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EXPLORING A NEW HOUSING DESIGN PARADIGM FOR POST PANDEMIC MULTI-STORY BUILDINGS IN LEBANON

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Abstract

When the fast-spreading COVID-19 was announced as a pandemic by the World Health Organization (WHO), people around the world rushed to go home. This worldwide widespread altogether affected our individual and proficient lives and features a coordinate bearing upon the exceptionally establishments of design hypothesis. As a result, the pandemic has contributed to concerns about how architects and designers should view and install antivirus-related ideas or redesign current spaces, as well as at what point our physical and built environment could be impacted by the pandemic. In forecasting the post-pandemic style and visualizing the appropriate antivirus scheme, the answers to these questions may help. This paper aims to develop a new paradigm of housing design. And especially, a new functional layout for residential unit in a multi-story building in Lebanon. In this order, a literature study and a survey has been conducted. One of the main goal of the literature study is to highlight on previous pandemic and residential experiences. In the other hand, the survey serves on analysing nowadays residential unit users. These two ways will lead for the future of residential units in multi-story buildings.

Keywords

Housing Design, Pandemic Era, Multi-Story Building, Paradigm

1. INTRODUCTION

1.1 Problem Definition

The pandemic of the COVID-19 coronavirus is the defining global health issue of our time and the biggest threat we have faced since the Second World War. The virus has spread to every continent except Antarctica since its arrival in Asia in 2019.

We have now hit the horrific mark of more than two million deaths, and under an almost unbearable burden of loss, the human family suffers.

But even more than a health crisis, the pandemic is an ongoing socio-economic crisis, too. It has the ability to produce catastrophic social, economic and political consequences that will leave deep and long-standing scars, stressing every one of the countries it affects.

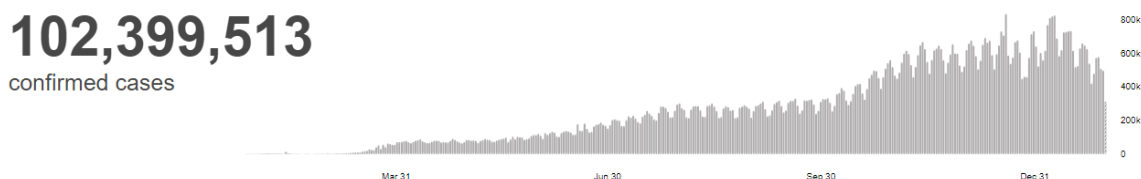


Fig.1: Graph showing the evolution of confirmed COVID19 cases from December 2019 till January 2021 worldwide. Reference: Adapted from WHO, 2021.

So how our houses should be designed? Should our balconies and terraces be re-designed? Should our residential unit accommodate a workspace environment? Could COVID-19 be a catalyst for healthier housing?

Post-pandemic housing

- Housing layout
- Space and density
- Shelter and safety
- Indoor air quality

The design of the built and physical environment plays the same role of the vaccine in reducing the impact of the epidemic. In a way, this pandemic has changed our built environment just to avoid to be infected. So, architecture will never be the same after Covid-19 outbreak. While the current global outbreak in the built environment presents a threat at all levels, it will take time to build an antivirus-enabled paradigm to minimize possible threats or avoid the spread of the virus.

1.2 Aim

To develop new paradigm and layout of housing design in the pandemic and post pandemic era.

1.3 Objectives

- To study the theory of pandemic
- To highlight on housing experience in the previous pandemic
- To analyze users lifestyle during the pandemic
- To recommend new modifications in housing design in the post pandemic era

1.4 Hypothesis

COVID-19 will reshape the architecture and the interior layout of houses in the post-pandemic era.

1.5 Outline Methodology

The most commonly used method of performing market research is primary quantitative research. The distinct characteristic of primary research is that instead of relying on data obtained from previous research, the researcher focuses on collecting data directly.

For this study, questionnaires were chosen because they are a reliable and fast way to collect data in an accurate and timely manner from multiple respondents.

There was no exception to this study and questionnaires were a fast and efficient way for the investigator to meet several respondents within several weeks.

2. THEORETICAL PART: LITERATURE REVIEW

2.1 Housing Design

The "House" refers to the essential shelter and dwelling unit in a narrow context. In a wider context, 'accommodation' encompasses not just the residential building but also the environmental service it constitutes (Khurana, 1995).

