DESIGN SOLUTIONS FOR INTERIOR ARCHITECTURE POST CORONAVIRUS (COVID-19)

الحلول التصميمية للعمارة الداخلية بعد فيروس كورونا (كوفيد-١٩)

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ABSTRACT

The beginning of 2020 the Coronavirus spread threatened the whole world. The world's population forced to stay at homes - quarantine - to limit the spread of the epidemic. All our daily life practice became from home, this affects the interior space in shape, function, and its impact on human physiological health. The research discusses the design solutions according to the instructions of World Health Organization from the view of interior designers and supports the State's plan innovation and development in the fourth-generation cities.

The priorities of the post-Coronavirus phase are to redesign environmentally sustainable interior spaces for existing or new ones. The research focuses on the design solutions for the shared and public spaces, to get ready for the second wave of the pandemic, thus, limiting its spread by the usage of digital technologies that exploit our environmental resources and face the architectural design challenges in future developments.

KEYWORDS

Pandemic architecture; Indoor spaces; Design solutions

الملخص

شهد مطلع ٢٠٢٠ انتشار وباء فيروس كورونا الذي هدد العالم اجمع، مما اضطر سكان العالم الي البقاء في منازلهم -الحجر الصحي-للحد من انتشار الوباء. أصبح ممارسة مختلف انشطة الحياة من المنزل، مما أثر على حيز العمارة الداخلية من حيث الشكل والوظيفة، إلي جانب أثرها على صحة الإنسان الفسيولوجية. جاء موضوع البحث ليتناول الحلول التصميمية المتاحة وفقا لتعليمات منظمة الصحة العالمية من وجهة نظر مصممي العمارة الداخلية، بما يواكب دعم خطة الدولة في الابتكار والتطوير بمدن الجيل الرابع.

تعتبر أولويات مرحلة ما بعد فيروس كورونا المستجد، إعادة تصميم حيزات العمارة الداخلية تصميما بيئيا مستدام، سواء للحيزات القائمة منها أو بالمشروعات الجديدة. تتركز الحلول التصميمية المطروحة بالبحث للفراغات المشتركة في الاستخدام وأيضا الفراغات العامة استعدادا الي الموجة الثانية من الوباء والحد من انتشار الفيروس، من خلال تفعيل استخدام التقنيات الرقمية التي تعمل على استغلال الموارد البيئية ومواجهة التحديات التصميمية المعمارية بما يواكب التطورات المستقبلية.

الكلمات المفتاحية

العمارة الوبائية؛ المساحات الداخلية؛ الحلول التصميمية.

1. INTRODUCTION

As they prevail, the COVID-19 pandemic may be continuing to substantially change the world and redefine the norm of people day-to-day living. There is no clear vision of how long this crisis will remain, also what other similar challenges the future is holding that can put humanity as vulnerable as today. Therefore, it becomes a necessity for interior architecture designers to imagine new interior design solutions towards a safe environment that minimizes the spread of viruses and diseases. Interior space considers human physical features and in post-covid-19, it needs to address well hygienic precautions and space interactions, which may take some time for everyone to adopt such new behaviors. As a fast track for successful adoption of interior architecture user behaviors by using of *touch-less technologies*, *self-cleaning materials*, *smart systems*, etc. Each one of these solutions considers behavioral characteristics, emotional needs of space users toward a resilient interior design that can accommodate a significant adaptive revision of an existing design. These dynamic solutions will be more effective compared to former methods, such as putting notes on vertical and horizontal surfaces. The research approach is to promote subjective well-being through healthy and contemporary interiors that can be applied in new projects to ensure innovative designs for the fourth-generation cities.

1.1 Problem statement:

One of the most important issues the COVID-19 pandemic causes is that people are spending most of their daily life indoors (quarantine), which makes them feel overwhelmed and distraught while the virus is spreading. It will become crucial to optimize the quality of public and private spaces, allowing the community to share and interact in the built environment that is designed for diverse vital activities. That is why we need creative solutions for interior architecture, to maintain human health and psychological needs, by using smart and digital technology that drive innovation in tomorrow's architecture and reshape every part of our spaces.

1.2 Aim:

Coronavirus coping strategies are one of the most important issues that must take into consideration for long-term use until the end of the crisis – as an indefinite period. The research proposes many approaches to reuse and reshape our interior architecture spaces, such as:

- Fit-out design solution in the existing built interior spaces according to public health recommendations.
- Initialization of interior space design to facilitate users to follow healthy strategies during the quarantine period.
- Make many decisions in the early design stage about how to make human life much better in the interior spaces.
- Adjust and optimize various design aspects functionally and environmentally.

1.3 Objectives:

- Highlighting the world health organization (WHO) Precautionary measures by supplying the interior architecture Sterilization and Disinfection Procedures, In addition to emphasizing the dimensions and proportions of space's area to keep hygienic environments for our emotional state of mind, improve relaxation in-addition to have health and wellness benefits.
- Discuss the innovative designs that could be creative services and resource optimization, aiming to face social, environmental, and technological changes.
- Focus on the importance of green and sustainable buildings design for human health, in addition to placing it in the design considerations of fourth-generation cities With the Possibility to digitize a design system.

1.4 Methodology:

Descriptive and analytical approaches explain the lack of how to manage the interior spaces in a way to reduce the spread of diseases and viruses. Moreover, the pandemic age reset and reshape our built environment. The study comprises data gathered from different resources then analyzed and interpreted in pursuit of results.

2. DESIGN SOLUTIONS

The Design Solution Definition Process takes high-level customer requirements and translates them into a design solution. The goal is to create a set of alternative solutions that can meet the technical requirements. Once a designer obtained a substantial set of alternative design solutions, it should analyze to determine the ideal solution. This analysis can be complete via actual studies, experiments, and simulations. (Design Solution Definition. pdf.p.1) The final design solution definition is a set of final specifications for future developments in interior design that designers could apply in a simple way that provides spaces with a personalized concept for each person while considering to follow the building regulations and parameters in design projects.

