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Investigation thermal comfort in urban environmental centres by combining traditional and modern principles

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ABSTRACT

Traditional cities have been able to provide thermal comfort to their residents through the use of simple physical principles related to the movement of air from cold areas high-pressure represented by a cold air gathering focal like the basements and the middle courtyard and shaded alleys to hot areas low-pressure such as large urban open courtyards that exposed to sunlight. However, due to the industrial revolution, The Urban development has deteriorated the traditional urban fabric, and it's environmental components, which provided urban fabric with thermal comfort reasons, have disappeared, and a modern urban fabric has emerged that does not take environmental considerations and thermal comfort into account. Here, the research tries to suggest a planning urban style that combines the Principles of architecture and traditional planning with a modern ideas that are appropriate for the times, achieving new urban centers within the city capable of providing thermal comfort to its occupants and creating an urban environmental vision to revitalize traditional urban areas by using vertical green walls.

Keywords: Investigation thermal comfort; urban environmental; combining traditional

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1. Introduction

The technical developments and the industrial revolution, brought about major changes and transformations in theshaping of contemporary built environment during the eighteenth and nineteenth centuries,and that were the reason for creating environmental problems, resulting urban expansion, high population and urban densities that led to phenomenon of urban thermal islands (UHI). That increased its impact on cities and there centres In general during summer season, in areas with a hot climate, which affected increased energy consumption and increased air pollution, as well as other environmental harms, which adversely affect levels of thermal comfort in urban areas [1]. In a closer look at the traditional cities and, we notice that these cities, through simple physical principles, have been able to provide thermal comfort for their occupants, depending on the principle of air movement horizontally from cold areas high-pressure to hot areas low-pressure, or vertically through the use of the chimney principle that is done by the air catcher, Or through the multi-storey open spaces of the building [2].Fromhere the research problemappearsin the lack of clarity of vision about the possibility and method of benefiting from the principles of traditional architecture and planning in providing thermal comfort to the urban areas.

1.1. The research aims

to reproduce urban centres, capable of providing thermal comfort for its users with a new environmental and urban style, that links the recipient's identity with the elements and formations of these canters, as they represent an extension of the elements and, environments familiar to the recipient that were and still are an essential part of its heritage.

1.2. Research assumptions

That vertical farming can be alternative source of air cooling in open urbanareas. while maintaining the principle of air movement in its traditional form, which can provide a thermal comfort in these urban environmental centres and improving the nature of their local urban climate.

1.3. Thermal comfort

Thermal comfort defined as the state of mind that expresses satisfaction with environmental heat [3,4]. (Fanger) defines thermal comfort as “a state of satisfaction when heat flows to and from the human body in equilibrium. That achieved when the body data (race rate and/or basic temperature and skin temperature) are within the range of human comfort” [5].

1.4. Standard model

The agreed standard through which thermal comfort indicators are measure in different environments. Standard indicators depend on a set of inputs, the results of which can be extracted either through special mathematical equations or through computer programs to produce values that are compared with the values of criteria for thermal comfort. The following are the most important of these criteria:

4.1 Predicted Mean Vote: PMVPMV is surveys of thermal comfort, taking places specializing in the thermal sense of people on a seven-point scale from cold (-3) to superheated (+3) was later approved as an ISO standard, in which it relies on equations derived from human-controlled physical assessments To determine thermal comfort. Fanger equations are used to calculate the expected average rating of PMV a set of environmental criteria (air temperature, average radiation temperature, relative humidity, air velocity, metabolic rate, dielectric insignia) [6].

1.5. Standard effective temperature SET

SET is a model of human response to the environment, and it is a comprehensive indicator of comfort that depends on equilibrium equations, which include the personal factors of clothing buffer, metabolic rate, and age. Defined as the dry air temperature in a standard virtual environment at 50% relative humidity, and an air velocity less than 0.1 m / s. In other words, the SET criterion is the temperature scale that affects relative humidity, average radiation temperature, and air velocity, taking into account the expected activity rate and the level of insulating clothing. This standard is a comprehensive indicator of comfort-seeking to integrate all six basics physical factors of thermal comfort in addition to physiological considerations [7]

1.6. Physiologically equivalent temperature PET

The PET standard defined as "the air temperature in a typical indoor environment in which the human energy budget is maintained at the same skin temperature as those subject to the conditions to be evaluated". Also, human thermal equilibrium is essential for hot climatic regions and it’s characterized by being a state of mind that transmits the state of saturation from the surrounding temperature [8]. Thus, reaching a level of thermal satisfaction is essential to the continued viability of urban space. Thus, the PET standard developed as an indicator that takes into account all basic thermoregulation processes, and it's one of the recommended indicators. Also, in the guidelines for urban and regional planners, as it used to predict changes in the thermal component of urban and regional climates as the temperature is between (35-23). A degree of Celsius is considered a little hot. However, studies have shown that humans interact differently with heat stress under different climatic conditions and cultures. The thermal comfort value of the PET standard will be adopted at a rate of (24-30) in Baghdad with a hot climate as a result of Recent studies in extreme weather are close to it [9]. Here comes Table (1) that shows the range of the values of each of the thermal comfort indicators and the recommended comfort zone for each value.

