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THE ROLE OF SMART ARCHITECTURAL ELEMENTS IN REDUCING THE PANDEMIC EFFECT IN RESIDENTIAL COMPOUNDS

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THE ROLE OF SMART ARCHITECTURAL ELEMENTS IN REDUCING THE PANDEMIC EFFECT IN RESIDENTIAL COMPOUNDS

Abstract

Pandemic is an episode of an illness that happens over a wide geographic zone, (for example, different nations or countries) and regularly influences a huge extent of the population, which is in our case a virus called COVID-19. The problem or the gap lies in the houses and type of residents we have now, that aren't adaptable and flexible enough to survive a pandemic while focusing on social distancing, safe living, and many other decisions, all the while keeping the human interaction alive. Therefore, the main aim of this research is to propose guidelines on how new smart architectural elements can help reduce the effect of the pandemic in residential compounds and create a quasi-utopian living. The research therefore will depend on a scientific methodology through analyzing different literature reviews to create a theoretical base. Then, the derived parameters will be used to inspect a case study on a site in Achrafieh, a part of the residential area of the city which is an affected area from Beirut's Port explosion. Data will be collected from site visits, photographs, and interviews. This site will be visualized to be an experimental location for a residential compound controlled by smart architectural elements such as Artificial Intelligence, Internet of Things, Automation, the use of sensors, during a pandemic. As a conclusion, it is important to go smart on the level of architectural elements, especially through such a pandemic, which should be considered as a design potential and a good risk to take, and not a threat.

Keywords

Pandemic, smart architectural elements, residential compounds, pandemic architecture, new normal

1. INTRODUCTION

COVID-19 is already having a huge influence on almost every corporation across the world, and the same can be said for residential design. The way we design, the technology used, the integration of smart architectural elements all will be ways to reduce the effects of this pandemic. As a research approach, Since the start of the pandemic, our homes and residents have been replacing our offices, schools, sports centers, and bars. Also, a significant number of us are investing more energy in them than any other time in history, and relative to that, architects are considering smart architectural elements in the design of homes to reduce the effect of this pandemic and create a quasi-utopian living. Guaranteeing the well-being of humans and advancing avoidance against COVID-19 are two of nowadays challenges for residential compound design. To unravel these challenges and create safe and intelligent places, the world Health Organization issued measurements to all countries fighting the global pandemic COVID-19 and an expansion within the sight of new technologies is expected in spaces such as homes and outdoor common spaces. (Sokolovic, 2020) Smart architectural elements are the new intelligent smart features in a building that are automated, using sensors, IOT and AI. The problem tackled in this research is the inability of the present homes and residents to adapt to this crisis, the pandemic. So, some modifications are a must in the new era which is called now the New Normal, therefore, smart architectural elements will be a solution for this problem. "The main aim of this research is to propose guidelines on how new smart architectural elements can help reduce the effect of the pandemic in residential compounds and create a quasi-utopian living". Thus, this research hypothesizes that, smart and intelligent residential compounds will reduce the pandemic effect on the human lives. In this research, the data and information gathering will rely upon a logical system through introducing a literature review. This examination will dissect the definitions, hypotheses, standards and approaches, just as the comparable models. This data will be upheld by past readings, office work, and separating from refreshed references. The examination will break down this information in a logical structure. All through the analytical study, the research will gather information from the read references, checking official planner's sites managing the handled point, and applying field overviews by visiting sites. These site visits will incorporate meeting with the inhabitants, catching recordings, open conversations with the site clients, photography, studies and poll, estimating measurements and highlights, and perceptions.

2. LITERATURE REVIEW

Pandemic is the worldwide episode of an illness. There are numerous models and the latest is the COVID-19 pandemic, proclaimed as such by the World Health Organization on March 12, 2020, which has affected the entire world in various sectors such as: health, education, work, social life, and mainly architecture. It is essential to develop the idea of the pandemic residential architecture as a literature review to be aware of the ideas that were taken into consideration in the past and how it can be of use in nowadays. And according to architects and designers, pandemic residential architecture is how the architecture will be reshaped after (COVID-19) in residential units and the effect of smart architectural elements in reducing this pandemic. (Kondeti, 2020):

We need to redefine the one place we have been limited to for the last six months, OUR HOUSE, when the climate progresses. We need to turn our homes into a sophisticated, clean, and stable atmosphere that is well prepared to tackle the pandemic and its effects on civilization. A home that embraces a contactless lifestyle, preserves our possessions, and loved ones, and one that can be tailored to our everyday needs. Home Automation Technology will allow you without thinking about encountering or spreading the virus inside your household as you go about your everyday routine. This is possible because Smart Homes replace a single point of contact with your Mobile for your most popular touchpoints at home. You can lock and unlock doors using a smartphone, turn on and off equipment, and plan your everyday routine. WITH SMART HOME Technologies, BE COVID FREE. Said by The CEO of Smart Den, Divyateja Kondeti.

