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A proposed model for the (Sustainable Ventilation) code to evaluate treatments and strategies for the impact of air movement in architecture

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Abstract:

With the increase in problems resulting from the lack of necessary use of natural ventilation in modern buildings and the lack of sufficient land and open spaces surrounding the building, the research problem emerged: the necessity of designing and proposing a code (sustainable ventilation) to evaluate treatments and strategies for the impact of air movement in architecture, as natural ventilation is one of the The important environmental elements for providing a healthy and comfortable environment in buildings in general and residential buildings in particular, which are addressed in this research paper, contribute to investigating the possibility of identifying treatments and strategies for the impact of air movement in architecture and indoor air quality. The research methodology is based on defining the research problem and then presenting The importance of the research field, determining the objectives, then studying previous literature related to the research, choosing the proposed measurement method and the reasons for choosing the applied study samples, then making questionnaire forms to conduct the research survey. The sample of the research study was chosen from 63 people who are experts in codes of green environmental treatments and studies of new and renewable energy and its applications in architecture and those concerned. Designed and approved by university professors, the codes were also presented to architects, designers, and specialists in the field of environmental architecture. It was also presented to students of the Department of Architecture in many universities and engineering institutes whose studies include environmental design and planning courses. The random method was excluded because it was not suitable for research and did not obtain Misleading opinions or answers for reasons outside the scope of the research, such as weak culture or the spread of misconceptions about the concept of treatments and strategies for the impact of air movement in architecture among the public, or a lack of understanding of the criteria presented in the questionnaires. Then the results and observations were monitored and it was noted that all strategies and treatments for air movement present in the proposed code It is very influential in ventilation and the indoor air quality of spaces. Therefore, it was observed that there were slight differences that were fairly similar in the averages of their values in the questionnaires resulting from the applied research study, but these differences must be noted and

emphasized because of their importance when making a comparison in choosing between the appropriate strategy before using it inside the building, which indicates The success of the proposed ventilation code and its effectiveness if applied, as the maximum success indicators of the strategy followed reached an average value of (5) in the strategy (directing and using openings to achieve natural ventilation), while the minimum indicators of success of the strategy followed reached an average value of (3) in the strategy (Using water walls on facades exposed to the sun to cool the air) The research paper recommends and proposes applying the applied research study on a larger scale and on a larger scale to all segments of society.

Keywords: Code for evaluating air movement in buildings, environmental treatments and strategies, sustainable architecture, indoor air quality, natural healthy ventilation.

Research problem:

The research problem lies in pointing out that despite the importance of the role of natural ventilation in buildings, it has not been exploited optimally in many buildings in a way that meets the needs of the occupants of environmental spaces, in addition to the lack of awareness among some architectural designers of the foundations of architectural design that benefited greatly from the movement Air, and the lack of sufficient awareness of the necessity of formulating and adopting an Egyptian code to evaluate treatments and strategies for the impact of air movement in architecture.

Objectives:

1- The research aims to deduce the design elements that directly and strongly influence air movement and their design standards, whether at the level of the building, its composition and external cover, or at the level of the external elements surrounding the building, and to formulate a proposed model for the (sustainable building) code to evaluate treatments and strategies for the impact of air movement in architecture.

2- Study the direct impact of these treatments and strategies on buildings and internal spaces to reach the standards of design foundations through which these elements can be designed positively to contribute to raising the efficiency of air movement and achieving the natural ventilation required for internal spaces during the stages of the design process. Next, as well as in evaluating the efficiency of ventilation and exploitation of air movement the actual interior and exterior of existing buildings with the aim of increasing their environmental efficiency.

3- Proposing a method for classifying environmental design treatments according to thermal control strategies and stages of the design process.

4- Using the study as an effective tool in formulating architects' thoughts and a reference for evaluating their architectural research results.

Research hypothesis:

The research study assumes that natural ventilation has the greatest impact on achieving a healthy environment that achieves the necessary thermal comfort for humans inside the building and reduces the effects of excess relative humidity, in addition to reducing the amount of conventional energy consumed. In order to prove or deny this research hypothesis, it is necessary to study the direct impact of the

design elements affecting the Air movement, its design parameters, its impact on the internal and external spaces of the building, and its extraction and formulation, whether at the level of the building, its formation, its outer shell, or at the level of the external elements surrounding it.

Research methodology:

The research methodology depends on deducing and defining the architectural vocabulary of buildings that have a direct impact on the movement and quality of air in buildings. To achieve the main goal of the research, the research study relies on the following methodology:

- Defining the research problem
- Setting goals
- Determine the research hypothesis
- Study of literature and previous theoretical studies related to the research topic.
- The most famous previous studies on codes and systems for evaluating air quality in buildings
- Elements that have a direct impact on the movement and quality of air in buildings
- Introducing applied case studies and choosing the proposed research measurement method.
- Reasons for choosing samples for the applied study
- Making and designing questionnaire forms to conduct the survey in the field of research.
- Monitoring results.
- Interpreting and analyzing the results in light of theories, hypotheses and previous studies.
- Necessary scientific recommendations.

Introduction:

Natural ventilation in the building is considered one of the basic axes of good and healthy design of buildings, regardless of their function, especially residential buildings, as the dwelling is for humans a place of rest and stability, and human comfort in the building is generally affected by many factors, including climatic factors such as temperatures, relative humidity scale, movement and speed of air, quantity and intensity. Solar radiation, and with the rapid expansion of the building services sector, people moved to provide thermal comfort requirements in buildings using modern mechanical means, whether cooling or heating, which leads to increased energy consumption and increased economic burdens and resulting health damages such as asthma, allergies, and respiratory diseases in general. Here the role of architects and specialists in the field of sustainable environmental studies appears, to work to achieve comfort for humans within the architectural spaces of buildings, and hence the research paper included a design and environmental study to employ two important elements of comfort, namely natural ventilation and indoor air quality (IAQ). He discussed the most important strategies and treatments for them to be the subject of study and research to determine their effects on the movement, speed and quality of air inside and outside the building.

1- Theoretical and analytical study:

1-1- Indoor ventilation environment:

One of the basics of the environmental design of any building is to take into account that the safety and quality of the indoor environment is an integral part of it, and of course this is directly related to the quality and characteristics of the building's indoor air in terms of it being healthy and sound, as high humidity levels, damage to heating and cooling units, and other problems that can cause It spoils the indoor ventilation environment and directly affects the building's energy consumption rates, especially if it continues in the long term. [1]

1-2- Efficiency of the indoor ventilation environment:

The safety and efficiency of the building's internal environment is not complete without the quality and characteristics of the building's indoor air in terms of its health safety, as a person needs 21% oxygen (0.04%), carbon dioxide 78%, nitrogen 1%, inert gas and 5:25 grams of steam. Water for every square meter of air at least, and as a result of the presence of people inside buildings, the percentage of carbon dioxide, water vapor, and disease-carrying germs increases, so we need natural ventilation to change the air in the building in order to maintain the health of users and constantly replenish the building's air. [2] Accordingly, the efficiency of the building's internal ventilation environment is achieved by providing natural ventilation and reducing reliance on mechanical ventilation systems, which works to rationalize and reduce energy consumption.

1-3- The concept of natural ventilation:

Natural ventilation in buildings is defined as the process of changing the indoor air that has been used and replacing it with fresh air from the outside by natural means only [3]. Natural ventilation is considered one of the most important means that can be used to control climatic elements and to provide a comfortable environment for humans, especially in relatively hot areas. Therefore, natural ventilation has been classified as one of the factors that play a major role in a person's health and feeling of comfort. Through researchers' studies, it has been shown that the effect of natural ventilation has more than one aspect. It can have a direct effect on the person himself or indirectly through its effect on degrees. Temperature and humidity inside the building. [4]

1-4- The importance of natural ventilation and air movement for buildings:

Natural ventilation is very important inside buildings in order to achieve appropriate indoor air quality by working to change the air inside the building and replacing it with fresh, fresh outside air for good healthy ventilation, working to provide the amount of oxygen that humans require, and controlling relative humidity. For internal air of spaces. [5], the basic purpose of nature ventilation is either to achieve thermal comfort or to cool the building or to achieve air quality as follows:

1-4-1- Ventilation For Thermal Comfort:

We obtain thermal comfort from ventilation by working to increase heat loss from the human body and reduce the moisture present on the skin as a result of sweat by increasing air movement and distributing it in an appropriate way to achieve thermal comfort for the occupants of the space and also controlling the relative humidity of the indoor air.

1-4-2- Ventilation In Order To Cool The Building:

We resort to cooling the building when the internal temperature of the spaces is higher than the outside air temperature.

