"Hospital's Thermo-neutral Zone for Patient Safety and Climate Change Sustainability

Tariq H. Abdtawfeeq[1], Ahmed Hasson[1], Waleed Khalid AlAzzawi[1]

1 Al-Farahidi University (AFU)

Funding: Al-Farahidi University and Al-Kademia Teaching Hospital

Potential competing interests: No potential competing interests to declare.

Abstract

The efficacy of Iraq's direct heat recovery system is influenced by the nation's architectural design, particularly in view of the escalating climate conditions. There is an increasing worry on the necessity to openly address the local building patterns in Iraqi cities due to the challenging task of mechanically cooling buildings in the absence of electricity. The model was built using data obtained from field research carried out from January 2021 to March 2022. The field measurements of microclimatological parameters were carried out between March and August 2022 in order to evaluate the accuracy of the models. This methodology showcases the potential to make accurate predictions of future air temperatures by utilising variables as low as 5 percent. The air temperature decreases by 0.5 °C for every G increase across an area of 0.03-0.20 m2/m2, which is equivalent to a Leaf Area Index (LAI) of 4.5 m2/ha. This work introduces a standardized approach for assessing thermal comfort in real-world settings. The study examines the continuous use of hybrid ventilation systems at Kadhimiya Teaching Hospital to ensure a consistent air quality in the wards. Installing temperature control systems in these sites is vital to provide thermal comfort, as it serves as a potentially effective but expensive measure to address the impacts of climate change. Installing fans in military fortifications in Iraq seems to be a cost-efficient and uncomplicated approach to enhance their resilience against the escalating heat caused by the projected effects of global warming. However, when assessing the thermal comfort of buildings in Iraq's present and future climates, the established method proves to be considerably more advantageous.

Tariq H. Abdtawfeeq[1], **Ahmed M. Hasson**[2,*], **Waleed Khalid AlAzzawi**[1]

[1] *College of medical technology, Al-Farahidi University, Baghdad, Iraq*

[2] *Architecture College of Technical Engineering, Al-Farahidi University, Baghdad, Iraq*

[*] E-mail: am.hasson2@gmail.com

Keywords: sustainable buildings; thermal comfort; ventilation; ward temperature.

1. Introduction

The concept of "sustainable construction" refers to construction methods that aim to reduce waste, preserve the environment, and adhere to all relevant regulations while maintaining high standards of quality and safety. Extensive research in the field of construction management has been dedicated to the study of green building practises since the 1980s [1]. The topic of expediting and enhancing the implementation of sustainable construction practises is currently garnering significant interest within both the academic and practical realms [2][3][4][5]. The study contractor selection for green buildings based on the fuzzy Kano model is grounded on the discovery that regulatory incentives [6][7][8], developer acceptance [9][10], a well-established supplier chain [11], and high-quality construction green building certification and compliance (CGCC) [12][13] are all factors for the actualization of green construction.

The implementation of green building practises is predominantly undertaken by contractors, and the extent to which the project's green building goals are achieved is significantly influenced by the Construction Green Building Certification (CGCC) programme.. There has been a significant rise in the quantity of research endeavours focused on CGCC during the previous decade or two. However, it remains uncertain to what extent we have advanced in comprehending this phenomenon. It is evident that our present state of knowledge surpasses that of previous eras. However, further elucidation is required about CGCC and its operational mechanisms [14]. The extensive use of ideas and concepts from diverse fields is mostly accountable for this phenomenon observed in CGCC. Scholars hailing from a variety of disciplines, including enterprise management,construction management, environmental management, and sustainability, contribute to the academic literature by publishing both empirical and theoretical research on the concept of Corporate Governance and Corporate Citizenship (CGCC) in numerous scholarly publications. This multidisciplinary approach results in a plethora of interpretations of CGCC from multiple perspectives, thereby enriching the understanding of this concept. Consequently, the existing comprehension of CGCC remains inadequate. Significantly, there is a notable lack of comprehensive discourse within the scholarly community regarding the correlation between these findings across other disciplines and a broader framework for the idea of CGCC.

The objective of this research is to provide insight into the interconnectedness across many disciplines within the subject of CGCC. Hence, the objectives of this study are to (1) conduct a comprehensive evaluation and critical examination of the current body of research on CGCC, (2) consolidate the outcomes into a cohesive, multidimensional, and interdisciplinary knowledge framework, and (3) identify potential areas of research that have not been adequately explored, with the aim of suggesting future directions for investigation.

Our review presents several significant contributions to the study and implementation of CGCC. Green construction refers to construction activities that maximize resource conservation and reduce the negative impact on the environment while ensuring quality, safety, and other basic requirements. Since the 1980s, a substantial amount of construction management research has focused on green construction Initially. Furthermore, an integrated framework was constructed in order to organise the existing literature and establish a foundation for future researchers to further develop the field and provide guidance to professionals.

Shade, dense building styles, and trees all have an effect on solar heat gains from typical, intensive construction in Iraqi metropolitan districts. Consequently, there is very little heat gain, even during the warmest months of the year. Improvements in system design over the past several decades have made it possible for thermal storage mass direct heating systems to operate at optimal efficiency during the summer when demand for heat is lowest. The design of direct cool temperatures recovery systems, which take advantage of the generous control of a sky viewing factor that reduce the input solar radiation in surrounding buildings, must therefore take environmental factors into account. As a result, the world is paying more attention to environmentally responsible building and service methods [15].

Determining the scope of CGCC is the first order of business. Following this, we detail our systematic evaluation process in great detail. Next, we provide a descriptive literature review, then systematically categorise and synthesise the existing literature according to keyword co-occurrence data, and finally, we propose a framework for synthesis. Then, we will go over the study's theoretical and practical implications. Lastly, we go over the review's caveats and where we think CGCC research should go from here. Designing comfortable hospitals in dry hot climates requires architects to consider the heat generated by patients and medical equipment. This approach works well for most high-end structures in Iraq. Additionally, since solar inflow varies with latitude, many regions experience warming summer breezes. In Iraq, cold air typically moves in from the west as part of the prevailing weather patterns. Theoretical studies suggest that urban heat has become a crucial issue in the world's largest cities [16][17]. To accurately assess heat load, the commission plans to run a simulation that incorporates the work of other works [18][19] Ozaki measures ambient temperature by considering the internal properties of materials [20]. The hospital's dual ventilation system incorporates both automatic and manually operated doors. This study aims to evaluate potential renovation outcomes for passively ventilated closets with regards to comfort.