3. PANDEMIC ARCHITECTURE AND SPACE RE-SETTING

The architectural design and health are bond through the spread of epidemics since ancient times of cholera, SARS, and other diseases and viruses that threaten our health life. Today's crisis necessitates designing a space with the quality of the indoor environment that works to improve human health and well-being, as the virus is part of our daily life. Nowadays, architects and designers have to consider the epidemiological considerations in the health and environmental fields of future "fourth generation" cities. The idea of pandemic architecture includes two re-design proposals based on actual reality or science fiction studies to cope with the Covid-19 in the architectural building. ("Pandemic Architecture Ideas Competition Open Call" 02 Apr 2020, para.17) as the following:
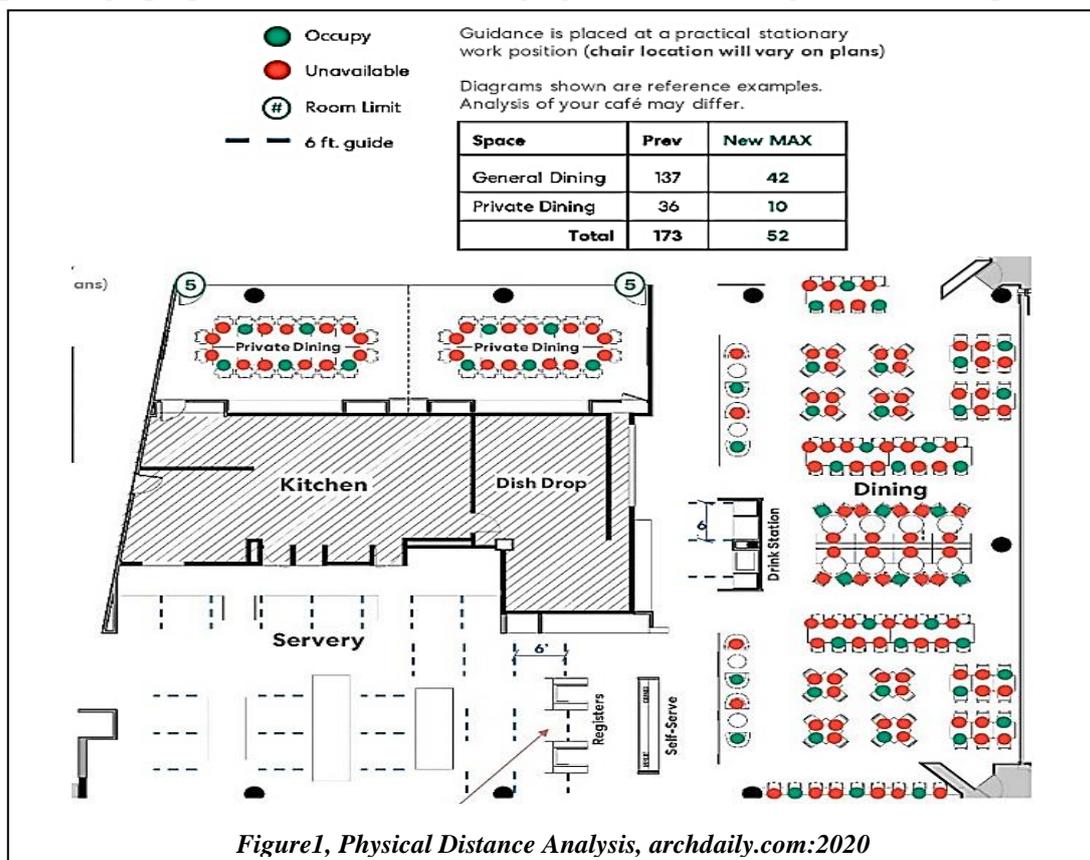
- First, design strategies and solutions for cities in emergency cases how to respond to the increased need for epidemic control facilities such as hospitals, isolation facilities, and cemeteries.

-Second, Design for living spaces such as (Homes, Workspaces, Apartments, Public Spaces, Hotels, etc.), not only to serve functional areas for human needs but also to double as a protected environment for people as they are practicing self-isolation.

The built environment spaces played a pivotal role in the recent global crisis of Covid-19, which clarified radical changes for the paradigm of indoor spaces and how we live within it if we are to survive the next inter-pandemic phase. If we look back at history, we can see that pandemics are not the exception in human history. While, we should be learning to live with a virus in our midst and change various aspects of our lives, including fundamental life activities that have taken an unusual way (going out generally). Therefore, Healthier Spaces in the future are required, irrespective of luxury, size of space, or even interior or exterior space. In this regard, we need to maintain the minimum level of our socialization, life activities, educational work, etc., in a new different way. Considering the Covid-19 pandemic crisis as a problem affecting the architectural space where humans interact in directly and keeping this in mind may cause radical changes in the future of design that relates to the interior architecture field now and over time. Based on our experience in the past few months, it could be enforced in rehabs, adaptive reuse projects, new homes, and apartments design strategies.

3.1 Social Distancing Solutions for Adaptable Interior Spaces Layout

After intense research, it is essential to understand that in the case of the novel coronavirus, no standalone method can prevent spread and infection. Different countries are starting to ease restrictions and allow the opening of public facilities to abide by the World Health Organization (WHO) and other authorities' guidelines. Therefore, the governments start to implement reopening plans that prioritize health and safety. Using science-informed designs to isolate people in public spaces and through setting a guideline that presents a phased multifaceted approach for planning and resilient design to ensure safe interior space, while making social distancing and face covering the only reliable solution to control the pandemic. (See Figure 1).