It is worth noting that the main source of natural ventilation for the building is the wind, as shown in Figure (1). It is important for the architectural designer to first study and understands the movement of the wind around and through the buildings and then benefit from it to design the natural ventilation of the building. [6]

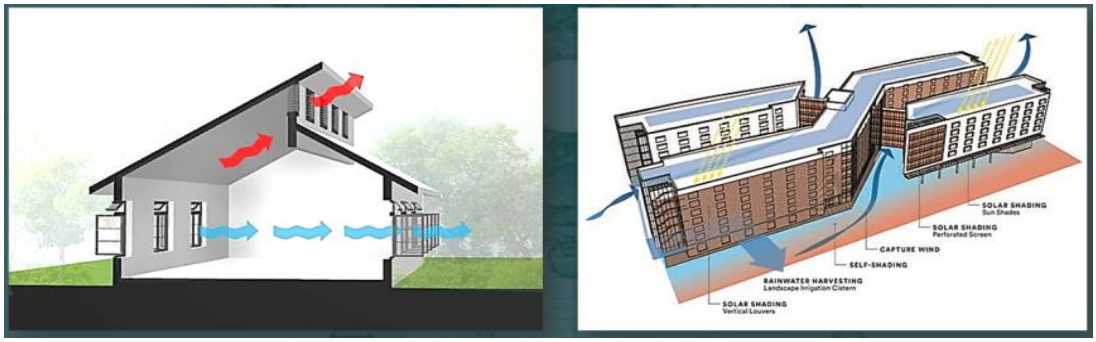


Figure (1): shows natural ventilation and air movement through it. Source: https://www.archpaper.com/wp-content/uploads/2018/06/ASU-Analysis_Page_1.jpg

1-4-3- Ventilation for air quality:

What is meant by healthy ventilation is to maintain the minimum level of air quality inside the building and replace it with fresh, healthy, renewable air from outside.

1-5-The concept of industrial ventilation:

It is the use of heating, ventilation and air conditioning (HVAC) systems to remove humidity and cool a building, for the purpose of creating a comfortable indoor environment regardless of the external conditions of the building. Recently, industrial refrigerants have become an essential component of HVAC for a wide range of buildings [7].

1-5-1- Disadvantages of artificial ventilation:

The large and uneven temperature change in artificially air-conditioned spaces inside and outside the building leads to a reduction in the human body's immunity against microbes and various diseases. Industrial air conditioners also introduce bacteria, dust, and dust into buildings. Closing artificially air-conditioned rooms is an easy environment for the accumulation of various pollutants. It is also considered a practical process. Maintaining air conditioners is expensive, and neglecting their maintenance is a strong cause of the accumulation of fungi and bacteria in the vacuum and the human body. [8]

1-6- Air quality index:

The air quality index is a measure of the air condition in relation to the requirements of one or more types of biological organisms. It is a simple number to indicate the state of ambient air quality. The air quality index is considered a simplified way to define the state of air quality, and is based on data received from air quality monitoring and control stations, where Pollutant concentrations are converted into simple numbers that the general public can understand and shown in the form of specific colors, and air quality stations measure the concentrations of pollutants in each country or region. Countries or regions define air quality indicators and classify the raw data into a descriptive rating scale. These indicators make it easier to determine the level of pollution and whether there are any risks associated with it. [9], [10]

1-7-Assessing air quality in buildings:

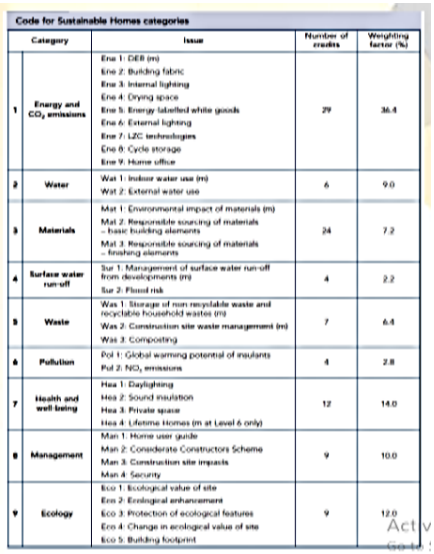
When evaluating the ventilation in any building, it must be verified that the ventilation in this building meets the rates necessary to achieve its basic function responsible for the health aspect, and to ensure that internal comfort is achieved for the occupants, and whether the percentage of oxygen available in the indoor air of the spaces is within the normal range or not, and what is the period that is It involves replacing and changing the air inside the building on a regular basis, and if clear answers are available about these important procedures related to air quality inside the building, it gives a comprehensive assessment of the state of ventilation and the quality of its indicators in any place, and this assessment must always be conducted regardless of the location or climate of the building's location. Or the nature of the building's internal activity and function. [11[

1-8-The most famous previous studies on codes and systems for evaluating air quality in buildings:

1-8-1- The British BREEAM system:

(Building Research Establishment Environment Assessment Method:)

It is a building monitoring system developed by the Building Research Corporation Limited in the United Kingdom. It is used to evaluate the environmental performance of the building during the design and construction stages. It is characterized by flexibility and adaptability to local conditions. It can be applied in any country. It has been in operation since 1990 in the United Kingdom. Then It has spread on a broader and more comprehensive scale and is applied to a large group of countries in Europe and the Arab Gulf countries. One of its most important goals is achieving thermal comfort and monitoring air quality, as shown in Figure (2), and reducing environmental pollution while reducing the emission of carbon dioxide. [12].



	Code for Sustainable Homes		
Categories of Environmental Impact	Total credits in each category	Weighting factor (% points contribution)	Approximate weighted value of each credit
Energy and CO2 Emissions	29	36.40%	1.26
Water	6	9.00%	1.5
Materials	24	7.20%	0.3
Surface Water Run-off	4	2.20%	0.55
Waste	7	6.40%	0.91
Pollution	4	2.80%	0.7
Health and Wellbeing	12	14.00%	1.17
Management	9	10.00%	1.11
Ecology	9	12.00%	1.33
	104	100.00%	

Figure (2): shows the presence of the air quality assessment element among the evaluation elements in the global environmental assessment system BREEAM.
Source: https://www.linkedin.com/pulse/building-research-establishment-environmental-assessment-meena-mogal

1-8-2- LEED system in the United States of America (Leadership in Energy and Environmental Design):

(Leadership in Energy and Environmental Design)

It is the Leadership in Energy and Environmental Design system, which is a system for evaluating buildings for accreditation according to the principles of architecture, developed by the US Green Building Council (USGBC). It is a measurement tool and not a design tool. Its beginning dates back to 1993, and it was supported by the Natural Materials Defense Council until 2006. It was adopted by important architects and increased in application from 1996 through Tom Palodin and engineer Lynn Barker, a member of the Technical Committee of the Natural Materials Defense Council. One of its most important goals is to achieve environmental quality in closed spaces, and given that most individuals now spend 90% of their time in closed spaces, this is why it is important to pay attention Air quality in the indoor environment is one of the priorities that must be achieved, by improving the climate inside the building and achieving the environmental efficiency goals of the internal spaces, as in Figure (3), and reducing environmental pollution while reducing the emission of carbon dioxide. [13].

PRODUCT	LEED SECTION: SUSTAINABLE SITES*	LEED SECTION: ENERGY & ATMOSPHERE	LEED SECTION: MATERIALS & RESOURCES**
Brick		4.1 - Brick contains 10% post-industrial (pre-consumer) material	5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested
Concrete Block			5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested
Concrete Pavers	7.1 - Heat Island Effect, *non-roof* 7.2 - Heat Island Effect, *roof*	4.1 - Pavers can contain up to 20% post-industrial (pre-consumer) material	5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested
Permeable Concrete Pavers and TurfStone (grass grid)	6.1 - Stormwater Design, *Quantity Control* 6.2 - Stormwater Design, *Quality Control* 7.1 - Heat Island Effect, *non-roof*	4.1 - Pavers can contain up to 20% post-industrial (pre-consumer) material	5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested
Segmental Retaining Walls		4.1 - SRW can contain up to 20% post-industrial (pre-consumer) material	5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested
DesignMix Mortar		4.1 - Design Mix mortar contains 4% post-industrial (pre-consumer) material	5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested
Hydrapressed Slabs	7.1 - Heat Island Effect, *non-roof* 7.2 - Heat Island Effect, *roof*		5.1 - 10% Regional Materials 5.2 - 20% Regional Materials 100% Manufactured Up to 100% Harvested

Figure (3): shows the presence of the air quality assessment element among the evaluation elements in the global environmental assessment system LEED.
Source: https://globalroofinggroup.com/blog/what-is-leed-certification

1-8-3- Green Star Australia System:

The Australian Green Star System is a set of principles developed by the Green Building Council Australia (GBCA) in order for buildings to be classified according to an approved principle and specific standards to guide the real estate industry towards sustainability by spreading green design thinking. Its application began in 2002, in order to reduce... The negative impact of the building on the environment, preserving the health of individuals, and solving the energy crisis, is done by granting certificates indicating that the building is accredited and which obtains evaluation certificates. One of the most important elements of evaluation with this code is the quality of the internal environment, as it seeks to encourage the provision of an appropriate amount of air required to ventilate all internal spaces so that Up to 95% natural ventilation, taking into account changing the air inside the building, renewing it, monitoring and monitoring volatile organic compounds and the percentage of carbon dioxide in the atmosphere, while providing a warning when the percentage of volatile organic pollutants increases. [14].

1-8-4- CASBEE system in Japan:

It is an evaluation tool based on the environmental performance of buildings, and it means the Comprehensive Assessment System for Built Environment Efficiency. It works to enhance sustainability, which is considered one of the major challenges facing the world, and aims to comprehensively evaluate the reduction of environmental impact through... Energy conservation, material preservation and

recycling, and the quality of environmental performance, in addition to being a description of the environmental style of buildings based on the evaluation of the environmental performance of buildings. CASBEE provides a new indicator to evaluate the concept of ecological efficiency and evaluates the efforts made in buildings to mitigate the effect of heat. One of the evaluation elements in this code is ventilation. And monitoring the air quality in spaces and the internal environment in terms of load value, thermal loads, and lighting (ventilation - use of recycled materials - ventilation rate). [15].

