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Master Program of Architecture – Sustainable Design

Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room.

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Thesis submitted in partial fulfillment of requirements of the degree.

Master of Architecture- Sustainable Design

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Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room

Ruba Mohammad Rashed

in partial fulfillment of the requirements for the degree of master's in architecture – Sustainable Design.

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Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room.

Ruba Mohammad Abdallah Rashed

ABSTRACT

Architectural designs showed failure during the spread of the (Covid 19) epidemic (Seo Eun Hwang, 2021). This became clear during the period of home confinement, which was used to prevent the spread of the epidemic. It was found that many buildings contributed to spread of infection among their residents and the decline in their immunity, and these failure became a reason for the deterioration of the mental, psychological and physical health of many residents of residential buildings. (Hyeon-Seung Lee, 2021) (Amerio, 2020). Residents were forced to stay for a long period, sometimes exceeding two months, in their apartments. Here a question arises: How do we make residential buildings more immune to the transmission of infectious diseases? How mechanisms could be used to improve the immune performance of a building, so it becomes less susceptible transmitting infectious diseases and healthier? How can the design of apartments be improved, and how the design could be linked to the effect of the ability of indoor greening to alleviate the pressures which resulting from the quarantine situation? This research attempt to develop procedures that improve residential apartments from both a health and psychological perspectives by designing a “Transformable living walls” and an attempt to develop a mechanism for isolation rooms. – Negative pressure room. Testing the system and its capabilities through the design builder simulation program. The research will also work on developing recommendations for a new design framework for the functional distribution of apartments in residential buildings by lessons learned from the experience of the Corona virus pandemic. The result is the design of a residential apartment that includes a negative pressure room - quarantine - and specifications that are more immune to the transmission of Contagious diseases. These recommendations are implemented by architects and building permit authorities in local authorities.

Keyword: (Covid 19) epidemic, Post pandemic architecture, home confinement, pandemic architecture, new normal, apartment design, psychological and physical health, isolation room

عمارة ما بعد الوباء الشقق السكنية: اقتراح لبناء ذو مناعة يتضمن غرفة الضغط السلبي

ربا محمد عبدالله راشد

ABSTRACT

اظهرت التصميمات المعمارية فشلها خلال انتشار وباء (كوفيد 19) (Seo Eun Hwang, 2021). وقد اتضح ذلك خلال فترة الحجر المنزلي الذي تم استخدام كأداة لمنع انتشار الوباء. وتبين أن العديد من المباني ساهمت في انتشار العدوى بين ساكنيها وتراجع مناعتهم، وأصبحت هذه الإخفاقات سبباً في تدهور الصحة العقلية والنفسية والجسدية للعديد من سكان المباني السكنية .(Hyeon-Seung Lee, 2021) (Amerio, 2020). واضطر السكان إلى البقاء لفترة طويلة، تجاوزت في بعض الأحيان الشهرين، في شققهم. وهنا يطرح سؤال: كيف نجعل المباني السكنية أكثر مناعة ضد انتقال الأمراض المعدية؟ كيف يمكن استخدام الآليات لتحسين الأداء المناعي للمبنى بحيث يصبح أقل عرضة لنقل الأمراض المعدية وأكثر صحة؟ كيف يمكن تحسين تصميم الشقق وربط التصميم بتأثير قدرة التخضير الداخلي على تخفيف الضغوط الناتجة عن حالة الحجر الصحي؟ نحاول في هذا البحث تطوير إجراءات تحسين الشقق السكنية من الناحيتين الصحية والنفسية من خلال تصميم " جدران حية متحولة" ومحاولة تطوير آلية غرف العزل – غرفة الضغط السلبي . اختبار النظام وإمكانياته من خلال برنامج محاكاة. كما سيعمل البحث على وضع توصيات لإطار تصميمي جديد للتوزيع الوظيفي للشقق في المباني السكنية من خلال الدروس المستفادة من تجربة جائحة فيروس كورونا. والنتيجة تصميم شقة سكنية تتضمن غرفة ضغط سلبي - حجر صحي - ومواصفات أكثر مناعة ضد انتقال الأمراض المعدية. يتم تنفيذ هذه التوصيات من قبل المهندسين المعماريين وسلطات تراخيص البناء في السلطات المحلية.

الكلمة المفتاحية: وباء (كوفيد 19)، عمارة ما بعد الجائحة، الحبس المنزلي، عمارة الجائحة، الوضع الطبيعي الجديد، تصميم الشقق، الصحة النفسية والجسدية، غرفة العزل

DECLARATION

I declare that the Master Thesis entitled" Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room" is my own original work, and herby certify that unless stated, all work contained within this thesis is my own independent research and has not been submitted for the award of any other degree at any institution, except where due acknowledgement is made in the text.

Student Name…….

Signature:———————————— Date:————————

DEDICATION

I dedicate my work on this thesis to my family for their support and encouragement.

For those who did not hesitate to help in times of need.

Ruba Rashed

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Chapter 1

1 Introduction

1.1 Preface:

The results of pandemic reviews showed that at the architectural level, most of the current residential apartment -multi unit building- design standards are not suitable for confronting epidemics, and the reason is not meeting the main and emerging needs of its residents (Hanna, 2023). The needs are health (physical and mental), individual (comfort and privacy), vocational, educational, social, recreational, or sports during the period of staying at home. Must add an important need, which is to give the building immunity against sick building syndrome, and to provide an internal protection feature among the residents themselves.

One of the most important lessons that humanity has learned after the Covid-19 experience which will not end as with any infectious disease, the best approach would be endemicity, as happened with other types of seasonal influenza, is that in cases of the spread of the epidemic, countermeasures must be one step ahead of the epidemic so that humanity can resist and resist. Some measures must also be a way of life in the presence of an epidemic or not. That is, the previous experience calls for reconsidering changing some lifestyles related to the architectural design of residential apartments from health aspects (Bancel, 2022) . It seems that isolation, social distancing and quarantine are practical solutions that should be adapted to our homes and cities (Budds, 2020). Scientists and researchers began asking questions about how to cope and adapt to the new situation, as this epidemic raises a question about how architects and planners work to confront these types of threats and achieve a balance between quarantine spaces and the required human activities (Hang, 2020). To develop solutions, try, and set rules for the new normal.

A person's fear for his loved ones may be a primary factor in choosing the way to design our homes from the inside. The home must be a safe haven from diseases. When epidemics spread, governments used home quarantine as a method to confront epidemic spread. Even homes become threat if the person is infected with the

infectious disease and could not be far from those who are responsible for them. The residences and apartments, which seemed to be the most critical places for human awareness of infectious diseases, had to be prepared to receive this situation. The model proposed in the research is a negative pressure isolation room system connected to a green outdoor terrace that allows communication between the residents of one apartment without the risk of contracting the virus and transmission of infection and ensuring movement. Internal services without spreading the disease. Focused studies on these themes began to appear with the development of the spread of the epidemic as a tool for crisis management at the present time. What we will discuss in this study is how to introduce mechanisms in residential apartments to become a tool that is taken into consideration in all circumstances, based on the Corona experience, and the solutions provided are not for temporary use to solve a crisis, but rather to be one of the standards that the designer follows when designing a multi-storey residential building.

G. Tokazhanov et al. clarified that overcrowded housing, which interferes with social distancing, worsens the comfort level during a stay home due to inadequate privacy (Tokazhanov, 2020). This is evident in multi-apartment buildings in Palestine Table 1, and the problem is more exacerbated in some cities, such as Gaza and Jerusalem see Figure 1 Number of buildings in Palestine , than in others. As a result of the dwindling land allocated for construction, the sharp rise in land prices, the high population density, and the high construction costs, citizens have moved towards housing in multi-apartment buildings, which are characterized by higher prices compared to other cities.

In the event of an epidemic spreading, the solutions proposed globally to increase the immunity of buildings against the aggravation spread the infectious diseases and pandemics among the population by increasing spaces will be unrealistic for a large segment of the population of the West Bank and Gaza Strip, especially since the prices of apartments are not proportionate and are not linked in Palestine to the level of per capita income see Figure *2*.

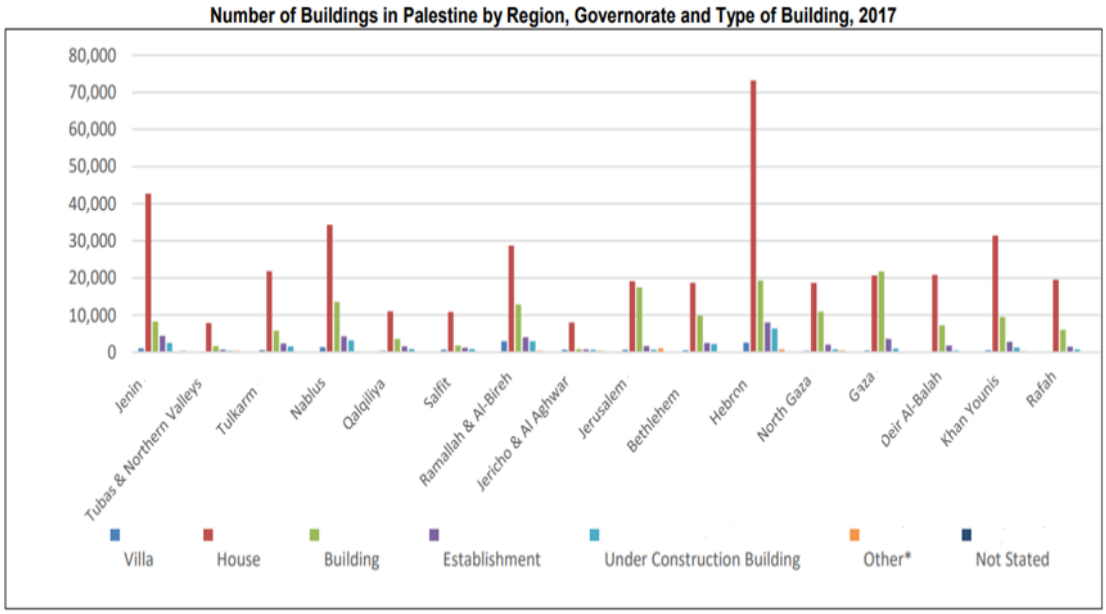


Figure 1 Number of buildings in Palestine *(Statistics, 2020)*

Table 1 Number of buildings in the West Bank and Gaza Strip, indicating their type.

Region/Governorate	Total	Type of Building					
		Not Stated	Other*	Establishment	Building	House	Villa
Palestine	**601,045**	**1,613**	**4,775**	**43,375**	**150,365**	**387,571**	**13,346**
West Bank	**419,160**	**1,295**	**3,385**	**31,520**	**94,949**	**276,358**	**11,653**
Jenin	**56,797**	295	73	4,430	8,256	42,672	1,071
Tubas & Northern Valleys	**10,789**	42	342	677	1,664	7,847	217
Tulkarm	**30,657**	16	11	2,389	5,837	21,834	570
Nablus	**53,889**	180	185	4,296	13,511	34,349	1,368
Qalqiliya	**16,716**	61	79	1,548	3,586	11,054	388
Salfit	**14,657**	49	35	1,234	1,802	10,852	685
Ramallah & Al-Bireh	**49,074**	172	379	4,028	12,833	28,713	2,949
Jericho & Al Aghwar	**10,681**	97	366	736	832	8,005	645
Jerusalem	**40,112**	139	1,037	1,661	17,469	19,167	639
Bethlehem	**31,747**	75	150	2,488	9,849	18,661	524
Hebron	**104,041**	169	728	8,033	19,310	73,204	2,597
Gaza Strip	**181,885**	**318**	**1,390**	**11,855**	**55,416**	**111,213**	**1,693**
North Gaza	**32,567**	47	470	2,073	10,919	18,702	356
Gaza	**46,764**	87	220	3,608	21,750	20,697	402
Deir Al-Balah	**30,393**	50	173	1,819	7,258	20,851	242
Khan Younis	**44,667**	97	314	2,849	9,470	31,445	492
Rafah	**27,494**	37	213	1,506	6,019	19,518	201

(Statistics, 2020)

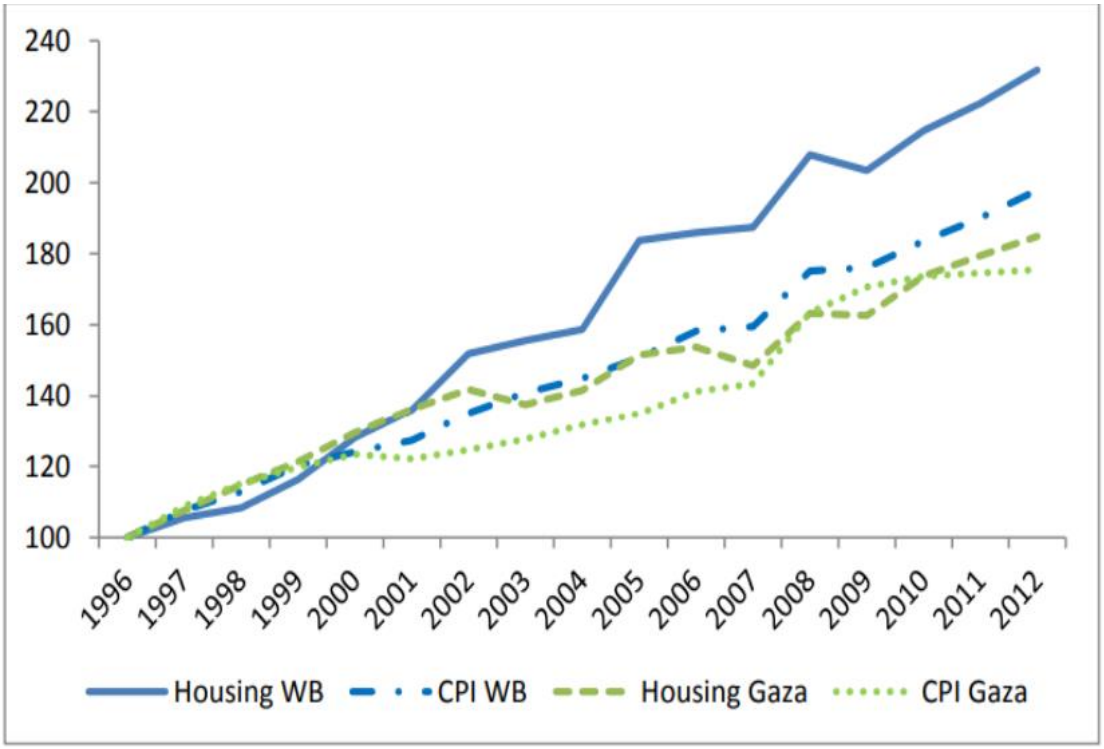


Figure 2 Housing prices and Palestinian CPI also told 1996 2012 (1996 = 100) *(Statistics, 2020)*

1.2 Literature review

The World Health Organization (WHO) defines a pandemic as the worldwide spread of unpredictable a brand-new infectious disease across multiple countries and affects many people, which they have little or no immunity to the virus or with no vaccine or medicine that can prevent its spread (World Health Orgnization, 2022). The world has resorted to various non-pharmaceutical strategies to reduce the spread of the epidemic until the vaccine is obtained in order to reduce the number of deaths, such as: hygiene and sterilization, isolating the patient, quarantine, social distancing, preventing gatherings, using masks and travel restrictions, closing schools and work offices (Madhav, 2018), so turning to education and remote work, This necessarily means spending more time in homes and apartments, this measure has been linked to an increasing incidence of depression and anxiety, and a decline in the physical, mental and psychological state of a large number of the population especially in high rise building Where a survey of professionals was applied to the effects of the Covid-19 pandemic on health in buildings, it was found that the last epidemic had a significant impact for buildings on health. It is necessary to focus on the design, construction and

operation of buildings in a way that ensures the health of the occupants, as professionals must care about high interior quality and reducing infection in indoor spaces. Design changes to adopt less dense layouts, use hands-free systems, and install antibacterial fabrics and coverings (Paria Akbari, 2021). A previous study stated that after the Covid-19 epidemic, the area of functional space must increase, increase the number of vertical and horizontal movement circles, and increase the width of horizontal corridors (Ahmad Alhusban, 2022). All future designs must be energy and water independent and self-sufficient and use non-renewable energy sources. The goal is to be independent from the outside world and reduce risks in the event of a complete lockdown (Makhno, 2020) General guidelines were given for the design, such as avoiding sharp corners for difficulty in cleaning, using non-absorbent, healthy, sustainable and easy-to-clean materials, using antibacterial finishing composite materials and self-sterilizing smart materials such as bronze, copper and brass, staying away from stainless steel, steel, cardboard and plastic materials as the virus lives on them for a period of time 2-3 days use germ-resistant floor surfaces, countertops and sanitary monitoring systems. Porcelain, tiles, and linoleum, especially in the most commonly used surfaces such as the kitchen, bathrooms, and laundry rooms (Budds, 2020) Using touch, smart sensing, voice response, and remote control technologies in design and construction (Wainwright, 2020) In general, a group of studies believe that the design of healthy residential apartments must take into account the importance in the post-epidemic phase: windows and views that support recovery, and lighting levels linked to multiple uses and users; Regulating the biological clock through comfortable bedrooms and living rooms that enhance indoor air quality and communication with nature, enhancing the role of balconies and emphasizing physical distancing as a guideline and reducing the occupancy rate is essential in determining unit sizes and layouts (Terri Peters, 2021). A study (Bad Air Can Also Kill: Residential Indoor Air Quality and Pollutant Exposure Risk during the COVID-19 Crisis) in Spain showed that residents' exposure to indoor pollutants during the lockdown period was stronger and longer-lived. The reason is due to the saving of household energy, the lack of proper ventilation and the extensive use of cleaning products and disinfectants during the Covid-19 crisis, and indoor pollutants

were at the highest levels of health. The average daily PM2.5 concentration was approximately 12% and the average TVOC was 37% to 559% (Samuel Domínguez-Amarillo, 2020). This calls for the development of negative mechanisms to control indoor air quality in terms of air renewal and trapping polluted air as much as possible. Such mechanisms have been searched at length, but no designs that developed such mechanisms. What this research will present is a negative pressure mechanism for one of the rooms of the apartment through which the movement of air can be controlled. The air, thus renewing it and thus raising indoor air quality, specifically in cases where home quarantine and home isolation for patients will be a decision, not an option. The strongest justification for the importance of the research is that the rapid global spread of the Covid-19 pandemic has been a major challenge for various countries in the ability of hospitals to accept and care for patients during the crisis. In a study to estimate hospital capacity during the Covid-19 pandemic, the opinions of doctors working in hospitals around the world were surveyed regarding available Covid-19 hospital statistics. The result was that although measures were taken to mitigate the spread of the virus and remove some pressure on the health care system, the truth is that a large number of hospitals are overloaded during periods of the pandemic (Norihiro Kokudo, 2021).

Housing reform

Researchers have partly attributed the clean modernist aesthetic to previous pandemics. Architectural designs have begun to take a trend of simplicity of form, using less curves , employ modern materials with a sense of function, and move away from decorations due to their role in the accumulation of soil and dust.

Modernist architects designed these therapeutic environments as purged (physically and symbolically) of disease and pollution. Beyond their aesthetic appeal, these features embodied modernist preoccupations with the therapeutic effects of light, air, and nature. These buildings included large windows, balconies, flat roofs that did not collect dust, and white paint, which emphasized the appearance of cleanliness (Budds, 2020). Against this background, the current health crisis must evolve our built

environment to increase the security layers that help prevent the spread of infections and diseases. In this context, there are multiple areas of research needed in relation to COVID-19 (Naglaa Megahed, 2020).

A group of studies appeared in the period following the announcement of the Covid-19 epidemic and included insights and analyzes by researchers and architectural designers, who developed a set of practical insights and recommendations to update home design requirements in the post-Covid stage. Perceptions included the change in space of the home; Residential space preparations; And home design supplements (Hanna, 2023). The goal is to produce designs that take into account the health aspects, both physical and mental, to stop the transmission of infection and protect physical and mental health. Table *2* shows Suggested interventions for post-COVID home design and its role in meeting its residents' needs imposed by epidemics It clearly did not address the specifics of residential apartments and multi-unit buildings.

Appropriate design strategies for infection prevention and control in some built environments, for example, such as health facilities: Design that promotes social distancing, design to enhance natural ventilation, daylight or sunlight, design using adaptive finishing materials and construction methods, and flexible design that emphasizes sustainability (Kalu, 2020).

Table 2: Suggested interventions for post-COVID home design and its role in meeting residents' needs imposed by epidemics. Source *(Hanna, 2023)*

RESIDENTS NEEDS AND IMPLICATIONS DURING THE MANDATORY SURVIVAL EXPERIENCE OF THE COVID 19- PANDEMIC			SUGGESTED VISIONS FOR POST-COVID HOUSING DESIGN												
			Change in House Spaces Design								**Residential space preparation**		**Home design compleme nt**	
			Entrance / Containment Space	Isolation Space Provided with a Hygienic Facility	Multifunctional Living Space	Larger Guest Area	Home Office Room	Semi-Open Space (Balcony)	Indoor environment quality for Spaces	Shared Spaces in the Residential Building	Indoor Materials Selection	Application of Smart Technologies and Systems	Indoor Greenery	Natural Views from the Windows
Comfort and privacy		Noise, disturbance, lake of comfort and privacy			■		■	■		■	■			
Health Protection	**Physical Health**	High rate of infection among family members, as well other families in building	■	■	■	■		■	■		■	■		
		Exposure to health disorders lake of concentration, headache, and exhaustion						■	■				■	■
		Exacerbation of some chronic and non-commonable diseases						■	■			■	■	■
	Mental health	Decrease the positive feeling		■		■		■	■	■			■	■
		The high rate of loneliness and depression as well emergence of negative feeling		■		■		■	■	■			■	■
Get work done and succeed		Deuteriations of work performance		■	■		■		■			■		
		Low productivity		■	■		■		■			■		
Social needs		Refraining from husting guest, losing human interaction, and feeling socially isolated				■				■				
Recreational and sport activities		Loss of participation in the creational or regular sports activities			■			■		■				

1.3 Research problem:

In cases of infection with infectious diseases, the patient may, according to the Corona experience, go through one of the following scenarios. The first scenario may be that the patient may face difficulty in obtaining a bed in a hospital. This is due to the inability of health facilities to accommodate unexpected numbers of infected people and for any other reason, The number of infected people some time is increasing rapidly, as health studies indicate in corona pandemic that there may be between 23,000 and 64,000 admissions to intensive care during the epidemic period if 2.5% of the population of one country is infected. The capacity of intensive care capacity has varied between countries, for example in Germany there are (33.9) bed in the intensive care unit for every 100,000 people, while Bangladesh has 0.72 beds and Italy has 12.5 beds. Ontario, one of the affected regions, also indicated that it will need to add 900 beds to deal with this sharp increase in patients' number during the first two weeks of April2020 (carlo ratti, 2020).

In this case, patient is forced to stay in his apartment with his family members. The second scenario is that the patient passes if the infection is suspected, or he is waiting for the results of his examination and is forced to be with his family inside his apartment until the infection is proven or denied. The third scenario may be that the person is infected and does not want to go to a hospital or health facility for reasons such as lack of awareness or fear of society's view or other things. In this case, his refuge is his residential apartment with its residents. All of these scenarios open to us the problem of the possibility of exacerbating the spread of the epidemic or infectious disease, whatever its type, and the contribution of shared housing to transmitting the disease, intentionally or unintentionally. This calls for consideration of the main goal of housing, which is obtaining security, and in this cases where housing has become a source of disease and its spread. This research is an attempt to address these and other scenarios in cases of the spread of diseases and epidemics within the residential

apartment, but mechanisms and strategies help limit the possibilities of the spread of disease causes.

1.4 Research Gap:

During the period of quarantine and social distancing, it became clear that the apartments were not suitable for home quarantine in terms of health, both physical and psychological, as the chances of transmission of infection between residents of one apartment and adjacent ones were very high, and resorting to home quarantine was necessary because of the high pressure on hospitals and insufficient beds. On the other hand, citizens do not want to go to hospitals and want to receive their treatment at home remotely. All of this led to the necessity of finding rooms inside the apartment that are flexible and can be transformed into health isolation rooms without high costs and that can be a source of protection for the residents of the apartment from the transmission of diseases to them without having to stay away from them. Here appears the gap between contribution of residential apartments in deseases transmission of diseases and the failure to provide a safe apartment for their residents during epidemics and their spread, even during periods of seasonal influenza.

1.5 Research questions:

The main question is How to make apartment buildings more immune to the transmission of infectious diseases?

Sub questions.

How is it possible to use mechanisms to improve the immune performance of the building so that it becomes less transmittable of infectious diseases and healthier?

How can apartment design be improved, and the design could be linked to the effect of indoor greening capacity to alleviate pressures resulting from the confinement situation?

1.6 Research aims and objectives.

Research aim: The main aim of the research is to increase the immunity of new residential apartment buildings to limit the spread of infectious diseases in the indoor environment and reduce the impact of risks resulting from the spread of epidemics on residents of residential apartments by providing safe haven for housing in the case that there are infected and uninfected people in the same residential apartment. This is to raise the quality of buildings and human well-being. Psychological and mental through the following 1- Providing a space of refuge for the sick and ensuring the health of healthy residents, 2- Creating movement corridors and safe paths inside the building that reduce the possibility of disease transmission, 3- Use materials and mechanisms that reduce the spread of infectious diseases and viruses and fight their causes

Research objectives:

- Develop proposals for easy-to-implement mechanisms, tools and strategies in residential buildings that reduce the spread of epidemics inside the building and increase the building's immunity against the transmission of diseases.
- Providing a flexible architectural space within the residential apartment to contain infected person with the infectious disease, especially in cases where it is not possible to receive him in the hospital, so that this space is prepared as necessary to ensure the psychological, mental and functional health of the patient and his companions in the one apartment.
- Connecting apartment users to the impact of greening, specifically indoor living walls, to alleviate pressures resulting from home confinement.

1.7 Definitions of Terms

Immune apartment: It is an apartment that has a set of mechanisms that protect its residents from infectious respiratory diseases. Some protection mechanisms are activated by the user and others are permanently effective. These mechanisms act as traps for pathogens.

Negative pressure room: also called isolation rooms in which patients with infectious illnesses are kept, or patients who are susceptible to infections from others, away from other. This method of infection control are used to isolate patients with contagious, airborne diseases such as measles, tuberculosis, SARS, MERS, and COVID-19. The air pressure inside the room is lower than the air pressure outside it. This means that when the door is opened, contaminated air or other dangerous particles from inside the room will not potentially flow outside into non-contaminated areas. The method in this research is based on the difference in the air column between the isolation room and the top of the building, which are connected together through a pipe, which requires the air to be sucked upward.

Sick building syndrome: (SBS) is a condition in which people develop symptoms of illness or become infected with chronic disease from the building in which they work or reside.[1] In the scientific literature, SBS is also known as Building Related Illness (BRI) or Building Related Symptoms (BRS) or Idiopathic Environmental Intolerance (IEI). (wikipedia, 2023)

Home quarantine: is a public health measure that means separation of people, who might have been exposed to a contagious disease, from the community even though they are not showing any signs of sickness. Quarantine enables people to be monitored for symptoms as well as being separated from others. The duration of quarantine depends on the nature of infection and the time it takes for the infecting agent (virus for example) to induce symptoms. In the case of the SARS-Cov-2 virus that causes COVID, this period is 14 days. (St Helena Government, 2020)

Home confinement: It is when residents remain confined to their homes for long periods of time in stressful environmental and media conditions due to the coronavirus disease 2019 (Covid-19) pandemic, where confinement has been used as a tool to stop the spread of infection.

Transformable living walls: It is a living green wall with adjustable position can be manually based on the user's desire. The nature of its design is based on circular

basins with axial fixation that enable it to maintain its position in the direction of Earth's gravity, regardless of the position of the part carrying the basins.

Pandemic: is an epidemic of an infectious disease that has spread across a large region, for instance multiple continents or worldwide, affecting a substantial number of individuals. (wikipedia, 2023)

Post pandemic: Refers to the period following the resolution or significant control of a pandemic. In the context of the COVID-19 pandemic, "post-pandemic" refers to the period after the widespread transmission of the virus has been brought under control, either through vaccination, herd immunity, effective treatments, or other means. During this time, societies may undergo significant changes in various aspects of life, including healthcare, economy, social interactions, and policies, as they adapt to the aftermath of the pandemic and work towards recovery and rebuilding. (Agodu, 2024)

Infectious respiratory diseases: Respiratory tract infection (RTI) is defined as any infectious disease of the upper or lower respiratory tract. Upper respiratory tract infections (URTIs) include the common cold, laryngitis, pharyngitis/tonsillitis, acute rhinitis, acute rhinosinusitis and acute otitis media. Lower respiratory tract infections (LRTIs) include acute bronchitis, bronchiolitis, pneumonia and tracheitis. ((NICE), 2008)

Telehealth: is the distribution of health-related services and information via electronic information and telecommunication technologies. It allows long-distance patient and clinician contact, care, advice, reminders, education, intervention, monitoring, and remote admissions. Telemedicine is sometimes used as a synonym, or is used in a more limited sense to describe remote clinical services, such as diagnosis and monitoring. (wikipedia, 2023)

Safe path: A vertical and horizontal path of movement that ensures the access of health services and medical care to the infected person from the hands of medical personnel without exposing them to the risk of infection. It is also used as a path for

the infected person to enter and exit without threatening others with the transmission of infection, since this path is outdoors and exposed to the sun's rays and heat. It can be considered a corridor for non-infected people who want to walk away from elevators and closed stairs during the pandemic period.

1.8 Research significant

The research contributes putting mechanisms and tools in the hands of decision-makers, designers, and ordinary people in emergency situations in cases of the spread of epidemics and the inability of health facilities to receive cases of infection with varying degrees of severity. This also happened in the Corona experiment by making their homes, specifically residential apartments, suitable to receive the patient by reducing the risk of transmission of infection to those living in the same apartment. This will contribute to alleviating the terror and fears of citizens in cases of the spread of epidemics, home quarantine, cases of the spread of seasonal infectious diseases, and cases of unwillingness to go to hospitals. Which will consequently improve the quality of life inside the apartments and make them safer psychologically, mentally and functionally for the individual and society.

1.9 The research problem is both local and global problem.

The research addresses a local and global issue. It has influential repercussions on humanity's approach to the concept of housing and the idea of the need for a basic requirement in it, which is security. Health security is a basic pillar of human survival and humanity's dedication to progress and development.

1.10 Research limit and limitations:

Research limit: The first limit of the study is the type of buildings discussed in the research, which are new apartment buildings (Proposed apartments design) in Palestine, The second limit is the experience of the Corona Covid 19 pandemic as a baseline to start designing a resistant building to infectious diseases (there may be

other types of viruses that have behavior and specifications, but this research deals with building in which the a design based on this experience specifically) diseases transmitted by aerosols and contacted with surfaces.

Study design: The design and methodology of this research is based on qualitative information and the tool used: semi-structured interviews.

first sample experts in the epidemiology and virology sector were interviewed on the recommendation of the Palestinian Ministry of Health, the model design was closely linked to their answers, as it was their responses that were discussed in semi-structured interviews with expert engineers in the fields of materials, mechanical systems, and engineering offices.

first sample size: The number of interviews was linked to recommendations from the Ministry of Health and the human resources available to the Ministry, who had experience with Covid-19 epidemic.

Duration of the study: Work on this study extended for 10 months. The study design allows for causal inferences due to overlapping factors influencing transmission. Sample characteristics: The first selected sample required knowledge of epidemiology, and the second required work within the period of the spread of the pandemic to draw conclusions from their experience. The second sample is sustainability engineers whose buildings received an evaluation from the Palestinian Green Building Council (due to the availability of sufficient scientific fitness among them and the proximity of the site and sustainable design experts, relied on recommendations from the Jordanian Engineers Association to identify offices working in this field).

The third sample is a random sample of apartment users in Hebron area, Palestine As for the verification stage, the sample relied on in-depth thinking, discussion, and review with the doctor supervising the thesis, in addition to engineering experts in the fields of materials and mechanics from the Polytechnic University.

The representation of the sample is appropriate for the context of the study whereas the experience was similar between all regions of West Bank and the continuous exchange of scientific expertise between human resources working in the health sector, due to the availability of their own union as well as the ministry.

Reliability and validity of the measurements and tools used: The design is based primarily on creating a disease-resistant model based on the recommendations of medical authorities and specialists from actual and real experiences they went through during the pandemic period. The capabilities of the engineering and mechanical construction sectors and the materials are available in the Palestinian market, and known by those working in the labor market themselves from engineering offices specialized in sustainability, and this is to create the design model.

Testing the design model will use the available software, which is design builder.

Generalizability: Is it possible to generalize the results of this research? The answer will be yes in terms of geographical contexts that will be similar to Hebron Palestine in terms of construction methods in same orientation, environment and climate and orientation. As for the isolation room and the proposed mechanisms, they are generalizable regardless of geographical context

Research limitations: limitations that were taken into account in the research on increasing the immunity of the architectural design of residential apartments and reducing its role in the transmission of respiratory diseases such as Covid-19, seasonal influenza, and other viruses that may appear in the future, are:

Geographic context: The study examining this theme was conducted in Hebron Palestine, the West Bank, which is a geographical context with its own urban characteristics and demographic settings. The results may not be universally applicable to all apartments. Differences in building regulations, climate, cultural practices, occupancy patterns and number of apartments can influence proposed solutions. Different studies and their locations may give different results.

Lack of longitudinal studies: the studies which supported this research conducted during the COVID-19 pandemic focused on immediate responses and short-term effects. Longitudinal studies that track infection rates over a long period are limited, making it difficult to assess the long-term impact of architectural design on virus transmission. especially that the world still until now in pandemic stage.

Interplay of multiple factors: Virus transmission is influenced by many factors beyond architectural design, including individual behavior, hygiene practices, ventilation systems, and community spread. It may be difficult to isolate the specific effect of architectural design alone on infection rates within residential apartments.

Lack of studies dealing with the subject of architectural design: Some studies may contain ideas or rely on case studies of specific buildings or outbreaks. These studies provide useful guidance, but may affect the full range of apartment designs, design details, and operating scenarios.

Variation in building conditions: Residential building conditions and designs can vary widely, which may affect ventilation systems, hygiene, and overall suitability for transmitting viruses. Factors such as building age, maintenance practices, and compliance with ventilation standards can affect results.

Evolving understanding of viruses and their change over time and mutations: As research continues into COVID-19 and other viruses and biological weapon mutations, our understanding of the virus, its modes of transmission, and effective mitigation measures is evolving. Therefore, the results of previous studies may need to be interpreted in the context of more recent scientific knowledge.

Architectural design is just one aspect of a comprehensive approach to mitigating virus transmission. Implementing multiple infection control measures, such as proper ventilation, hygiene practices, and adhering to public health guidelines, is critical in reducing the risk spreading the virus within residential apartments.

1.11 Research Structure:

- Chapter 1: Introduction

  In the first chapter, introduces the research problem, gap, research questions, discusses the advantages, and the importance of the study. Research Aim and Objectives, and master thesis structure.

- Chapter 2: Theoretical Background

  Second chapter, is improving understanding of the global state of the epidemic experience and its spread, and the reactions of the scientific and engineering community on how to deal with the epidemic and the learned lessons. It also contains the latest research founded in the field of research- State of the art.

- Chapter 3: Methodology

  The methods employed to collect information through interviews, observation are outlined, thematic analysis and simulation program to have a final conclusions

- Chapter 4: Analysis and Results

  In this chapter, an thematic analysis will be conducted using coding of the interviews that were held with the specific groups to arrive at results for developing a conceptual model that is resistant to diseases from an architectural perspective.

- Chapter 5: The Development of Apartment Model
- Chapter 6: Simulating Model (Results and Validation)

  Residential apartment buildings are immune to disease transmission, Linking the design to the effect of greening's ability to alleviate psychological pressures resulting from home confinement.

- Chapter 7: Conclusions and Recommendations

The last chapter concludes the research by summarizing key findings and providing recommendations for the future. See Figure 3

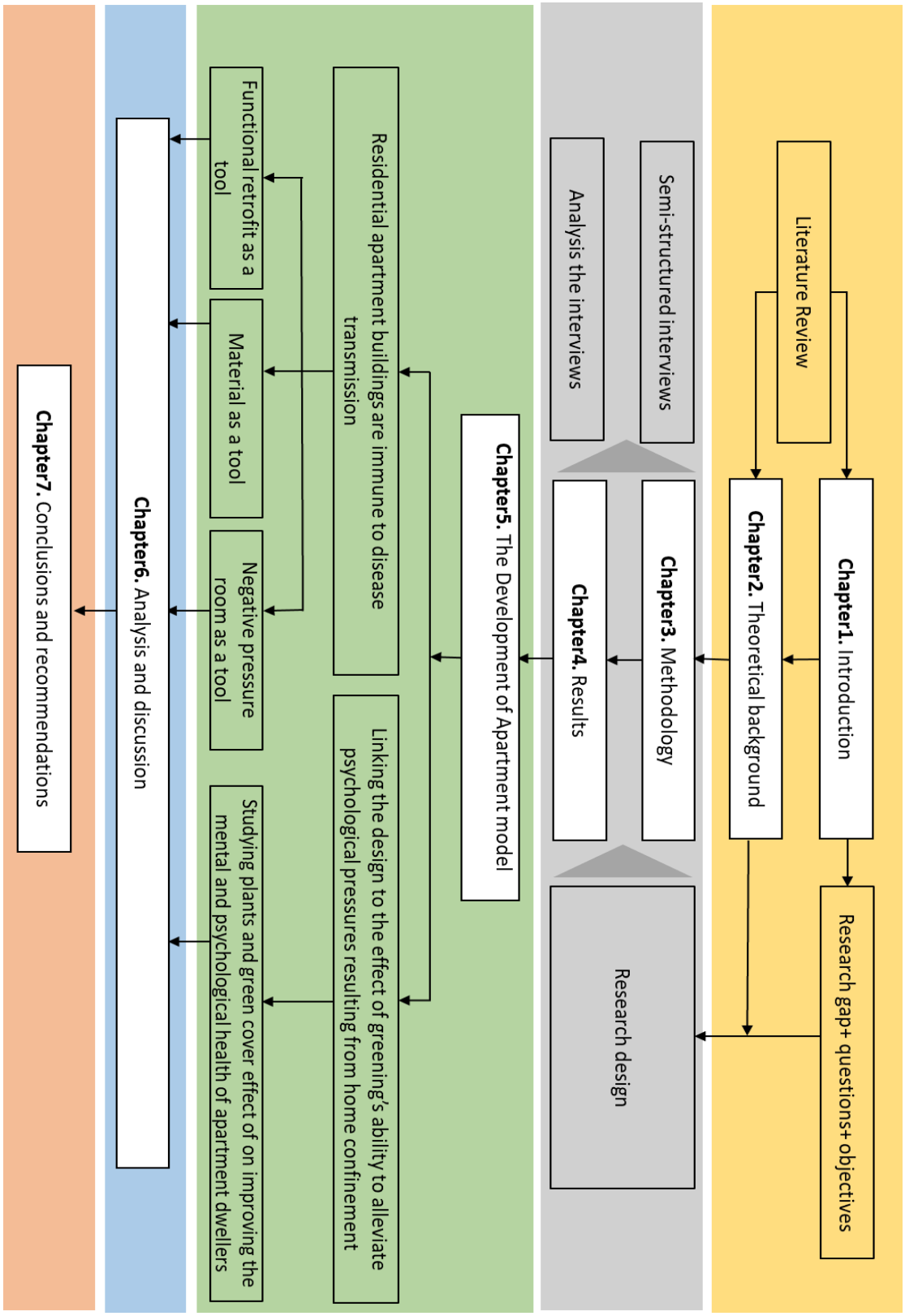


Figure 3 Research structure.

Chapter 2

2 Theoretical Background

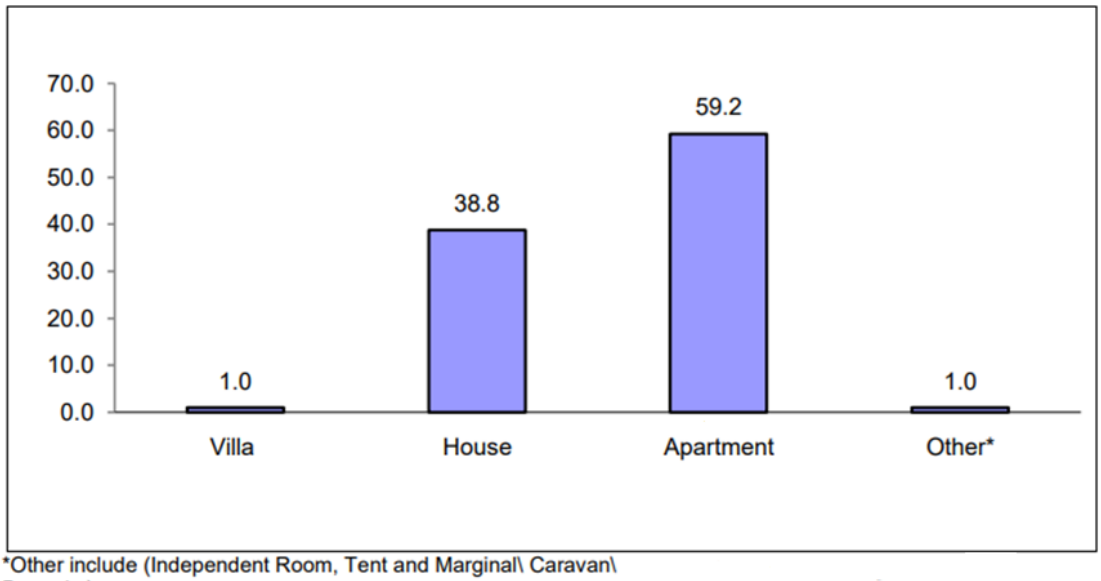
2.1 Preface

The issue of pandemic architecture or post-pandemic has become a theme of discussion after the World Health Organization announced on March 11, 2020, the United Nations organization, that it considers the new coronavirus that causes the disease "Covid-19," which is spreading throughout various parts of the world, a "global pandemic (WHO, 2023)". This is a natural reaction of the scientific community, as more difficult scenarios must have been expected to happen to the world as a result of man's encroachment on man and nature. Accordingly, the impact was addressed in terms of its economic effects, travel, and its effects on work, and from here the necessity of continuing work within the confines of homes emerged. It was necessary to continue work even during the stage of home confinement, as the trend towards remote work and distance education increased, and people were forced to spend more time at homes. There is no doubt that a home with garden and outdoor courtyards, help spending home quarantine period in it was not a negative experience in all its dimensions, But the problem is more difficult for apartment users, who are mostly from the working class and employees, also they have to work remotely, more over there is no doubt that they are the same people with limited, middle and low incomes.

2.2 Housing in Palestine and pandemic impact

The existence of affordable housing is important, our society suffers from poverty and the middle class is threatened with disappearance, and these people have the right to a decent life 29.2% of individuals in Palestine suffered from poverty during 2017, according to the monthly consumption patterns, which means that their families monthly consumption was below the poverty line, and that reached the Palestinian family of 5 members (2 adults and 3 children) 2,470 NIS (National Development Plan, 2021), and 16.8% of the Palestinians suffered extreme poverty, and the extreme poverty line has reached 1974 shekels for the same family, on other hand Housing needs in the West Bank and Gaza Strip until 2030 are estimated at about 643851

housing units (National Development Plan, 2021). The average housing density, number of people per room in Palestine in 2019, was about 1.4 people per room, distributed as 1.6 people per room in Gaza compared to 1.3 people per room in the West Bank. Type of dwelling: 38.8% of families in Palestine in 2019 live in dwellings in form house of While 59.2% live in apartment-style housing, the percentage of families who live in a villa is 1% (National Development Plan, 2021). This means that in Palestine the tendency to live in apartments is the predominant type and requires developing solutions to prevent the spread of infectious diseases due to the diversity and density of the population in vertical buildings. Figure 4



*Other include (Independent Room, Tent and Marginal\ Caravan\ Barracks) .

Figure 4 Percentage distribution of households in Palestine by type of housing units 2019

Figure 5 represents distribution of the West Bank governorate, which represents the Oslo Agreement, where the yellow color represents Area C 61% (Niksic, 2014) in which the Palestinians are prohibited from building even in the presence of the Tabu under the pretext of non-licensing from the Israeli authorities that do not grant the Palestinians building licenses even if an application is submitted for them. For example, the geopolitical division in Hebron governorate led to areas A representing 24% of the governorate's area, Area B 22%, and Area C 48%, in addition to nature reserves which representing 6% of the governorate's area, and this geopolitical

division led to the deprivation of Palestinians from exploiting about 50% From their lands, that means the construction process of any kind in the future will be difficult in light of the of the occupation continuing, and this is due to the lack of land. This means an exclusive approach to vertical growth, not to mention the high land prices that will accompany this process.

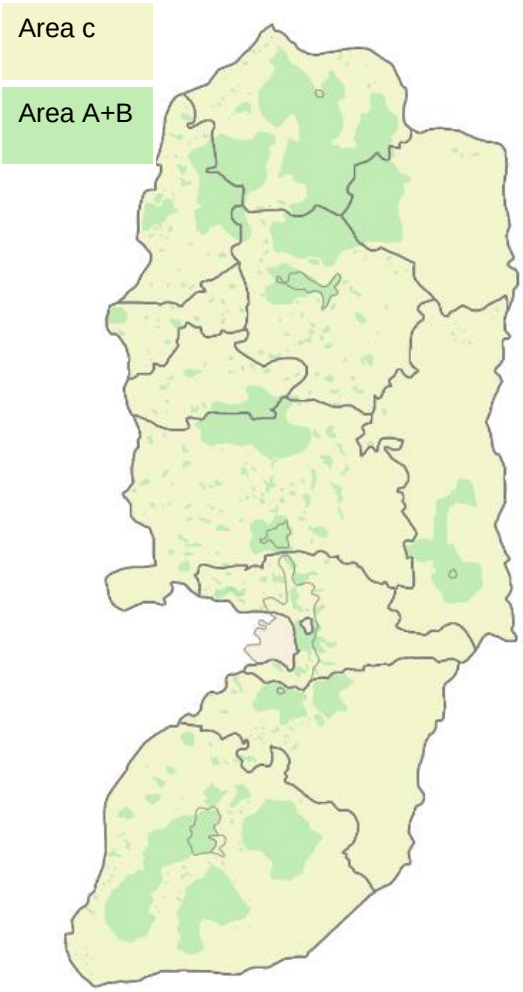


Figure 5 The color distribution of the governorates of the West Bank

(PCBS, 2020)

2.3 Health services in Palestine

The number of governmental and non-governmental hospitals in Palestine reached 85 in 2019, 53 hospitals in the West Bank and 32 hospitals in Gaza Strip. With a capacity of 6,435 beds in the Gaza Strip, 2,485 beds, and 3,950 beds in the West Bank. The number of beds per 1,000 people reached 1.3 beds per 1,000 people (Statistics, 2020), according to the World Health Organization The World Health

Organization recommends a minimum of 2 beds per 1,000 people, but 4 beds per 1,000 people in developed countries (WHO, 2023). This necessarily means providing an alternative in the event of a pandemic. Priorities will be classified to the most severe disease, which may affect someone's opportunity to obtain the necessary health service, and the accompanying threat to those around them who do not have alternative housing. Therefore, apartments must be prepared to provide health service and sanitary insulation to reduce pressure on health facilities.

2.4 Pandemic and post pandemic architecture.

Before the year 800 AD, the Valetudinarian classification appeared, then Lazaretto during the period from 1300 to 1800 AD. After the 1800s, Western architecture and modernism emerged in Asia (Anastasia Evangelista Sumanti, 2023)and the sanitarium movement emerged in Europe and the United States to house, treat, and isolate patients, and emphasized strict cleanliness and adequate exposure to sunlight and air. The treatment of tuberculosis was environmental. This led to the trend that a house is habitable when it is full of light and air. The influenza epidemic in the early nineteenth century contributed to housing reform and the development of solid waste services. In the twentieth century principles that promoted purity of form, strict geometry, and modern materials prevailed. And reject the decoration (Chang, 2020).

COVID-19 will not be the last pandemic. Pathogens will emerge and re-emerge with the potential to cause illness, death, and disruption of a magnitude equal to or greater than SARS-CoV-2. Outbreaks of infectious pathogens have been a defining feature of human history, and any trend analysis strongly suggests that Outbreaks of pathogens with pandemic potential will continue to increase in frequency for the foreseeable future. Most health emergencies have a disproportionately severe impact on low-income and fragile countries, but they also carry significant risks for all countries in today's interconnected world. Therefore, the actions and investments needed to address these risks should be considered a collective burden (World Health Orgnization, 2022)

Whether the pandemic ends or not, the outlook on designs before the pandemic must change to suit and adapt to the new reality of experience, as researchers conducted studies, the results of which were evidence that urban designers and architects cannot deal with living spaces as they did in the pre-pandemic phase. Although some aspects remain the same, there are also some new variables. Residents are now preparing their homes to adapt to the new conditions. Currently, there is an urgent need to develop new design concepts and principles; We must establish "controls and requirements" for the post-epidemic phase. But in light of the successive changes, life experiences during quarantine are still intertwined with a new design (Elrahman, 2020).

When reviewing previous literature in the context of pandemic and post-pandemic architecture, (Paria Akbari, 2021) addressed the theme in terms of housing preferences and the psychological impact of housing and its type on the mental and psychological health of the population. Most of it was related to analyzing the results of questionnaires and the results were positive. About that people living in private homes have better mental health than residents of low-rise or high-rise housing.

Regarding previous studies on the updated functional framework for multi-storey buildings, they dealt with (Yanqing Xu, Yi-Kai Juan, 2021) Case studies of buildings in China Develop appropriate design strategies for multi-unit residential buildings (MURBs) in China in the post-pandemic era and determine user preferences for these strategies. (Rosa-Jiménez, 2022) a case study in Spain, also highlighted three aspects in small-space housing: the need to consider the direction of housing to improve the quality of interior and exterior spaces; The need in public housing policies for a larger number of rooms to facilitate remote work and the importance of functional terraces overlooking green spaces.

Another study (Spennemann, 2021) addressed the distribution of used spaces and how they are supposed to take into account a functional hierarchy to prevent the spread of the epidemic and the repercussions of COVID-19 on new residential construction. It advocates a space of containment, separating the largely uncontrollable external

environment from the threatening internal residential space to separate entertainment areas for visitors and private sleeping areas, as well as designing a spatially separate master bedroom that can double as a self-isolation space if the need arises. The implications of this new design on existing housing stock are also discussed and design considerations for future residential developments are presented.

2.5 Telehealth, telemedicine, telecare, telemonitoring

Telehealth is the delivery of health care at a distance via a variety of communications tools, including telephones, smartphones, and portable wireless devices, with or without video communication. Telehealth is growing rapidly and has the potential to transform health care delivery for millions of people (Topol, 2016). There is no doubt that the emergence of epidemics encouraged trends in switching to telehealth, as it came in line with the requirements of social distancing. Data and studies have shown that after the Covid-19 pandemic, the use of telehealth services has increased globally. The UK has seen a rapid expansion of video consultations (1,000% increase in Scotland over a two-week period in March) (Webster, 2020). In Australia, the proportion of consultations provided via video increased from 0.2% in February 2020 to 35% provided via telephone and video conference in April 2020 (Emma E Thomas, 2020). This trend strongly supports the idea of the necessity of providing a home isolation space, as it will be compatible with the provision of remote health care services. After the experience gained during the Corona epidemic period through adjustments to the quality of service provided remotely, the availability of private and equipped rooms in homes will be fully integrated. The review (Snoswell, 2021) demonstrates that telehealth can be clinically equivalent or more effective when compared to usual care.

The architectural designs of residential buildings must keep pace with developments in the sector specialized in providing telehealth services and remote care. The fact that the service will be provided remotely means that at least a room within the apartment must respond to the requirements of obtaining remote care, specifically in light of the

fact that epidemics and viruses are constantly evolving, not to mention the development of biological weapons.

It has been confirmed that self-isolation of healthcare providers and patients, and providing healthcare remotely, contributes to reducing the risk of transmission of the Coronavirus (COVID-19). Preventing direct physical contact, providing continuous care for users, and reducing the number of infections and thus reducing deaths in the outbreak of the Coronavirus (COVID-19) (Hajizadeh, 2020).

