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Analysis of Energy Consumption Pattern & Thermal Comfort in Modern Scenario

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ABSTRACT

In the construction of educational facilities, thermal comfort is crucial, particularly in hot, arid climates. It has a significant effect on both energy usage and building interior temperature. The main goal of the current study is to evaluate the level of indoor thermal comfort and energy usage in a public elementary school in Egypt. A field research was undertaken in a school building that was created based on natural ventilation and air movement using ceiling fans to analyze the indoor thermal conditions based on the adaptable standard comfort model in order to achieve this purpose. Electrical utility invoices have also been gathered. Then, using Design Builder software, a dynamic building energy simulation model was created for thermal comfort.

KEYWORDS: *Thermal Comfort, Energy Consumption, Building energy efficiency, Climate change, Heat and cooling requirements.*

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INTRODUCTION

Warm solace assumes a significant part in the instructive structure area, particularly in sweltering parched environment. It immensely affects building inside temperature as well as on energy utilization. The current review is basically an endeavor to evaluate the current indoor warm solace status as well as energy utilization in Egyptian public elementary school building. To meet this goal, a systemic technique has been followed; a field review was directed in a school constructing that are planned in light of normal ventilation and air development through roof fans to survey the indoor warm circumstances in view of versatile standard solace model. Also, electrical service bills have been gathered. Then, at that point, a unique structure energy reenactment model was completed by utilizing, Plan Developer programming for looking at indoor solace conditions as well as the energy utilization of a normal building.

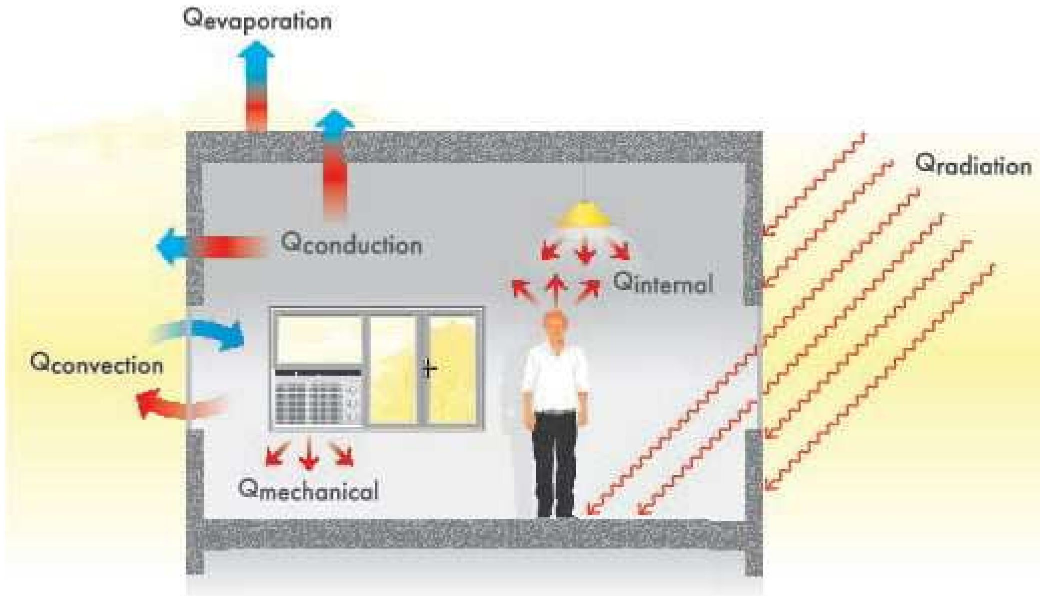

Fig.1 Thermal comfort aspects

FACTORS INFLUENCING THERMAL COMFORT

Thermal comfort results from a combination of environmental factors and personal factors:

Environmental factors-

Air temperature

The temperature of the air that a person is in contact with, measured by the dry bulb temperature (DBT).

Air velocity

The velocity of the air that a person is in contact with (measured in m/s). The faster the air is moving, the greater the exchange of heat between the person and the air (for example, draughts generally make us feel colder).

Radiant temperature

The temperature of a persons surroundings (including surfaces, heat generating equipment, the sun and the sky). This is generally expressed as mean radiant temperature (MRT, a weighted average of the temperature of the surfaces surrounding a person, which can be approximated by globe thermometer) and any strong mono-directional radiation such as radiation from the sun.