Table 1. Range of the values of each of the thermal comfort indicators, the recommended comfort zone, human feeling and physiological condition for each value [8]

PMV	SET	PET	sense	Physiological state
3.5>	>37.5	41	Too hot, absolutely uncomfortable	Evaporation system failure
3+ to 2 +	37.5-34.5	35	Hot, very unacceptable	Profuse sweating
to +2+1	30-34.5	29	Warm, uncomfortable, unacceptable	Sweating
to +1+0.5	25.6 -30	23	A little warm, a little unacceptable	Simple sweating, vasodilation
-0.5 ,+0.5	22.2-25.6	18	Comfortable, acceptable	Physiological stability
0.5- to 1-	17.5-22.2	13	A little cool, a little unacceptable	Narrowing in the vessels
to -1 -2	14.5-17.5	8	Cool, unacceptable	Simple body cooling
-2to-3	10-14.5	4	Too cold, totally unacceptable	The start of shivering

1.7. Description of the study area, Baghdad city, Iraq

Baghdad is the largest city and capital of the Republic of Iraq. It located in the centre and east of the country, on both sides of the Tigris River, which located at 33.34 latitudes and 44.40 longitudes in central Iraq. The climate of Baghdad characterized by being dry hot climate, cool summers, rainy winters, where temperatures during summer can reach 50 degrees Celsius and fall to zero during winter. Relative humidity in the city, in general, is low, and it can reach 70% as a maximum in January, and to 20% as a minimum in July. The average surface wind speed ranges between (3.6-2.4) m / s. Here comes Table (1) that shows the range of the values of each of the thermal comfort indicators and the recommended comfort zone for each value .As for the prevailing wind direction, it is from the northwest to large degree and a lesser degree from the southeast. According to the Köppen climate classification, Baghdad is located in a climate similar to that of New Mexico and Arizona. This type of climate requires special studies to measure the thermal comfort levels of urban users within urban areas. Although the overall planning for the city of Baghdad has gone through many developments from the design of Colts in 1917 to the comprehensive development plan for the year 2030, all of these developments and changes do not include measures of environmental impact of urban development that include changes in urban patterns and land use. As a result, this study focused on the importance of measuring changes in urban development planning through practical measurement methods and computer simulations to provide a consistent local climate that improves thermal comfort in the city of Baghdad.

2. Material and methods

The effect of vertical greening on the exterior walls of buildings on the external environment and its role in improving the local climate of Baghdad cityduring the summer will be studied and analysed, through the environmental simulation programs to study these effects, which are:

First: The (Envi-met v4.4(program, which is about a three-dimensional digital program, was used in this study to predict climate changes within the urban environment by entering several data and providing a large number of detailed local climate outputs. The motivation behind using this program was that field studies take a long

time and require multiple devices distributed within the study areas, but this program can predict with relatively acceptable accuracy the variables of the urban environment and the nature of the local climate [10] .

Second:)Rayman-Pro(, which is a simulation program dedicated to studying urban climate conditions, to extract thermal comfort indicators such as Average Expectation of Vote (PMV), Effective Temperature (SET) and Physiological Temperature (PET), which requires Regional data meteorology (air temperature, wind speed, air humidity, short and longwave radiation flows) and thermophysiological data (the type of activity and clothing [11]

2.1. Suggested study status (urban environmental centers)

Today, through the need for new strategies for urban dictation, as one of the methods of urban renewal to restore the activity and vitality for cities, and to reuse the abandoned spaces within their urban fabric to provide a new form of contemporary life. which, we try to link between the principles of traditional architecture, and contemporary ideas to create a new urban formation that is centered Urban environmental or, what is the research called (creative environmental urban centers) whose design is not characterized by a style of imitation and quotation, but rather by reflecting the essence of the old within a contemporary urban environmental production which will contribute to the development and revitalization of historic city centers or It is a new urban focus within the cities.The research presents a planning proposal in the city of Baghdad that depends on the integration of environmental, social and economic aspects through the approach between the principles of traditional planning and modern planning to achieve a sustainable planning pattern in harmony with the surrounding environment as well as the integration of the building system, building materials, and energy and with the least negative impact on the natural environment [12] .The traditional planning pattern achieves the aspects of environmental sustainability, as the nature of the climate plays the major role of making planning decisions, and design at all levels and interacting with all influencing factors, as it is considered part of a larger system in terms of building blocks that are organically and jointly interconnected, with progressive movement pathways interconnecting among them, The length and width depending on their importance and the specificity of the area in addition to the graduality in the privacy of patios, and internal, and external patios.The traditional fabric adapts to the surrounding environment at the level of the schematic and the level of a single building, through its vocabulary component to it starting from the form of a compact urban fabric right up to the design of a single residential unit, this gradient and solidarity create thermal comfort through aerial movement using the principles of aerodynamic.The traditional fabric achieves two principles in which the natural air movement ensured through the flow vacuum, the first principle depends on the discord in pressure, the air resulting from the difference in wind speed, which leads to the flow of air from the high-pressure areas, cold areas and their tanks (narrow and shaded passages, courtyards, and basements) Figure (1) to the low-pressure areas, the internal and external hot areas, and the Venturi action, which depends mainly on the Bernouli effect, is to understand how the movement of air occurs , As for the second principle, it depends on the movement of the air by the effect of convection resulting from heating the air and ascending to the top, which requires cold air solutions than it is in stature. The process may lead to what is called the effect of the stackeffect, when the warm air rises, it must be replaced by cold air, with a continuous heat source, a constant movement in the air is generated that flows into the buildings due to the load by the difference between the levels of the different openings [13]. Then the two principles are adopted in the streamlined space of the traditional fabric in the movement of the air current. It is worth mentioning that the effect of the stack effect has become a basis for most smart environmental solutions in contemporary buildings [14] In contrast to the modern planning pattern that neglected climate treatments and the local environmental reality, which led to creating a fabric that lacks dealing with the natural environment subject to all developments and changes that can happen to it, which makes the environmental design process unsuccessful due to the multiple design considerations and difficulty in dealing With it, on the other hand, there are many attempts in the modern era for architects who have worked to adopt traditional architecture and employ it in a contemporary style, including Dr. Muhammad Makiya, relying on observing the special nature of the place and identity, reinforcing this by saying, "Architectural and planning work cannot remain isolated from environmental influences" [15].As a result, two approaches emerged in the way of dealing with design factors and in planning decisions. The first approach looks at climate factors and their effects as treatments, can be inserted after performing the basic steps of the planning and design pattern (the climate impact is seen separately and secondary), while the second approach looks at climate impacts on It is the main factor in design decisions and isolates the rest of the other considerations. Thus, the research proposes an urban fabric for urban environmental centers or centers inspired by the traditional urban fabric consisting of a group

