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New living and working models after the COVID-19 pandemic

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Abstract

The COVID-19 pandemic has caused a severe health, economic and social crisis that deeply impacted cities and communities worldwide (UN-Habitat, 2021). The pandemic also radically altered the way that people live, work, interact (D'Alessandro et al., 2020), influencing urban life and economies and compelling policy makers to manage and rethink urban public spaces and services.

New trends in the living and working sector emerged following the adoption of government restrictions to limit the spread of the virus, like an increased use of homes for different purposes, increased use of digital service, extensive adoption of remote-working by companies, which has had repercussions for both businesses and households. On the one hand, firms paid rents for empty offices and therefore started reconsidering their physical space requirements for the future (WEF, 2021; ARUP, 2020). On the other hand, workers were forced at home, and often had to reconcile job and family care duties in inadequate spaces. New spaces, services and models are needed to accommodate new living and hybrid working modes that have been increasingly adopted, combining virtual and in-place presence.

This paper aims to investigate which changes have occurred in the living and working sector after the pandemic and how they affected the demand and supply of housing and office spaces. It also aims to identify the new living and working models that could respond to these changes and reflect them in the real estate market. For this purpose, the paper provides an overview of the main trends in the demand and supply of living and working solutions consequent to COVID-19 in cities, and in the use of public spaces and services, based on desk research of available literature on the topic. Through evidence collected from literature, it identifies key "dimensions of change" focusing on dimensions along which living and working needs, habits and solutions have been changing during the COVID-19 pandemic, and might further evolve in the future. Four key dimensions are selected as representative for this change, namely: flexibility and interaction, regarding the use of spaces; accessibility and integration regarding the use of services. The selected dimensions range from rigidity to fluidity in space configuration (Flexibility); from low to high social interaction in spaces (Interaction); from access restrictions to open access (Service accessibility); from low to high variety and number of services (Integration). By using the selected dimensions of change, a set of living and working models is defined and the most relevant models are described, also through the use of emblematic case studies.

1. Introduction

Since its outbreak, the COVID-19 pandemic has caused a severe health, economic and social crisis that deeply impacted cities and communities worldwide (UN-Habitat, 2021). The pandemic generated massive losses in terms of fatalities as well as social and economic instability in many urban areas (Berawi et al., 2020). As of the end of December 2021, the World Health Organization reports there have been more than 280 million confirmed cases of COVID-19, including almost 5,5 million deaths. The negative economic consequences are estimated to be within the range of -4.5% to -6% of GDP in 2020, with a partial recovery of 2.5% to 5.2% expected by the end of 2021 (CoronaDX based on OECD, 2021). The pandemic also radically altered the way that people live, work, interact (D'Alessandro et al., 2020), influencing urban life and economies and compelling policy makers to manage and rethink urban public spaces and services. It is found that approximately 90% of coronavirus cases globally were detected in cities (CoronaDX, 2021), where most of the world population and economic activities are concentrated. The pandemic urged city governments to think about the offer of green spaces, amenities and public services (like low-emissions public transport, active mobility infrastructure, digital infrastructure) to enhance the quality of life of citizens in light of the "proximity economy" concept that is gaining ground (OECD, 2020a).

New trends in the living and working sector emerged following the adoption of government restrictions to limit the spread of the virus, like an increased use of homes for different purposes, increased use of digital service, extensive adoption of remote-working by companies, which has had repercussions for both businesses and households. On the one hand, firms paid rents for empty offices and therefore started reconsidering their physical space requirements for the future, should hybrid models that integrate remote and on-site work be adopted in the long run (WEF, 2021; ARUP, 2020). On the other hand, workers were forced at home, and often had to reconcile job and family care duties in inadequate spaces. This highlighted the importance of benefitting from adequate dwelling characteristics (e.g. larger, adaptable spaces, the presence of a balcony and/or access to outdoor spaces) as well as from a wide range of services in the neighbourhood (e.g. proximity to amenities, access to childcare and eldercare).

Besides the challenges posed by the outbreak of the COVID-19 pandemic, new opportunities and models could arise from it. In the next years, shared housing and working models could gain new attractiveness thanks to their possibility to provide additional services - economic and professional - among which the inclusion of environmental, health and safety concerns could play an important role (e.g. improved sanitation services). Another example could include repurposing buildings to host more flexible, multi-purpose spaces where offices are connected to sports facilities, cafés, etc. with the possibility to enhance neighbourhoods and resilience against future shocks.

This paper aims to investigate which changes have occurred in the living and working sector after the pandemic and how they affected the demand and supply of housing and office spaces. It also aims to identify the new living and working models that could respond to these changes and reflect them in the real estate market. For this purpose, the paper provides an overview of the main trends in the demand and supply of living and working solutions consequent to COVID-19 in cities, based on desk research of available literature on the topic. Through evidence collected from literature, it identifies key "dimensions of change" focusing on dimensions along which living and working

needs, habits and solutions have been changing during the COVID-19 pandemic, and might further evolve in the future. By using the selected dimensions of change, a set of living and working models is defined and the most relevant models are described, also through the use of emblematic case studies.

The paper is structured as follows: 1) Introduction; 2) Methodology; 3) Overview of needs and trends in the living and working sectors, and in the use of public spaces and services, after the pandemic; 4) Definition of new living and working models; 5) Discussion and conclusions.

As the pandemic is still ongoing and there is uncertainty about its evolution, needs and trends might take different directions in the future. While the most restrictive measures (lockdowns) are currently less frequent in government policies to contain the virus, other measures like distancing and sanification are likely to remain relevant and will influence living and working models over time. This also set a possible direction for future research on post-pandemic living and working models.

2. Methodology

The COVID-19 pandemic deeply impacted almost every sector and aspect of our societies and economies. New habits, lifestyles and practices had to be implemented in a short time in everyday lives both at home and at work, in order to respond to the crisis and comply with the virus containment and prevention measures. Some of these changes and new habits are going to stay and become permanent, therefore they are likely to influence our living and working models in the long-term and be integrated into new housing and office supplies.

This study addresses the following research questions: Which changes have occurred in the demand and supply of housing and office solutions, following the new needs and trends consequent to the COVID-19 pandemic in the living and working domains? Which dimensions characterize these changes? Based on these outcomes, the study develops a framework to define new living and working models that respond to the trends emerging from the pandemic.

The methodology adopted in this study can be divided into the following steps:

1. identification and analysis of trends in the demand and supply of living and working solutions consequent to COVID-19 in cities
2. selection of the main dimensions along which living and working needs, habits and solutions have been changing during the COVID-19 pandemic
3. definition of living and working models and identification of models responding to new trends
4. exemplification of the selected models through emblematic cases.

The process is shown in the following image:

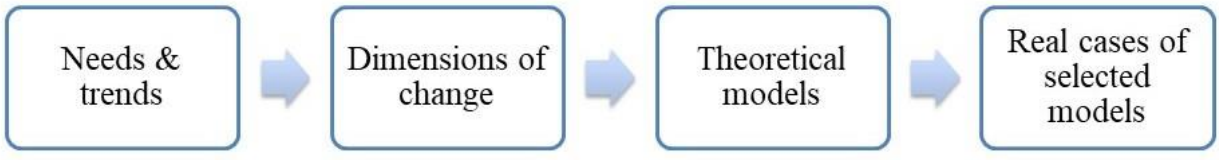

Figure 1: Steps and process to develop and analyse the living and working models

In the last two years, a wide range of literature has been published on the effects of COVID-19 on several aspects of urban life. As first step of the study, main trends in cities due to the pandemic were investigated, considering how COVID-19 affected the use of urban spaces and services. Subsequently, the analysis focused on the living and working sectors, by identifying the main trends in the demand and supply of homes and office-spaces. Overall, these trends relate to how indoor and outdoor spaces and services have been lived and used across the different phases of the pandemic. Each trend, when possible, is described in its temporal dynamic, starting from the first lockdowns taking place in 2020 alongside the most acute phases of the COVID-19 outbreak, as well as its evolution and possible prospects for future years. Trends were identified based on a desk research of available literature (grey and peer-reviewed) on the topic. Data sources included reports and articles published by international organizations, operators and observers of the sector, as well as scientific papers from different disciplines (urban studies, urban planning, urban economics). The outcomes are presented in Chapter 3.

Based on the evidence collected from literature, key "dimensions of change" have been identified focusing on dimensions along which living and working needs, habits and solutions have been changing during the COVID-19 pandemic, and might further evolve in the future. Selected dimensions regard the use of spaces and services and include: Flexibility (from rigidity to fluidity in space configuration); Interaction (from low to high social interaction in spaces); service Accessibility (from access restrictions to open access); Integration (from low to high variety and number of services). Each dimension can be applied both to the living and working domain. The identification and description of these key dimensions, their relation with key trends and the rationale for their selection are provided in Chapter 4.

By combining these dimensions, a set of living and working models were defined. Flexibility and interaction have been combined to analyse the use of spaces. Accessibility and integration have been combined to analyse the use of services. Each of these dimensions could be applied both to spaces and services, but in order to define the boundaries of our models, only this specific focus has been considered here. Each model is characterized by different features along the selected dimensions, and has been represented on a two-dimensional graph. Then models have been analysed according to the following structure:

- Description
- Type of spaces/services included
- Field of application
- Objectives
- Benefits
- Critical aspects

When possible, selected models have been exemplified through a case study. The description of models and their cases is provided in Chapter 4.

These models do not necessarily exist in real setting, as real cases might combine and include additional elements. They are proposed here as a framework to analyse ongoing changes in the living and working sectors. Further dimensions could be detected and applied to elaborate different models.

A discussion of models, addressing their main strengths and weaknesses and the conditions for their implementation, is provided in the last Chapter.

3. Overview of emerging living and working trends consequent to COVID-19 in cities

The coronavirus pandemic generated an unparalleled shock in peacetime. The outbreak of a pandemic in a globalized world compelled national governments to impose strict restrictions to limit the spread of the virus as much as possible. As a result, by the end of April 2020, about 4.2 billion people (54% of the global population, representing almost 60% of global GDP) were subject to complete or partial lockdowns and nearly all the global population was affected by some form of containment measures (IEA, 2020). Government responses to the pandemic were similar in the first months of the pandemic, whereas later on they started to diverge (Hale et al., 2021). Over the past two years, the restrictiveness of containment measures varied over time and between countries depending on factors like the number of cases and the advancement of the vaccination campaigns.

This chapter provides an overview of the main trends emerging since the health crisis in the use of urban spaces and services, as well as in the living and working domains, which might have repercussions on the real estate market. Each relevant trend identified from the literature is described in its temporal dynamic, disentangled between the first and most acute lockdown phase, the following evolution up to the end of 2021, and the possible future developments. In fact, while some clear paths have already emerged in the real estate sector, the long-term consequences of the COVID-19 pandemic are still unfolding, and it will take longer to clearly define where the market is heading to.