2.1.1 Meaning of Housing

In both appearance and in its context and importance to those who live there, a house may be many things.

- Housing as shelter:

The shortest and more traditional housing term is shelter. Undoubtedly, any human being wants shelter, a roof over his head, and this means a home for most people, a permanent 'base' where most of one's time is spent. The social and economic growth of residents is determined by the position of housing. For example, crime rate is observed to be higher in slums (Khurana, 1995).



Fig.2: Housing as a shelter. Reference: Adapted from World Habitat Award, 1991

- Housing as an industry:

Some previous studies have concluded that in the national, economic and social order, the housing industry plays a key role. It provides jobs for thousands of people engaged in the construction of new buildings, materials and equipment for manufacturing (Khurana, 1995).



Fig.3: House and the land plot. Reference: Adapted from Chaonan, 2020.

- Plot Housing:

For plot housing, each owner of the house is free to build his house under the terms of the building bye-laws, on a separate piece of created property, to his own taste (Khurana, 1995)

- Group Housing:

The notion of private possession of property does not stand up well in group housing, and houses and infrastructure services need to be provided cooperatively. This leads to a certain degree of standardization of designs and styles of houses; unfortunately, the exact specifications of any house owner may not be completely translated into the house given to him (Khurana, 1995).

2.1.2 Definition of Housing

While the concept of housing varies, a house or part of a building built to be inhabited by a single family or person is defined by most scholars.

Others defined housing generally as 'interior and exterior spaces' and explicitly as 'a nursery in which a child spends his formative years, the bath in which cleanliness fundamentals are learned, the room layout, and the streets to which the structure belongs.' Housing is more properly



Fig.4: Housing as a group. Reference: Adapted from Azevedo, 2019.

characterized as a mechanism involving an organism's association with its environment (Jadav, 1987).

2.1.3 Factors influencing Housing Design

- **Influence of Ecology:**

Housing designs are impacted, within a broad ecological sense, by the natural world, the scale and characteristics of the population and the available technologies and social institutions, economic and political practices and cultural values (Jadav, 1987).

- **Influence of Industrial Revolution:**

The family was supposed to be the largest social entity prior to the Industrial Revolution, and hence the family was assumed to be a tightly knit, essentially self-sufficient unit. New innovations, new equipment, new methods and new ways of manufacturing and delivery preceded industrialization, which primarily influenced housing design and arrangement. By the beginning of the 20th century, gas and electric stoves and steam heating systems became widespread. During the 19th century, the availability of water, plumbing and sanitation progressed steadily. At the turn of the century, however, the new style of living came into being with kitchens, separate dining rooms, a variety of bedrooms, bathrooms, verandas, etc (Jadav, 1987).



Fig.5: Basic principles of Ecology. Reference: Adapted from Jengerz 2020.

- **Influence of family structure:**

The family size was reduced, thus requiring less interior space in the house. This leads to the optimum ease and comfort. So, open plans and adjustable rooms that might be suited to the evolving needs of the household. In reaction to the casual living trend, multipurpose family rooms have evolved over time. The size of the family and the stage of the life cycle have had a significant effect on the form of accommodation that is available at a given point in time (Jadav, 1987).

2.1.4 Evolution of Housing Design

During the last three hundred years, houses have changed a lot. These developments, in essence, have altered family and social relationships and influenced them. There has become a fact with more personal privacy and space.

- **18th Century:**

Many of these buildings had space of less than 450 square feet (40 m²), but over time they were gradually remodeled and extended. Older houses everywhere were added to and aggressively remodeled through the middle years of the 18th century, with room heights rising a foot or more (Mason, 2020).

- **19th Century:**

Different functions of the house were separated into separate areas throughout the 19th century. There were public and private rooms kept separate. As in most other rooms, the bedroom was primarily a 19th century creation (Mason, 2020).

- **20th Century:**

As household sizes decreased, the physical scale of homes continued to increase. Houses have been getting larger as well. The small house has been on the decline for much of the century, although in the years 1881-1991 the number of individuals residing in a household declined by 50% (Ward). We went from having no bedrooms to having multiple bedrooms (Mason, 2020).