of streets connected to a group of urban courtyards of varying size around which a group of conglomerate buildings with green walls converges around (1) Realizing the following advantages:

- Green vertical wall surfaces work to reduce the temperature of the external air and improve the local urban climate as well as purify the air from the dust. Thus, these streets will be areas of high pressure and a source of cold air within the contemporary urban fabric instead of cold high-pressure areas in the architecture and traditional fabric represented by basements, patios, and alleys Misleading.
- The proposed fabric will provide open urban areas exposed to sunlight, making them low-pressure areas that work to draw cold air from high-pressure streets.
- Creating a sustainable urban fabric that meets the needs of modern society by the most attractive and beautiful environmental and local realities.

The movement of cold air from the streets and the surrounding buildings with high-pressure green walls towards the open urban areas exposed to sunlight with low pressure, through the urban fabric will provide thermal comfort in a contemporary style in a manner, and principles that are compatible with the local identity.
Table (2) shows the input data for July 15, 2018, which recorded the highest air temperature in Baghdad. (ENVI-met4.4) used to evaluate (temperature, humidity, wind speed, average radiant temperature).

Table 2. Details of initialization input parameters for the simulations in ENVI-met

Data Type	Parameter	Value
General	Data of start the simulation	15 July 2015
	Simulation starting time	7:00 A.M.
	Simulation duration	20 hours
Initial data	wind] m/s[Wind Speed in 10 m ab . Ground	2.00
	Direction (0:N..90:E..180:S..270:W..)	315
	]m [Roughness Length z0 at Reference Point	0.1
	Factor] g water/kg air[Specific Humidity in 2500	7.0
	of Shortwave adjustment (0.5 to 1.5)	0.9
	]K[Initial Temperature Atmosphere	315.250
Soil data	Initial temperature /RH Upper Layer (0-20 cm)	310.0 K/ 10%
	Initial temperature /RH Middle Layer (20-50 cm)	300.0 K/50%
	Initial temperature /RH Deep Layer (below 50 cm)	293.0 K/60%
Building Material properties	Albedo (%)	Wall: 0.3 Roof: 0.3
	Thermal conductivity (W/m.K)	1.3 1.9
Surface Material	Albedo (%)	Asphalt Street: 0.2 Concrete pavement gray: 0.5
LBC TYPES	LBC For T , q and TKE (1:open , 2: forced, 3:cyclic)	2
Façade Greening	LAI	1.50
	LAD	1.00
	Albedo of substrate	0.02
	Air Gap between Substrate and Wall	1.00
	Albedo of plant	0.20000
	Transmittance	0.30000