3.1. Urban spaces and services

The pandemic virus has had repercussions on people's behaviour, habits and lifestyles in every domain, and had the greatest repercussions on urban centres (UN-Habitat, 2021). Indeed, it is found that approximately 90% of coronavirus cases globally was detected in cities (CoronaDX, 2021), where most of the world population and economic activities are concentrated, and where urban lifestyles are based on physical proximity and social interactions more than elsewhere.

The use of urban spaces and services therefore exhibited new patterns throughout the evolution of the pandemic, and this section outlines the way they have been used by citizens and managed by residents, highlighting possible implications for future urban developments.

This section also provides a more general outlook that introduces the trends that emerged in the living and working domain. Indeed, the restrictions adopted to limit interpersonal contacts not only affected the way they live public spaces and use public services, but also the way people live within the boundaries of their private premises or when running business. For example, the restrictions on services like schools and other outdoor spaces had implications on the new functions on homes during lockdown periods, while services like broadband connectivity and public transport had also implications on remote work choices and possibilities.

Among the most relevant containment and mitigation measures to limit the spread of the virus, that can affect the use of public spaces and services, OECD *(2020b)* includes:

- Workplace social distancing, such as working from home and workplace closures
- School closures
- Banning mass gatherings
- Social distancing

- Travel restrictions

Depending on the severity of the measures, any type of outdoor activities could also be banned at all, or be allowed only within a limited distance from the premises[1].

A significant rise in the use of green spaces

The role of public space emerged for both social resilience and personal wellbeing during and after the acute phases of the pandemic. With the lack of available alternatives, the use of green spaces tended to rise substantially during lockdowns, where permitted, as they allowed for some forms of interactions and physical activity while safely keeping physical distancing. As UN-Habitat (2021) underlines, this "contributed to community cohesion, alleviated stress and played an important role in children's development". Wortzel (2021) underlines the multiple functions performed by outdoor and green spaces, ranging from serving as an escape from home isolation and a relatively safe place to socialize, to positively influencing mental wellbeing and preventing depression and anxiety during lockdowns. Spotswood et al. (2021) also shed light on the inequalities arising from uneven access to green space during the pandemic and find that the most disadvantaged socio-economic population targets are both the hardest hit by COVID-19 and have the least nature nearby.

Public spaces and buildings repurposed for social use, personal well-being and emergency purposes

Beyond preserving personal health, public spaces were also repurposed for social use and to serve new emergency needs like "the set-up of temporary hospitals, warehouses, isolation sites, community health centres and other facilities" that improved the resilience of the severely hit health sector (UN-Habitat, 2021).

With respect to mobility services, lower demand for work- and leisure-related commuting has had consequences in terms of reclaiming parking slots for other purposes (Li and Lalani, 2020[2]), including parklets and recreation (Cré, 2021), and shifted preferences towards minor non-motorized mobility patterns (walking and cycling). In many cities all over the world, several kilometres along existing streets have been dedicated to new cycle paths and pedestrian pathways (UN-Habitat, 2021).

Outdoor spaces could also be repurposed to host typical indoor businesses like restaurants, cafes, theatres, cinemas and gyms, which allowed to support livelihoods and economic activities and provide social and cultural services to communities (UN-Habitat, 2021). Deshpande (2020) addresses the urge to use leftover open spaces between and around the existing built environment, which due to the higher physical space requirements, citizens already started to use informally as play and exercise spaces. Deshpande (2020) also highlights the role that the integration of private and semi-private outdoor spaces (balconies, courtyards, podiums) into an "open space strategy" can play in supporting these needs and also promoting community building.

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[1] This is for instance the case of Italy during the first lockdown and the second lockdown depending on the epidemiological situation of a region: https://www.ictp.it/ictp_covidresponse/italian-government-actions.aspx

[2] As in https://www.weforum.org/agenda/2020/12/paris-parking-spaces-greenery-cities/

Outdoor spaces like streets, squares and parks were not the only ones gaining new functions during the pandemic. Single-use buildings like stadiums and schools were repurposed as well to support healthcare systems, and in particular to face the shortages in hospitals, vaccination hubs and other care facilities (UN-Habitat, 2021).

It is possible that the experience with COVID-19 will affect the future design of buildings used for public purposes, and that they will be built taking into considerations possible alternative uses for future crisis management.

Limited provision of public services and commercial activities

On the services side, the global abrupt halt brought about by COVID-19 radically altered the realm of services provided by government at different scales. Starting from transport services, the pandemic deeply affected travel and movement patterns. The reorganisation of social, economic and cultural activities to better serve local communities and limit the possibilities of contagion, including physical distancing and teleworking, led to an overall reduced demand for mobility (UN-Habitat, 2021). Public transport use experienced a significant reduction, reaching -76% in April 2020 (Lozzi et al., 2020). Where mobility needs remained, a shift has been observed from public transport to private transport use as well as non-motorized travel such as cycling and walking.

The fear of contagion in crowded and shared vehicles along with restrictions on maximum capacity are the key determinants of the decline in use of public transport and shared mobility, that were partially compensated by an increased use of private transport modes and active mobility (Habib and Anik, 2021; McKinsey, 2020; Elks, 2021; UN-Habitat, 2021). Nevertheless, it is suggested that reduced ridership and stricter hygiene measures (physical distancing, use of masks) are successful enough in preventing the spread of the virus and make public transport safe even during a pandemic (UN-Habitat, 2021). With prevention measures in place, and increasing vaccination rates in several countries, the use of public services has bounced back. Depending on the evolution of the sanitary crisis, it is reasonable to expect that the sector will at least partially recover. Overall, it is possible that the fear of contagion lead to changes in mobility patterns that can outlast the crisis, like a shift to active mobility and micro-mobility modes.

Overall, public transport disruptions and restrictions shed light on some limitations regarding the way people move in cities. The need to commute over long distances to reach the workplace or other essential services conflicts with the necessity to easily meet basic needs, like medical cures, within reasonable distance and with ease, especially during a crisis (Moser, 2021); this affects disadvantaged communities and peripheral areas the most (UN-Habitat, 2021). The pandemic urged to think about "integrated mobility networks that provide safe and affordable public transport, with first and last mile connectivity to make existing as well as newly planned cities more resilient" (ibid).

Travel restriction and other containment measures also strongly affected commercial services, which are among the most hardly hit activities overall, as they greatly rely on human interactions. The retail sector across OECD countries accounts for almost 5% of GDP and employs about 1 in 12 workers (OECD, 2020*c*). COVID-19 has dramatically disrupted the sector, although it affected disproportionally physical, non-essential, smaller shops compared to online, essential and large retailers (ibid). Administrative business shutdowns and general mitigation measures had sales across many sectors plummet (OECD, 2020d; OECD, 2020*c*).

Currently, several efforts are made at a global scale to avoid further restrictions on these types of services. Yet, the ongoing uncertainty around the evolution of the pandemic, with new variants and a large share of the global population still unable to access vaccines, make it likely that some restrictions will still affect these sectors (e.g. by restricting customer access based on proof of vaccination, testing and recovery).

Increased pressure on central and local government budgets

Such restrictions posed relevant challenges also to governments at different levels that supply and charge public services. Auerbach et al. (2020) find evidence that COVID-restrictions in the US "reduced state and local taxes and fees related to health care, entertainment, gambling and, in particular, transportation", with the latter experiencing a loss in revenues by over $45 billion in 2020, and estimate an overall state and local revenue reduction equal to $165 billion in 2021 and $143 billion in 2022. However, Dougherty and De Biase (2021) also underline that subnational tax revenues tend to be more stable than those of central governments as they mostly rely on property taxes or other immovable property, and that central governments provided financial support to help local governments manage this unprecedented crisis. Overall, early data reveal that local governments' fiscal positions in 2020 were not as heavily affected by COVID-19 as expected, albeit uncertainty remains (ibid). It is therefore hard to predict the overall future impact of the pandemic of the provision of essential public services and related revenue streams for government budgets.

The link between digital technologies and public services

Another relevant trend affecting public services during the COVID-19 pandemic is digitalization. The supporting role of digital technologies and connectivity emerged as a key enabler for reconfiguring and making public services like transit, but also business practices and the built environment, efficient and smart (C40-Arup, 2021). During the pandemic, innovative solutions adopted include: using digital tools for tracking the evolution of the pandemic; providing telemedicine and other online services; developing information and awareness campaigns (UN-DESA, 2020). Technologies like the Internet of Things, Artificial Intelligence and Big Data enable shared mobility solutions and online shopping reducing the need to physically travel to shops. Other non-minor applications for the Smart City include the efficient use of energy and water, increase in proximity and the promotion of adequate land use (Moreno et al., 2021).

Technology proved to be a powerful tool to improve the quality and effectiveness of many services, therefore it is reasonable to expect that further integration of innovative digital solutions will improve in the future, especially in fields like e-health.

Future developments of local neighbourhoods

The restrictions, measures and responses described so far have nonetheless allowed the neighbourhood to take on renewed importance in urban life, as "the ways urban dwellers are now using public space and local amenities where they live have changed drastically in many cities – and potentially for the long term" (UN-Habitat, 2021). During the acute phase of the health crisis, more compact, mixed-use neighbourhoods with robust street networks appeared to be better able to

provide access to essential services and meet other basic needs within short distances of their homes (ibid).

The temporary changes caused by COVID-19 may lead to the rethinking of urban planning principles and practices for neighbourhoods and cities. The idea of the "15-minute neighbourhood" gained indeed renewed momentum and growing support as early lockdowns entered into force. This concept is based on the principle that urban development should allow residents to meet essential needs within walking distance from home. The type of services provided at a more local scale should include a balanced mix of residential and work facilities, public gardens and green spaces, schools, healthcare facilities, commercial and financial services, local administrative offices, sports and leisure facilities, retail stores and shopping centres, public transport, active and micro-mobility infrastructure (C40-Arup, 2021).

In a pandemic crisis, mixed-use neighbourhoods can enhance urban resilience by containing the spread of viruses and ensuring local communities have equitable access to basic services needed. In the medium to long-term, this could be the natural development of cities due to the fact that reduced commuting needs because of teleworking can boost local demand (Urban Design, 2021). Besides, proximity-based services and facilities could trigger positive externalities in terms of healthier lifestyles based on active mobility and community cohesion (UN-Habitat, 2021).

As underlined by Bandarin et al. (2020), for cities to maintain their attractiveness and competitiveness as before the telework era compared to peri-urban and rural areas, the redesign of public spaces in light of the "15-minutes city" concept is deemed crucial, along with shifting from a logic of mobility to the one of accessibility. In addition to that, people-centred streets and mobility and tactical urbanism can "promote a sense of ownership towards public spaces" and encourage proactive stakeholder engagement (C40-Arup, 2021). Another example of management of public spaces where citizens are involved directly is Sweden's "one-minute city" approach, where residents take part in the decisions about what to do with the space right outside of their doorstep (Cré, 2021).

3.2. Living - housing

Demand for housing is driven by several factors, including households' income, interest rates, changes in the mortgage market, demographics, demand by non-residents and price expectations, (André, 2010). Furthermore, elements such as lifestyles, needs and habits shape the demand and housing preferences. Main drivers on the housing supply side are generally related to profitability, including housing prices, price expectations and housing production costs, as well as by local factors such as the availability of land for building, infrastructure and building regulations (André, 2010).