1-8-5-GPRS evaluation system:

It is the green pyramid rating system, which was created by the Egyptian Green Building Council for use in evaluating new buildings in any or all of the stages that the building goes through, whether in the design stage or in the post-construction stage. The Egyptian Green Building Council is a building approach. Complete sustainability through awareness of performance at key points, the most important of which is the quality of the indoor environment, including air quality and air movement in spaces [16].

1-8-6- SGBC evaluation system:

The Saudi Green Building Council. This council calls for the use of building materials that are less harmful to the environment and more efficient at the same time, instead of the materials currently used, which are considered adulterated and contribute to pollution of the environment with CO2 gas. At the same time, this council supports the idea of recycling construction waste in a way True, it aims to preserve the environment, and one of the most important standards for sustainable buildings is the commitment to implementing a thermal insulation system, rationalizing energy consumption, and monitoring air quality inside the building. [17].

1-8-7- Green-globes–Building-environmental-assessments evaluation system:

It is a computer program with an interactive interface with commercial objectives for evaluating sustainable buildings. It guides how to integrate sustainability principles into building design and is used in evaluating existing and new buildings. This system was developed by the Initiative-Building-Green Sustainable Buildings Initiative to be implemented in Canada in 2004 and is one of the most important contemporaries. The evaluation with this code is the quality of the internal environment, as in Figure (4), where the evaluation is done by measuring sustainability rates using the point acquisition system used in the Leed evaluation system, where each standard contains some requirements that must be met and a set of standards that can be achieved, and the level of project achievement is evaluated. Sustainability rates are measured at three specific stages: at the end of the design stage, at the completion of the preparation of implementation documents, and at the completion of the building's implementation [18].

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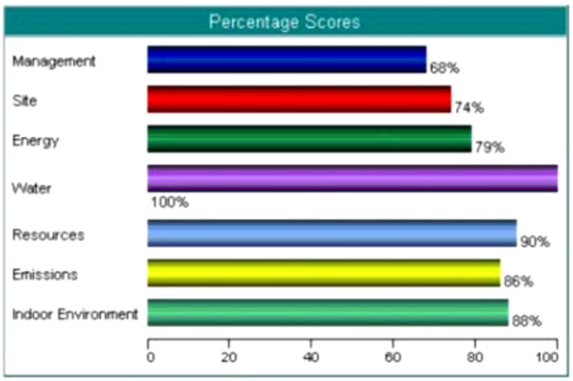


Figure (4): shows the presence of the indoor air quality assessment element for spaces among the evaluation elements in the Green-globes global environmental assessment system.
.Source: Green Globes (2010). Green Globes. www.greenglobes.com

1-9-Elements that have a direct impact on the movement and quality of air in buildings:

The direct impact of the design elements affecting air movement, their design standards, and their impact on the internal and external spaces of the building were studied, extracted and formulated, whether at the level of the building, its formation, or its outer shell, or at the level of the external elements surrounding it, and the standards of design foundations through which these can be designed were reached. Elements positively contribute In raising the efficiency of air movement and achieving natural ventilation of internal spaces during the successive stages of the design process, as well as in evaluating the efficiency of ventilation and exploiting the actual internal and external air movement in existing buildings with the aim of raising their environmental efficiency, which has been classified into nine main elements [19], [20], [21] They include the following:

1-9-1- Variation in the topography of the Earth's surface:

Topography is an important factor affecting climate because the difference in the slope of the land depends on the amount of light absorbed from the sun along with exposure to the wind, resulting in a difference in the prevailing weather from one place to another. The rate of decrease in air speed near the surface of the Earth depends on the topography of the surface and the effect of air friction on the buildings themselves. It shows The following figure (5) shows how air speed is affected in three locations.

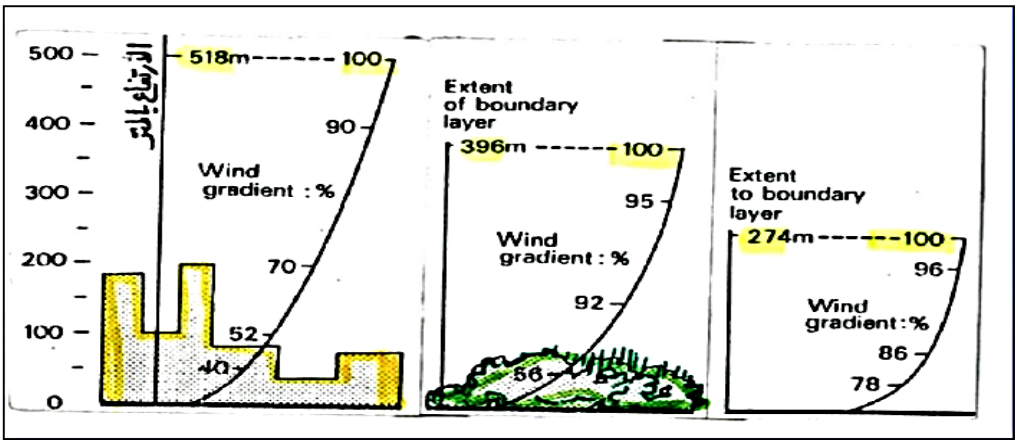


Figure (5): shows the effect of variation in the Earth's topography and its effect on air movement.
Source: https://www.geol.wwu.edu/rjmitch/climate.pdf

1-9-2- Trees and plants in the general location:

It has little effect in controlling air movement around tall buildings, but its location and size can help It is said that it has a clear effect on the movement of air above and around low-rise buildings during...Today, as in Figure (6), and in the hot and humid area when ventilation is very important, air enters the buildings through the shade without crossing over the hot surfaces, and plants in this case are necessary as long as they do not prevent the flow. Heat for the breeze.

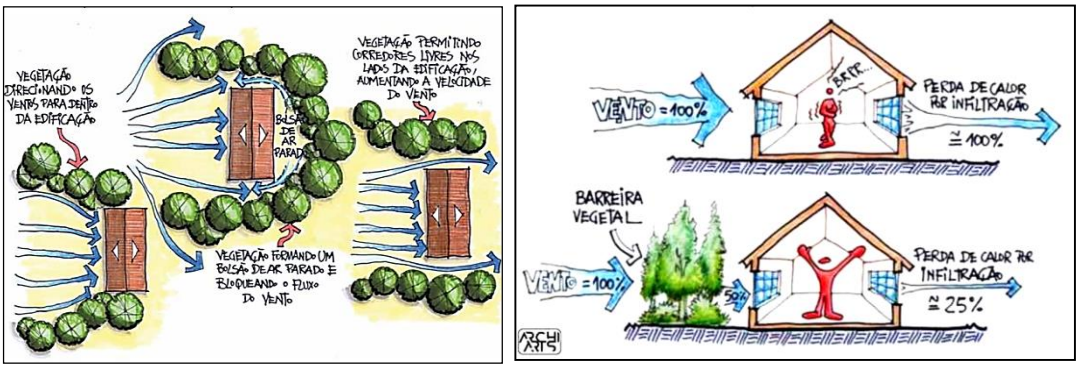


Figure (6): shows the effect of plants and trees and their effect on air movement. Source: https://bioclimaticaarq.blogspot.com/2015/11/influencia-da-implantacao-e-da.html

1-9-3- Elements of general site coordination (fence, barriers,.....):

The height of the fence and its distance from the building direct the movement of the wind with the use of plant elements where...If the wall is high, the air reaches the top of the building without entering it, and if the height is small, the air enters Inside the building, the height of the air barrier and the angle of the upper edge contribute to determining the protected distance behind it, as in Figure (7).

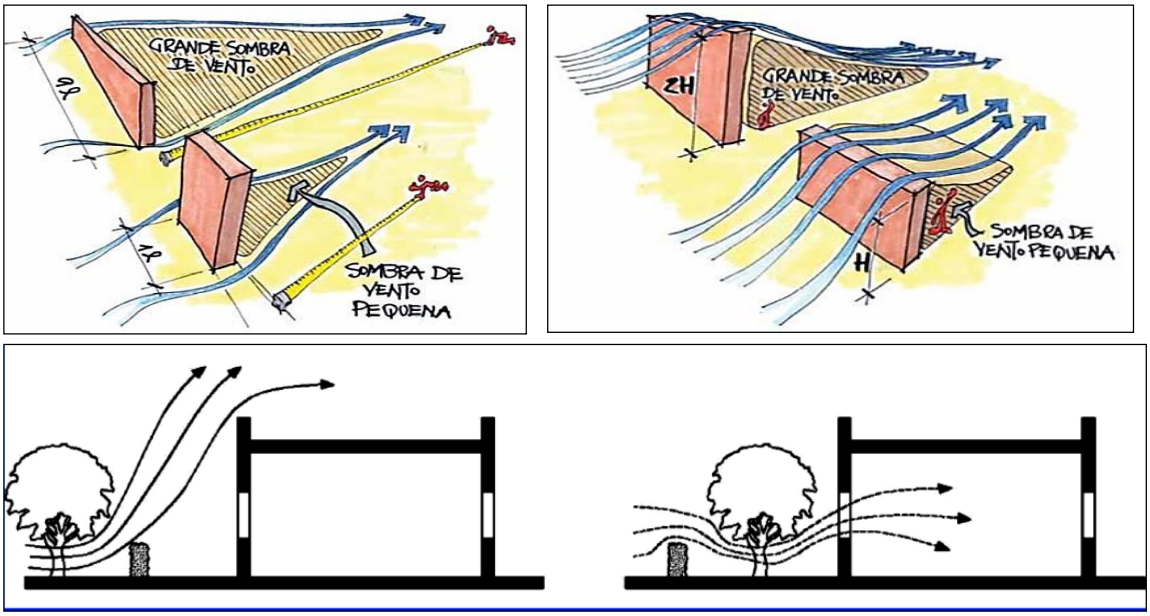


Figure (7): shows the elements of general site coordination (fences, barriers,.....) and their effect on air movement. Source: https://bioclimaticaarq.blogspot.com/2015/11/influencia-da-implantacao-e- da.html