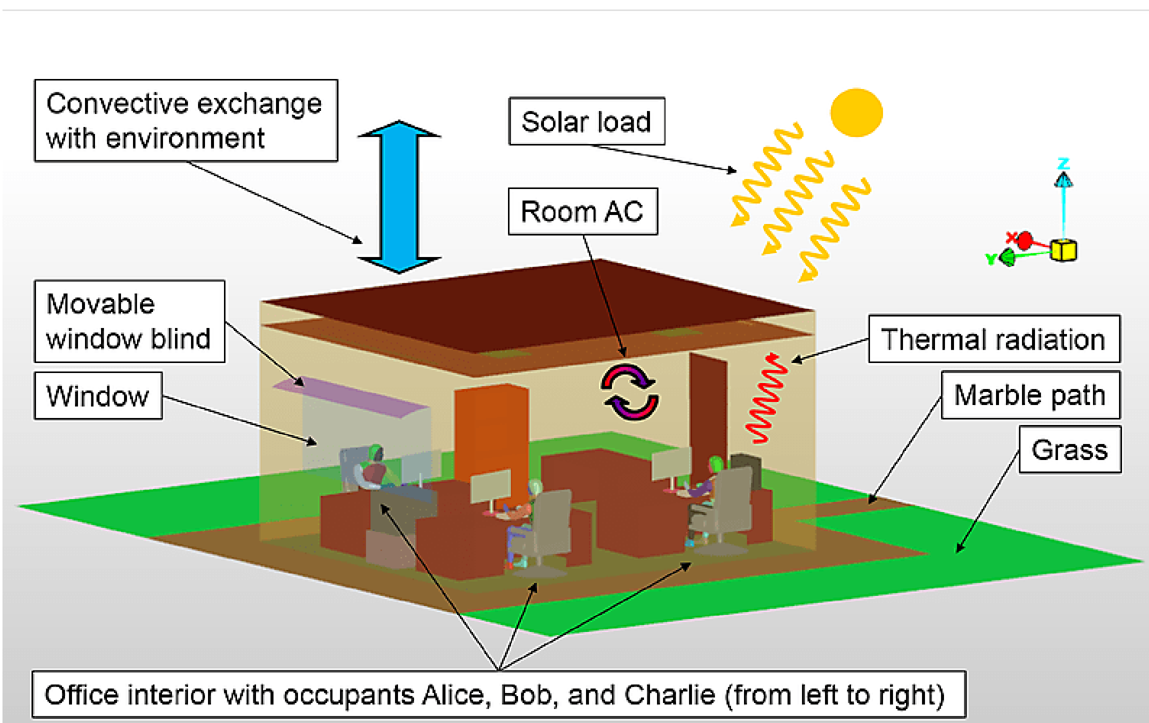

Fig.2 Factors of thermal comfort

Relative humidity (RH)
The ratio between the actual amount of water vapour in the air and the maximum amount of water vapour that the air can hold at that air temperature, expressed as a percentage. The higher the relative humidity, the more difficult it is to lose heat through the evaporation of sweat.

Personal factors-
Clothing
Clothes insulate a person from exchanging heat with the surrounding air and surfaces as well as affecting the loss of heat through the evaporation of sweat. Clothing can be directly controlled by a person (i.e. they can take off or put on a jacket) whereas environmental factors may be beyond their control.

Metabolic heat or level of activity
The heat we produce through physical activity. A stationary person will tend to feel cooler than a person who is exercising.

Wellbeing and sicknesses
Such as the common cold or flu which affect our ability to maintain a body temperature of 37°C at the core. Other contributing factors can include; access to food and drink, acclimatisation (this can be more difficult where there is a high outdoor-indoor temperature gradient) and state of health. In addition, thermal comfort will be affected by whether a thermal environment is uniform or not. For example, draughts and heaters can create a scorched face / frozen back effect and hot feet/cold head and hands effect.

'Thermal goes beyond this, proposing that the hedonic qualities of the thermal environment (qualities of pleasantness or unpleasantness, or 'the pleasure principle') are determined as much by the general thermal state of the subject as by the environment itself. In its simplest form, cold stimuli will be perceived as pleasant by someone who is warm, whilst warm stimuli will be experienced as pleasant by someone who is cold. Introducing a spatial component to this, it can for example be pleasurable to wrap cool hands around a warm mug. See Thermal pleasure in the built environment for more information.

THERMAL COMFORT AND AIR QUALITY
Providing a comfortable and healthy interior environment is one of the core functions of building energy systems and accounts for about a third of total building energy use. New technologies for heating, cooling, and ventilation not only can achieve large gains in efficiency, but they can improve the way building systems meet occupant needs and preferences by providing greater control, reducing unwanted temperature variations, and improving indoor air quality.