Telehealth uses live video conferencing and phone calls with health care professionals to ask questions, gather needed information, triage patients, consult supplies, and follow up. A person can self-monitor symptoms at home while they recover. Activate regular checks such as breathing rate, blood pressure, and oxygen level required at home (Zhai Y, 2020). There is no doubt that the obstacles and challenges such as: technical supplies, ensuring the privacy of the examination, data security and method of reimbursement, clinical examination for diagnostic purposes, the level of some segments of society, training of health care providers and patients, the relationship between the doctor and the patient, acceptability, poor internet connection and lack of comprehensive access to technological structure (Racha Ftouni, 2022).

2.6 Transmission of infection in built environments

Built environments, including apartments, serve as potential transmission vectors for the spread of COVID-19 by stimulating close interactions between individuals, through objects (objects or materials that potentially carry infectious diseases), and through viral exchange and airborne transmission. The density of building occupants, related to building type, occupancy schedule, and indoor activity, facilitates the accumulation of human-associated microorganisms (Leslie Dietz, 2020).

Studies have shown that most touchable surfaces in MERC patient units are contaminated by patients and healthcare workers, and viable virus can be spread through respiratory secretions from clinically fully recovered patients. These results emphasize the need for strict environmental hygiene practices for surfaces and an

adequate isolation period based on laboratory results and not only on clinical symptoms (Seo Yu Bin, 2016).

The indoor environments of multi-apartment buildings are affected by outdoor particles differently than individual homes, as air flow is more complex in multi-apartment buildings. A simulation study of winter airflow showed that air infiltrates from the outside into the lower part of the building and leaks out from the upper part. This proved that the lower floors of the multi-storey building were exposed to higher concentrations of fine particles compared to the upper floors of the building (Byung Hee Lee, 2017).

To understand the transport, dispersion and evaporation of saliva particles generated by human cough. The researchers (Talib Dbouka, 2020) applied the process of throwing saliva droplets into the air to mimic the real event of a human cough at a temperature of 20 degrees Celsius and 50% relative humidity. They found that the virus-laden saliva droplets are transmitted to 6 meters if the wind speed is from 4-15km/h. While when the wind speed was almost zero, the saliva droplets did not travel a distance of 2 meters. As known that the rapid spread continued circulation of influenza A virus in humans is aerosol or respiratory droplet transmission.

Table 3 Indoor air speed shows the speed of the air inside the indoor environment, all of which is almost zero. This helps us determine which paths and which behaviors the virus will take, which helps us in making a design that confronts its movement.

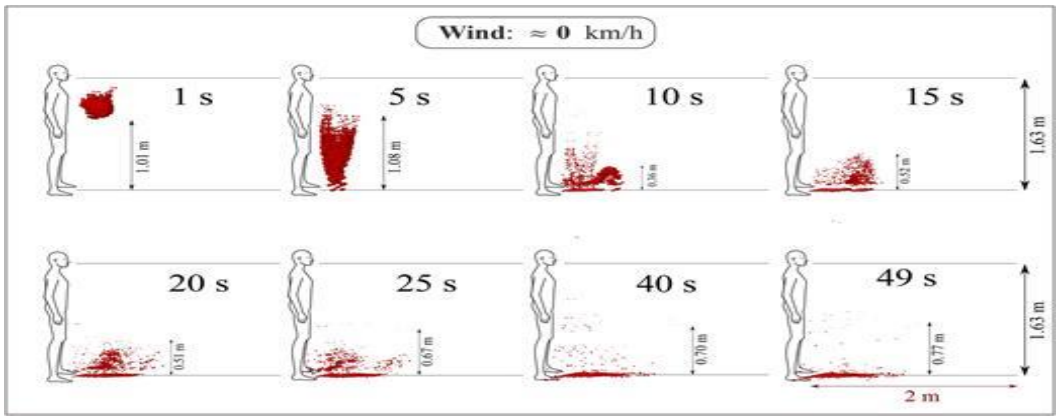
Table 3 Indoor air speed (buildings, 2021)

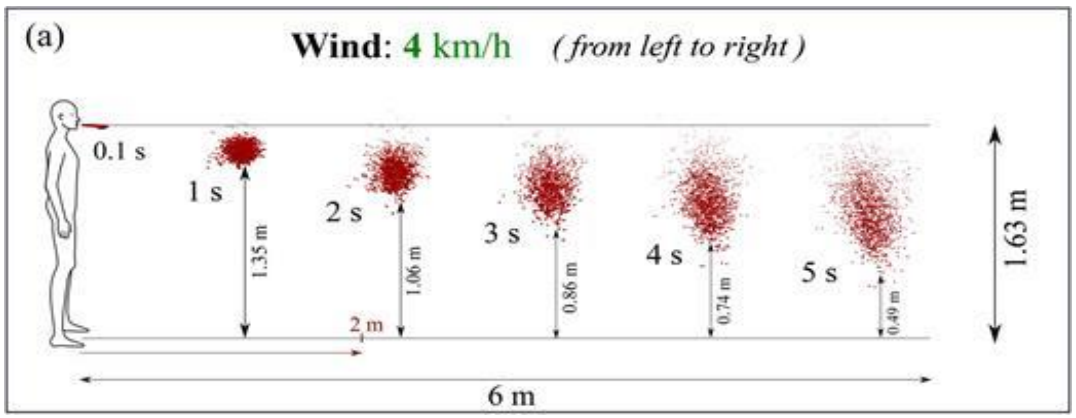
Indoor air speed	The effect
0 m/s	Stationary air. Note, minimum air change rates are required to maintain indoor air quality
0.1 m/s	May be used as the assumed internal air velocity in some simple heat transfer calculations
0.1 to 0.15 m/s and above	May be felt as a draught in a cold climate in the winter.
0.2 m/s (0.72km/h)	comfortable air speed

0.3 m/s and above	May be felt as a draught in a cold climate in the summer.
0.8 to 1 m/s and above 2.88 to 3.6 km/h	May be felt as a draught in a hot climate.

Figure 6 A human cough: saliva droplet's disease-carrier particles cannot travel more than 2 m in space at approximately zero wind speed. figure shows the effect of wind speed on the saliva droplet and transport under dispersion and evaporation. Wind blowing from left to right at speeds of 4 km/h. The environment is at ambient temperature, pressure, and relative humidity of 20 °C, 1 atm, and 50%, respectively (Talib Dbouka, 2020).

Figure 6 Relation between human cough and wind speed.





Infectious diseases are mainly transmitted through air, water, and surfaces. In this study, solutions for the two media, air and surfaces, are discussed and presented.

2.6.1 Airborne transmission and infectious aerosols

Indoor environments contain various pollutants (Guiseppina LR, 2013). Airborne transmission occurs because fine microbial particles remain in the air for a long time and spread due to the speed of air that a person may inhale (Lateef, 2009), such as the bacteria that cause tuberculosis, which remain in the air and are inhaled by people exposed to infection (Daniel Verreault, 2008). The diameter of viruses is (20-400 nanometers), which means they can easily remain suspended in the air of crowded and poorly ventilated environments (Guiseppina LR, 2013). When infected people sneeze, cough, or exhale, transmission of relatively large respiratory droplets (>10 micrometers) carrying viruses occurs (Guiseppina LR, 2013)single cough or sneeze in a corridor, hallway or corridor can release thousands of droplets (up to 40,000) at speeds of up to 50-200 mph, with each droplet consisting of millions of viral particles.

2.6.2 Transmission by contact or surface transmission

Direct or indirect contact are the methods of transmission of infection through contact. Through physical contact between an infected person, such as contaminated hands, gloves, or mucous membranes, with an uninfected person (Lateef, 2009). Indirect contact occurs when you come into contact with the surface of something that has viruses on it and then touch your nose, eyes, or mouth. Like the Coronavirus (Covid-19), it can live for 72 hours on a plastic surface, 24 hours on a cardboard surface, and a copper surface for 4 hours (Doremalen NV, 2020)

2.7 Indoor air quality and Infectious diseases

One of the studies that dealt with the indoor environment of the dwelling and the study of indoor air quality (Naglaa A. Megahed, 2021) focused on conceptual models for improving IAQ based on the risk control hierarchy. The conceptual framework

aims to help architecture ensure adequate ventilation in the design process while managing risks related to the COVID-19 pandemic.

2.7.1 Air filtration

The purpose of air filtration is to reduce contaminants from entering buildings (or parts of buildings) and to improve indoor air quality (IAQ) and airborne hygiene levels (buildings, 2021). The types of filtration systems: Mechanical and electronic air filters: They generate electric fields and ions and charged air passes through the filter. Absorbent air cleaners: They are used to remove harmful gaseous pollutants from moving air. By physical adsorption (with materials such as activated carbon) combined with chemical adsorption. Air cleaning with photocatalytic oxidation (PCO). Ultraviolet (UV-C) germicidal irradiation (UVGI). This is specialized in inactivating viruses, bacteria, and fungi by analyzing organic materials present in the air stream. The technology is employed as a portable air cleaning device.

2.7.2 Relative humidity

Among the data regarding the infection rate available in various sources are cold and dry conditions accelerate the spread of the Coronavirus. It has been found that in some indoor scenarios, coronaviruses in respiratory droplets become active due to the volume reduction that occurs in both static and airborne droplet nuclei resulting in increased spread. Understanding this mechanism will be very helpful to take necessary steps to reduce the rate of transmission by initiating corrective actions and maintaining required conditions in the indoor built environment (Antony Aroul Raj, 2020).

2.7.3 Ventilation

Studies have confirmed that the source of building ventilation and the extent of the external route affect the composition of internal microbial communities. Delivering outdoor air directly through the envelope to an adjacent spatial volume has been shown to increase the phylogenetic diversity of indoor bacterial, and fungal communities and create communities that resemble outdoor-associated microbes

more than air delivered through a central HVAC system (Leslie Dietz, 2020). The best way to get ventilation is still to open a window.

2.7.4 Light and daylight

The virology literature has shown that sunlight levels are inversely related to influenza transmission and can be used to better understand the potential for virus spread under a variety of environmental conditions such as for influenza. (Michael Schuit, 2019). Another study examined the effect of simulated sunlight, relative humidity, and suspension matrix on the persistence of SARS-CoV-2 virus in aerosols. Sunlight and the simulated matrix significantly affected the virus degradation rate. Relative humidity alone did not affect the decay rate; However, minor interactions between relative humidity and other factors were observed (Michael Schuit, 2020)

Studies have shown that far-UV light in the range of 207 to 222 nanometers effectively eliminates airborne viruses with a very low dose of 2mJ/cm2 of 222-nm light inactivating >95% of aerosolized H1N1 influenza virus. When the same test was performed on three-dimensional (3-D) models of human skin, it did not cause harm to the human skin and eyes (David Welch, 2018). airborne viruses can be eliminated by irradiation of 222 nm UVC excimer lamp in 60 seconds (Peiyong Ning, 2023).

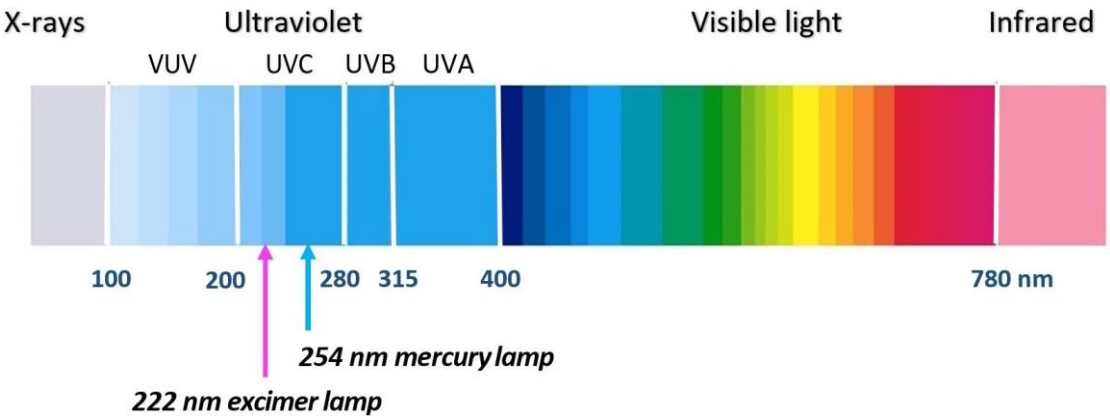


Figure 7 Excimer lamp

https://r-filter.hu/en/excimer/

2.7.5 Greening and healthier indoor air quality

Studies dealt with the psychological aspect, and the above studies showed the importance of plants and their role in improving mental state and well-being. The other aspect to be studied is the technical application of the plant in an apartment. A study (Dopko, 2015) shows that connecting with nature is one way to thrive in life. Accordingly, the use of plants may reduce the difficulty of spending time in a residential apartment, and here the necessity of studying relevant research to review all types of green wall systems in order to choose the most appropriate option for use within residential apartments. Therefore, it is important to understand the main differences between the systems in terms of installation and construction methods and show that the most suitable solution is to use LWS units as they have differences in their configuration, weight and assembly. (Maria Manson, 2015) They can be in the form of trays, pots, plant tiles or flexible bags. Trays are usually solid containers, which can be linked together, which can carry the plants and the weight of the substrate. However, one of the disadvantages of green systems, according to the study, is that most systems are designed to be applied in a vertical position, which allows, in some cases, to be applied in inclined plans with Some limitations. Therefore, green walls must evolve and adapt to different surface shapes and inclinations (for example, curved, vertical or horizontal surfaces), with appropriate modifications. This is what we will propose solutions for in this article.

A study (Paria Akbari, 2021)based on a questionnaire has evaluated the role of having plants at home during the period of confinement as a result of the COVID-19 pandemic, which deprived people of freely visiting open green spaces. Preferences regarding the amount of desired vegetation were also assessed as well as the ways in which the COVID-19 crisis has changed perceptions regarding the presence of plants in the home. The findings that the researcher reached were sparked interest, living wall systems were valued by respondents as an option to increase the number of Plants in the house. There was a clear preference for their use mainly outdoors (for example, on balconies) and the article put forward a suggestion that further research should be conducted in order to further link some of the specific characteristics of the

population to the effect of the ability of indoor greening to mitigate stresses resulting from confinement situations. The research question emerged: How can the design of apartments could be improved, and the design could be linked to the effect of greening capacity in indoor spaces to reduce the pressures resulting from the confinement situation? The issue of individual ordinary housing was discussed, but the development of treatments for apartments, especially existing ones, was not addressed. The majority of studies were related to functional solutions linked to a specific environment and specific study cases.

The environmental impact of living walls has been studied from several aspects, the most important of which is thermal, as it appeared in a study (Manso, Castro-Gomes, 2016) that the results showed that the Geogreen system, which is a living wall system, contributes to: reducing the maximum temperatures of the internal surface and increasing surface temperatures. Indoor minimum up to 7°C; Alleviate heat transfer, reducing maximum input heat flux by 75% and maximum outlet heat flux by 60%; Strengthen the thermal insulation of the wall; Increasing the thermal delay between the outside and the inside. These aspects can reduce and shift air conditioning energy loads and improve the thermal performance of buildings. Green roofs and vertical green space systems have also been studied (Arpón, 2016) as tools for energy efficiency in buildings. Experimental studies have shown the high potential of the GW - Green walls or living walls and GF - Double-skin green facade systems in reducing the electrical energy consumption of the building's HVAC system during the summer. This passive saving depends on the solar energy, on the one hand for solar radiation, and on the other hand on the shade factor provided by the vertical green space system classification. In Mediterranean continental climate conditions, GW systems showed energy savings of 58%. A direct relationship between energy saving and solar radiation on building facades was observed for both GW systems. The greater the solar radiation, the greater the cooling effect of VGS-Vertical greenery systems. The study of thermal performance by facade orientation in summer conditions showed that significant temperature drops were obtained on the external walls, ranging from 17°C to 21.5°C in the GW. Pilot studies in winter indicated a

promising effect in nighttime radiation insulation provided by the GW system to the building which contributed to energy savings of up to 4% in a Mediterranean continental climate. Experimental "in situ" acoustic measurements showed that a thin layer of vegetation (20-30 cm) was able to provide an increase in sound insulation of 1 dB for traffic noise, and an isolation increase of between 2 dB (GW) for pink noise.

2.8 Governance of the new normal

To be effective, all engineering and scientific efforts must be governed by procedures that call for a new normal design which ensures the risk of transmission of infectious diseases is reduced. It is included in the annexes to the laws related to construction, buildings, planning and city planning, building permits, civil defense approvals, and relevant relevant authorities. To reduce the transmission of infection in multi-unit buildings, it is not enough to clean surfaces or encourage residents to adopt good behaviors. usual practices must adapt to avoid gatherings (Eykelbosh, 2020).

Chapter 3

3 Methodology

3.1 The research type and research process

This research is qualitative research, some parts of research will be Quantifying in terms of interviews analyzing of as well as digital results related to the thermal performance of the model, lighting, and computerized fluid dynamic CFD, so its type can be a mixture of qualitative and quantitative research. (strategic basic research) revolves around finding improvements to residential apartment architecture on the health, indoor environment, psychological and physical levels of the user in an attempt to fill the gaps that appeared during the period of home confinement.

To reach the desired results, the impact of the pandemic on buildings will be addressed in the study, focusing on residential apartments and the impact on the user's well-being and the restriction of life. Figure *8* shows the sequence of the research approach.

To achieve the research thematic and fill the scientific gap that the research talking about, the following methodology was developed: collecting available information up to the history of research on infectious diseases and the development of architecture in confronting them. The information was organized within the theoretical background section. The interview tool was used then to access the additional necessary data for the researcher to reach the need stemming from the experience, that the world in general and Palestine in particular went through during the Covid pandemic. The interview tool was used in three stages, and the end of each stage was accompanied by an analysis of the interview answers to be used in developing the structure of the next stage. The interview took place in three stages and the analysis took place in three stages too in order to obtain results and evaluate the results to come up with a vision of the proposed solutions and implement them in an architectural design and subject this design to tests as to ensure its implementation. Increasing the apartment's immunity and finally coming up with results and recommendations.

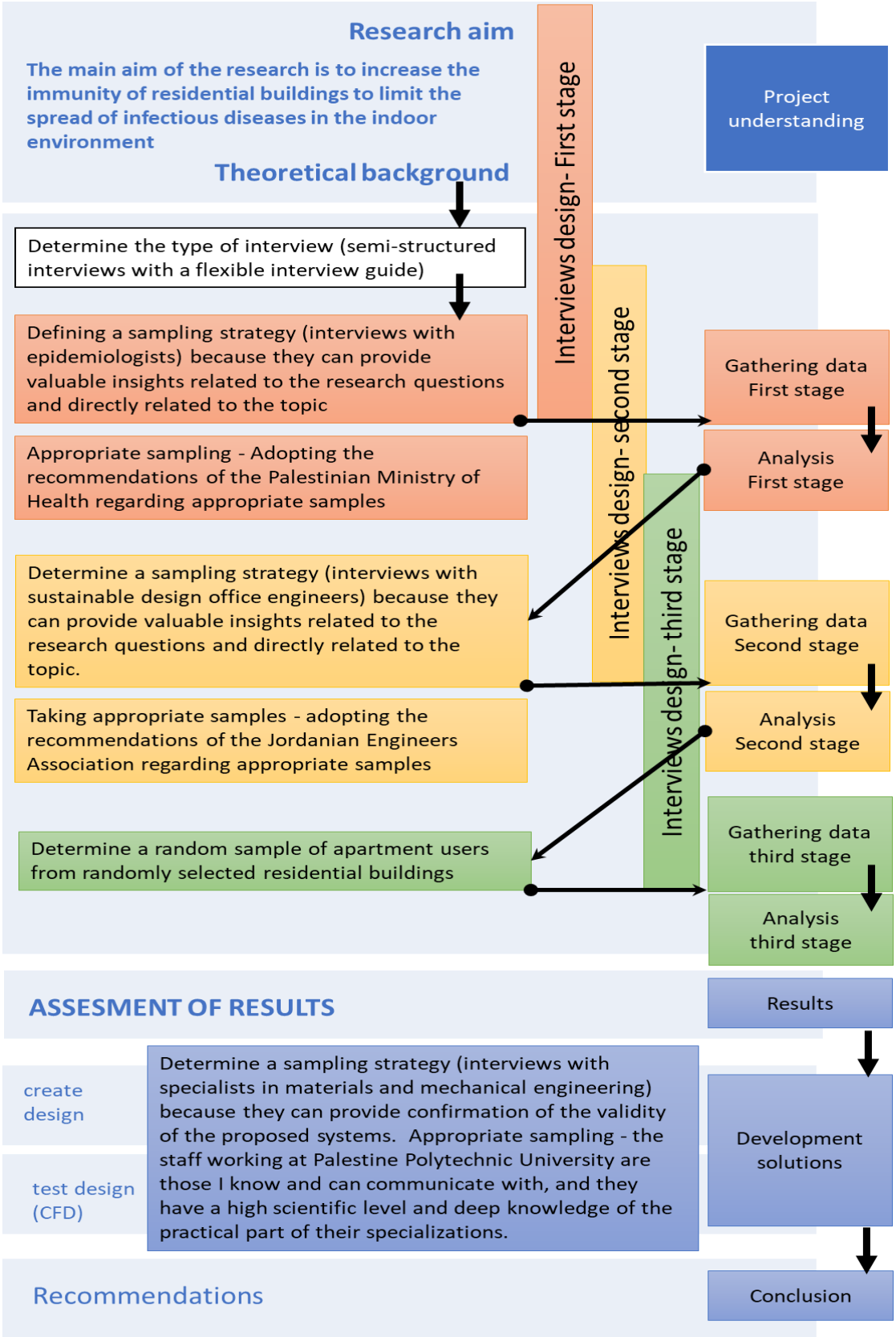


Figure 8 The sequence of the research approach.

3.2 Data collection

Considering previous studies and in continuation of what was previously achieved, two questions will pose: How is it possible to use mechanisms to improve the immune performance of the apartments building so that it becomes less transmittable of infectious diseases and healthier? How can apartment design could be improved, and the design coube linked to the effect of indoor greening capacity to alleviate the pressures resulting from the confinement situation?

1- Collect data through the interview tool and use the analysis to conduct a study of previous studies to modify the functions within the residential apartment in terms of architectural design in light of the results of personal interviews with specialists in the field preventive medicine (doctors), engineers (sustainability experts), and users. Where the interviews will be semi-structured. And the sample is intended. More details:

1-1 The use of the interview tool will be with workers in the **epidemiology sector** in the Palestinian Ministry of Health, and the personalities and their number will be selected based on the recommendation of the responsible ministry.

1-2 After that, the interview tool will be used by conducting a group of interviews with offices working in **sustainable design**, as it is the place closest to the researcher. This is based on the recommendation of the Jordanian Engineers Association, due to its knowledge of the offices working in this sector and the types of projects carried out by each of the offices whose names are proposed.

The interviews revolve around confirming the possibilities of application or not in the regions of Palestine in terms of building capabilities and adding the proposed system of the existing buildings, the availability of materials used in improvements to the design of residential apartments in the Palestinian market, and their experiences about the possibility of similar applications in architectural designs.

1-3 Conducting interviews with **users** and the sample is random. The aim of this interview is to measure whether the goal was met by covering the real need of the intended community, which is the users, as the sample was random. It provides, through an unstructured personal interview, details about citizens' needs for post-pandemic architecture and their preferences regarding psychological comfort. The way to obtain it and their preferences is to feel safe against transmitting diseases from outside the building to inside the building and from outside the apartment to inside the apartment and within the same apartment.

2 analyzing the interview, the hypothesis for the design will be developed, which revolves around four aspects: the health aspect, the physical aspect, and the aspect related to the environment involved in making the proposed design to improve indoor air quality in apartments through functional design and the negative pressure room, and the psychological aspect by making the design related to the design of the living wall.

Analyzing the interviews in the previous three stages using the method of manual thematic analysis, the necessary codes, statements and facts will be produced, and the complete functional framework for the supposed architectural distribution, the proposed greening, and the negative pressure isolation room will be formulated, and an imaginative prototype design will be developed for all of the above, including the proposed solutions for operating an immune-resistant apartment.

3 Confirmations will be taken about the behavioral aspects of the virus and the proposed systems and materials through interviews with specialists in each field from **a supervisor, a mechanical engineer, a materials expert, and a virologist**

4 Simulate the proposed design using the **Design Builder program** and examine its fulfillment of the user's thermal and visual comfort requirements, as well as examine the CFD system for the negative pressure room to ensure its operation.

5 Finally, come up with recommendations.

3.2.1 Key persons selection criteria

The interview sample was built in an organized manner, relying on consulting the relevant departments and ministries to obtain their guidance regarding obtaining the names of the people closest to the experience and whose insights could be valuable to the research in addition to their contribution to understand the needs, preferences, challenges, and expectations related to the problem in order to reach the desired solutions. See Figure 9 for details of sample selection. appendix 7 Details of interviews (number, interviewees, time of interview and location)

Figure 9 Details of sample selection.

Epidemic doctors: The specialists in epidemiology and doctors were selected based on the recommendations of the Palestinian Ministry of Health, and the criteria were based on the reality of their experrment and experience in combating the Corona epidemic and seasonal influenza.

- Criteria for selecting specialists for interview:
- The university PPU communicated with the Palestinian Ministry of Health and stated the research objective to the ministry
- The Ministry identified for the researcher the relevant authority for the research through its scientific research unit, which were the preventive medicine departments in the West Bank governorate directorates.
- After the study, the researcher was granted approval to interview the heads of preventive medicine departments only in Hebron Governorate directorates, which were four interviews (North, Center, and South).(4 with doctors and one with Virus scientist)
- No names were identified for epidemiologists in the ministry except those who were mentioned in the interview permission
- Semi-structured interviews were held with all of them in the three directorates and they have responded

Sustainable design specialists and engineers from the labor market: The sample of specialists in sustainable architecture and engineering offices working in this field was selected based on a list provided by the Jordanian Engineers Association, Al-Quds Center, and they were used because they are familiar with the specialized engineering offices and the sustainability projects that have been implemented.

- Criteria for selecting a sample of engineers specializing in sustainability:
- The Jordanian Engineers Association, Al-Quds Center, was contacted through Palestine Polytechnic University in an official correspondence to identify the consulting offices that had previously worked on special sustainability projects based on an evaluation by the Palestinian Higher Council for Green Building, as this entity is considered the only entity of an official nature in the State of Palestine specialized in green buildings and sustainability, and it was issued. Guide for green buildings in Palestine.
- The researcher was provided with the names of three consulting offices whose projects received a green building rating
- The specialist architect in the consulting office was contacted separately.
- Direct the architect to engineers specialized in sustainability for each project
- All specialists responded- 3 interviews
- Interviews were held via Zoom and Google Meet with sustainability specialists in Palestinian projects.

Residantial Apartment users: Random sample

- Criteria for selecting a sample of residential apartment users:
- The sample was chosen randomly within the geographical area of Hebron Governorate, as it is the governorate with which approvals to hold medical interviews were granted by the Ministry of Health, as the compatibility of information between the context in the health sector and the geographical context of residential building sites is necessary for the results to reflect actual reality within a specific geographical context.
- Semi-structured interviews were conducted until saturation was reached, which is the repetition of responses and their great similarity between different users (10 interviews)

3.2.2 Interviews Structure (Interview questions analysis and evaluation)

This section 1- Explains the type of interviews, 2- The justifications for choosing their type, 3- Why the themes chosen. It is noteworthy that 4- The design of each question, the reason for use, and the answers gained from it were also explained for each question in each sequence according to the themes.

The method of interviews adopted in this research is semi-structured interviews (in stage one (doctors' interviews), two (sustainable experts' interviews) and three (users interviews)). The reason for this type is that a flexible interview guide and a set of open-ended questions that will be developed to provide a framework for discussion with the selected experts, especially in the field of epidemiology, and that allow for a more in-depth exploration of the participants' experiences, viewpoints, and ideas. The information collection process will include three models of open-ended interviews. The components of each model depend on an original themes common to the three models, for example: The themes for indoor air quality and ventilation will be the first section in every interview, but the methods of asking for each stage will differ between a question directed to a doctor, engineer, or user. The reason is to investigate the best wording to reach the most truth possible through the interview. Each interview also contained its own themes based on the specialization of each specialist, in order to obtain the greatest possible benefit from the interview. An analysis of the structure of the interviews will begin for the common themes, after which the themes for each stage will be addressed separately at the end of the section.

The themes are:

1 Indoor Air Quality and Ventilation Theme
2 Space Planning and Layout Theme
3 Material Selection and Surfaces Theme
4 Lighting and Natural Elements Theme
5 Health and Safety Considerations Theme
6 Universal Design and Accessibility Theme
7 Acoustics and Noise Control Theme

3.2.2.1 Indoor Air Quality and Ventilation Theme:

The role of indoor air quality (IAQ) in architecture is vital for creating healthy and sustainable living and working environments. IAQ refers to the quality of the air within buildings, including the presence of pollutants, temperature, humidity, and ventilation. some key aspects highlights the importance of IAQ in : Health and well-being, Productivity and performance, Energy efficiency, Building material selection, Ventilation and air filtration, Adaptation to climate change, and Regulatory compliance and certifications. Look Figure 10 Indoor air quality questions for 3 stages.

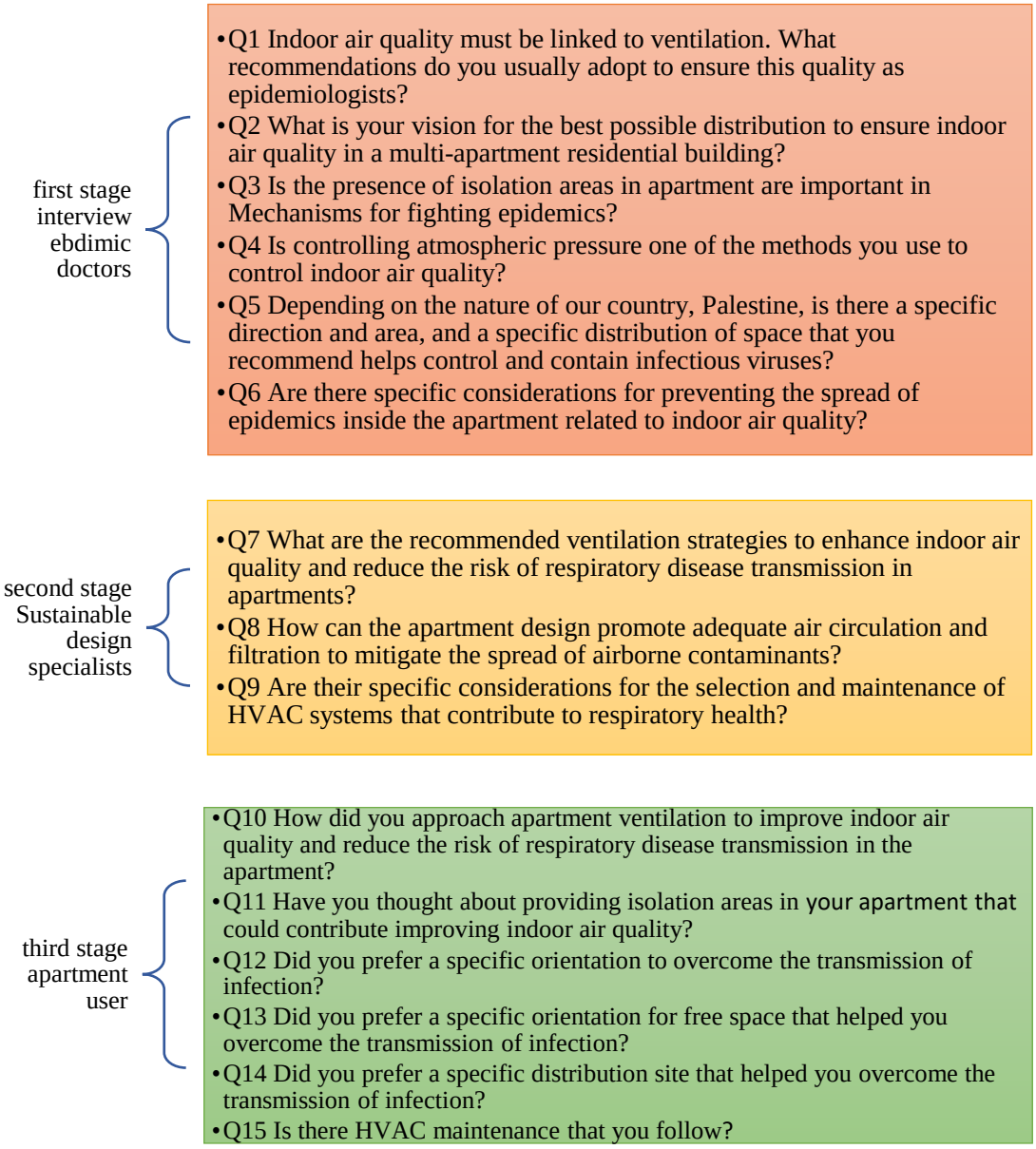


Figure 10 Indoor air quality questions for 3 stages.

For example, in this part, the justifications for formulating the questions and the expected answers for each question from each interviewee on the themes of indoor air quality and ventilation will be described, where orange is the design of questions for doctors and yellow is the design of questions for experts in sustainable design and green for apartment users.

- Q1 Indoor air quality must be linked to ventilation. What recommendations do you usually adopt to ensure this quality as epidemiologists?

It determines the type of suggestions that the doctor directed his patients towards in order to obtain appropriate ventilation, as well as to protect those present with him in the apartment, and to rely on mechanical ventilation or stop its systems, as well as preferring to use natural ventilation.

- Q2 What is your vision for the best possible design to ensure indoor air quality in a multi-apartment residential building?

Individual zoning and control zoning that allows occupants to control the ventilation and air quality in their individual apartments based on the incidence of individuals. This can be achieved through the use of adjustable vents which enable users to customize their internal environment based on their needs.

- Q3 Is the presence of isolation areas in apartments important in Mechanisms for fighting epidemics?

This question identifies an important confirmation of the research gap and gives confirmation about the justifications for the presence of this activity in residential apartments. The answer is supposed to be yes, because its presence rewards a few benefits: containing infected individuals, protecting vulnerable individuals, compliance with public health guidelines, reducing disease transmission within the building, mental health, comfort, flexibility in design, and the ability to adapt.

- Q4 Is controlling atmospheric pressure one of the methods you use to control indoor air quality?

This question gives an indication of the possibilities of creating a negative pressure room according to the model or hypothesis proposed in this research. It may be similar to mechanisms used in hospitals but transported in less expensive and more flexible ways. The answer must be that atmospheric pressure indirectly affects indoor air quality through its effect on ventilation and air exchange inside the building. Through positive pressure and negative pressure: Positive pressure and negative pressure refer to the pressure differences between indoor and outdoor environments. Positive pressure occurs when the indoor air pressure is higher than the outside air pressure. Positive pressure helps prevent outdoor pollutants and pollutants from leaking into the building. It can create a barrier that reduces the entry of outside air through leaks or openings, thus reducing the entry of outside contaminants, while negative pressure occurs when the inside air pressure is lower than the outside air pressure. Negative pressure is useful in specific situations, such as areas where pollutants are generated, Such as laboratories or isolation rooms. Negative pressure can help contain and exhaust airborne contaminants, preventing their spread to other areas within the building.

- Q5 Depending on the nature of our country, Palestine, is there a specific direction, area, and a specific distribution of space that you recommend to help control and contain infectious viruses?

This question determines the best options for locations to contain and confine sources of infection, whether from the outside to the inside through the person's property or the location of the isolation rooms, so that their design is based primarily on separation due to the difficulty of control, but it gives guidance regarding controlling the movement of air within the rest of the apartment to ensure continuous circulation and permanent change of air, as the design in our country, ventilation depends on cross ventilation, one-way ventilation, and the third type, the chimney effect

- Q6 Are there specific considerations for preventing the spread of epidemics inside the apartment related to indoor air quality?

This question shows the mechanisms that doctors follow to prevent the spread of infectious diseases. This gives the researcher indications about the extent of architectural intervention possibilities, and areas of interventions in the proposed design. The answers are supposed to include reducing the concentration of airborne pathogens, promoting the use of non-toxic and low-emission materials, and regular cleaning and disinfection: confirmation on the importance of regular cleaning and disinfection practices, especially for frequently touched surfaces, personal hygiene practices: Educating the population on the importance of personal hygiene practices in preventing the spread of epidemics. Emphasizing the importance of washing hands with soap and water for at least 20 seconds, isolation, and quarantine measures.

- Q7 What are the recommended ventilation strategies to enhance indoor air quality and reduce the risk of respiratory disease transmission in apartments?

This question determines which types of ventilation are preferred by sustainability specialists in cases of epidemics and pandemics, as ventilation varies between natural and mechanical. After selecting the option, determine the most effective mechanisms of the chosen type, noting caveats such as outdoor air quality, noise, filters and their maintenance, ventilation rate, and exhaust ventilation in areas with humidity. Install exhaust fans in areas exposed to high humidity, such as bathrooms and kitchens.

- Q8 How can the apartment design promote adequate air circulation and filtration to mitigate the spread of airborne contaminants?

This question identifies strategies that can be adopted to design an environment that enhances air circulation and change within the architectural space. The answers are supposed to be as follows: determining whether an open floor plan is better, appropriate planning and placement of furniture, designated areas for ventilation, size and orientation of windows and natural ventilation, air flow paths clear without obstacles, separating high-pollution areas such as kitchens, bathrooms, entrances, laundry rooms..., tight construction against outside pollutants and balanced ventilation and insulation.

- Q9 Are their specific considerations for the selection and maintenance of HVAC systems that contribute to respiratory health?

This question determines the reality of using these systems in residential buildings. If used, it is expected that the answers will revolve around installing filters with the ability to capture a wide range of airborne particles, including allergens, dust, and microorganisms, thus improving indoor air quality and reducing the risk of problems respiratory system, guidelines such as ASHRAE Standard 62.1 provide ventilation rate requirements based on occupancy and building size, the role of separating system paths and their contribution to disease transmission, air duct cleaning, tool options.

- Q10 How did you approach apartment ventilation to improve indoor air quality and reduce the risk of respiratory disease transmission in the apartment?

This question determines users' responses to ventilating their apartments, and its aim is to prepare their thinking to answer an upcoming question, which is: What did you wish was in the apartment that would have facilitated the process of ventilating the apartment, and which directions were your favorite for ventilating the apartment?

- Q11 Have you thought about providing isolation areas in your apartment that could contribute to improving indoor air quality?

This question determines users' preferences in terms of providing a flexible isolation room that can be used as another space in cases of non-isolation, and this is based on the experience they went through during the period of home confinement in the Corona pandemic.

- Q12 Did you prefer a specific orientation -orientation to overcome the transmission of infection?

This question is related to question number 10, which measures the level of comfort they had with a particular orientation in their apartments. The answer may also be related to a natural scene or an area with natural lighting that receives sunlight.

- Q13 Did you prefer a specific area for free space that helped you overcome the transmission of infection?

This question is related to question number 10, which measures the level of comfort they had with a particular orientation in their apartments. The answer may also be related to a natural scene or an area with natural lighting that receives sunlight.

- Q14 Did you prefer a specific distribution site that helped you overcome the transmission of infection?

The aim of this question is to measure the validity of the research hypothesis about the apartments' need for fundamental modifications in the commonly used designs based on the user's health and psychological needs.

- Q15 Is there HVAC maintenance that you follow?

Knowing the amount of use of air conditioners in apartments and awareness regarding their maintenance. The aim of the question is to know the suitability of their presence and operation during the time of pandemic and infectious diseases.

The rest of justifications for formulating the questions according to their themes can be found in appendices.

3.2.2.2 Space Planning and Layout Theme:

Space planning play an essential role in the design of post-pandemic apartments, where health and safety considerations are more prominent in relation to the necessity of providing dedicated remote working spaces. With the emergence of remote working and flexible arrangements, it is important to integrate dedicated workspaces within apartments and design flexible and multi-functional spaces. It includes privacy and enhanced access to the outside and balconies. Planning contributes to improving ventilation and air circulation and providing effective storage solutions, especially with the increase in remote shopping, and taking health and sanitation considerations into account by avoiding touching as much as possible and using self-cleaning and easy-to-clean materials, and adopting a design that confirms the application of social

distancing protocols in shared facilities such as stairs, elevators and integration technological architect in immune design.

To measure the role that architectural space planning contributes in building a resilient apartment and to know the interventions that can improve the quality of spatial planning for apartment buildings, the following questions were asked to three categories in three stages: preventive medicine doctors, sustainability specialists, and residential apartment users. see Figure *11* and *appendix 1*

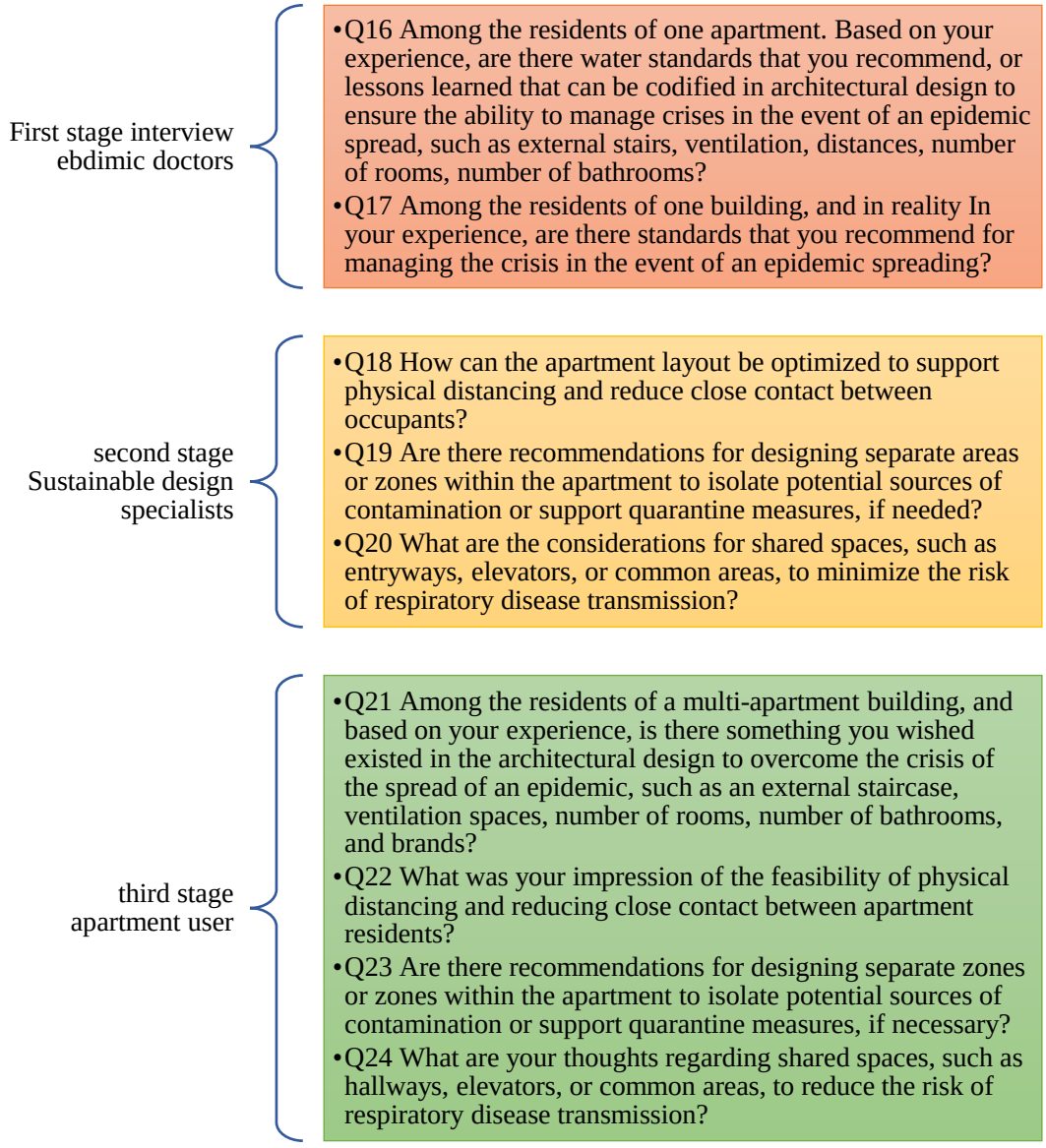


Figure 11 Space Planning and Layout Questions for 3 stages.

3.2.2.3 Material Selection and Surfaces Theme:

Choosing the appropriate materials and surfaces can contribute significantly to reducing the transmission of infection within the apartment. The surfaces should be non-porous, easy to clean, anti-microbial surfaces such as copper, smooth and seamless surfaces, have resistance to chemicals so that they can withstand frequent cleaning, easy-to-maintain floors, washable fabrics, specifically high-touch surfaces, pay attention to choosing their components from self-cleaning materials, and adopt photocatalytic techniques and antimicrobial coatings. Of course, the materials must be sustainable, recyclable, manufacturable, and low emission. See Figure 12 Material Selection and Surfaces questions. And appendix 2

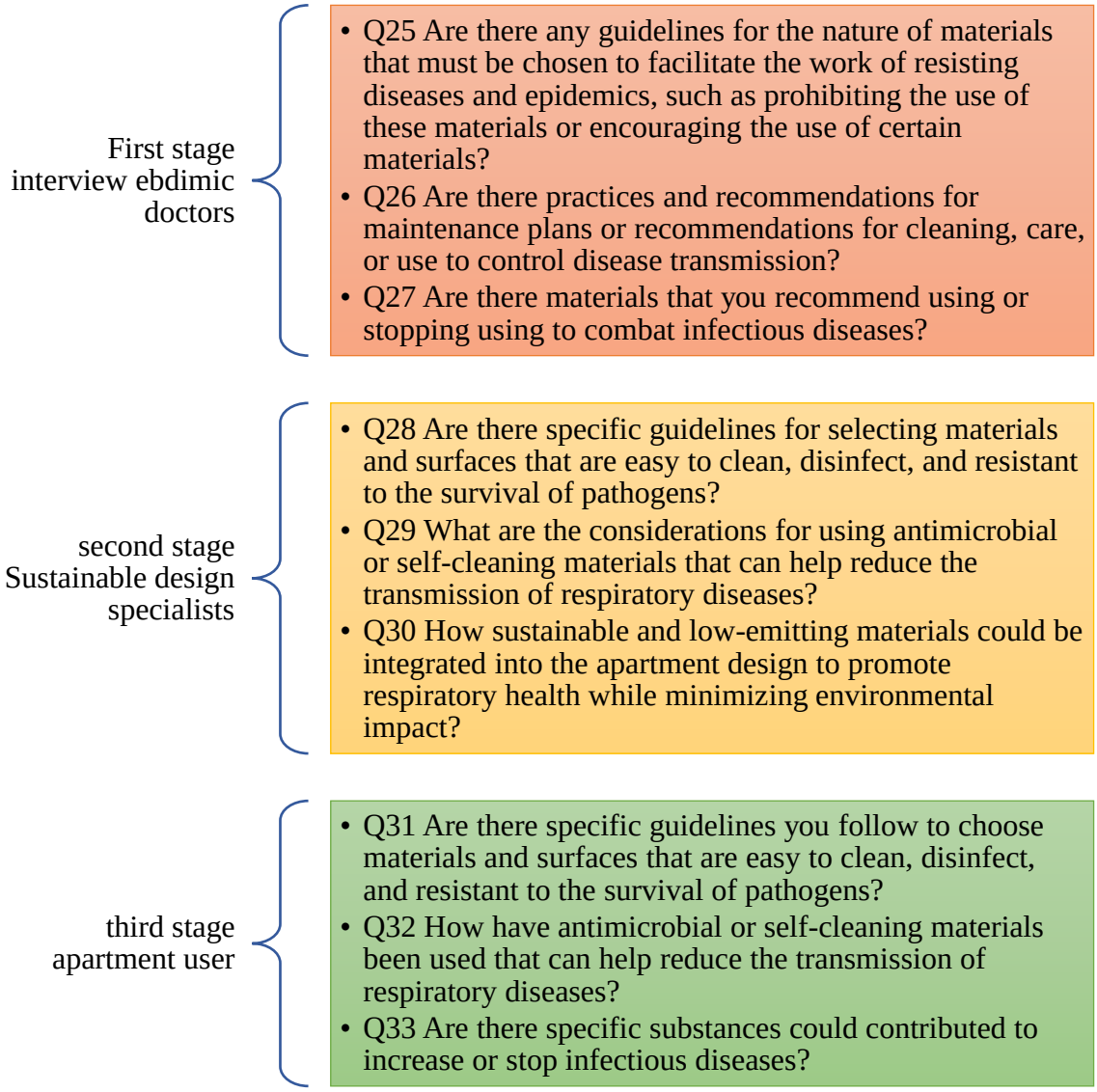


Figure 12 Material Selection and Surfaces questions.

3.2.2.4 **Lighting and Natural Elements Theme:**

The pandemic has emphasized the importance of lighting and landscaping in residential apartment architecture in terms of health and well-being through lively design, introducing daylight into living spaces, and enhancing outdoor spaces and balconies. see Figure *13* Lighting and Natural Elements Theme questions. And

appendix 3.

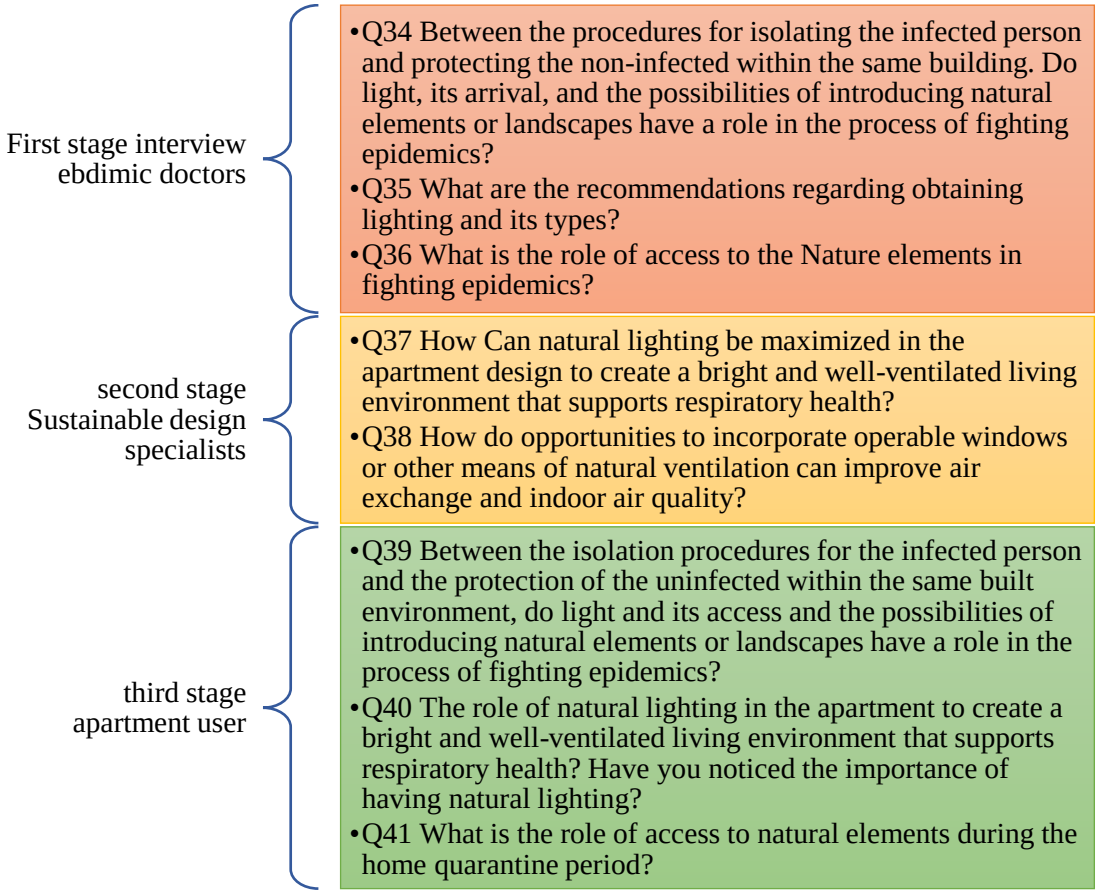


Figure 13 Lighting and Natural Elements Theme questions.

