Preference For Passive Cooling In A University Administrative Building

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Abstract: The use of passive cooling techniques combined with a low cooling load may result in good thermal comfort. The passive design responds to local climate and site conditions to maximize the efficiency and health of building users while minimizing energy use. It generally believed that passive cooling is healthier, cheaper and sustainable. However, it is not certain where there is provision for the active cooling system; users of such building may prefer passive cooling hence. This study aims to elicit users preference for passive cooling in the senate building chamber of Modibbo Adama University of Technology (MAUTECH) Yola; by administering questionnaires to the users available at the time of the research work. A total of 50 questionnaires were administered, 45 were retrieved and evaluated using 5-point Likert ordinal scale (5 = Strongly agree; 4 = Agree; 3 = Undecided; 2 = Disagree; and 1 = Strongly disagree). Weighted mean values were calculated based on which decisions were made: When the weighted mean value is not less than 3.5, it was decided as agreement; and disagreement when weighted mean values were not more than 2.4. The result showed users preference for passive cooling in the senate building chamber of Modibbo Adama University of Technology (MAUTECH) Yola and users awareness about issues of sustainability. It was recommended that passive cooling strategies should be incorporated in future building designs to boost energy conservation and reduce greenhouse gas emissions.

Keywords: passive cooling, energy conservation, sustainability.

1. INTRODUCTION

1.1 Background

Passive cooling is the least expensive means of cooling a building in both finance and environmental terms because it uses a free renewable source of energy such as the sun and wind to provide cooling, ventilation and lighting for building users. This way additionally

reduces the need for using mechanical cooling; applying passive cooling means reducing the difference between outdoor and indoor temperature, improving indoor air quality and making the building both a better and comfortable place to work in together. It can also reduce the level of energy use and environmental impact, such as greenhouse gas emission. Passive solar designs as a sustainable concept have had much interest in the last decade. A well-designed building envelope maximizes cooling through air movement and minimizes solar heat gain. There are many types of cooling strategies that can be recommended for use in Yola, which a hot, dry climate (Idowu and Okonkwo, 2012).
Passive design strategies that minimize the need for mechanical cooling systems include proper window placement and daylighting design; selection of suitable glazing for window and skylight, properly sized shading of glass when heat gains are being avoided. The use of light or reflective coloured materials for the building envelope and roof, careful siting and wise orientation that decides alongside appropriate landscaping design. (Santamouris and Asimakopoulos, 1996).

1.2 Statement of the Problem:

It is generally believed that passive cooling is healthier, cheaper and sustainable, but will users of MAUTECH senate building chamber prefer such design, especially when there is provision for active cooling means?

1.3 Aim and Objective of the study:

The aim is to elicit users preference for passive cooling in senate building chamber, test the usefulness of applying selected passive cooling techniques to improve thermal comfort, create awareness on green building practice and minimize energy consumption in office buildings. These objectives will achieve this way:

a.To determine users preference for passive cooling.

b. To determine users awareness about issues of sustainability.

2. REVIEW OF RELATED LITERATURE

2.1 Vegetation

Vegetation modifies the microclimate and the energy use of buildings by lowering the air and surface temperatures and increasing the relative humidity of the air. Furthermore, plants can control air pollution, filter the dust and reduce the level of nuisance from noise sources. Indoor simulations still tend to be isolated from an essential element affecting urban microclimate, such as urban trees. The main advantage of urban trees, as a bioclimatic responsive design element is to produce shade, reduce temperature and air pollutant whereas its main disadvantage is blocking the wind (Yoshida, Ooka, Moshida, Murakami and Tominaga, 2006). Besides, the effects of specific urban tree types - for example, the different leaf area densities and evapotranspiration rates of urban trees influence solar access and heat exchanges if planted around buildings (Radhi, 2009). Studies have been carried out on the preference for passive cooling or natural airflow in life buildings.

2.2 Natural ventilation

Natural ventilation depends solely on air movement to cool occupants. Window openings on opposite sides of the building enhance cross-ventilation driven by breezes. Since natural currents can't be scheduled, designers often choose to improve natural ventilation using tall spaces within structures called stacks. With openings near the top of the pile, warm air can escape, while cooler air enters the building from exits near the ground. Ventilation requires the installation to be open during the day to allow airflow.