The disruptive shock generated by COVID-19 already caused some immediate changes to adapt to the 'new normal', whereas embedding new solutions in the design of new living spaces will require more time. Some trends on the demand and supply side of living solutions are already visible in the market and are described in this section, together with key elements and prospects for the future identified from the literature.

3.2.1. Trends on the demand side

Homes as confinement and isolation spaces

In several countries across the world, including Italy, stay-at-home orders and recommendations lasted for over two months during the early stage of the COVID-19 pandemic. As a consequence, houses were the only place where people could spend their day and lives by sleeping, eating, working, studying, practicing sports, and socializing as far as it was permitted (Amerio et al., 2020).

During the lockdown, psychological distress arose from living in overcrowded households or, on the contrary, also living alone. Delmastro and Zamariola (2020) find a positive association between depressive symptoms and living alone, and not leaving home to go to work. Furthermore, it is also highlighted that physical characteristics of homes deeply affect health and wellbeing (Tinson and Clair, 2020). Features like having adequate spaces, access to outside private spaces like common gardens or balconies played a key role as relief measure for distress due to lockdown. The pandemic therefore has underscored the impact of housing on health and wellbeing, reinforcing the need for liveable spaces.

The ongoing uncertainty regarding the evolution of the pandemic makes it difficult to predict future limitations, and possible lockdowns may not be excluded completely.

Homes as remote working and learning environments

During the acute lockdown phase, the closure of workplaces, schools and shops deeply affected people's habits as well as the configuration of domestic spaces. The home was transformed into a 'virtual' working and learning environment, requiring a wide adoption of new technologies and equipment (Maalsen and Dowling, 2020). Remote working was massively employed by public administrations and companies, in sectors where this was feasible, to ensure public services and business continuity (ILO, 2020). This also had profound impacts on urban mobility volumes and patterns (see Paragraph 3.3).

Due to COVID-19, "legions of workers cleared off their kitchen counters and dining room tables to make room for laptops, screens, and keyboards, while their employers scrambled to deploy digital tools to help them maintain the productivity they had in the office" (McKinsey, 2021). When it comes to education, many countries implemented some form of remote learning during the early phase of COVID-19 as an emergency response (World Bank, 2021; Li and Lalani, 2020). Overall, the COVID-19 pandemic has disrupted education in over 150 countries and affected 1.2 to 1.6 billion students globally (ibid).

In the current epidemiological phase, as countries all over the world started coexistence with the virus also thanks to the availability of new vaccines, many of them are easing restrictions and limitations to personal movements and service access. Yet, given the uncertainty around new variants of the virus, home-working is still a widespread reality, and remote learning is still being resorted to as a way to prevent new clusters of the virus. This situation is expected to continue in the future, with implications for home design in terms of more flexible and multi-functional spaces that will be discussed later in the chapter.

Increased use of digital connection and digital services

During the lockdown, with physical distancing measures in place, and tasks and socialisation activities being carried out remotely, the use of digital connection at home increased substantially. Connectivity became a primary need to perform activities like remote working and schooling and access a variety of functions, like entertainment and socialisation, and online services, e.g. administrative, financial, commercial, etc.

Since the beginning of the pandemic, "demand for broadband communication services has soared, with some operators experiencing as much as a 60% increase in Internet traffic compared to before the crisis" (OECD, 2020*e; OECD, 2020f*). The associated impact on communication and connectivity in terms of higher data consumption stems from the extensive use of videoconferencing tools and other bandwidth intensive applications like streaming platforms. The pandemic highlighted and exacerbated the existing digital divide, as deprived households, schools and districts could not access remote education, remote working and other digital services due to lack or insufficient connectivity or of devices (UN, 2020).

Along with the need for connectivity, movement limitations and the closure of public and commercial physical stores generated the need to purchase services and products online, which led to a relevant increase in the use of online services since the outbreak of the Coronavirus pandemic. Google Trends data for OECD confirm this trend and indicate that in fields like retail sales, restaurant delivery, and mobile payments, online-platform use increased markedly during the first lockdown in 2020. This pattern varied between areas of activity and countries, depending on the levels of economic and technological development, the access to infrastructure and connectivity, the level of digital skills, and wider Internet use (OECD, 2021*c*). The scope of e-commerce has widened during the crisis, including new firms, consumer segments (e.g. elderly) and products (e.g. groceries), with transactions partly shifting from luxury goods and services towards everyday necessities, relevant to a large number of individuals (OECD, 2020*g*). With the elimination of public gatherings and most sports leagues suspended, online entertainment options have seen rapid increase in demand; similarly, the streaming of religious services and conferences has peaked (Deloitte, 2020). Also, the use of e-health dramatically accelerated, because of factors like the high risk of contagion, restrictions in place, risks perceived around public transport, as well as for the neglect of non-COVID-19 patients' clinical demands (Wang et al., 2021).

Even beyond the acute phase of the pandemic, OECD (2020*g*) stresses that online activity will remain high in areas like telework, e-commerce, e-health and e-payments; therefore, preventing the digital divide and guaranteeing adequate digital access is essential across countries, demographic and socio-economic groups and genders.

Higher use of second homes in tourist sites

Another phenomenon during lockdown periods in cities was the use of second homes located in less densely populated areas, which often are of higher interest for tourism purposes (mountain, seaside, countryside, historic centres, …). When travel restrictions allowed it, households having a second home could find a shelter from areas where the virus spread faster, or simply enjoy different amenities and commodities (Zogal et al., 2020).

This trend is supported by some data from online searches. In Italy, for example, requests and online searches for country homes increased by 20% between February and April 2020. In the UK,

the number of citizens looking for remote locations to buy a home increased. Luxurious and low-density places such as Inverness in the Scottish Highlands or the Shetland Islands experienced a, respectively, 167% and 131% year-on-year increase in searches in April 2020. Also in Spain, an increase is expected in the international demand for holiday homes or retirement properties in tourist regions such as the Costa de Sol or Costa Blanca (Zogal et al., 2020).

Even if looser restrictions during the actual phase make it less urgent for people to escape out of the city, the issue of second homes is also very relevant during post-Covid times as long as remote or hybrid work plans become more widespread, allowing for greater flexibility for the choice of where to work.

Demand for new dwelling characteristics and related amenities and services

On the demand side of the housing market, a change in preferences for housing location and characteristics could be observed during the first lockdown phase, which is driven by the necessities to have more functional spaces and accommodate the new functions of the dwelling.

New preferences could be observed towards larger, single-family (possibly with green and outdoor spaces) dwellings in less congested locations, although located in semi-peripheral areas and lacking mobility infrastructure (Guglielminetti et al., 2021; D'Alessandro et al., 2020; CdC, 2020). CdC (2020) also remarks that the house is becoming a commodity; provided services and the surrounding context are key elements of purchasing decisions. On the leading Italian property portal, Immobiliare.it, 7 indicators out of 12 regard the outside context and the availability of common rooms, of lockers to withdraw packages, and of a condo App. With respect to changes of internal spaces, a unique living space prevails, surrounded by bedrooms and other services. In the UK, research on Rightmove shows huge rise in interest in areas such as the Isle of Skye, Braemar, the coastal areas of Devon and East Sussex, and Cornwall. The word "garage" was the most popular keyword on property searches, driven by owners wanting to convert it into a permanent office - to allow them to work from home - or into a gym or workshop (Rightmove, 2021; Peachey, 2021).

These preferences further developed even beyond the first lockdown and can be summarized in the "Top 10 housing trends for 2021" by Zillow; these include include "zoom rooms", "homecation" (home plus vacation) amenities, intergenerational living, gourmet kitchens, backyard oasis, smart and safe tech, health and wellness at home (Kaklauskas et al., 2021**)**.

Kaklauskas et al. (2021**)** expect that many amenities in high-demand for the future in multifamily communities will be related to health and safety services (e.g., fitness centres, sanitation procedures, contactless food delivery, medical services, etc.), entertainment services (e.g., outdoor grill areas, recreation rooms, pools), and other convenience-based amenities (broadband services, lockers, EV charging stations, mailrooms).

Affordable housing as a primary concern

Given the dominant role played by private houses during the pandemic, an important aspect to consider is related to the affordability issue, which was deeply exacerbated by the economic consequences of the COVID-crisis. Housing affordability can be defined with respect to financial access, that is the capability to bear access and running costs related to the dwelling, while still

preserving the capability to maintain adequate living standards and respond to the new needs (WEF, 2021).

Tinson and Clair (2020) include, among relevant factors affecting health and wellbeing, financial stability (referred to as households' control over how long they live in their homes, and how secure they feel) and financial pressure (caused by housing payments related to housing, utilities and maintenance, with both direct effects – stress – and indirect effects via disposable income). Due to the socio-economic crisis triggered by the health crisis, both these factors may be negatively affected in both the immediate lockdown phase and the current phase of coexistence with the virus, with private renters suffering from more unstable economic conditions and being more exposed to eviction. This can be especially true for lower income, single-parent households and people belonging to more vulnerable categories (UN-Habitat, 2021).

OECD (2020*a*) reviews the efforts made at the local government scale to face the housing crisis during the pandemic, with cities like Lille, Liverpool, Mexico City, Rotterdam and Vienna adopting social housing policies in favour of the most disadvantaged. During the first waves of the pandemic, in at least 34 states of the US evictions were temporarily prohibited and, in addition, European countries including France, Germany, Italy and the UK also provided temporary mortgage reliefs; other policies adopted include suspended or limited rent payments, tax reliefs for mortgage borrowers, and extra rules regulating landlord–tenant relations (Kaklauskas et al., 2021). Serlin (2021) reports that in the US "lending volume remained strong for affordable housing" and that, according to many lenders, the "affordable housing industry has not been hit as hard and has shown its resiliency".

3.2.2. Trends on the supply side

Housing transactions

In the early stage of the pandemic, Balemi et al. (2021) document a "decreasing number of new home listings as well as pending home sales" in the US, with a 30% drop of residential property sales between February and June 2020 mostly caused by "sellers' risk aversion in light of considerable uncertainty dominating the market". In Italy, the first half of 2020 was marked by a relevant reduction in housing transactions, followed later on by a sharp rebound especially in small municipalities (Guglielminetti et al., 2021). When it comes to the European housing market, losses in housing investments varied depending on the different timing and restrictiveness of measures adopted, as well as the fiscal support measures by States (Battistini et al., 2021).

The trend in house prices seems to have remained fairly stable in both markets, with an upward pressure being observed following the second wave of the pandemic. This was mainly due to fiscal policy measures and supply-side constraints regarding production during the first wave and labour and material shortages in the subsequent waves, leading to higher delivery times and higher production costs (ibid). Overall, the EU housing market proved to be resilient both in terms of demand and supply during the second and third waves of the pandemic, from the combined effect of less tight restrictions and policy support in place (ibid).