Multiple design proposals should be encouraging social distancing between occupants to adjust

Figure1, Physical Distance Analysis, archdaily.com:2020

new space protocols in utilizing more partitions between departments and nearly eliminating open-plan spaces to allow safe circulation by having areas such as hallways, vestibules, and wider doorways and increasing the number of staircases. Meanwhile, restaurants considered a brilliant solution to dine-in following the pandemic as suspending individual plexiglass lampshade-like hoods over dining tables; this could allow reducing airborne infection risk (Figure 2). Another one is a small greenhouse for the restaurant hospitality industry (Figure 3). These solutions for safe indoor dining can be applied in addition to other changes to restaurant design and finding alternatives for menus and cash payments (Kristine Klein, MASS Design Group outlines redesign strategies for restaurants following coronavirus, May 2020, para.23,24). Such noticeably changing spaces features and their design strategies and building code to adapt to new purposes and needs of users resulting in more flexible and sustainable spaces. Furthermore, these strategies can include many different approaches combined in a way that minimizes the risk of human health. While a

built environment remains a place to connect and innovate, so it is hard to be replaced by having a fully remote workforce aided only by the technologies and smart solutions.

3.2 Residential Spatial Spaces Post-pandemic

Figure 2, plexi-glass hood for post-virus dining

Figure 3, Individual greenhouses let guest dine a

Spending time at home a few months ago during a covid-19 crisis is much greater than at any time before. Therefore, living has taken a new form towards implementing the policy of social distancing. A new way of living forced the majority of people to change many of their social habits, such as Quarantine, reducing social gatherings, and physical contact. A variety of spatial interior spaces and many amounts of services and functions as a key to combating human productivity lack and stimulate its state of mind, help for relaxation and wellness benefits, like the following:

- Eliminate the modern design trend in homes that unify the entrance of the living room, dining room, and kitchen. Toward having separate entrance area so that occupants can leave their potentially contaminated belongings or clothing such as shoes outside of the living quarters, in addition to using indoor green surfaces as air purifiers. (See Figure 4).

Figure 4, Partitions divides open space layout, architizer.com:2020
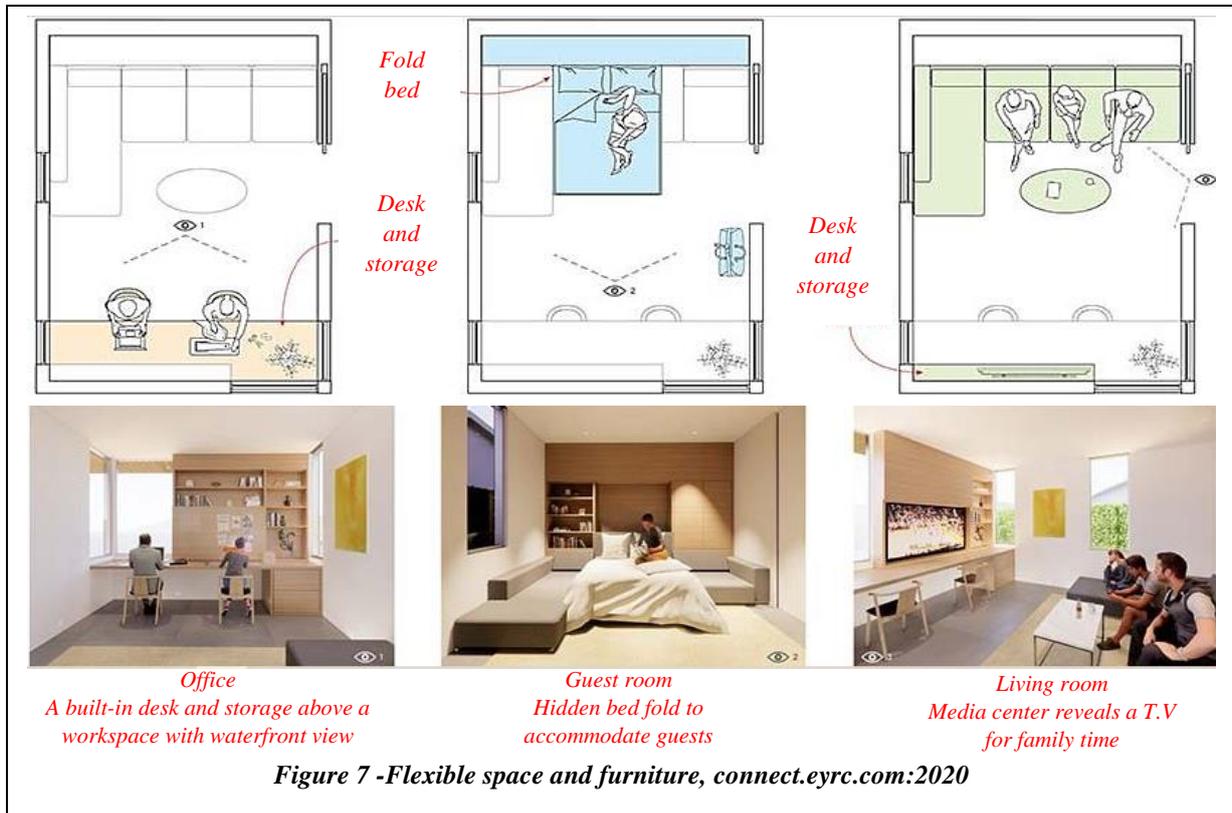
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Figure 5, work space from home, connect.eyrc.com:2020   *Figure 6, biophilic design, connect.eyrc.com:2020*

- Working from home require acoustically isolated room
  equipped with file storage and ideally technological cell for virtual meeting in a pleasant working space. (See Figure 5).

- Access to exterior space has vital during crisis time. It is named (biophilic design), which means a love of nature and connection with the outdoor environment. The biophilic interior design depends on a view extended beyond the limits of the vertical surfaces (walls) to view the landscape or green space -if applicable or even a terrace- that makes the users feel relieves the pressure of remaining in place that a quarantine instills. Besides, considering the abundant use of natural materials or its simulation via color, texture, and form. Make up the core of the approach with proven benefits for wellbeing. (See Figure 6).