3.2.2.5 Health and Safety Considerations Theme:

This code only in doctors and user interviews Health and safety considerations in apartment architecture after the pandemic include considerations that are necessary to follow when designing, such as promoting hygiene behaviors, such as the hypothesis of this research. It is necessary to provide hand-washing stations that are easily accessible with soap and employ non-touch fixtures, such as automatic doors and sensor-activated faucets. And motion-activated lights to reduce contact with surfaces. The second hypothesis revolves around the necessity of developing methods inside the apartment that enhance indoor air quality.

The third hypothesis is the role of choosing materials, as they must be easy to clean, disinfect and maintain, non-porous surfaces and resistant to bacteria and viruses. Activation of photocatalytic techniques in antimicrobial coatings or materials that have antimicrobial properties. Also, the idea of social distancing has become a new

normal reality in the hypothesis of this research, so providing sufficient space between seating areas, remote workstations, and other functional areas is inevitable. Designing circulation paths in shared facilities in residential buildings reduces congestion and allows one-way flows. Finding spaces that can be easily reconfigured to accommodate changing needs, such as the ability to convert larger spaces into separate areas. Terraces are no longer a luxury. Rather, research assumes the necessity of providing them as a health requirement to provide the minimum level of health safety for the user. Integrating technology into the design through touchless systems and occupancy sensors to control lighting and ventilation, and advanced HVAC systems with smart monitoring and filtration capabilities. Strong emergency systems. Comprehensive design to enhance service to all segments of society. The Ministry of Health should develop maintenance and cleaning protocols. To see questions type look at Figure 14 Health and Safety Considerations theme . And to appendix 4

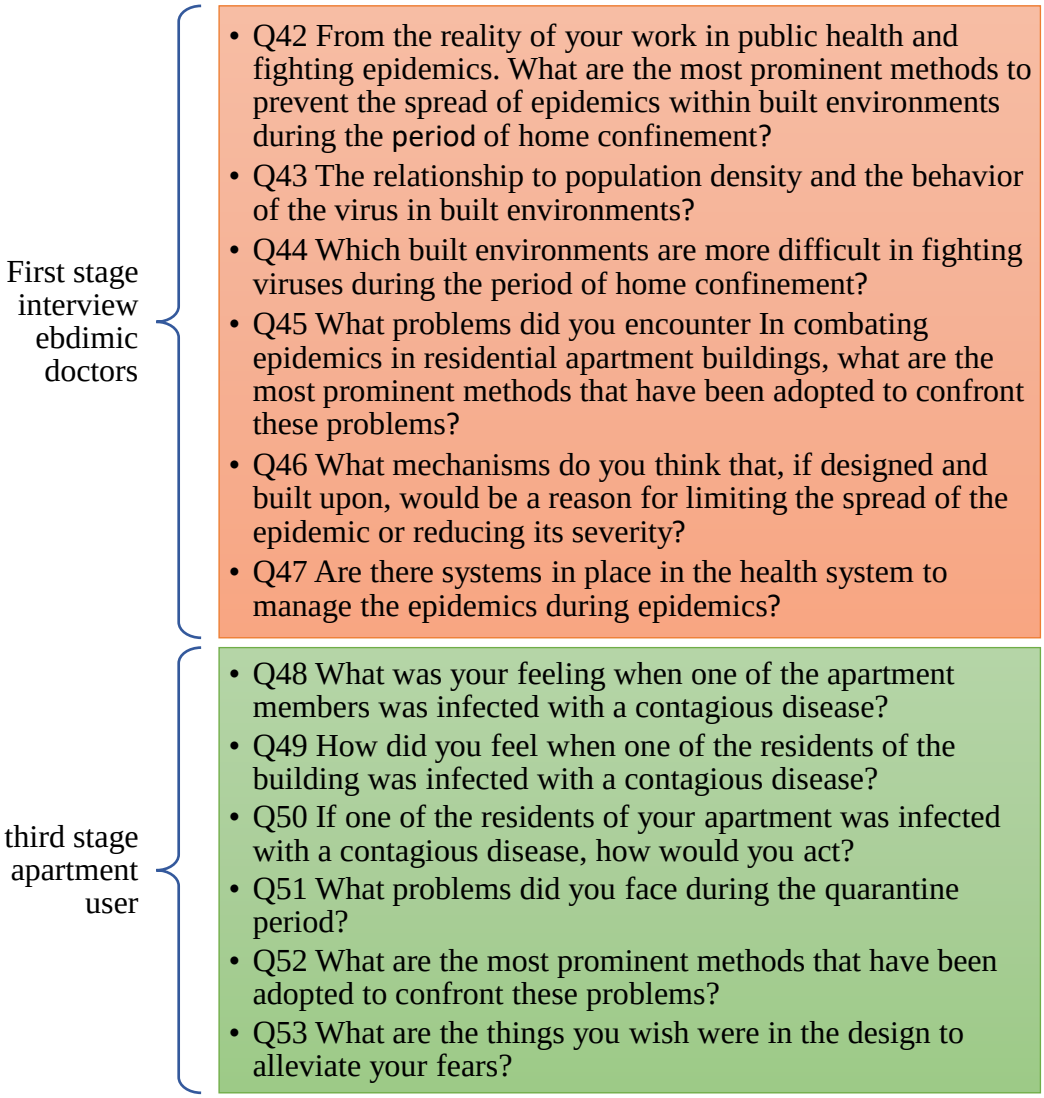


Figure 14 Health and Safety Considerations theme questions.

3.2.2.6 Universal Design and Accessibility Theme:

Universal design refers to designing products, environments and systems that are accessible, usable and inclusive for people of all abilities, ages and backgrounds. It aims to create inclusive spaces that can be used by everyone, regardless of their physical or cognitive abilities. and accessibility in creating inclusive and flexible spaces. This code was introduced into the interview questions of preventive medicine doctors and users with patterns similar to the knowledge, specialization, and experience of the people who were interviewed. As it is supposed to emphasize the research gap and emphasize the importance of providing isolation and quarantine rooms, as well as providing terraces as a basis in the design. See

appendix 5 and Figure 15 Universal design

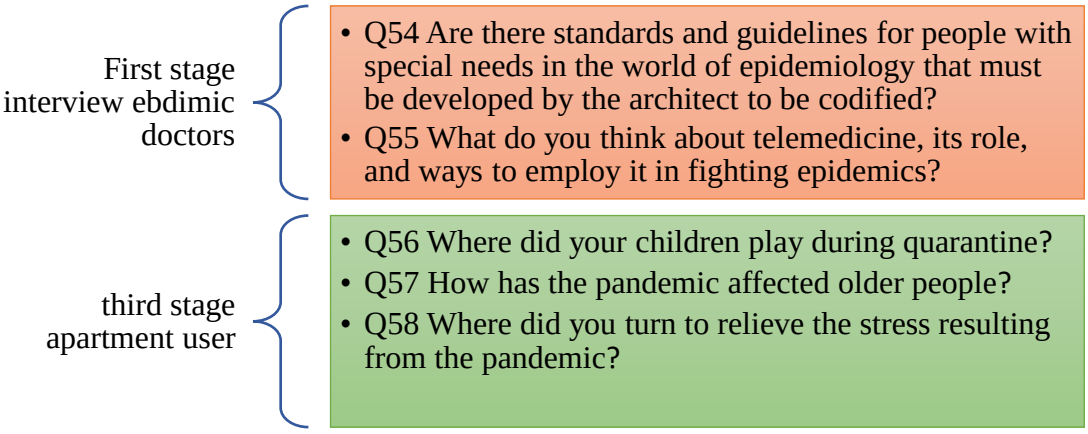


Figure 15 Universal design questions.

3.2.2.7 Acoustics and Noise Control Theme:

There is no doubt that acoustics and sound control are among the things that seem on the surface to have nothing to do with post-pandemic architecture, but in this research, the impact that poor acoustic design may have on users was addressed, such as their being forced to work remotely from themselves and other individuals in the same apartment and their lack of privacy and focus. In this situation, Likewise, the psychological impact that residents of adjacent units have, whether vertically or horizontally, hears the coughing of an infected person or their pain. Thus, the building loses the element of security and comfort. It may contribute in tension and anxiety, which affects health. On the other hand, it is possible to use sound to achieve a biophilic design by simulating the sounds of nature. Acoustic design can also be used to create sound systems that reduce touching processes that enhance the spread of epidemics. See questions in *Figure 16 Acoustics and Noise Control code questions.*. And appendix 6 acoustics and noise control question's structure

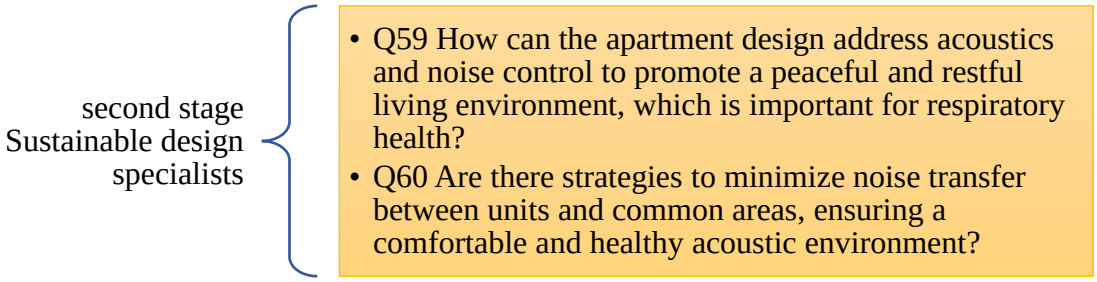


Figure 16 Acoustics and Noise Control code questions.

3.3 Interview model, objectives, and justifications.

Each interview stage will be included, accompanied by a table explaining the purpose of the themes, which facilitates the analysis process and extracting analysis codes and relationships to come up with the necessary theories to prepare the design model. The interview questions were reviewed with the supervising doctor to ensure their validity. To see interview forms See appendix 8,

appendix 9, and appendix 10.

First stage: Epidemic doctors semi-structured interviews see Table 4

Table 4 Epidemiologists and doctors semi-structured interviews

No.	Theme name	Question	The target of theme questions
1	Health and Safety Considerations:	1.1 from the reality of your work in public health and fighting epidemics. What are the most prominent methods to prevent the spread of epidemics within built environments during the period of home confinement? 1.2 The relationship to population density and the behavior of the virus in built environments? 1.3 Which built environments are more difficult in fighting viruses? 1.4 What problems did you encounter? In combating epidemics in residential apartment buildings, what are the most prominent methods that have been adopted to confront these problems? 1.5 What mechanisms do you think that, if designed and built upon, would be a reason for limiting the spread of the epidemic or reducing its severity? 1.6 Are there systems in place in the health system to manage the epidemics during epidemics?	The goal is to see additional aspects from the specialist's point of view that may differ from the architect's vision

2	Indoor Air Quality and Ventilation:	2.7 What recommendations do you usually adopt to ensure this quality as epidemiologists? 2.8 What is your vision of the best possible distribution to ensure indoor air quality in a multi-apartment residential building? 2.9 Is the presence of isolation areas important in Mechanisms for fighting epidemics? 2.10 Is controlling atmospheric pressure one of the methods you use to control indoor air quality? 2.11 Depending on the nature of our country, Palestine, is there a specific direction and area for distributing a specific distribution of space? Or do you give recommendations regarding controlling infectious viruses and containing them? 2.12 Are there any specific considerations to prevent The spread of epidemics?	The goal is to achieve an improved approach to controlling indoor air quality
3	Space Planning and Layout:	3.13 Among the residents of one apartment. Based on your experience, are there water standards that you recommend, or lessons learned that can be codified in architectural design to ensure the ability to manage crises in the event of an epidemic spread, such as external stairs, ventilation, distances, number of rooms, number of bathrooms? 3.14 Among the residents of one building, and in reality from your experience, are there standards that you recommend for managing the crisis in the event of an epidemic spreading?	The goal is to formulate an architectural guideline to control resistance to the spread of respiratory infectious disease within the apartment

4	Material Selection and Surfaces:	4.15 Are there any guidelines for the nature of materials that must be chosen to facilitate the work of resisting diseases and epidemics, such as prohibiting the use of these materials or encouraging the use of certain materials ? 4.16 Are there practices and recommendations for maintenance plans or recommendations for cleaning, care, or use to control disease transmission? 4.17 Are there materials that you recommend using or stop using to combat infectious diseases?	The goal is to guide the method of using materials in architectural surfaces in order to increase the immunity of the apartment
5	Lighting and Natural Elements:	5.18 Between the procedures for isolating the infected person and protecting the non-infected within the same building. Do light, its arrival, and the possibilities of introducing natural elements or landscapes have a role in the process of fighting epidemics? 5.19 What are the recommendations regarding obtaining lighting and its types? 5.20 What is the role of access to the Nature elements in fighting epidemics?	The goal is to achieve more effective mechanisms in enhancing the role of lighting in indoor air quality and user comfort
6	Universal Design and Accessibility:	6.21 Are there standards and guidelines for people with special needs in the world of epidemiology that must be developed by the architect to be codified? 6.22 What do you think about telemedicine, its role, and ways to employ it in fighting epidemics?	The goal is to take specialized details to ensure the correctness of the design so that it is universal and serves

These questions can serve as a starting point for discussions with an epidemiologist to obtain basic guidance on designing an apartment that prioritizes health, safety, and

well-being. It's important to engage in a collaborative dialogue to ensure a comprehensive and informed design approach.

Stage two: Sustainable design specialists and engineers from the labor market semi-structured interviews see Table 5

Table 5 Sustainable design specialists and engineers from the labor market semi-structured interviews

No.	Theme name	Question	The target of theme questions
1	Indoor Air Quality and Ventilation:	Q1 What are the recommended ventilation strategies to enhance indoor air quality and reduce the risk of respiratory disease transmission in apartments? Q2 How can the apartment design promote adequate air circulation and filtration to mitigate the spread of airborne contaminants? Q3 Are their specific considerations for the selection and maintenance of HVAC systems that contribute to respiratory health?	The goal is to achieve an improved approach to controlling indoor air quality
2	Spatial Planning and Layout:	Q1 How can the apartment layout be optimized to support physical distancing and reduce close contact between occupants? Q2 Are there recommendations for designing separate areas or zones within the apartment to isolate potential sources of contamination or support quarantine measures, if needed? Q3 What are the considerations for shared spaces, such as entryways, elevators, or common areas, to minimize the risk of respiratory disease transmission?	The goal is to formulate an architectural guideline to control resistance to the spread of respiratory infectious disease within the apartment

3	Material Selection and Surfaces:	Q1 Are there specific guidelines for selecting materials and surfaces that are easy to clean, disinfect, and resistant to the survival of pathogens? Q2 What are the considerations for using antimicrobial or self-cleaning materials that can help reduce the transmission of respiratory diseases? Q3 How sustainable and low-emitting materials can be integrated into the apartment design to promote respiratory health while minimizing environmental impact?	The goal is to guide the method of using materials in architectural surfaces in order to increase the immunity of the apartment
4	Acoustics and Noise Control:	Q1 How can the apartment design address acoustics and noise control to promote a peaceful and restful living environment, which is important for respiratory health? Q2 Are there strategies to minimize noise transfer between units and common areas, ensuring a comfortable and healthy acoustic environment?	The goal is the role of the audio system in raising the luxury of the apartment with immunity
5	Lighting and Natural Ventilation:	Q1 How Can natural lighting be maximized in the apartment design to create a bright and well-ventilated living environment that supports respiratory health? Q2 How to opportunities to incorporate operable windows or other means of natural ventilation to improve air exchange and indoor air quality?	The goal is to achieve more effective mechanisms in enhancing the role of lighting in indoor air quality and user comfort

Stage three: The third stage of interviews for collecting information and data was targeting a random sample of apartment users and residents. The interviews were conducted until saturation, as answers from users began to be repeated depending on their locations and experiences, and 10 interviews were reached.

The user interview questions followed the same division of the objective approach to classify the questions, but regarding the users' preferences and needs, which were specifically decided by them during the period of quarantine and home confinement during the Corona pandemic.

The form below (see Table 6 Apartments users' semi-structured interview) to includes the questions, their objectives, and initial codes before analyzing what the research expects. It should be noted that the questions have been clarified and the assumed answers to them analyzed in this section above.

Table 6 Apartments users' semi-structured interview

No.	Theme name	question	The target of theme questions
1	Health and Safety Considerations:	Q48 What was your feeling when one of the apartment members was infected with a contagious disease? Q49 How did you feel when one of the residents of the building was infected with a contagious disease? Q50 If one of the residents of your apartment was infected with a contagious disease, how would you act? Q51 What problems did you face during the quarantine period? Q52 What are the most prominent methods that have been adopted to confront these problems? Q53 What are the things you wish were in the design to alleviate your fears?	The goal is to see additional aspects from the specialist's point of view that may differ from the architect's vision

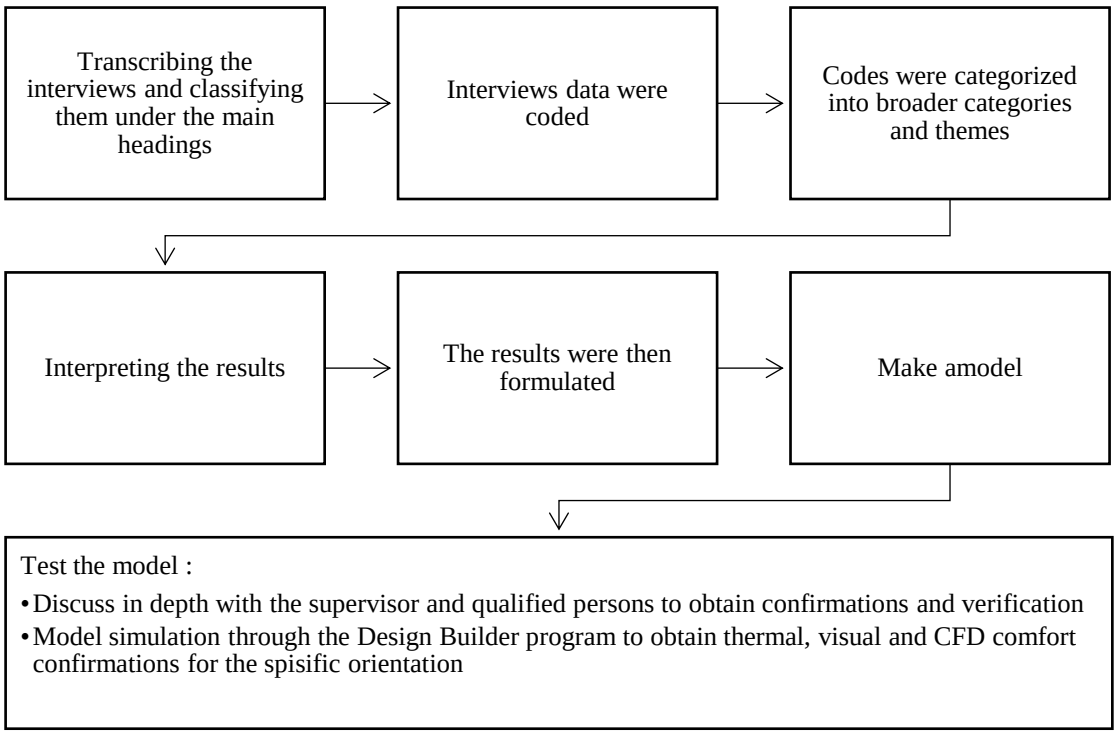
2	Indoor Air Quality and Ventilation:	Q10 How did you approach apartment ventilation to improve indoor air quality and reduce the risk of respiratory disease transmission in the apartment? Q11 Have you thought about providing isolation areas in your apartment that could contribute to improving indoor air quality? Q12 Did you prefer a specific orientation to overcome the transmission of infection? Q13 Did you prefer a specific orientation for free space that helped you overcome the transmission of infection? Q14 Did you prefer a specific distribution site that helped you overcome the transmission of infection? Q15 Is there HVAC maintenance that you follow?	The goal is to achieve an improved approach of controlling indoor air quality
3	Spatial Planning and Layout:	Q21 Among the residents of a multi-apartment building, and based on your experience, is there something you wish to be existed in the architectural design to overcome the crisis of the spread of an epidemic, such as an external staircase, ventilation spaces, number of rooms, number of bathrooms, and brands? Q22 What was your impression of the feasibility of physical distancing and reducing close contact between apartment residents? Q23 Are there recommendations for designing separate zones or zones within the apartment to isolate potential sources of contamination or support quarantine measures, if necessary? Q24 What are your thoughts regarding shared spaces, such as hallways, elevators, or common areas, to reduce the risk of respiratory disease transmission?	The goal is to formulate an architectural guideline to control resistance to the spread of respiratory infectious disease within the apartment

4	Material Selection and Surfaces:	Q31 Are there specific guidelines you follow to choose materials and surfaces that are easy to clean, disinfect, and resistant to the survival of pathogens? Q32 How have antimicrobial or self-cleaning materials been used that can help reduce the transmission of respiratory diseases? Q33 Are there specific substances that contributed to increasing or stopping infectious diseases?	The goal is to guide the method of using materials in architectural surfaces in order to increase the immunity of the apartment
5	Lighting and Natural Elements:	Q39 Between the isolation procedures for the infected person and the protection of the uninfected within the same built environment, do light and its access and the possibilities of introducing natural elements or landscapes have a role in the process of fighting epidemics? Q40 The role of natural lighting in the apartment to create a bright and well-ventilated living environment that supports respiratory health? Have you noticed the importance of having natural lighting? Q41 What is the role of access to natural elements during the home quarantine period?	The goal is to achieve more effective mechanisms in enhancing the role of lighting in indoor air quality and user comfort
6	Universal Design and Accessibility:	Q56 Where did your children play during quarantine? Q57 How has the pandemic affected older people? Q58 Where did you turn to relieve the stress resulting from the pandemic?	The goal is to take specific details to ensure validity of the design so that it is universal and serves everyone

3.4 Data analysis process

To analyze the interviews, a structured approach was followed to ensure accuracy, reliability and validity. Meaningful units of interview information were coded using manual method, After coding, codes were categorized into broader categories and themes. This step involves grouping related codes together to identify common patterns, themes, or concepts that emerge from the data.

Once the data was coded, categorized, and reduced, the process of interpreting the results began. It is the process of searching for connections, relationships, and patterns within and across categories. The points of view of different participants were compared, similarities and differences were made, and the results were then appeared.



3.5 Structure of the model

Based on the results extracted from the interviews and the viewpoints of the specialists, a set of solutions will be built and developed that should contribute to improving the immune role of the multi-story residential apartment building. The solutions will be distributed along the following Hypotheses:

Firstly, designing a quarantine room which is flexible to use and can be operated in emergency situations.

Secondly, designing a living wall -work as movable garden- it's possible to install vertically or horizontally as user desire that increases the wellbeing of the residential apartment, which positively affects the user's immunity.

Thirdly, a functional design to distribute the architectural spaces in the apartment in a way which serves the research objectives,

Finally, the use of materials and surfaces that contribute to increasing the immunity of the apartment and the isolation room.

Determine the location of the model.

When the model is simulating on the Design Builder program, the geographical location will be determined in the Hebron Governorate in the city of Dura, and this is based on the requirements that were determined by the circumstances of the interviews, as following:

First: the interviews that were approved by the Palestinian Ministry of Health were for doctors from the Preventive Medicine Department in Hebron Governorate only, north, center, and south.

Second: based on the first determinant, interviews were conducted with users in the same geographical context to ensure consistency of the samples and their conditions in the stages of collecting information.

Third: the climate in Hebron region is considered comprehensively representative of large areas in the West Bank. It is very similar to the climate of Bethlehem, Jerusalem, Ramallah, and part of Nablus. Look at Figure *17* Climatic zones of west bank and Gaza

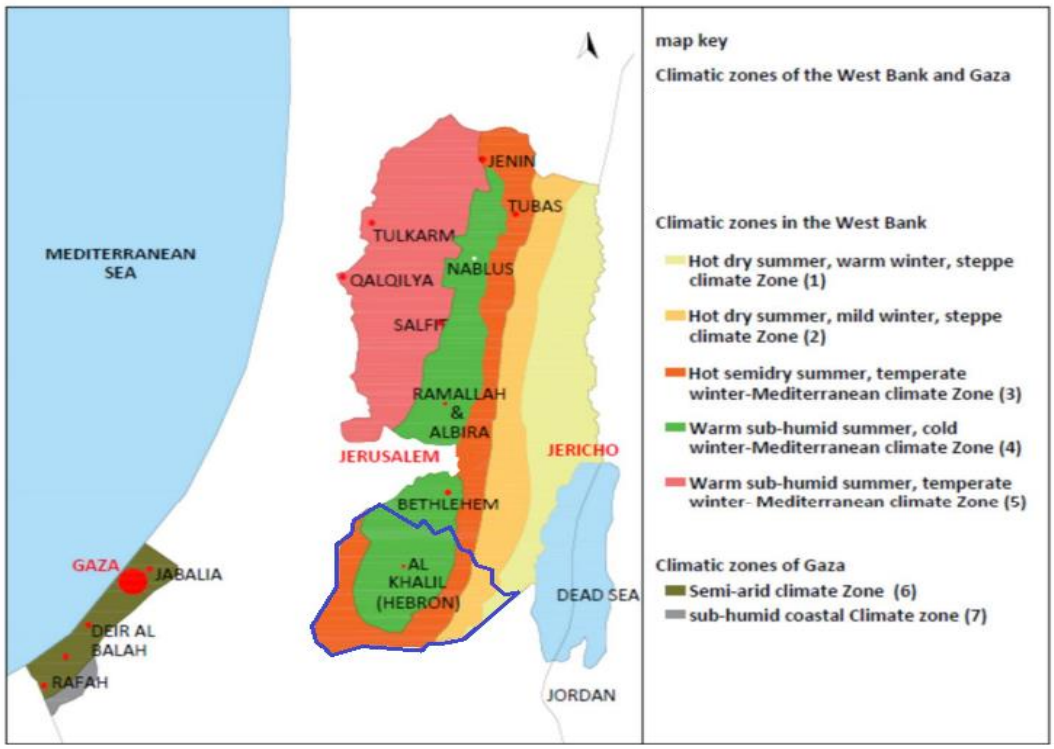


Figure 17 Climatic zones of west bank and Gaza

Zone in green: Hot semidry summer, temperate winter – Mediterranean climate This zone occupies 969.1 km2 of the total area of the West Bank and is positioned in the semi-arid region. The mean annual temperature measured for this zone is 18 0 C assigning 12 0 C in January and 26 0 C in August. Winter experiences a variation in rainfall from year to year to measure 316 mm as mean annual rainfall average. The wind prevailing has a speed of about 4.7 km/h and is western, northwestern, and southwestern directed.

Zone in brown: Warm sub-humid summer, cold winter – Mediterranean climate This zone is about 1314.6 km2 in area with population of 876971 persons, which represents approximately 47 % of the West Bank population. The zone temperate mean annual temperature of 16 0 C, mean annual average of relative humidity of 60 % and 715 mm of maximum mean annual rainfall. According to the aridity index of the West Bank, part of this zone is located in the sub-humid region; also, it lies within the West Bank Central Highlands climatic and topographic region sharing the same climatic properties. (ARIJ, 2003)

3.6 Testing and validation of the model

Testing the proposed model is a necessary procedure to generalize its results and use it by decision-makers in the field of public health, architects, or users who want an apartment with immunity. Therefore, it was tested in successive stages as follows:

1- The first phase was tested, where the functional framework and initial design were discussed with the supervisor doctor at Palestine Polytechnic University in order to determine the suitability of the design.
2- The second phase tested, presenting, examining and modifying the model from a selected number of PhD holders. These candidates were selected because they are qualified in design, sustainable mechanical engineering, and materials science curricula. The discussion and modification session includes the researcher's information, research needs, and objectives.
3- The third phase testing will be with a virology expert to take confirmations about the behavioral aspects of the virus and the responding of the proposed systems and materials.

This approach will enable the researcher to draw the opinions and experiences of the specialist on the prepared for solutions from the interviews analysis result and obtain rich and detailed information in his own words. It also has sufficient flexibility to follow the directions of the specialist. Especially with regard to the effect of the negative pressure system, the accuracy of the design, the details of the diameters, and the possible defects of the system, to obtain a deeper understanding of the details and clarify certain points. The same applies to the details of the selected materials and the method of implementing them.

4- Testing of the design will be done through useing design builder program to simulating the model and test thermal and visual comfort, and the second test will be for the successful operation of the negative pressure room by performing a CFD simulation through the Design Builder program.

The set of results will be formulated within a table of design recommendations for any designer who wishes to design a residential apartment that is resistant to infectious respiratory diseases among its residents. The Ministry of Health can use it as a procedural guide to grant the necessary approvals when licensing multi-unit residential buildings with shared facilities.

Chapter 4

4 Results and Discussion

In this section, qualitative data was analyzed after the data was collected in a semi-structured interview method, mean while patterns were searched to find the features that will determine the optimal design form for post-pandemic architecture with regard to the design of residential apartments. The data was manually analyzed using the tables below to later obtain the features that make up the immune apartment.

After that, common themes were found and confirmed between doctors, sustainability specialists, and users, and recurring ideas and common methods were created to come up with solutions from the Corona experience. The new zones, the proposed modifications, and the areas that need to be eradicated were identified.

4.1 Extract themes coding:

Tables for extracting coding for themes in the thematic analysis can be reviewed in the appendices section appendix 11

4.2 Interviews results:

In this section, the results of the interviews will be presented in the form of a MATRIX with two axes: the first is the interview questions and the second axis represents the responses of the interviewees from the three categories, where the vertical axis represents the responses and the horizontal axis represents the interview themes - the research - with the red color showing the opinions of doctors, the yellow color being sustainability experts, and the green color showing the apartment users. The answers of those interviewed will then be discussed based on the themes raised in the interview to come up with the features, components and specifications of the ideal model for an apartment with immunity that fulfills the hopes and aspirations of users, medical staff and sustainability experts in periods of the epidemic by prioritizing responses through the points that collected for each item and networking.

Relationships for design components, including rooms, facilities, and architectural design supplies. Look at *matrix 1 interviews results*

doctors responces
sustainable specialests responces
apartment users responces

ITERVIEWS QUESTIONS

sum.	Acoustics and Noise Control Theme		Universal Design and Accessibility Theme					Health and Safety Considerations Theme												Lighting and Natural Elements Theme								Material Selection and Surfaces Theme									Space Planning and Layout Theme									Indoor Air Quality and Ventilation															INTRVIEWEES ANSWERS
	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
16										1	2		1			1			1																			1														1					3	2			Attempts to contain pollutants - pathogens
9																1		1																1			1									1					1					3					Reducing humidity causing disease
11															1						1																2		1		1	1			1		2									1					Providing a general primary containment area
19								1		1	1				2	1																					1		1		1	1			1		2								2	1					Providing an initial containment area for the apartment
47							5	3		1	4	1				1	1		1																			1		1			2		3					4					2			4			If a special space is provided for the patient
36							5	3			2					1	1		1																								1		2		1			3					2			4			A private bathroom for the patient
25								1							2	1			1		1																3			3	1	1			2		1			1					2		1	2		1	Providing a safe vertical corridor in terms of air quality linked to the isolation room
14									1							1			2		1																2				1	1					1												3		Internal ventilated staircase
6																1					2	1			1		1																																		Providing plants that purify the air
10																3								1							1						1			1	1	1	1																		Use materials and surfaces that reduce the possibility of disease transmission
8																							2														2			1	1		1		1																Using remote sensing and artificial intelligence in building and apartment facilities
14								1							2		4	4																									1					1													Reducing overcrowding inside the building
13								1		1	2					2																					1																		2						Increase area
3																		1																									1																	1	Open design
13																1			2																												1		1		1			3					3	1	Natural ventilation
6																			1																																		1						1	3	Stop HVAC systems
5																																					3				1																			1	Fears of using the elevator
9																																														9															There is no split net
6														4																											1											1									Providing systems for managing residential buildings during pandemics
18			3		1			1	1										1																					2							1			1	1										Providing multiple balconies (more than one)
15								4	1																														1						1			2					1								Providing a private outdoor garden
14																1			2																														1		6					3				1	Spaces with opposing openings
6															1																								2			1	1													1					Primary storage area in the building as a whole
10								1							1																							2	1			1	1				1									1					Primary storage area in apartment entrance
16								3			3				1																									2										1											Providing more than one bathroom in the apartment
4									1																												2																								Determine the width of the internal stairs at least 180 cm
16												3			1	3												1			1						3			1	1		1												1						Avoid touching common surfaces as much as possible, such as handrails, elevator buttons, door handles...
23			1		1			2	2	3																														1									2		2										Attempts to take advantage of the external public entrance hall to provide ventilation, a place to play, or an outlet without compromising privacy
16							5				1		1																									1	2																						It is difficult for mothers and some special cases to isolate themselves out their apartments
3																																						1		1	1																				Providing space to receive purchases made remotely during periods of home confinement
18						5									1																											2						1										4			Flexibility in using rooms and possibilities to change use
5								1							1																												2																		Gradation in areas
5								1							1																												2																		Gradation privacy inside the apartment
7																														3			2							1															1						Surfaces Easy to clean
2																									1											1																									Antibacterial surfaces
2																									1											1																									Anti-virus surfaces
6																														3			2							1																					Surfaces that can withstand cleaning
5																														2			2							1																					Surface less rough and smooth
4																														2			1							1																					Less ornate furniture and corners
4																														2				1		1																									Providing a guide for choosing surfaces and materials inside apartments and residential buildings reduces the spread of infectious diseases
9															1	2			1										1						3																							1			Separate the infected person’s fluids, breathing, and waste from others
6																											1				2		2																		1										Using materials with specific specifications, such as VOC materials, material free of formaldehyde and copper chromates, activating the role of clean precursor materials, materials that can be reused and can be recycled, and reducing lead and mercury.
3																															1	1				1																									Awareness regarding green cleaning
2																														2																															Choose beautiful and comfortable surfaces
2																															1		1																												Self-cleaning materials
10												1				1			1									1	4								1																		1						Use cleaning materials such as chlorine and wash hands with soap and water
12																					2	2		1		3	2							1																		1									The use of ultraviolet rays, both natural and artificial, has an antimicrobial effect
21																				1	4	2		2		4	2		1								1											1	2										1		Access to sunlight is necessary to raise immunity
28									1		1					1					3	3		2		3	3		1								1	1											1		1					3			1		Access to sunlight is necessary for sterilization and cleaning
27								2	1	2										5	1	3		1	3		2		1																				1												Striving to provide a planted and natural space to relieve the infected and non-infected inside the apartment contributes to raising morale
23					1			2	3											3		3		2	2		1																																		Providing an easily accessible natural scene
14			1					3	1											2		2																																							Practice farming to obtain a natural scene
6																				2	1	2						1																																	Change the apartment for a natural scene
7													5																								1		1																						Feeling afraid when one of the residents of the apartment is infrcted
6												6																																																	Feeling afraid when one of the residents of the building is infected
23				5						6			1																																																Feeling psychological pressure
16					3			1	1	3																																																			Lack of space for children-play
8			2						1	1																																																			Leaving the apartment due to fears of infection
3														1		1			1																																										Awareness regarding infection prevention
10						5																																																							Activating telehealth and telecare at apartment
4	1	1																																																											Sound insulation between apartments and rooms
2		1																																																											Sound insulation from outside to inside - components of envelop - following the standard
4	1	1																																																											Insulation strategies - insulation materials - costal cluster -
4	1	1																																																											Furniture and its influence in sound insulation
2	1																																																												Design as sound insulation performance
0																																																													
7																												2									1	2	2																						Negative reaction

matrix 1 interviews results

4.2.1 First: The issue of indoor air quality and ventilation:

The indicators related to the topic that we obtained answers to were pollutants, humidity, and ventilation, as the entire sample showed 100% that indoor pollutants were the source of their greatest concerns. This was the discussion about what mechanisms might contribute to reduce these pollutants, and the answers revolved around 1- Finding a general containment area for each multi-storey building, and an external containment area specific to the apartment, such as a veranda, and a special containment area at the entrance that provides access to an initial cleaning area for people and things. 2- Staircase entrances that have With continuous ventilation and external self-sterilization, it acts as a safe passage. 3- A private isolation area inside the apartment, accompanied by accessories such as a private bathroom and a private entrance. 4- A vertical safe corridor exposed to the outdoors and an internal vertical corridor with good ventilation and dimensions that maintain distancing. 5- Plants that provide air purification. 6- Use materials that reduce the possibility of the spread of infection. 7- Using remote sensing and artificial intelligence in building facilities.

Overcrowding was one of the concerns expressed by 30% of those interviewed, as it may require more ventilation or a larger space to reduce the concentration of pollutants in the air inside the apartments.

Doctors and sustainability experts expressed their opinion in favor of passive ventilation and traditional heating over ventilation systems, as they may contribute to the transmission of infection, unless separate systems are created for each apartment, and this does not apply to apartments in the West Bank.

100% of doctors explained that there are no systems for managing buildings in pandemics.

4.2.2 Second: Spatial distribution and planning:

1- Doctors focused on the necessity of providing a safe corridor exposed to the open air in managing the crisis. 2-Special outdoor spaces for each apartment. Focus all categories of interviews on their priority. 3-One of the frequently asked answers among users regarding apartment planning is to find spaces with wide, opposite openings. 4-All groups expressed their fear of the lack of a station for items that come from outside and the necessity of providing an initial cleaning and storage station in the apartments. 5-Users aspire to have an additional bathroom in the apartment and additional balconies. 6-Users preferred the external stairs to the internal stairs and the internal stairs to the elevator, and 20% of the sample noted the need for it to be of an appropriate width in line with social distancing. 7-All groups showed a tendency to avoid touching surfaces as much as possible. 8-Also, there was a tendency among apartment residents to open the apartment door with one of the windows to close cross-ventilation, and this sometimes violated privacy, and there must be a solution to provide this. 9- Mothers, as apartment users, showed a strong tendency to isolate themselves in the event of infection in their apartments due to the difficulty of leaving their children and their responsibilities. 10-20% of users had difficulty receiving their purchases made remotely due to the lack of a special solution for such emergency use. 11-In designing the apartment, sustainability experts focused on the need of having a gradation and privacy of spaces, reduce touch surfaces, and the need to provide flexible isolation areas.

4.2.3 Third: Selection of materials and surfaces

According to the virologist's answer, there are anti-bacterial materials, anti-viral materials, and easy-to-clean surfaces.

There are no guidelines regarding the type of materials and surfaces that can be used to confront epidemics. Smooth, non-rough surfaces so as not to be a place for mold growth and a hiding place for pathogens.

Doctors stressed the need to separate the infected person’s waste, including liquids and solids, and himself from others

As for sustainability experts, they unanimously agreed on the necessity of using materials with specific specifications, such as low v.o.c materials - Volatile Organic Compounds- that are free of formaldehyde and copper chromates, activating the role of clean predecessor materials, materials that can be reused and can be recycled, and reducing lead and mercury. Activating the role of green cleaning.

As for users, they tend to adhere to the following criteria in choosing surface materials (beauty and comfort). It is easy to clean and can withstand cleaning materials without damaging it, especially the kitchen space. The cleaning materials are chlorine, soap and water.

4.2.4 Lighting and Natural Elements Theme:

The results of the doctors' interviews regarding the issue of lighting revealed the role of the sun in achieving two goals: the first is increasing psychological and physical immunity, and the second is cleaning, sterilizing, and eliminating mold.

Taking advantage of ultraviolet rays and using natural and artificial ones, it has an antimicrobial effect. This is done by seeking to provide a planted and natural space to relieve the infected and non-infected inside the apartment. It contributes to raising morale, which is the point that doctors, users, and sustainability experts alike have focused on and access to it easily.

It was clear to the research groups that they were convinced that plants have a role in purifying the air from pollutants

4.2.5 Health and Safety Considerations Theme:

This theme had the greatest results in guiding the safe and immune design, as the answers of interviewees categories were rich, clear, and widely intersecting.

1- The answer to the necessity of providing a special place to isolate the infected person and the room’s facilities, including a bathroom and an exit in the apartment, received the highest points out of all categories.
2- Attempts to take advantage of the public entrance between the apartments to provide ventilation, a place to play, or a refuge-yard for sports and escaping boredom were an indicator that must give a shift in the design of the apartments in order to provide security for the user inside the apartment.
3- To increase their sense of health security during the pandemic, their answers revolved around the necessity of having more than one bathroom in the apartment and reducing crowding. This requires the architect to consider solving the dilemma in a logical way, which is that increasing space is difficult and the reason is costs, but adopting open spaces and open designs which can be a solution to this problem.
4- Frequently answers about ways to contain pathogens from the categories revolved around providing a containment station for pathogens, providing private balconies, and everything that would provide easy access to sunlight and natural views.
5- Users had a frequent answers about the necessity of providing a suitable place inside the apartment for children to play.
6- There have been repeated concerns about touching shared facilities inside the building, which calls for solutions.

4.2.6 Universal Design and Accessibility Theme:

All the doctors' answers considered that the flexibility of the design would contribute to make the design more universal and meet the requirements of a larger segment of users.

The apartment must be designed to be a place for quarantine for aunts who find it difficult to be away from family, such as mothers, as well as people with special needs with disabilities.

It is necessary to activate telehealth, and this requires infrastructure that must be worked on at a governmental level.

4.3 Interviews discussion:

Based on the results of the matrix that was prepared in the previous section, the first result will be discussed: the priorities of the amendments that need to be introduced to the functional framework system for designing apartments. This is based on converting the preferences, desires, fears and suggestions of the research categories into the form of numbers and arranging priorities to build a greater harvest of votes. Extracted from interviews as shown in *Table 7 Results priorities*.

1- It appears from the results of the matrix that the first input is the necessity of providing isolation space and the accompanying needs of a bathroom and an external exit linked to the safe path and a strong relationship with the natural landscape to protect the isolated person from the pressures resulting from confinement.

2- The second priority is the necessity of providing access to sunlight to the components of the apartment and achieving their role in sterilization and cleaning. The effect of this will be clear in the modifications introduced through creating an external garden, and developing the distribution of jobs inside and outside the apartment.

3- Adapting the user's desire to go out during the period of confinement made him use the location in front of the apartment as an attempt to get out and to create an air flow and other things. Therefore, it was necessary to think of a solution that simulates the user's subconscious and creates his own space, but outside the entrance to the apartment, the balcony was in an intermediate location between the stairs and the apartment itself. It will also appear in the Model Development chapter.

4- The priority is to provide areas to contain infection through surfaces and materials, access to a natural view, and access to natural light, and this is on two levels for the building as a whole and for the apartment in particular. It contains a warehouse and

space for purchases, and most importantly, a difference in levels, a sequence of privacy, and a sink for cleaning and sterilizing everything coming from outside.

5-Then come the priorities to confirm the usual desires of any person who lives in an apartment and the preferences that he seeks to have inside the building so that he can obtain the minimum level of health security in the apartment.

6-Details related to materials and surfaces whose role must be understood in reducing the number of people infected as a result of contact with a contaminated surface.

7- The answers of those interviewed show that all global trends and directions call for developing the design to be flexible and accommodate areas of remote treatment, remote work, and remote study. The arrangement also gives indications of the difficulty of quarantining some groups of society except in the apartment, such as mothers and people with special needs.

8-The theme of acoustics and sound insulation received the least votes, but the role of this theme cannot be underestimated, as some users expressed their fears when hearing the sound of others coughing and sneezing outside the apartment, which contributed to increase psychological pressures.

Table 7 Results priorities

priority		**point**
1	If a special space is provided for the infected person	47
2	A private bathroom for the infected	36
3	Access to sunlight is necessary for sterilization and cleaning	28
4	Striving to provide a planted and natural space to relieve the infected and non-infected inside the apartment contributes to raising morale	27
5	Providing a safe vertical corridor in terms of air quality linked to the isolation room	25
6	Attempts to take advantage of the external public entrance hall to provide ventilation, a place to play, or an outlet without compromising privacy	23
6	Providing an easily accessible natural scene	23
6	Feeling psychological pressure	23

7	Access to sunlight is necessary to raise immunity	21
8	Providing an initial containment area for the apartment	19
9	Attempts to contain pollutants - pathogens	18
9	Providing multiple balconies more than one	18
9	Providing more than one bathroom in the apartment	16
9	Avoid touching common surfaces as much as possible, such as handrails, elevator buttons, door handles...	16
9	It is difficult for mothers and some special cases to isolate themselves except within their apartments	16
9	Flexibility in using rooms and possibilities to change use	16
9	Lack of space for children- for play	16
10	Providing a private outdoor garden	15
11	Internal ventilated staircase	14
11	Reducing overcrowding inside the building	14
11	Spaces with opposing openings	14
11	Practice farming to obtain a natural scene	14
12	Increase areas	13
12	Natural ventilation	13
13	The use of ultraviolet rays, both natural and artificial, has an antimicrobial effect	12
14	Providing a general primary containment area	11
15	Use materials and surfaces that reduce the possibility of disease transmission	10
15	Primary storage area in apartment entrance	10
15	Use cleaning materials such as chlorine and wash hands with soap and water	10
15	Activating telehealth and telecare at apartment	10
16	Reducing humidity causing disease	9
16	Separate the infected person’s fluids, breathing, and waste from others	9
17	Using remote sensing and artificial intelligence in building and apartment facilities	8
17	Leaving the apartment due to fears of infection	8
18	Using surfaces easy to clean	7
18	Feeling afraid when one of the residents of the apartment is infected	7
19	Providing plants that purify the air	6
19	Stop HVAC systems	6
19	Providing regulations for managing residential buildings during pandemics	6
19	Primary storage area in the building as a whole	6
19	Surfaces self-cleaning	6
19	Using materials with specific specifications, such as low-emission materials that are free of formaldehyde and copper chromates, activating the role of clean precursor materials, materials that can be reused and can be recycled, and reducing lead and mercury.	6
19	Change the apartment for a natural scene	6

19	Feeling afraid when one of the residents of the building is infected	6
20	Fears of using the elevator	5
20	Gradation in spaces	5
20	Gradation privacy inside the apartment	5
20	Using surface less rough and smooth	5
21	Determine the width of the internal stairs at least 180 cm	4
21	Less ornate furniture and corners	4
21	Providing a guide for choosing surfaces and materials inside apartments and residential buildings reduces the spread of infectious diseases	4
21	Sound insulation between apartments and rooms	4
21	Insulation strategies - insulation materials - costal cluster -	4
21	Furniture and its influence	4
22	Open design	3
22	Providing space to receive purchases made remotely during periods of home confinement	3
22	Awareness regarding green cleaning	3
22	Awareness regarding infection prevention	3
23	Antibacterial surfaces	2
23	Anti-virus surfaces	2
23	Choose beautiful and comfortable surfaces	2
23	Self-cleaning materials	2
23	Sound insulation from outside to inside - components of the cover - following the standard	2
23	Design as sound insulation performance	2

4.3.1 Discussion for design relationship links according to themes

Figure 18 Discussion for design relationship shows the interconnection of the common relationships between the codes of the themes as attempt to find the modifications and interventions that are supposed to be necessary to create an immune apartment. Figure 19 Trends in interventions and solutions in research - an introduction to the next chapter shows the research direction that will be taken in this research to achieve the immune apartment.

4.3.1.1 Indoor Air Quality and Ventilation theme links:

- Recommendations for better ventilation for apartments are through enhancing passive ventilation, and mechanical systems must be stopped during the spread of infectious diseases, separating the

ventilation outlets for rooms, especially for the isolation room, periodic maintenance of filters, and activating the use of skylights.

- To ensure indoor air quality, a design must be provided that enhances the role of isolation and air movement, and the presence of air purifying plants.

- The presence of isolation areas in the apartment is important as a Mechanisms for fighting epidemics and living in a safer way. But with conditions, the most important is ensuring the flexibility of the space and the possibility of operating it only when it is needed, the cost of operating and setting up is low, and the most important thing is providing facilities for the room, such as its own bathroom.

- The movement of contaminated air with the breath and spray of the infected person can be controlled through atmospheric pressure.

- For ventilation during pandemic times, we rely on the speed of getting rid of air contaminated with infection, as we always take at least double or more than 15% more than the minimum required for ventilation. It is preferable to use cross-ventilation for the apartment as it is the fastest in renewing the air.

- Enhancing privacy in the design and reducing the occupancy rate is one of the most important methods used to reduce the possibility of infection within one apartment, as well as using open areas such as balconies and verandahs. The third method is to ensure that infection is not brought from outside by creating an initial containment station at the entrance to the apartment for initial storage and placement of luggage, and it is necessary to have a sink there.

4.3.1.2 Health and Safety Considerations theme links:

- Police and Hygiene must implement a binding protocol imposed by the Ministry of Health on residential apartments, and we should not limit ourselves with examining the presence of a septic tank. Because there are no laws and regulations for the Palestinian Ministry of Health to manage buildings during epidemics

- Prominent methods to prevent the spread of epidemics within built environments during the period of home confinement: personal cleanliness, good ventilation by using (Large window, External corridors, Open yard), Awareness, personal protection, masks,

- Safety rule: first Reducing social mixing, because it is more difficult to identify those who have been in contact with the infected person, Lack of awareness of isolation procedures, Shared facilities between all apartments pose a threat, second Creating distances between one person and another, Crowding increases the spread of disease faster.

- Problems encounter in combating epidemics in residential apartment buildings: same places shared between the residents of the building are all a cause of infection and spread of the disease, Exits are shared, and parking is shared handrails, shared sewage network, and shared facilities.

- Most prominent methods that have been adopted to confront these problems: A private room and special benefits for this room to contain illness, control and prevention, confine infected person fluids and breathing in a specific place, There is nothing better than water and soap to eliminate germs, but there are people who are advised to wear gloves and masks according to the patient's capabilities.

- The mechanisms that if the apartment was designed according to it would limit the spread of the epidemic or reduce its severity :Ways to reduce contact, levels of movement between the entrance and the apartment, creating space in the entrance for washing hands, an area for primary storage, distances between people, reducing the concentration of the virus and the number of copies that cause infection, activating the role of the emergency stairs to evacuate the infected and their movement.

- Regarding users' impressions, preferences, and feelings:

    - 20% of people did not care about the presence of a sick person in their apartment, and this led to an exacerbation of the infection, and the infection of members of the building with the disease, and this led to the infection and death of an individual with low immunity, while 80% were afraid for themselves and for their children from the idea of infection, and for their elderly relatives.

    - 90% of users expressed more fear in the event that one of the residents of the building becomes infected, especially among individuals who use shared facilities. Fears increased in the event of poor conditions in the facilities, such as poor lighting and ventilation, or weak policies towards crisis management by

apartment owners. Fears were linked to the personal behavior of the infected person.

- Users' behavior towards someone in the apartment being infected with a contagious disease: 10% found they did not care and continued life normally without procedures. 20% were unable to isolate themselves for reasons like not having prepared rooms or because they were the ones providing services to their family members. 70% isolated themselves or their patients in private rooms, but bathroom was shared and that kept infection fears.

- The most important problems faced by apartment users during the period of home confinement: lack of space for children to play, boredom, increase in free time, increase in problems between family members in the apartment, lack of space to exercise, poor sound insulation and hearing sneezing sick people in neighboring apartments.

- Methods that users followed to solve problems: Filling children's time with activities that do not require space, but this was not enough, 20%, and resorting to the space in front of the apartment to walk and change the atmosphere, 30%. Resorting to the balcony and sitting in it if available 30%. 20% were breaking the rules and going out to relieve stress, and this was due to the poor condition of the apartment.

- Preferences and things that the user wanted to have in the apartment to relieve the pressure of home confinement: A space in front of the apartment that has privacy and accommodates 40% games and sports. Additional bathroom belonging to the room: 40%. Separation between uses is 20%. A secure external staircase for the building 20%. Place for agriculture 30%. Store input 10%.

4.3.1.3 Space Planning and Layout theme links:

- It is necessary to emphasize the spatial gradient in the design of the apartment between the entrance station of the containment space, the high activity station, the low activity station for the bedrooms, and a wing parallel to the guest room, the proposed isolation room.
- The emergence of new spaces such as containment space and the distance learning and distance working room.

