SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

SingHealth DukeNUS ACADEMIC MEDICAL CENTRE

01.101: TECHNOLOGIES FOR SUSTAINABLE GLOBAL HEALTH (AY2023 TERM 7)

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COOLING PODS

FOR DEMENTIA PATIENTS AT HOSPITALS

A way to create a **comfortable and calming environment**, which is adaptable, for dementia patients to reduce their agitation and anxiety while in the hospital.

Identify

Significance of Problem

Prevalence of Dementia

1 in 10 people aged 60 and above, and

1 in 2 people aged 80 have dementia in Singapore [1]

Hot Climate

1.4℃ - 4.6℃

Projected increase in daily mean temperature [2]

Needs of Dementia Patients

Hospitalisation or a change in environment often causes agitation and anxiety in dementia patients. [3]

How to help them

Calming strategies | Soothing sounds | Comfortable environment | Exercise | Emotional support

Needs Criteria for Solution

Must-have

- Enclosure large enough for 1 person to stand in
- Cooler than surrounding by 2°C
- Sound of flowing water
- Have a roof/cover
- Modular units

Good to have

- Solar Chimney to create airflow
- Cooler than surrounding by 3°C
- Sustainable
- No/Low Power

Ideate

Evaporative Cooling

Water absorbs heat from its surroundings, undergoes evaporation, and cools the surrounding air

Porous material with larger surface area for **water absorption**

Bamboo

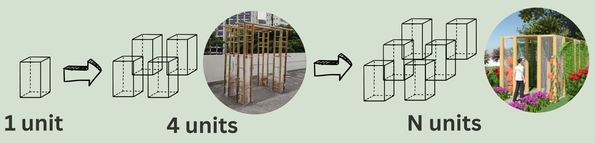
- Lightweight, durable
- Structurally stable
- Stripped bamboo used for cooling
- Eco-friendly

Terracota

- Excellent water absorption and retention
- Broken into chips to increase evaporative surface area

Flexible Design

Modular, standalone evaporative cooling columns could be combined to design complex structures.



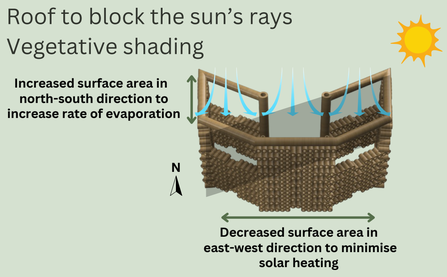
Cooling Optimisation

Maximising airflow

Instead of a solar chimney we exploit the **natural north-south wind** flow in Singapore by exposing a greater surface area to the north-south

Maximising solar shading

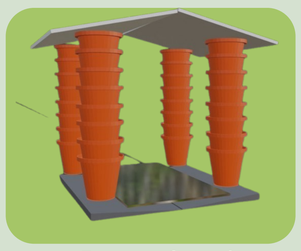
- Reduce surface area exposed to **east-west** direction
- Roof to block the sun's rays
- Vegetative shading



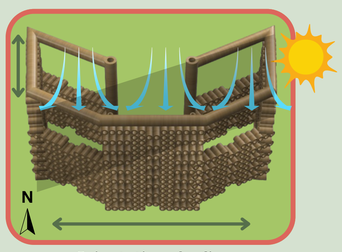
Relaxing Environment

Sound of water flowing is the easiest way to generate pink noise. Pink noise can help calm down and relax individuals. This can be especially useful for dementia patients at the hospital.