In this era, smart residential houses and compounds are more flexible and adaptable to change and help in reducing pandemic effects and the spreading of a virus. See Fig. 1 and Fig. 2, Coexistence of both pandemic architecture and smart designs results in smart pandemic residential architecture (L. Wang, 2015).



Fig.1: (a) on the left-The control center quite intentionally recalls a spaceship. All of the house's technical functions can be controlled from here. (b) On the right- Spaceship Home a smart home designed by NOEM. (Source: Inhabitat website).



Fig.2: Nico van der Meulen Architects, integration of the smart-home technology (archello,2017), (Source: M Square Lifestyle Design).

2.1 Historical Context of the 'Pandemic Residential Architecture'

The 20th century and the 21st century have seen an expanding number of epidemics and pandemics, for example, the Spanish influenza in 1918, Asian influenza in 1957, Hong Kong influenza in 1968, SARS in 2002, winged creature influenza in 2009, MERS in 2013 and Ebola in 2013-2014, didn't influence architecture straightforwardly, yet Cholera, which was water bone infection so it affected the infrastructure, for example, sanitary strategies for houses and residential areas in addition to its influence on the urban design and planning in London, Marseilles and Hamburg (A. Megahed, M. Ghoneimb, 2020)



Fig.3: (a) On the left-Furnished bathrooms in the 19th century (b) On the right The Dymaxion Home, (Source: Archdaily website).

The greatest change came to the bathrooms. See Fig.3 (a). They use to be rooms with substantial curtain and covered floors, until the Sanitary Movement in the mid to late nineteenth century. Brought on after a Cholera flare-up in London, general wellbeing, and the plan of homes, turned out to be progressively significant. Certain decorations were seen to gather germs, so materials with smooth, impenetrable surfaces turned into the standard. White tiles were introduced so workers could quickly detect any dirt on them, and effectively clean it off. Today, that exemplary white subway tile is utilized by architects in numerous kitchens and showers. Another example of a pandemic architecture prototype was the Dymaxion House Fig.3(b) that was designed by the architect, Buckminster Fuller to construct an economical self-governing single family dwelling, the living machine of the future taking into consideration future pandemics so he designed it to be mobile and shipped around the globe from prefabricated and sustainable materials, this invention was a utopian invention at that time and still it's what we're looking for nowadays (G.Merin, 2019).

2.2 An Example of 'Isolated Residential Architecture'

Solar-powered POD-Idladla is a tiny flat-pack home for two that lets you live almost anywhere. Fig. 4 186-square-foot POD-Idladla, a spacious two-person prefab house that can travel virtually anywhere you want. Architect Clara da Cruz Almeida, based in South Africa, partnered with local architecture company Dokter+Misses to build the modular nano-home that is powered by solar energy and can be configured off-site to the needs of the user. Flat-pack and assemble on site in a snap, the minimal and charming handheld pod ships. The POD-Idladla is designed for off-grid capabilities (L. Wang, 2015).

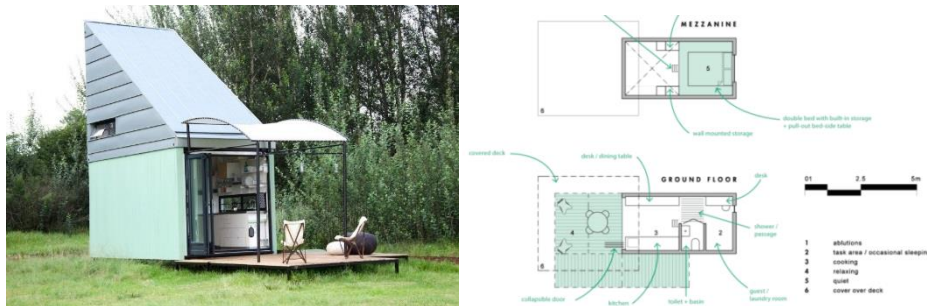


Fig.4: (a) on the left, Solar-powered POD-Idladla, perspective, (b) floor plan of a basic pod, (Source: Inhabitat website).