- Developing the work of the emergency stairs to create a safe path for medical personnel and users.
- Enabling voice technology and remote control in shared facilities
- Providing an isolation room with its own bathroom in each apartment
- Activating the role of the skylight to enhance cross-ventilation and extract air effects.
- Providing a vertical green space that serves as a medical garden within the apartment terraces.
- Providing a garden that creates a unique and new spatial outlet to provide an outdoor outlet that is compatible with periods of home confinement.
- With regard to shared facilities, activating sterilization mechanisms, using Wind Curtain, and creating reception areas for remote purchases and delivery.
- Providing large spaces between apartments and an internal staircase that receives sunlight and is well ventilated.
- Reducing shared services, the most important of which is the shared water well.

4.3.1.4 Lighting and Natural Elements theme links:

- In this matter, it is not enough to rely only on the results of the interviews, but rather literature reviews will be used to obtain an effective design.
- A specific percentage of greening for each apartment.
- Raising the patient's immunity, speeding recovery, and psychological health.
- Cultivation of building roofs.
- Raising the level of comfort and cleanliness.
- Raising morale and feeling happy.
- Fill free time.
- Prevent the appearance of mold and clean the indoor air atmosphere.
- Access to the natural landscape contributed to the speedy recovery of their patients.
- 100% of the sample is desired for cultivation, even on a small vertical surface, for medicinal herbs.

4.3.1.5 Material Selection and Surfaces theme links:

- In this matter, it is not enough to rely only on the results of the interviews, but rather literature reviews will be used to obtain an effective design.
- Smooth surfaces, easy to clean surfaces.
- low voc (volatile organic compounds).
- Environment friendly and health.
- Folding furniture.

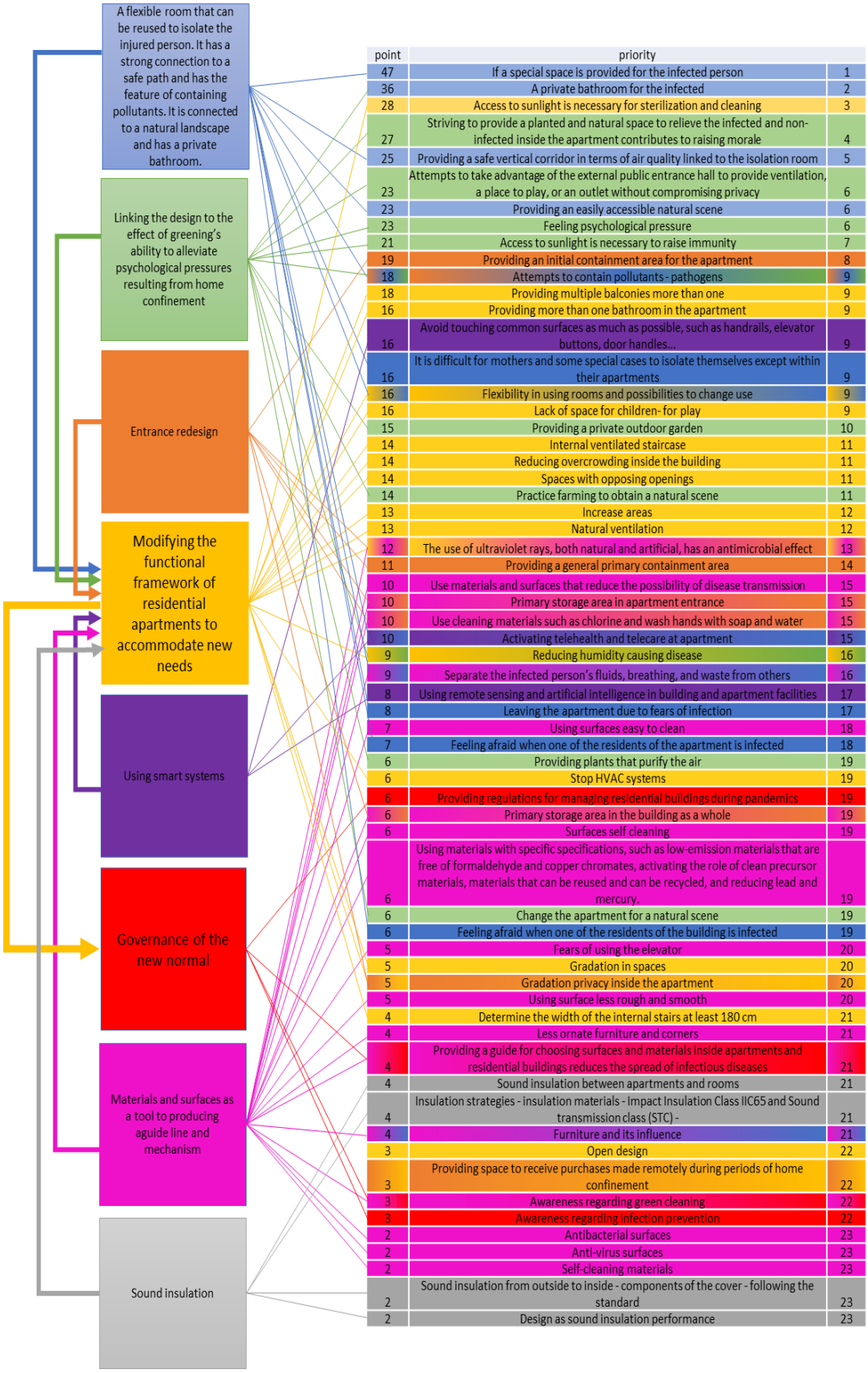
4.3.1.6 Acoustics and Noise Control theme links:

- In this matter, it is not enough to rely only on the results of the interviews, but rather literature reviews will be used to obtain an effective design.
- Sound insulation areas: insulation from the outside to the inside, insulation between apartments, and insulation within one apartment.
- Weak areas: doors, windows and openings: wall Construction: solid and well-insulated wall construction that helps to block out external noise. using materials with high Sound Transmission Class (STC) ratings to reduce noise transmission through walls. Window Design: Use double-glazed or laminated windows to minimize external noise infiltration. Proper sealing and weatherstripping around windows can also help reduce noise penetration. Floor Coverings: flooring materials that have noise-reducing properties, such as carpets, cork, or rubber flooring. These materials can absorb impact noise and reduce footfall noise between floors. Design of the building envelope to reduce noise entry. Proper insulation, filling gaps or cracks, and using noise-reducing materials can help create a more acoustically controlled environment.
- Sealed design: Room Layout Carefully plan the layout of living spaces, bedrooms, and common areas to minimize noise transfer. Place bedrooms away from noise sources, such as elevators, stairwells, or mechanical rooms. utilizing buffer spaces, such as closets or utility rooms, as a barrier between noise sources and living areas.
- Using Soundproofing Materials: Incorporate sound-absorbing materials in the construction of walls, floors, and ceilings to minimize the transmission of noise between units. This can include using materials such as acoustic insulation, double-layered drywall, and carpets or rugs with sound-dampening properties (Impact Insulation Class IIC65 and Sound transmission class (STC)).
- These themes contribute to improving sound insulation and its relationship to post-pandemic architecture, which is obtaining psychological comfort that contributes to raising immunity for apartment residents.

4.3.1.7 Universal Design and Accessibility theme links:

- There must be facilities for some special cases with special needs, and home isolation will be more appropriate because they are like mental or physical disabilities, require close care and service.
- Telemedicine, its role, and ways to employ it in fighting epidemics by working more comfortably, communicating by phone with patients, and overcoming the danger of the pandemic, specifically for medical personnel.

- It is necessary for the design to take into account the needs of children in order to be universal.
- Taking into account the needs of the elderly, specifically for security from infection and exposure to the risk of death resulting from their weak immunity, so it was necessary to provide isolation rooms within the boundaries of residential apartments.
- Many of them suffered from difficulty coping in hospitals and low morale. Providing isolation for them in their apartments, and by activating telehealth, recovery will be more guaranteed for their cases.



point	priority	
47	If a special space is provided for the infected person	1
36	A private bathroom for the infected	2
28	Access to sunlight is necessary for sterilization and cleaning	3
27	Striving to provide a planted and natural space to relieve the infected and non-infected inside the apartment contributes to raising morale	4
25	Providing a safe vertical corridor in terms of air quality linked to the isolation room	5
23	Attempts to take advantage of the external public entrance hall to provide ventilation, a place to play, or an outlet without compromising privacy	6
23	Providing an easily accessible natural scene	6
23	Feeling psychological pressure	6
21	Access to sunlight is necessary to raise immunity	7
19	Providing an initial containment area for the apartment	8
18	Attempts to contain pollutants - pathogens	9
18	Providing multiple balconies more than one	9
16	Providing more than one bathroom in the apartment	9
16	Avoid touching common surfaces as much as possible, such as handrails, elevator buttons, door handles...	9
16	It is difficult for mothers and some special cases to isolate themselves except within their apartments	9
16	Flexibility in using rooms and possibilities to change use	9
16	Lack of space for children- for play	9
15	Providing a private outdoor garden	10
14	Internal ventilated staircase	11
14	Reducing overcrowding inside the building	11
14	Spaces with opposing openings	11
14	Practice farming to obtain a natural scene	11
13	Increase areas	12
13	Natural ventilation	12
12	The use of ultraviolet rays, both natural and artificial, has an antimicrobial effect	13
11	Providing a general primary containment area	14
10	Use materials and surfaces that reduce the possibility of disease transmission	15
10	Primary storage area in apartment entrance	15
10	Use cleaning materials such as chlorine and wash hands with soap and water	15
10	Activating telehealth and telecare at apartment	15
9	Reducing humidity causing disease	16
9	Separate the infected person's fluids, breathing, and waste from others	16
8	Using remote sensing and artificial intelligence in building and apartment facilities	17
8	Leaving the apartment due to fears of infection	17
7	Using surfaces easy to clean	18
7	Feeling afraid when one of the residents of the apartment is infected	18
6	Providing plants that purify the air	19
6	Stop HVAC systems	19
6	Providing regulations for managing residential buildings during pandemics	19
6	Primary storage area in the building as a whole	19
6	Surfaces self cleaning	19
6	Using materials with specific specifications, such as low-emission materials that are free of formaldehyde and copper chromates, activating the role of clean precursor materials, materials that can be reused and can be recycled, and reducing lead and mercury.	19
6	Change the apartment for a natural scene	19
6	Feeling afraid when one of the residents of the building is infected	19
5	Fears of using the elevator	20
5	Gradation in spaces	20
5	Gradation privacy inside the apartment	20
5	Using surface less rough and smooth	20
4	Determine the width of the internal stairs at least 180 cm	21
4	Less ornate furniture and corners	21
4	Providing a guide for choosing surfaces and materials inside apartments and residential buildings reduces the spread of infectious diseases	21
4	Sound insulation between apartments and rooms	21
4	Insulation strategies - insulation materials - Impact Insulation Class IIC65 and Sound transmission class (STC) -	21
4	Furniture and its influence	21
3	Open design	22
3	Providing space to receive purchases made remotely during periods of home confinement	22
3	Awareness regarding green cleaning	22
3	Awareness regarding infection prevention	22
2	Antibacterial surfaces	23
2	Anti-virus surfaces	23
2	Self-cleaning materials	23
2	Sound insulation from outside to inside - components of the cover - following the standard	23
2	Design as sound insulation performance	23

Figure 18 Discussion for design relationship

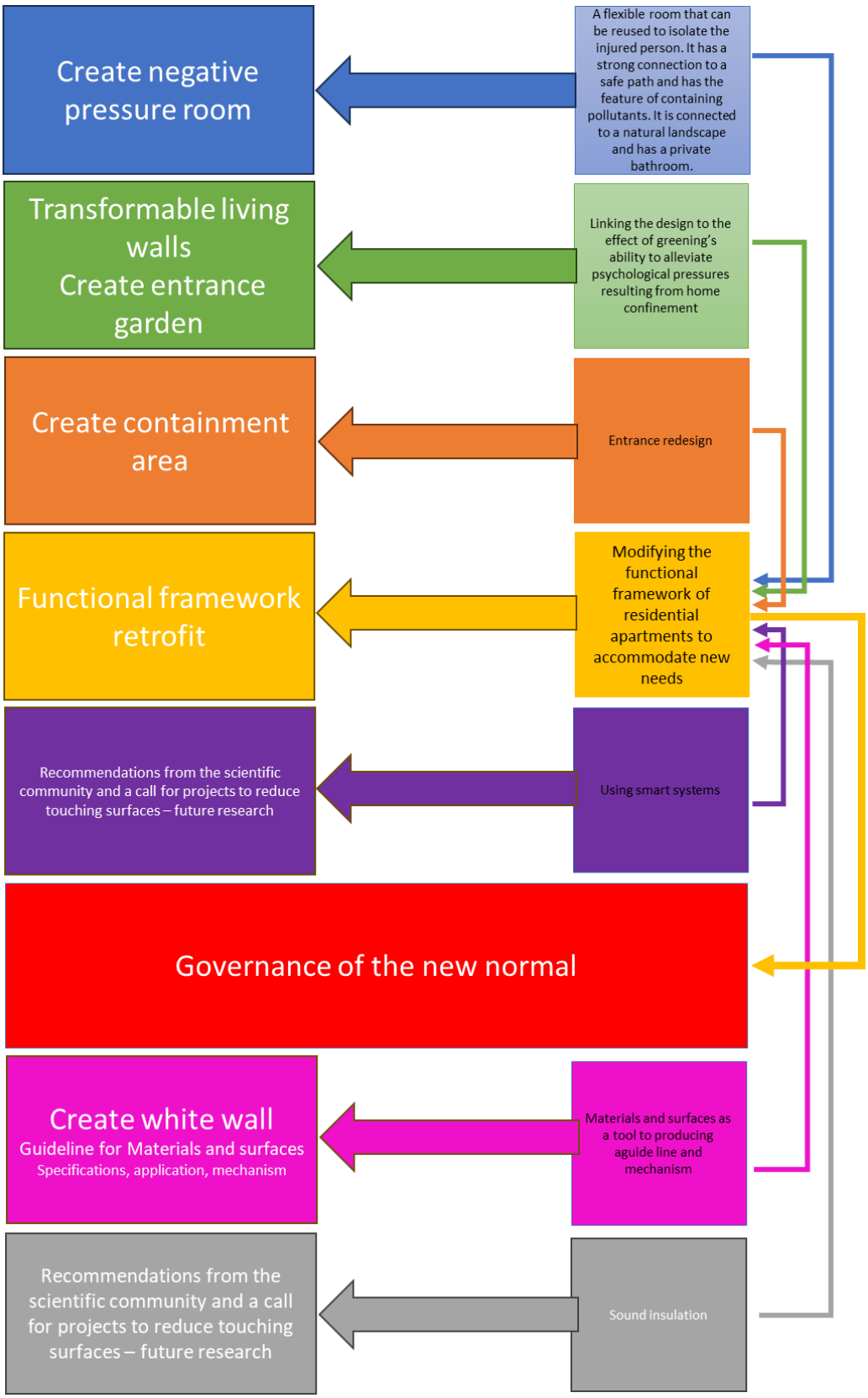
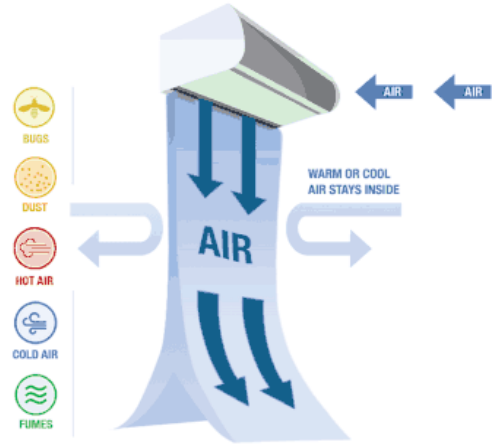


Figure 19 Trends in interventions and solutions in research - an introduction to the next chapter

4.3.2 Formulating the functional framework for the external and internal spaces of the apartments

Table 8 Proposed functional treatment for apartment spaces		
NO.	Space	Proposed functional treatment
Common areas used by the residents of the building		
1	Entrance lobby of the residential building	Installing wind curtain at entrances to prevent pathogens and other dust from entering the interior see Figure20 Wind curtain. Providing a storage area for online and delivery purchases A sterilization area for things and people, such as an Airlock (sas door) with strong contact with the outside Use a white wall to act as a trap for airborne pathogens see Figure 40 *W*hite  *Figure20 Wind curtain.*

		- Reducing surfaces and tools that are subject to frequent touching by residents and visitors by activating remote control and voice control technologies and using self-cleaning materials.
2	elevator	Reduce touching with hands
		Increase the speed of a single trip to reduce the possibility of infection
		Reduce the number of users at one time
		Making different doors for the same elevator, and this requires re-visioning the design to serve privacy
3	Internal stairs	Finishing materials and their design to be more in contact with the outdoors
		The width of the stairs is not less than 180 cm to ensure social distancing
		Natural lighting as much as possible, and natural ventilation
4	External stairs - emergency stairs	Treating it as a main staircase, therefore, its design must be in a location that creates a feeling of security for the user in terms of durability and location, as it will be the safe path for use by medical personnel and a path for the passage of infected people, and the safest stairway for use since it is outdoors.
5	Counter areas, cabinets and network hubs	Control of meters and storage in post-pandemic architecture must be automated and remote through phone applications that carry out operations remotely via phone, laptop, or a central device connected to sub-devices for each apartment.
6	Heating, air	Preventing shared units at the building level, and the system, if any, must be linked to one space

	conditioning and ventilation systems	within each apartment in cases of home isolation of the infected apartment
7	Mechanical systems (feeding and draining)	The apartment water supply network must be divided into two parts: First: The drinking and bathing water network, which must be in line with World Health Organization standards Second: The cleaning and sterilization water network must be in line with the previously mentioned standards, but with additions that are appropriate for private use, to add the recommended percentages of sterilizers.
8	The garage	It must be intended for residents only Enhancing the ventilation and lighting of this service
9	skylight	The role of the negative skylight will end and have an essential function in the process of sterilizing residential apartment rooms, as it will be the link that activates the proposed negative pressure system, through which the pipe will pass that works to empty the supposed isolation room of polluted air.
Inside the apartment		
10	entrance	1- Entrances - the containment area - must contain additional space for sterilization and cleaning (for people and things), for removing shoes and coats, washing hands, and receiving purchased materials. Many techniques can be used, and depending on the material, water and steam are possible. The entrance must also contain a hand washing basin, as studies have shown. To help

		prevent the spread of disease at the individual level, good hand washing is a critical component of controlling the spread of SARS-CoV-2, other coronaviruses, and many respiratory infections. (Leslie Dietz, 2020) 2- Modifying the space to accommodate a new function 3- This change is a revival of a custom that characterized buildings in the Far and Near East and in Islamic architecture, where the custom of taking off shoes before entering the house was and still is prevalent in many societies and is evident in mosques. 4- Finding a difference in levels between entrances, containment space, and exits.
11	Guests room	1- During the period of pandemics and the spread of infectious diseases, people avoid visits, if they are not sometimes prohibited due to measures to break the chain of infection. Therefore, the empty guest room becomes a candidate to be an Airborne infection isolation room (AIIR). 2- It must be attached to its own bathroom 3- Strong and direct communication with the escape stairway - the emergency - which will be the safe path 4- Strong connection with a natural landscape to enhance mental health 5- With the development of technology, the introduction of the concepts of remote work and distance education, electronic cities and the metaverse, and the strengthening of the concept of social distancing, all of this will inevitably affect the design of the guest room space, and its space will become much smaller, if it is not completely eliminated. It will be easy to communicate with others remotely via Internet, as such meetings will be less expensive and easy to access . 6- Converting part of this space into multiple places, such as a work office with a suitable background and equipped with the necessary equipment for remote communication. 7- Converting part of the guest room area into a place for distance learning for all levels. One of the consequences of this will be a reduction in the areas of school buildings, as courses and certificates are awarded through online meetings. This will lead to reducing the areas of many

		public buildings in general . 8- Part of this space was transformed into terraces, balconies, and verandas, as it will become safe for apartment residents to sit and work in the open air, as it has a more positive impact on mental and physical well-being, as the need to go outside the home will decrease. 9- All of this will have a positive impact on the external environment, as the consumption of fossil fuels will decrease and the use of transportation will decrease, and this will lead to a reduction in carbon dioxide emissions.
12	kitchen	1- Promoting the concept of cross-ventilation for the purpose of protecting against disease transmission in space design. 2- The relationship of the kitchen with the entrance is through a transitional space - the containment space - for sterilizing foods and purchases.
13	dining room	1- A strong connection to the natural landscape and the apartment's balconies.
14	Living room	1- The living space is separated from the rest of the spaces. 2- More contained, so that it is less open to other spaces and activities. 3- With a strong connection to an outdoor terrace or balcony, with the possibility of combining the two activities together to practice sports, for example in cases of home confinement.
15	bedroom	1- It is necessary that one of the rooms has a private bathroom. 2- It is necessary that at least one of the bedrooms be connected to an outdoor terrace or veranda to achieve a natural ventilation system to control the movement of wind and prevent the spread of infection. 3- The ventilation and air conditioning system for one of the rooms is isolated from the rest of the system to prevent the spread of infection through the droplets of the infected person.
16	Toilets and bathrooms	1- Users recommended that bathrooms to be far from bedrooms and that their privacy be respected. 2- There is more than one bathroom in one apartment to serve isolation cases.

		3- The use of technology in these spaces, specifically with regard to sterilization with ionizing radiation, ultraviolet radiation, and innovative materials treated with nanotechnology that clean themselves. Review the table of materials (Anna Rabajczyk, 2021).
17	Terraces, verandas and balconies	Most of the interviewees expressed a tendency to try opening the apartment door and exiting, even if it was to the space in front of the apartment. In this research, there is an attempt to nurture the user's desire to give his subconscious mind the experience of going out inside, and how to do that by making the entrance to the apartment a garden that has the privacy of being separate from the entrance. The stairs and elevator, especially in the apartment, are separated from the apartment by the apartment door. It is possible to review the model drawings to get a clearer idea. The experience of home confinement and social distancing has exacerbated the importance of providing this function within any residential apartment, and it is supposed to be considered one of the most important conditions for approving the granting of licenses for residential buildings, as it is 1- First, it contributes to provide a suitable space for making living walls. 2- Exploiting it to raise the indoor air quality of residential apartments. 3- Working to increase the readiness of residential buildings for any home quarantine process for the infected or home confinement for the uninfected during any upcoming pandemic. 4- Maintaining the mental and psychological safety of the isolation user during the quarantine. 5- Raising the level of human well-being. 6- Preserving the environment.
18	Loundary room	1- This area must have a strong connection with the entrance, unlike before, where the relationship was strong with the bedrooms. Here the actual determinant of the distribution of spaces and functions must be to prevent the transmission of viruses, diseases, and dirt from the external environment to the internal built environment. 2- Connecting the room to common sterilization systems for the entire building with regard to the

		buildings' water supply systems, which include special additives for washing, cleaning and sterilization away from the drinking water and bathing water network. The work surfaces around the sinks must be cleaned using a 10% bleach solution or a detergent solution containing alcohol on a regular basis. (Leslie Dietz, 2020) . Therefore, it is difficult for this water to be drinkable, and therefore it is necessary to separate the two systems.
19	Storage rooms	1- The importance of this area comes immediately after sterilization of food items in its own storage area which linked to the kitchen space. 2- Storage rooms for non-food items and linked to the washing room and sterilization areas. 3- The impact of shiftting to electronic commerce will have a strong impact on home space, as purchases will become more and the need for storage spaces will be greater.

In Table 9 Materials and functional solutions below are suggestions for including a set of proposed treatments for the design (materials and functional solutions)

Table 9 Materials and functional solutions

No.	Required strategy	Suggested solutions
	Systems that do not depend on touch, especially in elevators, stairs, entrances, and garages	It is possible to use applications on the smartphone related to remote control of opening the door of the elevator or entrance. Facial fingerprint recognition mechanisms for owners.
	Air quality	The focus is on building otientation with the movement of air, and this is through controlling the pressure or temperature of the air.

		Separating ventilation and air conditioning units and extensions between spaces and floors. Moving towards open spaces and designs with a strong connection with the outside in spaces of a social nature. Use green plant systems.
	Shared services and facilities	Reducing numbers by using design methods that maximize the privacy of each apartment, such as elevators that open from both directions. Strong connection with the outside through external stairs, secondly by increasing the proportion of openings, and thirdly by increasing the proportion of the balcony area. Ending the counter space at the entrance to buildings with multiple apartments. Providing a dedicated bathroom for every two bedrooms.
	Use finishing materials that are disease-resistant and self-cleaning	Use an antimicrobial polymer to finish the walls. Copper surfaces door handles and stair handrail handles. UV Lamps for Sterilization Spaces UVGI is safe if installed in mechanical ventilation ducts or in attic applications to indirectly treat air through convection air movement. (Leslie Dietz, 2020). Integrating steam sterilization equipment into ventilation and air conditioning installations.

		Nano Coating TiO2-ZnO-Ag Note the material table below.
	Adding new spaces for apartments and buildings	Adding delivery space and sterilization for packages and materials purchased online. Adding a primary space for each apartment that includes a cleaning and changing station for shoes and clothes. Adding space for working from within the home and space for distance learning. Finding spaces for multi-use balconies.
	Biofiltration technology	Plant technology that can absorb carbon dioxide, nitrogen dioxide and sulfur dioxide to filter the air. Green walls and microalgae structure are possible applications. (Naglaa A. Megahed, 2021).

In order to maximize the role of plants in improving the psychological state of the user of the built environment, it was necessary to study the precise effect of green cover for use in apartments on each of the environmental factors, which are: (indoor air quality, outdoor air quality, aesthetic aspects, acoustic comfort, visual comfort and reducing solar radiation, thermal comfort)

Environmental factors	**Environmental effect**	**Ref.**
Air quality	• Plants humidify and purify the air, which improves the air quality inside the space.	(Naglaa A.

	• It effectively contributes to reducing carbon dioxide in the atmosphere and increasing oxygen. • Plants are a technology that can absorb carbon dioxide, nitrogen dioxide and sulfur dioxide to filter the air.	Megahed, 2021)
Acoustic quality	Acoustic insulation of walls A thin layer of vegetation (20-30 cm) was able to provide an increase in sound insulation of 1 dB for traffic noise, and an isolation increase of between 2 dB (GW) for pink noise.	(Arpón, 2016)
View quality Daylight quality	Aesthetic view Provides visual comfort	(Browning, 2014)
Thermal quality	• It is considered an insulating layer and reduces temperature transfer between the inside and the outside and improves thermal comfort. • Reducing summer temperatures because the façade scatters rays. • Reduce maximum internal surface temperatures and increase minimum internal surface temperatures by up to 7°C; Alleviate heat transfer, reducing maximum input heat flux by 75% and maximum outlet heat flux by 60%; Strengthen the thermal insulation of the wall; Increasing the thermal delay between the outside and the inside. • A study of the thermal performance through facade orientation in summer conditions showed that significant temperature drops were obtained on the external walls, ranging from 17°C to 21.5°C in the GW. • Pilot studies in the winter indicated a promising effect on the radiation insulation during the night provided by the GW system for the building, which contributed to saving up to 4% of energy in a Mediterranean continental climate.	(Maria Manson, 2015) (Arpón, 2016)

Chapter 5

5 The Development of Apartment model

5.1 Preface

After the pandemic, the scientific community must correct architectural thinking towards housing. There is no doubt that planning will take a new direction towards outside the city instead of heading into the city, and this is a result of the shift to distance learning and remote work policies and the upcoming change in the form of people's sources of livelihood. It is inevitable that the trend towards multi-storey buildings will become futile over time at the long term, but this transformation will require time, and from now on, health problems must be addressed at the individual level and the built environment that resulted from the quarantine period for users.

The impact included the internal design mechanisms of buildings, the necessity of thinking about the immunity of buildings, and providing spaces for isolation and storage for sterilization and disinfection. Maximize the use of daylight and ventilation to reduce transmission of infection and move towards developing mechanisms to limit the spread of infection. The close connection with agriculture and nature will return, and this means heading to buildings that include a garden. Increasing technological development for remote communication with families, businesses, and tasks requires providing special spaces for this, and enhancing the principle of privacy in the design, As a result for reducing mixing to reduce infection.

This will lead us to the disappearance of empty guest room by time in the Palestinian society, and the shrinking of built environments such as schools and universities when shifting to e-learning. All that is need a smart screen, a connection to the internet, and government buildings will be less, where services which will be provided electronically, and Markets will also be diminished, as marketing and promotion will be via the internet and purchasing will become via the internet. Internet and purchase with home delivery via order. The emergence of telehealth and telemedicine, the enhancement of their use, and the increase in their popularity among health and medical care departments and recipients of health services will have an impact on the

built environment in which these services are provided and received. The form of this effect must initially appear in the spaces used (areas). All these indicators lead us to the fact that the only space that is heading toward expansion is the built environment for residential purposes.

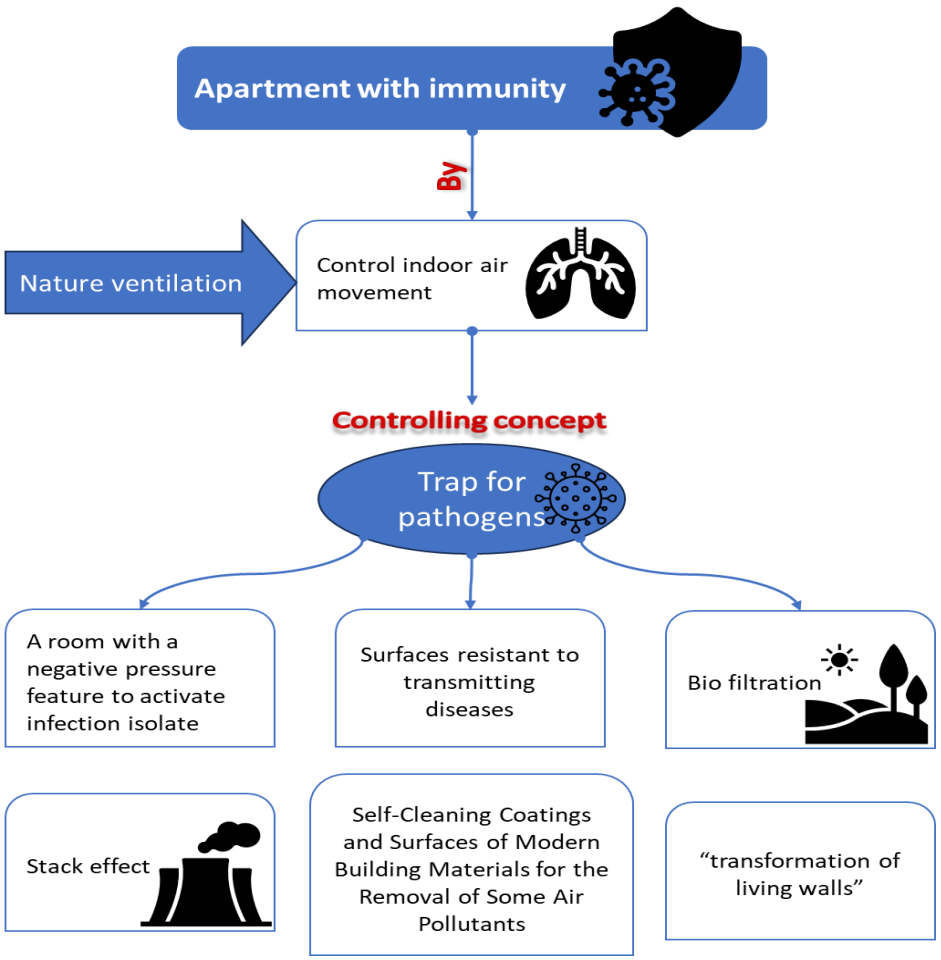


Figure 21 Solutions approach.

Researcher,2023

5.2 Residential apartment buildings are immune to disease transmission.

In biology, immunity is the state of being insusceptible or resistant to a noxious agent or process, especially a pathogen or infectious disease. Immunity may occur naturally or be produced by prior exposure or immunization. (wikipedia, 2023). In this model prepared according to the results of the thematic analysis of the interviews, the fortification mechanisms that will be included in this chapter were reached and are based on the first four tools: functional retrofit, the negative pressure tool, the materials and surfaces tool, and the tool for employing green cover to improve health.

5.3 Model specifications.

Basics have been developed to define the specifications of the **imaginary model**, including applications, modifications, and suggestions resulting from the interviews conducted and analyzed in the previous sections. This model will be addressed as a specific case in terms of orientation and as a general case in terms of organization, functions, and reconfiguration of the apartment and the possibility of generalizing the designed green wall, the white wall, and the isolation room, where a specific air working mechanism must be applied. Future research is needed to generalize the findings regarding orientations differences.

The following points describe the generalities of the model and a description of the general location:

1- Adopting the location in Hebron for the reasons previously mentioned in Methodology Chapter 3.5, in addition to the fact that when distributing the number of apartments across the governorates of Palestine, and the largest number is concentrated in Hebron Governorate; The number of apartments reached 62,950 apartment.

2- The building specifications consist of two apartments on each floor, which is prevalent in Hebron area and most in demand

4- The number of floors and building specifications were determined based on the organizational use of Housing A according to the master plan of the chosen site and adherence to the Palestinian building system.
5- The design adopts passive design strategies.

project sustainability triple bottom line:

Table 10 Triple bottom line

project sustainability (triple bottom line)	Social aspect	• Building immunity: Providing buildings with immunity. against disease transmission. • urban compactness. • Providing a private medical garden for each apartment. • Private open space for apartments. • Winter garden and summer garden. • Sunlight and daylight comfort. • Air quality and comfort. • Preparing the building for future needs such as the containment space, the space for receiving remote purchases, and primary sterilization entrances.
	Environmental impact	• Reducing the spread of infectious diseases - raising indoor air quality. • No home heating. • Passive solar heating. • photovoltaic energy. • Improve the environmental value of the site. • Land as a finite resource. • Vertical green cover .
	Economical effect	• Housing related construction costs. • affordable housing. • High demand for special sale items. • Planning gains to add development value. • Reducing electricity poverty. • Low operational energy bills.

5.3.1 Functional retrofit as a tool

This section is based on the results of the two sections 4.2+ 4.3

Talking about residential apartments is talking about expensive space. One of the most important design specifications is flexibility, as increasing the space may not be an available option as much as working to adapt and change the space to suit the needs of the stage.

After considering the different aspects of external and internal adaptation, architects are supposed to provide flexible designs and multi-use spaces. Taking into account information and communications technology to create different types of virtual places (Elrahman, 2020).

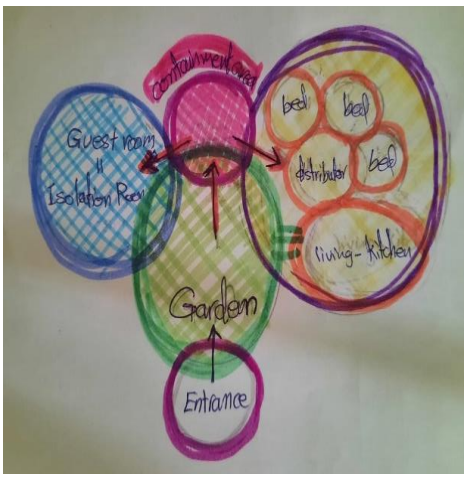
As a result of interviews with the relevant authorities, it became clear that when carrying out an architectural design for architectural apartments after the epidemic or during the epidemic, some functional modifications must be made to them so that the buildings are safer for the health of their users, as the apartments must be flexible enough for cases of home isolation and cases of prolonged confinement which it may not be short. The results were presented in table form for the uses that were prevalent before the pandemic, and the result will be placed next to its own space in the in the table 9 below. Look at Table 11 Spaces and Response form- Architectural design response.

After considering different aspects of external and internal adaptability, architects are supposed to provide flexible designs and multi-use spaces. Taking into account ICT to create different assumed types of places.

To develop the conceptual design, basic points were adopted, the most important of which are entry through a garden and the functional relationships between the apartment's activities according to the degree of threat from the outside to transmit infection and developing a bubble plan to determine the relationships and functional distribution of the apartment's rooms.

Entry to the apartment through the garden

The garden with Direct connection to containment space has two directions for circulation. The first lead to the isolation room in case of injury as visual connection, which in the normal situation is a guest room, the room with flexible furniture that is easy to transform.



The second leads to the living room and kitchen.

Residential floors are identical, with some minor changes. Every floor plan contains two apartments, each apartment can accommodate a minimum of six people.

One of the design features is the living space, the kitchen and the dining area got four orientations and has the possibility of connecting with two gardens, summer, and winter garden.

The staircase is being opened at the height of the building is continuous, and the feature of wind catcher has been activated to renew the air and increase its movement during summer days, as these openings are equipped with a valve that can be opened and closed.

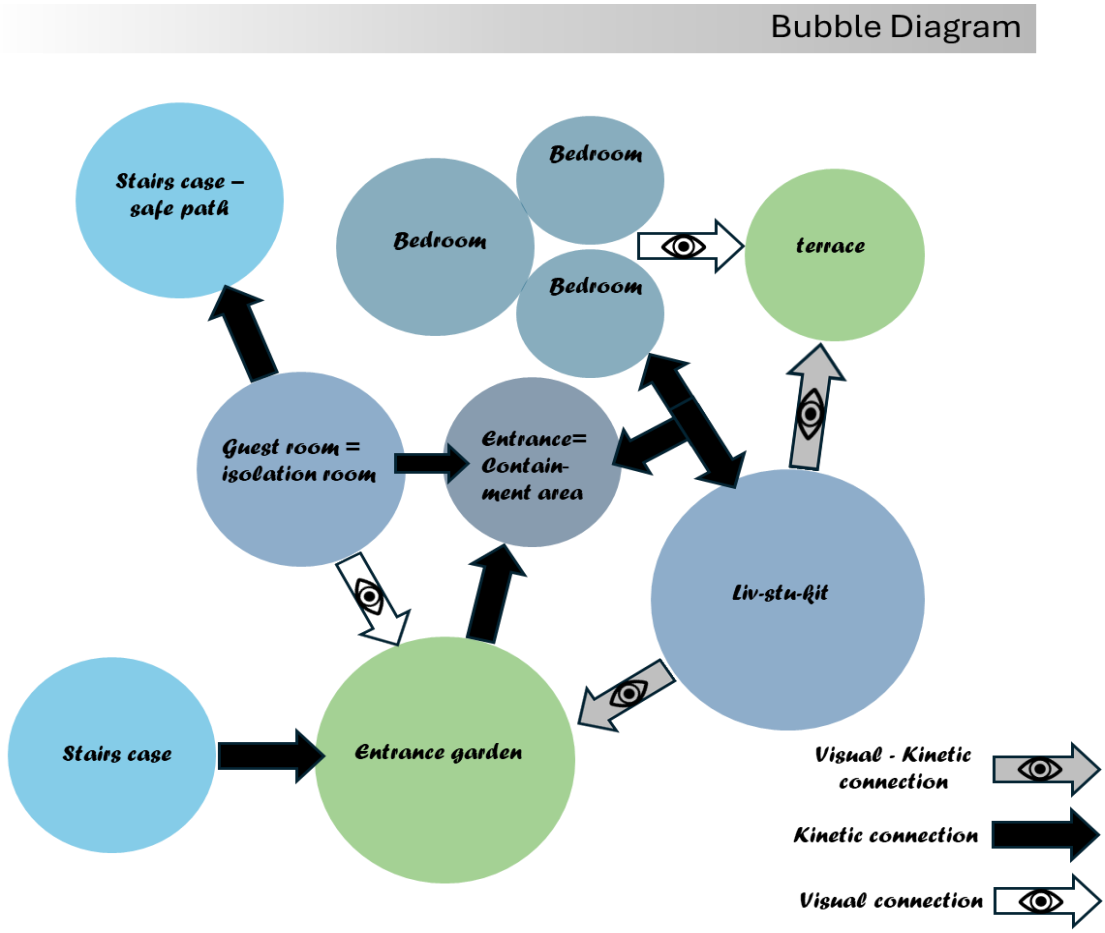


Figure 22 Bubble diagram

The above diagram shows the relationships that were deduced from discussing the opinions of those interviewed according to priorities and the attempt to cover needs within one apartment. Where the beginning of the diagram is shown from the left first interior staircase (bottom of

the diagram) and the second (top of the diagram), the escape staircase, which the research called the safe path because of its connection to the isolation room, which is the guest room.

The apartment is entered through a garden containing a transformable living wall, and the first space that meets you after the garden is the containment area, which includes a primary storeroom and a sink, and then to the right, the opened design for morning activities linked to another balcony. There is a distributor leading to the bedrooms, and all of these are separated by levels to maintain cleanliness.

To the left of the guest room with its bathroom, which is the negative pressure room designated for isolation during the pandemic, that is visually connected to the outdoor garden.

Figure 23 The repeated plan of the proposed imaginary design.

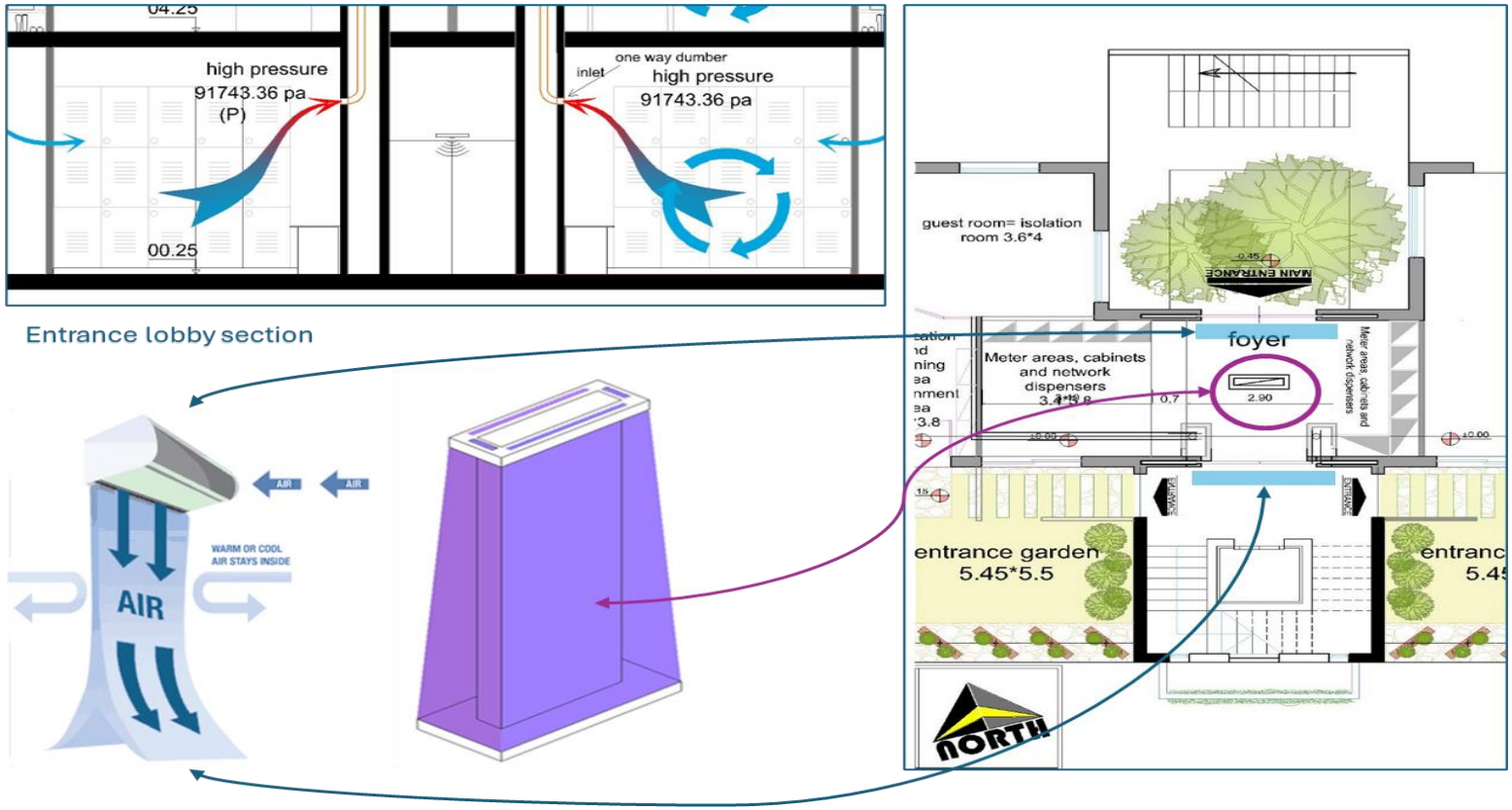
Table 11 Spaces and Response form- Architectural design response		
No.	Space	Response form- Architectural design response (For details regarding the design justifications, see Table 8 Proposed functional treatment for apartment spaces)
1	Entrance lobby of the residential building	

Figure 24 Entrance lobby details

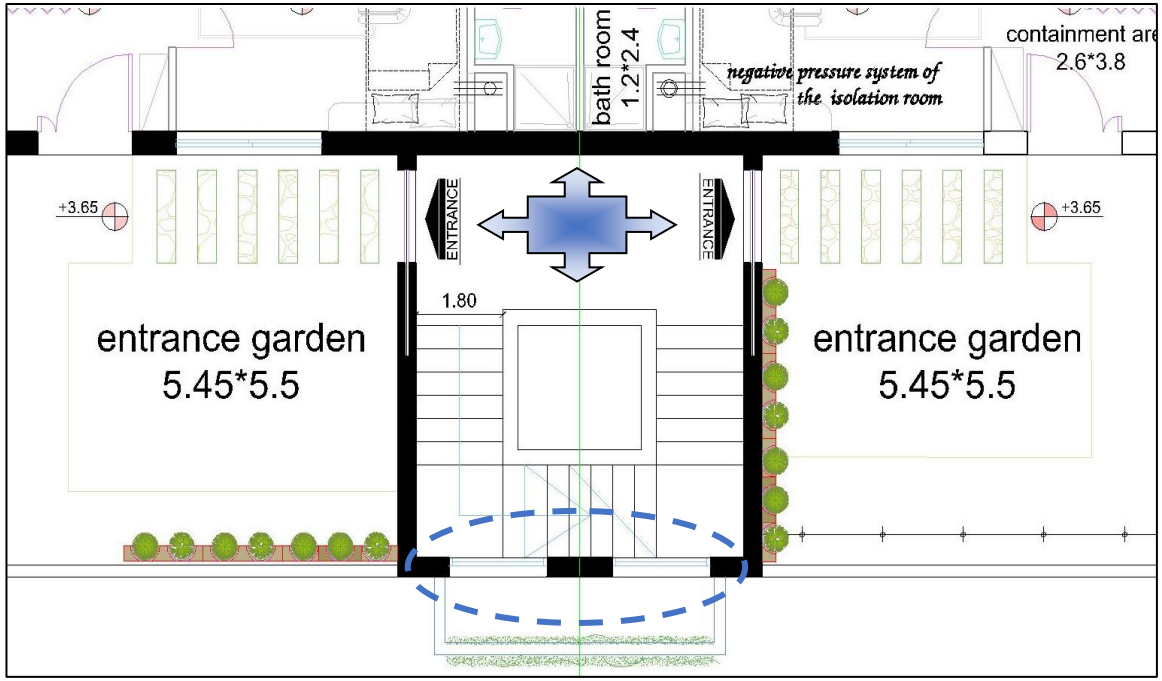
2	Internal stairs	

Figure 25 Internal stairs nature lighting

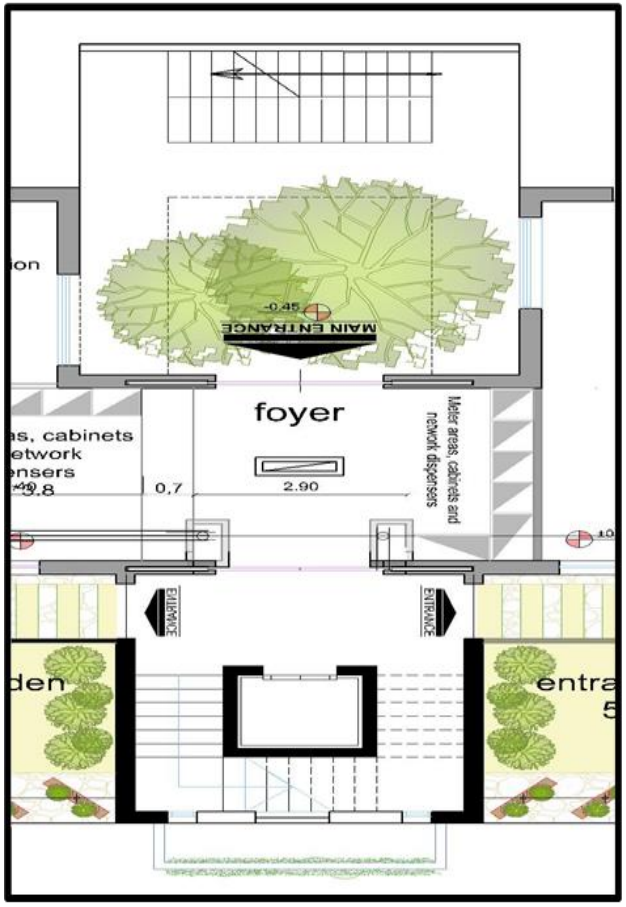
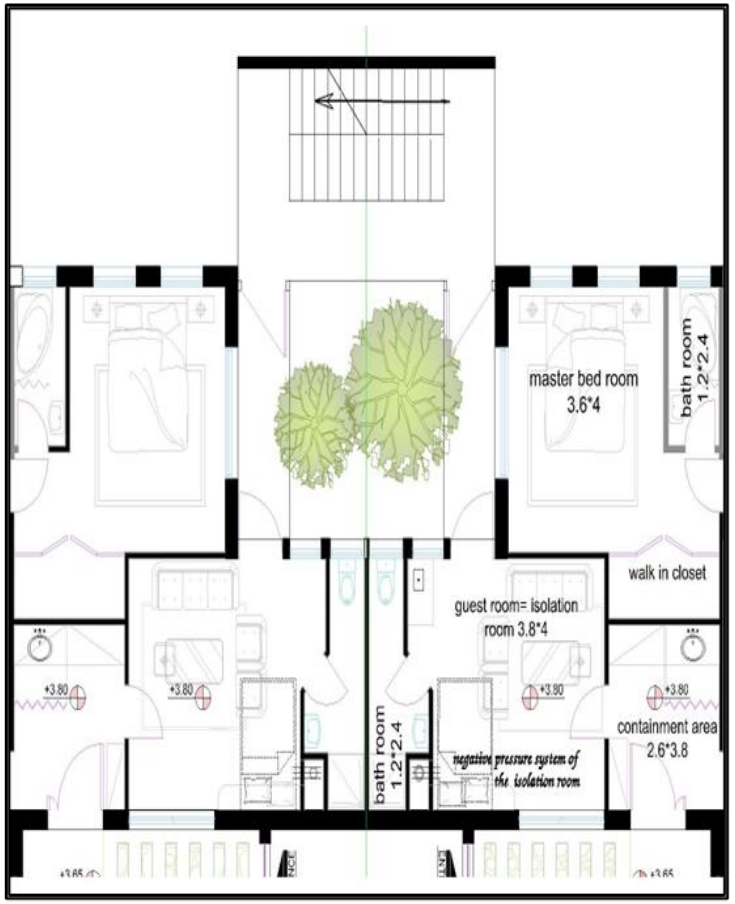
3	External stairs - emergency stairs- safe path	 External stairs –ground floor  External stairs –first floor