Convective cooling by (ventilation is a very effective method to improve indoor comfort, indoor air quality and reduce the temperature. Higher airspeeds inside the building may enhance thermal comfort when they do not exceed specified values. The technique is usually limited to night time ventilation; however, daytime ventilation may be used when the ambient temperature is lower than the indoor temperature.

Natural ventilation is due either to wind forces, temperature differences, or both, a severe reduction of the cooling potential is observed in dense urban environments as a result of the dramatic decrease of the wind speed in cities (Geros et al., 2001). Careful positioning of the openings in naturally ventilated buildings is a crucial parameter that determines the effectiveness of the process. A review of the sizing methodologies is given by Anthienitis and Santamouris (Anthienitis and Santamouris, 2002).

2.3 Air movement

Air movement is the most crucial element of passive cooling. It increases cooling by increasing evaporation rates. Generally, cross ventilation is most useful for air exchange (building cooling) and fans for air movement (people cooling). Air movement provides proper cooling in all climates but may be less effective in tropical climates during periods of high humidity. However, humidity levels in Yola are not as high as the coastal areas.

According to Reardon (2008), an airspeed of 0.5m per second equates to a 3-degree drop in temperature at a relative humidity of 50 per cent results to a physiological cooling effect. In higher humidity, greater airspeeds are required to achieve the same cooling benefits.

A life study was carried out in an apartment in Australia; residents generally expressed a preference for natural airflow to air conditioning. The majority of residents (80%) had space cooling equipment in their dwelling, while (53%) had space heating equipment. Survey result indicated that, when thinking about ‘climate control’ in summer, the residents were more likely to open their windows and doors (83%) rather than turn on the air conditioner. Resident preferred natural airflow to the air conditioner as long as other negative impacts such as noise or air pollution were not introduced as an unwanted consequence. (Queensland development code, 2009).

A study in Sidney by (Rowe, 1996), showed a reduction in energy use by 25 -33% in naturally ventilated mixed-mode building and high occupant satisfaction scores.

2.4 Orientation

The orientation of the building is to minimize the impact of the sun on the building in summer; it represents the relation between its elevation and the original geographical direction (Rania and Neveen, 2017). A pattern of solar radiation on different walls results in a clear preference for north-south orientation of the main façades, and especially of the windows (Khan en Qureshi 2020). Such exposure enables easy and inexpensive shading of the southern window in summer. The heating effect of solar radiation impinging on walls can further be minimized by choosing reflective colours of the walls. (Rania and Neveen, 2017) stated that with the right orientation, the need for cooling is reduced, resulting in lower energy bills and reduced greenhouse gas emissions. Buildings should be made to maximize the site's potential and to achieve the best possible orientation. Orientation should aim to exclude sun year-round and maximize exposure to cooling breezes.

3. RESEARCH METHODOLOGY

This study adopts questionnaires, a total number of 50 were administered to senate building chamber users available at the time of the research, a total number of 45 questionnaires were retrieved and analyzed using 5- Likert ordinal scale of agreement/disagreement; These strongly agree, Agree, undecided, Disagree and Strongly disagree. A Likert scale is a psychometric scale commonly involved in research that employs questionnaire. It is the most widely used approach to scaling responses in survey research, such that the item is often used interchangeably with rating scale or more accurately the Likert scale, even though the two are not synonymous. Named after its inventor, psychologist Rensis Likert; when responding to a Likert questionnaires item, responses specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of the statement. It assumes that distances on each item are equal. Importantly "all items are assumed to be a replication of each other or items is considered to be a parallel instrument". The weight attached to the Likert items are 5= strongly agree (SD), 4 = agree (A), 3 = undecided (UD), 2 = disagree (D) and 1 = strongly disagree (SD).the weighted mean was calculated by first obtaining the weighted total and then dividing it by the total number of the respondent (N). Decisions on preference or agreement were made when the weighted mean value is not less than 3.5 and disagreement when the weighted mean value not more than 2.4.