Fold bed

Desk and storage

Desk and storage

Office
A built-in desk and storage above a workspace with waterfront view

Guest room
Hidden bed fold to accommodate guests

Living room
Media center reveals a T.V for family time

Figure 7 -Flexible space and furniture, connect.eyrc.com:2020

- Flexible spaces and furniture that offer adaptable configurations to use in multi-purpose activities, in addition to another option to create rooms that easily divided into two rooms in preparation for quarantine and allowing a potential future use. (See Figure 7).

3.3 Functionally And Environmentally Indoor Quality

Coronavirus makes a general state of anxiety for everyone to communicate with others and to touch any surface of the interior space naturally. Focusing on hygiene and sanitization indoor space is an important consideration as well as through surfaces material choices vertically, horizontally, and doorknobs and faucet handle. Therefore, coating surfaces with non-porous, smooth, and Germ-resistant materials like Copper, silver-copper alloys, bronzes, cupronickel, copper-nickel-zin, etc., is considered much easier to clean and disinfect. These materials have intrinsic properties that help to kill large numbers of different microorganisms (Table 1). (Antimicrobial surface, Wikipedia contributors, 2020). In addition to the invention of a lot of new technologies can be integrated inside furniture, fabrics, and rugs to achieve a self-cleaning feature.

Surface material	Virus lifetime	Half lifetime for virus
Stainless steel	48h	5h
plastic	72h	7h
copper	8h	1h
cardboard	48h	3h

Table 1, covid-19 transmission on material within 7days in 23 °C and humidity

On other hand, the global lockdown has helped to reduce air pollution in various countries. Which led to the reliance on natural ventilation to improve the efficiency of the environmental indoor space and increase the benefits from airflow and its positive impact on human health in making it feel happy and comfortable because of optimizing the level of CO_2 in the fresh air. Moreover, reducing the energy consumption used in mechanical heating and air conditioning (HVAC). It is also important to track the CO_2, relative humidity (RH), and chemical toxins (VOCs) which are need to adjust it through air quality sensor to keep a healthy level for interior spaces. Otherwise, the lack of ventilation has a negative impact on human health, which leads to fatigue, headaches, and lower productivity levels. In addition, the humidity at healthy levels (50-60%) defend against mold and heightened reaction to allergies, besides preventing airborne pathogens, such as the covid-19. Another reason that may affect the indoor air quality is excess usage of Disinfectants material - Emissions of off-gas chemicals (VOCs) - for surfaces and furnishing.(connect.eyrc.com,2020) Therefore, having air purification mechanics helps users to control a healthy level of air quality through a Mechanical system that could remove 99.9% of air contaminants. The air management system that provides 20 air exchanges per hour/per unit, 5x the recommended rate, and Sensors detection that maintains healthy levels of VOCs, that keeps indoor spaces well ventilated with fresh air at a temperature of 20 degrees and 60 % relative air humidity (Manchwall, 2020).
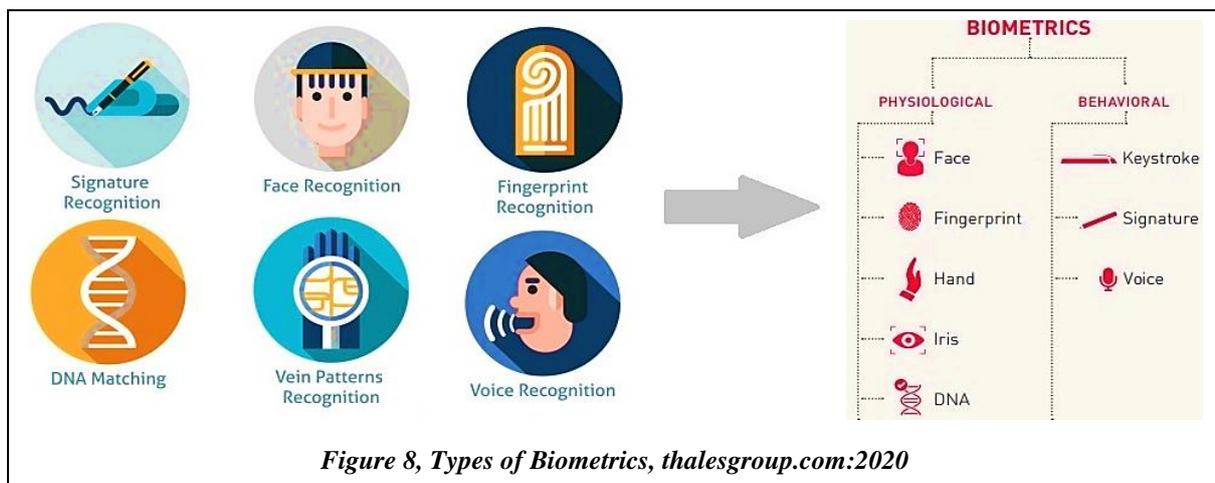
4 AUTOMATION SYSTEM FOR INDOOR SPACES

The designers have been using a smart vision facing the Changes of limiting human contact and practice social distancing, which magnifies the important role of automation independence instead of manual transactions inside spaces in order to skip traditional activities and saving people time and money. Furthermore Looking forward to Futuristic design solutions with responsive

automated systems, In order to cope with the challenges of the second wave of the epidemic whether in the existing interior spaces or the early design stages as a safeguard solution to eliminating as much as possible steps that require human to human contact, Here are ways to illustrate it:

4.1 Smart And Sanitize Entryway

These solutions are reducing the risk of exposure to germs from the first point of entry of any buildings such as stores, offices, hotels, restaurants, etc., and help the building owners and government to open safely. Besides, applying for a critical role in screening public health and reassure customers to move in again. Using technology in entryway facilitates social distancing, provide customers and users a contactless self-service experience, based on mobile-based

Figure 8, Types of Biometrics, thalesgroup.com:2020

solutions, voice-enabled solutions, computer vision application or gesture detection technologies. Through using sensors that measure a person's biometrics such as voice, irises image, facial features, behavioral characteristics, etc. to identify and authenticate individuals is becoming a method for identification more mainstream. (Figure 2)

Biometric technology depends on unlocking mobile phones by using fingerprint or face recognition. Biometrics technology deployed across a host of public buildings. The main goal is to build a multi-modal Entry/Exit system that uses a person's biometrics for identification and verification to advance adoption in the built environment. Such solutions introduce more convenient, efficient data systems while simultaneously achieving the highest level of safety. In addition, it reduces operating costs in some applications.