2. Methodology

2.1. The Al-Kadhimiya Teaching Hospital Structure

Since its initial construction in (1987), Baghdad, the of Iraq`s capital, located at 60 street north east Baghdad city, has a hot desert climate. The summer months, from June to August, are extremely hot with temperatures averaging between 40°C and 45°C. The winter months, from December to February, are mild with temperatures ranging between 10°C and 15°C.very little changes have been made to the four-story hospital, where the wards rise from the podium's lower three floors. The first and second temperature control devices were set up in three distinct wards and a nursing station on the ground level. The wings at the top, like the area, take up the entire width of the tower on level (2) (18.3 m). There are five meters of guards on the sixth floor. The hospital occupies the bulk of the edifice. North-west corner and both ends of the separate elevator tower (Fig.1).

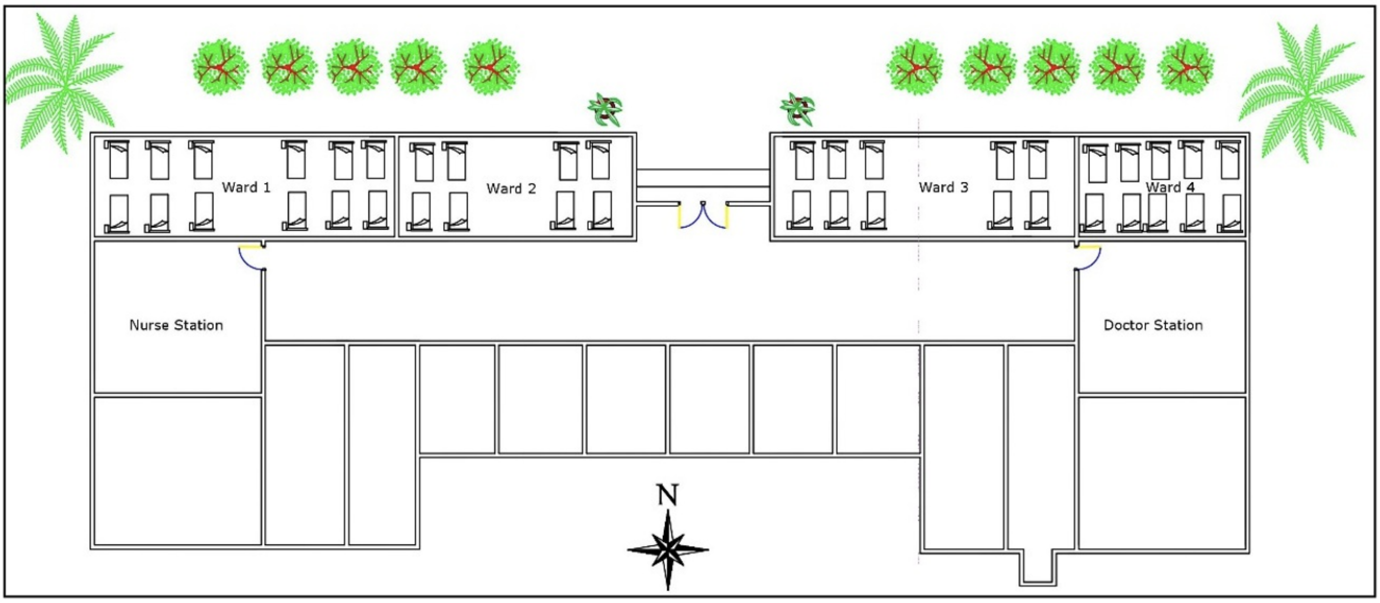

Figure 1. Al-Kadhimiya Teaching Hospital Ground Floor Plan (Source, authors).

By comparing the expected and measured temperatures, a dynamic thermal model was calibrated. It was challenging to adjust the model such that it matched the observed exceedances of the BSEN15251 envelopes' upper and lower bounds. It is challenging to reproduce the impact of occupants on building temperatures in free-running structures, which is why this is the case. The model was built using data collected in the field from January 2021 to March 2022. Field measurements taken between March and August of 2022 were utilized to check the accuracy of the models. The study involved measuring various meteorological parameters, including average, minimum, and maximum air temperatures, total solar irradiation, reference point incidence, and reflected hemisphere sun radiation (0.3-3 micro). These measurements were conducted using the Eppley 4-48 pyrometer, which was positioned horizontally on the device. The production of shielded copper-constantan thermocouples and anemometers is being discussed. Thermocouple Technology, LLC is a company specialising in the development and application of thermocouple technology.

The Penman-Monteith equation is frequently suggested as the established method for calculating the reference evapotranspiration (ET 0) and assessing other ET 0 equations. One significant limitation of this equation is its reliance on weather data, such as solar radiation or sunlight hours (n), which may not always be readily accessible. Given the absence of solar radiation data and the limited availability of n data in Libya, the primary aim of this work was to provide a dependable equation for the estimation of sunshine hours (n e) in order to assess monthly ET 0 in arid locations.

The collection of air temperature data is conducted through the utilisation of shielded copper-constant thermocouples. The albedo of the Earth's surface was determined by subtracting the average amount of light reflected from the average amount of light obtained via shortwave radiation. Greenfield coverage as a percentage of total land area, the ratio of real sunshine hours to estimated sunshine hours (n/n), and wind speed (WS). The percentage of land area within a circle with radii of 50 and 100 meters.

Daily monthly average air temperature was monitored by means of shielded copper-constantan thermocouples. Total solar radiation. The ratio of daily total reflected, and incoming shortwave radiation was calculated for surface albedo, actual sunshine hour's ratio n/N, wind speed, relative humidity.

Above the medical center, a sensitive anemometer was installed to measure wind velocity. Analogue transmissions from a Hewlett-Packard/Compaq. The data gathering system was linked to the output data on an hourly basis using a Hewlett Packard 9845 B computer.

The sum of all the stories was tallied at the medical center. Primary ward features and surrounding vegetation were analyzed. Under the umbrella word "G." is the H / B ratio, which compares the height to the width of the building. Reactive analyses are carried out to learn the temperature dependence of each air parameter. For the purpose of the sensitivity analysis performed on the basis of conditions on 10 June 2022, the data from the Baghdad Weather Station are summarized in Table 1.

Climate Factors	Data
Reference Minimum Air Temperature	26.6 C
Reference Average Air Temperature	38.6 C
Reference Maximum Air Temperature	50.5 C
Reference Incoming Total Solar Radiation	33.4 $MJ/m^2/d$
Reference Outgoing Solar Radiation	6.6 $MJ/m^2/d$
Reference Maximum Solar Radiation	3.24 $MJ/m^2/d$
Reference Incident Solar Latitude	80 degrees
Reference Sunshine	14.3 hours
Reference Wind Speed	6.5 m/s

Table 1. Input on climate predictors based on data at the local weather station on 10 June 2022.