New rent models

After the acute phase of the pandemic, according to CdC (2020) new real estate investors have been moving towards more stable, albeit lower-return investments, and are paying attention to new living models to account for new demand patterns (dwelling dimensions, new family types and lifestyles), new targets and demographic change, e.g. tailoring senior housing based on a wide range of individual and collective services, as well as to drivers like flexibility and affordability. The demand for flexible living spaces, that allow for safe social interaction as well as integrated services, can be an opportunity for real estate investors to explore the potential of new or already existing models.

According to WEF (2021), "*the real estate industry has started to consolidate the rental market through build-to-rent and co-living in order to leverage economies of scale and offer affordable solutions".* Build-to-rent (BtR) is an alternative housing model in which units are intentionally built to be rented rather than sold, which "grants accessible rents to tenants due to the economies of scale in development and asset management." In addition, Kaklauskas et al. (2021) also identify new models like multifamily schemes (multiple units in a single building or connected by shared walls) and other models of managed rentals, like lease-to-own (lease contracts allowing the tenant to eventually purchase the property), co-investment (where multiple investors contribute for investing in a specific residential real estate asset) and other tenancy–ownership options to access new, more affordable housing.

Co-living can take different forms, but generally these spaces offer users furnished rooms with shared common areas (including sometimes also co-working spaces) with an all-inclusive rent under flexible and, generally, more affordable terms (Von Zumbusch and Lalicic, 2020). While co-living, especially short-term, was deeply impacted by the physical distancing restrictions and the fear of contagion, the model has the potential to adapt and thrive even in a post-pandemic world, e.g. by "*thinking about topics like density of occupancy, circulation patterns, pathway tightness and applying nudges for simple behavioural changes*" (Coliving Insights, 2020). Indeed, co-living is conceived to provide a variety of shared services and common spaces that were highly demanded in lockdowns, but the biggest need it responds to is the one for safe, social interactions. It is found that, globally, longer-term co-living did not exhibit significantly declining occupancy rates and that, on the contrary, "*having a live-on community is appealing during the time of lockdown"* (Coliving Insights, 2020).

Another model that can gain new momentum after the relaxation of restrictive measures is the one of "micro-living". Microapartments are ready-to-occupy, fully-furnished housing units ranging from approximately 20 to 40 sqm, adapted to the needs of students, commuters and company employees who are looking for locations close to the centre, flexible rental agreements, or community and smart living (Bauer, 2021). Although hit hard by the pandemic, demographic trends like the rising number of single households and the need for flexibility accelerated by COVID-19 can be the premises for a new surge in this model (ibid).

Prospects for the future of housing design

COVID-19 will likely produce profound changes in home design that respond to the new needs expressed on the demand side, which will lead to the enhancement of safety, health and comfort.

In order to properly integrate the home-office, dedicated design solutions have been applied during the lockdown and current phases (e.g., dedicated rooms for the setup of a quiet work station) and can further be embedded in future residential developments.

Flexibility will be considered in new housing solutions with internal spaces that can be easily reconfigured, to accommodate for a variety of functions inside homes. Design solutions that can allocate flexible spaces for activities like remote working and home-schooling include moving walls, sliding doors and flexible furniture with modular, movable pieces. With more household members staying together for longer, privacy has also become a more stringent necessity, which can be satisfied using acoustic separation between spaces (Killianpur et al., 2021). Sanitation habits are already part of today's lifestyle, but specific technologies could be more deeply widespread and integrated into new homes, and prevention measures could affect home design. In light of the possibility of new health emergencies, houses may be endowed with an entrance guest bathroom that could be used as a sanitation area (Politini, 2020), as well as with ultraviolet lamps to kill viruses and bacteria. Healthcare workers highlight that the house of the future will be the place for first aid, due to healthcare systems that will likely be unable to promptly respond to similar crises in the future (ibid).

3.2.3. Link between the pandemic and the demand for sustainable residential buildings

The pandemic shed also much light on the global environmental and climate crisis, providing evidence that human activities do heavily affect ecosystems around us. Many studies identify a correlation between air pollution and COVID-diffusion, highlighting the intertwining of different crises (Zang et al., 2022; Ali and Islam, 2020). Such concerns could be a push towards supporting decarbonisation from the built environment, in particular by retrofitting the existing building stock, improving climate resilience and reducing carbon emissions (e.g. via temperature management), and adopting solutions like superior thermal envelopes, passive ventilation, smart systems, electrification, and higher penetration of renewables (WEF, 2021). These issues are also relevant to the extent that Green Building Certification Systems (GBCSs), like BREEAM and LEED, may vary to meet new requirements to adapt to the post-pandemic reality (Tleuken et al., 2021). This applies both to residential developments and for office buildings.

At the same time, there is evidence that the Covid-19 health and economic crisis has affected building renovation plans of families and businesses. According to a survey conducted by UIPI (2021), 27.88% of respondents stressed that the pandemic affected their renovation plans, by postponing these plans (62.22%), downsizing them (19.24%), abandoning the idea (14.30%) and reducing their budget (12.99%). A slight shift is observed after the Covid-19 pandemic, where the low-budget categories (less than 5,000€ with 36% and 5,000 - 10,000€ with 28%) seem to gain advantage comparing to the higher budget categories. Here percentages decreased to 16% and 19% for investments of 10,000 - 20,000€ and more than 20,000€ respectively (UIPI, 2021). Recovery policies and strategies at the different levels, such as the Renovation Wave in Europe, will play a key role in keeping up the investments and the transition towards sustainable buildings.

3.3. Working

In the working domain, the coronavirus pandemic brought about unprecedented changes due to the restrictions on in-person interactions and travel that traditional business models used to rely on heavily. Among the most relevant trends, COVID-19 pushed towards a massive deployment of remote-working, strong acceleration of digitization for transactions, consultation and collaboration, automation and the deployment of Artificial Intelligence (McKinsey, 2021). E-commerce and other virtual transactions have boomed (with a growth of two to five times compared to pre-COVID), as many consumers discovered its convenience, and it often was the only available alternative to in-person shopping. Most of the new users are not willing to give it up even after the crisis.

These trends will impact substantially on the role and features of offices in future years. There is a vast literature that considers the role of different demand and supply factors in shaping commercial real estate dynamics, in particular office space rent. These include income, level of economic activity, supply of office space, vacancy rates, employment (Allan et al., 2021). Furthermore there are many cultural and organizational aspects, needs and habits in the working environment, as well as technological developments, that contribute to shape the demand and supply of office spaces.

As reported also for the "Living - housing" sector, COVID-19 brought some immediate changes in working practices and office spaces to adapt to the pandemic situation, whereas some changes will take place in a longer time frame. Some trends on the demand and supply side of working spaces are already visible in the market and are described below, together with key elements and prospects for the future identified from literature.

3.3.1. Trends on the demand side

Physical distancing, remote working and decreasing office utilisation rates

In office-based working, during the first phases of the COVID-crisis the need for physical distancing was essential to carry out work activities safely, therefore physical presence had to be reduced and office utilisation rates substantially decreased.

COVID-19 brought about drastic changes in the organisation for many firms and constituted an unprecedented, mass experiment of remote work models. As Eurofound (2020) reports, 48% of respondents in Europe classified as "employee" worked at home at least some of the time during the COVID-pandemic, of which one third worked exclusively from home. It is estimated that almost 40% of paid work by dependent employees was carried out remotely, with rates varying based on education attainment of workers: 74% of employees with tertiary education worked from home, compared to 34% of those with secondary qualifications and 14% of those with primary education only. There was also an important divide in the uptake of homeworking by sector, with a higher incidence in the service sector (especially education, financial services and public administration). According to OECD (2021*b*), the widest adoption (over 50%) occurred in "highly digitalised industries, including information and communication services, professional, scientific and technical services as well as financial services".

Almost two years after the World Health Organization declared the global pandemic, remote working is still widely adopted, yet some changes occurred. With the partial relaxation of containment measures, occupancy rates in offices have slightly increased. The share of fully remote workers dropped from 51% in January 2021 to 35% in June 2021; this was compensated by an

increase in the share of hybrid workers from 22% to 30% and of on-site workers from 26% to 35% (McFeely, 2021). Steward (2021) projects that, by the end of 2022, 16% of companies in the world will be 100% remote while, by contrast, 44% of companies won't allow remote work.

When it comes to the potential for remote work in the future, McKinsey (2021) estimates that roughly 20 to 25% of the workforce in advanced economies may be as productive working remotely as from the office, depending on the type of tasks and the extent to which human interactions and the use of specific equipment are determinant. This is in line with Barrero et al. (2021), expecting a share of work carried out remotely rising to 20% compared to the previous 5% in the US. The Gartner CFO Survey reveals 74% of CEOs intend to shift some employees to remote work permanently. Nearly three in four CFOs plan to shift at least 5% of previously on-site employees to permanently remote positions post COVID-19 (Gartner, 2020).

Upgrades of technological systems and cybersecurity requirements

Several organizations were not prepared for such a radical switch to remote-working happening overnight (Mariotti, 2021). Work-from-Home (WfH) required adequate equipment that needed to be put in place, and both workers and firms had to face costs for creating a suitable home working environment. This often came hand in hand with difficulties related to the lack of digital skills of some workers using new tools and doing new tasks for the first time. A related aspect, also highlighted by Zuffi (2021), arising with the massive adoption of remote working is cybersecurity, with remote workers being vulnerable targets of hacker attacks. Where WfH did not exist previously, an issue that arose frequently is also related to the difficulty to set clear boundaries between online and offline hours, with negative consequences in terms of employees' work-life balance and mental health (Mariotti, 2021).

Given the likely persistence of remote work schemes in the future, the topics of adequate technological equipment and cybersecurity will still remain a relevant issue also in the next years.

New office space requirements and lease schemes

On the demand side of the commercial real estate market, since the lockdown phase companies have been reconsidering their office space requirements in light of possibilities enabled by remote-working, and are also increasingly considering satellite offices as a way to improve employees' safety and work-life balance and reduce travel-related journeys (Kim et al., 2021). This is also connected to the preference of workers to work from other locations and the choice of firms to strengthen the network of decentralized offices. According to WorkplaceDNA (2020), "unused office space after coronavirus could cost London-based businesses almost £13bn" as a direct effect of a decline in the "utilisation rate per office from 44% pre-COVID to 28% post-COVID, meaning 72% of all office rent paid by businesses in London would be spent on empty desks". Similar trends are also confirmed by Unispace (2020).

According to Katten (2021), the shift to remote or hybrid working, the decline in some Commercial Real Estate values, and the ongoing uncertainty caused by COVID-19, are causing many tenants to look for flexible and short-term lease structures in the post-lockdown phase. Overall, however, new leases haven't been impacted much: more than 75 percent of new leases signed in the first half of 2021 were for terms greater than four years, and 25 percent were for terms of more than 10 years,

consistently with pre-pandemic levels. The full impact of COVID will not completely unfold until it will be clear how remote working will be incorporated by companies as a stable practice, and therefore how this will affect office space demand.