2.3 Smart Architectural Criteria for Pandemic Residential Architecture

In the battle against this pandemic, smart home automation and the usage of smart architectural elements appear to be a legit answer for changing your home into a sheltered and secure climate for your family. With the need for smart home technology, we will see a monstrous change in the architecture and interior of Modern Homes and residential compounds (D. Kondeti, 2020). In addition to the recent updates and solutions to understand the health and environmental issues that are related to COVID-19 focusing on the Indoor Air Quality (IAQ) (A. Megahed, M. Ghoneim, 2020)

2.3.1 Smart Construction

- Take into consideration the wall thickness for internet Wi-Fi coverage to be accommodated.
- Enabling the infrastructure to accommodate Smart Home Technology.
- Doorknobs controlled with a smart home app to allow contactless with the surfaces
- Replacing switchboards with smart switches, plugs and outlets that are atomized by apps, sensors, gestures, and voice creating a contactless home.
- Light and energy control that are endless ways for that (Hickok Cole, 2020).

2.3.2 Smart Home Technology

- Self-sufficient power and water, in case of a full lockdown the aim is to create an independent environment from the exterior world. Fig. 5 (b)
- Filtration and neutralization, the aim of filtration is to purify and filter the air from any virus or disease entering and regulating temperature and ventilation.
- Spatial organization and adaptable rooms, in this case furniture will be adaptable the rooms can be multitasking in addition to the use of sliding walls to change in the plan layout. (Gillen, Nicola, 2021)

2.3.3 Smart Material Decisions

- Metals such as copper, brasses, and bronzes are natural antimicrobial materials.
- Quartz is one of the hardest non-precious stones on earth, therefore countertops made from quartz Fig. 5 (a) are hard, stain and scratch-resistant, and the most sanitary. Quartz is already popular, and that will only increase post Corona virus.
- Woods like bamboo; oak and cork stop bacteria and microorganisms from growing (Berk, 2020)

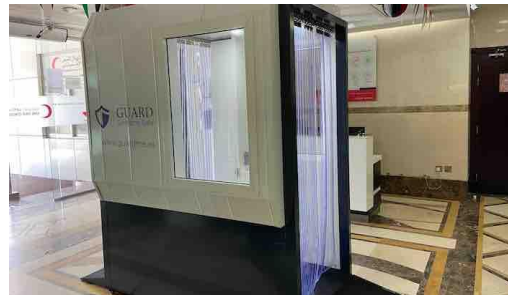


Fig.5: (a) on the left side, using in kitchen quartz countertop and bamboo closets for less germs. (b) On the right side including a sanitizing room at the entrance (Source: Anonymous)

Social distancing has given another meaning throughout this pandemic where housing is treated differently, the old concept of a house was a shelter now it's the space in which we have to work, learn, and have quality time in. many techniques are invented during this pandemic. Fig. 6 and 7, in other words it's the safe haven including all activities. (Marin, Ciubano, Zamfir, 2020)

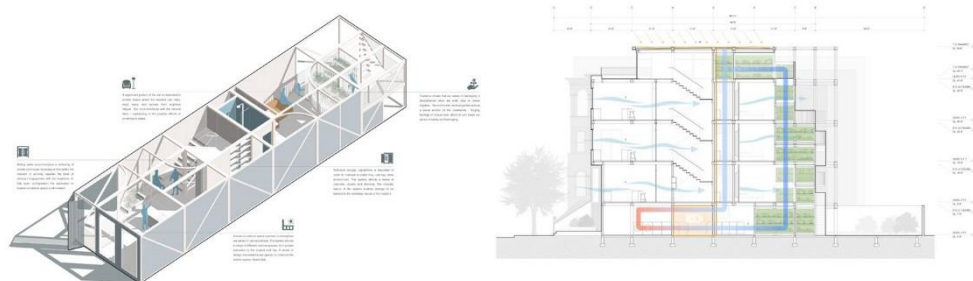


Fig.6: Framlab diagram a proposal of a house in a pandemic (Source: design boom) usage of interior gardens and the thermal bridging inside a building

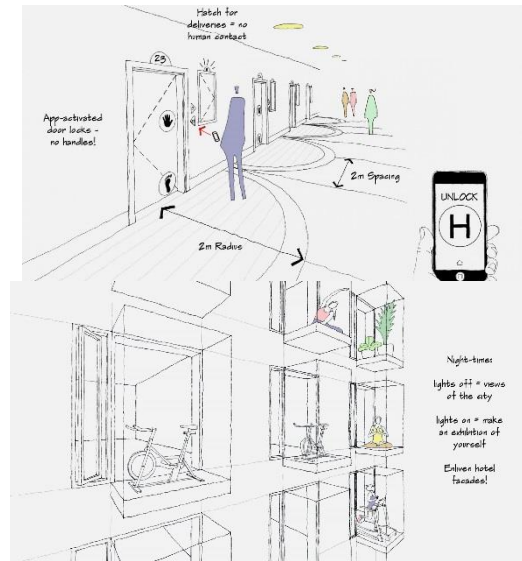


Fig.7 : Sketches (a) and (b), In the post pandemic world, residential complexes need to incorporate major changes to ensure safety, usage of sensors and applications on the mobile to unlock doors and separate apartments. (Source: Architectural Digest)