Data from the local Weather Station and Research Center in Baghdad for the prediction of air temperature including minimum, average maximum air conditioning, gross incoming, outgoing solar radiation, wind speed, precipitancy, and sunset durations. The other measurement parameters H / B, A covered, A opened, G covered, W area are simple to obtain. The estimate of albedo, LE, and n / N.

3. Results and Discussion

3.1. Air conditions and Temperature

To determine how fast the wind was blowing, a sensitive anemometer was dangling from the roof of the hospital. The analog signals were from an HP or Compaq computer. each HP 9845 B computer was used to connect the data collection system to the output data once each hour.

According to Kruger and Givont, estimation, ambient temperature is one of the most important factors in the natural world. It all started with counting floors at a hospital [21]. Key characteristics of wards and the green area immediately adjacent to them were examined. The letter G also includes the height-to-width ratio, or H / B ratio, of the building. To learn how all air characteristics change with temperature, reactive analyses are performed. The results of the sensitivity analysis are based on the state of affairs on June 10, 2022.

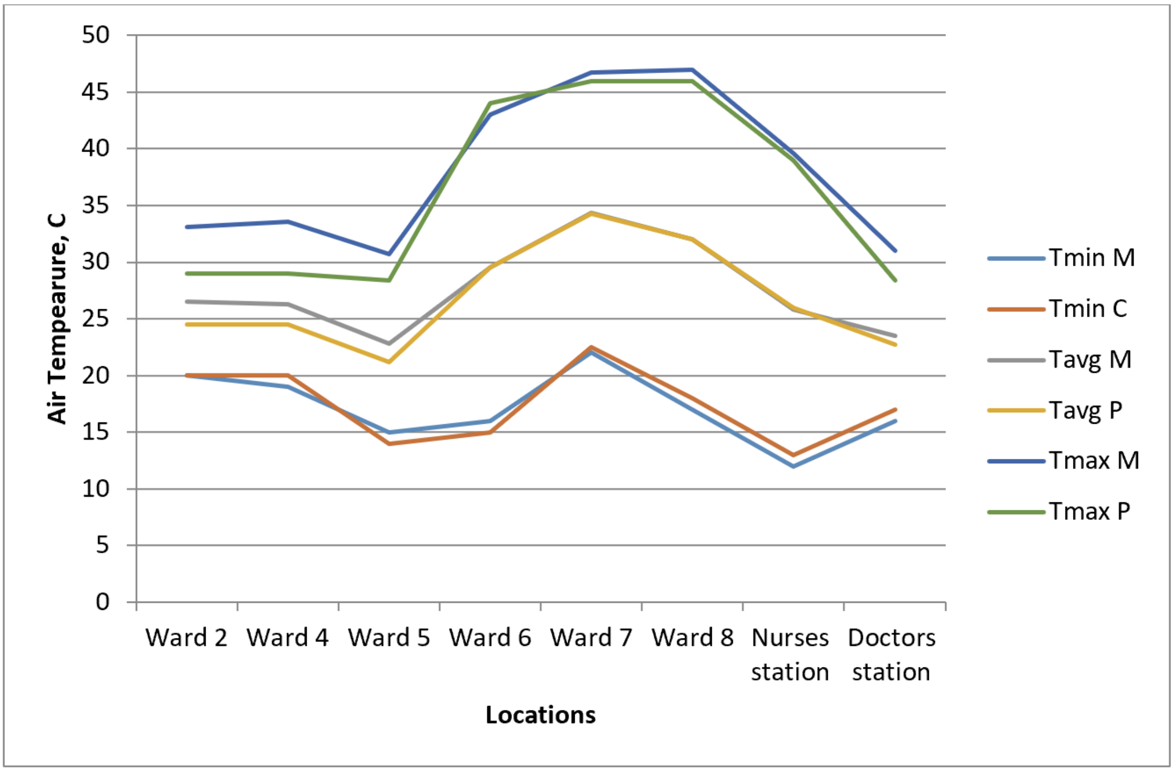

Figure 2. The values of between the minimum, average, and maximum air temperatures comparisons. (measured, M, calculated, C predicted, P)

Figure 2 displays the minimum, median, and typical air temperatures (measured, M, calculated, C predicted, P). Low, average, and high temperatures are tracked based on how the air behaves near plants based on their Leave Area Index, LAI. Increasing plant cover has been shown to reduce air temperature maxima (Table 1). The green ratio shielded G and the sky, and LAI determined the mean temperature. Diffused sunlight from a low above sky helps to maintain a comfortable temperature. It has a high LAI, which accounts for its vibrant green color. The average air temperature reduces by 0.5 °C with every G increment over a 0.03-0.20 m^2/m^2 area, which is equivalent to an LAI of 4.5 m^2/ha. The green density modifies sky penetration, which in turn modifies maximum air temperature by shading effect [22][23]

	Inter (a)	Slope (b)	Area covered %	Q_t	G cover	H/B ratio	W area	N	α	R^2	F	SE
T min	2.04	0.886	0.007		0.210	0.032	2.0E-5			0.90	1805	0.53
T avg	5.76	0.746	0.006	2.0E-02	0.03	-0.025	1.0E-02	0.33		0.68	334.5	0.37
T max	17.17	0.431	0.009	0.13		0.18	5.3E-03	1.333	.98	0.46		

Table 2. Relationships between air temperatures and reference climatic factors at Baghdad.

When buildings are raised to higher heights, the surrounding air temperature is influenced to remain low, average, and typical (Table 2). Because of the cooling effect of looking up towards the sky. As a result of the increased LAI. Table 2 and Figure 3 display the variables used in the sensitivity analysis that were modified in the various temperature models. Small (5%) variables are used in this approach to construct accurate predictions of future air temperatures. In regression, the variables work in the other direction.