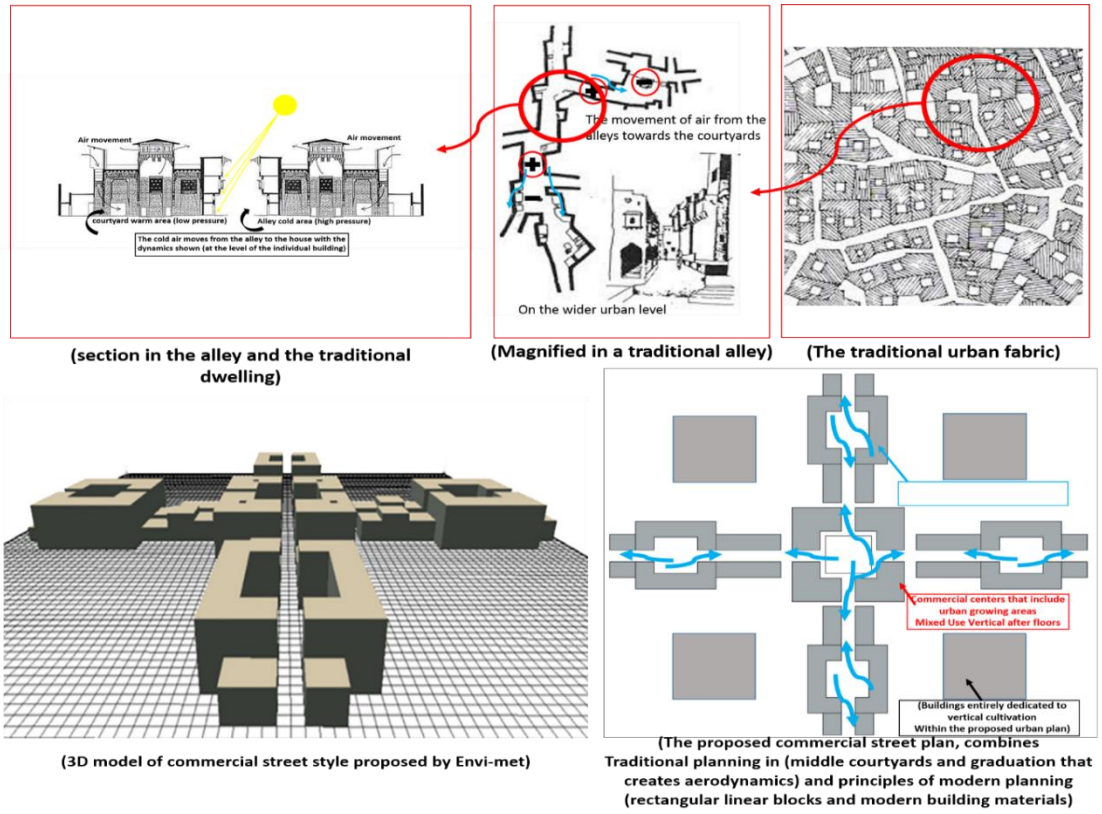
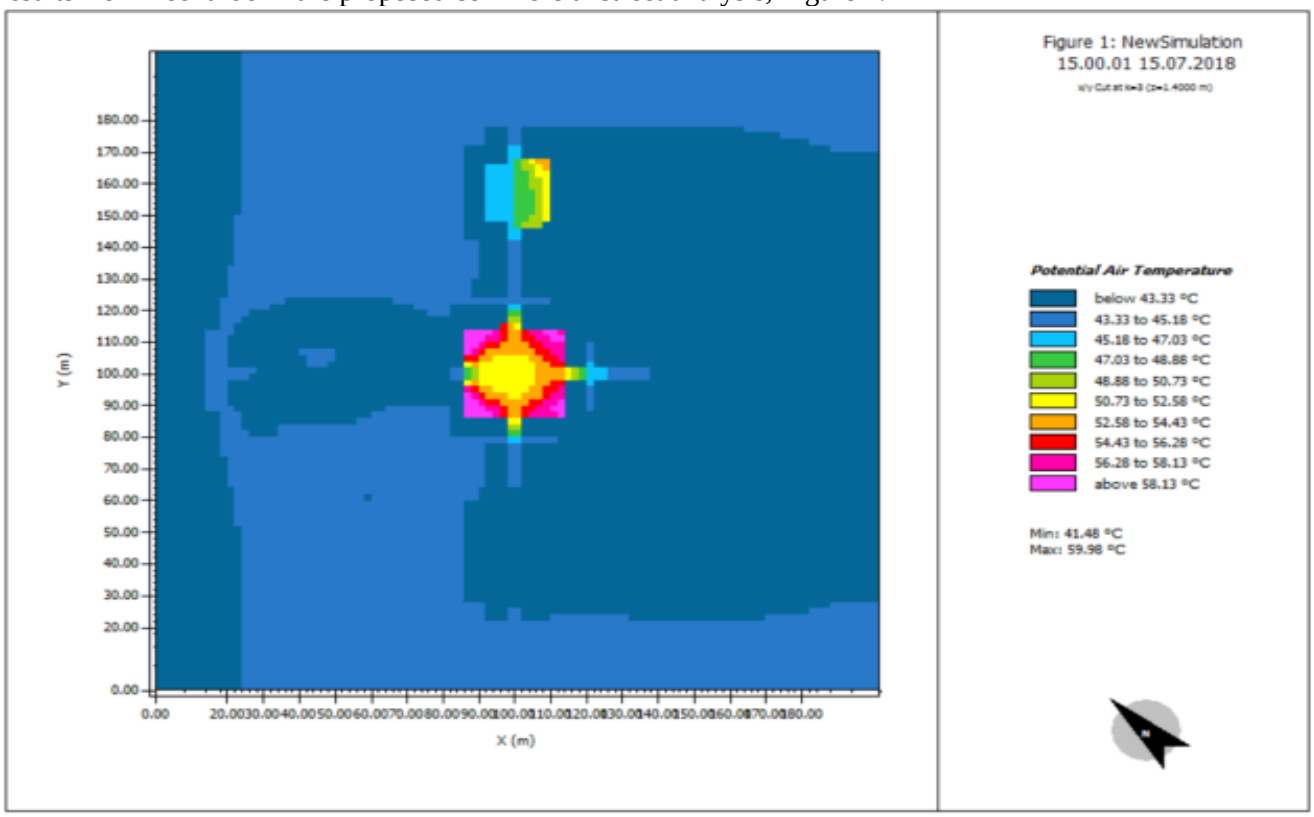