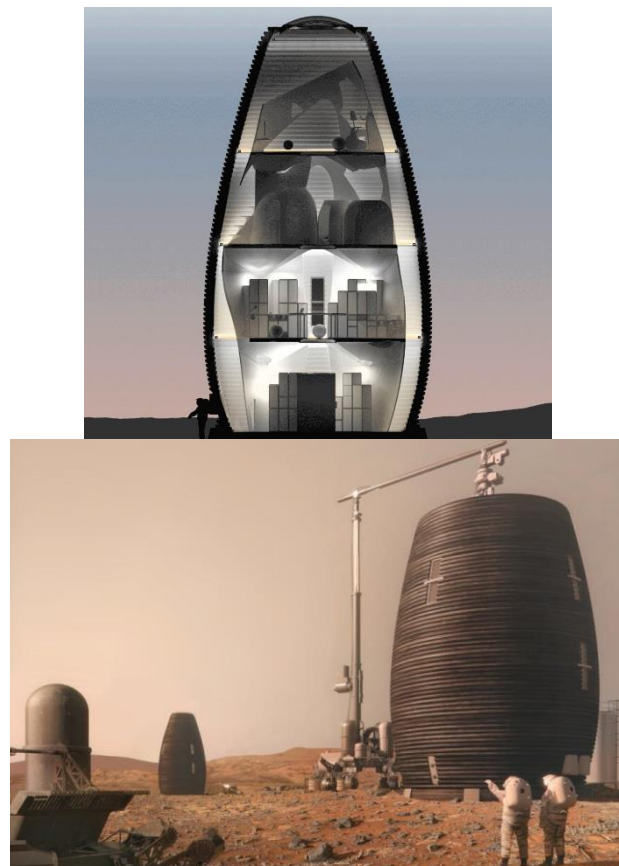


Fig. 8: (a) on the left side Marsha 3D printed pod section for the 3D printed pods on Mars, self-sufficient pods that are fully isolated from the external environment, works in a pandemic. (b) on the right side a full perspective for the 3D printed pod (Source: Archdaily)

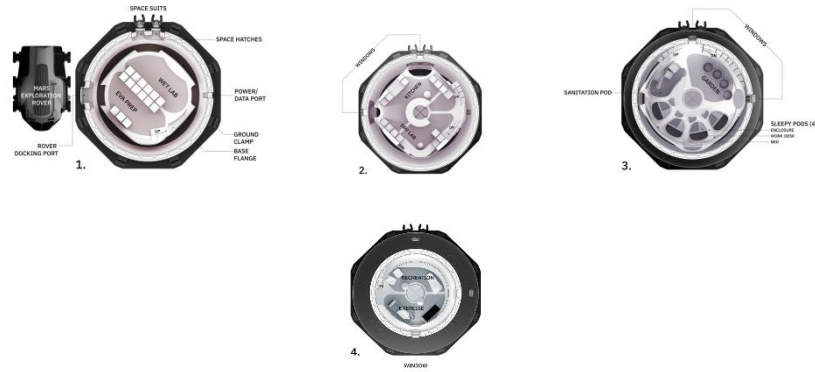


Fig.9: Marsha 3D printed pods, plans, using smart interior that is adaptable, power data port, virtual meeting rooms, sanitation pod and other smart features. (Source: Archdaily)

2.4 Parameters of Analysis

Based on analyzing and understanding the effect of smart architectural elements on pandemic architecture and especially in the housing sector, the followings are the parameters that characterize a successful pandemic residential design.

Table (1): Parameters of Analysis
Source: Author

1	2	3	4	5
Smart Construction	Smart Home Technology	Smart Material Decision	Post-Pandemic layout plan	Landscape/ Urban context

After presenting a literature review on pandemic residential architecture, the paper analyzes a case study following a scientific methodology as follows.