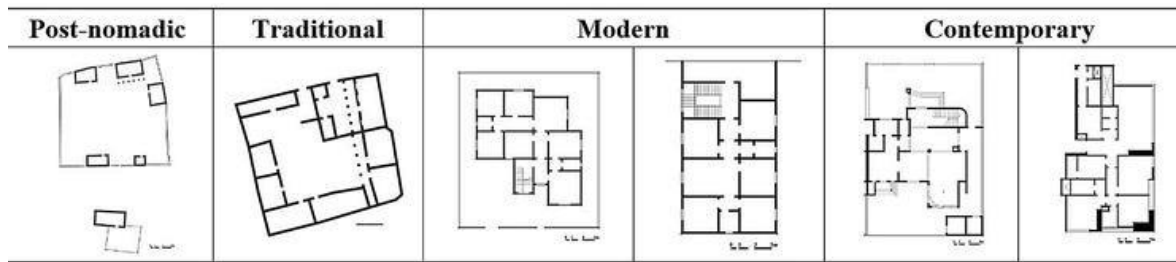


Fig.6: The Evolution of residential Unit from post-nomadic to contemporary era. Adapted from Remali et al, 2016.

One of the architectural problems facing new home development in the years and decades to come will be bigger houses on smaller lots.

2.2 Pandemic

2.2.1 Definitions

- What is a pandemic?

The World Health Organization (WHO) describes a pandemic as the worldwide spread of a new emerging disease.

According to the Centers for Disease Control (CDC) and Prevention of the United States of America, a pandemic is the spread of an epidemic over the countries and the continents, affecting a large number of people.

Hence, we talk about a pandemic when an infectious disease affects a significant number of people on a large scale crossing international boundaries. For example, even though cancer causes numerous deaths all over the world, it cannot be classified as a pandemic because it is neither infectious nor contagious.

- What is quarantine?

Quarantine, originated from a Latin word meaning “forty days”, means limiting the movement of individuals or merchandise. It started in the Middle Ages to stop the spread of the bubonic plague in Venice (Budds, 2020).

Ships arriving from regions in which “Black Death” was spread were required to moor for 40 days before the crew could land. Also, when Apollo 11 astronauts got back from the moon in 1969, NASA isolated them for 21 days in Airstream trailer, in case they carried back with them bacteria or organisms from their mission (Budds, 2020).

Manuagh declares that “Quarantine is a spatial buffer, it’s a temporal buffer” (Budds, 2020). It means that it provides additional space and time, postponing anything from happening right away. That remained this way over the centuries” (Budds, 2020).

2.2.2 Historical background

The creation of communities 10 000 years ago in the agrarian life made epidemics more possible. With time, the civilization of these communities increased the spread of pandemics.

- 430 B.C.: Athens.

The first pandemic appeared in the Peloponnesian War. It went through Libya, Ethiopia and Egypt, and Athena to kill two-thirds of its population (History.com Editors, 2020).

- 165 A.D.: Antonine Plague.

The Antonine plague disease, which is an early appearance of a viral disease known as smallpox, infected the Huns in the first place in 165 A.D. The infection was transferred from the Huns to the Germans, and finally to the Romans (History.com Editors, 2020).

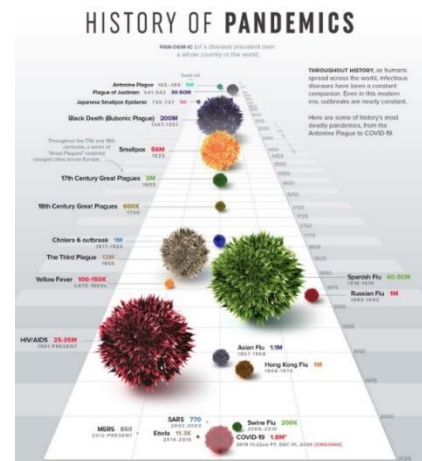


Fig.7: Pandemics that have taken place over the year. Reference: Adapted from LePan, 2020.

- 250 A.D.: Cyprian Plague.

The Cyprian Plague disease appeared in 250 A.D. in Ethiopia. It moved from Northern Africa, to Rome, then to Egypt and northward (History.com Editors, 2020).