Considering the future prospect of a wider uptake and stabilization of remote-working, it is however unclear to what extent the reduction in the number of in-person workers will be compensated by larger space requirements to allow for physical distancing (ARUP, 2020; Ellison, 2020; OECD, 2021*b*) and for creating environments that are suited to favour interaction and collaboration opportunities (Ferreira et al., 2020). Organisations are likely going to carefully consider new habits when planning for their space requirements, with 29% of large firms willing to differentiate them, 12% to widen them, and 10% to reduce them (Balabio et al., 2020). According to other studies, it is expected that 20% or more of workers will work full-time remotely in the future, leading to a 20% decline in office demand and footprint (Shellenback and Polovina, 2020; Regus). McKinsey (2021) reports that two-thirds of executives are orienting their offices towards more team spaces and conference rooms, with an overall reduction of office space of 30%.

The decision to adopt remote working by companies is driven by several elements. The pandemic has demonstrated several benefits deriving from remote working, if properly used (WeWork, 2020; Farrer, 2020). For workers, it has the potential to improve the work-life balance thanks to the reduction of commuting times, providing they are capable and allowed to set boundaries between online and offline hours and do not compensate the time gained by overworking. More generally, it can help achieve improved well-being and overall health by limiting stress. On the employer side, a gain in productivity can be achieved by remote workers, e.g. in terms of reduced sick days and lower absenteeism. It is being argued that offering more flexible work plans is also a factor taken into account by most skilled workers, so remote work can be part of a broad strategy to attract and retain talent. Advantages can also be obtained in terms of reduced costs for office space rent, but also in terms of lower costs spent for each telecommuter (Clancy, 2020). On the other side, remote working has some downsides, especially for younger employees at the beginning of their career, as it may negatively affect team cohesion, networking and innovation (Yang et al., 2021; Kaplan and Hoffower, 2020). WEF (2020) highlights some business leaders' concerns around workers' productivity. Emanuel and Harrington (2020) find evidence of a negative selection into remote work, with workers hired into remote jobs being 12% less productive compared to those hired into on-site jobs. It is also found that there is a 50% reduction in probability for remote workers of being promoted to upper-level positions compared to their on-site peers (ibid).

Enhancement of office safety and sanitation procedures

To cope with COVID, government regulations were adopted worldwide to ensure business is conducted safely, and are still affecting firms when organising work shifts, sanitation and cleaning, and to ensure interpersonal distancing. Among the first measures adopted to ensure worker safety as soon as it was possible to return to the office, firms continued to adopt remote work plans to reduce the number of on-site workers and therefore allow minimum per-capita space and physical distancing. Clear and effective instructions regarding both personal and equipment cleaning and disinfection, and the correct use and disposal of face masks played an important role, too, along with safety protocols for the use of meeting rooms and other common areas (CDC, 2021; Krause, 2020).

Safety will be a primary concern also in the future (Zuffi, 2021), and COVID-19 will likely produce profound changes in office design leading to an overall enhancement of health and safety. It is suggested that disinfection infrastructure shall be thoughtfully incorporated and improved, as well as sanitation tunnels and efficient heating, ventilation and air conditioning (HVAC) systems (CDC, 2021; Kumar, 2020). Increasing the percentage of outdoor air circulation and improving central air filtration can also be good solutions to prevent the indoor diffusion of the virus (CDC, 2021). Replacing high-touch communal items, grips and buttons with single-use items and contactless technologies can also reduce virus transmission (ibid).

3.3.2. Trends on the supply side

Business closures and vacant buildings consequent to containment measures

As highlighted above, restrictions heavily affected almost any type of economic activity, and especially those service sectors where human interactions are vital. Government restrictions led to numerous business closures, vacant buildings and, ultimately, to lower commercial property sales (Balemi et al., 2021). The large transaction volume decrease, accompanied by no substantial changes in price, is in great part attributable to a supply shift, as sellers raised their reservation prices vis-à-vis a reduction of the reservation price by buyers (ibid). Beyond that, "uncertainty and low growth expectations are leading to a devaluation of commercial property portfolios of high-net-worth individuals, private equity funds, private as well as public real estate investment trusts or developers" (ibid).

Towards flexible and collaborative office space models

According to Urban Design (2021), "the traditional boundaries of offices, shops and leisure will start to blur", and already some new hybrid, cross-over formats between co-working and retail are emerging; the office of the future "will be more permeable, particularly at ground floor to reflect the new work model and the new purpose of the office as a creative hub". The demand for flexible workspaces and models, that allow for cooperation as well as the possibility to integrate various services within the work environment, is giving co-working spaces a new momentum.

Co-working refers to "flexible, shared, rentable and community-oriented workspaces occupied by professionals from diverse sectors" (Fuzi, 2015). Co-working spaces can be part of a broader design to enhance office liveability, as workers could choose their preferred job location without the need to undertake long commutes. Employers could also decide to allow their employees to work from these decentralized spaces as alternative to their presence in a centralized office. The overall sector has not been heavily affected by the pandemic worldwide, with the number of co-working spaces rising from approximately 18k units in 2019 to 19k in 2020, and projected to reach 23.5k in 2021 and almost 42k by 2024 (Di Risio, 2020). It is also estimated that 5 million people will be working from co-working spaces by 2024, an increase of 158% compared to 2020 (ibid). According to Mayerhoffer (2021), there appears to be "a solid member base which is loyal to their space, and there is the opportunity for co-working spaces to diversify and explore new, long-term models of operation with increased degrees of flexibility to react quickly to the further development of the Covid-19 pandemic". It is projected that co-working and flexible spaces could reach a 30% market share (JLL*a;* JLL*b;*; Ferreira et al., 2020).

The office as a place for cooperation, interactions and culture-building

In terms of functions, the office will not only have to accommodate hybrid working models, but also be a space to connect and share ideas, build corporate culture, and attract and retain talent in a post-pandemic world where worker preferences have also been strongly affected[3]. WEF (2021) suggests that these functions will likely be summarized by the '3 Cs' (Colleagues, Culture and Collaboration). The office will need to be the place where unplanned interactions between people occur, allowing the flow of ideas and social relationships to happen. It will also need to be a place to attract talent by allowing flexibility, offering nonfinancial perks, generous food and beverage, gym, games, recreation spaces, and enhancing "user experience" (WEF, 2021; ARUP, 2020; OECD, 2020*h*; JLL*c*; Ferreira et al., 2020). To provide a stimulant work environment, open plan offices, hot desking, break-out areas and meeting rooms, phone booths/zoom-cubicles and sleeping pods can be some elements that favour productivity and collaboration between workers (Kumar, 2020).

Flexibility as a major requirement for the office of the future

In order to accommodate for greater uncertainty related to future crises (health emergencies, economic shocks, climate change), flexibility is a key characteristic that could distinguish both office space and new work models. It is a wide concept, but it can be applied, following Ferreira et al. (2020) and Mahon (2021), through:

- space design, which allows to rearrange and adapt physical spaces, to cater to a variety of businesses should multiple short-term leases be prevalent in the future. Solutions could include lighter furniture, that can more easily be moved, re-adaptable shared spaces, dividers like large bookcases, etc.;
- lease schemes, which allow to choose between long- vs short-term schemes;
- geographic location, which allows employees to choose what office works best for them;
- working hours, which allow workers to redistribute working hours by reconciling their own needs with the ones of the employer (e.g. during peak hours).

Flexibility in the commercial real estate domain can also be meant as the combination of the capability to adjust needs quickly, agile design, and technology integration. Among the new trends that can give responses in this direction is the so-called "activity-based workplace", which has dynamic and collaborative layouts, maximises the value of in-person contact, and accommodates various uses during the day, including co-working spaces, on demand meeting rooms, home office, project office – and provides amenities like focus zones, work cafes, gyms and other recreational spaces (WEF 2021).

3.3.3. The implications of remote work models for urban economies

This paragraph has deepened the dynamics of remote working, which is the key trend in the office-based working domain in the current pandemic situation. Such a massive shift to remote and hybrid work has the potential to affect significantly urban economies in the future and has relevant implications for urban planning. The reduced need for job-related (as well as other purpose-related)

[3] One example of this can be the "YOLO Generation", willing to give up a job if not aligned with its expectations.

commuting, as well as the fear of contagion in crowded places, led to a relevant decline in the use of public transport services (see also Paragraph 3.3). The partial relocation of businesses out of the city centres during the pandemic phase already contributed to the "reduction in demand for commercial services near workers' offices – from cafes and sandwich shops to hairdressers, gyms and drycleaners", with implications in terms of business closures and redundancies (De Fraja et al., 2021). The phenomenon could have wider economic consequences, including on the demand for office and residential real estate, transportation, gasoline and auto sales, and restaurants and retail in urban centres, and other consumption patterns (McKinsey, 2021).

The underutilisation of commercial real estate properties poses questions around the use of vacant buildings. In the UK, it is estimated that 33% of the real estate is in excess, and "vacant department stores are being reconfigured for new uses from housing to shared-offices, indoor trampolining to food halls" (Urban Design, 2021). C40's Reinventing Cities programme is assessing some initiatives to convert vacant office spaces into housing[4]. Such a solution can be a policy instrument to promote affordable and sustainable housing; however, the economic case for converting office space into housing is still debated, with "the building regulation framework and the morphology of office buildings being the most important obstacles to the widespread adaptive reuse" (Cutieru, 2021). Viros and Nappi (2021) outlines some possible ways forward to facilitate the conversion, e.g. by means of fiscal incentives, land-use and spatial planning policies and public-private partners.

3.3.4. Link between the pandemic and the demand for and supply of sustainable office buildings

Considering aspects related to environmental sustainability, like the reduction of CO_2 emissions from building construction and operations, and the connection of the office with nature can also be seen as a relevant trend for the commercial sector for the future. This is due to the commitments and pledges made by several firms to reduce GHG emissions and act more sustainably overall; measures in this respect can be undertaken at the design, construction, operations and maintenance phases (WEF, 2021). Based on the number of LEED-certified buildings, offices and residential developments are the leading asset classes in sustainability. Demand for net zero carbon buildings is increasing from ESG investors, with more sustainable buildings commanding increased rental values from 6 to 11% and having fewer void periods (WEF, 2021). As highlighted in the living domain, building sustainability standards may need to adapt in order to account for the different needs for flexible and adaptable spaces, and environmental criteria may also be affected (Tleuken et al., 2021; Kaklauskas et al., 2021). In order to improve the connection to nature, offices will also need to have more open-air spaces, use natural materials, and possibly include nature-based solutions like green roofs (Bauder[5]). Corporations are already redefining office boundaries – for instance with *pocket gardens* or *campuses*[6], and creating "corporate parks"[7] to be used by employees, their families, and local communities.