3. METHODOLOGY

This paper follows three scientific research methods: first, the field method concentrating on a case study, surveying its site, taking photographs, and making face to-face interviews. Second, the analytical methodology depends on analyzing the information that had been collected from the field survey, third, the deductive methodology trying to deduct a strategy that may overcome problems of the pandemic and recently the COVID19 that will drastically shape the architecture and in particular the housing sector and residential units. Moreover, the research will adopt an analytical comparative method in the last part to compare between four case studies referring to the same parameters, two of which are local projects and the other two are international ones. The comparison will shed light on the differences and similarities found in the case studies. The last part will deliver various ends and propose proposals coordinated to specific kinds of areas for designers and architects. People who are interested about the new residential compound measurements in the new era and living through a pandemic and want to know the importance of the effectiveness of building design ways in reducing the threats to the users will find this research very enlightening and useful. (A. Megahed, M. Ghoneim, 2020)

3.1 Reasons of Selecting the Case Study

The site selection is the way evaluating and selecting different options and evaluating various selections and evaluating their pros and cons in a SWOT analysis of each site to focus on one specific site for the project. This site, Mdawwar’s significant geographical location in the capital of Beirut is characterized by easy accessibility, as it is located near

the main entrance to Beirut and close to the Central District of Beirut. The economic system is thus shaped by internal structures and external variables, and it is dependent on numerous sources and exchanges in addition to the problem of the unorganized building boom in the region that a significant role can be played in the economic dynamics of the city has urged the Beirut Municipality to consider an urban project is capable of ensuring a promising future. Therefore, a residential complex with a utopian vision fits perfectly in this residential area of the site and makes a shift in the quality of housing in the post pandemic era (Green Lebanon Conference, 2016).

3.2 Introducing the case study of ‘Mdawwar District’, Mar Mikhael neighborhood Beirut, Lebanon

Each Mdawwar neighborhood is considered a fractured area with dislocated elements, with its own components, characteristics, and peculiarities of conduct. It is affected by external factors. In addition to being socially responsible, unequal social interactions are missing between the three populations groups increasing the division between local populations. Fig. 10.



Fig.10: Mdawwar Location in Beirut and the districts and neighborhoods in Mdawwar, uploaded from the site, (Source: Mdawwar Municipality)

The case study is located in Mar Mikhael neighborhood to the port side, directly parallel to Charles Helo highway in a parking area in front of the Skyline tower and might take part a leftover from the port site which is an isolated urban island between Charles Helou Highway and Beirut Port, the urban situation of Mdawwar made it a highly privatized industrial city. Reviving the region has led to the selection at the entrance of Mdawwar of a residual land that is neither used nor by the city nor by Beirut Port: a no man’s land. Fig. 11

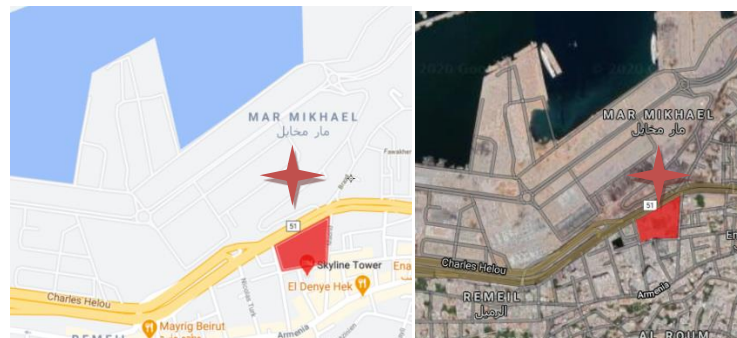




Fig.11: Google earth maps for the location of the site chosen

3.3 Problems and Challenges of the Site Chosen

- The social situation: alienation and disintegration
- Crowded place to live in a pandemic, without any green areas and the least measures of social distancing
- The roles of buildings are more commercial than healthy residential buildings, and their forms are nearly horizontal. Most residential buildings have been constructed on small units of lots with facades and uncoordinated proportions. With a portion of its people having left, absence of balconies and restricted interior space were the result (M. Jishi, 2018).
- Randomly built neighborhoods and slums in the area increased after the port explosion
- Mdawwar morphology, a non-traditional combination.

3.4 Populations of Al-Mdawwar, Lebanon

The population of Beirut was approximately 10,000 in 1840 and 80,000 today, including Ras Beirut to the west, Medawar and Rmeil up to east Beirut, estimating 600 housing units in Medawar that more than half of them were highly affected with port explosion.

3.5 Importance of the Chosen Site

The importance of the Mdawwar district is that the site chosen is located in the city center next to the sea, in a neighborhood which was affected by the port explosion but with a lot of potentials. In this area services are found everywhere from social services and activities to healthcare projects, educational centers, restaurants, coffee shops and more than that. In this site there is the components of a neighborhood where people can have everything just at a walking distance from the residential compound that is planned for this area. In the figures below are some landmarks in Mdawwar district and the neighborhood close to the site (Mdawwar Municipality) Fig. 12, 13 and 14.