This intelligent biometric gate used to permit the rapid passage of people (Figure 9) and also special needs (e.g. the elderly and disables) in metro, airport, and other transport installations. This
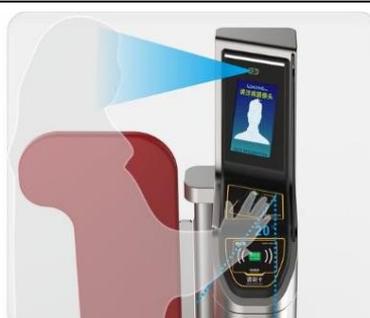

Figure 9, Radar Sensor   *Figure 10, Oriented Design*   *Figure 11, Gate wings design*
Source : https://ifworlddesignguide.com/profile/12801-grg-intelligent-technology-solution , 2018

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intelligent biometric gate permits the rapid passage of people (Figure 9) and also special needs (ex. the elderly and disabled) in the metro, airport, and other transport installations. The innovative design of the radar sensor effectively shortens the gate length and integrates face and finger vein recognition and other technologies into the compact body (Figure 10).

The supreme advantage of this machine is that passengers can pass through quickly without registering in advance. This machine will improve a proper management level of railway transit, lighten staff workload, and reduce administrative costs (intelligent biometric gate/ automatic gate machine, if world design guide, 2018). Therefore, it improves efficiency and lightens staff workload, and reduces business operation costs (Figure 11). Additionally, it eliminates the need for manual data entry and collection for the management of attendance and time, Also, simplifying the process of access and control the user passage in an easy way, hence, better security control and convenience of access card-less entry for users.

With the movement of people within the space, there is direct and indirect contact with the surfaces around them. Virus particles can spread and re-suspended due to natural airflow or mechanical airflow, as well as the movement of feet while walking. It could have second-degree contact without had physical contact with another human but only just being in a place it has consider a source of infection. Therefore, it is essential to understand the potential transmission dynamics of COVID-19 within the built environment ecosystem and human behavior while providing an ideal design solution that potentially mitigates the spread and transmission of viruses.
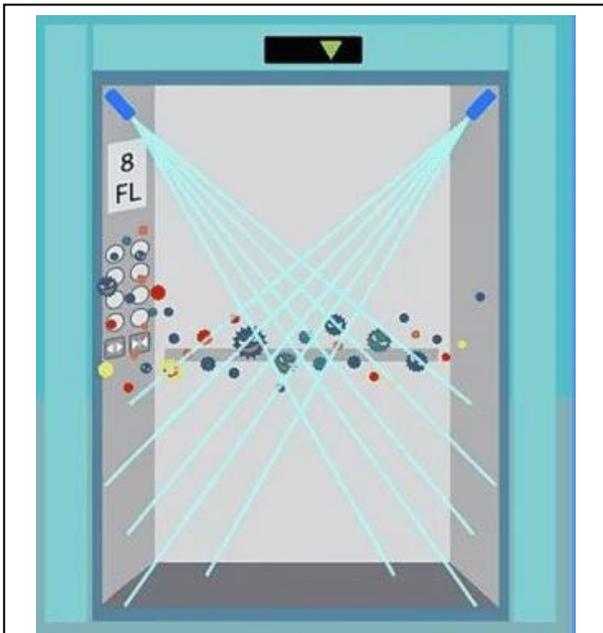

Figure 12, Elevator UV-C light system kill viruses inside airborne and surfaces: cbinsights.com, 2020
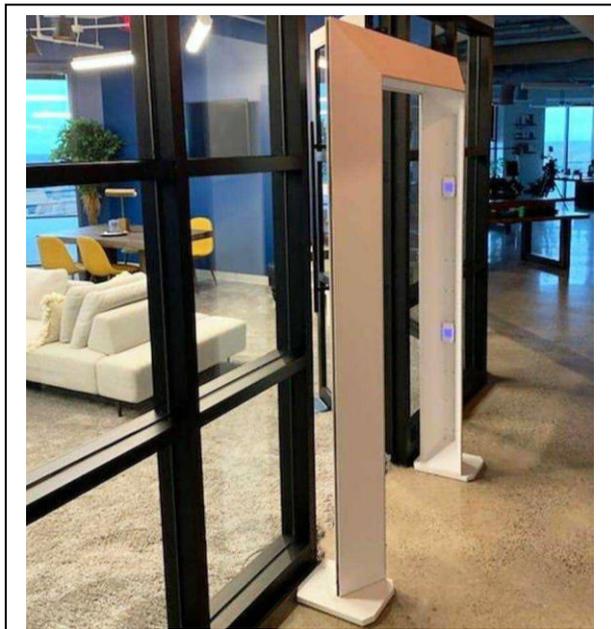

Figure 13, UV-C light system installed office entrance: cbinsights.com, 2020

Neutralize harmful pathogens by using a combination of hardware and software of Ultraviolet (UV-C) light technology that provides users with the tools that they need to ensure measurably safer and cleaner environments to kill bacteria and viruses (Figure 12, 13) (UV Partners Inc., 2020).