4. RESULTS

Table 1: Respondent's Age Range

Age range	Frequency
Below 30	0
30 – 39	5
40 – 49	25
50 – 60	15
60 and above	0
Total	45

Source: Researcher's survey, (2015).

Respondents' age range shows that age range 40 – 49 have the highest frequency value of 25, next age range is 50-60 having a frequency value of 15, 30 -39 having frequency value of 5 and there are no respondents with the age range of below 30 and 60 and above.

Table 2: Respondents' Gender

Gender of respondents	Frequency
Male Female Total	40 5 45

Source: Researcher's survey, (2015).

Table 3: Respondents' Opinion, Weighted total and Weighted mean value.

Source: Researcher's survey, (2015).

The total weighted mean value for all the respondents 3.8, which showed a level of agreement for the preference of passive cooling to air conditioning in the senate building chamber, MAUTECH

Questions	SA = 5	A= 4	UD =3	D = 2	SD=1	Weighted total (Wt)	N	Weighted mean(Wm)

Questions	SA = 5	A= 4	UD= 3	D= 2	SD = 1	Weighted total (Wt)	N	Weighted mean (Wm)
Q1	14	21	5	3	2	177	45	3.9
Q2	25	15	2	3	0	197	45	4.3
Q3	13	20	7	2	3	173	45	3.8
Q4	8	12	2	8	15	125	45	2.7
Q5	6	24	9	5	1	163	45	3.6
Q6	30	8	2	1	4	194	45	4.3
Q7	8	22	10	5	0	168	45	3.7
Q8	10	20	8	4	3	165	45	3.6
Q9	24	15	3	3	0	195	45	4.3
Q10	10	25	5	3	2	173	45	3.8
Total	740	728	159	74	29	1730	450	**3.8**

Yola.

Table 4: Users Awareness on Issues of Sustainability

	5	4	3	2	1	total (Wt)		mean (Wm)
Q1	10	18	4	2	2	140	36	3.8
Q2	20	13	0	3	0	158	36	4.3
Q3	12	15	5	2	2	141	36	3.9
Q4	5	10	2	8	11	98	36	2.7
Q5	4	20	8	4	0	132	36	3.6
Q6	25	7	0	1	3	158	36	4.3
Q7	6	20	5	5	0	135	36	3.7
Q8	9	14	7	4	2	132	36	3.6
Q9	22	13	0	1	0	164	36	4.5
Q10	9	24	3	0	0	150	36	4.1
Total	610	616	102	60	20	1408	360	**3.9**

Source researcher's survey, (2015)

Mean for group1 = $\frac{Es1}{N} = \frac{38.5}{36} = 1.07$

Mean for non-science = $\frac{Es2}{N} = \frac{35.8}{36} = 3.98$

Variance for science related discipline:

$S1 = \frac{Exi - nx2}{n-1} = \frac{155.14 - 36(38.5)2}{36 - 1}$

$$S1 = \frac{155.14 - 53.361}{35}$$

$$S1 = \frac{-93205.86}{35} = -1520.17$$

Variance for non- science related discipline:

$$S2 = \frac{Exi - nx2}{n-1} = \frac{130.7 - 9(35.8)2}{9-1}$$

$$t = \frac{X1-Xi}{\sqrt{s12 1}} = \frac{1.07 - 3.98}{\frac{-1520.17}{36} + \frac{(-1425.51)}{9}}$$

N1

$$= \underline{-2.91} \text{Squ}$$

Calculated t = 0.2

Degree of freedom: n1-1 = 36-1 =35

Degree of freedom: n1-1 = 9-1 = 8

Two tail: t value = 2.02

Therefore there is no significant difference because tabulated t – value is greater than calculated t- value.

4. CONCLUSION AND RECOMMENDATIONS

The result showed users preference for passive cooling in the senate building chamber of Modibbo Adama University of Technology (MAUTECH) Yola and users awareness about issues of sustainability. It was recommended that passive design strategies should be integrated into future building designs to boost energy conservation and reduce greenhouse gas emissions.

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