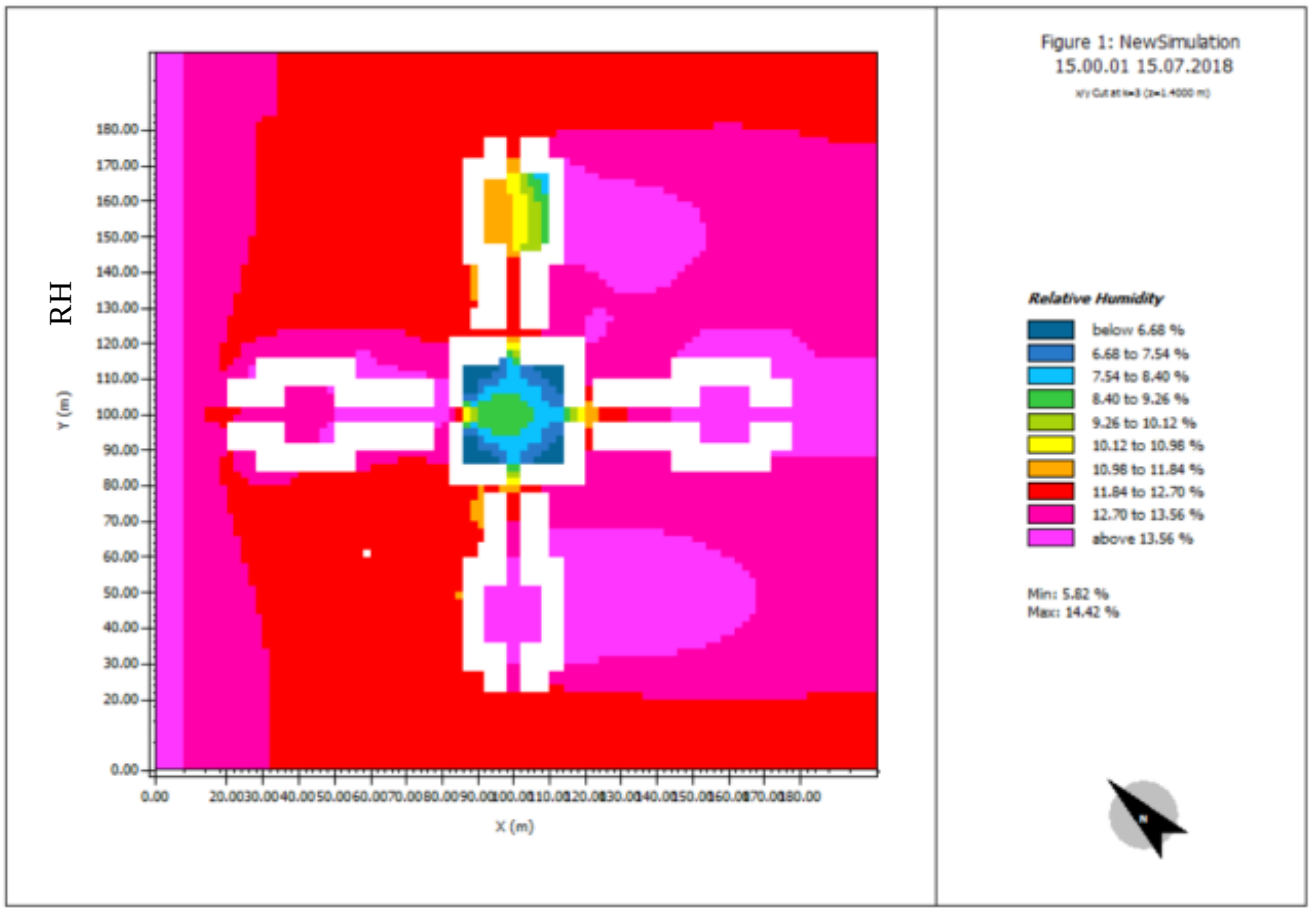
Figure 1. Low-pressure areas, the internal and external hot areas, and the Venturi action

