution 1, we propose a cleaning schedule for the ceiling fan.[2]

- At least once every two weeks, the fan is to be dusted clean.
- At least once every month, the fan should be brushed and vacumned thoroughly.

3 Future improvements

For Consideration 1, more advanced models could be tested and experiments conducted in order to determine the precise relationship between a solution's airflow circulation, humidity control and the perceived hotness experienced.

In the determination process of Consideration 2, predictions could be made on future electricity tariffs in order to better estimate long-term cost.

In the process of judging Consideration 3, the author's personal tastes and preferences were invoked as judgement. As improvement, we could come up with mock-up designs for each solution, and allow the students to choose the one they like most.

References

[1] Energy Market Authority. *Electricity Tariffs*. 2018. URL: https://www.ema.gov.sg/Residential_Electricity_Tariffs.aspx (visited on 26/10/2018).

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[3] Metereological Services Singapore. *Past Climate Trends*. 2017. URL: http://www.weather.gov.sg/climate-past-climate-trends/ (visited on 26/10/2018).

[4] Nicole Weers. "Dangers of dust mites: 6 things to know about these tiny bugs lurking in your home". In: *The Straits Times* (May 2016). URL: https://www.straitstimes.com/singapore/health/dangers-of-dust-mites-6-things-to-know-about-these-tiny-bugs-lurking-in-your-home (visited on 27/10/2018).