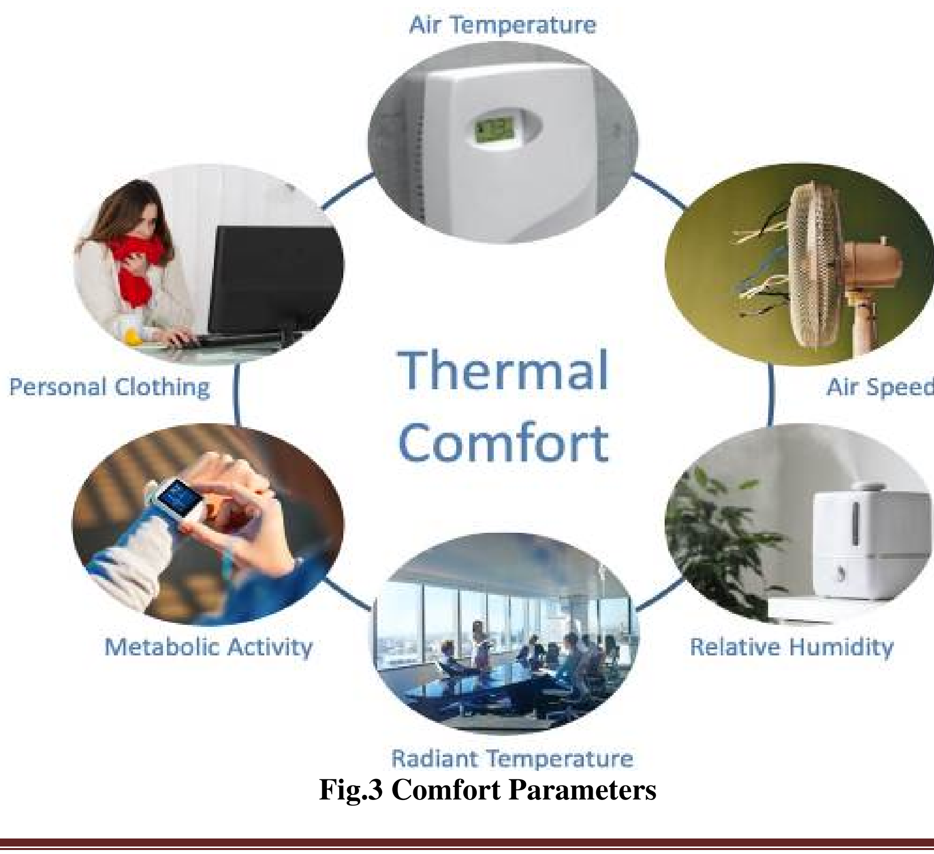

Fig.3 Comfort Parameters

BUILDING WALLS, ROOFS, AND FOUNDATIONS

The walls, roofs, and foundations of buildings also control the flow of heat, moisture, and air. Their color and other optical properties affect the way heat is absorbed and how the building radiates heat back into the atmosphere, but they must do so in ways that meet aesthetic standards and serve functions such as building stability and fire-resistance. Ideal materials are thin, light, and easy-to-install, and provide opportunities to adjust their resistance to flows of heat and moisture. Thin materials offering high levels of insulation are valuable for all building applications but are particularly important for retrofits since space for additional insulation is often limited. Promising approaches include vacuum insulation and lightweight silica aerogel.

Fig.4 Building elements

Flexible insulation materials with thermal resistance of nearly R-10 per inch are available from several suppliers. Because of high costs, use of these insulating materials has been limited to industrial applications such as pipelines, although building applications have been explored. More federal research here is justified only if there is evidence that there are significant opportunities to find novel materials that offer high levels of insulation in thin products that can cost-effectively meet fire, safety, and other building code requirements that the private sector is not pursuing on its own. The new materials must also be practical for construction ideally it should be possible to cut, bend, or nail them.

BUILDING ENERGY EFFICIENCY

The energy efficiency of a building is the extent to which the energy consumption per square meter of floor area of the building measures up to established energy consumption benchmarks for that particular type of building under defined climatic conditions.

Fig.5 Building Energy Efficiency

Commercial building sector is a significant energy user and producer of carbon emissions. It includes a range of building types, including offices, hospitals, schools, and more. Buildings retrofitted to higher energy-efficiency standards provide multiple benefits to those who own and occupy them, including:

- **Long-term energy and cost savings:** an energy efficient building will have the advantage of lower energy, water, and maintenance costs.
- **Lower emissions and overall environmental impact:** energy efficient buildings have lower greenhouse gas emissions due to their reduced reliance on fossil fuels. Buildings that use primarily clean energy such as hydroelectricity have the lowest emissions.
- **Better thermal comfort:** well-designed mechanical systems and building components work together to manage comfortable indoor temperatures.
- **Improved comfort and health:** continuous ventilation and fresh air throughout the building can lead to better well-being with occupants and as a result, a more productive workforce.
- **Higher Value:** businesses and consumers see the value in energy efficient buildings, and as a result there is a premium associated with buying or leasing space in well-built, energy efficient buildings.