4.2 Smart cleansing

The post-pandemic period raised our awareness about how long viruses can live in a variety of environments, such as physical exposure to body fluids (Touching disposable sanitary supplies, coughing) and all potentially contaminated organic and inorganic residues. Cleaning automation in bathrooms will now be a priority, as a space of high risk of contamination. It becomes important to integrate advanced sanitary features such as smart toilets similar to that used in some countries such as Japan, as well as, automatic cleaning faucets, which are common only in public restrooms. These features should be more commonly utilized in both public and private restroom designs (ELISABETTA RIZZATO, 2020, para.4). Some manufacturers such as cleaner dispensing toilet
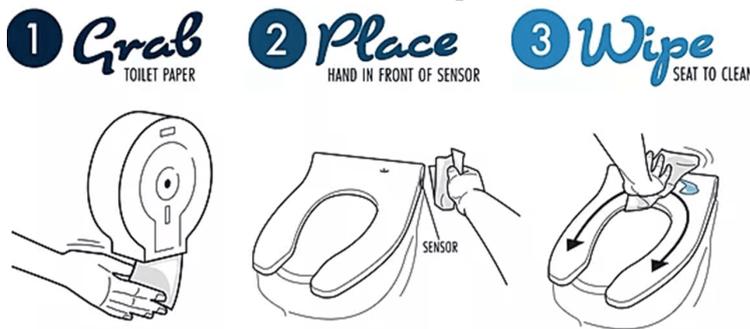

Figure 14, a toilet seat with a cleaning solution that will rise to the surface of the seat: cbinsights.com, 2020
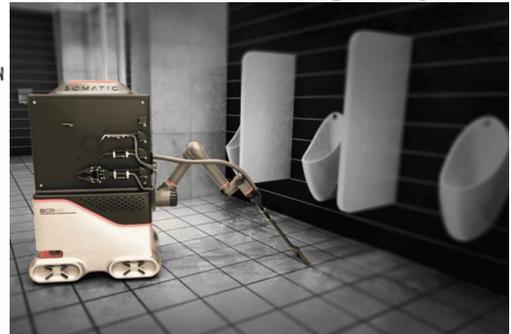

Figure 15, cleaning robots: cbinsights.com, 2020

sea that operated by a sensor for pre-use cleaning (Figure 14) are introducing new technologies. According to health recommendation for frequent sanitizing, using cleaning robots (Figure 15) and self-cleaning devices can lower infection threat on janitorial staff, limiting their job to handling spaces that require manual cleaning only.

The preventive measures and standards catalyzed many significant changes and innovations indoor built environment. The radical re-think of how we are conducting our lives should take into
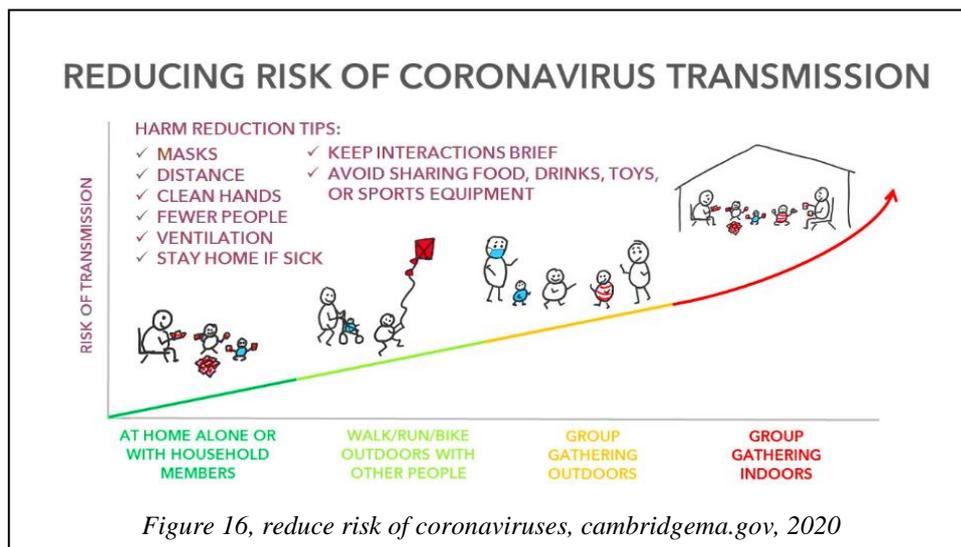

Figure 16, reduce risk of coronaviruses, cambridgema.gov, 2020

concern for the pandemic threats and any viral contagion. Besides how to minimize risks of any simple strain viruses like flu which can affect large quantities of people rapidly. COVID-19 has been highlight the importance of proper cleaning and sanitizing strategies that eliminate the spread of disease, including social distance in a closed environment within 2 m reach or longer than 15 min (Figure16).

4.3 Digital Pre-design System

There is no doubt that in the next few months, there are constantly changing antivirus - the built environment will be a completely different experience from what we currently know. It may require having advanced technology in the construction sector and a tool to quicken the digital transformation. This approach requires using techniques outside the mainstream to secure our built environment by running alternatives, exploring, and inspiring new ways of constructing more sustainable and safe buildings. (Naglaa.A & Ehab.M, 2020) Moreover, the global public health crisis has confirmed the urgent need to find safer and smarter ways of building homes and offices. All over the world, the designers forced in the early design stage of the new smart establishments and its investments looking for a healthier and more appealing environment that assumes human morale needs of psychological and sociological effects. Using digital technology, artificial intelligence, robotics, and the Internet of Things throughout the design and construction process can provide to tackle design problems, inefficiency, outdated techniques, and environmental challenges have also improved it along the physical dimension. (Table 2- *Fluxus + Arcadis, 2020*)