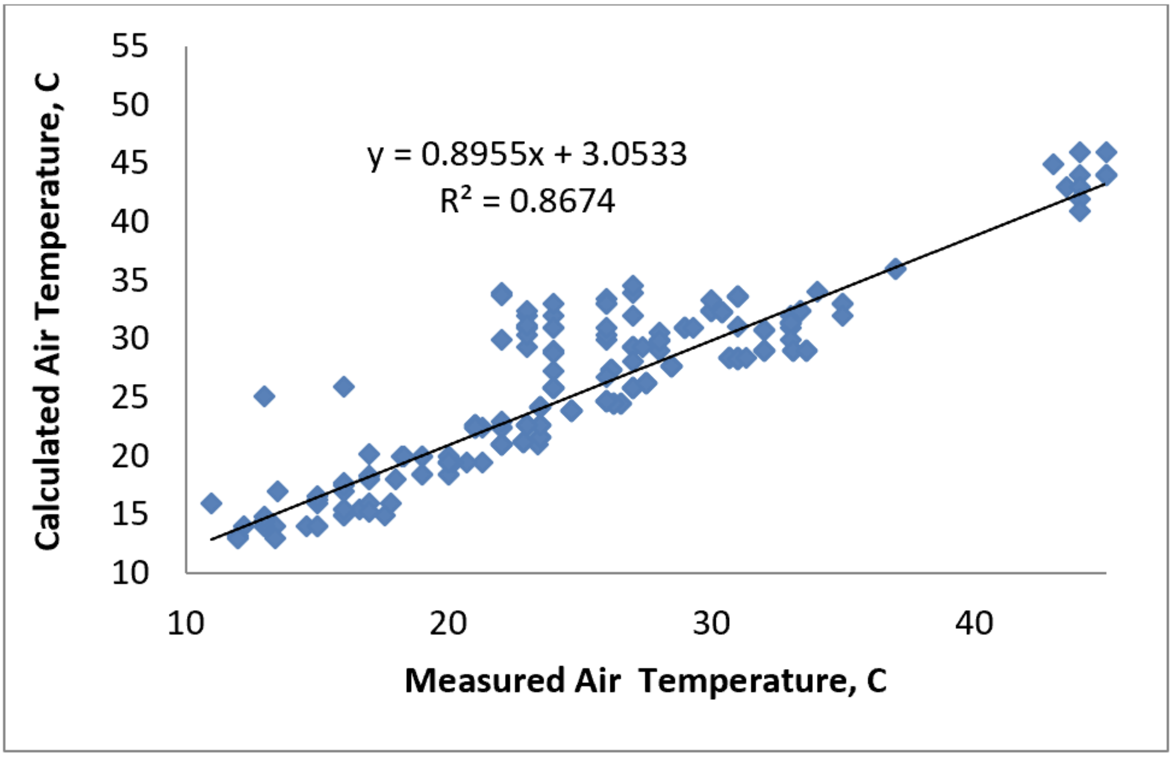

Figure 3. Relationships between calculated and measured temperature.

3.2. Thermal Comfort Evaluation for Hospitals

Increases in building height have a moderating effect on the ambient air temperature, keeping it near the norm regardless of the building's height (Table 2). Because taking in expansive views of the sky can help you feel more refreshed. Given the higher LAI. In Table 2 and Figure 3, we can see the sensitivity analysis variables that were changed in the different temperature models. This method uses relatively small (5%) variables to create reliable forecasts of future atmospheric temperatures. Contrary to what one might expect, in regression the variables are the ones that change directions.

3.3. Easy Criteria for Overheating

In the 1980s, engineers working on dynamic thermal models that recorded the temperature inside a building once an hour had to devise ways to simulate actual overheating [3]. This is especially crucial for autonomously operated passively heated and cooled structures, which was considered by Lomas et al. [24]. Although no field study had linked internal temperature with a thermal comfort impression by the late 1980s, academics and technology practitioners had created practical proposals based on the engineering assessment. Other research [25][26] revealed four unique sets of parameters. The idea of utilizing severe days to test compliance with the same requirements was first proposed in the late 1990s; these days are a UK approach that has little to do with climate change when they were provided.

Neither the standard procedure nor the possible outcomes of picking a particularly difficult year for development are questioned. There is no theory or data to back up the paper's claim.

Average daily air temperatures throughout the summer months of June, July, and August indicated that the forecasted year was the third warmest out of the previous 20. When it comes to commercial and institutional buildings in modern Iraq, "6 percent yearly occupied above 30 °C" is deemed acceptable, while "the appropriate temperature is 37 °C in warm weather." Because of imprecise service descriptions, compliance requirements are not met. In the Handbook, we get a high-level summary of the few data we have on the internal workings. Without air conditioning, it is recommended that classrooms and businesses adhere to the 32 °C/6% humidity norm. The Giridharan et al. HTM03-01 Technical Memorandum [27] details hospital-specific internal design characteristics for single and generalized stations with ventilation.

No information on nighttime lows is provided, and nursing stations do not offer any direct protection for the weather data that will be used to decide eligibility. The memorandum does not touch fans or other forms of low-energy cooling devices.

Thermal comfort and the ability to sleep through the night in a hospital setting are of utmost importance for patients, family members, and medical staff. The literature review highlighted the vagueness of the criterion, in part because, as is typical, thermal comfort is unrelated to sleep due to "this mindset which conveys thermal environments' happiness." Table 3 lists the climate variables that influence well statistically.

Table 3. The influencing climate variables

Variables	Intercept (a)	Slope (b)	R^2
Mean Well-being x Mean hourly Temperature (Clear sky)	0.1	2.38	0.80
Mean Well-being x Mean hourly Temperature (Dusty sky)	0.07	1.1	0.52
Mean Well-being Temperature x Mean hourly Temperature (Clear sky)	0.71	2.38	0.91
Mean Well-being x Mean hourly Temperature (Dusty sky)	0.58	1.03	0.68
Mean Energy Reduction x TSD	0.005	23.5	0.63

Many studies have shown positive correlations between higher temperatures and happier people, but less is known about the link between a less polluted environment and happier people [28][29]. No one in Baghdad, Iraq, or the Gulf region seems to connect the dots between deadly air temperatures and health problems. The impact of dust and heat on orange can now be better understood. The primary objective is to discover a quick and cheap approach to measuring how temperature affects people's health and happiness.

The other objective is to examine the connections between dusty regions and thermal fluxes and idle heat. Baghdad's daytime temperature and general health are discussed in terms of their hourly values throughout the summer's dusty and dust-off cycles.