- 541 A.D.: Justinian Plague.

The Justinian Plague disease emerged from Egypt, spread through Palestine and the Byzantine Empire, and lastly reached the Mediterranean. Over the next two centuries, outbreaks ultimately destroyed about 26 percent of the world's population, corresponding to about 50 million people (History.com Editors, 2020).

- 11th Century: Leprosy.

Leprosy disease appeared in the 11th century and officially became a pandemic in Europe in the middle Ages. (History.com Editors, 2020)

- 1350: The Black Death.

The Black Death is the second large outbreak of the bubonic plague. It caused the death of 33% of the world population (History.com Editors, 2020).

- 1665: The Great Plague of London.

The graph shows the chart of mortality in 1665 and 1666 in London. The solid and the dotted lines represent respectively all the deaths and the deaths attributed to plague, showing that most of the deaths were caused by the plague (History.com Editors, 2020).

- 1817: First Cholera Pandemic.

Over the next 150 years, the first of seven choleras characterized by small intestine infection originated in Russia causing the deaths of one million people (History.com Editors, 2020).

- 1855: The Third Plague Pandemic.

The bubonic plague started in China then moved to India and Hong Kong, causing 15 million victims (History.com Editors, 2020).

- 1875: Fiji Measles Pandemic.

This pandemic was spreading quickly and caused the death of 40 000 people in total (History.com Editors, 2020).

- 1889: Russian Flu.

The Russian Flu originated in Siberia and Kazakhstan in 1889. By the end of 1890, the death of 360,000 people was recorded (History.com Editors, 2020).

- 1918: Spanish Flu.

This is an avian-borne flu that first appeared in Europe, the United States and Asia, then quickly spread all over the world. Overall, 50 million deaths have been reported (History.com Editors, 2020).

- 1957: Asian flu.

The first wave started in Hong Kong in 1957, and then was spread to China, the United States and England resulting in 1.1 million deaths worldwide (History.com Editors, 2020).

- 1981: HIV/AIDS.

The HIV/AIDS is a disease that spreads through some body fluids. On a good note, the global rate of death linked to HIV decreased from 2.2 million to 1.6 million between 2005 and 2012 (History.com Editors, 2020).

- 2003: SARS.

In China, humans and cats caught the Severe Acute Respiratory Syndrome because of bats. Then, twenty-six countries were affected by this disease, causing 8096 infections with 774 deaths. Quarantine stopped the virus from spreading, hence ended it (History.com Editors, 2020).

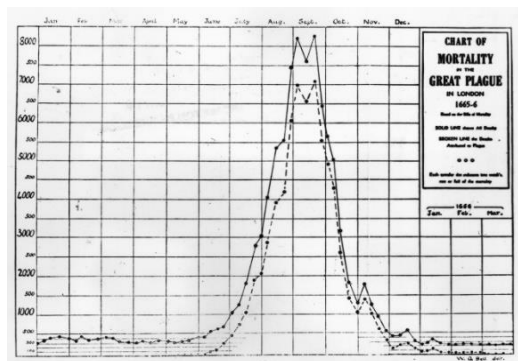


Fig.8: A graph that demonstrates the immense rise in deaths between the 1665 and 1666 Great Plague of London. Both deaths and the split line deaths due to the plague are marked by the strong line. Reference: Adapted from History.com Editors, 2020.

2.2.3 COVID-19

In December 30, Wuhan was the first city to report pneumonia cases which led to the activation of the emergency management team of the WHO. It was directly reported to the world and a global health emergency was issued accordingly in January 2020. By the end of January, a total of 82 cases were reported outside China in 18 different countries. This is when China was assessed with a very high level of risk at the national level, and high risk at the globally.

In 11 March 2020, the WHO officially classified the COVID-19 as a global pandemic after the alarming spread of the virus across 114 countries infecting more than 118 000 people.

Coronaviruses are a family of viruses that can cause illnesses such as the common cold, Severe Acute Respiratory Syndrome and Middle East Respiratory Syndrome. The virus is now known as SARS-CoV-2 and the disease it causes is called COVID-19 (Walsh, 2020).