1-9-4- The effect of building fabric and height:

The air is affected by the height of the building, as the shadow area varies, which affects the air pressure and changes its movement. The fabric also affects the movement of the air, as the reciprocating fabric works to disturb the wind, while the parallel fabric works to create areas of wind shadow behind the buildings, as in Figure (8), in order for the air to reach the row. Second, the distance between it and the first row must be six times the height of the building in the first row.

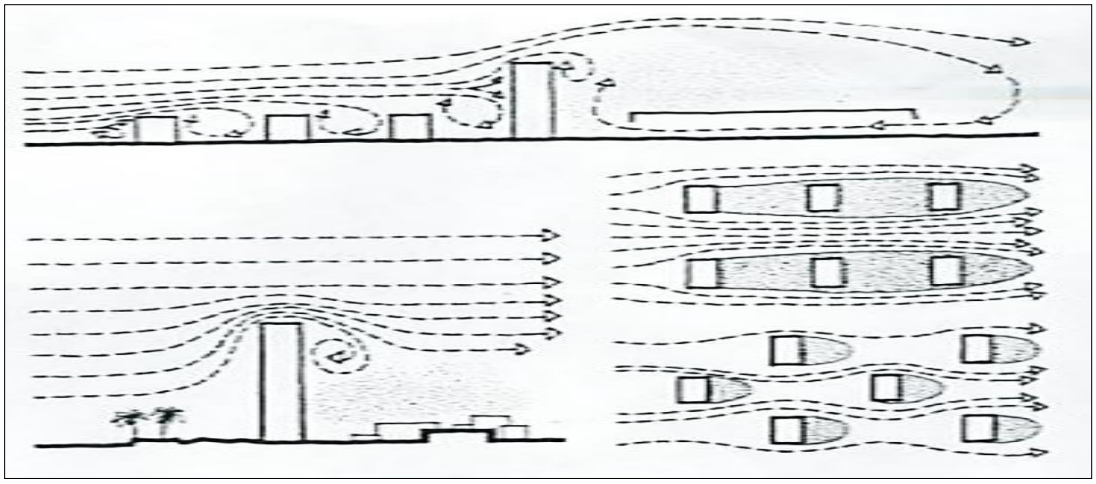


Figure (8): shows the fabric of the buildings, their height, and their effect on the movement of air around the buildings. Source: https://www.researchgate.net/figure/the-effect-of-the-urban-environment-of-wind-movement-Source- Allan-konya2011_fig3_319475260

1-9-5- The effect of the building's mass and orientation:

The air is affected by its collision with the façade directed in the direction of the air, as exposure to the wind increases by directing towards it. Although the greatest pressure on the side of the building facing the wind is generated when the façade of the building is perpendicular to the direction of the wind, as shown in Figure A. Givony pointed out that if the windows are placed at an angle of 45 degrees to the direction of With wind, the rate of indoor air speed increases and provides the best distribution of air movement inside, as shown in Figure B. This conflict can help in solving the orientation problem when it requires a contradiction between the requirements of the sun and the wind inside architectural spaces. The shape of the building's roof also affects the movement of air, as shown in Figure (9).

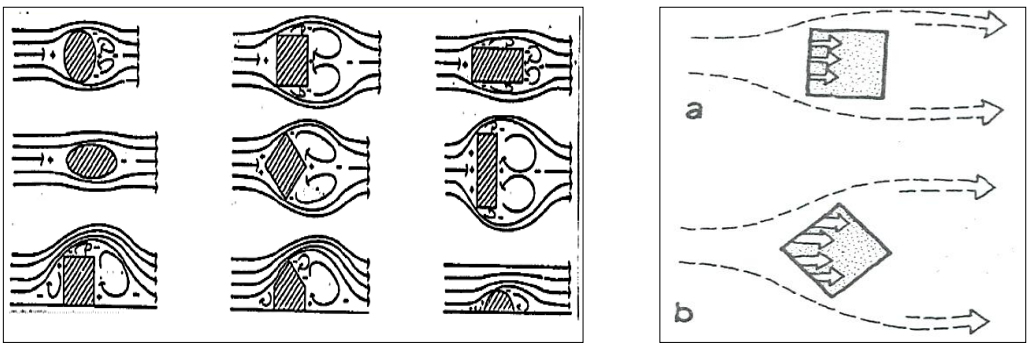


Figure (9): shows the mass of the building, its orientation, and its effect on the movement of air around the buildings, as well as the shape of the roof. Source: https://ahouseforcrossedcrocodiles.blogspot.com/2014/10/wind-shadow-aw-spirn.html

1-9-6- The effect of skylights:

Using skylights and stairwells to bring air into the spaces, as they are vertical areas with high pressure in which air is stored and then distributed to the spaces, as well as the courtyard, which helps provide ventilation by storing cold air during the night and distributing it to the building's spaces during the day, in addition to making two courtyards, one larger than the other and at The temperature rises, and the air moves between the two courtyards, thus providing ventilation for the spaces, as shown in Figure (10).

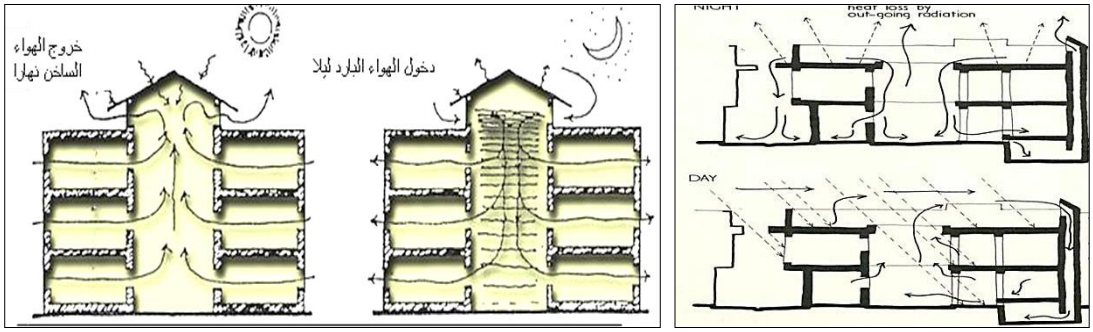


Figure (10): shows skylights and stairwells and their effect on air movement around buildings. Source: https://erjeng.journals.ekb.eg/article_125458_1934ae79ce6c34a265f13c2f657ad8d0.pdf

1-9-7- The effect of roof openings on the building mass (roof shape - upper openings - wind tower-Roof openings):

Discharging the hot indoor air and getting rid of it through the natural negative method is most easily done at the highest point of the roof. This is when the hot indoor air collects to exit, and these upper openings allow it to exit through the roof. The monitor, chimney, and wind towers are adjustment devices to allow the breeze to enter. The internal air is emptied to the outside when it collects at the barrier and the opening flap is closed. This method is effective in ventilation, as shown in Figure (11).

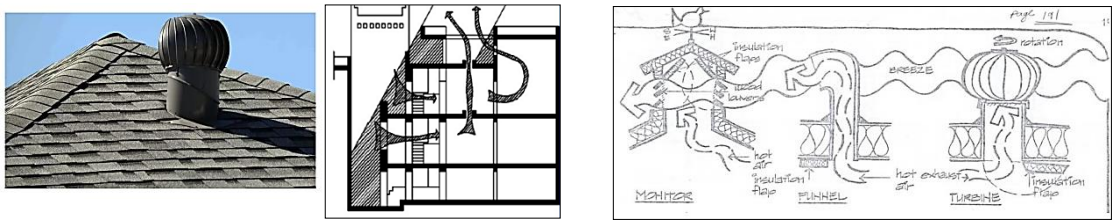


Figure (11): Shows roof openings and their effect on air movement around buildings. Source: https://mirathlibya.blogspot.com/2010/09/blog-post_22.html

1-9-8- The effect of the position of openings on the entry and exit of wind in buildings:

The effect of the wind, whether in terms of direction or speed, makes the air flow determine the cooling effect on natural ventilation. Scientifically, the temperature drops to 3 degrees Celsius if the air speed is 61 m/min (200 feet/min). The air speed can be adjusted by opening and closing the vents and adjusting the positions. Windows are as in Figure (12) to suit comfort needs. To strengthen ventilation, there must be an inlet and outlet on the opposite side or on the sides adjacent to the space, as the air flow over the space openings on the windward side is more effective when the wind direction is within 30 degrees and in the normal position. For openings, and also when the wind blows towards the building, the air collected over the side facing the wind creates an area of high pressure, and the air coming around the building creates an area of low pressure for the building directly towards the wind. Accordingly, the pressure difference that exists between the side from which the wind is blowing and the side towards which it is blowing The wind works to increase natural ventilation and wind movement, because in this way we find that the air will move through the building if the openings are from the high pressure side (high pressure area) to the low pressure side (absorption area).