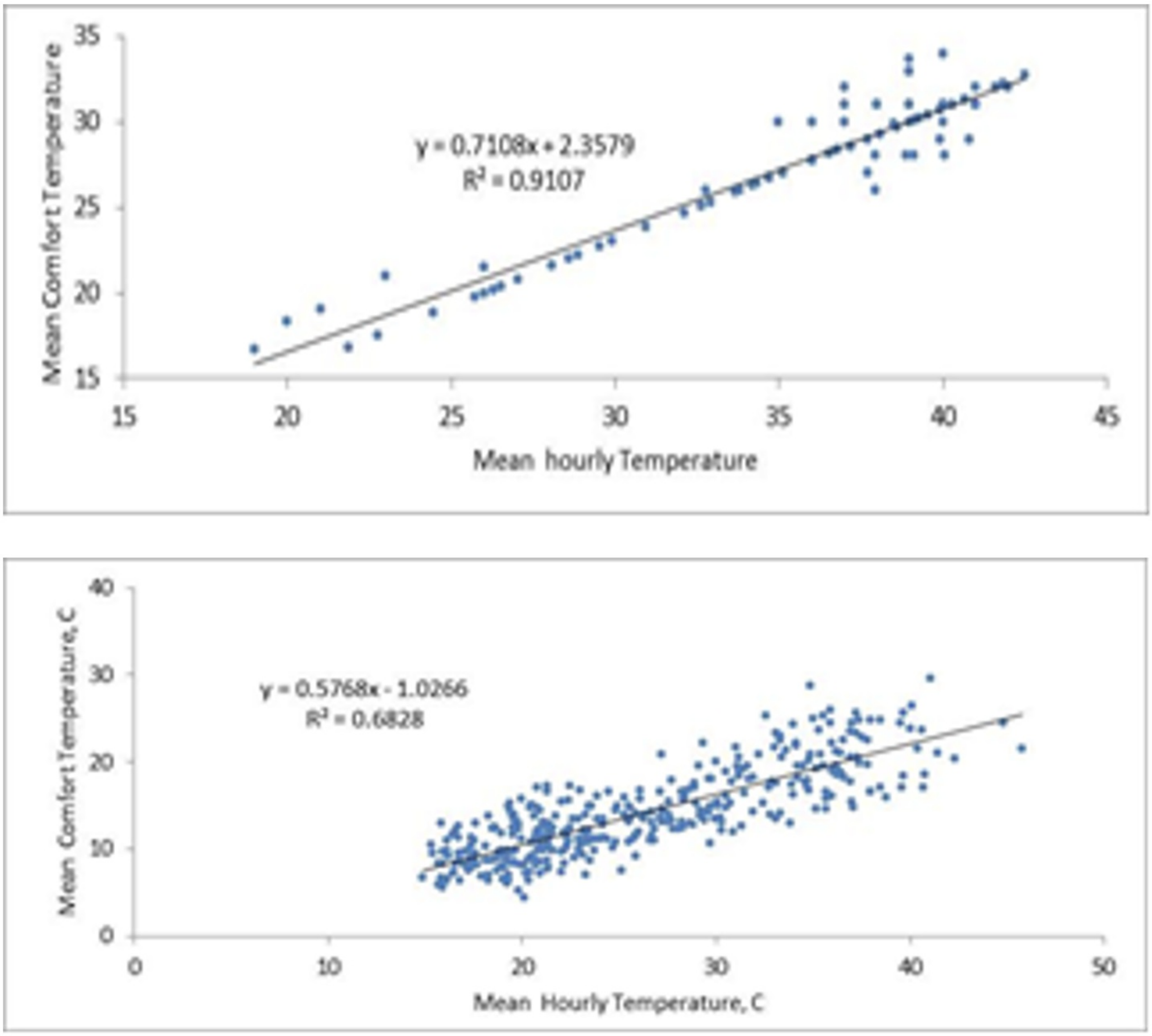

Figure 4. Relations between idling heat and dusty regions with the thermal fluxes.

Figure 4 presents a statistical breakdown of the climate variables that have an impact, although the null hypothesis that environmental heat impacts are larger than poisoned storms cannot be rejected. Heat waves and dust storms are only two examples of how climate change has negatively impacted human health and well-being. This adaptive behavior just needs to account for the orange dust concentration, according to the discussion of factor comparisons between extreme weather and this behavior [30][31].

While several studies have examined the correlation between temperature and other variables, less attention has been paid to the correlation between goodness and the presence of dust in the air. It is not often known that toxic or extremely hot weather can strike the Gulf region, which includes Baghdad, Iraq. The results of this study shed light on the effects of dust and heat. The primary goal at this time is to locate a simple and inexpensive approach to estimating the degree to which temperature affects human health [32][33]. The other goal is to look into how dusty places are related to thermal fluxes and unused heat. It is explained why the daytime and nighttime values of dusty and dust hours in Baghdad during the summer are the way they are.

Baghdadis' quality of life, health, and productivity suffer when they are subjected to the city's dangerously high temperatures and thick layers of orange dust.

Also, climate change over the next few decades will exacerbate both outdoor and indoor pollution. City-specific regulations for improving outdoor climate can play a significant role in reducing the effects of climate change if individuals and governments work together to implement them. In order to reduce air temperature and prevent future dangerous dust events that threaten the health of people in Baghdad and its neighbors, the fight against desertification will develop forested areas and regenerate range land in the region.

3.4. Criteria of Adaptation

Artificial and natural ventilation systems are utilized interchangeably in hospitals. The population's thermal responses in unrestricted areas and those in restricted areas (such as those with artificial heating and cooling) have historically differed [34][35]. Such systems continue to sway now due to variations in climate and other extraneous influences like people's thermal expectations. An engineering vibration design is used for the evaluation [36][37]. In addition, the use of renewable energies like wind technology is essential for sustainable urban and building construction (Figures 5-6).

Patients have grown accustomed to and appreciative of the cozy atmosphere in the facility. The temperatures in abandoned buildings are unbearable. There should be more than just ordinary air conditioning; there should be areas that reflect the weather, the season, and the culture. Because of the people that work and visit hospitals in Iraq, the temperature almost always needs to be changed. Hospitals work hard to reduce patients' need to stay overnight so that they can better accommodate their patients (and guests). Numerous field studies lend credence to the idea of temperature adaptation. [29]. Adaptive thermal comfort standards have led to an appropriate rise in interior temperature and the acceptance of all adaptive requirements on operating temperature OT. There has been a recent rise in ambient air temperature.

The primary contention is that the adaptive parameters are given too much leeway due to the large number of factors that can influence thermal comfort. Given the foregoing, it is appropriate to utilize adaptive comfort measurement in line with the research of De Dear and Brager [30] to foresee whether hospital patients in Iraq may be uneasy in the future based on the criterion [33]. Since 2004, the ASHRAE thermal comfort envelopes have been used as the basis for this design. A. Ballinger. 1992 [19].