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[4] E.g. in Paris: https://www.c40reinventingcities.org/en/professionals/sites-in-competition/converting-offices-into-housing-various-sites-1511.html

[5] https://www.bauder.co.uk/technical-centre/case-studies/green-roof-case-studies

[6] e.g., Palazzo Bernini in Turin (https://agep.it/eventi_e_notizie/agp-greenscape-progettera-la-nuova-corte-della-fondazione-compagnia-di-san-paolo-a-torino/), Monte Rosa 91 offices in Milan (https://monterosa91.it/it/)

[7] e.g., "Orti di Siemens" in Milan (https://agep.it/progetti/parco-gli-orti-di-siemens/) and "Parco Green Life" of Crédit Agricole in Parma (https://agep.it/progetti/credito-agricole-green-life-parco-arboretum/)

The following tables summarizes the main trends* identified in the Living and Working domains:

LIVING	Trends
Demand side	Houses as confinement and isolation spaces
	Higher psychological distress from poor housing conditions
	Increased use of outdoor dwelling spaces during lockdowns
	Homes as remote working and learning environments (used for multiple purposes like exercising, recreation, socialising, …)
	Increased use of digital connection and services for various purposes
	Higher use of second homes in lower-density and tourist sites
	Demand for new dwelling characteristics and related amenities and services
	Raised concern for affordable housing *and higher exposure to eviction*
Supply side	Greater investments in social and affordable housing
	Reduced number of housing transactions consequent to the first lockdown
	Upwards property prices following the second wave
	Raised interest towards new, flexible rent models
	New flexible home design solutions
	New health and safety design solutions

WORKING	Trends
Demand side	Acceleration of digitization for transactions, consultation and collaboration
	Acceleration of automation and the deployment of Artificial Intelligence
	Massive adoption of remote working
	Lower office occupation rates due to physical distancing
	Improvements of technological systems and cybersecurity
	New office space requirements and lease schemes
	Enhancement of office safety and sanitation measures
Supply side	Business closures and increased vacant buildings consequent to containment measures
	Commercial property sales dropped
	Rise of new flexible and collaborative office space models
	Rise in the number of co-working spaces worldwide
	Office as a place for cooperation, interactions and culture-building
	Flexibility as a requirement for the future of office

** Titles of paragraphs of 3.2.1, 3.2.2, 3.3.1, 3.3.2 summarize the identified trends. Further trends described within the paragraphs are shown in italics.*

4. Definition of new living and working models

4.1. Main dimensions of change in the living and working domains

Chapter 3 detected the main trends on the demand and supply side that are emerging both in the living and working domain. These trends relate to how indoor and outdoor spaces of homes, offices, urban spaces and services have been lived and used across the different phases of the pandemic.

Real estate players are increasingly paying attention to these trends and to new living and working lifestyles; some of them are already captured by the housing and office supply in the market as well as in the projects under development. Some other features will take more time to be incorporated into projects, also depending on what the "new normal" will look like.

The aim of this chapter is to define a framework to describe how living and working models have been changing during the pandemic, identifying a set of "dimensions of change". Based on the evidence collected in Chapter 3 and on the literature on COVID impact in cities, four key dimensions have been selected as representative for this change. The rationale for selecting each dimension is provided below.

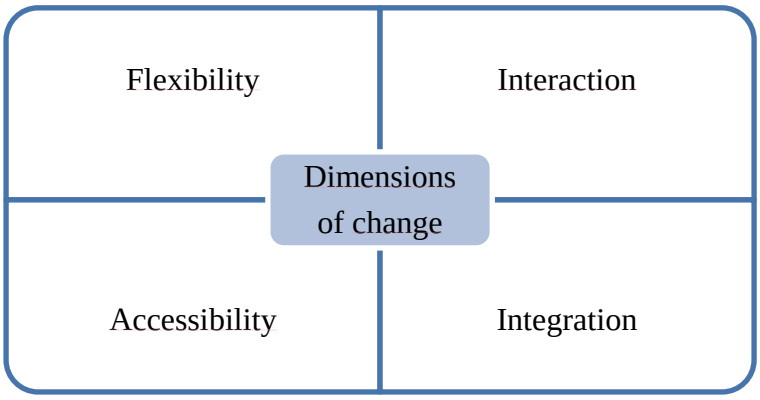


Figure 2: Selected dimensions to develop the models

Flexibility

COVID prevention and containment orders during the most acute waves of the pandemic obliged many people to spend most of their lives inside their homes, even for long periods. With the pandemic evolution and the emergence of new variants of the virus, it is possible that similar measures could be adopted again in the future. In the living domain, there is therefore a clear need to adequate spaces to different uses changing over time, according to restrictions/conditions in place (e.g. remote working, home-schooling). Homes should be more flexible and adaptable, in order to allow for easy reconfiguration and accommodate different functions. Housing already has to be flexible in order to respond to household modifications over time (e.g. household formation, aging, change of socio-economic conditions) (Gilani and Turker, 2020). COVID-19 has increased the need for higher flexibility and adaptability.

Also in the work environment, the COVID-19 crisis highlighted the need for further flexibility. After the first pandemic waves, a return-to-office has gradually started in many countries. Companies are currently revisiting their office needs and requirements, in light of new working practices and models enabled by digitalisation. As shown in Chapter 3, it is still uncertain how much remote-working will be adopted as stable practice in office-based work, and in which shares.

Despite this uncertainty, it is acknowledged that also offices will have to adequate their spaces to different needs changing over time, according to restrictions/conditions in place (e.g. variation in the number of personnel working in presence/remotely).

Flexibility is a multi-dimensional concept, which can be applied in several ways. It can be defined as *"the capacity designed into buildings, building programs, or building technologies to ensure an initial good fit and to enable them to respond to subsequent change"* (Hamdi, 1995). In this study, it is interpreted as functional flexibility, or *"ability to interchange and exchange spaces […] to accommodate a variety of spatial layouts and activities by changing the configuration of space, through modifying volumes, elements and furniture"* (Gilani and Turker, 2020, based on several studies).

Interaction

Social interaction has been heavily limited since the start of the pandemic, as proximity and closeness are key enablers for the diffusion of the virus. Social distancing has become a key rule of lifestyles and behaviours in public settings, which has also deeply influenced the way we have been living indoor and outdoor spaces during the pandemic.

The spatial configuration of settings can influence the way we experience social interaction. Co-living models for example dedicate specific areas to individual use and allocate a certain amount of common spaces to allow social interactions. The presence of common areas for shared use is a distinctive feature of the co-living housing model.

COVID has increased the need for privacy/independence at home, for example when a person has to isolate in case of COVID infection or in order to perform specific tasks such as working or studying at home without interference from other people. At the same time, COVID has also generated the need to socialize in a safe way with people out of one's household, to overcome the negative consequences and distress from isolation.

Also in the offices, COVID has generated a dichotomy. On one side, physical presence in the office has to respond to specific rules in order to avoid the contagion. At the same time, the need for social interaction with colleagues has been amplified by the heavy reliance on remote working. Digital interaction with colleagues has some limitations. Social interaction with colleagues is considered to contribute to improve creativity and collaboration. Therefore, offices need spaces with different degrees of interaction with colleagues: spaces for individual work and areas for collaborative work, taking into account the virus containment measures. Spaces and facilities that facilitate interaction and discussion can play a role in promoting a pleasant and collaborative work environment.

In this study, interaction refers to the presence of individual spaces and common/shared spaces in the building/office, and the possibility for users to interact within these spaces.

Accessibility

The concept of accessibility is related to the previous dimension, interaction. In order to avoid contacts and ensure social distancing, COVID-19 measures have often limited the access to specific services according to several criteria (e.g. maximum number of people in a room/shop/venue; access open only to vaccinated people, etc.). In some countries, the concept of "social bubble" has been defined and even formalised, meaning *"an exclusive social unit whose members are allowed*

physical contact amongst themselves but not with others" (Trnka and Davies, 2021). For some public services, e.g. schools, the concept of bubble has been implemented in order to limit the spread of the virus. Which implications will COVID have in the future in terms of openness and accessibility to services? In the residential settings, there are already examples of shared facilities, services and spaces that are reserved for exclusive use by residents. This could be further amplified by COVID as prevention and containment strategy.

The same question also applies to working spaces. Some models like co-working spaces integrate different functions and services that go beyond the supply of a shared office. Examples of these additional functions and services include restaurants, amenities, sport facilities, etc. How open and accessible will these services be in the future? Will the concept of bubbles or access restrictions be implemented, as prevention measure, also at offices?

In this study, the accessibility dimension describes whether the services provided by the living/working solution are open and can be accessed with no particular restrictions (e.g. free access to amenities) or are restricted/targeted to specific users (e.g. based on a membership to a club). In this context, service accessibility is not intended in spatial terms, but rather as possibility to use the service.

Integration

The Covid-19 pandemic significantly constrained the use of many services, because of the need to maintain social distancing and face different waves of virus diffusion. Many facilities like amenities, cinemas, theatres, museums, sport centres, restaurants and cafés, shops and others were closed for long periods and only gradually returned to full occupation/utilisation, depending on each country policies and restrictions. On the other side, the use of digital services increased substantially over the period, with e-commerce and home delivery that experienced a relevant increase.

According to the results presented in Chapter 3, homebuyers are increasingly interested in services provided in the context of properties, as well as in services available in the residential complex itself. Benefitting from commercial and professional services at a "hyperlocal" level could indeed make local communities more resilient and enhance local economies in case working from home further shifts demand away from city centres. Also in the working domain, in light of the need for more collaboration and safe social interaction with colleagues, offices are experiencing a further integration of services and amenities, for different purposes (i.a. to stimulate creativity and create comfort/wellbeing for employees).

This dimension labelled "integration" considers whether residential settings will change towards a higher variety and integration of services in residential solutions. This might contribute to increase residents' wellbeing and provide them with access to specific services also in case of new movement limitations (e.g. for new lockdowns, other restriction measures…).

In the working domain, this dimension considers whether offices will change towards a higher variety of services in office-solutions and working spaces.

4.2. Models' definition

By using the selected dimensions of change, a set of living and working models have been defined.

1. Flexibility + Interaction → with particular focus on the use of spaces

2. Accessibility + Integration → with particular focus on the use of services

Each model is characterized by different features along the dimensions:

- Flexibility: models' features range from rigidity to fluidity in space configuration
- Interaction: from low to high social interaction in spaces
- Service Accessibility: from access restrictions to open access
- Integration: from low to high variety and number of services.

The combination of dimensions generated the following models:

Models based on Flexibility and Interaction - Use of spaces

Model A1: characterised by a rigid configuration of spaces, mostly designed and used in a shared/collective way.

Model B1: characterised by a fluid configuration of spaces, where rooms can be easily reconfigured and adapted; most spaces are designed and used in a shared/collective way.

Model C1: characterised by a rigid configuration of spaces, mostly designed for and used by individual households (living)/employees (working).

Model D1: characterised by a fluid configuration of spaces, where rooms can be easily reconfigured and adapted; most spaces are designed for and used by individual households (living)/employees (working).