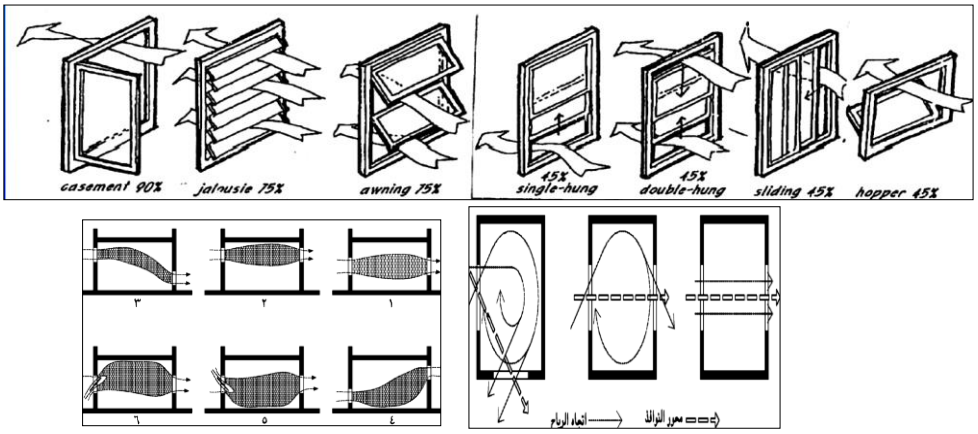


Figure (12): shows the effect of the position of openings on the entry and exit of wind in buildings:
Source: https://mirathlibya.blogspot.com/2010/09/blog-post_22.html

1-9-9- The effect of internal partitions:

Separators are placed inside the building to control the movement and speed of air flow inside the building in terms of Directing it to the areas most in need of air, to the areas with moderate need, and then isolating it from the air Areas that do not require air movement in the vacuum, as shown in Figure (13).

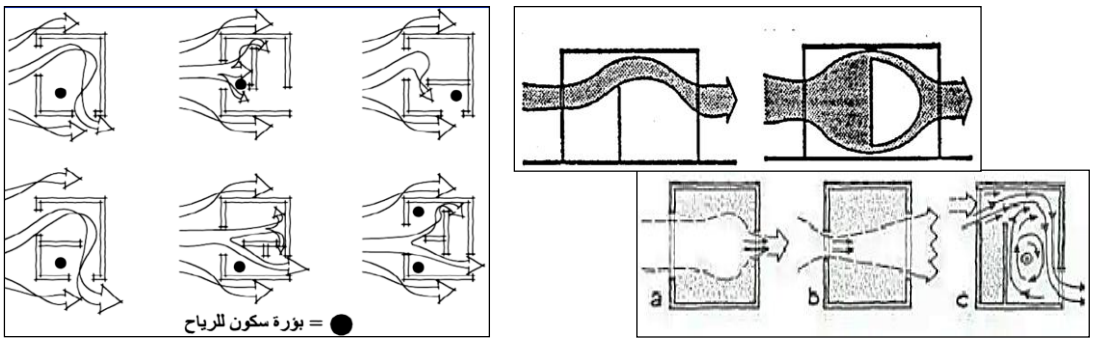


Figure (13): shows the internal partitions and their effect on air movement inside buildings, source: https://erjeng.journals.ekb.eg/article_125458_1934ae79ce6c34a265f13c2f657ad8d0.pdf

2-Applied study:

The approach to accrediting the safety and efficiency of a building's indoor environment is not complete without healthy ventilation and indoor air quality. It is a solution-based approach and is best used when problems arise that require practical solutions. The applied study for this research is achieved through a proposed design for a code (sustainable ventilation) to evaluate Treatments and strategies for the effect of air movement in architecture.

Objective of the applied study:

Testing the extent of the success of the proposed ventilation code and its effectiveness if applied to buildings inside and outside Egypt to increase the efficiency and quality of natural ventilation required in the building and contribute to rationalizing energy consumption in buildings as one of the most important sources of renewable energy. By conducting a survey. This applied research study is considered an important step towards a deeper understanding that goes beyond Only the traditional application of the concept of healthy ventilation and indoor air quality, and therefore the research necessity came to formulate a proposed methodology to measure the extent of the impact of deducing the design elements that directly and strongly affect the movement of air and its design standards, whether at the level of the building, its composition and external cover, or at the level of the external elements surrounding the building, and to formulate a proposed model for the code. (Sustainable Building) to evaluate treatments and strategies for the impact of air movement in architecture, by analyzing and monitoring some treatments and strategies used to control and adapt air movement in buildings.

The applied study was conducted in successive stages as follows:

1- The stage of selecting the study sample.

2- The stage of conducting the survey and questionnaires and designing the proposed methodology.

3- The statistical measurement and calibration stage using the SPSS statistics program.

4- The stage of comparison, evaluation, and formulation of results.

1-The stage of selecting the study sample:

The sample of the research study was selected from 63 people, experts and participants in preparing codes for green environmental treatments and studies of new and renewable energy and its applications in architecture, and those concerned with designing and approving the codes from university professors. It was also presented to architects, designers and specialists in the field of environmental architecture. It was also presented to students of the Department of Architecture in There are many universities and engineering institutes whose studies include environmental design and planning courses, regardless of their schools and architectural orientations to which the study sample belongs. The random method was excluded because it is not suitable for research and does not obtain misleading opinions or answers for reasons outside the scope of the research, such as weak culture or the spread of misconceptions about the concept. Health ventilation and indoor air quality for architectural spaces in the field of architecture among the public or lack of understanding of the standards presented in the questionnaires.

2- The stage of conducting the survey and questionnaires and designing the proposed methodology:

About 48 diverse strategies for the design elements affecting air movement and their design standards and their impact on the internal and external spaces of the building were selected, extracted and formulated, whether at the level of the building, its formation, its outer shell or at the level of the external elements surrounding it in the questionnaire forms, and the standards of the design foundations that were achieved were reached. Who can During which these elements are designed positively to contribute to raising the efficiency of air movement and achieving natural ventilation of internal spaces during the stages of the successive design process, as well as in evaluating the efficiency of ventilation and exploiting the actual internal and external air movement in existing buildings with the aim of raising Its environmental efficiency, which was previously explained and analyzed in the analytical part of the research Then, questionnaire forms were designed in which the study sample was asked to evaluate the proposed treatments and strategies, and to make a comparison between the averages, percentages, and the extent of the arrangement of treatments and strategies for the impact of air movement in architecture in the research study in each element.

3- The statistical measurement and calibration stage using the SPSS statistics program:

A five-point scale was used as shown in the questionnaire form in the appendices part and as shown in Table (1) as follows:

(Very strong): It is opposite the number (5) as its meaning. (Strong): It is opposite the number (4) as its meaning. (Medium): It is opposite the number (3) as its meaning. And (Weak): It is opposite the number (2). As its meaning and (very weak): It is matched by the number (1) as its meaning.

Table 1: Levels of statistical measurement and calibration and their equivalent as a numerical meaning. Source: Researcher.

Level	Grade given
5	very strong
4	Strong
3	Average
2	Weak
1	very weak

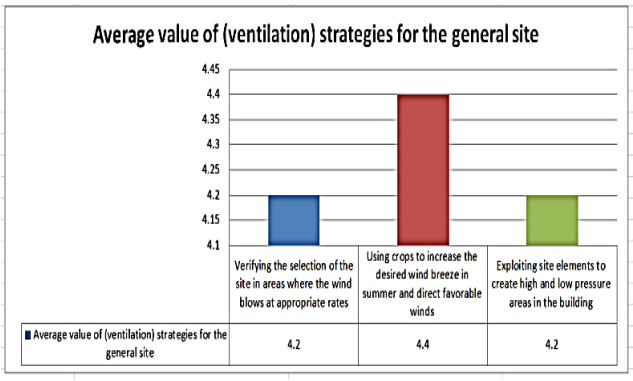
This is to identify the degree of percentages and rates of the effectiveness and efficiency of managing natural ventilation and its quality in the interior spaces of buildings, as suggested in the treatments and strategies listed and present in the questionnaires. The questionnaires were unpacked, the inputs were included in the statistical analysis program SPSS, the necessary data tables and graphs were made, and the results were formulated.