Fig.12: St. Michel Maronite Church Fig.8: St. George Hospital, (Source: Official website page)



Fig.13: EDL, (Source: Richard Nield Photography)



Fig.14: Skyline tower, Bernard

3.6 Historical Background of Al-Mdawwar, Lebanon

In the course of 40 years from 1936, the port area was established with an excess area of around 1,085,000 square meters, which divided the circular area from the sea link, rendering it closed. In the 1960s, the formation of the Mdawwar led to its separation into heterogeneous materials. The station at Charles El Helou contributed to a complete separation from its north, dwellings south of the station, by canceling five roads and four roads (Green Lebanon conference, 2016). As shown in Fig. 15, 16 and 17



Fig.15: Beirut area and the mdawwar district in year 1923, (Source: Beirut Municipality)



Fig.16: Beirut area and the mdawwar district in year 1936, (Source: Beirut Municipality)

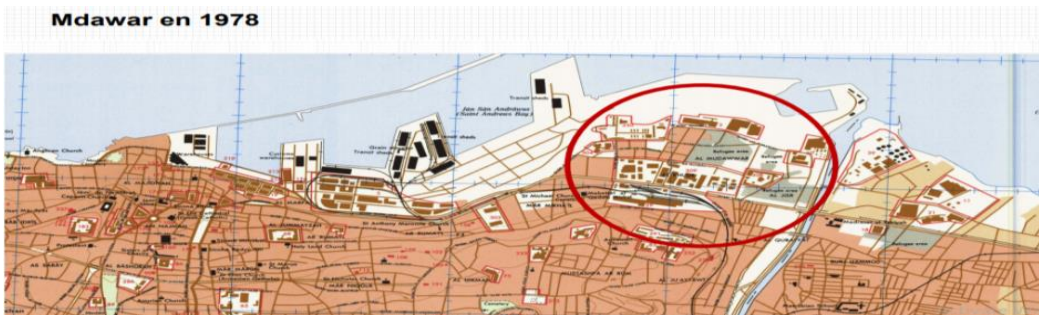


Fig.17: Beirut area and the mdawwar district in year 1978, (Source: Beirut Municipality)

3.7 Face-To-Face Interviews and Questionnaires To Inhabitants From The Chosen Site

The investigation of the site undertook interviews, with a group of 50 people of different classes and groups some are residents, shop owners, people infected by COVID19 or they know someone infected In their family or friend group and asked them some questions related to the area and how it's influence on the pandemic is it being helpful or the area isn't a healthy place to be in. The age group was between 20 and 50 years, these interviews their goal was to gather different opinions from different groups of people in order to address the most major problems considering the area in Mdawwar, Mar Mkhael district and trying to end up with an effective conclusion that can be applied in future planning and strategies.

3.7.1 Perspectives of the first category of people

During interviews with residents, shop owners, people infected by COVID19 or they know someone infected, the following questions were asked:

- Do you work from home? Do you have a home office? If no, from where do you work?
- How do you get your groceries in a lockdown?
- What space you discovered in the pandemic was missing in your home space and wish you can add it?
- How COVID19 affected your daily life and the place you're living in?
- Where do you workout in a lockdown?

A sample of the answers was said by the resident Mr. George, 36 years old: "I discovered that my apartment isn't livable, my family and I had hard times in coping with life in the lockdown, and I couldn't have a calm place for me to work from while my children are playing. In addition to the lack of space for any workout or physical activity we can make to vent, enclosed between four walls all day was hell of an experience."

3.7.2 Meeting with A Group Of Experts In The Medical Field, Planners, And Architects Asking Them Similar Questions To Know Their Perspectives On The Problems Of The Residential Buildings In A Pandemic In The Chosen Area And Their Proposed Solutions

Architects, planners and experts in the medical field I asked where emphasizing on the idea of housing will definitely change in the post pandemic and especially in crowded residential areas such as Mdawwar, and they suggested to integrate all needs of a resident in one residential complex where individuals can still meet all their needs in a residential complex while in a lockdown, with all the facilities, services and safety needed that protect them from any contagious disease, such as the Corona virus nowadays and in future pandemics. The following questions were asked:

For architects and planners:

- What are the new elements of a house in a pandemic era?
- What are the best materials used for construction?
- How will the plan layout changes from pre-pandemic to post-pandemic?
- Will there be a shared landing for several apartments together or the concept of a landing will change?
- What in your opinion is the biggest change that will be caused to the housing unit due to COVID-19?
- What are the helpful elements that will enhance a healthy IAQ (Indoor Air Quality)?
- Where do you see IoT system is most integrated?
- Do you believe that modular construction will be a good solution for the pandemic?
- How can you as an architect make working from home an effective process?
- Do you recommend using existing buildings or building new ones with new housing concepts?