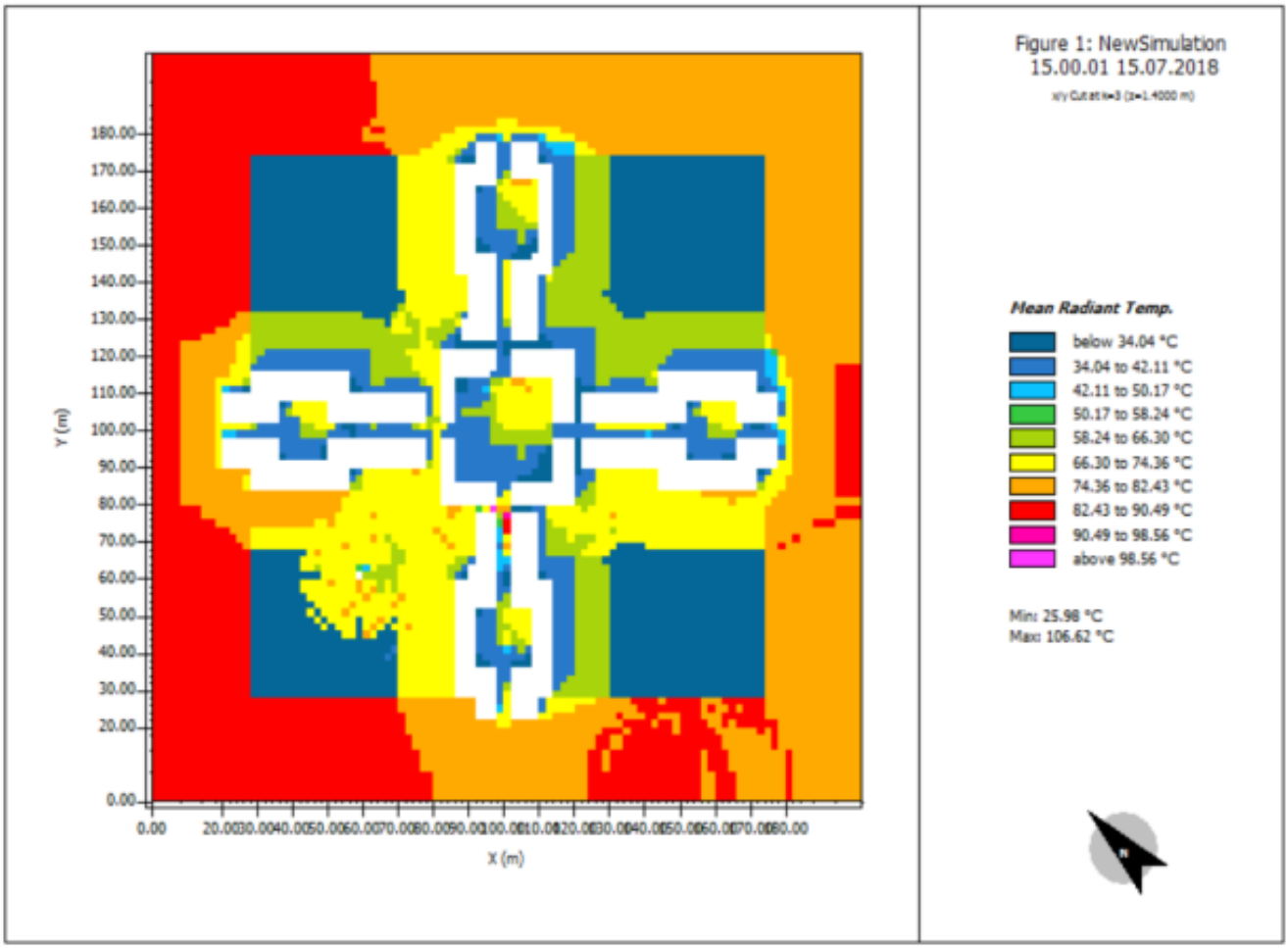
3. Results and discussion

3.1. Study status analysis by simulation software

In this proposal, the scenario involving virtual vertical greening was modeled with dimensions (83 * 83 * 60), making the total area of the proposal (166 * 166 * 60) sq.m. Orientation: Northwest, and here are the mock results from Leonardo in the proposed commercial street analysis, Figure 2.




RH
Y (m)
X (m)
Figure 1: NewSimulation
15.00.01 15.07.2018
Relative Humidity
below 6.68 %
6.68 to 7.54 %
7.54 to 8.40 %
8.40 to 9.26 %
9.26 to 10.12 %
10.12 to 10.98 %
10.98 to 11.84 %
11.84 to 12.70 %
12.70 to 13.56 %
above 13.56 %
Min: 5.82 %
Max: 14.42 %


Y (m)
X (m)
Figure 1: NewSimulation
15.00.01 15.07.2018
Mean Radiant Temp.
below 34.04 °C
34.04 to 42.11 °C
42.11 to 50.17 °C
50.17 to 58.24 °C
58.24 to 66.30 °C
66.30 to 74.36 °C
74.36 to 82.43 °C
82.43 to 90.49 °C
90.49 to 98.56 °C
above 98.56 °C
Min: 25.98 °C
Max: 106.62 °C