Figure 26 Safe path plans

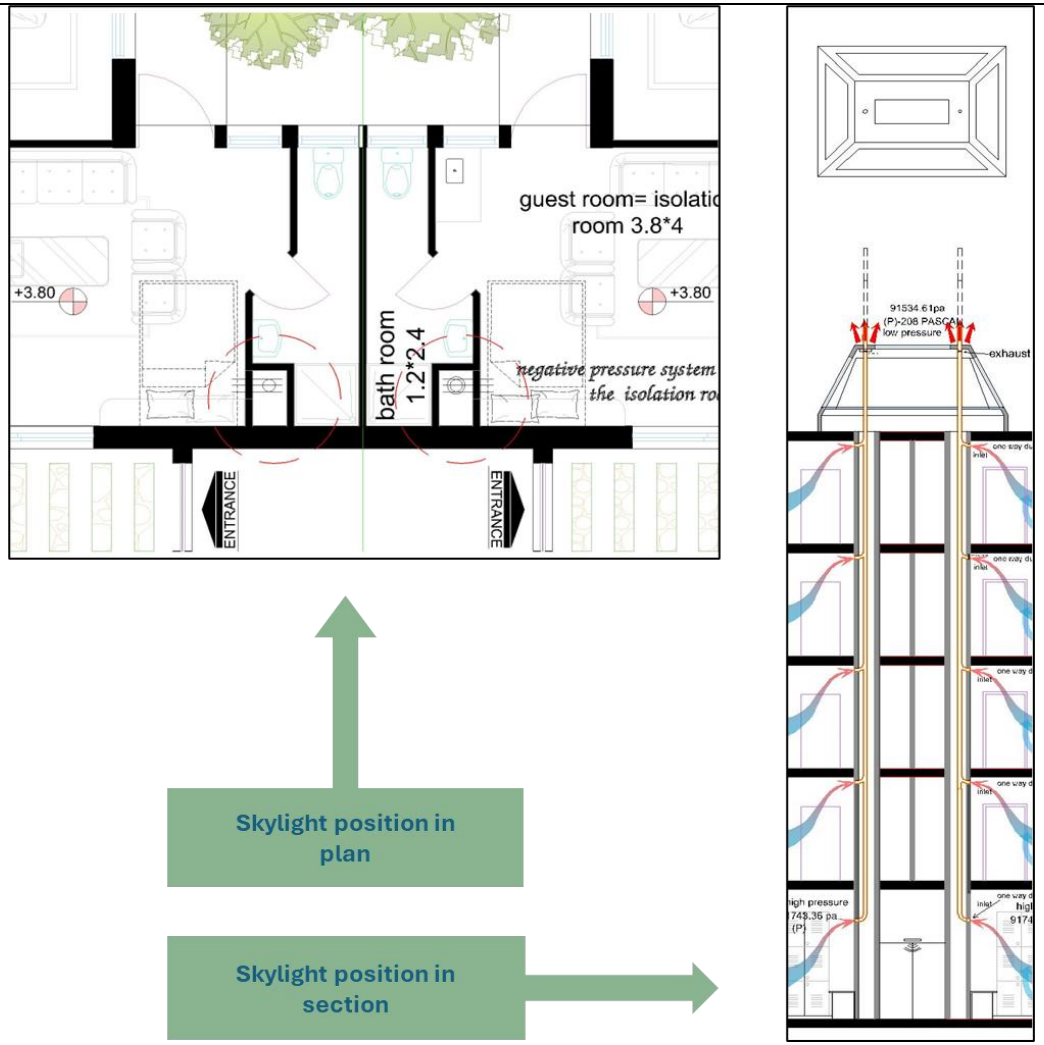
4	skylight	

Figure 27 Skylight details

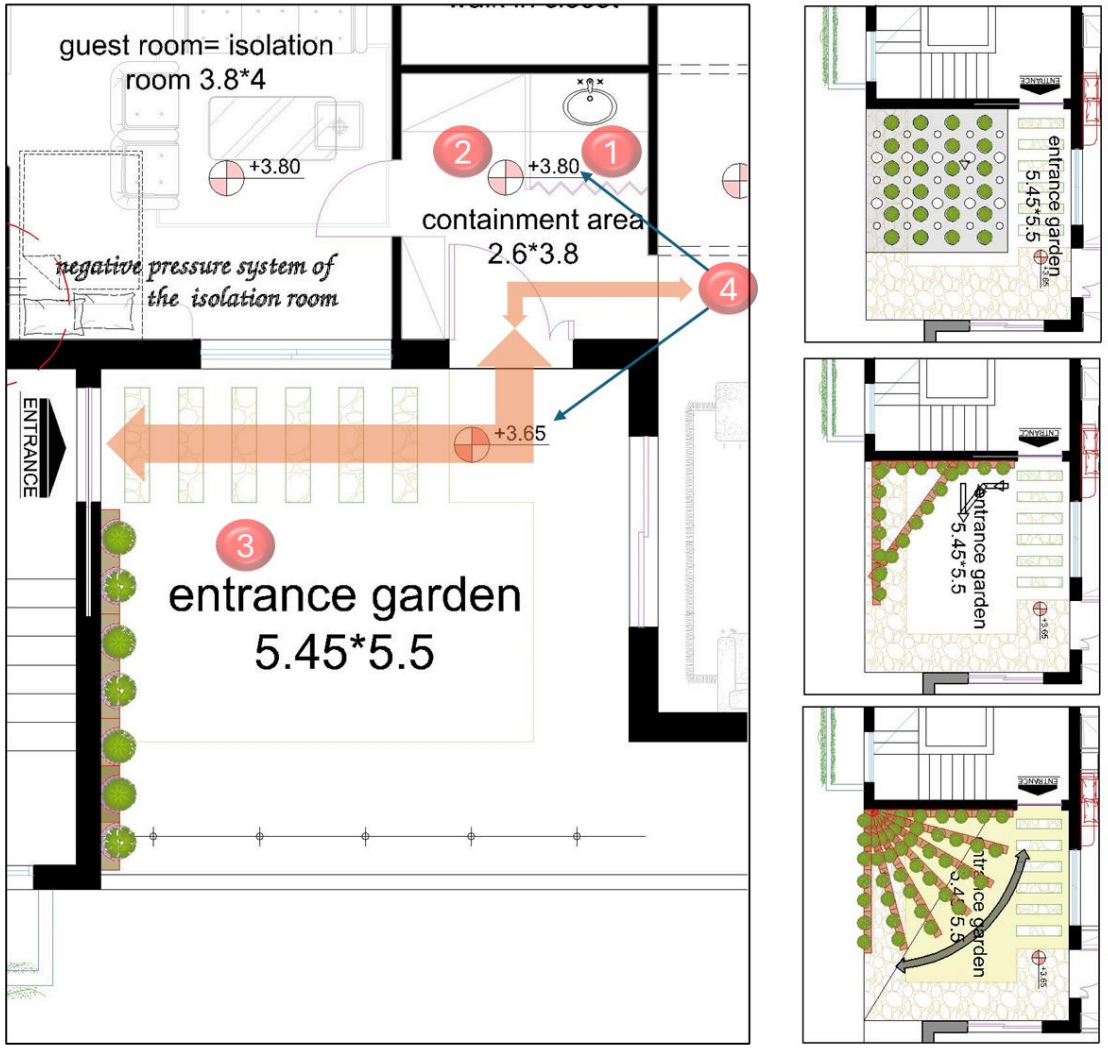
5	Apartment entrance	

Figure 28 Apartment entrance design

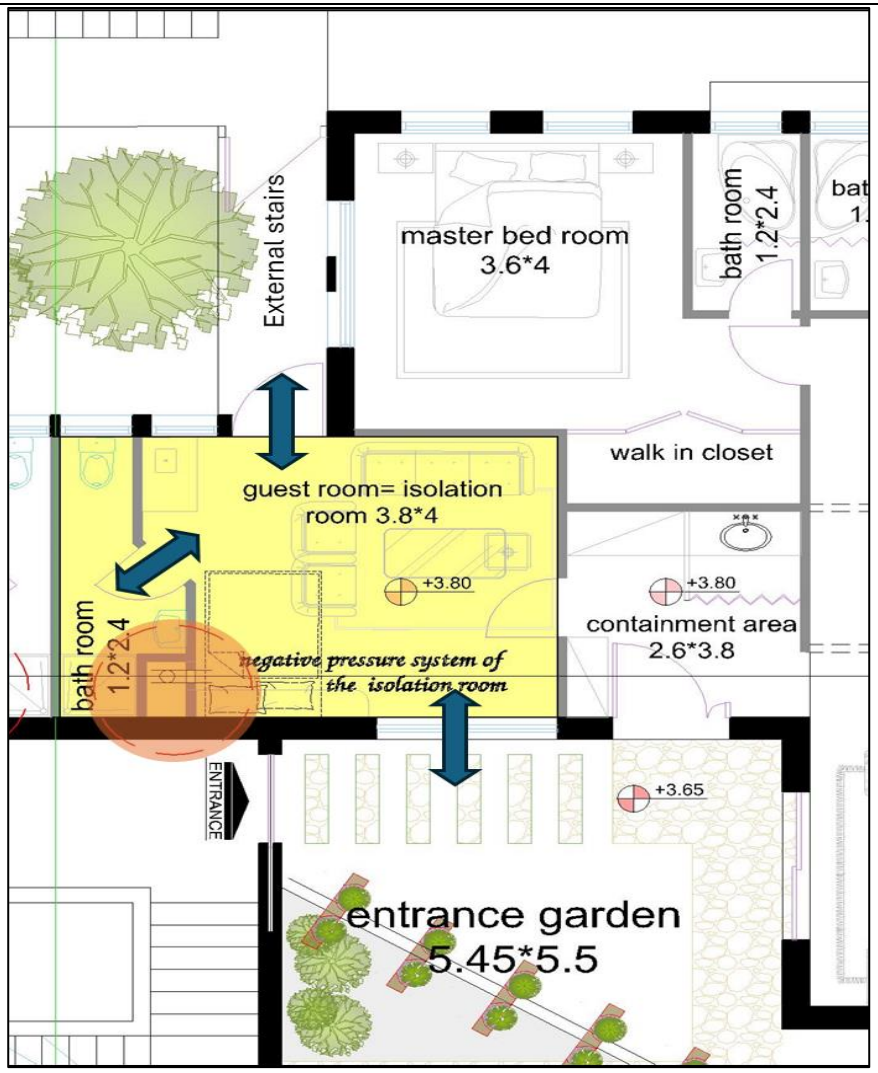
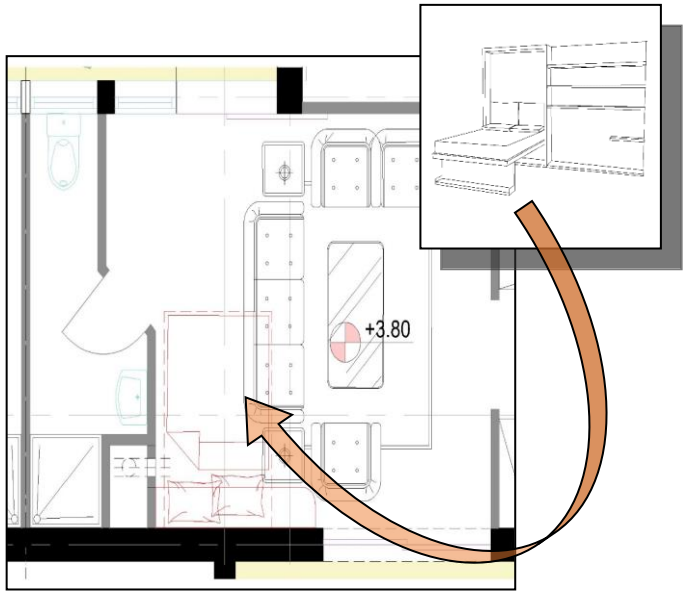
6	Guests room- proposed isolation room – negative pressure room	  Folding bed: One of the features of the isolation room is that guests furniture is taken aside, the foldable bed is opened to make the room for the patient.

Figure 29 Plane for negative pressure room

7	kitchen	
8	dining room	
9	Living room	

Figure 30 Kitchen, living, study, and dining area

bedroom

Figure 31 Bedrooms area

5.3.2 Negative pressure room as a tool

Airborne infection isolation room (AIIR). Also known as a negative pressure isolation room, an AIIR is an individual patient care room used to isolate people with a suspected or confirmed airborne infectious disease. Environmental factors in AIIRs are controlled to minimize transmission of infectious agents that are typically transmitted from person to person via droplet nuclei associated with coughing or splashes of contaminated fluids.

Negative pressure rooms are used globally in health facilities, AIIR devices must provide negative pressure in the room (so that air flows down the door gap into the room); and air flow rate 6-12 ACH (6 ACH for existing structures, 12 ACH for new construction or renovation); and direct exhaust of air from the room to the outside of the building or recirculation of air through a HEPA filter before being recirculated (CDC, 2015) AII rooms should remain under negative pressure relative to all adjoining rooms whenever an infectious patient is present. They should be tested for negative pressure daily whenever an infectious patient is present (Ashrae, 2020).

The negative pressure strategy was used in isolation departments in hospitals, and it was not used in residential apartments. This is for several reasons, including the high costs of producing a negative pressure system, as it requires a tight mechanical system. Also, there was no urgent need to create this service since it was not a situation similar to that of the Corona pandemic. The negative pressure system depends on producing low pressure inside a room compared to the surrounding spaces, which leads to controlling the movement of air, as the movement will be from areas of high pressure to low pressure. According to ASHRAE/ASHE

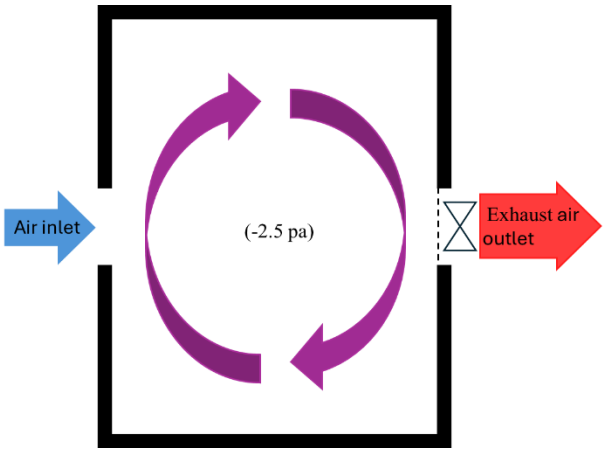


Figure 32 Negative pressure room concept

Standard 170-2017, Ventilation of Healthcare Facilities, the pressure difference required to maintain negative pressure is a minimum of 2.5 Pa. (Cho, et al., 2019)

Engineering controls required for isolation rooms.

1- Maintain a constant negative pressure (-2.5 pa) relative to the air pressure in the corridor. Monitor periodically using a pressure gauge, smoke tubes, or flutter strips.
2- Ensure that rooms are closed well.
3- Install self-closing devices on all isolation room doors.
4- Provide adequate ventilation to ensure ≥12 ACH for new or renovated rooms and ≥6 ACH for existing AII rooms.
5- Direct the exhaust air outward, away from the intake area and populated areas. If this is not practical, the air may be recirculated after passing through a HEPA filter.

Abbreviations: ACH, air changes per hour; AII, airborne infection isolation; HEPA, high-efficiency particulate air. (Hill, 2020)

Suggested model:

The proposed model for controlling pressure inside the apartment will depend on the presence of two elements connected to the room to be isolated, as it must contain an air inlet and an air outlet. The air outlet will be **a pipe** added to the apartment connected vertically through **the skylight** to create a pressure difference based on the height difference of the air column between the pipe entrance (inside the room) and its outlet where the pressure is lower (on top of the roof of the building), which leads for drawing air from inside the room to Outside the apartment. The pipe at its entrance into the supposed isolation room must be connected **to a regulating valve** to control when the system is operated. Based on the opinion of the mechanical systems expert, the system will be effective.

Atmospheric pressure decreases at a rate of 1 hectopascal (i.e. 100 Pascals) whenever we rise 8 meters above the surface of the earth. Most residential apartment buildings consist of at least 5 floors, each of which is not less than 3 meters high, in addition to the presence of a warehouse floor, them may reach a height of approximately 4 meters, i.e. a lower rate of height. A residential building reaches 20 meters according to the Palestinian building system, meaning there is a pressure difference of up to 250 Pascals.

On the roof of the multi-apartment building and at the outlet of the pressure pipes, a

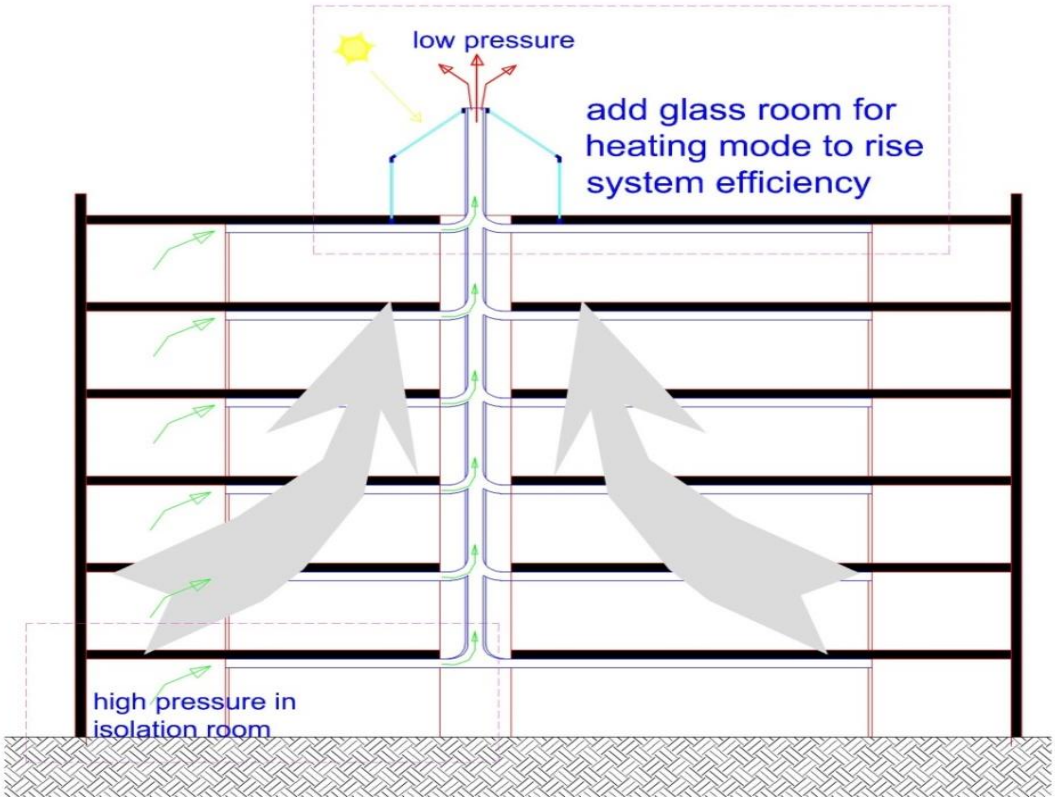


Figure 33 Air movement according to pressure difference

heating chamber will be placed to strengthen the system, especially for the upper apartments, where the pipes will heat up and thus heat the air that passing through them so the air will rise upward due to its decreased density, subsequently the pipes

will work in an additional stage as a suction for air from the lower areas. The heating chamber enhances the system through two functions:

1- Working to increase the temperature of the suction pipes, which heats the air, that reduces its density, so the air rises upward, in addition to the effectiveness of the difference in atmospheric pressure between the gaps of the insulation crest and the surface.

2- Coating the surface of the room with titanium oxide, since it is constantly exposed to light, it works through the photocatalytic process to reduce, obstruct and eliminate pathogens emerging from the pipes.

The ends of system pipes passing through the skylight are terminated by a movable elbow equipped with a wing (wind vane) that directs the opening in the direction of the wind path to prevent air from returning. See Figure *34 T*he end of pipe

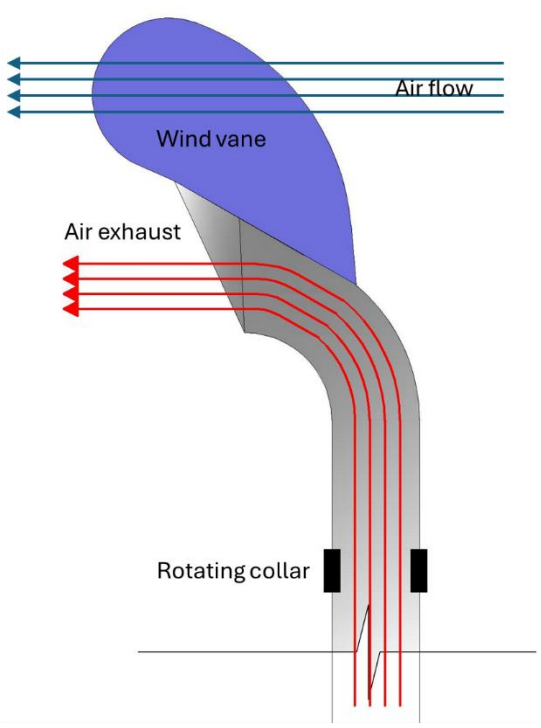


Figure 34 The end of pipe

The height of the imaginary model above sea level is 830 m (geomolg, 2024) and the pressure average for this site at 15°C is 91743.36 Pascals.

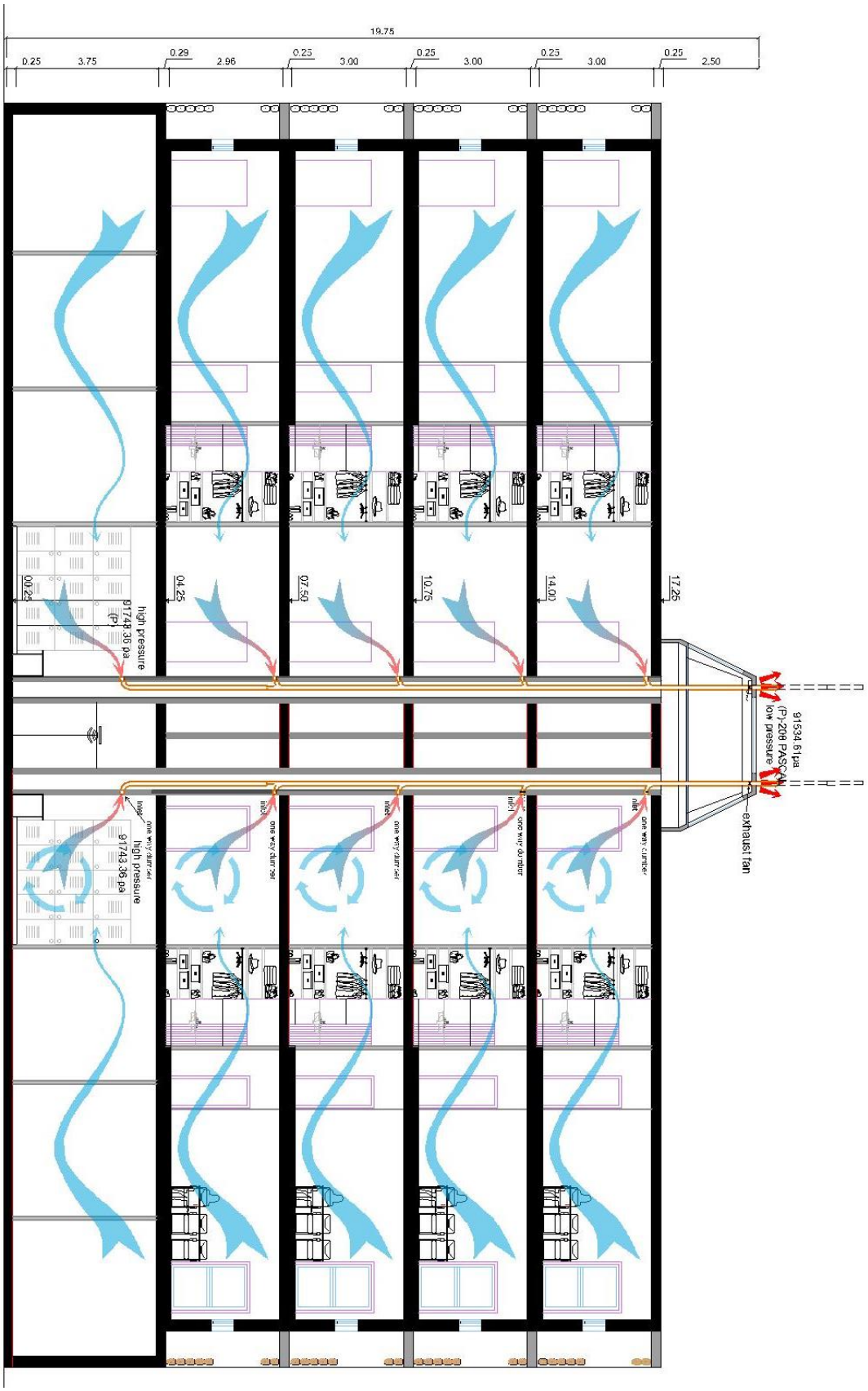


Figure35 Section of the negative pressure room along the building

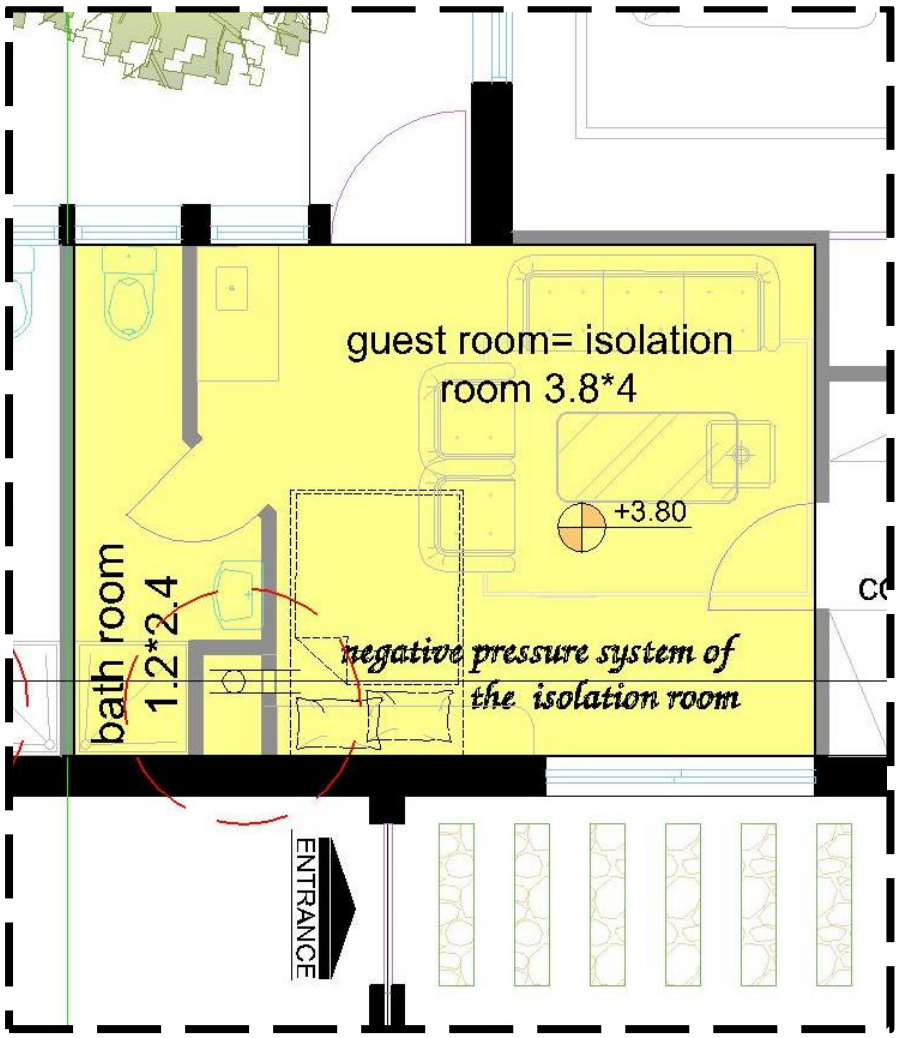


Figure 36 Negative pressure room plan

Fresh Air Supply to room equation: (how to calculate):

$q = n V$ (1)

where:

q = fresh air supply (ft3/h, m3/h)

n = air change rate (h-1)

V = volume of room (ft3, m3)

Air Change Out Frequency in minutes.

The "Air Change Out Frequency" in minutes can be calculated as

nm = 60 / n (2)

where:

nm = Air Change Out Frequency (minutes)

to find the r for pipe:

q= speed(m/s) *area(m2) (3)

Basically, at the beginning of the negative pressure pipe, **a damper** will be placed that controls the system on or off and is used as a simple air flow control device. It will also be used for fire protection to prevent the return of smoke, and it also has an important role in preventing the return air if it returns through the pipe. The system must be equipped with fire **dampers**, which are passive safety systems that prevent the spread of fire, heat, and smoke to different areas. It is one-way, allowing entry and exit.

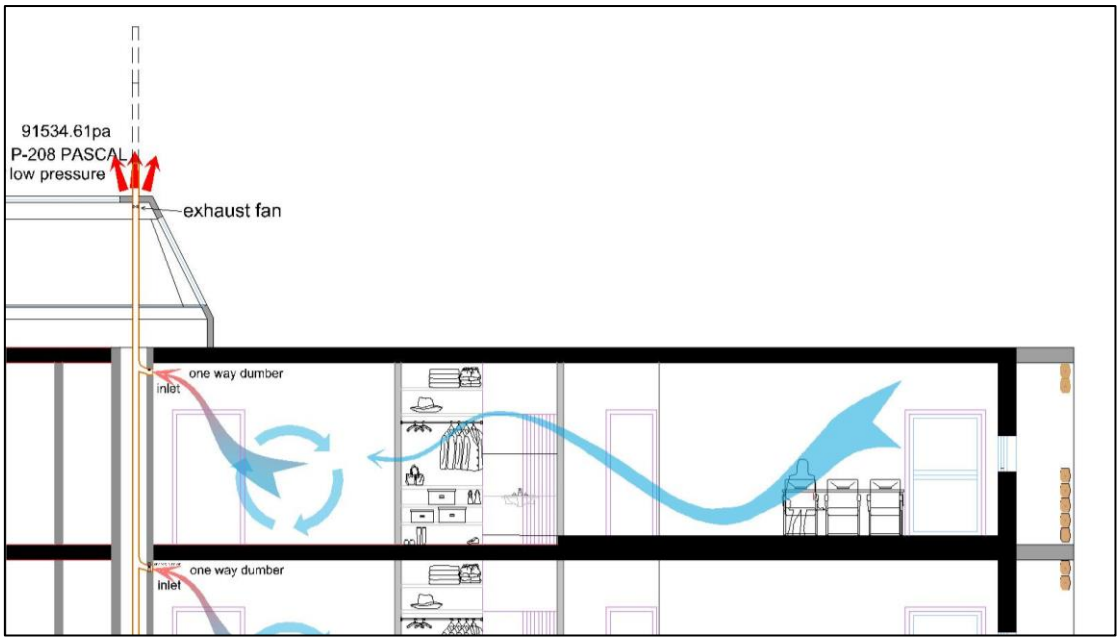


Figure 37 The end of the system on the roof

For emergency situations, to increase the effectiveness of the system, it is provided with a exhaust fan at the end of the system, which can be operated if the pressure difference is insufficient in winter.

Inside the room, **electric locks** will be placed on the windows. Their operation is linked to **indicators to measure carbon dioxide and indoor air quality.** They work when the system is activated to regulate the entry of air into the room by opening the locks until the air quality is adjusted and closing them automatically.

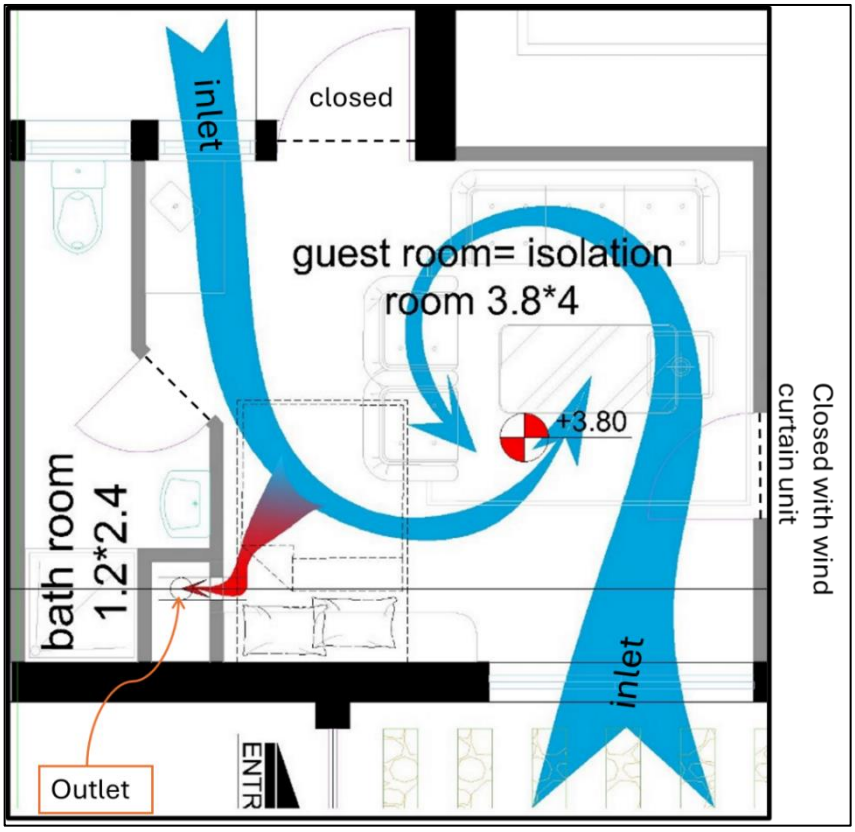


Figure 38 Air behavior in the room

5.3.3 Materials and surfaces as a tool

The choice of materials in terms of type, shape, and texture will now receive greater attention, as technological development and the introduction of nanotechnology have given wider options for selecting finishing materials that may contribute to reduce the transmission of disease and infection, or antibacterial, self-cleaning, and the use of sterile rays. The researchers believe that post-epidemic engineering may apply more cleaning strategies based on new technologies. To implement a technology-driven strategy, take into account other potential risks associated with nanomaterials (Megahed, 2013).

Superhydrophobic/super oleophobic and self-cleaning surfaces have a great opportunity to contribute to the protection of sanitary facilities and can be used in the proposed sanitary isolation room in the apartment. Oleophobic surfaces have the ability to self-clean and resist fouling from biological and organic contaminants in both aerial and underwater applications (Bhushan, 2009). Superhydrophobic surfaces play a role in combating microbial contamination involving fungi, bacteria and viruses, especially during the global COVID-19 pandemic (Yuxiang Chen, 2023).

Based on the results of literature reviews and the interviews, it was found that choosing the appropriate materials and surfaces can contribute significantly is reducing the transmission of infection within the apartment and between apartments. The specifications can be summarized as follows:

1- Non-porous.
2- Easy to clean.
3- Anti-microbial surfaces such as copper
4- Smooth and seamless surfaces
5- Have resistance to chemicals so that they can withstand frequent cleaning
6- Easy-to-maintain floors.
7- Washable fabrics, specifically high-touch surfaces, pay attention to choosing their components from self-cleaning materials, and adopt photocatalytic techniques and antimicrobial coatings.
8- Humidity-resistant materials in moisture-prone areas, such as bathrooms and kitchens, to prevent mold and mildew growth, maximize natural lighting, incorporate biophilic design principles by incorporating elements of nature, Efficient waste management.
9- The materials must be sustainable, recyclable, manufacturable, and low emission.
10- Employing surfaces materials based on their effectiveness, longevity, and durability, evaluating the safety and potential environmental impact of the materials used, and integrating them with other preventive strategies such as regular cleaning and disinfection, hand hygiene, proper ventilation, and adherence

to health guidelines. General, regular maintenance to ensure optimal performance, are best suited to high touch surfaces.

11- The contribution of materials to improve indoor air quality. Natural, non-toxic materials such as natural fiber carpets, linoleum, bamboo, or cork flooring, which emit fewer chemicals compared to traditional synthetic materials. Use sustainable and renewable materials such as responsibly sourced wood, or... Recycled content, or rapidly renewable resources such as bamboo or cork. Look for certifications like Forest Stewardship Council (FSC) or Cradle to Cradle (C2C) to ensure sustainable sourcing.

12- Recycled or upcycled materials for construction and finishes, such as recycled glass or reclaimed wood flooring. energy-efficient appliances and fixtures to minimize energy consumption and environmental impact. Non-Toxic Finishes and Sealants. Moisture-resistant materials in areas exposed to moisture.

In the Figure 39 Materials resistance forms for germ., attempt to classify surfaces based on two important properties for combating pathogens, but their employment is based on the designer's vision when creating a specific mechanism that can be used as an initial reference for selecting a surface based on the first property, which is self-cleaning, and the second, antimicrobial surfaces.

materials ressistance forms for germe	**self clean**	Surface Wettability	hydrophobic
			Hydrophilic
			oleophilic
			oleophobic
		Photocatalysis	ZnO ،CeO2 ،SnO2 ،ZrO2 ،CdS ،ZnS ، WSe2 ،α-Fe2O3 ،SrTiO2 ،WO3 ،In photocatalytic processes, TiO2 is most popular for its high photocatalytic, physical and chemical activity. Stability in the dark, non-corrosion, non-toxicity, availability, and low cost. Therefore, TiO2, known as white pigment, is added to building materials.
	antimicrobial	Heavy metals (Ag, Ni, W);	
		Metal compounds (Ag2MoO4, CuO, ZnO, Na2WO4, NaBr);	
		NORGANIX (silicate concrete sealant);	
		Free HNO2;	
		Nano-inorganic antimicrobial materials (such as Cu2O, CaCO3, TiO2, ZnO, CuO, Al2O3, Fe3O4)	
		One such substance is TiO2	

Figure 39 Materials resistance forms for germ.

Table 12 Suggested procedures for application

No.	element	Proposed materials and surfaces in architecture	Ref.
1	concrete	To make antimicrobial concrete, it is possible to add: heavy metals (Ag, Ni, W); Metal compounds (Ag2MoO4, CuO, ZnO, Na2WO4, NaBr); NORGANIX (silicate concrete sealant); Free HNO2; Antimicrobial nanostructured inorganic materials (such as Cu2O, CaCO3, TiO2, ZnO, CuO, Al2O3, Fe3O4)	(Liangsheng Qiu, 2020)
2	coating	Use of organic and inorganic hybrid polymer materials as binders often containing polysiloxanes or fluoropolymers, acrylic resins, hydrophobic silica nanoparticles and use of the rich chemistry of reactive silicone and polysiloxane compounds using sol-gel processes Biomimetic anti-adhesion coating Controlled release coating Plasma-based surface coating Multi-functional coating Kill-release switchable surface coating	(Anna Rabajczyk, 2021) (Gray, 2021)
3	Door handles and buttons	Sharklet film	(Yuxiang Chen, 2023)
3	Window frames	Coated with titanium oxide to act as a photocatalyst to eliminate viruses, bacteria and fungi	(Megahed, 2013)

4	For building entrances, ventilation openings and windows	wind curtains with purification and disinfection feature	(Jingcui Xu, 2022)
5	Fabrics cotton	Catechol-amine	(Jose Bolaños-Cardet, 2024)
6	Fabrics	AgO–ginger nanocomposite loaded in the gelled matrix	(Florentina Monica Raduly 1ORCID, 2024)
7	Surfaces exposed to frequent touching	superhydrophobic surfaces	(Yuxiang Chen ، 2023)

A proposal for a wall to reduce the concentration of airborne pathogens can be called white walls. See Figure *40 W*hite wall. It consists of 1- A wall painted with a layer of highly hydrophilic and oil-loving materials such as ethylene glycol. An ultraviolet lamp is shined on this wall.

2- Another suggestion is to employ high-adhesive superhydrophobic state materials such as rose petals, for example the Wenzel case. The surfaces of rose petals show a highly adhesive and water-repellent state, where water balls form upward, but cannot roll easily even when the surface is upside down. Poly vinyl alcohol for fabrication of rose petals template

Suggested light type: (Ultraviolet C (UV-C light, 280 nm), pulsed xenon UV light (PX-UV; 200–280 nm) , and high-intensity narrow-spectrum light (HINS; 405 nm), all offer efficient killing of S. aureus, including MRSA, Staphylococcus epidermidis, Pseudomonas aeruginosa, Acinetobacter, S. pyogenes, Clostridium perfringens, E.

faecalis, and VRE within ~10–30 min for germicidal UV wavelengths and 2–5 h for The High-Intensity Narrow-Spectrum light HINS. (David Welch, 2018)

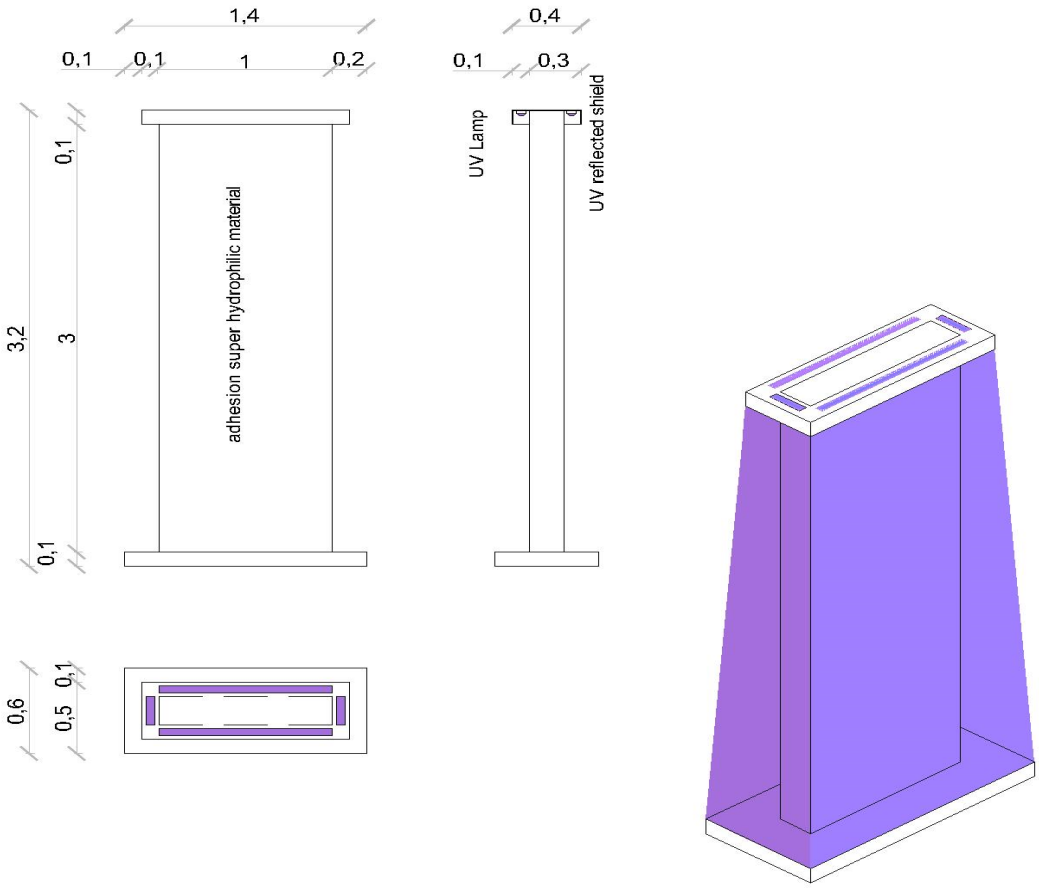


Figure 40 White wall.

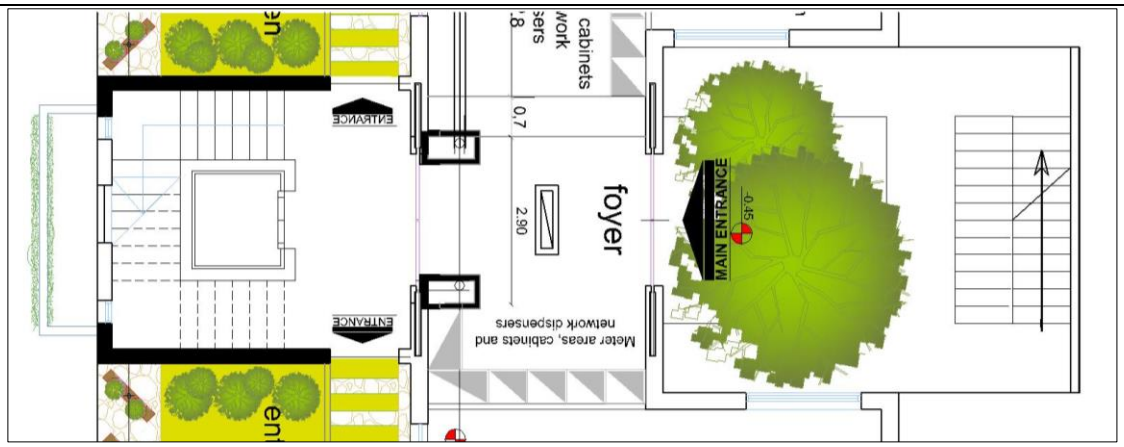


Figure 41 White wall installation site

5.3.4 Linking the design to the effect of greening's ability to alleviate psychological pressures resulting from home confinement.

Perhaps the thing that most seems to be the first refuge is nature, and researchers concerned with mental health and functional health have long emphasized the fundamental role of nature in refining the human psyche and providing comfort to the user (P´erez-Urrestarazu, 2021). An undistracted assessment was made by researchers in a scientific study issued in November. 2020, on the impact of indoor and outdoor plants on the well-being of users of residential spaces during the period of emotional home quarantine - taking into account behavioral, social and demographic variables. The emotional state of respondents was neutral, and a large proportion expressed positive feelings. The presence of indoor plants was associated with more positive feelings, and indoor residents devoted more time to plant care. In contrast, negative emotions were prevalent in respondents who were associated with a positive COVID-19 case, which was more common in females and young participants who living in small homes that receive low levels of natural light and have little or no plants. A small number of strategically placed indoor plants is also preferred compared to a large number of plants. In contrast, an increased number of plants accompanied by living walls has been favored in outdoor spaces. "Living walls were considered beneficial for increasing indoor vegetation but were also associated with technical and economic hurdles." (Dopko, 2015) has delved into The impact of green cover, with its many shapes and types, on the building and the user through what is known as biophilic design, as it emphasized the role that nature plays in several aspects, as "the biophilia hypothesis assumes that the well-being and survival of our ancestors depended on communication with nature (for example, to find food and water, "Mobility, predicting time or future weather conditions, etc.)" This constituted a necessity for treating the problem of high-rise buildings, which may pose a psychological danger to the users, and this danger develops into a danger to mental health and physical health.

The understanding of the real impact of vegetation cover in improving mental and psychological health in general has been deepened through studies that dealt with

biophilic design, and since vegetation cover is an essential part of biophilic design, the results of its studies related to psychological and mental health can be generalized, as the design that will be adopted for the living wall consists of basins suspended on the wall This facade is mobile and not fixed, as it is fixed on the balcony, which is the only outlet for the apartment. It must be variable in location, as it can be installed vertically, parallel to the wall or perpendicular to the walls of the room. The third case is horizontal, which is, in a way that mimics the external garden.

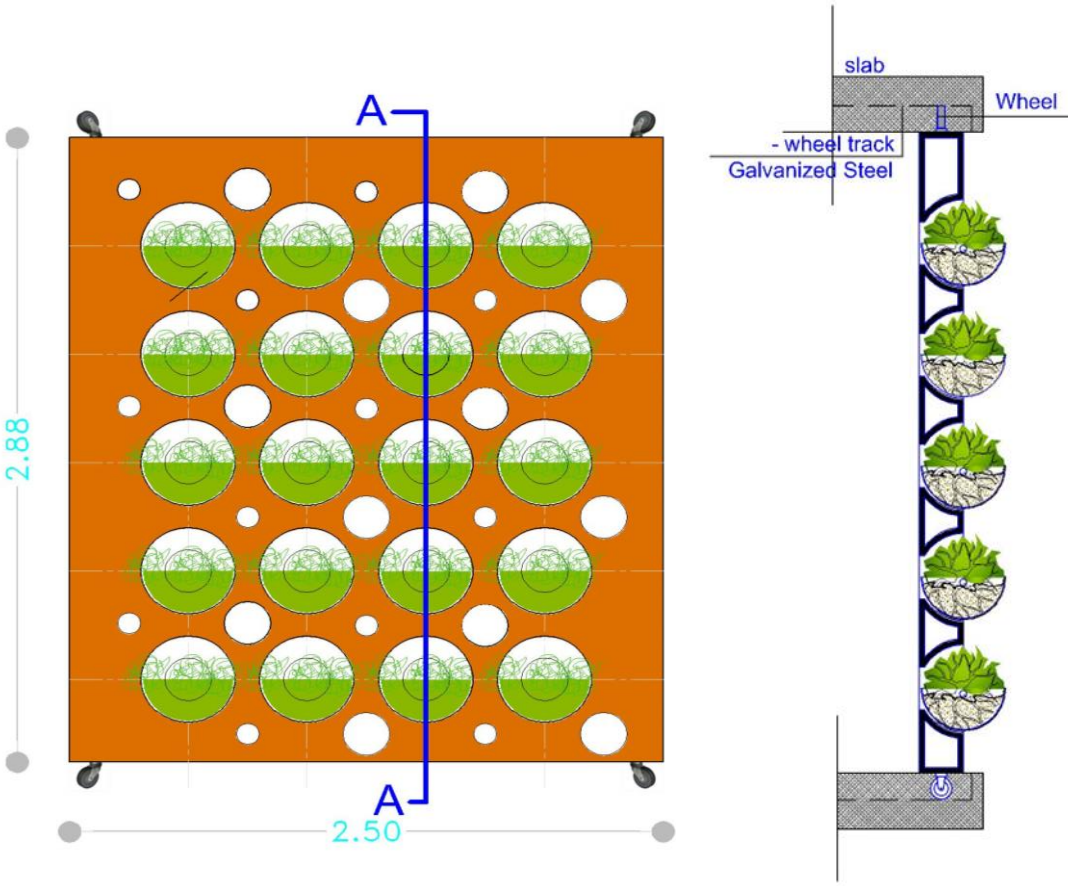
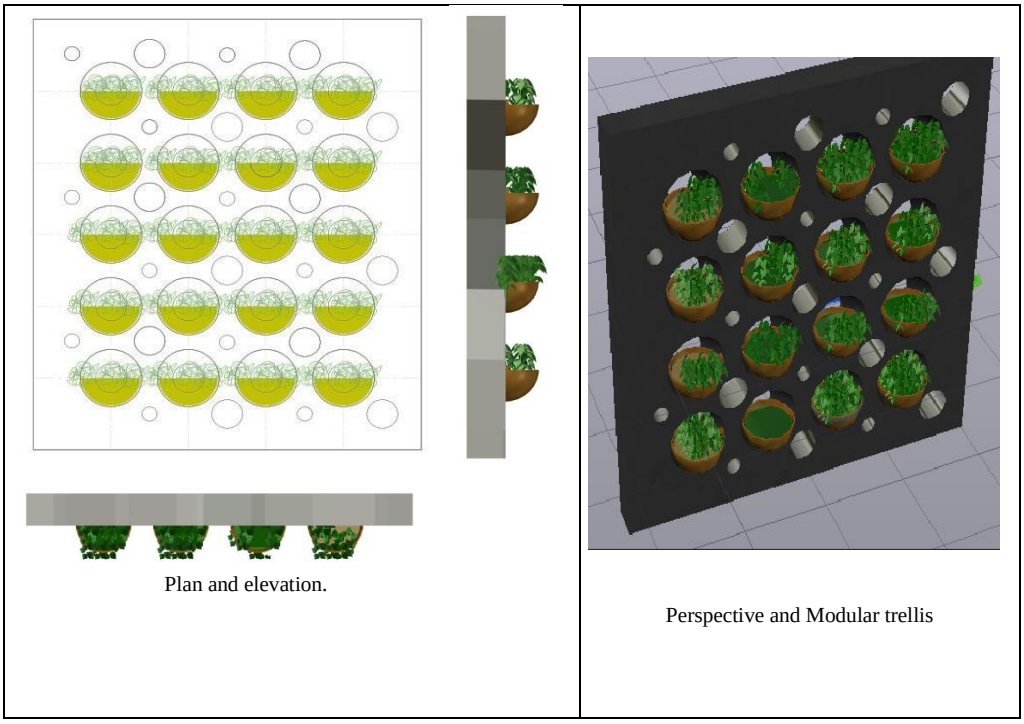


Figure 42 Section A-A living wall

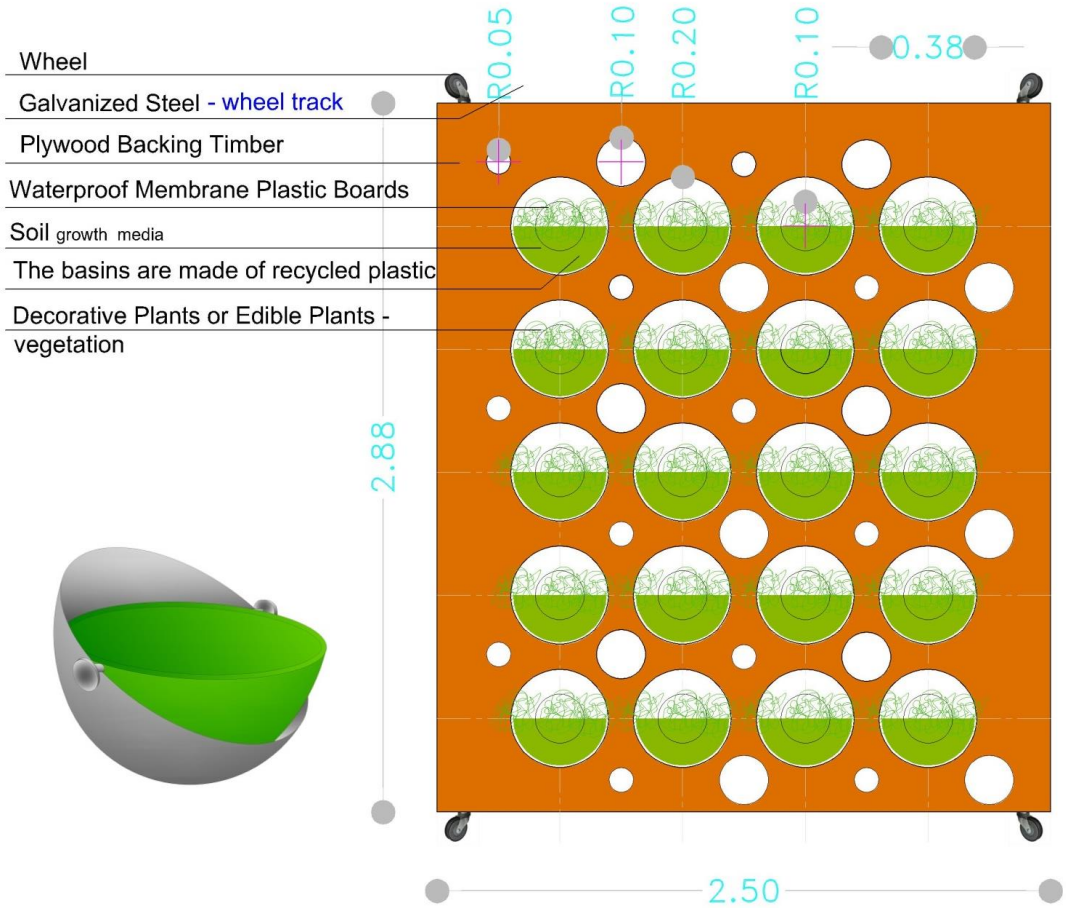
Figure 43 Plan, Elevation and Perspective



Plan and elevation.