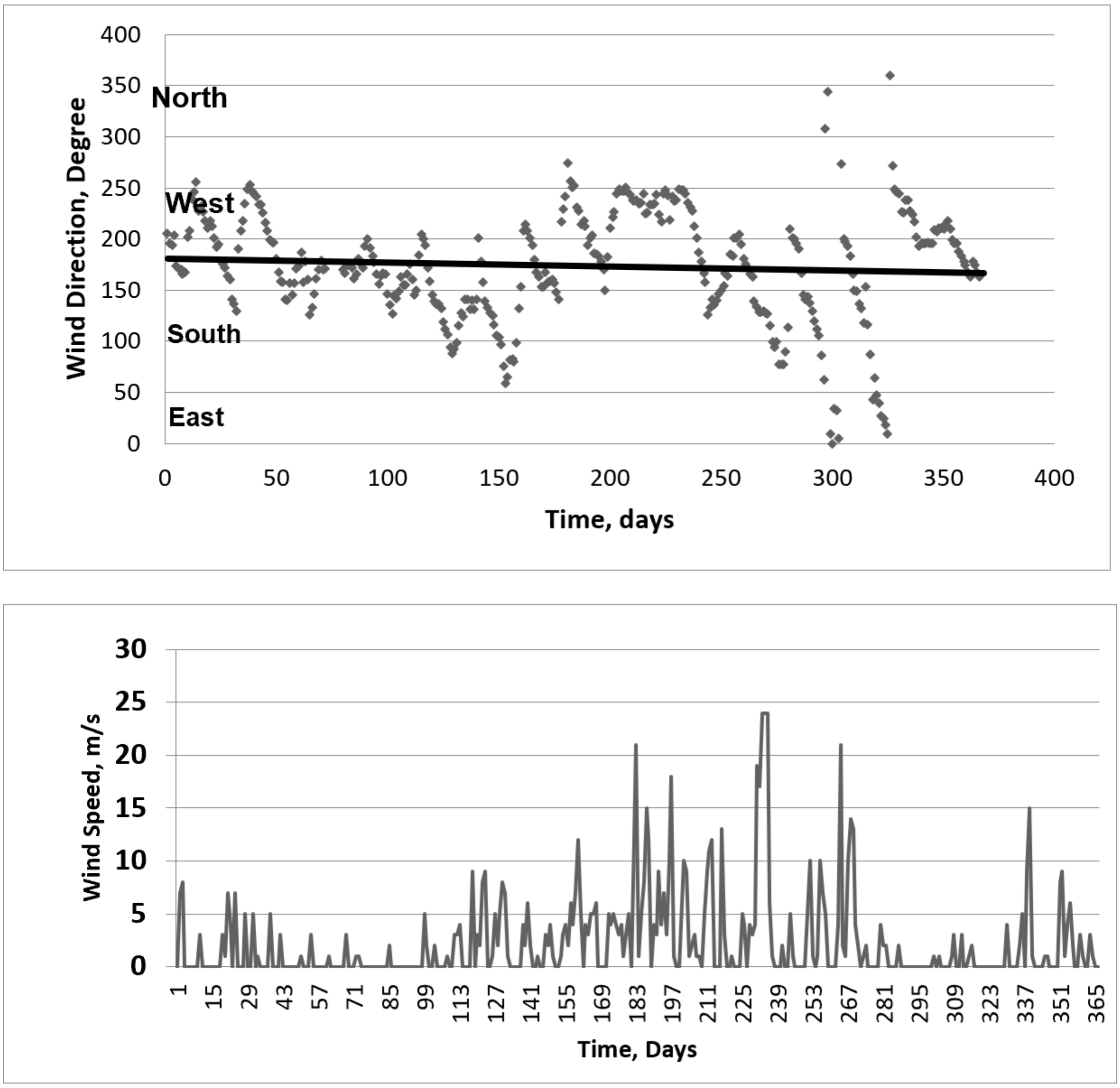

Figure 5. Wind speeds and directions during the year days.

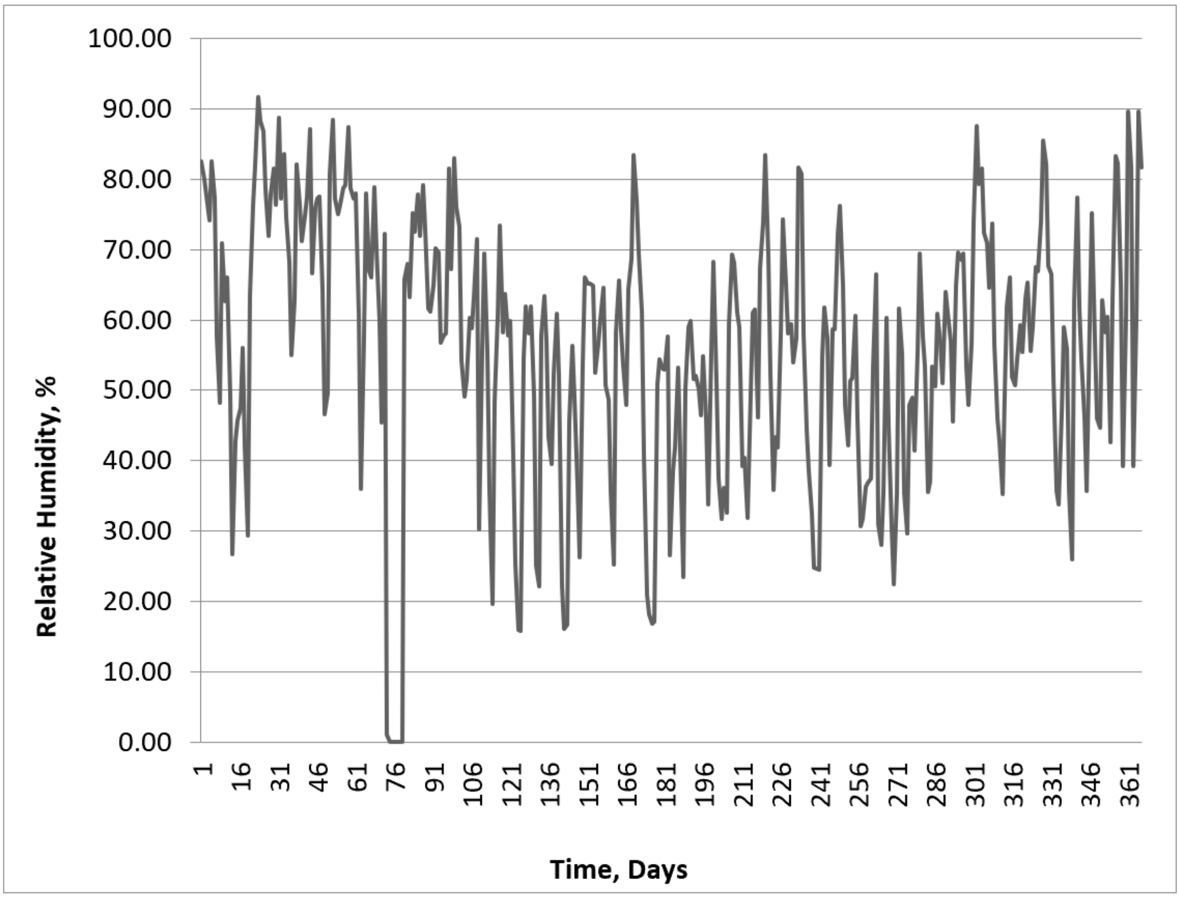

Figure 6. Relative humidity of year days.

3.5. Monitoring

During the hot summer months, three independent hospital wards exceeded the temperature range anticipated by the thermal comfort adaptive model despite low-level monitoring. Since indoor temperatures tend to rise when outside temperatures rise, this feature ensures that the two remain in equilibrium (as seen in Fig. 7). If the nurse's station doesn't have access to electricity, the temperature can rise, causing discomfort for the nurse and the patient. It's likely that energy power heat is escaping through windows and ceilings that aren't properly insulated, leading to overheating. Because no windows can be opened and the radiant ceiling thermostats don't work, people are more agitated than usual because they have no means to monitor the temperature where they are.