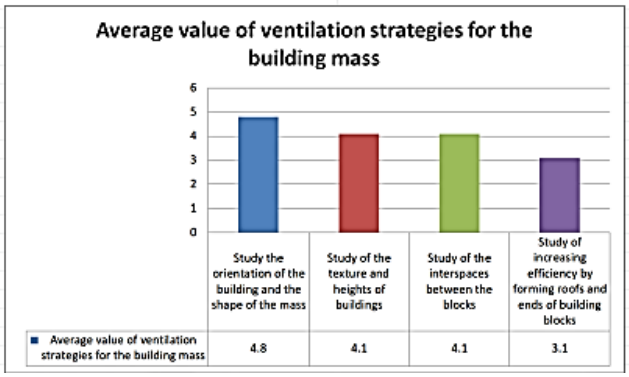
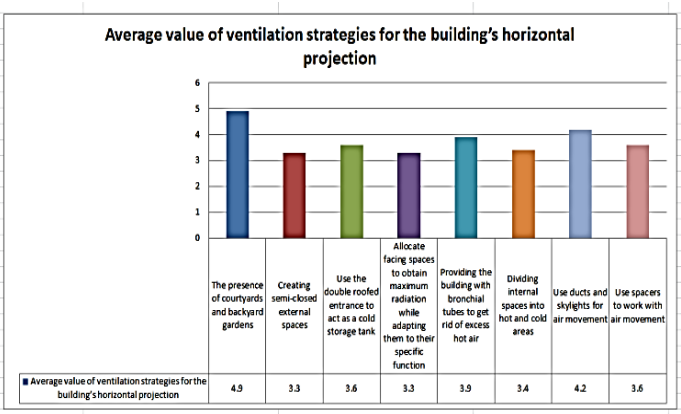
4-The stage of formulating the results:

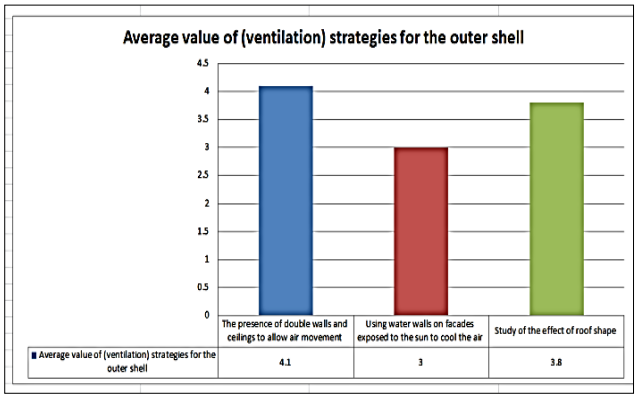
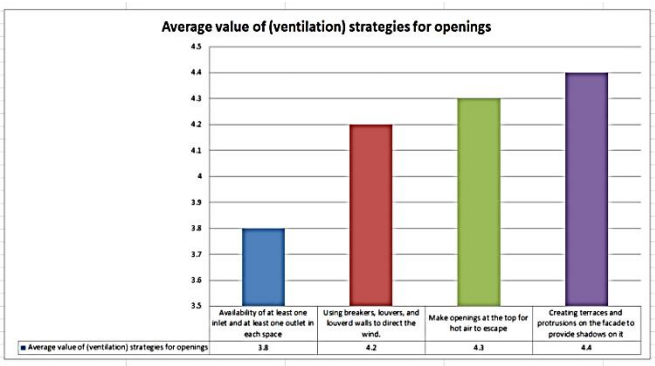
First: comparison and comparison between the averages of the sub-strategies in the extent of their impact on air movement and quality in architecture in the research study:

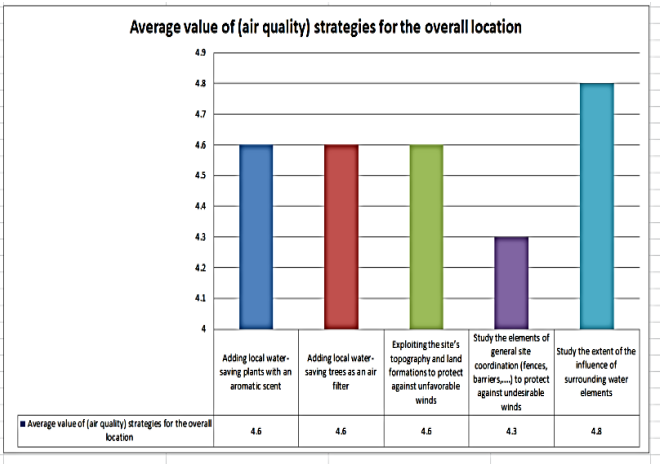
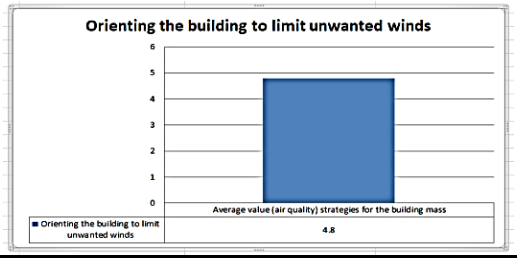
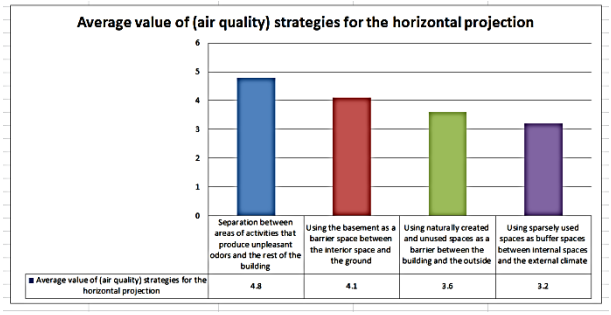
From the outputs of the statistical analysis program SPSS for the survey questionnaire study, the researcher counted several average values of the expected impact range of treatments and strategies for the impact of air movement in architecture. The results varied and varied, then the researcher conducted a comparison and comparison of the selected types of strategies and treatments, which are (48) strategies and formulations. The results, with explanation and analysis, are as shown in the following Table No. (2):

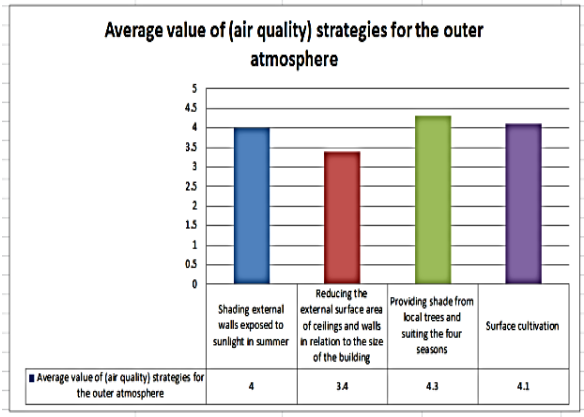
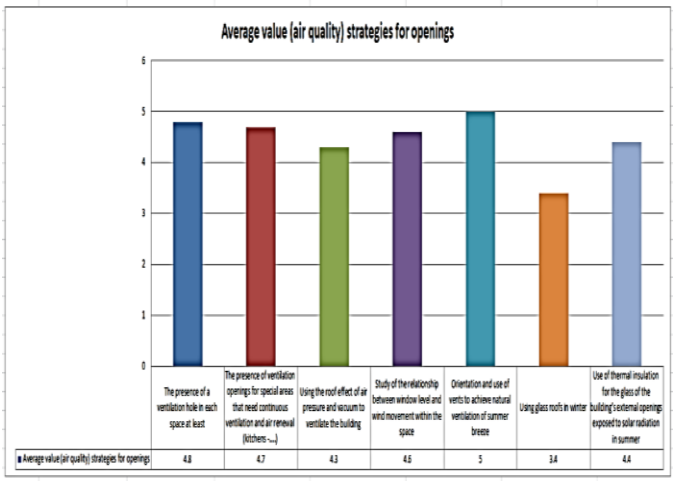
Table 2: Comparison and comparison between the averages of the sub-strategies in terms of the extent of impact on air movement and quality in architecture. Source: Researcher.

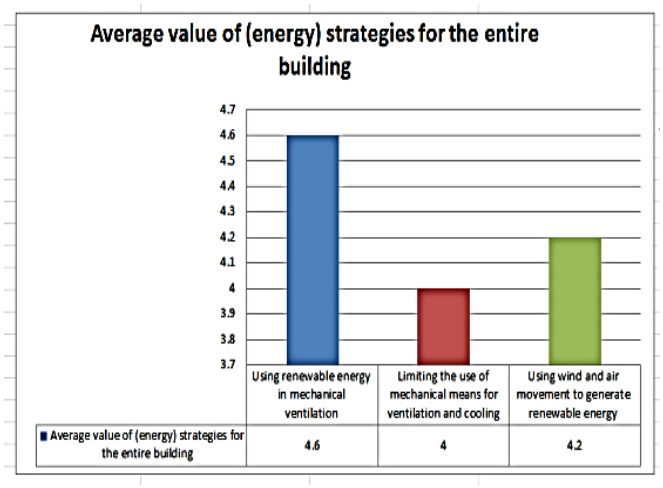
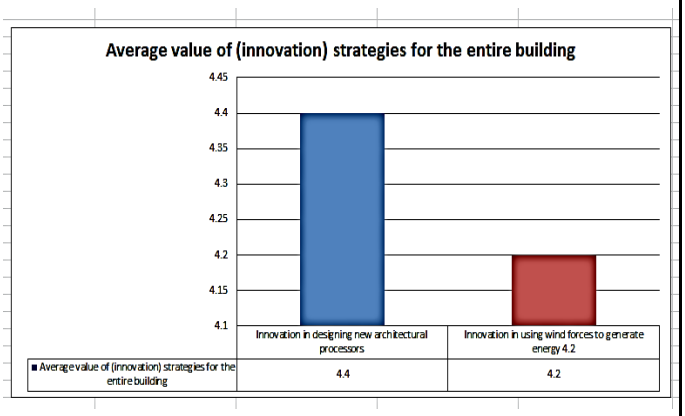
Element	The strategy	Average	Figure	Results And Observations
Ventilation at the general site level	1. Verify the selection of the site in areas where the wind blows at appropriate rates	4.2		It was found from the statistical analysis that the strategy of using crops to increase the desired wind breeze in summer and to direct favorable winds reached an average score of (4.4), which indicates a strong impact on the possibility of controlling air movement in buildings, while the strategy of verifying the choice of the site in windy areas occurred. With appropriate rates and a strategy for exploiting the elements of the site to create areas of high and low pressure in the building, at an average level of (4.2), which indicates the weak effect on the ability to control air movement in .buildings
	2. Using crops to increase the desired wind breeze in summer and direct favorable winds	4.4		
	3. Exploiting site elements to create high and low pressure areas in the building	4.2		