One of the architects I met proposed an idea saying: “In a district like Mdawwar area, Lebanon it’s great if we created a residential complex connecting both residential neighborhoods that was dissected by the Charles Helou site while creating a healthy, utopian residential environment”.

For experts in the medical sector:

- What are the elements that must be in the room of isolation in someone's house?
- Every how much time should the home get sanitized?
- Is it better to use natural ventilation or artificial ventilation?
- Do you recommend a person in isolation to do physical activities and workout or rest all day until he/she is fully cured?

4. FINDINGS

After procedures of the field methodology, the paper analyzes the findings. As a result, the pandemic has influenced drastically the entire lifestyle of humans and especially their houses and living complexes, specifically, the neighborhood of Mdawwar, area relative to many conditions the area went through in 2020 and the crowded neighborhoods that were a very risky atmosphere in the pandemic, COVID 19. People discovered that the area their living in isn’t safe and adaptable for pandemics, their houses lack many important features that will make them survive this infectious and contagious disease. From the important things that the people living in district Mdawwar found they lack after being in lockdown and have to work from home, is not enough space for every member of the family to work from a home office, an outdoor area in order to vent or a natural scene, not enough storage areas for food and needs throughout a lockdown, getting mentally drained and affected by the lockdown and in addition to the lack of sanitizing and less touchable surfaces. In addition to the tackled people, experts in the field of medicine and architecture where asked and interviewed and their answers helped in highlighting on specific measurements that should be taken care in this pandemic, that came out to be:

- Natural ventilation and lighting is very crucial for a healthy indoor environment.
- The isolation room should be an added room in the program and can be used for other activities incase there is no one infected in the house.
- Concerning physical activity at home doctors emphasized on the importance of workout but all within a person’s ability. Therefore, architects recommended a space for home exercising it can be either indoor or outdoor.
- Concerning materials, architects and medical experts suggested materials that are self-cleaning hat the virus or any bacteria can’t stick to it.
- Considering existing buildings architects suggested, that We cannot ignore the current buildings, but we can enhance them to be more healthy in a general way, minimize the densities of occupation as much as possible, and adding more outdoor spaces.

The charts in Fig. 18 represent, the percentage of the survey of questions asked to the people living in Medawar district about living in the pandemic era. From the results it was clear that around 80% of the people do not have a home office to work from, were they are forced to stay at home and work from there. It was shown that people aren’t even interacting with their neighbors, getting their groceries once a week or delivery and 70% replied that their keeping their social life alive just through social media and zero social interaction. Moreover, the people missed mostly having an outdoor area or space to garden and vent and an office to work from, where in most cases it wasn’t available.

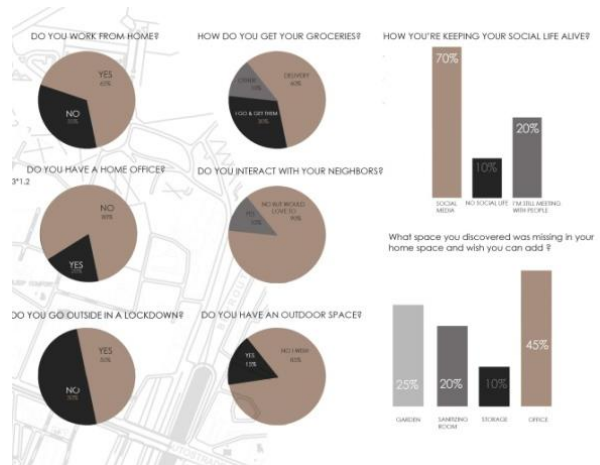


Fig.18: The percentage of the survey of questions asked to the people living in Mdawwar district about living in the pandemic era. (Source: Author)



Fig.19: (a) On the left, The Charles Helo Highway separating Mdwwar neighborhoods (Source: Google earth), (b) On the right, Crowded neighborhood in Medawwar



Fig.20: Hand sketch of the crowded skyline in the area of Mdawwar, (Source: Atelier des Architectes Associés).