Models based on Accessibility and Integration - Use of services

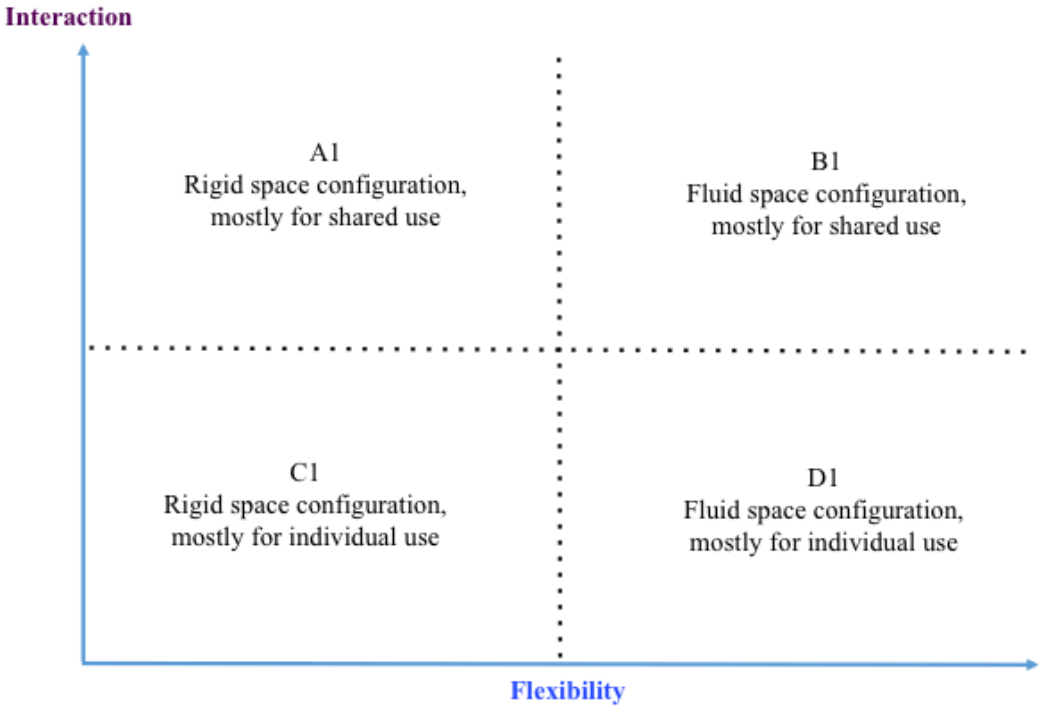
Model A2: characterised by a limited number of services within the building or the narrower neighbourhood, which are accessible to any user with no particular restriction.

Model B2: characterised by a high variety of services within the building or the narrower neighbourhood, which are accessible to any user with no particular restriction.

Model C2: characterised by a limited number of services within the building or the narrower neighbourhood, which are only accessible for and used by specific users.

Model D2: characterised by a high variety of services within the building or the narrower neighbourhood, which are only accessible for and used by specific users.

Some of these combinations deliver models that are not realistic or implementable, whereas some of them represent pre-pandemic models that are not suitable anymore to respond to the new trends emerged in the demand and supply of living/working solutions.



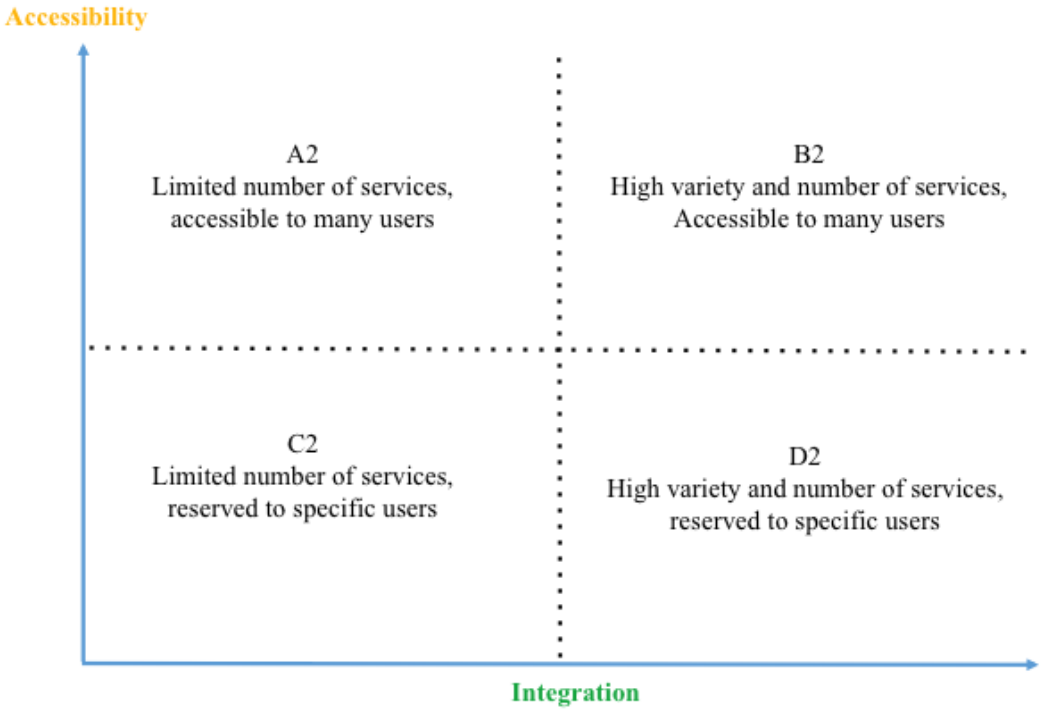


Figure 3: Graphical representation of models

4.3. Models description and analysis

The main features of each model are described in this section using the following structure:

- **Description:** tailored according to the domain (living/working)
- **Type of spaces/services**: for Models 1, this refers to the types of spaces/rooms that can be used in a shared/individual way in the home/office; for Models 2, it refers to services which can be integrated in the residential setting or the workplace
- **Field of application**: this presents some possible settings where the model could be applied (or is already applied)
- **Objectives**: these refer to the underlying goal that the model aims to achieve
- **Benefits**: strengths and possible beneficial outcomes of the model regarding social and economic aspects, as well as its positive implications in terms of COVID-19 prevention and control, which may encourage its application
- **Critical aspects**: weaknesses of the model regarding social and economic aspects, as well as negative implications in terms of COVID-19 prevention and control, which may discourage its application.

4.3.1. Models based on Flexibility and Interaction - Use of Spaces

Model A1: Rigid space configuration, mostly for shared use

	Living	Working
Description	It is a model characterised by a rigid configuration of spaces, mostly designed and used in a shared/collective way by different individuals/households.	It is a model characterised by a rigid configuration of spaces, mostly designed and used in a shared/collective way by employees/companies.
Type of spaces	Common dwelling indoor and outdoor spaces like living rooms, kitchens, bedrooms, bathroom, studios, entrance rooms, lofts, garage, basements, gardens, balconies.	Common rooms for office-based work; meeting rooms; shared break rooms.
Field of application	It is a model that can be applied by people willing to create a community living together (e.g. communes, co-living).	It is a model that can be applied to workplaces where workers need to interact often and perform several collaborative tasks.
Objectives	• to promote interaction and collaboration among household/community members • to encourage people to meet and know each other • to create a sense of community.	• to promote collaboration and interaction among colleagues • to create corporate community.
Benefits	• creates sense of community and belonging; • possibility to interact with other people also during pandemic, alleviating isolation	• creates sense of community and belonging to the company • possibility to interact with colleagues which alleviates social isolation.
Critical aspects	• lack of privacy/independence; no opportunity to isolate (e.g. in case of COVID infection); • limited possibility to adequate rooms to different functions over time in case of evolving needs for the community (e.g. new lockdowns), due to rigid space configuration • need to manage social interaction in order to prevent COVID transmission.	• lack of privacy/independence (in case an employee needs to perform an individual task); • limited possibility to adequate rooms to different functions over time in case of evolving needs for the company (e.g. increased share of employees working remotely), due to rigid space configuration • rigidity of spaces could also imply an underutilisation of some rooms, and therefore some hidden costs • need to manage social interaction in order to prevent

		COVID transmission.

Model B1: Fluid spaces, mostly for shared use

	Living	Working
Description	It is a model characterised by a fluid configuration of spaces, where rooms can be easily reconfigured and adapted; most spaces are designed and used in a shared/collective way by different individuals/households.	It is a model characterised by a fluid configuration of spaces, where rooms can be easily reconfigured and adapted; spaces are mostly designed and used in a shared/collective way by employees/companies.
Type of spaces	Common dwelling indoor and outdoor spaces like living rooms, kitchens, bedrooms, bathroom, studios, entrance rooms, lofts, garage, basements, gardens, balconies.	Common rooms for office-based work; meeting rooms; shared break rooms.
Field of application	It is a model that can be applied by people willing to create a community living together (e.g. communes, co-living models), which expects to change/evolve significantly.	It is a model that can be applied to workplaces where workers need to interact often and perform several collaborative tasks, by companies expecting to change/evolve significantly.
Objectives	• to promote interaction and collaboration among household/community members • to encourage people to meet and know each other • to create a sense of community; • to accommodate different functions and uses over time.	• to promote collaboration and interaction among colleagues • to create corporate community • to adapt to evolving needs of the company.
Benefits	• it creates sense of community and belonging • possibility to interact with other people also during pandemic, alleviating isolation • possibility to adequate rooms to different functions over time in case of evolving needs for the community (e.g. in case of changes in the community or in case of external events which impact on peoples' habits and practices, e.g. new lockdowns).	• it creates sense of community and belonging to the company; • possibility to interact with colleagues which alleviates social isolation. • possibility to adequate rooms to different functions over time in case of evolving needs for the company (e.g. increased share of employees working remotely). Flexibility can also contribute to limit the risk of

		underutilisation of some rooms.
Critical aspects	• Lack of privacy/independence, but the flexibility of spaces can also bring the opportunity to adapt/reconfigure spaces in order to create individual spaces if needed. • Integrating flexibility in buildings since the planning/design phase increases slightly initial costs and construction time, but it is capable to generate savings and shorten renewal time in case renovations are required (Slaughter, 2001). • Need to manage social interaction in order to prevent COVID transmission.	• Lack of privacy/independence (in case an employee needs to perform an individual task); but the flexibility of spaces can also bring the opportunity to adapt/reconfigure spaces in order to create individual spaces if needed. • Integrating flexibility in buildings since the planning/design phase increases slightly initial costs and construction time, but it is capable to generate savings and shorten renewal time in case renovations are required (Slaughter, 2001). • Need to manage social interaction in order to prevent COVID transmission.

Case study description: Google offices (US) - model B1 Working

Google has been long known for its innovative open offices, which also comprised a range of amenities and benefits for its employees to create a comfortable and creative workplace environment. With the pandemic and the switch to remote-work for a large share of its personnel, the company is now reconsidering how to design its offices to accommodate a hybrid work model and respond to new needs, habits and behaviours that employees developed during these COVID-years.