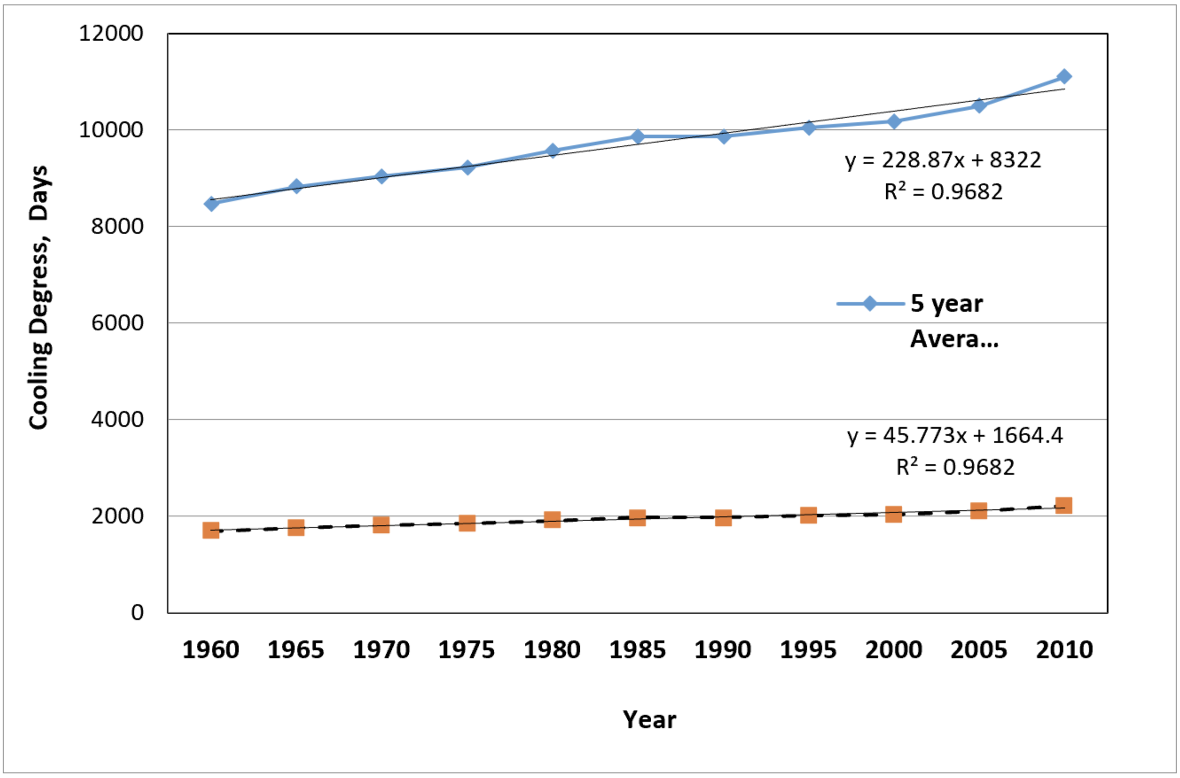

Figure 7. The relationship between cooling degrees and years for the period 1960-2010.

In hot climates, where heat waves and extreme weather are typical, unregulated internal heating makes structures more tolerant to overheating. Therefore, sound procedures in the field of renewable energy are essential for boosting power supply and keeping or reviving the health of the energy industry. These modest costs won't have much of an impact on the hospital's day-to-day operations. Maintenance on a regular basis helps reduce fuel costs and carbon emissions.

4. Conclusions

The sensitivity analysis of the air temperature estimation models showcased the efficacy of the models' parameters. The arrangement of the building and the flora surrounding it are mutually enhancing. The management of buildings has a crucial role in reducing the adverse effects of heat on the workplace in Baghdad and its adjacent suburbs. The preservation and improvement of the industrial ecological system must be prioritised and safeguarded at any expense. At certain instances, employees require additional space to expand, hence augmenting the influx of natural light into the workplace. The air in this region is cooled by both evaporation and the shade produced by the surrounding vegetation. This approach enables precise forecasting of future atmospheric temperatures by utilising variables as small as 5 percent. Modifying the height of structures to higher levels (as shown in Table 2) is a method of maintaining the ambient air temperature at a moderate, average, and typical level. taring up at the sky has a cooling impact due to a straightforward reason. Due to the significant increase in Leaf Area Index (LAI). The altered variables in the various temperature models for the sensitivity analysis are displayed in Table 2 and Figure 3.This method generates precise forecasts of future air temperatures by utilising a minimal number of variables (5%).Regression entails the reversal of the direction of action for the variables. Technicians in the building sector should fine-tune the model's settings to optimise it according to the specific requirements and financial constraints of the project. This study aims to initiate a discussion on the sufficiency of current thermal comfort criteria in assessing a building's ability to adapt to climate change and its potential consequences. The integrated method of monitoring and modelling used should be applicable to evaluating the risk of overheating in different types of buildings.

Acknowledgments

The authors express their gratitude to Al-Farahidi University's chancellor for effectively cooperating with the Ministry of Health in order to collect and collate the requisite data. The researchers express their gratitude to the Technical Engineering College at Al-Farahidi University for providing funding for the endeavour.

Other References

- de Dear, R. J., & Brager, G. S. (1998). Developing an adaptive model of thermal comfort and preference. ASHRAE Transactions, 104(1a), 145-167.
- Jeary, A. P. (1997). The wind climate of Hong Kong. Journal of Wind Engineering and Industrial Aerodynamics, 72, 433-444.