COVID-19 has different effects on people. Some patients are symptomatic while others are asymptomatic. The common signs and symptoms of COVID-19 include a fever, a dry cough, tiredness and a loss of taste or smell in some cases. Other symptoms may also develop such as breathing problems, sore throat, muscle pain, runny nose, headache and chest pain. The time between the exposure and the appearance of symptoms is called the incubation period, which is two to 14 days for the case of COVID-19. An infected individual may contaminate another person by coughing, sneezing or even talking because of the droplets produced (Noi, 2020).

To mitigate the risk of infection, the WHO has recommended that the distance between two persons must be 1.5 or 2 m (about 6 feet). Yet, a recent study supports the hypothesis of virus spread over 2 m from an ill individual (Bourouiba, 2020).

2.3 Housing Design in Pandemic Era

Human beings have turned to physical space for thousands of years to treat and relieve sickness. Now that new viruses, such as COVID-19, are arising, one of the most successful alternatives is to resort to the physical: social distancing, quarantine, separation, and even adaptation to our cities, neighborhoods, and houses (Budds, 2020).

2.3.1 Past pandemics and housing needs

During pandemics, the fear of contamination has always accompanied the form, almost as much as the feature. Earlier, citizens redesigned interior design, architecture, towns, and facilities to minimize the possibility of infectious diseases.

In addition to previous examples of modernization following cholera outbreaks, tuberculosis outbreaks triggered advances in sand filtration and chlorination systems to purify water sources. Many major manufacturing cities in the United States adopted codes requiring toilet rooms in every apartment building unit by the early 1900s.

The Spanish flu pandemic of 1918 helped to improve ventilation standards. Following the pandemic, public health authorities realized that densely packed urban housing played a role in disease transmission. New advances in open spaces and air circulation were prompted by heightened understanding of how the infectious flu spread.

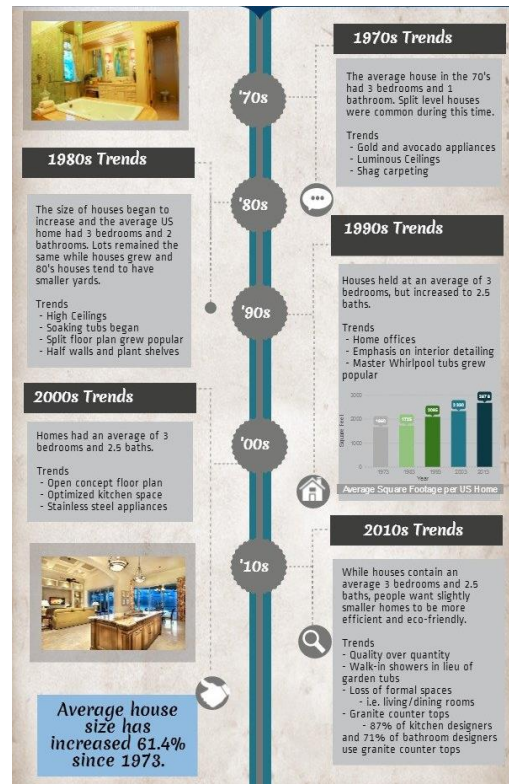


Fig.9: Styles and trends that have gone from 1970 to present day. Reference: Adapted from Bold, 2014.

Houses began to have porches and walls, and subsequent legislation in the United States mandated that all apartments have fire escapes, three-foot-wide hallways, and private bathrooms.

As we continue to adapt to emerging understanding of disease prevention and technological evolution, housing patterns have mirrored health trends over time. Each pandemic has taught us something new about what tenants want in their living quarters (Budds, 2020).

2.3.2 Housing plan history (1970-Now)

In the summarized figure below, all housing trends from the past 5 decades will be clearly explained.

2.3.3 Design problems and challenges

Architects, designers, and urban environment experts are willing to explore several social and architectural ramifications to produce new use trends and configurations. Although COVID-19 has many potential impacts on the built environment, our emphasis is on how post-architecture can shift in the following points. Although social distancing and quarantine interventions are commonly adopted as the first prevention method, other causes, as discussed below, raise the likelihood of contracting the virus (Honey-Roses et al, 2020).

- Population density

Certain heavily populated areas have proven to be especially vulnerable to the possibility of contamination in our on-going health crisis (Chang, 2020).