Perspective and Modular trellis

Figure 44 Design of the transformable living wall:



The following Table13 shows the biophilic patterns that were adopted to apply to the

Table13 Biophilic patterns			
	Category	pattern	Implementation method
1	Nature in space	Visual contact with nature	Perforated facade in case the balcony is closed.
		Visual contact with nature	The possibility of changing its positions at any angle of inclination from the horizon line, or closing it completely with the horizon line.
2		The invisible connection with nature	If the wall is facing outwards.
3		Non-rhythmic sensory stimuli	The sounds of birds when they approach the wall if it is placed parallel to one of the walls of the vertical balcony The sound of leaves of plants grown in living wall pots.
4		Thermal effect and air flow	The effect of changing the air flow resulting from its passage through the perforated facade and around the wall with its different positions and the effect of its temperature on the planted plants.
5		Dynamic diffused light	Light enters and shadows form through holes and the shadows of plants growing in the living wall.
6		Connection with natural systems	Living wall plants, like any plants, change with the seasons.

In terms of the impact on psychological health, by achieving the above patterns, benefit will be achieved at the levels of stress reduction (lower blood pressure and heart rate and lower stress hormones, also has a positive impact on comfort, well-being and visual comfort and the performance of the circadian system is positively affected), productivity and cognitive performance (from Through improved mental engagement/attention, positive impact on cognitive performance, observable and quantitative behavioral measures of attention, exploration, and concentration (positively affected), emotion, mood, and preference (positively affected attitude, general happiness, observed improvements in mental health and calmness, improved perception of temporal pleasure, enhanced positive health responses; change in perception the environment). (Browning, 2014)

How to move the living wall:

The movement of the wall depends on the installation of wheels with a 360-degree angle of movement:

Table 14 Wheels details

Size 4”	
Wheel diameter 100 mm	
Wheel width 30mm	
Load capacity 50 kg	
Wheel material polyurethane	
Loading chair Ball bearing chair	
Adjustment height 128mm	
Radius of rotational motion 95 mm	
Measuring the nail 14*12 mm	

Installation options : It must be installed in the entrance garden, and this location was chosen based on the preferences of specialists and users alike, as the problem of not having a suitable view is repeated in all directions of the building, which necessarily requires providing and making one inside the apartment.

1- Figure *45* The movement of the wall around a vertical terminal axis allows the living wall to be used parallel to an internal wall or a solar breaker, with its green façade facing outside.

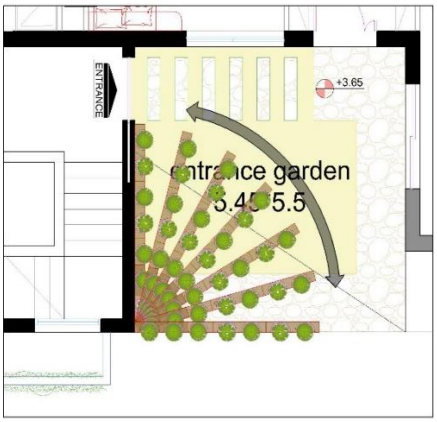


Figure 45 The movement of T.L.W

1- A lateral displacement movement Figure 46 & Figure 48 3D living wall movement- A lateral displacement allows for the previous two positions, but the green cover is facing inside

Figure 46

2- Horizontal movement Figure 47 & Figure *49* movement allows for the simulation of an outdoor ground garden

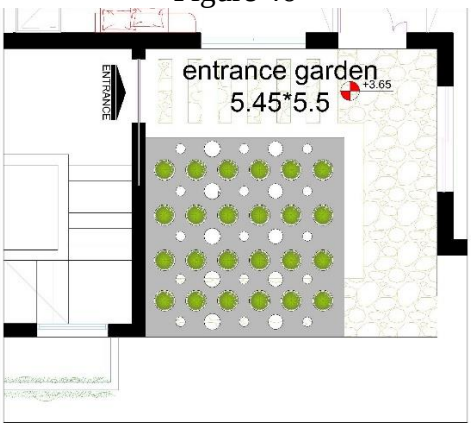


Figure 47

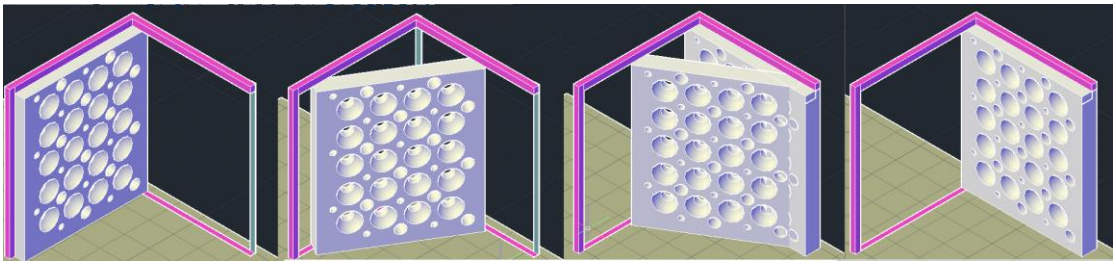


Figure 48 3D living wall movement- A lateral displacement

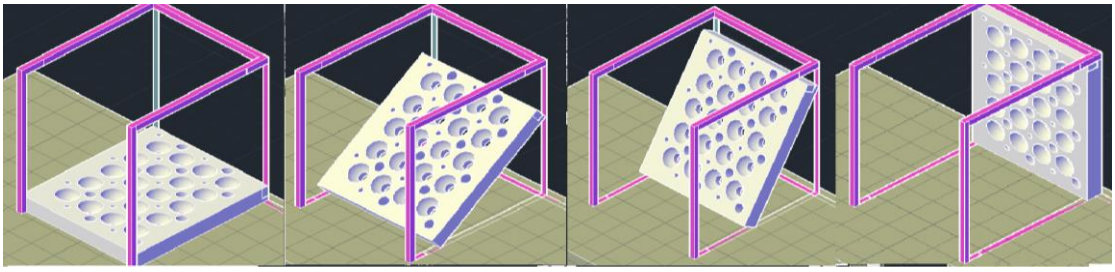


Figure 49

6 Simulation model (results test and validation)

6.1 Site and site analysis:

Proposed site: Location: Palestine| west bank| Hebron| Dura |wad abu alqamrah

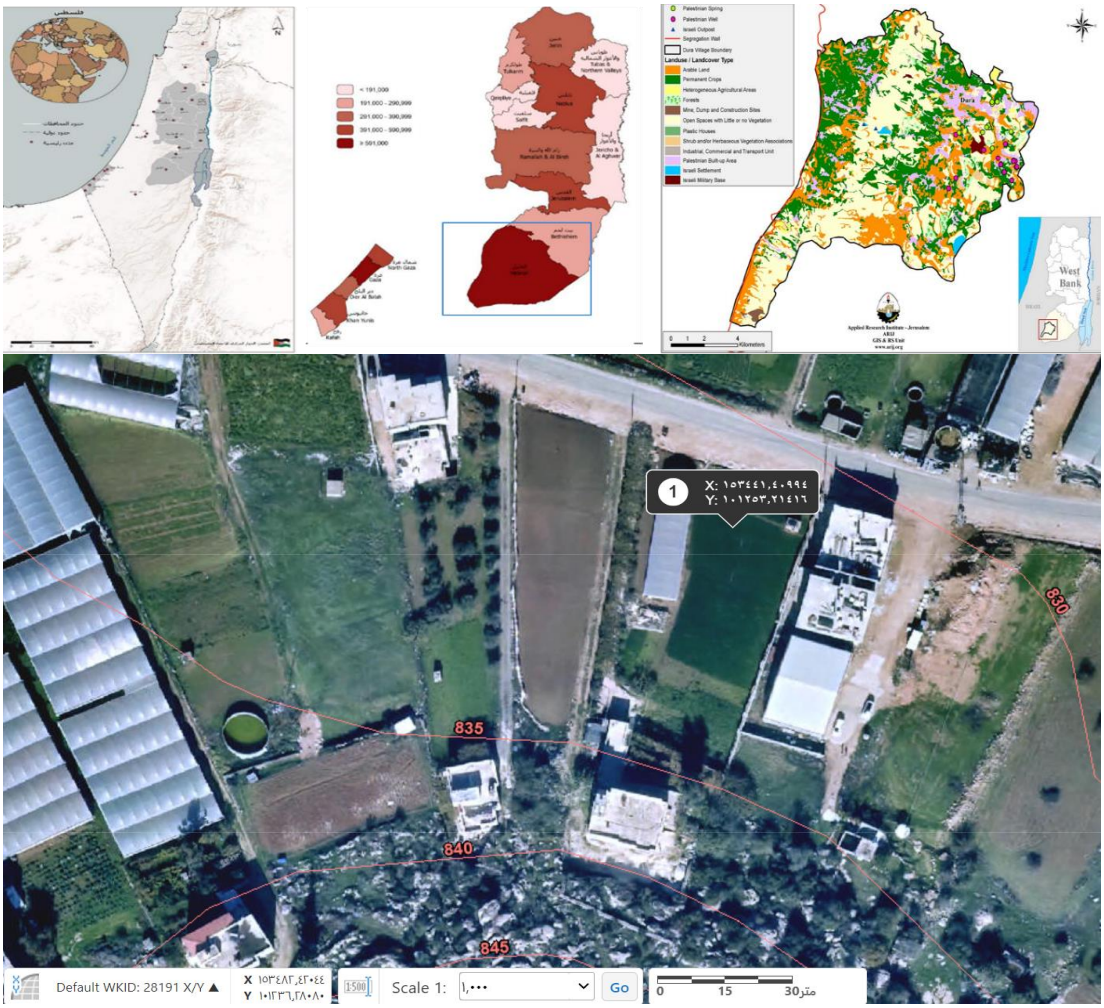


Figure 50 Site Palestinian coordination.

Site analysis: The Site is within the boundaries of the 2009 approved master plan of Dora city, and as it appears, the classification of the land is housing A. It is 8.47 kilometers away from the governorate center. (geomolg, 2024) The height of the imaginary model above sea level is 830 m (geomolg, 2024) and the pressure average for this site at 15°C is 91743.36 Pascals.

Climate: The attached climatic data shows the following data: Most days of the year are dry and sunny days, approximately 300 days, and this gives an indication of the

humidity level. The wind speed most of the days is between 12-19 km per hour, and its direction is westerly to northwest. The amount of precipitation is 450-590 mm annually. And temperatures at the top do not exceed 40, and at the bottom they are not less than -4.

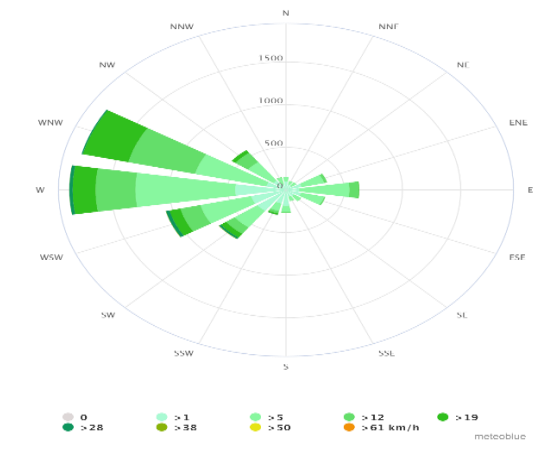
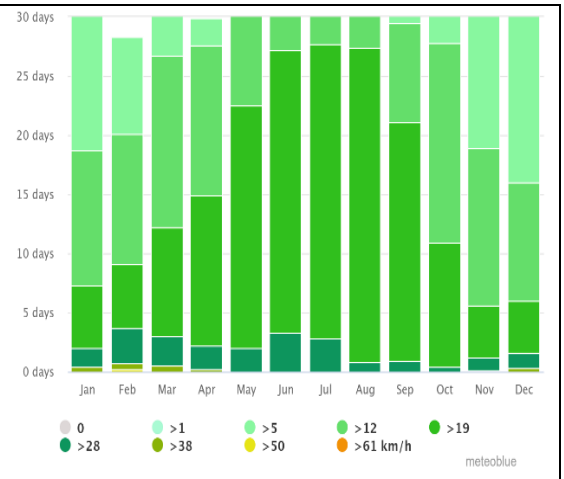
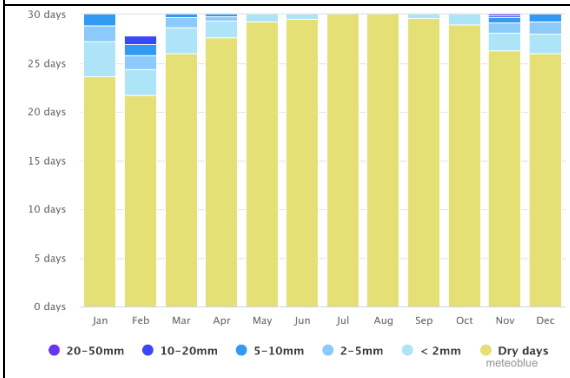
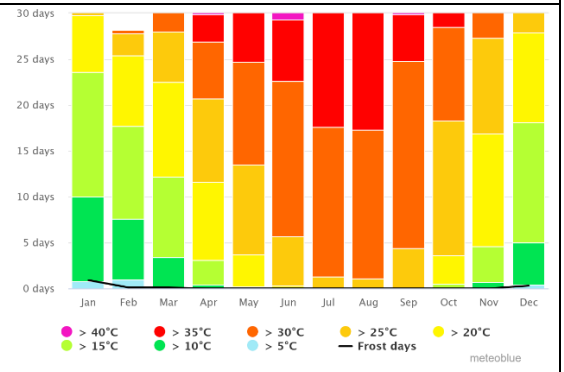
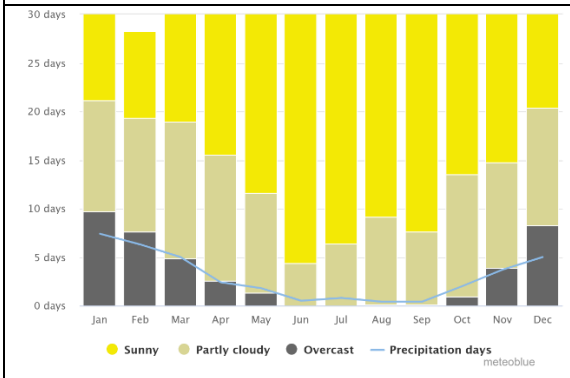
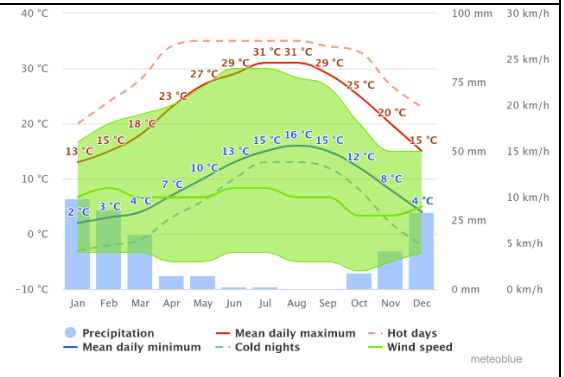
<table>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Wind rose: The prevailing winds are westerly-westerly-northly</td><td>Wind speed :Wind speed ranges most days of the year from 12 to 28 km /hour</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Precipitation amounts: Most days are dry</td><td>Maximum temperatures: In most cases, temperatures range from 25 to 30 degrees Celsius</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Cloudy, sunny, and precipitation days: Most days are sunny</td><td>Average temperatures and precipitation</td></tr>
</table>

Table 15 Simulated historical climate and weather data for Hebron, *(meteoblue, 2023)*

After studying the climatic situation of Hebron region, it turns out that its climate is hot, and the following recommendations will be applied:

- Considering the compact planning of houses with courtyards.
- Finding uncovered and open spaces that allow the breeze to pass through, taking into account the provision of appropriate protection from cold and hot winds.
- Place rooms so that they allow constant air movement.
- Use medium holes (30-40%.)
- Use light walls with little time lag.
- The use of light, thermally insulated ceilings

Regulatory requirements

Governorate: Hebron

Number of Floors: 5

Front Setback: 5 M

Side Setback : 3 M

Rear Setback : 4 M

Accumulative Floor Area Percentage : 210%

Surface area percentage : 42%

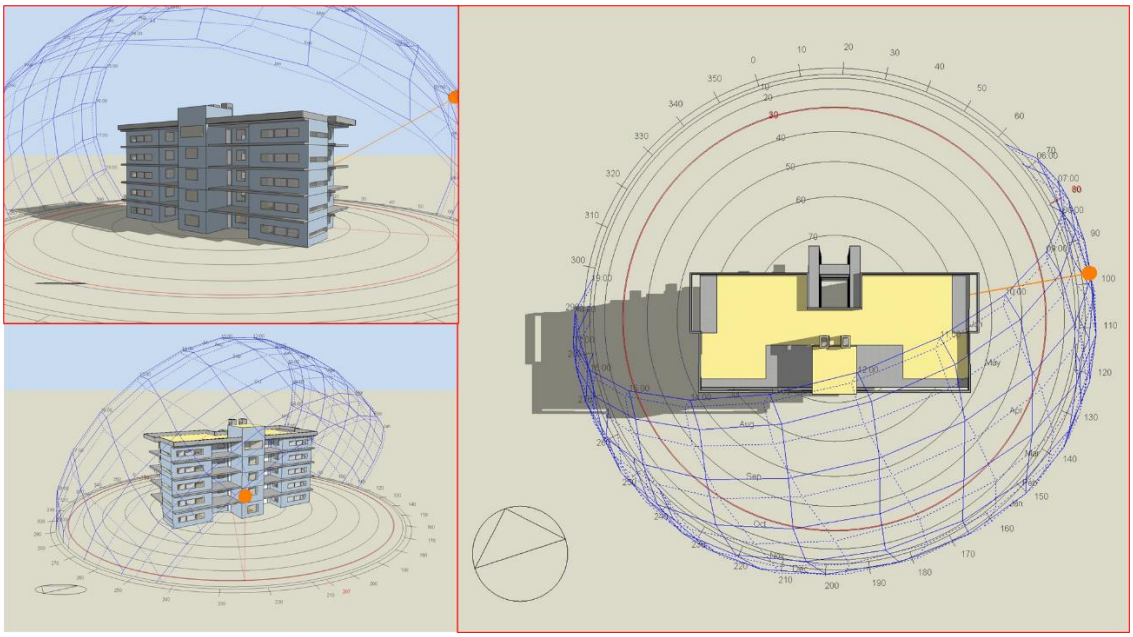


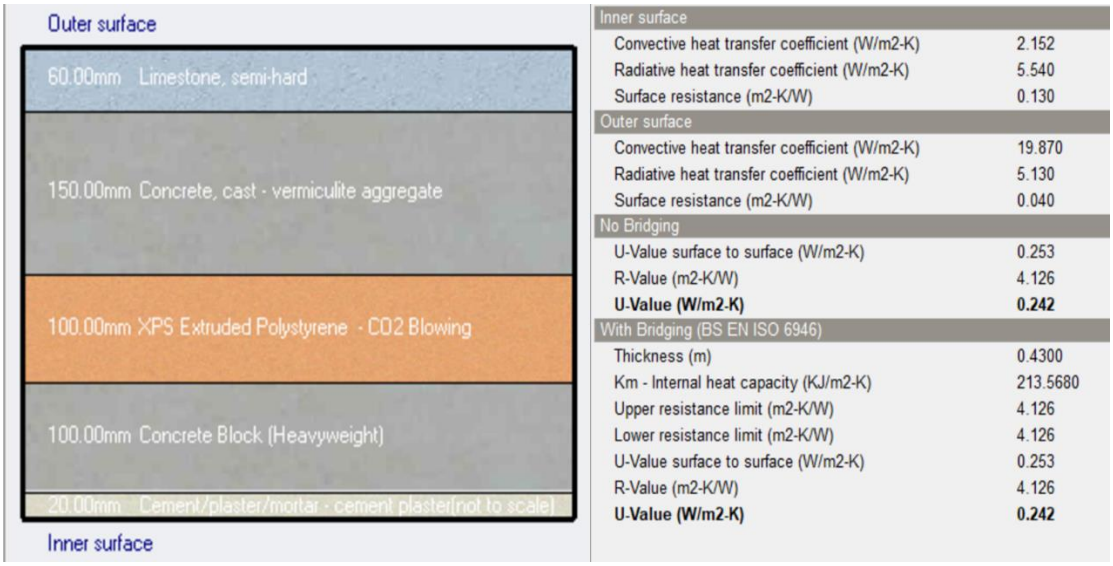
Figure 51 Site sun path

6.2 Simulation process

The design simulation process was carried out using the Design Builder version (6.1.0.006 copyright 2000-2019), design builder Ltd) program, where the model resulting from the objective analysis process of the previous stage was built, after which the building's material components were identified and it was ensured that they achieved the thermal transfer values specified according to the green building standards, and then the thermal performance of the five-storey 2apartments/floor building was analyzed over a period of a full year, the results were analyzed, the model was subjected to a daylighting test, the results were analyzed, and finally, it was subjected to an internal CFD analysis for the isolation rooms and an external one for the general location. Below is a presentation of the results and treatments to ensure that the model achieves the required limit of sustainability requirements.

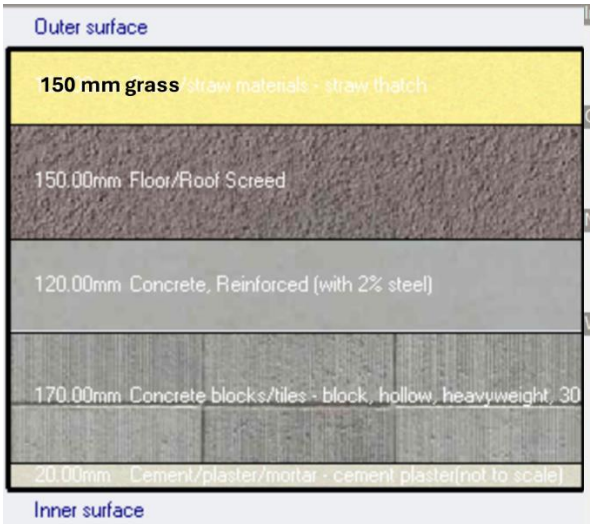
Model construction:

External wall:



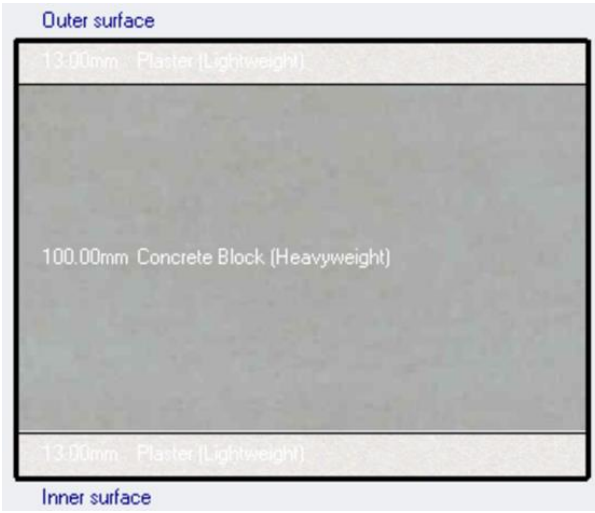
Inner surface	
Convective heat transfer coefficient (W/m2-K)	2.152
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.130
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.253
R-Value (m2-K/W)	4.126
U-Value (W/m2-K)	**0.242**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.4300
Km - Internal heat capacity (KJ/m2-K)	213.5680
Upper resistance limit (m2-K/W)	4.126
Lower resistance limit (m2-K/W)	4.126
U-Value surface to surface (W/m2-K)	0.253
R-Value (m2-K/W)	4.126
U-Value (W/m2-K)	**0.242**

Flat roof:



Inner surface	
Convective heat transfer coefficient (W/m2-K)	4.460
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.100
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.367
R-Value (m2-K/W)	2.864
U-Value (W/m2-K)	**0.349**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.6200
Km - Internal heat capacity (KJ/m2-K)	116.088
Upper resistance limit (m2-K/W)	2.864
Lower resistance limit (m2-K/W)	2.864
U-Value surface to surface (W/m2-K)	0.367
R-Value (m2-K/W)	2.864
U-Value (W/m2-K)	**0.349**

Internal partitions:



Inner surface	
Convective heat transfer coefficient (W/m2-K)	2.152
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.130
Outer surface	
Convective heat transfer coefficient (W/m2-K)	2.152
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.130
No Bridging	
U-Value surface to surface (W/m2-K)	4.467
R-Value (m2-K/W)	0.484
U-Value (W/m2-K)	**2.067**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.1260
Km - Internal heat capacity (KJ/m2-K)	207.900
Upper resistance limit (m2-K/W)	0.484
Lower resistance limit (m2-K/W)	0.484
U-Value surface to surface (W/m2-K)	4.467
R-Value (m2-K/W)	0.484
U-Value (W/m2-K)	**2.067**

Ground floor:

Inner surface	
Convective heat transfer coefficient (W/m2-K)	0.342
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.170
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	0.529
R-Value (m2-K/W)	2.101
U-Value (W/m2-K)	**0.476**
With Bridging (BS EN ISO 6946)	
Thickness (m)	1.0470
Km - Internal heat capacity (KJ/m2-K)	0.0000
Upper resistance limit (m2-K/W)	2.101
Lower resistance limit (m2-K/W)	2.101
U-Value surface to surface (W/m2-K)	0.529
R-Value (m2-K/W)	2.101
U-Value (W/m2-K)	**0.476**

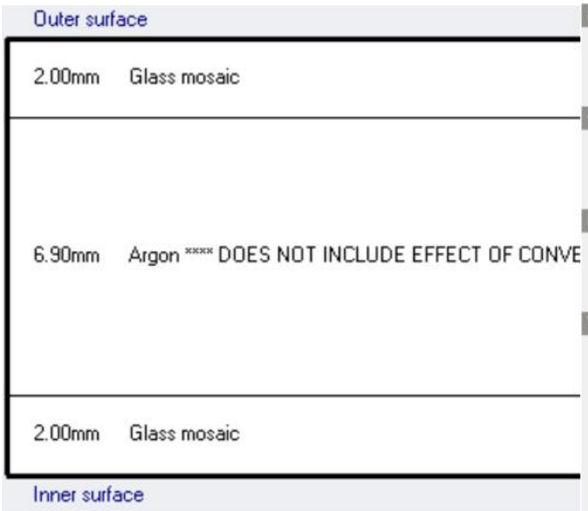
External floor:

Inner surface	
Convective heat transfer coefficient (W/m2-K)	0.632
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.162
Outer surface	
Convective heat transfer coefficient (W/m2-K)	7.216
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.081
No Bridging	
U-Value surface to surface (W/m2-K)	0.251
R-Value (m2-K/W)	4.234
U-Value (W/m2-K)	**0.236**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.4112
Km - Internal heat capacity (KJ/m2-K)	20.5758
Upper resistance limit (m2-K/W)	4.234
Lower resistance limit (m2-K/W)	4.234
U-Value surface to surface (W/m2-K)	0.251
R-Value (m2-K/W)	4.234
U-Value (W/m2-K)	**0.236**

Internal floor:

Inner surface	
Convective heat transfer coefficient (W/m2-K)	0.342
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.170
Outer surface	
Convective heat transfer coefficient (W/m2-K)	4.460
Radiative heat transfer coefficient (W/m2-K)	5.540
Surface resistance (m2-K/W)	0.100
No Bridging	
U-Value surface to surface (W/m2-K)	1.132
R-Value (m2-K/W)	1.153
U-Value (W/m2-K)	**0.867**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.4930
Km - Internal heat capacity (KJ/m2-K)	0.0000
Upper resistance limit (m2-K/W)	1.153
Lower resistance limit (m2-K/W)	1.153
U-Value surface to surface (W/m2-K)	1.132
R-Value (m2-K/W)	1.153
U-Value (W/m2-K)	**0.867**

External door



Inner surface	
Convective heat transfer coefficient (W/m2-K)	4.460
Radiative heat transfer coefficient (W/m2-K)	3.874
Surface resistance (m2-K/W)	0.120
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19.870
Radiative heat transfer coefficient (W/m2-K)	5.130
Surface resistance (m2-K/W)	0.040
No Bridging	
U-Value surface to surface (W/m2-K)	2.444
R-Value (m2-K/W)	0.569
U-Value (W/m2-K)	**1.757**
With Bridging (BS EN ISO 6946)	
Thickness (m)	0.0109
Km - Internal heat capacity (KJ/m2-K)	3.0030
Upper resistance limit (m2-K/W)	0.569
Lower resistance limit (m2-K/W)	0.569
U-Value surface to surface (W/m2-K)	2.444
R-Value (m2-K/W)	0.569
U-Value (W/m2-K)	**1.757**

Occupancy density(people/m2):

The occupancy rate was calculated based on the Palestinian census, where the number of members of one family reaches 5 individuals. Considering that there are 10 apartments, each apartment containing five individuals, the number of residents becomes at least 50. The number of individuals was divided by the total area of the building (50/1117.5) = 0. 045(people/m2)

Glazing type: Dbl Blue 6mm/13mm Arg:

Calculated Values	
Total solar transmission (SHGC)	0.494
Direct solar transmission	0.373
Light transmission	0.505
U-value (ISO 10292/ EN 673) (W/m2-K)	2.626
U-Value (W/m2-K)	**2.511**

HVAC (Natural ventilation - No Heating/Cooling)

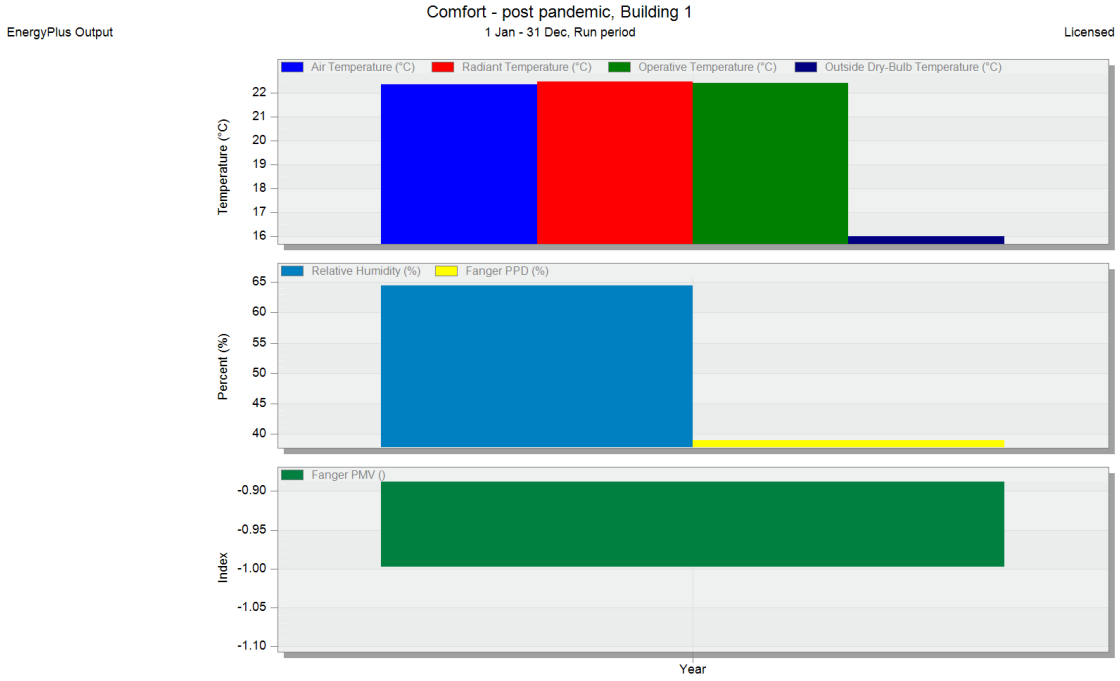
Lighting: general lighting

6.2.1 Thermal comfort

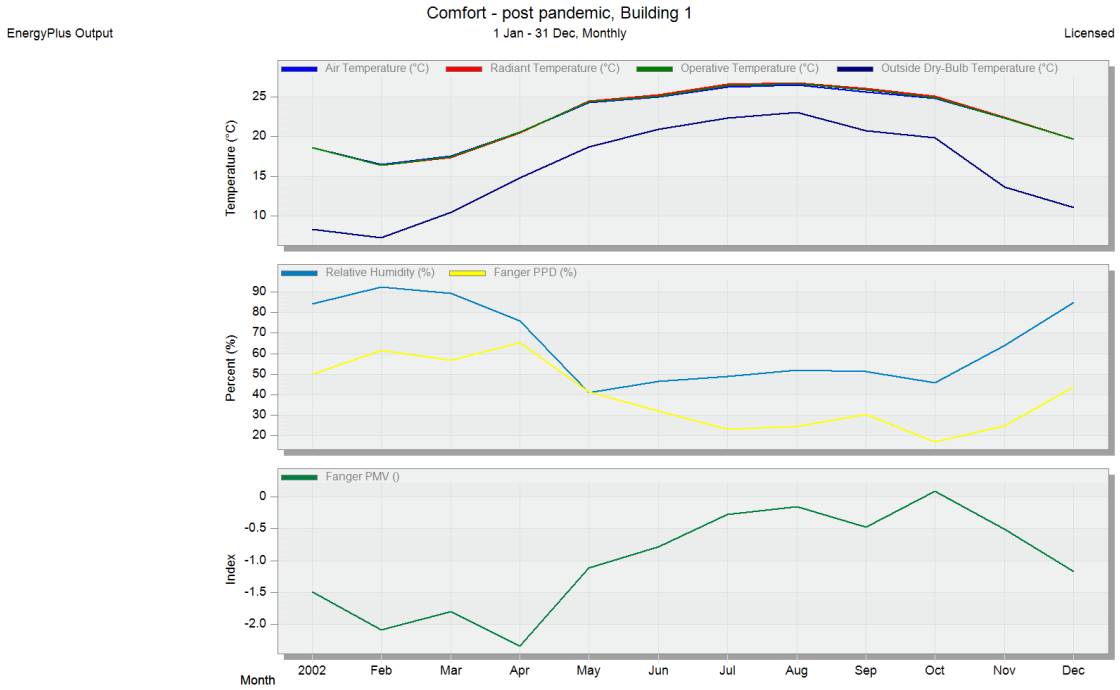
Table 16 The maximum value of thermal transfer U for the exposed outer shell elements shows the thermal transfer coefficient for the building elements according to the green building guideline in Palestine. The aim of presenting it is to compare it with what is required to achieve thermal transfer of the proposed model and to ensure the effectiveness of its thermal insulation in all its elements. The following is a presentation of each element and its thermal transfer coefficient.

Table 16 The maximum value of thermal transfer U for the exposed outer shell elements (council, 2013)

No.	structural elements in the outer envelope of the building	(U) W/ m2. K	Model (U)
1	Exterior wall	0.5	0.242
2	Exposed horizontal ceiling	0.39	0.349
3	The exposed slanted roof is	0.39	-
4	Solid floors connected to the ground	0.46	0.476
5	Exposed floors	0.46	0.236
6	External windows	2.46	2.511
7	Exposed external doors	6	1.757



Air Temperature (°C)	22.34
Radiant Temperature (°C)	22.48
Operative Temperature (°C)	22.41
Outside Dry-Bulb Temperature (°C)	16.01
Relative Humidity (%)	64.49
Fanger PPD (%)	39.05
Fanger PMV ()	-1.00

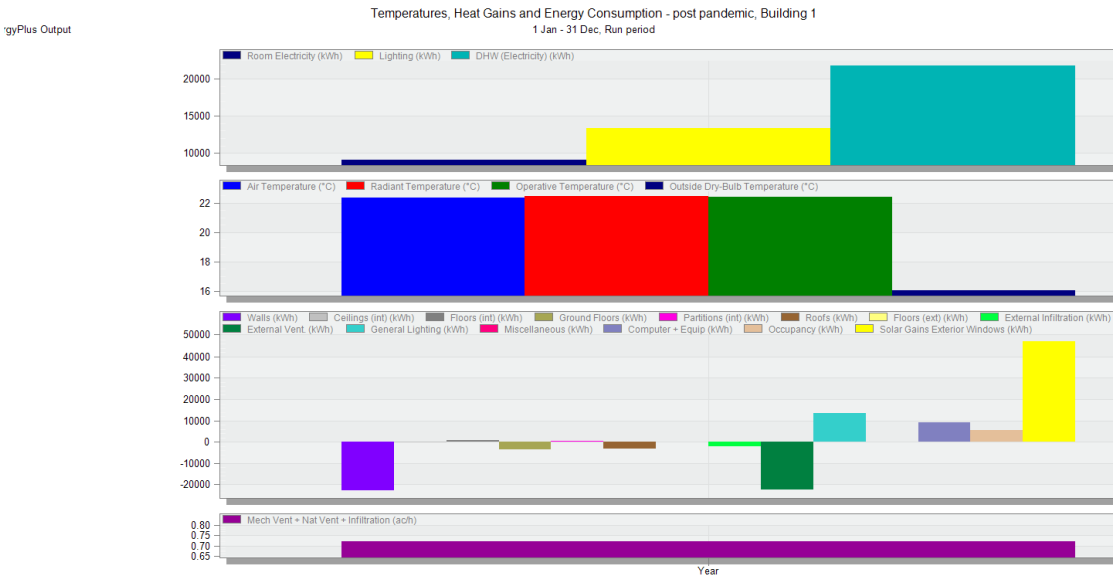


	2002	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air Temperature (°C)	18.66	16.47	17.53	20.60	24.25	24.99	26.21	26.50	25.64	24.80	22.30	19.72
Radiant Temperature (°C)	18.65	16.40	17.42	20.51	24.46	25.24	26.58	26.81	26.04	25.10	22.44	19.68
Operative Temperature (°C)	18.66	16.44	17.48	20.55	24.36	25.12	26.40	26.65	25.84	24.95	22.37	19.70
Outside Dry-Bulb Temperature (°C)	8.37	7.34	10.47	14.85	18.74	20.91	22.33	23.08	20.73	19.87	13.68	11.14
Relative Humidity (%)	84.01	92.57	89.25	75.99	41.06	46.39	48.75	52.05	51.15	45.69	64.08	84.94
Fanger PPD (%)	49.82	61.51	56.81	65.44	41.30	32.15	23.09	24.39	30.29	17.19	24.79	43.84
Fanger PMV ()	-1.49	-2.09	-1.80	-2.33	-1.12	-0.78	-0.27	-0.15	-0.47	0.10	-0.50	-1.17

The results show excellent thermal performance in the summer and fall seasons. The results show that the temperature inside the building is appropriate in all months, as the internal temperature in the winter is approximately 10 degrees higher than the

external temperature. This means that the insulation of the building elements is appropriate.

While the humidity inside the building increases during the winter, this may explain the high rate of discomfort in winter and spring seasons, and this is to make the apartment more immune, as cold and dry conditions accelerate the spread of the Corona virus. Corona viruses are transmitted in respiratory droplets, and low humidity makes the size of the droplet smaller, and it is transmitted easily. In contrast to the high humidity, which makes the weight of the drop large, causing it to fall to the ground away from those who use it. Employing this is very beneficial to reduce the possibility of infection transmission and ensure the security of the indoor built environment. This means that it may be necessary to use heating methods that are based on radiation and do not cause air movement, such as using an electric heater and staying away from air conditioning. It should be noted that the simulated apartments did not include any air conditioning system or heating or cooling design. The results were based on natural ventilation.



Room Electricity (kWh)	9041.22
Lighting (kWh)	13358.80
DHW (Electricity) (kWh)	21838.60
Air Temperature (°C)	22.34
Radiant Temperature (°C)	22.48
Operative Temperature (°C)	22.41
Outside Dry-Bulb Temperature (°C)	16.01
Walls (kWh)	-22703.44
Ceilings (int) (kWh)	-202.14
Floors (int) (kWh)	853.39
Ground Floors (kWh)	-3400.36
Partitions (int) (kWh)	282.92
Roofs (kWh)	-3148.58
Floors (ext) (kWh)	-49.14
External Infiltration (kWh)	-2074.58
External Vent. (kWh)	-22268.34
General Lighting (kWh)	13358.80
Miscellaneous (kWh)	75.04
Computer + Equip (kWh)	8966.18
Occupancy (kWh)	5469.14
Solar Gains Exterior Windows (kWh)	47124.80
Mech Vent + Nat Vent + Infiltration (ac/h)	0.72

6.2.2 Visual comfort

The third floor, which is the middle floor of the building, was tested in terms of its ability to achieve the lighting requirements and standards of Green Star Design

Builder, which is to achieve the necessary limits of daylight lighting without the need of artificial lighting. Contents and criteria of the report:

The rooms that need to be achieved for success are the living room, the kitchen, the study room, and the bedrooms. The rooms achieved a score of 1 to 2 points

Greenstar Credit IEQ4 Report

The aim of the daylighting credit is to encourage and recognize designs that provide appropriate levels of daylight for building users.

Criteria for meeting the credit is defined in the "Green Star Office Design v3 Technical Manual" as follows:

Up to three points are available where:

- The percentage of the NLA as stated below has a measured Daylight Factor (DF) of not less than 2.0%, at desk-height level (720mm AFFL) under a uniform design sky;

OR

- The percentage of the NLA as stated below has a Daylight Illuminance (DI) of at least 250 lux.

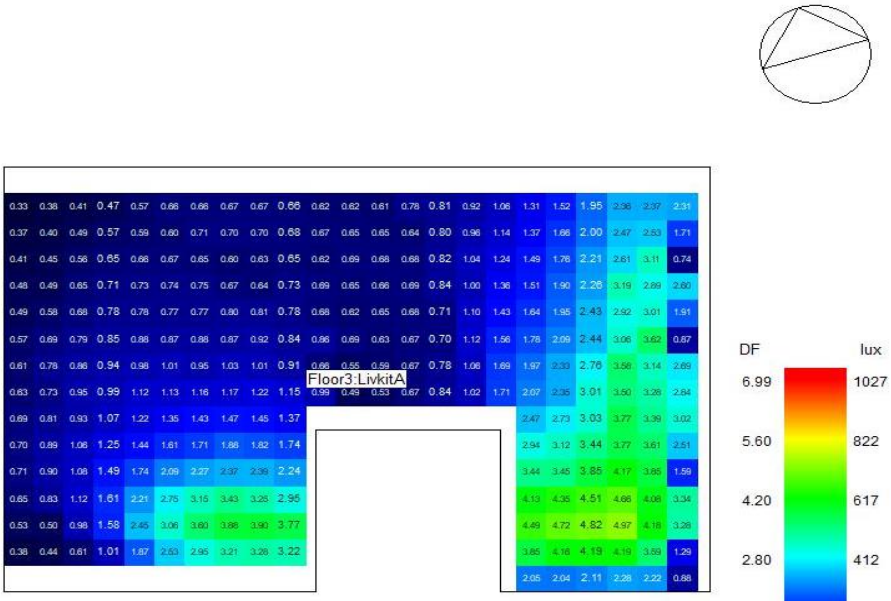
In both cases the points are awarded based on percentage of NLA as per:

- One point is awarded for 30% of NLA
- Two points are awarded for 60% of NLA; and
- Three points are awarded for 90% of NLA.

The Daylight Factor (DF) method is used to show Green Star compliance. DF is defined as the ratio of internal horizontal illuminance to external global horizontal illuminance. It represents the proportion of available external light which illuminates a given point inside the building.

Below will be presented the daylight plan for the aforementioned rooms on the third floor and their reports.

Living room kitchen dining A daylight map and report:



GreenStar Credit IEQ4 Report

The aim of the daylighting credit is to encourage and recognize designs that provide appropriate levels of daylight for building users.

Criteria for meeting the credit is defined in the "Green Star Office Design v3 Technical Manual" as follows:

Up to three points are available where:

- The percentage of the NLA as stated below has a measured Daylight Factor (DF) of not less than 2.0%, at desk-height level (720mm AFFL) under a uniform design sky;

OR

- The percentage of the NLA as stated below has a Daylight Illuminance (DI) of at least 250 lux.

In both cases the points are awarded based on percentage of NLA as per:

- One point is awarded for 30% of NLA
- Two points are awarded for 60% of NLA; and
- Three points are awarded for 90% of NLA.

The Daylight Factor (DF) method is used to show Green Star compliance. DF is defined as the ratio of internal horizontal illuminance to external global horizontal illuminance. It

It represents the proportion of available external light which illuminates a given point inside the building.

The results below were calculated using the Radiance simulation engine which provides a detailed multi-zone physics-based calculation of illumination levels on the working pla

planes of the building.

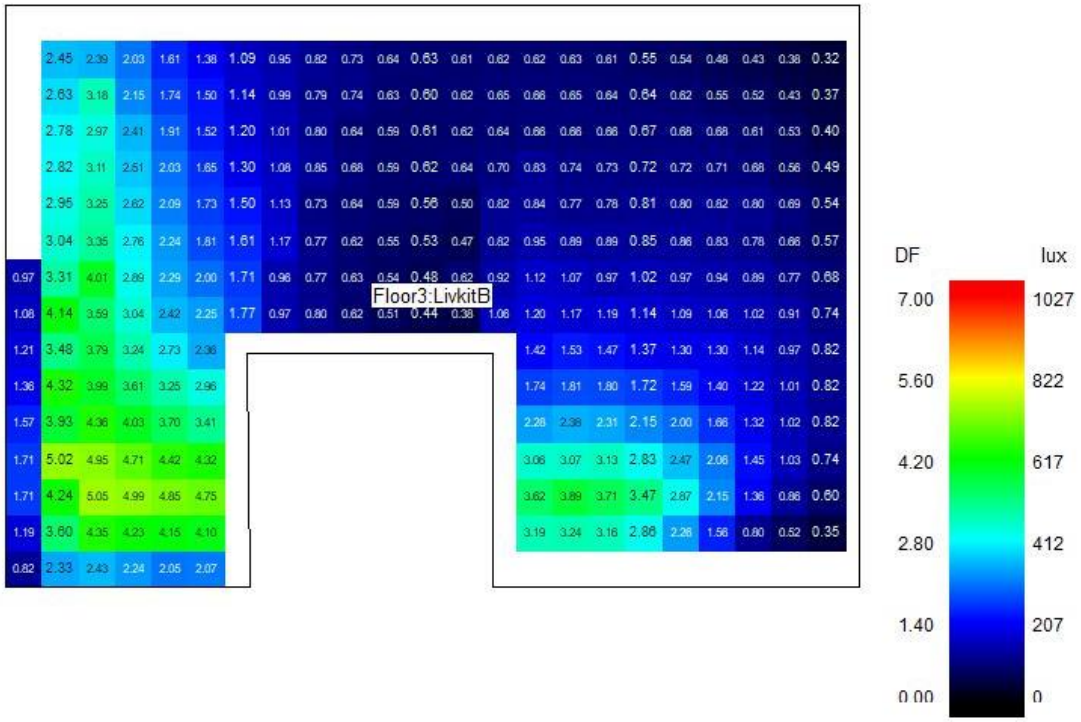
Daylighting data	
Project file	C:\Users\rubar\Documents\resalah\POST designbuilder.dsb
Report generation time	14/4/2024 19:35:40
Sky model	1-Standard sky, 7-Uniform cloudy sky
Location	JERUSALEM AIRPORT
Working plane height (m)	0.100
Max Grid Size (m)	0.300
Min Grid Size (m)	0.300
Daylight factor threshold (%)	2.000

Summary Results	
Total area (m2)	30.3
Total area meeting requirements (m2)	9.8
% area meeting requirements	32.2
GreenStar Credit IEQ4 Status	1 Point

Eligible zones for daylighting

Zone	Block	Floor area (m2)	Min DF (%)	Working plane area within Limits (%)
floor 3	livkit A	30.3	0.33	32.2
Total		**30.3**	**0.33**	**32.2**

Living room kitchen dining B daylight map and report:



GreenStar Credit IEQ4 Report

The aim of the daylighting credit is to encourage and recognize designs that provide appropriate levels of daylight for bu

Criteria for meeting the credit is defined in the "Green Star Office Design v3 Technical Manual" as follows:

Up to three points are available where:

- The percentage of the NLA as stated below has a measured Daylight Factor (DF) of not less than 2.0%, at desk

OR

- The percentage of the NLA as stated below has a Daylight Illuminance (DI) of at least 250 lux.

In both cases the points are awarded based on percentage of NLA as per:

- One point is awarded for 30% of NLA
- Two points are awarded for 60% of NLA; and
- Three points are awarded for 90% of NLA.

The Daylight Factor (DF) method is used to show Green Star compliance. DF is defined as the ratio of internal horizonta

l illuminance to external global horizontal illuminance. It represents the proportion of available external light which illuminates a given point inside the building.

The results below were calculated using the Radiance simulation engine which provides a detailed multi-zone physics-b

-based calculation of illumination levels on the working planes of the building.