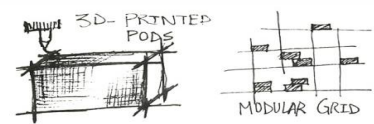
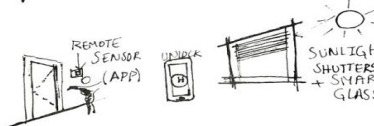
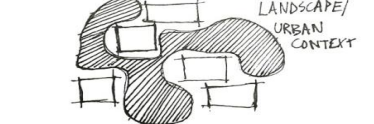

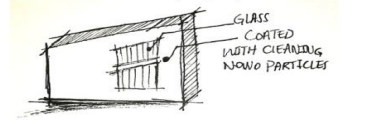
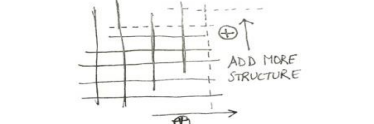
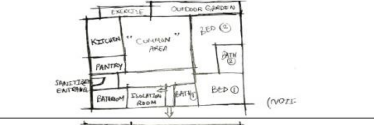

5. DISCUSSION

Based on the previous findings, Mdawwar district is a residential crowded neighborhood consists of different areas separated by Charles Helou highway which is very dominant and bold in the urban fabric of the area. Planners and architects can work on the negatives of these crowded neighborhoods in the times of a pandemic by turning the residential buildings existing there into smart buildings with smart architectural features that can cope and adapt with the pandemic and the virus in lockdowns. This can be done by different solutions that can be implemented into old and new residential complexes. Based on the analysis of the findings, the paper produces certain solutions that can be followed to improve the present condition of Mdawwar neighborhoods as follows:

- Creating residential complex with a 3D printed pods for adaptable housing
- Including horizontal and vertical lifts for humans, cars, and groceries in case of lockdowns when people can't go out to get their stuff.

- Build a local market and a medicine store
- Implement in the pods smart robots and sensors that make surfaces less touchable for less risk of COVID 19
- Create a home theatre for entertainment in lockdowns
- Insure an outdoor space for workout and venting
- Ensuring a pod for home gardening, which is a greenhouse pod so the users can grow their own foods?
- Use of swarm robots that can be helpful in changing the interior design of a room for example from a living room to a yoga room.
- Choosing materials wisely that creates surfaces where germs and and viruses don't stick to
- Having a virtual meeting room, where people in isolation can still meet and see their beloved ones or for work meetings, for example the hologram.
- Including in the design an isolation medical room for infected family members in the virus, were they can stay at home but isolated from their family members.

Table (2): Smart Features helping in reducing the effects of the pandemic
Source: Author

Smart Architectural Elements	Sketch / Diagram	Benefits smart features on residential compounds
1- Smart Construction		Creating residential complex with a 3D printed pods for adaptable housing
2- Smart Home Technology		Include smart technology and sensors where door knobs and surfaces are less touchable and are controlled by mobile applications
3- Landscape/ Urban Context		Including in the landscape ad the urban context outdoor places to vent and places for several activities between buildings
4- Gathering Areas		Within the residential complex people will have gathering areas to be in , yet respecting the social distancing and health measurements
5- Material Decision		Cleaning Products: Nanotechnology Applications Titanium oxide nanoparticles as part of a film that uses the energy in light to kill bacteria on surfaces.
6- Flexible and adaptable Modular Grid		Flexible housing where pods can be added on the grid over time and creating more spaces between pods to breathe.
7- Post- Pandemic layout plan		Post-Pandemic Layout Plan Program: -Isolation room -Outdoor area -workout area -Kitchen pantry
8- Isolation room		Isolation Rooms includes: - A clinical handwash basin within the room -An Ensuite shower and toilet - A self-closing door. -A pan sanitiser located near the room is an optional element for Class S Isolation Rooms.

These mentioned smart architectural solutions, as shown in table (2), can be a base of a way to turn the existing buildings and the new constructed buildings into smart residential complexes that are adaptable and flexible with pandemics.

6. CONCLUSION

Finally, this research is multidisciplinary, integrating between architecture and the medical field, as one of the important points to protect health and wellbeing is to live in healthy residential units. And this can be done by the following measurements:

- a) Collaboration of architects and professionals from the medical sector, in order to reach healthy measurements for pandemic housing.
- b) Engineers and architects who work in the municipalities should work on adding more landscape and outdoor spaces and parks for the people living in the neighborhoods.
- c) Pandemic architecture will improve life quality and way of living, tremendously.
- d) Focusing on the infrastructure and sustainable solutions for residential complex needs, for example, grey and sea water recycling.
- e) Create mini markets and shops in every neighborhood district so people can get their stuff without going so far from their homes.
- f) Planners and architects should shape architecture differently in the era of pandemic and especially the houses that they will be the place the humans will spend 24/7 of their time in.

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