- Household size

A big, huge, or extended household would have a better risk of taking the virus home. This will take special attention in the creation of infection control solutions (Saadat et al, 2020).

- Social distancing level

Working from home can decrease social interaction but is only accessible to certain individuals focusing on jobs linked to a higher socio-economic status. In addition, for those living in smaller houses or without outer rooms, stay-at-home laws will be more than an obstacle (Saadat et al, 2020).

- Shared facilities

A wide variety of environments and special considerations include communal accommodation. In order to stop the spread of COVID-19, people living and working in this form of building may have problems with social distance (CDC, 2020).

3. ANALYTICAL PART

3.1 National and International Applications

Being in quarantine is a foreign phenomenon for most of us that can impair our mental health and emotional wellness. We've never experienced a life of living exclusively from home, only going out for shopping, and not being around to see relatives or friends.

Below are some examples of how and what people did during their quarantine.

3.1.1 Exercise at Home

While some enjoy their stay at home by eating, others prefer to stay fit and workout. Working out not only has physical positive effects, but it can boost someone's mood and help him fill his day with positivity. Virtual online classes can now serve for this purpose, you can find on any social media platform online classes such as cardio and Zumba that help improve the workout experience at home during quarantine. People could adapt easily at



Fig.10: Virtual online classes that help improve the workout experience at home. Reference: Adapted from Les Roches, 2020.

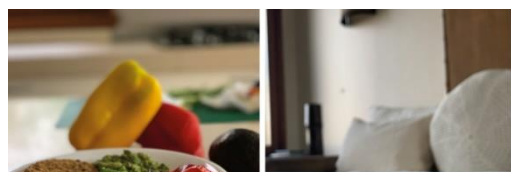


Fig.11: Cooking and baking experience at home. Reference: Adapted from Les Roches, 2020.

home, some started using home objects as gym equipment such as chairs, bottles, benches... (Les Roches, 2020).

3.1.2 Cooking/Baking

Many decided to enter the kitchen and learn new recipes during quarantine. Some already have this hobby and developed it while others tried it for the first time and loved it. This is an activity that can be done alone or with family members which helps spending more time with them (Les Roches, 2020).

3.1.3 Socializing Virtually

During this time, we all really miss family and friends. And while we have to physically separate ourselves emotionally, that doesn't mean that you can't always call your loved ones. In order to sustain your relationships, keeping involved is highly necessary and it also profoundly improves your mental health by getting you out of your head-space (Orcuilo, 2021).

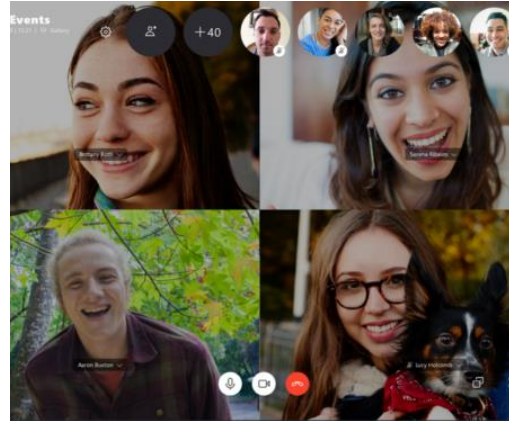


Fig.12: Video call gathering. Reference: Adapted from Orcuilo, 2021.

3.1.4 Watch movies / series

Quarantine means you have more time to watch movies or series at any time of the day. Many people need to escape reality and change their world for few hours, which can be possible by watching Films/Series.

3.1.5 Working / Studying from home

As students or workers begin to do their home-from-home or remote jobs, they can wonder and worry about their job efficiency. They may be worried about the loneliness of peers and friends by being distant and withdrawn, and wonder if they are really going to get all their work done when they are at home. When it comes to success, maintaining a clean and orderly workspace is really important.



Fig.13: Watching films and using streaming services. Reference: Adapted from Rodgers, 2020.

3.1.6 Gardening and roof planting

Gardening is becoming a more and more traditional practice in quarantine. It seems like all of us are seeking to become more self-sufficient in this moment of crisis. Growing plants in a time of confusion and loneliness is a perfect way to feel connected to the outdoors and life.