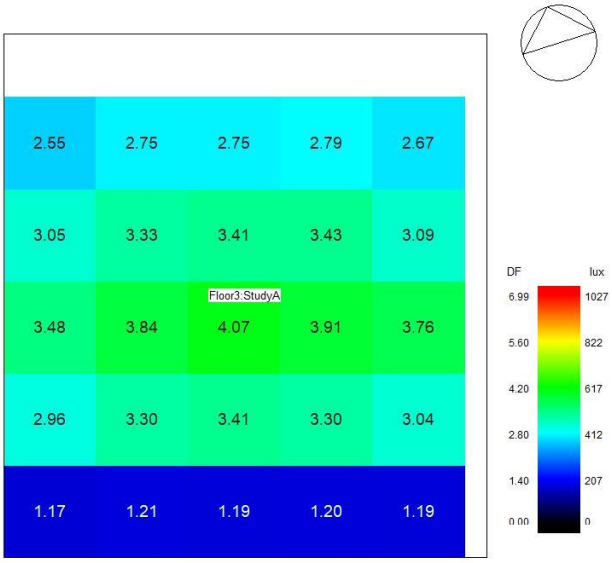
Daylighting data	
Project file	C:\Users\rubar\Documents\resalah\POST designbuilder.dsb
Report generation time	14/4/2024 19:33:27
Sky model	1-Standard sky, 7-Uniform cloudy sky
Location	JERUSALEM AIRPORT
Working plane height (m)	0.100
Max Grid Size (m)	0.300
Min Grid Size (m)	0.300
Daylight factor threshold (%)	2.000

Summary Results	
Total area (m2)	29.8
Total area meeting requirements (m2)	9.4
% area meeting requirements	31.4
GreenStar Credit IEQ4 Status	1 Point

Eligible zones for daylighting

Zone	Block	Floor area (m2)	Min DF (%)	Working plane area within Limits (%)
floor 3	livkit B	29.8	0.32	31.4
Total		**29.8**	**0.32**	**31.4**

Study room daylight map and report:



GreenStar Credit IEQ4 Report

The aim of the daylighting credit is to encourage and recognize designs that provide appropriate levels of daylight for building users.

Criteria for meeting the credit is defined in the "Green Star Office Design v3 Technical Manual" as follows:

Up to three points are available where:

- The percentage of the NLA as stated below has a measured Daylight Factor (DF) of not less than 2.0%, at desk-height level (720mm AFFL) under a uniform design sky;

OR

- The percentage of the NLA as stated below has a Daylight Illuminance (DI) of at least 250 lux.

In both cases the points are awarded based on percentage of NLA as per:

- One point is awarded for 30% of NLA
- Two points are awarded for 60% of NLA; and
- Three points are awarded for 90% of NLA.

The Daylight Factor (DF) method is used to show Green Star compliance. DF is defined as the ratio of internal horizontal illuminance to external global horizontal illuminance. It represents the proportion of available external light which illuminates a given point inside the building.

The results below were calculated using the Radiance simulation engine which provides a detailed multi-zone physics-based calculation of illumination levels on the working planes of the building.

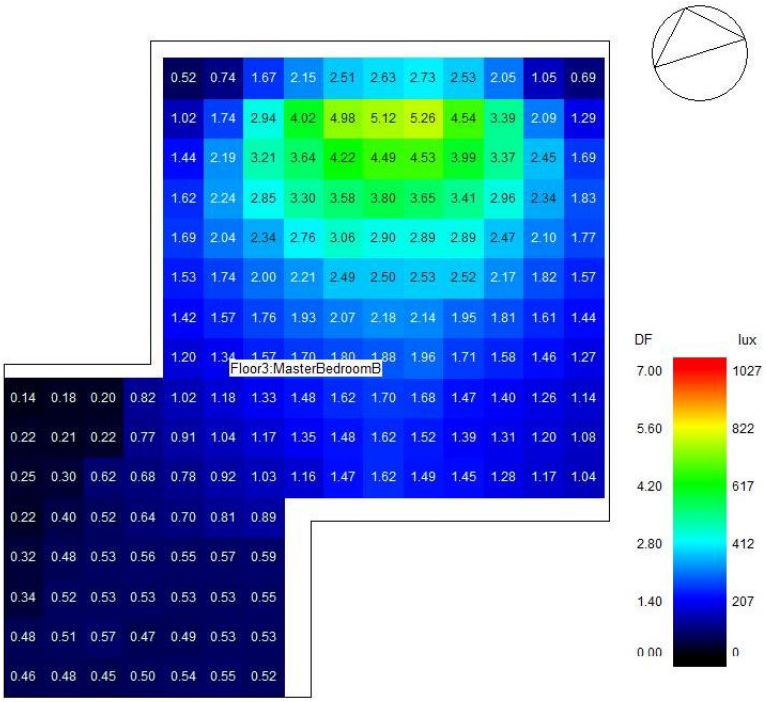
Daylighting data	
Project file	C:\Users\rubar\Documents\resalah\POST designbuilder.dsb
Report generation time	14/4/2024 19:49:39
Sky model	1-Standard sky, 7-Uniform cloudy sky
Location	JERUSALEM AIRPORT
Working plane height (m)	0.100
Max Grid Size (m)	0.300
Min Grid Size (m)	0.300
Daylight factor threshold (%)	2.000

Summary Results	
Total area (m2)	2.7
Total area meeting requirements (m2)	2.1
% area meeting requirements	80.0
GreenStar Credit IEQ4 Status	2 Points

Eligible zones for daylighting

Zone	Block	Floor area (m2)	Min DF (%)	Working plane area within Limits (%)
floor 3	study A	2.7	1.17	80.0
Total		**2.7**	**1.17**	**80.0**

master room daylight map and report:



GreenStar Credit IEQ4 Report

The aim of the daylighting credit is to encourage and recognize designs that provide appropriate levels of daylight for building users.

Criteria for meeting the credit is defined in the "Green Star Office Design v3 Technical Manual" as follows:

Up to three points are available where:

- The percentage of the NLA as stated below has a measured Daylight Factor (DF) of not less than 2.0%, at desk-height level (720mm AFFL) under a uniform design sky;

OR

- The percentage of the NLA as stated below has a Daylight Illuminance (DI) of at least 250 lux.

In both cases the points are awarded based on percentage of NLA as per:

- One point is awarded for 30% of NLA
- Two points are awarded for 60% of NLA; and
- Three points are awarded for 90% of NLA.

The Daylight Factor (DF) method is used to show Green Star compliance. DF is defined as the ratio of internal horizontal illuminance to external global horizontal illuminance. It represents the proportion of available external light which illuminates a given point inside the building.

The results below were calculated using the Radiance simulation engine which provides a detailed multi-zone physics-based calculation of illumination levels on the working planes of the building.

Daylighting data	
Project file	C:\Users\rubar\Documents\resalah\POST designbuilder.dsb
Report generation time	14/4/2024 19:44:34
Sky model	1-Standard sky, 7-Uniform cloudy sky
Location	JERUSALEM AIRPORT
Working plane height (m)	0.100
Max Grid Size (m)	0.300
Min Grid Size (m)	0.300
Daylight factor threshold (%)	2.000

Summary Results	
Total area (m2)	16.8
Total area meeting requirements (m2)	5.1
% area meeting requirements	30.4
GreenStar Credit IEQ4 Status	1 Point

Eligible zones for daylighting

Zone	Block	Floor area (m2)	Min DF (%)	Working plane area within Limits (%)
floor 3	master bedroom B	16.8	0.14	30.4
Total		**16.8**	**0.14**	**30.4**

As for the **annual daylight results**, standards were applied LEED v4 Daylighting BD+C: New Construction (sDA and ASE)

Zone	Block	Floor area (m2)	sDA area in range (m2)	sDA % in Range%	ASE area in range (m2)	ASE % in range
master bedroom A	floor 3	17.230	0.000	0.00	17.230	100.0
G.bedroom A	floor 3	11.328	0.000	0.00	8.706	76.9
livkit A	floor 3	30.326	8.377	27.62	28.524	94.1
study A	floor 3	2.687	0.000	0.00	2.687	100.0
livkit B	floor 3	29.796	7.938	26.64	27.078	90.9
master bedroom B	floor 3	16.754	0.000	0.00	16.754	100.0
G.bedroom B	floor 3	11.502	0.000	0.00	11.312	98.3
B.bedroom B	floor 3	10.361	0.000	0.00	10.361	100.0
study B	floor 3	3.167	0.000	0.00	3.167	100.0
	Total	**133.143**	**16.315**	**54.26**	**125.819**	**95.9**

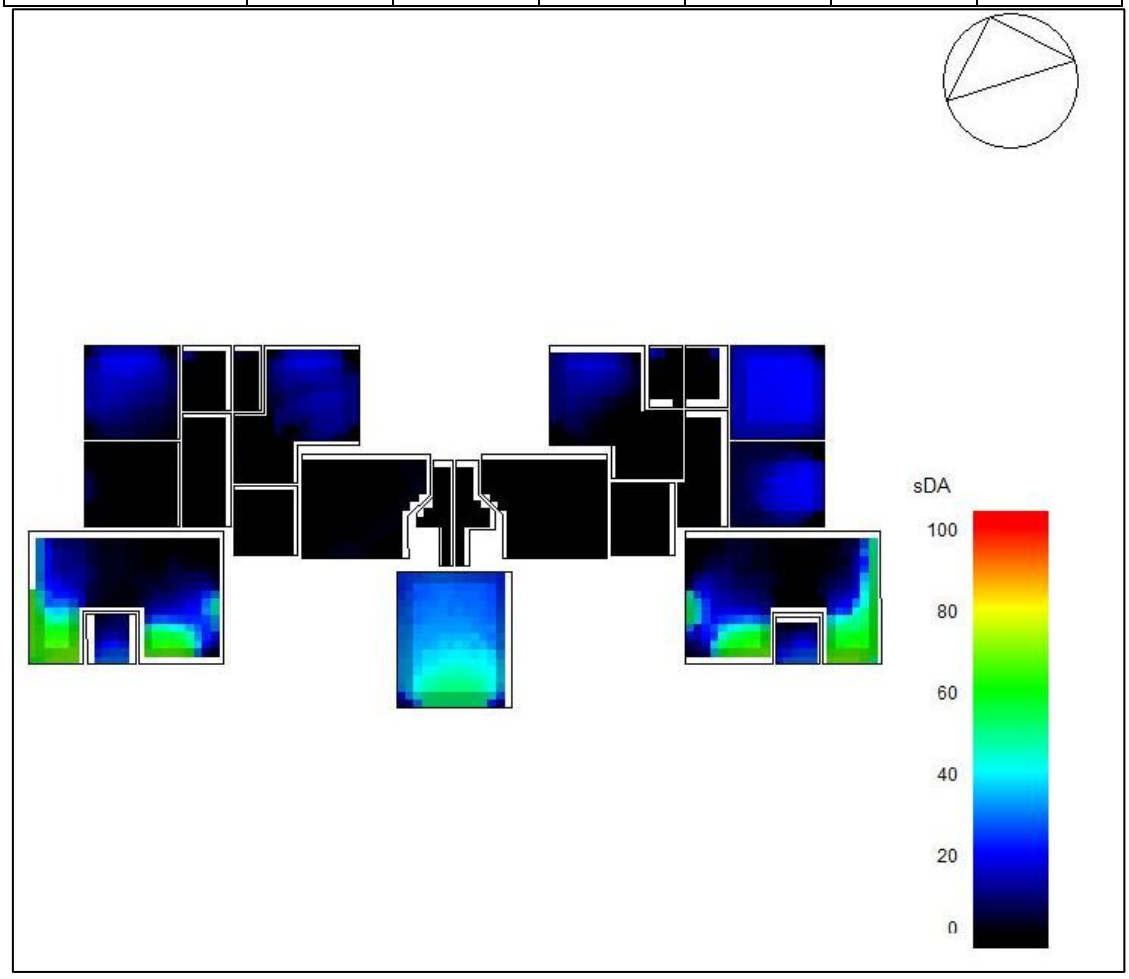


Figure 52 3RD floor SDA

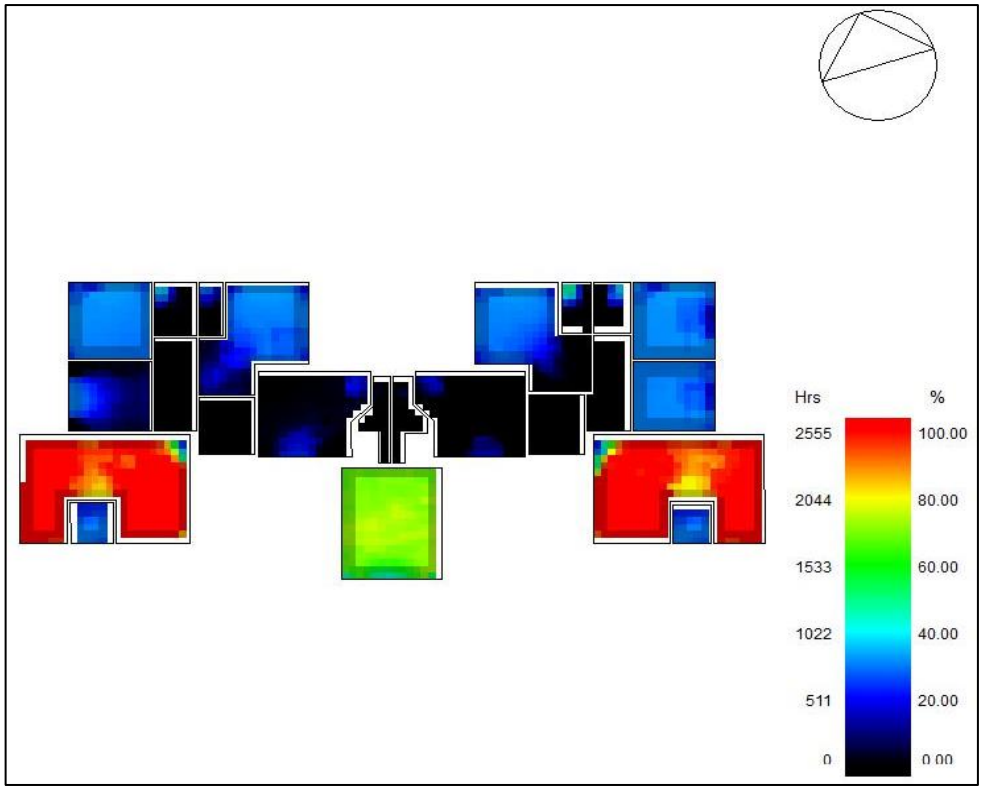


Figure 53 3RD floor UDI

6.2.3 CFD

Computational Fluid Dynamics (CFD) dune by using design builder.

External CFD analysis:

The Figure 54 A plan showing the location of the CFD simulator on the last floor show the distribution of air speed and pressure around the multi-apartment building structure resulting from the influence of wind. Pedestrian comfort was evaluated, solutions to problems were developed, and the most accurate pressure coefficients were calculated to simulate natural ventilation.

Figure 54 A plan showing the location of the CFD simulator on the last floor

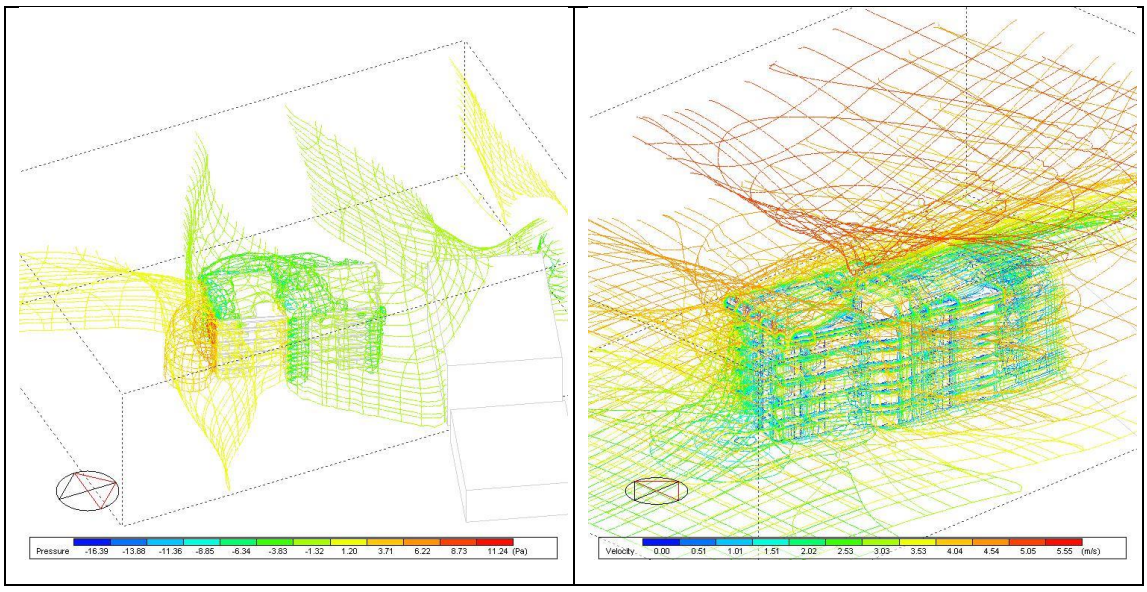


Figure 55 External pressure left and velocity right

Figure 55 External pressure left and velocity right show that the increase in air speed at the top of the building led to a decrease in pressure, which contributed to an increase in the process of suctioning air from the building through the skylight tubes.

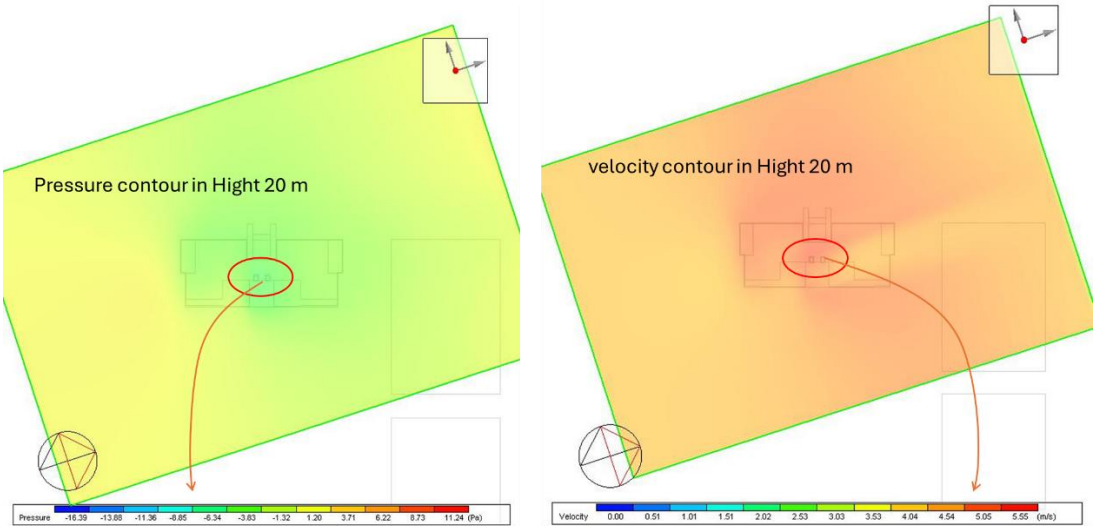


Figure 56 Readings external pressure left and velocity right

CFD test for negative pressure system:

Isolation room: The atmospheric pressure of the isolation rooms on the ground and fourth floors was simulated to examine its effectiveness and operation. It was found through a CFD examination that the system is working, and the air is being drawn upwards, as the attached pictures show.

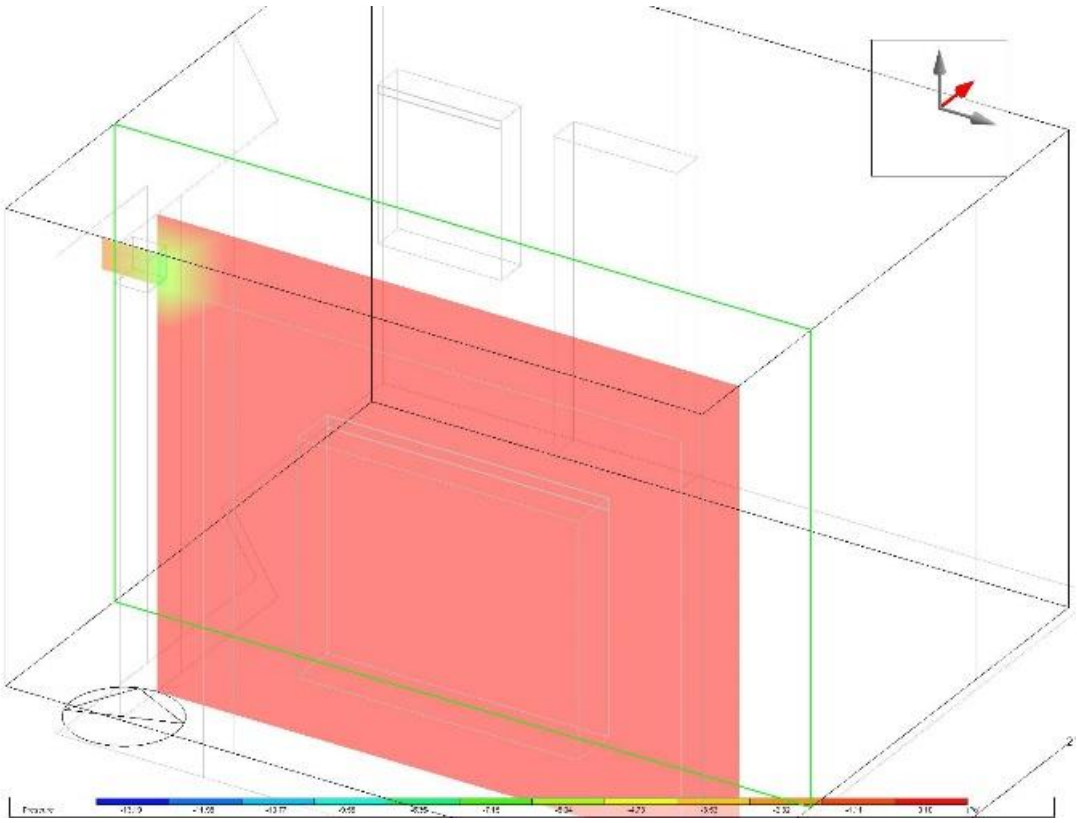


Figure 57 Pressure contour in isolation room in floor 4

Figure 57 Pressure contour in isolation room in floor 4 Show the transfer of pressure from high to low in skylight direction which mean the air will move to opening to extract from to the upward through tube.

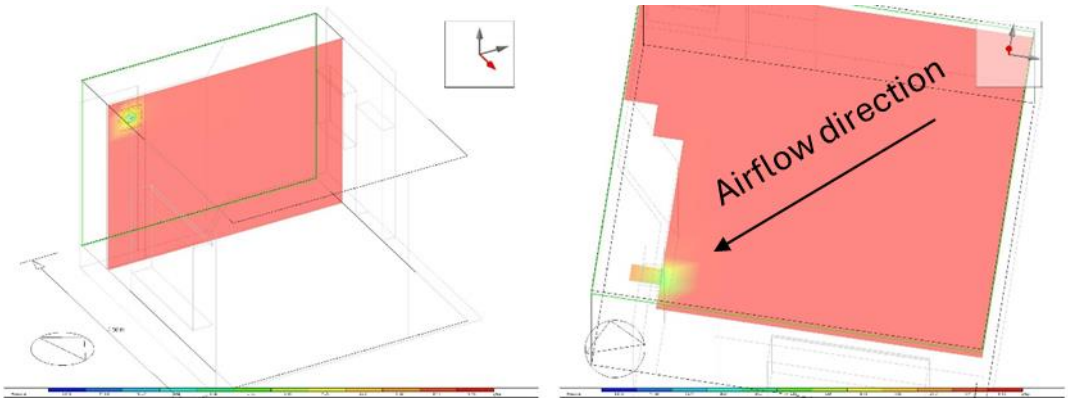


Figure 58 Vertical and horizontal slice in isolation room 4th floor

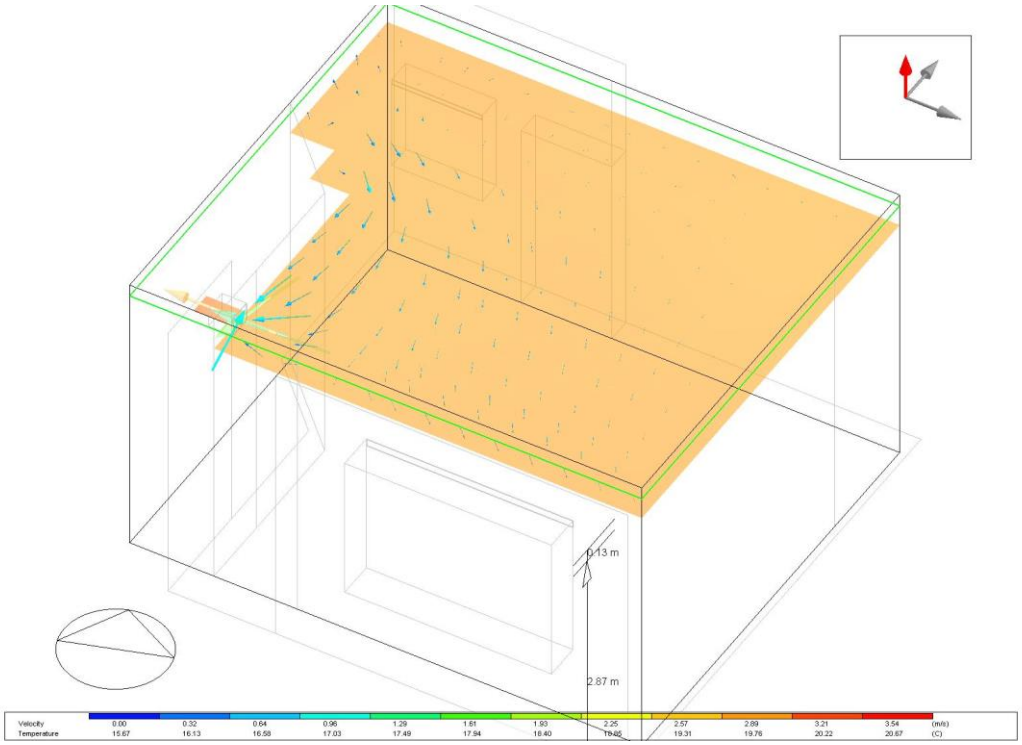
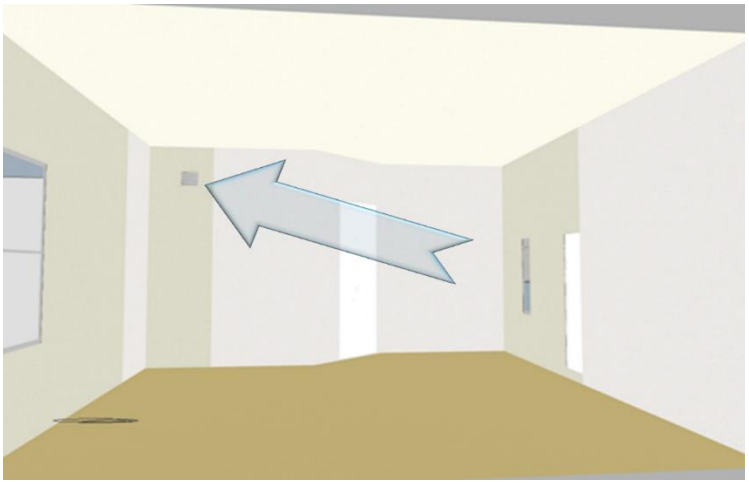


Figure 59 Pressure and velocity in isolation room ground floor

In the picture above Figure 59 Pressure and velocity in isolation room ground floor, the direction of the arrows indicates the direction of air movement towards the opening of the negative pressure system, which pulls air from the room to the top of the building's roof through the suction tube passing through the skylight. Look Figure 60 Color representation of pressure difference and direction of air



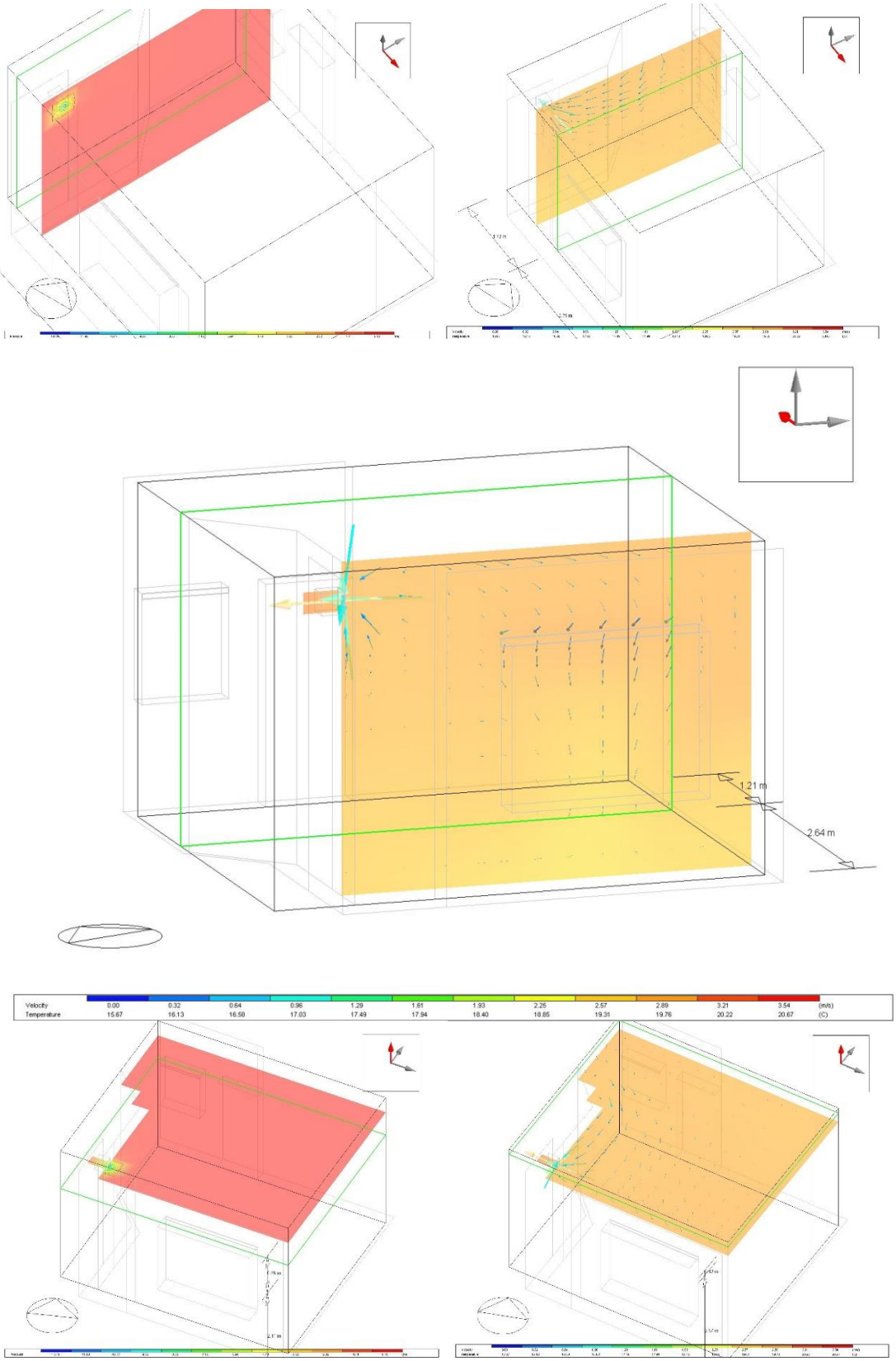


Figure 60 Color representation of pressure difference and direction of air movement.

Air suction skylight:

The picture below shows the longitudinal, transverse, and horizontal sections of the natural atmospheric pressure inside the suction tube for the passive isolation rooms for the entire apartments, specifically at the location at the top of the roof see Figure *61* Location of the room increases the effectiveness of the system. The pictures show a decrease in pressure as we move upward, and this necessarily means that the air moves upward, which gives the exhaust -extract- effect.

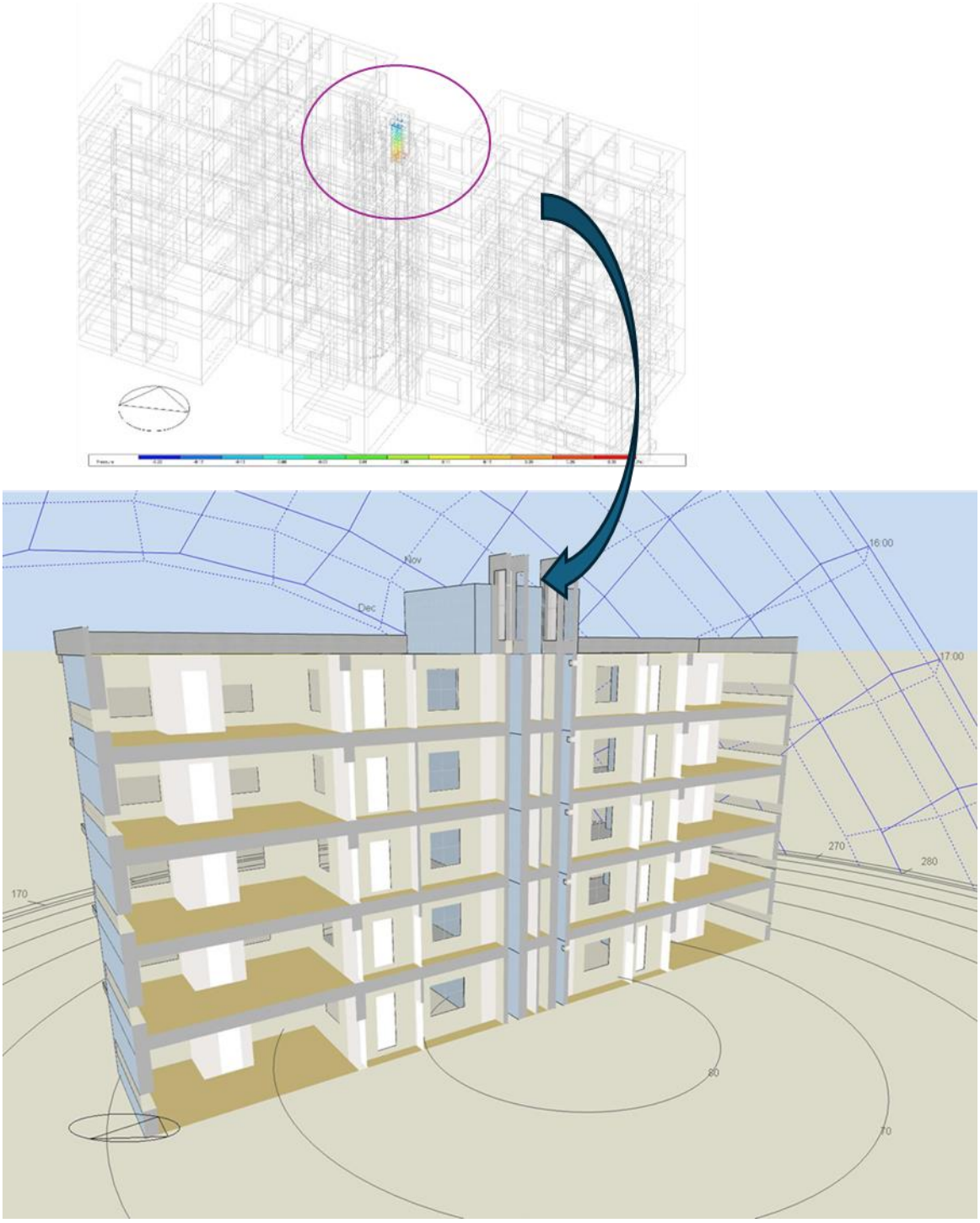


Figure 61 Location of the room increases the effectiveness of the system

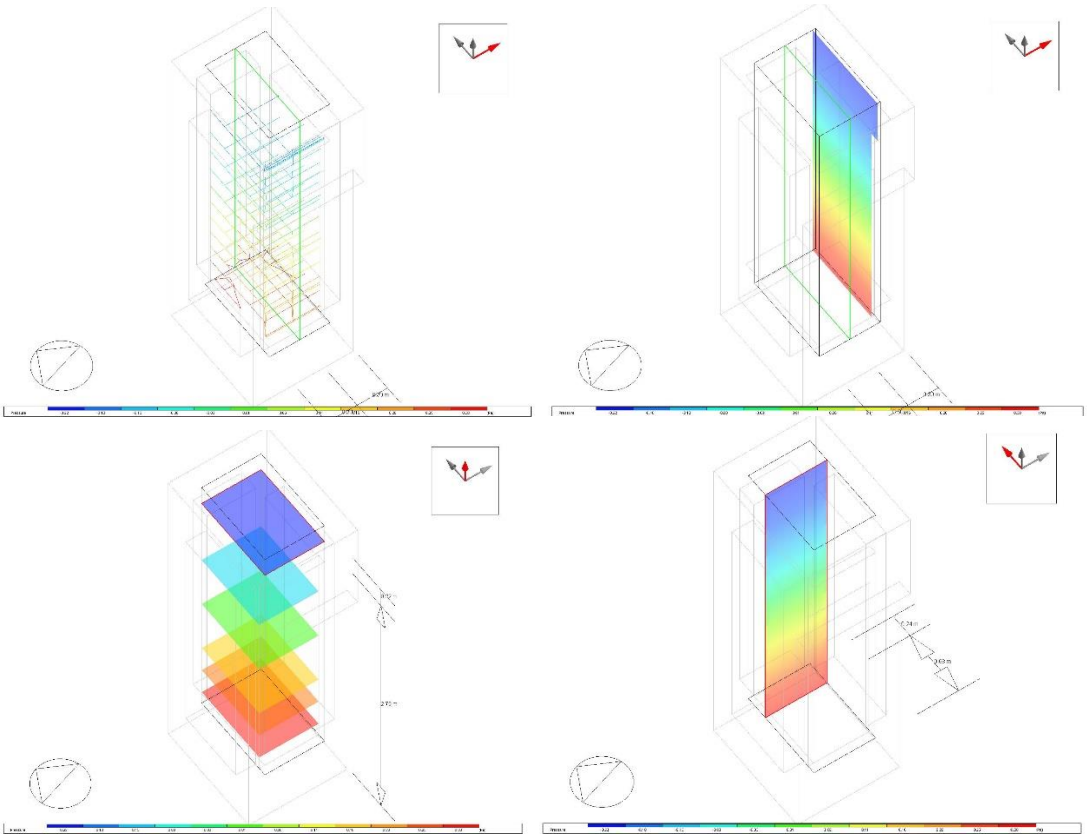


Figure 62 The pressure difference inside the suction pipe

Chapter 7

7 Conclusions and Recommendations

Talking about residential apartments is about expensive space. One of the most important design specifications is flexibility, as increasing the space may not be an available option as much as working to adapt and change the space to suit the needs of the stage.

The emergence of drug-resistant infectious diseases and the unexpected events of the severe acute respiratory syndrome coronavirus pandemic and the H1N1 influenza pandemic alert us to the need of adopting strong programs to prevent and control airborne infections. Scenarios of another influenza pandemic, bioterrorism, and not ruling out the possibility of a new airborne virus with a high fatality rate should be enough to convince condominium and apartment building licensing officials to ensure that their facilities are equipped with robust and redundant isolation and infection prevention capabilities. The negative pressure system may not be only most important defense against airborne infection, but it may play an important role in epidemic situations. Local government Authorities responsible for building certification which must adopt a precautionary approach that include a negative pressure system in the design and planned construction of residential buildings.

In order to answer The main question How to make apartment buildings more immune to the transmission of infectious diseases? certain specifications achieved in the imaginative model resulting from the trends and ambitions of doctors, users and sustainability experts will be circulated, as this design is suitable for generalization in Hebron for designs with identical guidance with five floors, with two apartments on each floor, with an area of 457 square meters, and facades of 17% window wall, and for each piece with a similar surrounding, it can be generalized the results on it.

Conclusions and recommendations that has a fundamental impact on the architectural design of this research:

The conclusions are the product of the interviews, and these findings can be generalized. Simulation conclusions: The effectiveness of the negative pressure system can be generalized, and the designed plan is considered an architectural representation of the design and public trends. However, if the orientation and geographical context change, it is necessary to rethink the basic architectural details and re-examine the thermal and visual comfort of the project.

1- Emphasizing the necessity of providing a flexible isolation room, where its original role, and in non-epidemic cases, is a guest room equipped with an isolation system, which is a system that turns the room into **a negative pressure room** with operating valves and supplies to prevent returning of air. It is a room that mimics isolation rooms in hospitals, but with a passive design, lower costs, and a strong connection to the external staircase, which is called the safe path, and a strong visual connection to the entrance garden which containing the transformable living wall. It is worth noting that any additional bedroom can be prepared with the same negative pressure system proposed in the research to make it ready to become an isolation room. The justifications for the system adopting an isolation room inside the apartment, the most important of which is the statement of the virologist, where he said: **"**We are talking about the rare aspect, but in the event of an epidemic or pandemic such as Covid, if it is more deadly, and this is not in our control, like in 2003, the virus was more dangerous, but it did not kill a greater number. The number reached 8,000 people, but the reason for the method of transmission is that it was weak and easy to control, and the Corona virus was easy to transmit, but less severe or harmful than the previous virus, but if a new Corona virus appears among us, it is easily transmitted by the Covid virus and the danger of SARS. In this case, societies become looking for any means to reduce the danger and consequences of the spread of the virus. Generations may pass before we feel the need for it or the appearance of this virus. But if this virus appears, we must be prepared for such a scenario". And the global trend towards

telehealth and teletherapy confirms the importance of providing flexible isolation rooms inside apartments as an inevitable future option.

2- One of the most prominent preferences of users in relieving themselves was the experience of leaving the door of the apartment, and therefore this feeling must be transformed into a design behavior that makes the user of the apartment feel that he has left the apartment by placing the **balcony at the entrance** to the apartment, and the path shown in the plan was also adopted.

3- **A containment area** must be designed at the apartment entrance to provide two services:

A- A temporary **primary storage station** for materials, tools, and necessities brought inside from outside that may require cleaning or sterilization before entering more private space in the apartment.

B- Providing a **hand-washing station** near the apartment entrance. This meets the necessity of cleaning hands before entering the interior spaces of the apartment.

4- Also, a **containment area** must be designed at the entrance to the multi-residential building, for the purpose of receiving purchases and also to stop any pathogens that may enter from the outside into the entrance hall, by employing the white wall mechanism.

5- Providing **a Transformable living walls** that can be modified by the user. Its nature is to simulate vertical gardens at times and horizontal gardens at other times through designing in a manner of installation, rails and basins that have a central movement. They are placed in the entrance balcony and give the opportunity to provide a biophilic natural landscape for the characteristics of the apartments, as many apartments lack a landscape.

6- One of the most important conclusions has been reached is that decision makers must provide facilities to increase the building areas for affordable housing in apartments, especially since all public spaces, including hospitals, are taken to shrink, in light of technological development and performing all services remotely like health care is provided. Currently, **the spaces that need to be increased and supported are residential apartments and green public parks**

7- Modifying and updating the **functional framework as shown in Chapter Five**, taking specifications and directives for materials and surfaces, and employing technological development in design will contribute effectively to alleviate the spread of infection in multi-apartment buildings.

8- In times of the epidemic, it is necessary to preserve the health of citizens and provide safe corridors for medical teams so that they can enter and exit multi-apartment buildings with the least amount of risk. Therefore, it is necessary to adopt the results of the research regarding providing the location of the escape staircase and granting it a safe character and greater accessibility to serve as **a safe path** for medical staff, infected people and users during the pandemic.

9- **Governance of the new normal**: Policymakers must make affordable housing a key priority. To confront potential failures in the field of public health, clear

legislation must be adopted in strategic plans regarding health requirements, such as developing a special guide for managing residential buildings during periods of the epidemic, and a guide to procedures for adopting materials, surfaces, and design methods that support psychological and physical health, and it must be bound on the part of Ministry of Health. When licensing any building in order to achieve health security, it will be difficult to face any future setback.

10- Increasing the **awareness** of those involved in the process of improving the affordable housing sector about matters that affect health, and educating citizens, officials, contractors and engineers about design methods that meet standards of well-being and health security and that contribute in protecting the environment and the safety of users.

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9 Appendices

9.1 Interviews Structure (Interview questions analysis and evaluation)

appendix 1 space planning and layout question's structure

Space Planning and Layout Theme:

- Q16 among the residents of one building. Based on your experience, are there water standards that you recommend, or lessons learned that can be codified in architectural design to ensure the ability to manage crises in the event of an epidemic spread, such as external stairs, ventilation, distances, number of rooms, number of bathrooms? This question attempts to monitor the suggestions that might have been felt important by the doctor who faced the disease when he visited patients in the apartments or when he listened to his crews when carrying out their work in providing medical service to the residents of the apartments, which is what is expected to be his answer according to the research hypothesis that the availability of open external drawers is especially necessary. If it is connected to the proposed quarantine room, it will provide a safe passage for medical teams and give users more exposure to the open air from their apartments to the outside and vice versa, and also provide additional bathrooms for the apartment, additional exits,…

- Q17 among the residents of one apartment, and in reality, In your experience, are there standards that you recommend for managing the crisis in the event of an epidemic spreading? This question determines whether it is necessary to establish binding and controlling laws for the design of residential apartment buildings, such as adopting a technology that reduces touching of surfaces to reduce the causes of disease transmission, as well as emphasizing the idea of having an isolation room and its own bathroom, as well as the relationship of spaces and their services to each other in terms of ventilation, drainage, and air conditioning.

- Q18 How can the apartment layout be optimized to support physical distancing and reduce close contact between occupants? It is assumed that a comparison will be presented in this question for a design system that

enhances ventilation through an open design that enhances air circulation as well as reduces the possibility of the presence of pathogens and supports a gradient of privacy based on separation and the entry of use of a flexible space that can be transformed into an isolation room, additional spaces for temporary storage, and remote work areas. design enhances access to the outdoors and the natural landscape

- Q19 Are there recommendations for designing separate areas or zones within the apartment to isolate potential sources of contamination or support quarantine measures, if needed? This question identifies the importance of providing a station at the beginning of the design that provides a temporary store for all tools brought from outside, coats, mobile phones, keys, and purchases, such as a cleaning station, first sorting, and a hand washing station before entering the living room, kitchen, and the rest of the apartment.

- Q20 What are the considerations for shared spaces, such as entryways, elevators, or common areas, to minimize the risk of respiratory disease transmission? Determines the tendency of professionals to use voice or facial recognition technologies for shared facilities and designs that can provide physical distancing, such as open drawers, and notes the disturbing potential of the proposed solutions.

- Q21 Among the residents of a multi-apartment building, and based on your experience, is there something you wished existed in the architectural design to overcome the crisis of the spread of an epidemic, such as an external staircase, ventilation spaces, number of rooms, number of bathrooms, and brands? This research question provides a source of suggestions that users see that could have provided them with psychological or physical comfort to reduce the risks they experienced during the pandemic, to draw lessons and identify needs.

- Q22 What was your impression of the feasibility of physical distancing and reducing close contact between apartment residents? This question determines the extent to which users respond to distancing and the extent of the realism of the proposition, especially when we are talking about a mother and her children, or an elderly mother and father and those who care for them, or a patient with low immunity and someone who suffers from a chronic disease with those who care for him. The goal is to measure the level of possible interventions.

- Q23 Are there recommendations for designing separate zones or zones within the apartment to isolate potential sources of contamination or support quarantine measures, if necessary? The same goals as Question 19, but it was asked to users

- Q24 What are your thoughts regarding shared spaces, such as hallways, elevators, or common areas, to reduce the risk of respiratory disease transmission? This question identifies users' preferences about the ways they used to protect themselves and the options that were available and should be available.

appendix 2 Material Selection and Surfaces question structure

Material Selection and Surfaces Theme:

Q25 Are there any guidelines for the nature of materials that must be chosen to facilitate the work of resisting diseases and epidemics, such as prohibiting the use of these materials or encouraging the use of certain materials This question identifies the mechanisms that may be related to the architectural space or the proposed surface finishing, such as germ-resistant surfaces and focusing on the hand-cleaning point. This will help confirm the research hypothesis about the necessity of providing a hand-washing station at the entrance to the apartment.

Q26 Are there practices and recommendations for maintenance plans or recommendations for cleaning, care, or use to control disease transmission? This question determines how to deal with the infected person and his waste, which will therefore confirm the necessity of providing an isolation room to separate his air, fluids, and waste.

Q27 Are there materials that you recommend using or stopping using to combat infectious diseases? The answer to this question is supposed to be the use of options such as non-porous and antimicrobial surfaces, single-use materials, multi-cleanable surfaces, and avoiding porous surfaces and surfaces that are not susceptible to microbial growth. Here the importance of moisture resistance appears.

Q28 Are there specific guidelines for selecting materials and surfaces that are easy to clean, disinfect, and resistant to the survival of pathogens? Similar to Question 27 but posed to sustainability professionals. The guidelines provided by them aim to reduce the risk of transmission of infectious diseases by ensuring that surfaces can be cleaned and maintained effectively. Such as smooth and non-porous surfaces, seamless and non-crevice surfaces, resistance to cleaning agents, durability and corrosion resistance, antimicrobial coatings or treatments, compatibility with cleaning methods:.

Q29 What are the considerations for using antimicrobial or self-cleaning materials that can help reduce the transmission of respiratory diseases? This question defines mechanisms for the researcher to follow in employing materials, and the answers are supposed to be employing them based on their effectiveness, longevity, and

durability, evaluating the safety and potential environmental impact of the materials used, and integrating them with other preventive strategies such as regular cleaning and disinfection, hand hygiene, proper ventilation, and adherence to health guidelines. General, regular maintenance to ensure optimal performance, are best suited to high-touch surfaces

Q30 How sustainable and low-emitting materials be integrated into the apartment design to promote respiratory health while minimizing environmental impact? The question determines the contribution of materials to improving indoor air quality. Choose natural, non-toxic materials such as natural fiber carpets, linoleum, bamboo, or cork flooring, which emit fewer chemicals compared to traditional synthetic materials. Use sustainable and renewable materials such as responsibly sourced wood, or... Recycled content, or rapidly renewable resources such as bamboo or cork. Look for certifications like Forest Stewardship Council (FSC) or Cradle to Cradle (C2C) to ensure sustainable sourcing.

recycled or upcycled materials for construction and finishes, such as recycled glass or reclaimed wood flooring. energy-efficient appliances and fixtures to minimize energy consumption and environmental impact. Non-Toxic Finishes and Sealants. Moisture-resistant materials in areas exposed to moisture, such as bathrooms and kitchens, to prevent mold and mildew growth, maximize natural lighting, and incorporate biophilic design principles by incorporating elements of nature. Efficient waste management.

Q31 Are there specific guidelines you follow to choose materials and surfaces that are easy to clean, disinfect, and resistant to the survival of pathogens? Same as question 28 but directed to users

Q32 How have antimicrobial or self-cleaning materials been used that can help reduce the transmission of respiratory diseases? Same as question 30 but directed to users

Q33 Are there specific substances that contributed to increasing or stopping infectious diseases? sterilizers and pesticides

appendix 3 Lighting and Natural Elements questions structure

Lighting and Natural Elements Theme:

Q34 Between the procedures for isolating the infected person and protecting the non-infected within the same building. Do light, its arrival, and the possibilities of introducing natural elements or landscapes have a role in the process of fighting epidemics? This question confirms the researcher's concern about giving these aspects more priority in post-pandemic designs, and it is expected that the answers will revolve around Natural light has antimicrobial properties and can help reduce the survival of pathogens in the environment. Adequate ventilation with fresh outside air can dilute and remove airborne contaminants, reducing the risk of transmission. Biophilic design and landscapes provide **psychological benefits.** Designing buildings with access to outdoor spaces, such as gardens, courtyards, or balconies, provides opportunities for infected individuals to safely spend time outdoors while maintaining isolation protocols. Daylight also has disinfecting properties, especially germicidal ultraviolet rays, and helps in disinfecting surfaces. Reduces feelings of confinement and isolation

Q35 What are the recommendations regarding obtaining lighting and its types? The answer to this question is supposed to revolve around the importance of exposing people, specifically in the Middle East, to sunlight and the resulting increase and strengthening of the immune system. With regard to species, an explanation of the effect on cleaning and sterilization of natural and artificial light.

Q36 What is the role of access to the Nature elements in fighting epidemics? It promotes mental and emotional health during periods of confinement and provides an incentive for physical activity and exercise, which strengthens the immune system. Exposure to fresh air and improved ventilation disperses airborne particles, reducing the risk of infection. Chronic stress resulting from confinement or fear of infection weakens the immune system and increases susceptibility to infection

Q37 How Can natural lighting be maximized in the apartment design to create a bright and well-ventilated living environment that supports respiratory health? Orientation and planning by improving the orientation of the apartment to maximize exposure to natural light, adopting an open design, and using internal glass to allow natural light to penetrate deeper into the apartment. Incorporate large windows and glass doors to maximize the entry of natural light. Floor-to-ceiling windows or windows with minimal frames can allow for unobstructed views and better light transmission. Adopt skylights and light wells. Use light-reflecting surfaces and arrange furniture to avoid blocking windows and allow light to reach deep into the room.