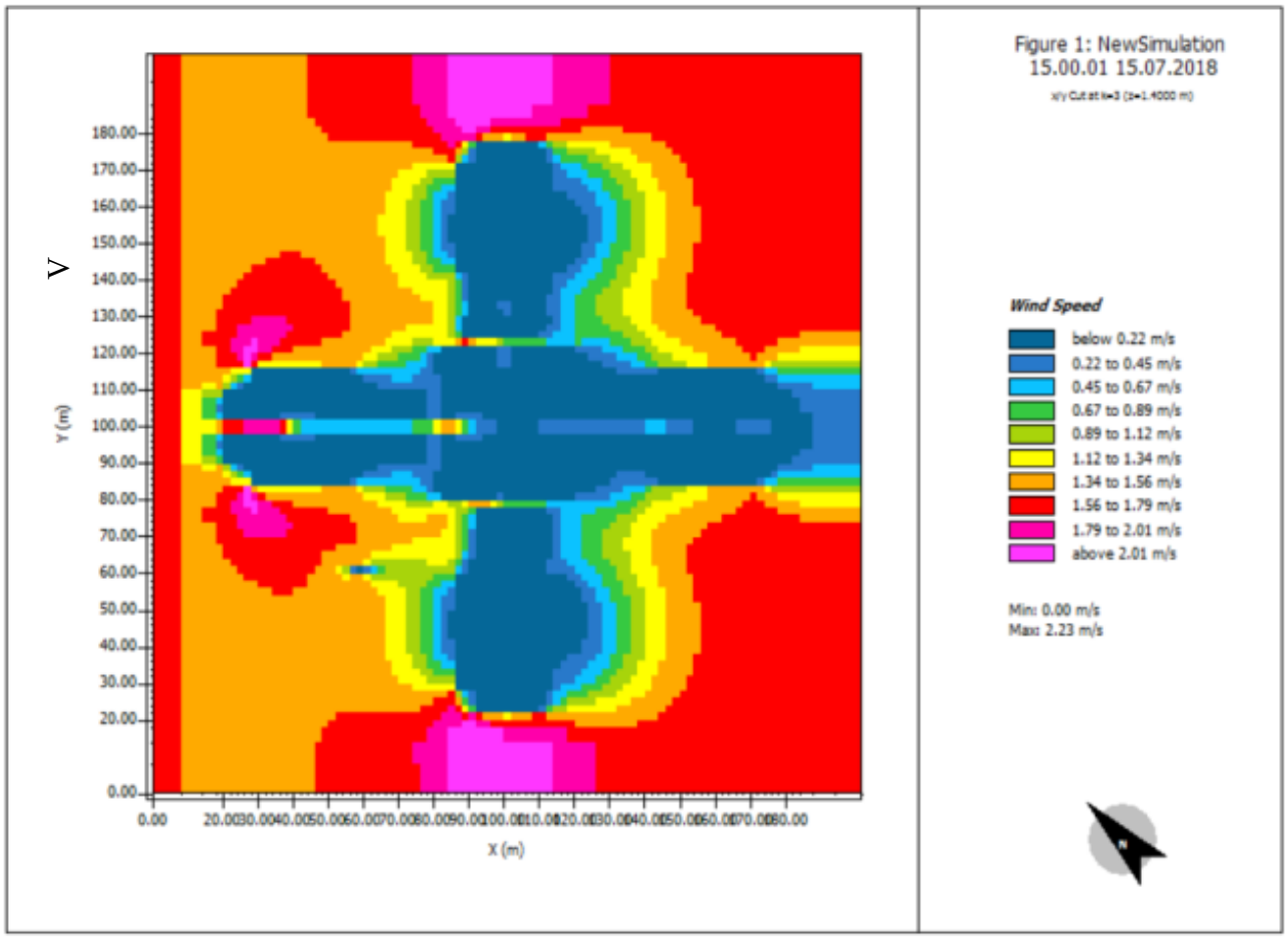


Figure 2. Case study analysis (urban environmental focus proposal)

Digital Outputs of the Case Study

	A	B	C	D	E	F
1	**Date**	**Time**	**V (m/s)**	**Ta (°C)**	**R H (%)**	**Tmrt. (°C)**
2	15.07.2018	08.00.01	0.30054	40.443	10.84	28.66
3	15.07.2018	09.00.01	0.28318	37.788	9.7718	33.284
4	15.07.2018	10.00.01	0.27133	37.8	8.952	28.883
5	15.07.2018	11.00.01	0.25916	36.843	9.4686	49.308
6	15.07.2018	12.00.01	0.25367	35.45	9.2821	33.017
7	15.07.2018	13.00.01	0.25065	35.52	7.8627	34.582
8	15.07.2018	14.00.01	0.24723	34.228	7.5339	56.706
9	15.07.2018	15.00.01	0.24347	34.572	7.862	64.315
10	15.07.2018	16.00.01	0.23983	33.822	8.4068	70.337
11	15.07.2018	17.00.01	0.23649	32.506	8.5116	43.386
12	15.07.2018	18.00.01	0.23073	31.406	10.512	31.935
13	15.07.2018	19.00.01	0.2201	28.305	11.515	30.221
14	15.07.2018	20.00.01	0.22742	27.204	12.511	28.998
15	15.07.2018	21.00.01	0.23154	25.205	13.511	27.518
16	15.07.2018	22.00.01	0.23411	24.15	13.52	26.406
17	15.07.2018	23.00.01	0.23637	24.123	15.612	26.632
18	16.07.2018	00.00.01	0.23914	23.1	16.612	25.69
19	16.07.2018	01.00.01	0.24	23.1	17.631	25.219
20	16.07.2018	02.00.01	0.24126	24.2	18.023	24.406
21	16.07.2018	03.00.01	0.23691	23.52	22.25	23.99
22	16.07.2018	04.00.01	0.23244	23.65	27.324	23.698
23	16.07.2018	05.00.01	0.23167	23.7	30.428	24.753
24	16.07.2018	06.00.01	0.24579	23.8	33.468	24.642

Figure 3. Digital outputs for the second case study using a program Microsoft Office Excel