Ventilation at the building mass level	4. Study the orientation of the building and the shape of the mass	4.8		It was found from the statistical analysis that the strategy of studying the orientation of the building and the shape of the mass reached an average score of (4.8), which indicates a very strong effect on the possibility of controlling air movement in buildings, while the strategy of studying the fabric of buildings and their heights and studying the interstitial spaces between the blocks received an average score in it (4.1), which indicates a relatively moderate effect on the possibility of controlling air movement in buildings, while the strategy of studying increasing efficiency through the formation of roofs and ends of building blocks obtained an average score of (3.1), which indicates a weak effect on the ability to control air movement in .buildings
	5. Study the fabric of buildings and their heights	4.1		
	6. Study of the interspaces between the blocks	4.1		
	7. Study of increasing efficiency by forming the roofs and ends of the blocks of the building	3.1		
Ventilation at the horizontal level of the building	8. The presence of backyards and gardens	4.9		It was found from the statistical analysis that the strategy of studying the presence of courtyards and backyard gardens reached an average score of (4.9), and the strategy of using (ducts) and skylights for air movement obtained an average score of (4.2), which indicates a very strong impact on the possibility of controlling air movement in buildings, while The strategy of using the double roofed entrance to act as a cold storage tank received an average score of (3.6), the strategy of supplying the building with bronchial tubes to get rid of excess hot air received an average score of (3.9), and the strategy of using dividers to work in air movement received an average score of (3.6). Which indicates the moderate effect on the possibility of controlling air movement in buildings, while the strategy of creating semi-closed external spaces and the strategy of allocating facing spaces to gain maximum radiation while adapting them to the function specified for them received an average score of (3.3), and the strategy of dividing internal spaces into areas Hot and cold, with an average temperature of (3.4), which indicates the weak effect on the ability to control air .movement in buildings
	9. Making semi-closed external spaces	3.3		
	10. Use the double roofed entrance to act as a cold storage tank	3.6		
	11. Allocate facing spaces to gain maximum radiation while adapting them to their specific function	3.3		
	12. Providing the building with bronchial tubes to get rid of excess hot air	3.9		
	13. Dividing internal spaces into hot and cold areas	3.4		
	14. Use ducts and skylights for air movement	4.2		
	15. Use spacers to work with air movement	3.6		

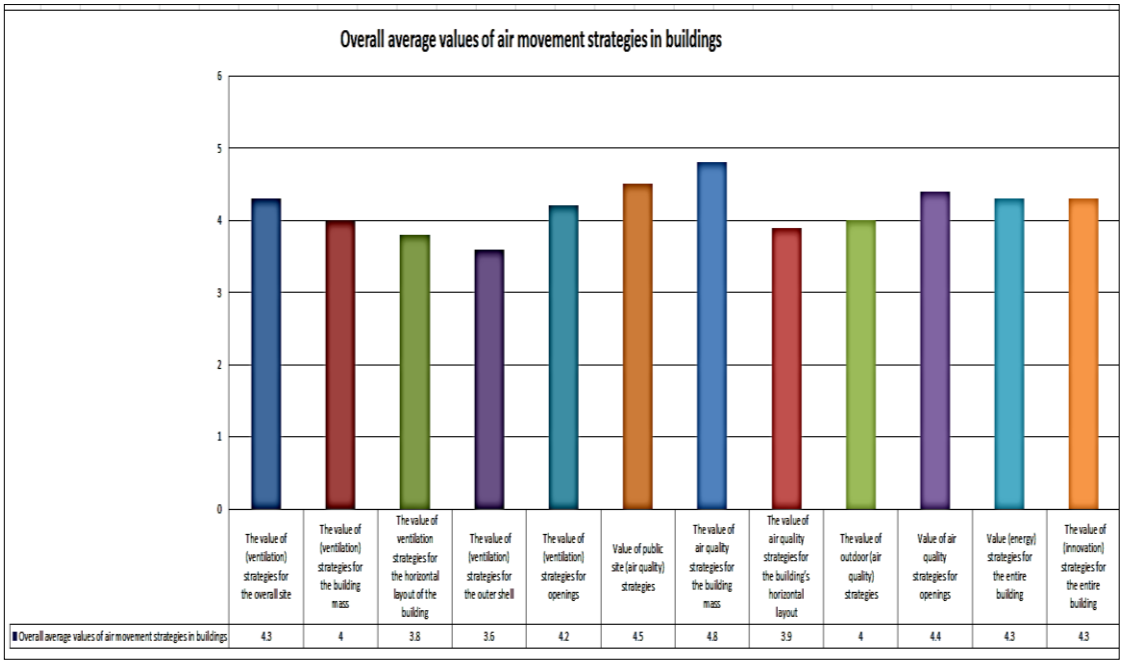
Ventilation at the outer shell level	16. There are double walls and ceilings to allow air movement	4.1		It was found from the statistical analysis that the strategy of having double walls and ceilings to allow air movement had an average score of (4.1), which indicates a strong impact on the ability to control air movement in buildings, while the strategy of studying the effect of the shape of the ceilings obtained an average score of (3.8), which indicates The average effect on the ability to control air movement in buildings, while the strategy of using water walls on facades exposed to the sun to cool the air received an average score of (3), which indicates a weak effect on the ability to control air movement in buildings.
	17. Use water walls on facades exposed to the sun to cool the air	3		
	18. Study the effect of roof shape	3.8		
Ventilation at the level of external openings	19. The availability of at least one entrance and at least one exit in each space	3.8		The strategy of making terraces and protrusions on the façade to provide shade on it received an average score of (4.4), which indicates a very strong effect on the ability to control air movement in buildings, while the strategy of making upper openings for hot air to escape received an average score of (4.3), and it was found that From the statistical analysis, the strategy of studying the use of (breaks - louvers - louverd wall) to direct the wind. It obtained an average score of (4.2), which indicates a relatively moderate effect on the ability to control air movement in buildings. The strategy of providing at least one entrance and at least one exit in every space reached an average score of (3.8), which indicates a weak effect on Possibility of controlling air movement in buildings.
	20. Use (breaks - louvers - louverd wall) to direct the wind.	4.2		
	21. Make openings at the top for hot air to escape	4.3		
	22. Creating terraces and protrusions on the facade to provide shadows on it	4.4		

Air quality at the general site level	23. Add local water-saving plants with an aromatic scent	4.6		The strategy of studying the extent of the influence of surrounding water elements received an average score of (4.8), which indicates a very strong impact on the possibility of controlling air movement in buildings, while the strategy of adding local water-saving plants with an aromatic scent, and the strategy of adding local water-saving trees as an air filter. The strategy of exploiting the site's topography and land formations to protect against undesirable winds has an average score of (4.6), which indicates a relatively moderate effect on the ability to control air movement in buildings. The strategy of studying the elements of general site coordination (fences, barriers, ...) to protect against Unfavorable winds averaged (4.3), which indicates a weak effect on the ability to control air movement in buildings.
	24. Add local water-saving trees as an air filter	4.6		
	25. Exploiting the site's topography and land formations to protect against undesirable winds	4.6		
	26. Study the elements of general site coordination (fences, barriers,....) to protect against undesirable winds	4.3		
	27. Study the extent of the influence of surrounding water elements	4.8		
Air quality at the building mass level	28. Orient the building to limit unwanted winds	4.8		The strategy of orienting the building in a way that reduces unwanted winds received an average score of (4.8), which indicates a very strong impact on the ability to control air movement in buildings.
Air quality at the horizontal level of the building	29. Separation between areas of activities that produce unpleasant odors and the rest of the building	4.8		The strategy of separating the places of activities that produce unpleasant odors from the rest of the building received an average score of (4.8), which indicates a very strong impact on the ability to control air movement in buildings, while the strategy of using the basement as a barrier space between the interior space and the ground received an average score of (4.8). (4.1), which indicates a relatively strong effect on the possibility of controlling air movement in buildings. The strategy of using naturally created and unused spaces as a barrier between the building and the outside was achieved, and its average score reached (3.6), which indicates a moderate effect on the ability to control air movement in buildings. While the strategy of using sparsely used spaces as buffer spaces between the internal spaces and the external climate, the average score reached (3.2), which indicates the weak effect on the possibility of controlling air movement in buildings.
	30. Using the basement as a buffer space between the interior space and the ground	4.1		
	31. Using naturally created and unused spaces as a barrier between the building and the outside	3.6		
	32. Use spaces that are rarely used as buffer spaces between the internal spaces and the external climate	3.2		