Concept Generation



Terracotta focused evaporative cooling pod



Orientation shading

Hybrid cooling columns with terracotta chips and bamboo evaporative substrate

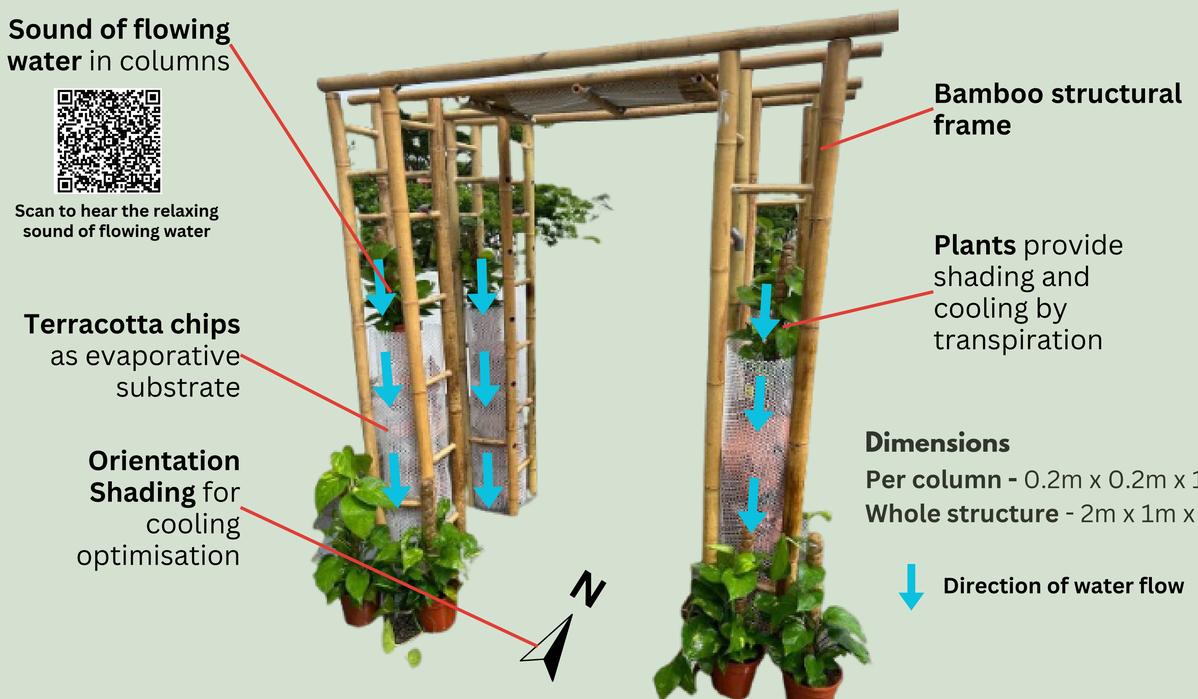
Terracotta and bamboo pod with aesthetic water trough

Bamboo Pagoda

Our Solution

Modular Evaporative Cooling Column

Prototype fabricated for functional and usability testing.



Testing methodology and results

Usability Testing

A user study with 10 participants gathered through convenience sampling was conducted in an open area with the lack of vegetative cover over the cooling pod (similar to that of a garden) to test the prototype

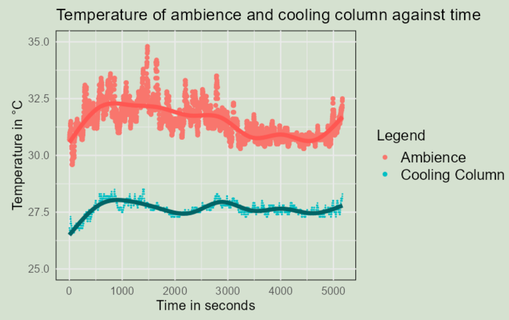
Findings:

- Temperature difference in the middle of the cooling pod is not so apparent to the user in an open area.
- However, close proximity to a single column allows the user to feel a difference in temperature.

Recommendations:

- Increase number of cooling columns to trap enhance cooling effect within the pod.

Functional Testing



A 2 sample left-tailed Student T-test assuming equal variance was conducteded

H_0 : μpod ≥ μambient

H_1 : μpod < μambient

P-value ≤ 0.05: Reject H^0

3.84°C mean decrease!

μambient= 31.5 (std= 0.768)
μpod = 27.6 (std= 0.315)

Max decrease- 6.9°C
Min decrease- 2.5°C

Conclusion

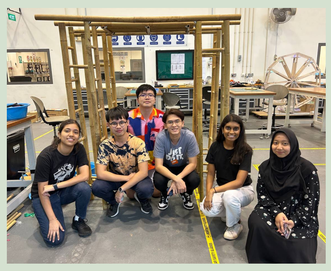
Summary

- Used **evaporative cooling** mechanism to build a cooling pod for dementia patients as a comfortable and calming place
- Selected **terracotta chips** as evaporative cooling surface and **bamboo** as structural component
- Measured a **significant difference in temperature** in cooling pod as compared to ambience
- Developed **modular evaporative cooling columns**

Future Considerations

- The **modular columns can be combined** to make complex structures as per the developer's design
- **Addition of solar chimney** to increase air flow in the cooling pod
- **Use of hydraulic ram pumps** to eliminate the need for electric energy
- **Addition of a suinikutsu** (Japanese Water Harp) to play soothing sounds
- Close-loop **water collection and recycling system** integrated with the water supply of the hospital

Team Photo



References
[1]https://www.aic.sg/resources/Documents/Brochures/Mental%20Health/4Books%202022/AIC_Living%20With%20Dementia_Booklet%201_Eng.pdf
[2]https://www.nccs.gov.sg/singapores-climate-action/impact-of-climate-change-in-singapore/
[3]https://www.alz.org/help-support/caregiving/stages-behaviors/anxiety-agitation#:~:text=Anxiety%20and%20Agitation,-Anxiety%20and%20Agitation&text=A%20person%20with%20Alzheimer's%20may,when%20focused%20on%20specific%20details.