Human Body and Thermal Comfort

The term air-conditioning is usually used in a restricted sense to imply cooling, but in its broad sense it means to condition the air to the desired level by heating, cooling, humidifying, dehumidifying, cleaning, and deodorizing. The purpose of the air-conditioning system of a building is to provide complete thermal comfort for its occupants. Therefore, we need to understand the thermal aspects of the human body in order to design an effective air-conditioning system.

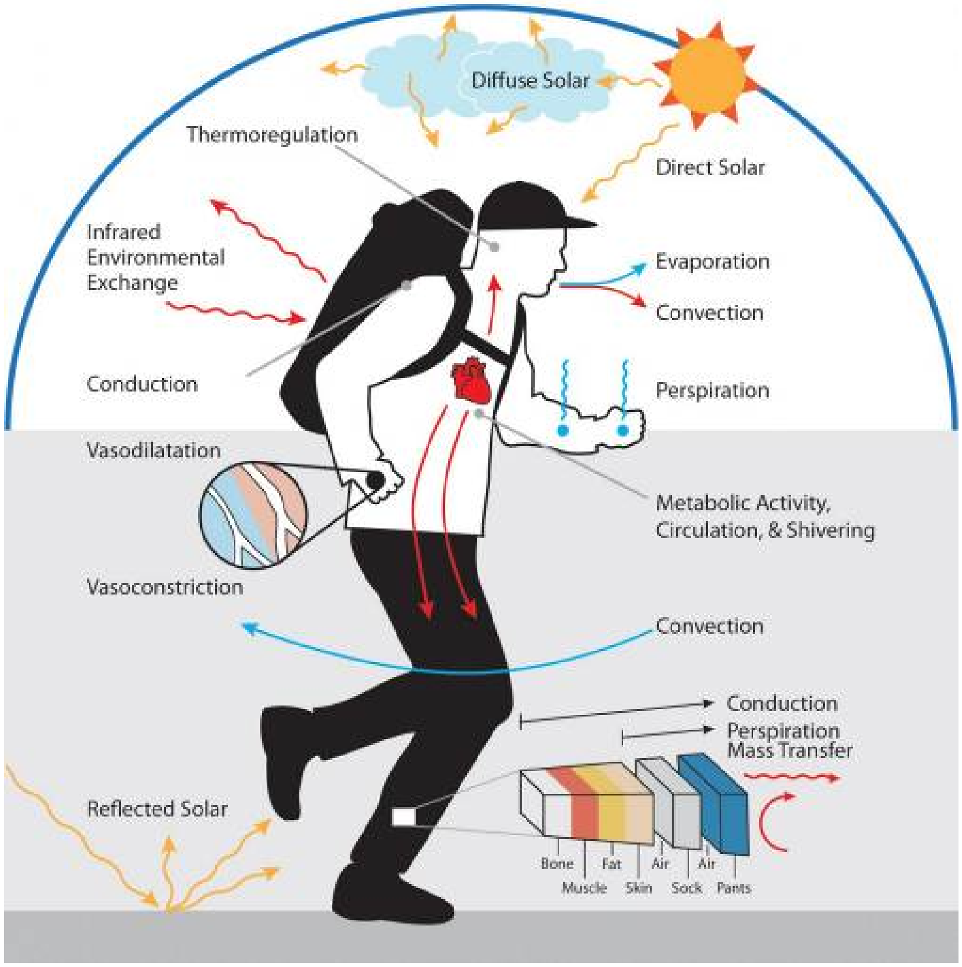

Fig.5 Human Body and Thermal Comfort

The building blocks of living organisms are cells, which resemble miniature factories performing various functions necessary for the survival of organisms. The human body contains about 100 trillion cells with an average diameter of 0.01 mm. In a typical cell, thousands of chemical reactions occur every second during which some molecules are broken down and energy is released and some new molecules are formed. The high level of chemical activity in the cells that maintain the human body temperature at a temperature of 37.0C (98.6F) while performing the necessary bodily functions is called the metabolism. In simple terms, metabolism refers to the burning of foods such as carbohydrates, fat, and protein.

CONCLUSIONS:

This study investigation at the thermal comfort levels and energy use in public elementary schools that are built with ceiling fans and natural ventilation (infiltration) as the principal sources of air movement. The output results could help with school construction. Designers and stakeholders to enhance the thermal environment conditions in such institutions classrooms. The following are the study's main accomplishments it is fair to infer from this research that Design Builder is a suitable simulation tool for evaluating thermal comfort conditions and estimating energy consumption for public school buildings.

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