Air quality at At the level of the outer shell	33. Shading external walls exposed to sunlight in summer	4		The strategy of providing shade from local trees, which is compatible with the four seasons, received an average score of (4.3), which indicates a very strong impact on the ability to control air movement in buildings, while the strategy of planting roofs received an average score of (4.1), which indicates a strong impact. Relatively, in the possibility of controlling air movement in buildings, the strategy of shading the external walls exposed to sunlight in summer was achieved, and its average score reached (4), which indicates a strong impact on the possibility of controlling air movement in buildings, while the strategy of reducing the external surface of the ceilings and walls in relation to the size of the building was obtained. Its average score was (3.4), which indicates the relatively weak effect on the ability to control air movement in buildings
	34. Reducing the external surface area of ceilings and walls in relation to the size of the building	3.4		
	35. Providing shade from local trees that suits the four seasons	4.3		
	36. Rooftop cultivation	4.1		
Air quality at the level of external openings	37. There is at least a ventilation hole in every space	4.8		It was found from statistical analysis that the strategy of directing and using openings to achieve natural ventilation from the summer breeze reached an average score of (5), which indicates a very strong effect on the possibility of controlling air movement in buildings, while the strategy of having a ventilation opening in every space reached at least a score of Its average score was (4.8), and the strategy of having ventilation openings for special areas that need continuous ventilation and air renewal (kitchens - ....) obtained an average score of (4.7), which indicates a relatively strong impact on the ability to control air movement in buildings. While the strategy of studying the relationship between the window level and the movement of wind inside the space obtained an average score of (4.6), and the strategy of using thermal insulation for the glass of the external openings in the building exposed to solar radiation in the summer obtained an average score of (4.4), which indicates the average effect on the ability to control the movement of Air in buildings, while the strategy of using the effect of roofs from compressing and vacuuming air to ventilate the building got an average score of (4.3), and the strategy of using glass roofs in winter got an average score of (3.4), which indicates the relatively weak effect on the possibility of controlling air movement in buildings. .
	38. The presence of ventilation openings for special areas that need continuous ventilation and air renewal (kitchens -....)	4.7		
	39. Using the roof's effect of air pressure and vacuum to ventilate the building	4.3		
	40. Study the relationship between the window level and the movement of wind inside the space	4.6		
	41. Orientation and use of vents to achieve natural ventilation of summer breeze	5		
	42. Use of glass roofs in winter	3.4		
	43. Use thermal insulation for the glass of the building's external openings exposed to solar radiation in the summer	4.4		

Energy at the entire building level	44. Using renewable energy in mechanical ventilation	4.6		It was found from statistical analysis that the strategy of using renewable energy in mechanical ventilation was (4.6), which indicates a very strong impact on the ability to control air movement in buildings, while the strategy of using wind and air movement in generating renewable energy obtained an average score of (4.2), which indicates It had a very good effect on the ability to control air movement in buildings, while the strategy of limiting the use of mechanical means for ventilation and cooling received an average score of (4), which indicates a moderate effect on the ability to .control air movement in buildings
	45. Limit the use of mechanical means for ventilation and cooling	4		
	46. Using wind and air movement to generate renewable energy	4.2		
Innovation at the building level	47. Innovation in designing new architectural processors	4.4		It was found from the statistical analysis that the innovation strategy in designing new architectural treatments was (4.4), which indicates a strong impact on the ability to control air movement in buildings, while the innovation strategy in using wind movement forces to generate energy received an average score of (4.2), which indicates It has a very good effect on the ability to control air movement in buildings.
	.48Innovation in using wind forces to generate energy	4.2		

Second: Comparison between the overall main elements of treatments and strategies for the effect of air movement in architecture in the research study:



3-Discussion and general conclusions:

We conclude from the above that all the air movement strategies and treatments included in the proposed code have a very effective effect on ventilation and the indoor air quality of spaces. Therefore, it was observed that there are slight, fairly close differences in the averages of their values in the questionnaires resulting from the applied research study, but these differences must be noted and emphasized because of their importance when making a comparison in Choosing the appropriate strategy before using it inside the building, which indicates the success of the proposed ventilation code and its effectiveness if applied to buildings inside and outside Egypt to increase the efficiency and quality of natural ventilation required in the building and contribute to rationalizing energy consumption in buildings as one of the most important sources of renewable energy.

4- Future studies and suggested recommendations:

1- The research proposes to apply the applied research study on a larger scale and on a larger scale to all segments of society in order to better understand the concept of treatments and strategies for the impact of air movement in architecture, with the aim of measuring the extent of their awareness and identifying the understanding and awareness of the general users, which has been proven from previous studies that it often differs from understanding Analysis, interpretation and preference of architects and specialists in this field.

2- The need to increase the dissemination of cultural and scientific awareness among designers and society regarding the concept of treatments and strategies for the impact of air movement in architecture in architectural buildings.

3- The necessity of applying and including the results of this important applied research study and adding it to the academic curricula in colleges specialized in architecture, especially environmental studies, so that students can keep up with the findings of scientific research studies and modern experiences in this field.

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6 -Appendix:

Questionnaire forms Source: Researcher:

A proposed model for a code and system (sustainable building) to evaluate treatments and strategies for the impact of air quality and movement in architecture

1- Personal data:

Name: ..... (Optional), Academic degree: ....., Occupation:.....

2- Analyze and explain the importance and effectiveness of the following elements and treatments of the proposed (green building) code model to evaluate the principles and strategies of the impact of air movement in buildings in terms of first: ventilation, second: air quality, third: energy, fourth: innovation through the following levels of influence (strong Very, strong, moderate, weak, or very weak):

Item	Requirements	Item	Strategy	Very Strong	Strong	Good	Weak	Very Weak
First: ventilation	Building cooling and air movement	At the general site level	1. Verify the selection of the site in areas where the wind blows at appropriate rates					
			2. Using crops to increase the desired wind breeze in summer and direct favorable winds					
			3. Exploiting site elements to create high and low pressure areas in the building					
		At the building block level	4. Study the orientation of the building and the shape of the mass					
			5. Study of the texture and heights of buildings					
			6. Study of the interspaces between the blocks					
			7. Study of increasing efficiency by forming roofs and ends of building blocks					
		At the horizontal level of the building	8. The presence of courtyards and backyard gardens					
			9. Creating semi-closed external spaces					
			10. Use the double roofed entrance to act as a cold storage tank					
			11. Allocate facing spaces to obtain maximum radiation while adapting them to their specific function					
			12. Providing the building with bronchial tubes to get rid of excess hot air					
			13. Dividing internal spaces into hot and cold areas					
			14. Use ducts and skylights for air movement					
			15. Use spacers to work with air movement					
		At the level of the outer shell	16. There are double walls and ceilings to allow air movement					
			17. Using water walls on facades exposed to the sun to cool the air					
			18. Study the effect of roof shape					
		At the level of the external openings	19. The availability of at least one inlet and at least one outlet in each space					
			20. Using breakers, louvers, and louverd walls to direct the wind.					
			21. Make openings at the top for hot air to escape					
			22. Creating terraces and protrusions on the facade to					

			provide shadows on it					
:Air quality	Reducing air pollution	At the general site level	23. Add local water-saving plants with an aromatic scent					
			24. Add local water-saving trees as an air filter					
			25. Taking advantage of the site's topography and land formations to protect against unfavorable winds					
			26. Study the elements of general site coordination (fences, barriers,...) to protect against undesirable winds					
	Control the amount of humidity		27. Study the extent of the influence of surrounding water elements					
	Reducing air pollution	At the building block level	28. Orienting the building to limit unwanted winds					
	Reducing air pollution	At the horizontal level of the building	29. Separating the areas of activities that produce unpleasant odors from the rest of the building					
	Temperature control		30. Using the basement as a buffer space between the interior space and the ground					
			31. Using naturally created and unused spaces as a barrier between the building and the outside					
			32. Using sparsely used spaces as buffer spaces between internal spaces and the external climate					
	Temperature control	At the level of the outer shell	33. Shading external walls exposed to sunlight in summer					
			34. Reducing the external surface area of ceilings and walls in relation to the size of the building					
			35. Provide shade from local trees and suit the four seasons					
	Control the amount of humidity		36. Roof cultivation					
	Healthy ventilation	At the level of the external openings	37. There is at least one ventilation hole in each space					
			38. The presence of ventilation openings for special areas that need continuous ventilation and air renewal (kitchens -....)					
			39. Using the roof effect of air pressure and vacuum to ventilate the building					
			40. Studying the relationship between window level and wind movement within the space					
			41. Orientation and use of vents to achieve natural ventilation from the summer breeze					
	Temperature control		42. Use of glass roofs in winter					
			43. Use of thermal insulation for the glass of the building's external openings exposed to solar radiation in the summer					
Third: energy		Throughout the building	44. Using renewable energy in mechanical ventilation					
			45. Limit the use of mechanical means for ventilation and cooling					
			46. Using wind and air movement to generate renewable energy					

Fourth: Innovation		Throughout the building	47. Innovation in designing new architectural processors					
			48. Innovation in using wind forces to generate energy					