Table 2- Digital transformation of building	
Digital collaborative platform	A digital platform such as cloud-based building information modeling is essential in the workflow to the industry-wide shift into remote ways of collaboration to better manage risk, enable collaborative workflow globally, and plan for sustainability.
Artificial intelligence	Artificial intelligence can speed up and automate elements of design and construction. Algorithms development helps to automate the assembly of prefabricated building components to form varying massing and layout, which directly respond to define physical and environmental conditions, using GIS-data to optimize volumes to achieve the highest yield of units and drive value and possibly learning from occupants changing living behavior to define next-generation homes of future living.
Internet of thing and robotic	The internet of things (IoT) is a vital interface in connecting physical and digital operations. Industrialization of the connected building will likely become mainstream because successful integration of sensors, antennas, control system, and other components into the building envelop is best managed in a factory setting have entered the market. One-site applications including autonomous excavating equipment, surveying drones, painting machines, worker exoskeletons, will also continue to proliferate.

Innovative architecture and cities are moving faster and becoming more interconnected, we need to adopt a new toolkit of options, which are resilient, complete, and reactive, to respond quickly to the pandemic. A smart building is a building that interacts and adjusts its creation points and requirements according to specific situations. If the occupancy reduced, the need for ventilation must also reduce to meet air quality standards, and energy consumption will be required, so the measure to maintain air quality at the highest standards must be adapted to the building's occupancy, optimum energy consumption, and continued compliance. With commitments to the sustainability of carbon dioxide emissions and carbon neutrality, renewable energies, energy storage. (Safe air in a post-COVID built environment, worldgbc.org) The Coronavirus has reminded us of several challenges that we should pay attention to. We cannot wait to feel flustered. We need to be proactive, not reactive and be prepared like our country's initial response to the COVID-19 pandemic.

5. GREEN AND SUSTAINABLE SPACES POST COVID PANDEMIC

Green building investments are key to achieving the post-pandemic economic recovery, clean growth, and climate change. Therefore, a "green recovery" could benefit not just the climate but also human health and ecological prosperity. The basic recommendation for measures of establishing environmental responsibility in designing and constructing green buildings are as follows (James Wines, 2019):

- Keep maintenance of the building surrounding environment, and the use of gardens on the roof for developing sustainable spaces.
- Utilization of renewable or recycled building materials, especially if they are locally manufactured and free of toxic chemicals.
- Recycling and repurposing of gray water and rainwater and the installation of monitors in order to control water usage and conservation.
- Improve Energy efficiency and increase its usage by storing it and exploiting its renewable resources. Example: taking full advantage of seasonal changes of the sun's position, the incident radiation, usage of diversified and regionally appropriate energy sources, as well which may depending on geographic location such wind, geothermal, biomass, water, or natural gas.
- Enhance the quality of the indoor environment by providing the users with smart control of the air quality and temperature of their spaces.

The dependence on natural energy sources and the preservation of available environmental resources took into consideration for future architecture designs. Therefore, it enhances the principles of sustainability due to its implications for human psychological health. For example, the advanced research has emphasized the importance of ultraviolet rays and natural ventilation to limit the spread of infection, especially in the post-coronavirus period, which clarified the total dependence on mechanical ventilation against the sterilization and prevention measures that the World Health Organization has confirmed. On the other hand, increasing awareness of the negative impact on the environment confirmed the idea of limiting the use of water and electricity sources and move forward to design Independent buildings could achieve humanitarian needs and the quality of built indoor environment. In addition to green outdoor spaces will be merging with the interiors to get exposure to natural ventilation and light, to improve psychological stress during quarantine, protect mood disorders that people could feel during pandemics spaces.

5.1 ecological or eco-design Approaches and consideration

Through design principles and techniques that are sustainable, the Environmentally Sustainable Interior Design (ESID) enables the users' healthy environments indoors for the physiological and psychological perspectives. Focusing on two aspects of the design:

- Firstly, the green design is the aspect that addresses the issues of people's health, well-being, and safety.
- Secondly, sustainable design is considered similar issues of the planet from a global point of view.

While focusing on an optimum design approach that would better support the health of space users and accommodate the future needs of the city considered as a holistic way to engage with the environment in which we live, to emphasize the role of sustainable physical space in the built environment.

Ecological design is a system-level approach where all three social, environmental, and economic principles are integrated. It embraces the direct effect space design has on our lives and our
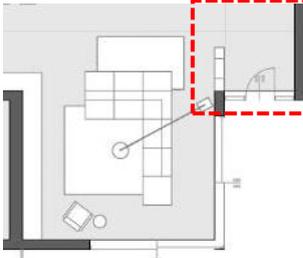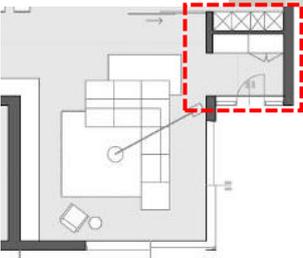
surroundings. To apply it in the interior architecture were focuses on the occupants quality of life and the global effects it on our planet.
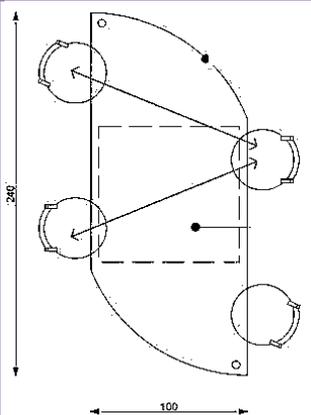
6. DISCUSSION AND ANALYSIS

The major problem of the Covid-19 pandemic is the spread of tiny particles of the virus and their adhesion to surfaces, whether in the internal or external space, which forced us to reconsider the current design system, as well as the methods by which we design the future and the ability to confront unexpected risks.