Fig.14: Working / studying zone at home during quarantine. Reference: Adapted from Orcuilo, 2021.

3.1.7 Gathering outside

Individuals are very advised to wear a mask, social distance, and quarantine while introduced to someone tested positive with coronavirus. People are obliged to stay at home. So, the best way to gather outside is to use their balconies and to socialize with neighbors.



Fig. 16: Gathering outside at balconies' apartment. Reference: Adapted from Les Roches, 2020.



Fig.15: Home gardening during the pandemic. Reference: Adapted from Ieronimo, 2020.

3.2 Survey

The questionnaire had 26 questions and was designed to capture some of the main dimensions of designing residential unit in the pandemic era. The questions are organized along three main parts. The first one looks into the personal information of the respondent. The second focuses on the residential unit of the respondent during quarantine. Questions from the third part cover several aspects related to modifications in the residential unit in the pandemic era.

The questionnaire mixed open-ended and multiple-choice questions with predefined responses, allowing respondents the opportunity to select and rank among many choices.

The survey was conducted in August 2020 and 153 persons living in Lebanon were selected. They received an invitation to participate.

3.2.1 Data analysis

- Result 1:

For those who have the choice between spending their quarantine in a city house and in a village house.

34% of the respondents (52/153) owned a house in a city and in a village:

- 30% (16/42) choose to quarantine in their city house
- 70% (36/52) choose to quarantine in their village house

Conclusion: Most of the people who have the chance to choose between quarantining in their city or village house, they choose to quarantine in their village house. It means, the importance of the built environment in which we live in.

- Result 2:

40% (60/153) of the respondents quarantine in city house and 60% (93/153) of the respondents quarantine in village house.

- 82% (49/60) from those who quarantine in a city house live in an apartment within a multi-story building and 18% (11/60) in a single house.
- 52% (48/93) from those who quarantine in a village house live in an apartment within a multi-story building and 48% (45/93) in a single house.

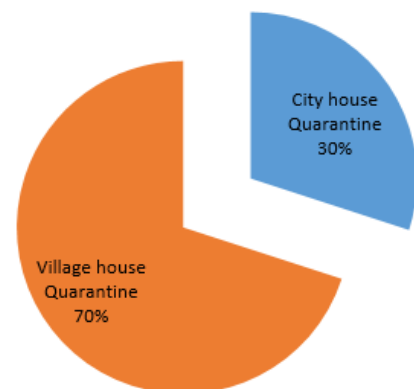


Fig.17: Chart showing respondent's results when they have the choice between quarantine in village or in city. Reference: Author, 2021.

- Result 3:
The room in which respondents spent most of the time:

Table 1: Table showing in which room respondents spent most of the time. Reference: Author, 2021.

Room	City Apartment in a multi-story building	Village Apartment in a multi-story building
Living room	40%	33%
Bedroom	40%	27%
Kitchen	8%	8%
Balcony	12%	10%
Garden		19%
Roof		3%

Conclusion: Respondents, living in a residential unit in a multi-story building, spent most of their times in living room, bedroom and balconies respectively.

- Result 4:
The room in which respondents choose while studying or working from home:

Table 2: Table showing in which room respondents study or work from home. Reference: Author, 2021

Room or Area	City Apartment in a multi-story building	Village Apartment in a multi-story building
Public Area (living, salon, dining)	47%	38%
Semi-Public (Kitchen)		10%
Private Area (Bedroom)	45%	25%
Outdoor Area (Balcony, garden, roof)	8%	27%

Conclusion: While working / studying from home, people are using public area in the residential unit, which means their privacy has been lost. At the same time, workers or students are looking for the good environment when they choose the outdoor areas.

- Result 5:
Activities done by respondents during quarantine:

Conclusion: Watching movies/series, cooking, sport, planting and reading are the most doable home activities by respondents during quarantine respectively.

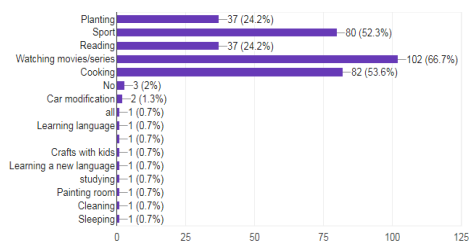


Fig.18: Chart showing the activities done by respondents during quarantine. Reference: Author, 2021.