3.2. Measurement of thermal comfort indicators for the study case

The following are the results extracted from the Rayman program after the default vertical greening of Table (3). We note that the values of the thermal comfort indicators resulting when compared to Table (1), which represents the standard thermal comfort values, we found that the three values (PMV, SET, PET) Indicate a number inside the thermal comfort zone, which leads to achieving a feeling of comfort and ability to perform human physiological functions in their natural form in this region for the proposed scenario that includes vertical greening

Table (3) the thermal comfort values for the study case (the case of vertical greening) researcher

PET	SET	PMV	
15,8	12,6	1,3	**Suggested case**

The value of PET has reached (25,8), as it is located within the thermal comfort zone, which means the success of the hypothesis in arriving at the efficiency of the process of modern planning approach from traditional planning principles and computer modeling, and thus, reaching thermal comfort for occupants and visitors of the commercial street, and achieving sustainability at several levels The most prominent environmental aspect.

3.3. Temp Ta

By adding the green vertical walls, the effect of the proposed urban form factor, the length-to-width ratio and the shadow-and-light phenomenon, we notice the gradual decrease in the proposed temperature, noting the decrease in wind speed.

3.4. Relative humidity RH

The process of adding vertical green walls to the buildings led to a gradual increase in relative humidity and a decrease in air temperatures with a decrease in wind speed due to a decrease in the value of (H / W). However, the relative humidity cannot be considered a decisive factor in reaching the external thermal comfort zone.

3.5. Wind speed V

A gradual decrease in the wind speed observed as the vertical green walls worked as fenders that reduce the wind speed, and with this, the air temperature decreased, thus. The wind factor is an important factor in achieving thermal comfort and improving the urban climate.

3.6. Tmrt

Through the results obtained from the ENVI-Met program, the Tmrt factor is very important for calculating the thermal stress associated with Ta, V, RH and other factors such as vegetation, urban form, ground cover type, whether soil or asphalt, and calculating the external heat transferred by measuring the total thermal effect of each From long-wave radiation. The results (34.19) indicated the importance of the Tmrt factor and its ability to reduce UHI and control external temperatures. As a result, the combination of appropriate vegetation and value (H / W) and high-white materials has a marked effect on achieving thermal comfort.

3.7. Earth's temperature Ts

Earth's surface temperature is a critical factor in achieving thermal comfort because it depends on many variables including environmental, social, and economic differences [16]. such as population density, human activities, carbon dioxide emissions, and urban surface characteristics such as building densities and others. The value of Ts calculated through the Rayman program. After entering the data and applying all the factors, we note that value of Ts decreases to (32,4) degrees, and thus we conclude that the sky visibility factor and the value of H: W, and in addition to that vertical greening a significant role in reducing the temperature value The land we see decreases in the structurally intensive areas and rises in the open areas (the relationship is direct).

3.8. Sky view factor (SVF)

Sky view factor has a role in determining cold air flows and reducing the absorption of solar radiation, but the process of placing green vertical walls on the facades of buildings overlooking commercial streets does not

contribute significantly to changing the proportion of sky view on the street Same if it does not contain those green walls, then the role affecting this factor becomes the urban form itself and the ratio of H: W.

3.9. Physiological Equivalent Temperature (PET)

The results are obtained (PET levels neutral and comfortable, which is acceptable, and this means the process of placing green vertical walls on the building blocks are successful measures to reduce (UHI) in areas with hot dry climate, in addition to that, it can provide high structural density and middle yards solutions Fine environmental conditions lead to possible increases in daily thermal comfort..

4. Conclusions

Through the use of the principles of architecture and traditional cities related to providing thermal comfort to their occupants through the movement of air in its various forms and methods, and their integration with modern urban planning methods, The proposal was presented for an urban environmental design consisting of a group of commercial streets linked to a group of open spaces of varying size surrounded by mix used buildings with different Height. The façades of the buildings consist of living walls covered with plants.

• The plants on the façade of buildings are considered a way to reduce the temperature of the outside air. thus, the source of cold air that will be moved within this urban fabric depending on the pressure variation between the shaded cold areas (streets and shaded patios surrounded by green walls), and hot areas (large open patios exposed to sunlight). Just like air movement in traditional cities.

• Through environmental simulation programs, vertical cultivation achieved a noticeable decrease in the following values ((Ta, (V), (Ts) and (SVF) with an increase in the relative humidity level due to the high evaporation values and consequently a decrease in the values of (Tmrt) (PET) and reducing stress). The thermal model and achieving levels close to the levels of thermal comfort. thus, the proposed model achieves thermal comfort by combining the principles of traditional architecture with contemporary ideas represented by green walls as a way to reduce the temperature of the outside air.

• The proposed urban environmental centers could be the basis for developing cities and creating new urban centers in which they take into consideration environmental and climate issues, and issue of thermal comfort as a basis when planning or designing. These centers can also be a means of developing and restoring historic cities through their implementation as urban dictation projects (infill), within its traditional urban fabric to be the alternative to traditional urban areas, that are worn out or left behind within this fabric. And to create creative urban environmental foci that develop these areas in harmony and integrate with their traditional surroundings, and a new flavor in a way that achieves the link between the old and the contemporary through a language not far from the recipient' that is incompatible with human identity Cultural, environmental and urban.

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