The fourth-generation cities concepts are a relatively new initiative launched by Sustainable Development Strategy Egypt Vision 2030. An essential milestone in the comprehensive development process in Egypt that links the present to the future and is inspired by the achievements of the ancient Egyptian civilization, to adopt a clear development path for an advanced and prosperous nation dominated by economic and social justice and to revive the historical role of Egypt in the regional leadership. It also represents the roadmap that aims to maximize the benefits of competitive advantages and components and works to implement the dreams and aspirations of the Egyptian people to provide a decent life (cabinet.gov.eg). Therefore, the role of interior designers nowadays come to shape the interior architecture for innovative future that match health and hygienic standard for indoor space. In addition to wellbeing, the design needs to generate new patterns that meet human psychological needs to maintain good environment quality that serves our overall health and wellness.

This research identifies the following finding aspects.(Table 3).

<table>
<tr><td rowspan="2">finding aspects</td><td colspan="2">Table 3 -Design interior spaces in post Covid-19 pandemic</td></tr>
<tr><td>Problem investigation</td><td>New sights</td></tr>
<tr><td>Layout and space organization</td><td>- Open layout accelerate virus transmission.
- Surfaces helps energy conserving.</td><td>- Designers should target simple plans to reduce internal surface area of the space and promote social distance.
- Separate sanitize entry.
- Less energy demand for heating, cooling and lighting.</td></tr>
<tr><td>examples</td><td colspan="2">
Figure 17,
Plan pre- covid-19
sbid.org, 2020   *Figure 18,*
Plan post- covid-19
sbid.org, 2020   *Figure 19,*
Wall storage to left outdoor fit
sbid.org, 2020</td></tr>
</table>

(Sub.) finding aspects	(Sub.) Table 3 -Design interior spaces in post Covid-19 pandemic	
	Problem investigation	**New sights**
social distance	*Figure 20,* *Pre- covid-19 furniture orientation* *sbid.org, 2020*	*Figure 21,* *post- covid-19 furniture orientation* *sbid.org, 2020* *Figure 22, Distance Furniture plan* *sbid.org, 2020*
Indoor gardens	- Absence of space horticulture.	- Improve stress relief and air quality. - Human psychological comfort. - Adds an inspirational and futuristic character to the living spaces and offices.
examples	*Figure 23,* *Office without access to outdoor* *sbid.org, 2020*	*Figure 24,* *Office with access to outdoor* *sbid.org, 2020* *Figure 25,* *Connect indoor with outdoor space,* *sbid.org, 2020*
Smart system	- different space functionality and environment aspects can be adjusted and optimized remotely	- Pre-installed control devices include (security and surveillance systems, PIN pads, credential scanning, motion sensors, and alarms). - Remotely controlled cameras. - Emergency response systems. - Automated lock down systems, to lock and secure all entry points immediately through one command.
Hygienic building materials	- spread of tiny particles of the virus and their adhesion to surfaces	- hygienic antibacterial material - Technologically advanced cleaning strategies. - Nano-solutions.

Study results and Recommendation

Covid-19 pandemics age highlights the limitations of how we manage our space environmentally regardless of how we should be creative designers. In addition to the new features of the post-pandemic interior and exterior spaces should be applied. As well as, we were a force to re-set our planning theories and designing strategies to save healthy spaces in a ready state for the second wave of the epidemic and respecting conventional architectural methods and standards.

The new design guideline follows the current emergency measures stated by the World Health Organization (WHO), besides, to meet the human needs while practicing their daily life safely in the existing built environment. Furthermore, to promote sustainable architecture could engage the development strategies for fourth-generation cities.

Digital technologies exploit our environmental resources and face architectural design challenges in future developments. To consolidate the new buildings to be able to absorb and adapt to any potential changes with a rapid recovery from any consequences that follow such disruptions that affect human beings and the natural environment, these changes give us a chance at how our cities could change for the better in the long-term.

The world after the pandemic would face different challenges that demand a comprehensive knowledge of the COVID-19 virus and its effect on society socially and economically. However, the future stays unclear, so it is necessary to have future multidisciplinary research. Therefore, the results state various solutions for interior architecture designers to apply the precautionary regulation of health authorities and government development while meeting the human psychological and sociological needs as well as the benefits of wellbeing. This approach must be parallel to environmentally sustainable (ecological design) interior architecture and to take consideration of the future policies that pave the way to keep up with the times, this paper recommended the following:

- **Economically:**
- Maintain the workflow in public spaces. There is no need to complete closure in case of receiving the second wave of the epidemic. That leads to economic stability (increase economic activity, enhance income, limiting bankruptcy) at the institutional and state level.
- It is necessary to make the interior architecture more resilient and responsive to emergency changes through self-sufficient, independent, healthy design while utilizing the available technologies to face current and future challenges.

- **Environmentally:**
- Accept the potential gains in some environmental dimensions (lower energy consumption, fewer air emissions) and how to benefit from toward healthy environment.
- Develop architectural building codes to implement sustainable green building to face future challenges in 2030.
- As digital transformation and distance communication reshape our long-established interactive habits, it encourages restoring the quality and efficiency of the indoor environment and enhancing the interior spaces to a remaining place for innovation. Also, build an accurate database that includes needs, requirements, and preferences, to facilitate managing the indoor environment.

- **Health:**
- The most relevant solutions not only resolve infections but also enhance other functions, such as improvements in lifestyle toward healthy behaviors and less disease transmission.

- The introduction of human health to the goals of sustainable development is a logical step to manage built environmental space for a better life for humans and nature.
- The design solutions are no longer sufficiently safe to rely on the protection of our interior architecture. However, it is necessary to reconsider each detail in interior architecture, such as material, systems, etc.
- **Socially:** During the quarantine time, all life activities (housing, learning, working, and even medication) occurred at home. That, Allows a social mix between all the family members. Therefore, it must take into consideration that the design of interior architecture help to perform various vital activities with high efficiency while maintaining family cohesion.

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