- Result 6:
Is the design of the residential unit of today's house suitable with COVID-19 pandemic?

Table 3: Table showing if today's residential units are suitable with COVID-19 pandemic. Reference: Author, 2021.

	Apartment in a building	Apartment in a building
Yes	22%	29%
No	78%	71%

Conclusion: Neither in Village or City, most of our residential units are not suitable with COVID-19 diagnosed people and not ready with pandemics.

● Result 7:

During and post pandemic, for sure our lifestyle will be modified, so what do we need in our future houses?

Conclusion: Sport room, working/studying room, entertainment room, isolation room and planting room are the most needed rooms to be added to respondent's house.

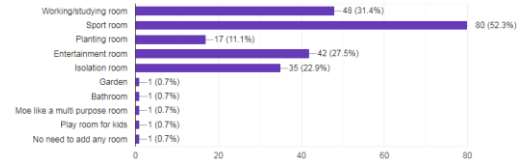


Fig.19: Chart showing the room that respondent wants to add to his/her house. Reference: Author, 2021.

● Result 8:

Based on the room in which we spent most of the time, the area of which room should be increased?

Conclusion: Bedroom, living room, balcony and kitchen are the rooms that areas should be increased to satisfy respondent's needs.

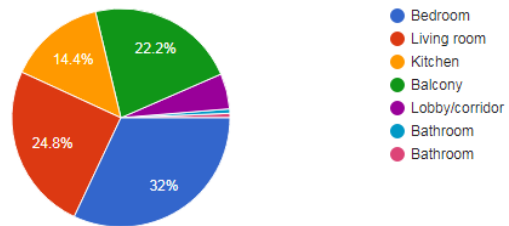


Fig.20: Pie chart showing the area of which room should be increased to meet respondent's needs. Reference: Author, 2021.

● Result 9:

Based on the lost privacy for respondents during quarantine, some modifications are needed in their private rooms.

Conclusion: In future residential unit, if applicable, a small living area, a balcony, a bathroom, a green zone and/or a kitchenette respectively should be added to user private room.

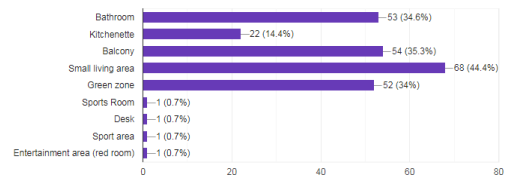


Fig.21: Chart showing the needed area to be added in the private room of the respondent. Reference: Author, 2021.

4. CONCLUSION & RECOMMENDATIONS

A deeper feeling of respect for our houses has come from the pandemic. People need houses that can provide social isolation efficiently and provide protection against viruses and pathogens. Working and Studying from home will be the trend, even after COVID-19 pandemic and quarantine. So, home design definitely might change.

The WHO recommended towards a healthy housing. The current pandemic highlights on the importance of garden space, food production, social distancing and the healing effects of natural elements (sunlight, air, view). Staying at home is the suitable time to know about indoor green zones and gardens, even in multi-story buildings.

Contact between neighbors in a multi-story building is unavoidable. Consequently, the future should rely on the touch-less experience from the front door to the door of the apartment itself.

So below are a list of recommendations for post pandemic residential unit in a multistory building located in city neither in village:

- Post-pandemic accommodation might incorporate more partitions between shared areas in a building and no more open-plan spaces.
- Wider corridors and doorways, and more staircases will change the building code and regulations in residential building.
- Secure flexible and adaptable spaces for all users in order to adapt to the needs that may vary over time.

- The necessity of adding a multipurpose room (like Sports room, working/studying room, entertainment room, isolation room) in a suitable and healthy environment to the element of a residential unit.
- Living room and bedroom dimensions should be increased to satisfy user's needs.
- Balconies should have a higher floor percentage (>20-25%).
- Converting flower box and planting areas in residential apartment to an accessible larger area.
- The future design of bedroom should satisfy user's privacy such like adding a small living area, a balcony, a bathroom, a green zone and/or a kitchenette.



Fig.22: House plan layout for the recommended modifications for post pandemic residential unit in multi-story building. Reference: Author, 2021

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