References

1. ^*Mokhlesian, S.; Holmén, M. Business model changes and green construction processes. Constr. Manag. Econ. 2012, 30, 761–775.*
2. ^*Almalkawi, A.T.; Balchandra, A.; Soroushian, P. Potential of using industrial wastes for production of geopolymer binder as green construction materials. Constr. Build. Mater. 2019, 220, 516–524.*
3. a, b*Onubi, H.O.; Hassan, A.S. How environmental performance influence client satisfaction on projects that adopt green construction practices: The role of economic performance and client types. J. Clean. Prod. 2020, 272, 122763.*
4. ^*Cheng, B.Q.; Lu, K.; Li, J.C.; Chen, H.H.; Luo, X.W.; Shafique, M. Comprehensive assessment of embodied environmental impacts of buildings using normalized environmental impact factors. J. Clean. Prod. 2022, 334, 15.*
5. ^*Cheng, B.Q.; Huang, J.L.; Lu, K.; Li, J.C.; Gao, G.B.; Wang, T.P.; Chen, H.H. BIM-enabled life cycle assessment of concrete formwork waste reduction through prefabrication. Sustain. Energy Technol. Assess. 2022, 53, 9.*
6. ^*Cheng, B.Q.; Chang, R.D.; Yin, Q.H.; Li, J.C.; Huang, J.L.; Chen, H.H. A PSR-AHP-GE model for evaluating environmental impacts of spoil disposal areas in high-speed railway engineering. J. Clean. Prod. 2023, 388, 135970.*
7. ^*He, L.; Chen, L. The incentive effects of different government subsidy policies on green buildings. Renew. Sustain. Energy Rev. 2021, 135, 110123.*
8. ^*Cheng, B.Q.; Huang, J.L.; Li, J.C.; Chen, S.H.; Chen, H.H. Improving Contractors' Participation of Resource Utilization in Construction and Demolition Waste through Government Incentives and Punishments. Environ. Manag.*

2022, 70, 666–680.

9. ^*Cai, J.; Li, Z.F.; Dou, Y.D.; Teng, Y.; Yuan, M.Q. Contractor selection for green buildings based on the fuzzy Kano model and TOPSIS: A developer satisfaction perspective. Eng. Constr. Archit. Manag. 2022.*
10. ^*Tran, Q.; Nazir, S.; Nguyen, T.H.; Ho, N.K.; Dinh, T.H.; Nguyen, V.P.; Nguyen, M.H.; Phan, Q.K.; Kieu, T.S. Empirical examination of factors influencing the adoption of green building technologies: The perspective of construction developers in developing economies. Sustainability 2020, 12, 8067.*
11. ^*Sun, H.F.; Mao, W.X.; Dang, Y.G.; Xu, Y.S. Optimum path for overcoming barriers of green construction supply chain management: A grey possibility DEMATEL-NK approach. Comput. Ind. Eng. 2022, 164, 107833.*
12. ^*El-Sayegh, S.M.; Basamji, M.; Ahmad, A.H.; Zarif, N. Key contractor selection criteria for green construction projects in the UAE. Int. J. Constr. Manag. 2021, 21, 1240–1250.*
13. ^*Gurgun, A.P.; Koc, K. Contractor prequalification for green buildings—Evidence from Turkey. Eng. Constr. Archit. Manag. 2020, 27, 1377–1400.*
14. ^*Nikoofard, S., Ugursal, V., & Beausoleil-Morrison, I. (2011). Effect of external shading on household energy requirement for heating and cooling in Canada. Energy and Buildings, 43, 1627-1635.*
15. ^*Oke, T. R., & Eas, C. (1971). The urban boundary layer in Montreal. Boundary-Layer Meteorology, 1, 411-437.*
16. ^*Padmanabhamurty. (1990 & 1991). Microclimates in tropical urban complexes. Energy and Building, 15(3-4), 83-92.*
17. ^*Sani, S. (1990 & 1991). Urban climatology in Malaysia; an overview. Energy and Building, 15(3-4), 105-117.*
18. ^*Swaide, H., & Hoffman, M. E. (1990). Prediction of urban air temperature variations using the analytical CTTC model. Energy and Building, 14, 313-324.*
19. [a, b]*Eliasson, I. (1996). Urban nocturnal temperature, stress geometry and land use. Atmospheric Environment, 30, 379-392.*
20. ^*Giridharan, R., Lau, S. S. Y., Ganesan, S., & Givoni, B. (2007). Urban design factors influencing heat island intensity in high rise density environment of Hong Kong. Building and Environment, 42, 3669-3684.*
21. ^*Hasson, A., & Alaskary, A. (2013). Potential of effect microclimate factors in environmental design of building in Iraq context. International Journal of Science and Engineering Investigations, 2(15), 83-86.*
22. ^*Asawa, T., Hayano, K., & Nakaohkubo, K. (2008). Thermal design tool for outdoor spaces based heat balance simulation using a 3 DCAD system. Building and Environment, 43, 2112-2123.*
23. ^*Ozaki. (2004). Cabinet simulation of heat and air and moisture on the cooling energy. SMASH, IBEC, 49, 25-29. (In Japanese).*
24. ^*RezaHoseini, A.; Noori, S. Integrated scheduling of suppliers and multi-project activities for green construction supply chains under uncertainty. Autom. Constr. 2021, 122, 103485.*
25. ^*Kruger, E., & Givont, B. (2007). Outdoor measurements and temperature comparison of seven monitoring stations, Brazil. Building and Environment, 42, 1685-1698.*
26. ^*Lomas, K. J., Giridharan, R., Short, C. A., & Fair, A. J. (2012). Resilience of 'Nightingale' hospital wards in a changing climate. Building Services Engineering Research and Technology, 33(1), 81-103.*
27. ^*Cohen, R., Munro, D. K., & Ruyssenaars, P. (1993). Overheating criteria for non-air conditioned buildings. In CIBSE National Conference (pp. 132-142).*

28. ^de Dear, R. J. (1998). A global database of thermal comfort experiments. ASHRAE Technical Data Bulletin, 14(1), 15-26.
29. a, bISO. (1975). Standard Atmosphere (ISO 2533). International Standard Organization.
30. a, bMatzarakis, A., Rutz, F., & Mayer, H. (2000). Estimation and calculation of mean radiant temperature within urban structure. In R. de Dear, G. Kalma, & A. Oke (Eds.), Urban climatology at the turn of the millennium (pp. 375-378). A.A. Balkema.
31. ^Matzarakis, A., Rutz, F., & Mayer, H. (2000). Estimation and calculation of mean radiant temperature within urban structure. In R. de Dear, G. Kalma, & A. Oke (Eds.), Urban climatology at the turn of the millennium (pp. 375-378). A.A. Balkema.
32. ^Rashid, H. A. (2014). Microclimatic factors effect on productivity of the construction industry. Open Journal of Civil Engineering, 4, 173-180.
33. a, bDepartment of Health. (2007). Health Technical Memorandum 03-01: Specialised ventilation for healthcare premises. The Stationery Office.
34. ^ANSI/ASHRAE 55-2004. (2004). Thermal environmental conditions for human occupancy. American Society of Heating, Refrigerating and Air Conditioning Engineers.
35. ^Humphreys, M. A. (1978). Outdoor temperatures and comfort indoors. Building Research and Practice Journal, 6(2), 92-105.
36. ^McCartney, K. J., & Nicol, J. F. (2002). Developing an adaptive control algorithm for Europe: results of the SCATs project. Energy and Buildings, 34(6), 623-635.
37. ^ANSI/ASHRAE 55-2005. (2010). Thermal environmental conditions for human occupancy. American Society of Heating, Refrigerating and Air Conditioning Engineers.