Q38 How to opportunities to in corporate operable windows or other means of natural ventilation to improve air exchange and indoor air quality? In terms of window design and placement, the answer must be windows that can be opened and closed easily, taking into account prevailing wind directions, and enhancing air flow throughout the apartment. Window size and number, activating natural ventilation strategies, using window treatments that increase their effectiveness

Q39 Between the isolation procedures for the infected person and the protection of the uninfected within the same built environment, do light and its access and the possibilities of introducing natural elements or landscapes have a role in the process of fighting epidemics? The same as question 34, but it was asked in a different way to the user, and here the consideration is linked to the user's own experience

Q40 The role of natural lighting in the apartment to create a bright and well-ventilated living environment that supports respiratory health? Have you noticed the importance of having natural lighting? This question determines the type of natural lighting that users have a preference for and which is the result of need and experience

Q41 What is the role of access to natural elements during the home quarantine period? This question helps the researcher determine the size of the natural elements and the area of intervention with the lowest possible cost.

appendix 4 Health and Safety Considerations questions structure

Health and Safety Considerations Theme:

Q42 from the reality of your work in public health and fighting epidemics. What are the most prominent methods to prevent the spread of epidemics within built environments during the period of home confinement? This question identifies for the researcher the areas that health sector workers advise and focus on within safe environments to prevent the spread of epidemics, and this will require directing architectural designs primarily towards these points. The answers are supposed to revolve around awareness of cleaning, disinfection, and hand hygiene, communication and education regarding preventive measures, and the necessity of maintaining the building, and one of their most important roles was in tracking those infected and testing them.

Q43 The relationship to population density and the behavior of the virus in built environments? The goal of this question is to explain the dynamics of the spread of the virus in the built environment, specifically during the period of confinement, which are multi-apartment buildings. It is expected that the answers will be in the direction of the direct proportion between the high occupancy rate and the probability of infection with the disease.

Maximum reproduction number (R0): The reproduction number (R0) represents the average number of people to whom an infected person is likely to transmit the virus in a susceptible population. In densely populated areas, with a higher concentration of susceptible individuals in close proximity, the R0 may be higher, resulting in faster spread of the virus. The problem of the difficulty of implementing social distancing also arises. Impact on healthcare systems negatively.

Q44 Which built environments are more difficult in fighting viruses during the period of home confinement? This question identifies the impact of the research and confirms the gap from those who fought the epidemic on the front lines. The answers

will be: Multi-unit residential buildings: In high-density apartment complexes or housing units, residents share common areas such as elevators, stairs, or lobbies.

Q45 What problems did you encounter In combating epidemics in residential apartment buildings, what are the most prominent methods that have been adopted to confront these problems? The goal of the question is to understand the problems based on the pandemic experience and answer the question :

problem	reason	solutions
Limited space	Challenges in conducting effective contact tracing, identifying and isolating infected individuals, and implementing social distancing measures within the building.	- Collaborate with building management and residents to implement and enforce social distancing measures, such as staggered use of common areas, limiting the number of people in elevators, and maintaining physical distancing in common spaces. - Provide guidance and recommendations to residents on appropriate hygiene practices, including hand washing, wearing masks, and sanitizing shared surfaces. - Increase communication and educational campaigns to raise awareness of preventive measures and the importance of adhering to guidelines. - Facilitate testing and contact tracing efforts within the building, and work closely with public health authorities to

		immediately identify and isolate cases.
Shared Facilities and Common Areas	Many residents come into contact with the same surfaces and spaces.	- Implement cleaning and disinfection protocols for shared facilities and common areas, focusing on frequently touched surfaces. - Providing sterilization stations so that residents clean their hands before and after using shared facilities. - Promoting responsible behavior among residents, such as wearing masks in common areas and practicing proper hygiene. - Make schedules and reservations to use shared facilities to reduce crowding and facilitate social distancing. Via apps
Vulnerable Populations	This population may face additional challenges in accessing health care services, adhering to preventive measures, or understanding risks associated with the pandemic.	Providing positive and negative isolation rooms

Q46 What mechanisms do you think that, if designed and built upon, would be a reason for limiting the spread of the epidemic or reducing its severity? Adequate ventilation, designated isolation areas: flexible space design, easy-to-clean surfaces, control of entry and exit ports and the possibility of separating them.

Q47 Are there systems in place in the health system to manage the building during epidemics? Answering this question gives feasibility to this research if the answer is negative, as this research must be a cornerstone for developing such systems.

User questions:

Q48 What feeling did you feel when one of the apartment members was infected with a contagious disease? This question identifies users' concerns to prepare them for the expected change of apartments and the importance of having isolation rooms in the apartment and terraces....

Q49 How did you feel when one of the residents of the building was infected with a contagious disease? This question confirms the necessity of implementing the research hypothesis in shared facilities and the dynamics of movement therein.

Q50 If one of the residents of your apartment was infected with a contagious disease, how would you act? This question determines for the researcher the users' responses to the injury and the methods he used to deal with the situation. This gives the researcher an awareness of the extent of the limits of the user's capabilities in receiving changes in the design of the apartments.

Q51 What problems did you face during the quarantine period? This question gives the researcher an idea about whether there are questions that did not occur to her to solve the research problem.

Q52 What are the most prominent methods that have been adopted to confront these problems? Understanding the user's preferences in moments of fear provides guidance to the designer in providing safety and luxury in the treatments provided and is more closely aligned with the users' desires and needs.

Q53 What are the things you wish were in the design to alleviate your fears? This question identifies a broader range of needs that may be related to additions to the apartment that may enhance the user's resilience during epidemics.

appendix 5 Universal Design and Accessibility questions structure

Universal Design and Accessibility Theme:

Q54 Are there standards and guidelines for people with special needs in the world of epidemiology that must be developed by the architect to be codified? In this question, the researcher is trying to indirectly explain the doctors' answer to the necessity of providing a flexible space that serves as a quarantine room in apartments, especially in the event that they need special care, which includes multiple types of people with special needs, as they need a personal companion in most cases.

Q55 What do you think about telemedicine, its role, and ways to employ it in fighting epidemics? This question determines doctors' perceptions about the capabilities of telemedicine and telehealth care and its contribution to protecting medical personnel during periods of epidemics, and what it entails as a result of the necessity of providing a space in the apartment to contain the recipient of the service.

USERS interview questions structure:

Q56 Where did your children play during quarantine? This question monitors the problems of providing children's needs during the epidemic period and the capabilities that can be developed to solve such problems through architectural design.

Q57 How has the pandemic affected older people ؟This question is to find out the problems of providing the needs of the elderly during the epidemic period and the capabilities that can be developed to solve such problems through architectural design.

Q58 Where did you turn to relieve the stress resulting from the pandemic? This question develops for the researcher the most important needs for which new spaces must be provided in the design of a post-pandemic apartment.

appendix 6 acoustics and noise control question's structure

Acoustics and Noise Control Theme:

Q59 How can the apartment design address acoustics and noise control to promote a peaceful and restful living environment, which is important for respiratory health?

1. Soundproofing Materials: Incorporate sound-absorbing materials in the construction of walls, floors, and ceilings to minimize the transmission of noise between units. This can include using materials such as acoustic insulation, double-layered drywall, and carpets or rugs with sound-dampening properties.

2. Wall Construction: opt for solid and well-insulated wall construction that helps to block out external noise. Consider using materials with high Sound Transmission Class (STC) ratings to reduce noise transmission through walls.

3. Window Design: Use double-glazed or laminated windows to minimize external noise infiltration. Proper sealing and weatherstripping around windows can also help reduce noise penetration.

4. Floor Coverings: Choose flooring materials that have noise-reducing properties, such as carpets, cork, or rubber flooring. These materials can absorb impact noise and reduce footfall noise between floors.

5. Room Layout: Carefully plan the layout of living spaces, bedrooms, and common areas to minimize noise transfer. Place bedrooms away from noise sources, such as elevators, stairwells, or mechanical rooms. Consider utilizing buffer spaces, such as closets or utility rooms, as a barrier between noise sources and living areas.

6. Design the building envelope in a way that reduces noise entry by using insulation materials and closing gaps and cracks. This serves the goal of control.

Q60 Are there strategies to minimize noise transfer between units and common areas, ensuring a comfortable and healthy acoustic environment?

Orient the building in the direction with the least noise and direct the rooms according to use, away from noise sources, providing isolation barriers, such as storage rooms and corridors, to isolate sound, Disable audio paths by designing overlapping inputs, Use of insulating materials in the building's structural elements, Use double wall techniques, Adding materials to floors and ceilings reduces noise and sound transmission.

9.2 appendix 7 Details of interviews (number, interviewees, time of interview and location)

Details of interviews (number, interviewees, time of interview and location)				
No.	Interviewees Specialization	Time of interview	location	date
1	Molecular virology	10:00 am	Professor's Office, Korean Polytechnic University Building, 2nd Floor	2024-1-2
2	Physician Head of Preventive Medicine Department	14:00	South Hebron Health Directorate	22-12024-
3	Physician Head of Preventive Medicine Department	02:15	North Hebron Health Directorate	24-1-2024
4	Physician Head of Preventive Medicine Department	12:15	Center Hebron Health Directorate	24-1-2024
5	Physician Head of Preventive Medicine Department	12:00	South Hebron Health Directorate	21-12-2021
6	He holds a doctorate in architecture from the Polytechnic University of Milan in Italy, specializing in environmental sustainability and building technology. He specializes in the field of sustainable architecture mainly in environmental design, energy efficiency in buildings, use of renewable energy in buildings and green buildings.	10:00 pm	Zoom Application	2024-2-5
7	Developing an intelligent and integrated energy management system	06:46	Zoom Application	6-2-2024
8	AP LEED engineer	10:00	Google Meet	8-2-2024
9	USER / housewife	01:30	User apartment	2024-2-5
10	USER / secretary	04:00	User apartment	2024-2-5
11	USER / English literature	2:30	User apartment	2024-2-5
12	USER / TEACHER	1:00	User apartment	2024-2-5
13	USER / housewife	6:00	User apartment	2024-2-13
14	USER / housewife	1:10	User apartment	12-2-2024
15	USER / teacher	9:30	Google Meet	11-2-2024
16	USER / An employee with a master's degree	2:12	Google Meet	12-2-2024
17	USER / housewife	2:00	Google Meet	11-2-2024
18	USER / housewife	3:10	Google Meet	11-2-2024
19	Assistant Professor at Mechanical Engineering Dep. (Mechatronics) Palestine Polytechnic University Hebron P7261286, Palestine PhD Control of power converter for Renewable energy systems-Paris sud 11 University	10:00	PPU OFFICE	26-3-2024
20	Philosophy Doctorate, Geotechnical, Geo-environmental Branch (Carleton University, Ottawa, Ontario, June 1995)	11:00	PPU OFFICE	26-3-2024
21	PhD in Architectural Design Theory and Technology, University of Palermo, Italy	MANY TIMES	PPU OFFICE	MANY

9.3 appendix 8 Doctor interview form

مقابله الأطباء ومتخصصين الوبائيات وعلماء الفايروسات		
أولا :البيانات الأولية		
تاريخ المقابلة	مكان المقابلة	وقت المقابلة

ثانيا: البيانات الأساسية للمستجيب وفقا لمتغيرات البحث		
1	الاسم	
2	المؤهل العلمي	
3	التخصص	
4	البلد / المحافظة	
5	الوصف الوظيفي	
6	الخبرة	

ثالثا :ملخص عن البحث

عنوان البحث:

Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room.

مشكلة البحث:

إمكانية تفاقم انتشار الوباء او المرض المعدي أيا كان نوعه ومساهمة السكن المشترك في نقل المرض بقصد او بدون قصد، وهذا يستدعى النظر فى الهدف الرئيس من السكن وهو الحصول على الامن وفى هذه الحالات أصبح السكن مصدرا للمرض وانتشاره في هذا البحث محاولة لمعالجة هذه السناريوهات وغيرها في حالات انتشار الامراض والأوبئة ضمن شقة السكن ولكن باليات واستراتيجيات تساعد على الحد من احتمالات انتشار مسببات المرض.

أهداف البحث:

- وضع مقترحات لآليات وأدوات واستراتيجيات سهلة التنفيذ في المباني السكنية تقلل من انتشار الأوبئة داخل المبنى، وتزيد من مناعة المبنى ضد انتقال الأمراض.
- توفير مساحة معمارية مرنة داخل الشقة السكنية لاحتواء الشخص المصاب بالمرض المعدي، خاصة في الحالات التى لا يمكن استقباله فى المستشفى، بحيث يتم إعداد هذه المساحة بالشكل اللازم لضمان سلامته النفسية والعقلية والصحية. الصحة الوظيفية للمريض ومرافقيه في الشقة الواحدة.
- توعية مستخدمي الشقق بتأثير التخضير، وتحديداً جدران المعيشة الداخلية، لتخفيف الضغوط الناتجة عن الحجر المنزلى.

أهمية البحث:

تكمن اهمية الدراسة في جانبين الاول وضع الية لربط مستخدمي الشقق بتأثير قدرة التخضير وتحديدا الجدران الحية فى الاماكن المغلقة لتخفيف الضغوط الناتجة عن الحبس المنزلى والثانى تحديث الاطار الوظيفى لتصميم الشقق عن طريق التصحيح البيئي وعل الشقق اقل نقلا للأمراض المعدية من خلال استخدام مبدا غرفة الضغط السلبي والايجابى

الغاية من المقابلة:

يساهم البحث في وضع اليات وأدوات بين يدي صانعي القرار والمصممين و الناس العاديين في حالات الطوارئ فى حالات انتشار الأوبئة و عجز المرافق الصحية عن استقبال حالات الإصابة بدرجاتها المتفاوتة من الخطورة كما حصل في تجربة كورونا بجعل مساكنهم وتحديدا الشقق السكنية ماهلة لاستقبال المريض بتخفيف من خطر انتقال العدوى للقاطنين لنفس الشقة وهذا ما سيساهم في التخفيف من روع ومخاوف المواطنين في حالات انتشار الأوبئة والحجر المنزلى وحالات انتشار الامراض المعدية الموسمية وحالات عدم الرغبة فى الذهاب للمستشفيات، مما سيؤدي بالتالي الى تحسين جودة الحياه داخل الشقق وجعلها اكثر امانا من الناحية النفسية والعقلية و الوظيفية للفرد و المجتمع.

رابعا :أسئلة المقابلة:	
1	الامان والصحه
1.1	من واقع عملكم في الصحه العامه ومحاربه الاوبئه ما هي ابرز الطرق المضاده لانتشار الأوبئة داخل البيئات المبنيه
1.2	كيف تصف العلاقه بين الكثافه السكانيه وسلوك الفيروس في البيئات المبنيه
1.3	اي البيئات المبنيه اكثر صعوبه في محاربه الفيروسات
1.4	ما المشاكل التي واجهتكم في محاربه الاوبئه في مباني الشقق السكنيه؟ وما ابرز الطرق التي تم اعتمادها لمواجهه هذه المشاكل
1.5	ما الاليات التي ترى انها لو تم التصميم البناء عليها سيكون سببا في الحد من انتشار الوباء او تقليل حدته
1.6	هل يوجد انظمه لدى الصحه لاداره الابنيه فى الاوبئه
2	جوده الهواء الداخلي والتهويه
2.7	لابد ان جوده الهواء الداخلي مرتبطه بالتهويه ما التوصيات التي عاده ما يتم اعتمادها لديكم لضمان هذه الجوده كمختصين فى علم الوبائيات
2.8	ما رؤيتكم لافضل توزيع ممكن لضمان جوده الهواء الداخلي في المبنى السكني متعدد الشقق
2.9	هل وجود مناطق عزل مهم في اليات محاربه الاوبئه
2.10	هل التحكم في الضغط الجوي أحد الاساليب التي تستخدمها في ضبط جوده الهواء الداخلي
2.11	تبعا لطبيعه بلدنا فلسطين هل هناك اتجاه معين ومساحه معينه توزيع معين للفراغ يساعد توصون به للتحكم بالفيروسات المعدية واحتوائها
2.12	هل هناك اي اعتبارات معينه لمنع انتشار الأوبئة
3	التوزيع المكاني والتخطيط
3.13	بين سكان العمارة متعددة الشقق ومن واقع تجربتكم هل هناك معايير توصي بها او دروس مستفاده ممكن ان يتم تقنينها في التصميم المعماري لضمان قدره اداره الازمات في حاله انتشار وباء مثل درج خارجي تهويه مسافات عدد غرف عدد حمامات
3.14	بين سكان الشقة الواحدة ومن واقع تجربتكم هل هناك معايير توصون بها لاداره الازمه في حال انتشار الوباء
4	مواد واسطح
4.15	هل يوجد اي ارشادات لطبيعه المواد اللازم اختيارها لتسهيل عمل مقاومه الامراض والاوبئه مثل يمنع استخدام هذه المواد او تشجيع استخدام مواد معينه
4.16	هل يوجد ممارسات وتوصيات لخطط الصيانة او توصيات تنظيف ورعاية او استخدام للتحكم في انتقال الامراض
4.17	هل هناك مواد توصون باستخدامها او وقف استخدامها لمحاربه الامراض المعدية
5	الضوء والاضاءة الطبيعيه والعناصر الطبيعيه
5.18	ما بين اجراءات العزل للمصاب وحماية غير المصاب في ضمن نفس البيئة المبنيه هل الضوء ووصوله وامكانيات ادخال العناصر الطبيعيه او المناظر الطبيعيه دور في عمليه محاربه الاوبئه
5.19	ما التوصيات بخصوص الحصول على الإضاءة وانواعها
5.20	ما دور الوصول الى العناصر الطبيعية في محاربه الأوبئة
6	التصميم العالمي وقابليه الاستعمال من قبل الجميع
6.21	هل هناك ما يخص ذوي الاحتياجات الخاصه في عالم الوبائيات معامله معايير ارشادات يجب ان يتم تطويرها لدى المعماري ليتم تقنينها؟
6.22	ما رأيك فى العلاج عن بعد ودوره وطرق توظيفه فى محاربه الأوبئة؟

appendix 9 sustainable design expert interview form

مقابله مهندسين معماريين في مكاتب استشارية عملوا في مشاريع تصميم مستدام		
أولا :البيانات الأولية		
تاريخ المقابلة	مكان المقابلة	وقت المقابلة

ثانيا: البيانات الأساسية للمستجيب وفقا لمتغيرات البحث	
1 الاسم	
2 المؤهل العلمى	
3 التخصص	
4 البلد / المحافظة	
5 الوصف الوظيفى	
6 الخبرة	

ثالثا :ملخص عن البحث

عنوان البحث:

Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room.

مشكلة البحث:

إمكانية تفاقم انتشار الوباء او المرض المعدي أيا كان نوعه ومساهمة السكن المشترك فى نقل المرض بقصد او بدون قصد، وهذا يستدعى النظر فى الهدف الرئيس من السكن وهو الحصول على الامن وفى هذه الحالات أصبح السكن مصدرا للمرض وانتشاره فى هذا البحث محاولة لمعالجة هذه السناريوهات وغيرها فى حالات انتشار الامراض والأوبئة ضمن شقة السكن ولكن باليات واستراتيجيات تساعد على الحد من احتمالات انتشار مسببات المرض.

أهداف البحث:

- وضع مقترحات لآليات وأدوات واستراتيجيات سهلة التنفيذ فى المبانى السكنية تقلل من انتشار الأوبئة داخل المبنى، وتزيد من مناعة المبنى ضد انتقال الأمراض.
- توفير مساحة معمارية مرنة داخل الشقة السكنية لاحتواء الشخص المصاب بالمرض المعدي، خاصة فى الحالات التى لا يمكن استقباله فى المستشفى، بحيث يتم إعداد هذه المساحة بالشكل اللازم لضمان سلامته النفسية والعقلية والصحية. الصحة الوظيفية للمريض ومرافقيه فى الشقة الواحدة.
- توعية مستخدمى الشقق بتأثير التخضير، وتحديداً جدران المعيشة الداخلية، لتخفيف الضغوط الناتجة عن الحجر المنزلى.

أهمية البحث:

تكمن اهمية الدراسة فى جانبين الاول وضع الية لربط مستخدمى الشقق بتأثير قدرة التخضير وتحديدا الجدران الحية فى الاماكن المغلقة لتخفيف الضغوط الناتجة عن الحبس المنزلى والثانى تحديث للخطط الوظيفى لتصميم الشقق عن طريق التصحيح البيئى وعل الشقق اقل نقلا للأمراض المعدية من خلال استخدام مبدا غرفة الضغط السلبى والايجابى

الغاية من المقابلة:

يساهم البحث فى وضع اليات وأدوات بين يدي صانعى القرار والمصممين و الناس العاديين فى حالات الطوارئ فى حالات انتشار الأوبئة و عجز المرافق الصحية عن استقبال حالات الإصابة بدرجاتها المتفاوتة من الخطورة كما حصل فى تجربة كورونا بجعل مساكنهم وتحديدا الشقق السكنية ماهلة لاستقبال المريض بتخفيف من خطر انتقال العدوى للقاطنين لنفس الشقة وهذا ما سيساهم فى التخفيف من روع ومخاوف المواطنين فى حالات انتشار الأوبئة والحجر المنزلى وحالات انتشار الامراض المعدية الموسمية وحالات عدم الرغبة فى الذهاب للمستشفيات, مما سيؤدي بالتالى الى تحسين جودة الحياه داخل الشقق وجعلها اكثر امانا من الناحية النفسية والعقلية و الوظيفية للفرد و المجتمع.

فى ضوء الدراسات المركزة حول سلوك فيروس كورونا والجائحة التى بدايت منذ عامين وقد تمتد لاكثر من 50 عام قادم نود ان نطرح إسئلة ذات علاقه بسلوك الفايروس .ضمن البيئة المبنية وتحديدا فى العمارات السكنية والتى تتميز بالكثافة السكانية العالية مقارنه باي نوع اخر من انواع السكن وعليه لا بد من وضع اليات. لجعل البناء والسكن اكثر امانا واقل لقابليه ليكون وسط ناقلا للامراض المعديه بما فيها كوفيد 19

code		
Indoor Air Quality and Ventilation:	1	ما هي استراتيجيات التهوية الموصى بها لتحسين جودة الهواء الداخلي وتقليل خطر انتقال أمراض الجهاز التنفسي في الشقق؟
	2	كيف يمكن لتصميم الشقة أن يعزز دوران الهواء وتنقيته بشكل مناسب للتخفيف من انتشار الملوثات المحمولة جواً؟
	3	هل هناك اعتبارات محددة لاختيار وصيانة أنظمة التدفئة والتهوية وتكييف الهواء (HVAC) التي تساهم في صحة الجهاز التنفسي؟
Spatial Planning and Layout:	1	كيف يمكن تحسين تخطيط الشقة لدعم التباعد الجسدي وتقليل الاتصال الوثيق بين شاغليها
	2	هل هناك توصيات لتصميم مناطق أو مناطق منفصلة داخل الشقة لعزل مصادر التلوث المحتملة أو دعم إجراءات الحجر الصحي، إذا لزم الأمر؟
	3	ما هي الاعتبارات المتعلقة بالمساحات المشتركة، مثل المداخل أو المصاعد أو المناطق المشتركة، لتقليل مخاطر انتقال أمراض الجهاز التنفسي؟
Material Selection and Surfaces:	1	هل توجد إرشادات محددة لاختيار المواد والأسطح التي تتميز بسهولة التنظيف والتطهير والمقاومة لبقاء مسببات الأمراض؟
	2	ما هي اعتبارات استخدام المواد المضادة للميكروبات أو مواد التنظيف الذاتي التي يمكن أن تساعد في الحد من انتقال أمراض الجهاز التنفسي؟
	3	كيف يمكن دمج المواد المستدامة ومنخفضة الانبعاثات في تصميم الشقة لتعزيز صحة الجهاز التنفسي مع تقليل التأثير البيئي؟
Acoustics and Noise Control:	1	كيف يمكن أن يتناول تصميم الشقة التحكم في الصوتيات والضوضاء لتعزيز بيئة معيشية هادئة ومريحة وهو أمر مهم لصحة الجهاز التنفسي؟
	2	هل توجد إستراتيجيات لتقليل انتقال الضوضاء بين الوحدات والمناطق المشتركة، مما يضمن بيئة صوتية مريحة وصحية؟
Lighting and Natural Ventilation:	1	كيف يمكن تعظيم الإضاءة الطبيعية في تصميم الشقة لخلق بيئة معيشية مشرقة وجيدة التهوية تدعم صحة الجهاز التنفسي؟
	2	ما هي فرص دمج النوافذ القابلة للتشغيل أو غيرها من وسائل التهوية الطبيعية لتحسين تبادل الهواء وجودة الهواء الداخلي؟
Maintenance and Cleaning Practices:	1	ما هي بروتوكولات التنظيف وممارسات الصيانة الموصى بها لضمان بيئة صحية داخل الشقة؟
	2	هل هناك منتجات تنظيف مستدامة وغير سامة يمكن استخدامها لتقليل مهيجات الجهاز التنفسي مع الحفاظ على النظافة والنظافة؟

9.4 appendix 10 user interview form

مقابله سكان الشقق		
أولا :البيانات الأولية		
تاريخ المقابلة	مكان المقابلة	وقت المقابلة

ثانيا: البيانات الأساسية للمستجيب وفقا لمتغيرات البحث	
1	الاسم
2	المؤهل العلمي
4	البلد / المحافظة
5	الوصف الاسرة
6	الخبرة

ثالثا :ملخص عن البحث

عنوان البحث:

Post pandemic apartments in Palestine: A proposal for immune building including negative pressure room.

مشكلة البحث:

إمكانية تفاقم انتشار الوباء او المرض المعدي أيا كان نوعه ومساهمة السكن المشترك فى نقل المرض بقصد او بدون قصد، وهذا يستدعى النظر فى الهدف الرئيس من السكن وهو الحصول على الامن وفى هذه الحالات أصبح السكن مصدرا للمرض وانتشاره فى هذا البحث محاولة لمعالجة هذه السناريوهات وغيرها فى حالات انتشار الامراض والأوبئة ضمن شقة للسكن ولكن باليات واستراتيجيات تساعد على الحد من احتمالات انتشار مسببات المرض.

أهداف البحث:

- وضع مقترحات لآليات وأدوات واستراتيجيات سهلة التنفيذ فى المبانى السكنية تقلل من انتشار الأوبئة داخل المبنى، وتزيد من مناعة المبنى ضد انتقال الأمراض.
- توفير مساحة معمارية مرنة داخل الشقة السكنية لاحتواء الشخص المصاب بالمرض المعدي، خاصة فى الحالات التى لا يمكن استقباله فى المستشفى، بحيث يتم إعداد هذه المساحة بالشكل اللازم لضمان سلامته النفسية والعقلية والصحية. الصحة الوظيفية للمريض ومرافقيه فى الشقة الواحدة.
- توعية مستخدمى الشقق بتأثير التخضير، وتحديداً جدران المعيشة الداخلية، لتخفيف الضغوط الناتجة عن الحجر المنزلى.

أهمية البحث:

تكمن اهمية الدراسة فى جانبين الاول وضع الية لربط مستخدمى الشقق بتأثير قدرة التخضير وتحديدا الجدران الحية فى الاماكن المغلقة لتخفيف الضغوط الناتجة عن الحبس المنزلى والثانى تحديث للاطلاد الوظيفى لتصميم الشقق عن طريق التصحيح البيئى وجعل الشقق اقل نقلا للأمراض المعدية من خلال استخدام مبدا غرفة الضغط السلبى والايجابى

الغاية من المقابلة:

يساهم البحث فى وضع اليات وأدوات بين يدي صانعى القرار والمصممين و الناس العاديين فى حالات الطوارئ فى حالات انتشار الأوبئة و عجز المرافق الصحية عن استقبال حالات الإصابة بدرجاتها المتفاوتة من الخطورة كما حصل فى تجربة كورونا بجعل مساكنهم وتحديدا الشقق السكنية ماهلة لاستقبال المريض بتخفيف من خطر انتقال العدوى للقاطنين لنفس الشقة وهذا ما سيساهم فى التخفيف من روع ومخاوف المواطنين فى حالات انتشار الأوبئة والحجر المنزلى وحالات انتشار الامراض المعدية الموسمية وحالات عدم الرغبة فى الذهاب للمستشفيات, مما سيؤدي بالتالى الى تحسين جودة الحياه داخل الشقق وجعلها اكثر امانا من الناحية النفسية والعقلية و الوظيفية للفرد و المجتمع.

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1	الامان والصحه
1.1	ما الشعور الذي انتابك عند إصابة احد افراد الشقة بمرض معدي
1.2	ما الشعور الذي انتابك عند إصابة احد سكان المبنى بمرض معدي
1.3	في حال إصابة احد سكان شقتك بمرض معدي كيف تصرفت
1.4	ما المشاكل التي واجهتكم في فترة الحجر؟
1.5	وما ابرز الطرق التي تم اعتمادها لمواجهه هذه المشاكل
1.6	ما الأمور التي تمنيت لو انها في التصميم للتخفيف من مخاوفك
2	جوده الهواء الداخلي والتهويه
2.7	كيف تعاملت مع تهوية الشقة لتحسين جودة الهواء الداخلي وتقليل خطر انتقال أمراض الجهاز التنفسي في الشقة؟
2.8	هل فكرت بتوفير مناطق عزل في شقتك
2.9	هل فضلت توجيه معين للتغلب على انتقال العدوى
2.10	هل فضلت مساحة معينه للفراغ ساعدك بالتغلب على انتقال العدوى
2.11	هل فضلت توزيع معين موقع ساعدك بالتغلب على انتقال العدوى
2.12	هل هناك صيانة أنظمة التدفئة والتهوية وتكييف الهواء (HVAC) تتبعها
3	التوزيع المكاني والتخطيط
3.13	بين سكان العمارة متعددة الشقق ومن واقع تجربتكم هل هناك تمنيت وجودها في التصميم المعماري لضمان قدره التغلب على الازمات في حاله انتشار وباء مثل درج خارجي تهويه مسافات عدد غرف عدد حمامات بريندات
3.14	كيف كان انطباعكم عن جدوى التباعد الجسدي وتقليل الاتصال الوثيق بين سكان الشقة؟
	هل هناك توصيات لتصميم مناطق أو مناطق منفصلة داخل الشقة لعزل مصادر التلوث المحتملة أو دعم إجراءات الحجر الصحي، إذا لزم الأمر؟
	ما هي انطباعاتكم المتعلقة بالمساحات المشتركة، مثل المداخل أو المصاعد أو المناطق المشتركة، لتقليل مخاطر انتقال أمراض الجهاز التنفسي؟
4	مواد واسطح
4.15	هل توجد إرشادات محددة اتبعتوها لاختيار المواد والأسطح التي تتميز بسهولة التنظيف والتطهير والمقاومة لبقاء مسببات الأمراض؟
4.16	كيف تم استخدام المواد المضادة للميكروبات أو مواد التنظيف الذاتي التي يمكن أن تساعد في الحد من انتقال أمراض الجهاز التنفسي؟
4.17	هل هناك مواد محددة ساهمت زيادة او وقف الامراض المعديه
5	الضوء والاضاءة الطبيعيه والعناصر الطبيعيه
5.18	ما بين اجراءات العزل للمصاب وحمايه غير المصاب في ضمن نفس البيئة المبنيه هل الضوء ووصوله وامكانيات ادخال العناصر الطبيعيه او المناظر الطبيعيه دور في عمليه محاربه الاوبئة
5.19	دور الإضاءة الطبيعية في الشقة لخلق بيئة معيشية مشرقة وجيدة التهوية تدعم صحة الجهاز التنفسي؟ هل لاحظت أهمية لوجود الإضاءة الطبيعية
5.20	ما دور الوصول الى العناصر الطبيعيه في فترة الحجر المنزلي
6	التصميم العالمي وقابليه الاستعمال من قبل الجميع والصيانة
6.21	اين كان يلعب اطفالكم وقت الحجر
6.22	كيف كان تأثير الجائحة على كبار السن

9.5 appendix 11 Extract themes coding for analysis.

Extract themes coding for analysis.

no	Themes	question	Respondent	the answer/fact	Codes
1	Indoor Air Quality and Ventilation code:	Q1 Indoor air quality must be linked to ventilation. What recommendations do you usually adopt to ensure this quality as epidemiologists?	Doctors		Mechanical systems must be stopped. Special ventilation for insulation area Addressing the issue of bacteria and filters and their colonization in them Providing the four directions in the building Activate the use of the skylight
		Q2 What is your vision of the best possible disgn to ensure indoor air quality in a multi-apartment residential building?			Providing sunlight and healthy air
		Q3 Is the presence of isolation areas in apartment important in Mechanisms for fighting epidemics.		The patient's breath and fluids must be controlled, and one must think about how to dispose of them Isolation for cases in the hospital is based on the priority of severity and difficulty of the case. Therefore, some cases are evacuated and are followed up remotely by phone call. In many cases, the isolation process is linked to protecting those around the person from people with poor health and immunity. This is to not overwhelm the health system in cases of pandemics, and this is necessary to break the chain of infection.	Flexibility of the isolation area in cases of no pandemic, taking into account the cost, development, and living a safer life
		Q4 Is controlling atmospheric pressure one of the methods you use to control indoor air quality?		Singapore The country was prepared based on the SARS experience, and we must be prepared for such pandemics at any time	The system must be equipped with a one-way valve to prevent air backflow
		Q5 Depending on the nature of our country, Palestine, is there a specific direction and area, and a specific distribution of space that you recommend helps control and contain infectious viruses?			Air flow, sunshine, good ventilation, garden at the entrance

		Q6 Are there specific considerations for preventing the spread of epidemics inside the apartment related to indoor air quality?		Closed spaces contributed to the spread of infection	Providing a skylight that brings sunshine and ventilation to all apartments. Entering the kitchen first for the purpose of washing increases the chances of transmission of infection
		Q7 What are the recommended ventilation strategies to enhance indoor air quality and reduce the risk of respiratory disease transmission in apartments?	Sustainable design specialists	Green building example	We always take double or at least 15% more than the minimum required for ventilation, and passive ventilation techniques are preferred. Mechanical ventilation contributes to the transmission of diseases, and the prevailing winds are used in the design to create negative pressure and the possibility of using mechanical suction.
		Q8 How can the apartment design promote adequate air circulation and filtration to mitigate the spread of airborne contaminants?		It is most appropriate not to rely 100% on mechanical ventilation	Increase the rate of disposal of polluted air and use cross-ventilation design methods as much as possible. Regarding the separation of mechanical ventilation of apartments, a split net can be used.
		Q9 Are their specific considerations for the selection and maintenance of HVAC systems that contribute to respiratory health?			Maintenance is periodic, solarization of spaces and a functioning system Electrical discharge or ultraviolet light kills living organisms handling unit If we install filters on it, we can receive purified natural air
		Q10 How did you approach apartment ventilation to improve indoor air quality and reduce the risk of respiratory disease transmission in the apartment?	The users	All of these options were linked to the weather condition, as the spread of the disease occurred at the beginning of spring, which made it possible to resort to this option, and if the weather was cold, ventilation would not be good.	Adopting natural ventilation (opening windows, opening the balcony door, regular fans, and opening the apartment door)
		Q11 Have you thought about providing isolation areas in your apartment that could contribute to improving indoor air quality?		2 out of 10 thought it was not necessary, and through their statements it became clear that the entire building was infected with the disease, and they were not concerned about contracting it and did not follow confinement or physical distancing measures. The deteriorating ventilation condition in the apartment led to him leaving it and living for a short period in other people's homes	Flexible room with attached bathroom 8 out of 10

		Q12 Did you prefer a specific orientation to overcome the transmission of infection?			The northwest is a source of the strongest air, but it is accompanied by the disadvantage of not allowing sunlight to enter The phenomenon of lack of sunlight entering apartments leads them to leave their apartments and visit others during the day
		Q13 Did you prefer a specific orientation for free space that helped you overcome the transmission of infection?			Rooms that are used by the smallest possible number of people Open spaces such as the balcony A cleaning area at the beginning of the entrance, such as a sink Private bedroom
		Q14 Did you prefer a specific distribution site that helped you overcome the transmission of infection?			There is a large space between the apartments where children can play A space dedicated to e-learning Distribution enhances cross-ventilation Longitudinal balconies Bathroom far from the bedrooms A safe and strong external staircase A temporary storage place at the beginning of the entrance before bringing purchases and items into the kitchen and rooms
		Q15 Is there HVAC maintenance that you follow?			There is no direction to install an air conditioning system
2	Space Planning and Layout	Q16 among the residents of one apartment. Based on your experience, are there water standards that you recommend, or lessons learned that can be codified in architectural design to ensure the ability to manage crises in the event of an epidemic spread, such as external stairs, ventilation, distances, number of rooms, number of bathrooms	doctors		Establishing mechanisms for the entrance to the building to stop the paths of the virus, activating sound technology and remote control in the shared facilities, an external staircase as a second exit and since it is exposed to the sun and air, it will be a safe path, and a garden at the entrance.
		Q17 among the residents of one building, and in reality In your experience, are there standards that you recommend for managing the crisis in the event of an epidemic spreading?			Separate isolation room entrance, private bathroom
		Q18 How can the apartment layout be optimized to support physical distancing and reduce close contact between occupants?	Sus. Design specialist		The Flexible system has the ability to change the internal division and enhance the internal environment through plants. It is applicable and scalable in space, No touch building, and Smart building. Isolation room operation with its services and movement plan

		Q19 Are there recommendations for designing separate areas or zones within the apartment to isolate potential sources of contamination or support quarantine measures, if needed?			We use it for isolation, but we do not designate it for isolation, remote work, ventilation for elevators, and a primary storage station that serves as a containment space
		Q20 What are the considerations for shared spaces, such as entryways, elevators, or common areas, to minimize the risk of respiratory disease transmission?		today best practies are tomorrow stand of life	Police and Hygiene created a protocol and sterilization areas at the entrance, elevators, and common areas, and placed wind curtain at the entrances and physical distancing, avoiding touching surfaces, group spaces being open as much as possible, providing delivery and receiving space for the delivery
		Q21 Among the residents of a multi-apartment building, and based on your experience, is there something you wished existed in the architectural design to overcome the crisis of the spread of an epidemic, such as an external staircase, ventilation spaces, number of rooms, number of bathrooms, and brands?	users	Mixing residential and public use in some residential buildings leads to an exacerbation of the spread of diseases	Ample space between apartments More balconies A room attached to a bathroom other than the master Exposed external staircase Touchless services in the elevator, stairs or garages A place to store jackets, tools and shoes A terrace that respects privacy in front of the apartment Water well is not shared
		Q22 What was your impression of the feasibility of physical distancing and reducing close contact between apartment residents?		Shared service areas, if policies are weak, are always a source of diseases due to the absence of a sense of responsibility and community control	The mother's infection may contribute significantly to the spread of the infection within the same family, as she is the one in charge until the days of her illness, as the entire sample showed that she faced difficulties in isolation and social distancing during the period of the mother's illness within the same family.
		Q23 Are there recommendations for designing separate zones or zones within the apartment to isolate potential sources of contamination or support quarantine measures, if necessary?			A primary storage place at the entrance to the building for online purchases A storeroom is at the first entrance to the apartment Use methods to impose limits on not bringing shoes inside
		Q24 What are your thoughts regarding shared spaces, such as hallways, elevators, or common areas, to reduce the risk of respiratory disease transmission?			Choose its orientation so that it is not a place for dust and waste to collect %50 of the sample preferred to use the outdoor stairs during times of pandemic rather than the indoor stairs or the elevator Staircase with large area and dimensions Reducing touched surfaces and providing touchless services Good ventilation, large space and access to natural light Preparing common areas with applications and places for cleaning and sterilization

3	Material Selection and Surfaces	Q25 Are there any guidelines for the nature of materials that must be chosen to facilitate the work of resisting diseases and epidemics, such as prohibiting the use of these materials or encouraging the use of certain materials.	doctors		Surfaces that do not collect dust and dirt, smooth surfaces, surfaces that are easy to clean and sterilize
		Q26 Are their practices and recommendations for maintenance plans or recommendations for cleaning, care, or use to control disease transmission?		Separating the air, fluids, and waste of the infected person	
		Q27 Are their materials that you recommend using or stopping using to combat infectious diseases?			Reducing humidity, providing something for the isolated person to fill his time with
		Q28 Are there specific guidelines for selecting materials and surfaces that are easy to clean, disinfect, and resistant to the survival of pathogens?	Sus.design speci.		Low voc (volatile organic compounds), it is forbidden to use such as formaldehyde and copper chromates, using self-cleaning has a greater ability to fight the accumulation of dirt on it. Materials with specific cleaning specifications related to the degree of roughness
		Q29 What are the considerations for using antimicrobial or self-cleaning materials that can help reduce the transmission of respiratory diseases?			Environment friendly and healthy
		Q30 How sustainable and low-emitting materials be integrated into the apartment design to promote respiratory health while minimizing environmental impact?			Renewable and renewable, reducing the use of materials containing lead and mercury, with low emissivity

		Q31 Are there specific guidelines you follow to choose materials and surfaces that are easy to clean, disinfect, and resistant to the survival of pathogens?	users		There were no clear guidelines but users developed their own mechanisms such as: Smooth surfaces that can withstand cleaning materials. Surfaces that are easy to clean, especially in the kitchen and sink, and can withstand sterilization Without pillow patterns, without slits It is healthy for children and the elderly Folding furniture Pieces that are easy to put in the washing machine
		Q32 How have antimicrobial or self-cleaning materials been used that can help reduce the transmission of respiratory diseases?		In many cases, sterilizers led to allergic reactions and negative effects on the respiratory system	Dettol, chlorine, and regular soap The sample showed complete reliance on water and soap for hands inside the home vaporizer Use single-use wipes Exposure to solar radiation
		Q33 Are there specific substances that contributed to increasing or stopping infectious diseases?			Places that are frequently touched Single-use tools
4	Lighting and Natural Elements	Q34 Between the procedures for isolating the infected person and protecting the non-infected within the same building. Do light, its arrival, and the possibilities of introducing natural elements or landscapes have a role in the process of fighting epidemics?	doctors		To improve the cleanliness of the air from dust and other things, raise morale, raise immunity and improve psychological well-being, an outlet with sufficient space to prevent infection
		Q35 What are the recommendations regarding obtaining lighting and its types?		The role of the sun, the accompanying temperature, and ultraviolet rays have a major sterilizing role in eliminating microbes	
		Q36 What is the role of access to the Nature elements in fighting epidemics?		People are more likely to isolate themselves at home than in hospitals	Planting the roofs of buildings to purify the air, a specific greening rate for each apartment to contribute to raising the patient's immunity and recovery, mental health.

		Q37 How Can natural lighting be maximized in the apartment design to create a bright and well-ventilated living environment that supports respiratory health?	Sus.design speci.		Orientation, sterilization of buildings, the view and its role in raising morale and preventing the feeling of isolation, the ratio of windows to the wall, as recommended, at least 30 percent to 40 percent, ensures the entry of natural lighting.
		Q38 How to opportunities to incorporate operable windows or other means of natural ventilation to improve air exchange and indoor air quality?			Mix Ventilation is very positive, with a carbon dioxide measurement, so it opens the window, especially if there is an alarm
		Q39 Between the isolation procedures for the infected person and the protection of the uninfected within the same built environment, do light and its access and the possibilities of introducing natural elements or landscapes have a role in the process of fighting epidemics?	users	The lack of it leads users to be unable to stay in their apartments and leave to visit relatives and neighbours Completely change residence	Raising the level of comfort and cleanliness Raising morale and feeling happy Fill free time Prevent the appearance of mold and clean the indoor air They contributed to the speedy recovery of their patients 100% of the sample is desired for cultivation, even on a small vertical surface, for medicinal herbs
		Q40 The role of natural lighting in the apartment to create a bright and well-ventilated living environment that supports respiratory health? Have you noticed the importance of having natural lighting?			Clean the air In the absence of lighting and natural scenery, users notice a decrease in their immunity and a slow recovery when sick Improved psychological feeling and satisfaction My children's health has improved
		Q41 What is the role of access to natural elements during the home quarantine period?			Raise morale, fill free time, and eliminate boredom Having a place, even a small one, for cultivation is desirable for the elderly Reducing stress Improving the mood
5	Health and Safety Considerations	Q42 from the reality of your work in public health and fighting epidemics. What are the most prominent methods to prevent the spread of epidemics within built environments during the period of home confinement?	doctors		Large window, External corridors, Open yard, prefer natural ventilation, Stop artificial ventilation, Awareness, personal protection, masks, Hagel personal cleanliness, good ventilation

		Q43 The relationship to population density and the behavior of the virus in built environments?		Medical personnel faced greater difficulties in confronting the pandemic in residential apartments than in single homes or separate floors.	Reducing social mixing It is more difficult to identify those who have been in contact with the infected person, Lack of awareness of isolation procedures, Shared facilities between all apartments pose a threat Creating distances between one person and another, Crowding increases the spread of disease faster
		Q44 Which built environments are more difficult in fighting viruses during the period of home confinement?		Multi units building is the most built environments difficult to fight viruses during the period of home confinement	
		Q45 What problems did you encounter In combating epidemics in residential apartment buildings, what are the most prominent methods that have been adopted to confront these problems?		same places shared between the residents of the building are all a cause of infection and spread of the disease, Exits are shared and parking is shared handrails	Shared sewage network, shared facilities, A private room and special benefits for this room to contain illness, control and prevention, confine his fluids and breathing in a specific place, There is nothing better than water and soap to eliminate germs, but there are people who are advised to wear gels and masks according to the patient's capabilities.
		Q46 What mechanisms do you think that, if designed and built upon, would be a reason for limiting the spread of the epidemic or reducing its severity?		The nature of life in apartments is over-crowded and life is in a way of strong closeness, and this contributes to increasing the severity of the transmission of infection between people.	Ways to reduce contact, levels of movement between the entrance and the apartment, creating a space in the entrance for washing hands, a location for primary storage, distances between people, and the concentration of the virus and the number of copies that lead to infection, the old traditional construction of the "knot" is the most correct and appropriate, an emergency staircase for evacuation of the infected and their movement. , reduce humidity
		Q47 Are there systems in place in the health system to manage the epidemics during epidemics?		NA	NA
		Q48 What feeling did you feel when one of the apartment members was infected with a contagious disease?	users		%20 of people did not care about the presence of a sick person in their apartment, and this led to an exacerbation of the infection and the infection of members of the building with the disease, and this led to the infection and death of an individual with low immunity, while 80% felt afraid for themselves and for their children from the idea of infection, and for their elderly relatives.

		Q49 How did you feel when one of the residents of the building was infected with a contagious disease?			90% of users expressed greater fear in the event that one of the residents of the building becomes infected, especially among individuals who use shared facilities. Fears increased in the event of poor conditions in the facilities, such as poor lighting and ventilation, or weak policies towards crisis management by apartment officials. Fears were linked to the personal behavior of the infected person.
		Q50 If one of the residents of your apartment was infected with a contagious disease, how would you act?			Users' behavior towards someone in the apartment being infected with a contagious disease: 10% found they did not care and continued life normally without procedures. 20% were unable to isolate themselves for reasons of not having prepared rooms or because they were the ones providing services to their family members. 70% isolated themselves or their patients in private rooms, but The bathroom was shared which kept infection fears at bay
		Q51 What problems did you face during the quarantine period?			The most important problems faced by apartment users during the period of home confinement: lack of space for children to play, boredom and boredom, increase in free time, increase in problems between family members in the apartment, lack of space to exercise, poor sound insulation and hearing the sound of sneezing sick people in neighboring apartments.
		Q52 What are the most prominent methods that have been adopted to confront these problems?			Methods that users followed to solve problems: Filling children's time with activities that do not require space, but this was not enough, 20%, and resorting to the space in front of the apartment to walk and change the atmosphere, 30%. Resorting to the balcony and sitting in it if available 30%. 20% were breaking the rules and going out to relieve stress, and this was due to the poor condition of the apartment
		Q53 What are the things you wish were in the design to alleviate your fears?			Preferences and things that the user wanted to have in the apartment to relieve the pressure of home confinement: A space in front of the apartment that has privacy and accommodates 40% games and sports. Additional bathroom belonging to the room: 40%. Separation between uses is 20%. A secure external staircase for the building 20%. Place for agriculture 30%. Store input 10%.
6	Universal Design and Accessibility	Q54 Are there standards and guidelines for people with special needs in the world of epidemiology that must be developed by the architect to be codified?	doctors	Some people with special needs need close care from another person	It is necessary to have an accompanying person for some cases, and home isolation will be more appropriate

		Q55 What do you think about telemedicine, its role, and ways to employ it in fighting epidemics?		It is an urgent necessity in some cases, especially in cases where hospitals are overcrowded, and some cases who were isolated at home have actually been followed up telehealth	Working more comfortably, communicating by phone with patients, avoiding the danger of the pandemic
		Q56 Where did your children play during quarantine?	users		Playing on electronic devices Playing in the balcony or inside the house when space is limited In front of the apartment, which disturbed the neighbors Kitchen and drawing activities Breaking the rules and going out
		Q57 How has the pandemic affected older people?			Special care He isolated himself so as not to infect them, and avoiding visiting them increased their isolation Sitting on the veranda Their fears increased, which affected their psychological well-being
		Q58 Where did you turn to relieve the stress resulting from the pandemic?			Veranda and balcony 50% Leave the apartment and go for visits 20% The yard in front of the apartment 20% Plants that I grew 10%
7	Acoustics and Noise Control	Q59 How can the apartment design address acoustics and noise control to promote a peaceful and restful living environment, which is important for respiratory health?	Sust.design special.		Insulation of building components, Acoustic Cluster, sealed windows, privacy between rooms
		Q60 Are there strategies to minimize noise transfer between units and common areas, ensuring a comfortable and healthy acoustic environment?		Sound transmission factor stc: the higher its value, the lower the insulation. We try to make it as high as possible	Design, separation and materials, Impact Insulation Criteria is very high

Ministry of Health correspondence

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رابطة الجامعيين/ محافظة الخليل
جامعة بوليتكنك فلسطين

التاريخ:٢٠٢٣/١٢/٢٦
الرقم: ك ع/٢٠٢٣/٤١

حضرات السادة / وزارة الصحة المحترمين

الموضوع: تسهيل مهمة

تحية طيبة وبعد ،،،

نهديكم من جامعة بوليتكنك فلسطين أطيب التحيات ونشكركم على التعاون الدائم مع طلبتنا.

أرجو من حضرتكم التكرم بتسهيل مهمة الطالبة **(ربا راشد)** (ماجستير الهندسة المعمارية / العمارة المستدامة) بالحصول على ما يلزمها من **بيانات خاصة برسالة الماجستير التي تحمل عنوان:**

Post pandemic apartments in Palestine: A proposal for immune)
(building

علما أن هذه المعلومات ستستخدم لأغراض البحث العلمي فقط .

وتفضلوا بقبول فائق الاحترام ،،،

عميد الدراسات العليا والبحث العلمي
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Ministry of Health
Education in Health and Scientific Research Unit

دولة فلسطين
وزارة الصحة
وحدة التعليم الصحي
والبحث العلمي

Ref.: ....
Date:..................

الرقم: عد/٤٤/٢٠٢٤
التاريخ: ٢٠٢٤/١/١١

عطوفة الوكيل المساعد لشؤون الصحة العامة وصحة الاسرة المحترم،،،
تحية واحترام...

الموضـــوع: تسهيل مهمة بحث

يرجى تسهيل مهمة **الطالبة: ربا راشد – ماجستير هندسة معمارية/ العمارة المستدامة/ جامعة بوليتكنك فلسطين**، في عمل بحث بعنوان:

" Post pandemic apartments in Palestine: A proposal for immune building"

من خلال السماح للطلبة بجمع معلومات من خلال مقابلة اطباء الطب الوقائي (بعد اخذ موافقتهم)،

وذلك في:

- **مديريات صحة الخليل (شمال – وسط – جنوب)**

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على ان يتم تزويد الوزارة بنسخة PDF من نتائج البحث، التعهد بعدم النشر.

مع الاحترام...

د. عبد الله القواسمي
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