Flexibility is a key dimension that characterizes the solutions Google is planning. Some examples include “Team Pods” instead of desks, whose elements (chairs, desks, whiteboards) can be combined and quickly rearranged in different ways; movable walls and “ballons” that can be inflated by robots on the spot to create privacy when needed; customizable hot desks that can be reserved by employees coming to office only for limited time, which can be adapted to specific configurations and preferences.

At its headquarters in the Silicon Valley, open-air meeting rooms shaped like tents have been implemented in a former parking site to allow for safer meetings, developing a new concept for outdoor offices.

In terms of interaction, Google is considering a de-densification of spaces to take into account the need for distancing between workers (e.g. through furniture and plants), as well as is developing solutions to facilitate the interaction between in-person and online workers. An example is the “Campfire” meeting room, where employees sit in a circle endowed with displays that show participants connected remotely, enabling them to participate as if they were seated in the room.

Source: https://www.nytimes.com/2021/04/30/technology/google-back-to-office-workers.html

Model C1: Rigid space configuration, mostly for individual use

	Living	Working
Description	It is a model characterised by a rigid configuration of spaces, mostly designed for and used by individual households.	It is a model characterised by a rigid configuration of spaces, mostly designed and used by individual employees.
Type of spaces	Dwelling indoor and outdoor spaces like living rooms, kitchens, bedrooms, bathroom, studios, entrance rooms, lofts, garage, basements, gardens, balconies	Dedicated individual office rooms/spaces, with pre-allocated desks for each employee, limited number of meeting rooms and break rooms.
Field of application	It is a model that resembles many residential settings available today, where spaces are typically allocated to one main function.	It is a model that resembles the traditional office, where each employee has an individual desk/cell and common spaces are minimized; it can be applied in a company where employees perform individual tasks and do not need to interact often with colleagues.
Objectives	to provide spaces that are essential for household needs.	to provide spaces to concentrate on individual tasks.
Benefits	• privacy and independence for each household • safer in terms of COVID transmission, as contacts with other households are limited	• fewer distractions for workers • safer in terms of COVID transmission, as contacts with other employees are limited
Critical aspects	• limited social interaction, lack of community; isolation • limited adaptability to meet varying needs of households due to rigid space configuration; for example, during the COVID-19 pandemic, difficulties were met when adapting existing housing spaces to home-office and home-schooling spaces • higher costs and time required to implement changes (modifications in size, interior spaces layout).	• limited interaction with colleagues can create a sense of isolation and hampers collaboration/creativity; • limited possibility to adequate rooms to different functions over time in case of evolving needs for the company (e.g. increased share of employees working remotely), due to rigid space configuration • the rigidity of spaces could also imply underutilisation of some rooms, and therefore some hidden costs. It also implies higher maintenance and heating/cooling costs. • higher costs and time required to implement changes (modifications in size, interior spaces layout).

Model D1: Fluid spaces, mostly for individual use

	Living	Working
Description	It is a model characterised by a fluid configuration of spaces, where rooms can be easily reconfigured and adapted; most spaces are designed for and used by individual households.	It is a model characterised by a fluid configuration of spaces, where rooms can be easily reconfigured and adapted; spaces are mostly designed for and used by individual employees.
Type of spaces	Dwelling indoor and outdoor spaces like living rooms, kitchens, bedrooms, bathroom, studios, entrance rooms, lofts, garage, basements, gardens, balconies.	Dedicated individual office rooms/spaces, with pre-allocated desks for each employee, limited number of meeting rooms and break rooms.
Field of application	It is a flexible model that can be suitable for different types of households, as it is also capable to adapt over time.	It is a model that can respond to challenges posed by COVID, as it limits the interaction and can be adapted over time to company changes. It can be applied in a company where employees perform individual tasks and do not need to interact often with colleagues.
Objectives	to respond to households' evolving needs over time.	• to provide spaces to concentrate on a task; • to adapt to evolving needs of the company.
Benefits	• Possibility to have privacy/independence; low interference among different uses; • Safer in terms of COVID transmission, as contacts with other households are limited. • Flexibility of internal spaces offers the possibility to adequate rooms to different functions over time in case of evolving needs for households (e.g. new lockdowns).	• Fewer distractions for workers • Safer in terms of COVID transmission, as contacts with other employees are limited • Flexibility offers the possibility to adequate rooms to different functions over time in case of evolving needs for the company (e.g. increased share of employees working remotely). • Flexibility can also contribute to limit the risk of underutilisation of some rooms.
Critical aspects	• Scarce opportunities to interact with other people • Integrating flexibility in buildings since the planning/design phase increases slightly initial costs and construction time, but it is capable to generate savings and shorten renewal time in case renovations are required (Slaughter, 2001).	• Limited interaction with colleagues can create a sense of isolation and limits collaboration/creativity. However, flexibility can enable the reconfiguration of spaces to create common spaces if needed. • Higher initial costs, but savings in case of renovation.

Case study description: Adaptable House (Denmark) - model D1 Living

The “Adaptable House” is part of a large development project named “The MiniCO2 Houses” which was carried out in Nyborg (Denmark) in 2013 by architects GXN and Henning Larsen. The project aimed to demonstrate a range of solutions to reduce CO2 emissions in the construction, use and maintenance of a house through six emblematic detached houses; five of them display specific solutions to reduce carbon emissions; the sixth one combines the different solutions together.

The Adaptable House project, in particular, is focused on flexibility and adaptability, with the aim to respond to a family’s changing needs over time. Flexibility is enabled by different solutions, including movable and sliding walls that can create new rooms, modular elements that can be used to open new entrances in the façade, and cabling solutions placed inside a dedicated cable duct to allow the placement of electrical sockets where convenient. The project demonstrated how flexible design can save materials, CO2, time and resources in case of alterations and extensions to the building.

Even if it was designed before COVID, and with a focus on CO2-reduction, the Adaptable House represents a home model with high flexibility that can respond to different circumstances and conditions. It includes design solutions like sliding doors/walls, which are currently also employed in flexible apartments to accommodate different functions in small living spaces (e.g. accommodation, remote-work and leisure).

Source: https://www.archdaily.com/546890/adaptable-house-henning-larsen-architects-gxn

4.3.2. Models based on Accessibility and Integration - Use of services

Model A2: Limited number of services, accessible to many users

	Living	Working
Description	It is a model characterised by a limited number of services within the building or the narrower neighbourhood, which are accessible to any user with no particular restriction.	It is a model characterised by a limited number of services offered within the workplace environment, which are accessible by anyone.
Type of services	Some examples of services provided can include: residential, recreational (e.g. green spaces, playgrounds), commercial (e.g. laundry), education and culture, health (e.g. convention with healthcare workers or health clinics for on-site visits), administrative (management of the contract, condo app), transport, work, sharing services (e.g. car sharing, co-working spaces), personal care services (e.g. childcare, eldercare)	Some examples of services provided can include: workplace, recreational (sports centres), commercial (cafés and restaurants), personal care services (e.g. for personal beauty, hairdresser, barber shops), residential, education and culture (kindergartens), health (convention with MDs), administrative, transport, including amenities to stimulate creativity and create comfort/wellbeing for employees.
Field of application	It is a model that resembles some typical current residential neighbourhoods, which mainly provide a residential function.	It is a model that resembles some typical current office settings, which mainly provide an office-based function but integrate in the building a limited number of additional services.
Objectives	to provide housing and satisfy a limited number of needs, reaching a wide potential scope of users.	to provide a place to carry out office-based work and satisfy a limited number of needs, reaching a wide potential scope of users.
Benefits	Available services are limited, but can be accessed by everyone (e.g. people living in the neighbourhood and also beyond).	Available services are limited, but can be accessed by everyone (e.g. people from other different companies working in the building or neighbourhood residents).
Critical aspects	• Residents have to commute to other places to access further services. This might be problematic if new physical restrictions are put in place (e.g. for COVID) • As services are accessible by anyone, there could be implications in terms of COVID diffusion and it might	• Employees have to commute to other places to access further services. This might be problematic if new physical restrictions are put in place (e.g. for COVID). • There is no incentive to come to the office, therefore employees might prefer (if possible) remote-working and work from home.

	imply further costs to keep track of service users.	• As services are accessible by anyone, there could be implications in terms of COVID diffusion and it might imply further costs to keep track of service users.

Model B2: High variety and number of services, accessible to many users

	Living	Working
Description	It is a model characterised by a high variety of services within the building or the narrower neighbourhood, which are accessible by anyone.	it is a model characterised by a high variety of services offered within the workplace environment, which are accessible to anyone.
Type of services	Some examples of services provided can include: residential, recreational (e.g. green spaces, playgrounds), commercial (e.g. laundry), education and culture, health (e.g. convention with healthcare workers or health clinics for on-site visits), administrative (management of the contract, condo app), transport, work, sharing services (e.g. car sharing, co-working spaces), personal care services (e.g. childcare, eldercare).	Some examples of services provided can include: workplace, recreational (sports centres), commercial (cafés and restaurants), personal care services (e.g. for personal beauty, hairdresser, barber shops), residential, education and culture (kindergartens), health (convention with MDs), administrative, transport, including amenities to stimulate creativity and create comfort/wellbeing for employees.
Field of application	It resembles to mixed-use neighbourhoods with a high variety of functions. With this model, people can benefit from a wide variety of services beyond the residential function, and are therefore able to meet their needs without the need to commute for long.	It is a model that can be advantageous for firms to attract and retain the best talent pool, which is looking for an enhanced experience going beyond staying in the office all day-long.
Objectives	to provide a variety of services to a wide potential scope of users.	to provide a variety of services to enhance user experience and attract and retain talent.
Benefits	• easier access to services elsewise more difficult to access (e.g. health: longer waiting lists) • saved time and costs for commuting needs	• saved time and costs for commuting needs • easier access to services elsewise more difficult to access (e.g. health: longer waiting lists)

	• strong sense of community at the "hyperlocal" level • enhancement of local economies.	• strong sense of belonging and affinity with firm culture that promotes employees' wellbeing.
Critical aspects	• Integrating many services implies higher investments and management costs. If services are provided by external suppliers, there are also coordination costs. • As services are accessible by anyone, there could be implications in terms of COVID diffusion and it might imply further costs to keep track of service users.	• Integrating many services implies higher investments and management costs. If services are provided by external suppliers, there are also coordination costs. • As services are accessible by anyone, there could be implications in terms of COVID diffusion and it might imply further costs to keep track of service users.

Case study description – "Tour & Taxis", Brussels – model B2 Living and Working

Tour & Taxis is a mixed-use urban project, which is part of the Gare Maritime redevelopment hub in Brussels. Tour & Taxis blends together 22,000 sqm of affordable housing and market rate housing units, along with office, retail and leisure spaces. The residential site is located in a quiet location well connected to the centre of Brussels, and is surrounded by a park and shopping, eating, culture venues and more. Its workspace solutions aim to meet the needs of businesses, start-ups, and individuals and to promote a productive and inspiring environment.

Both residential and working sites are connected to a wide variety of amenities and services accessible to both the direct users and the wider community, and therefore the model exhibits a high level of both service integration and accessibility. These amenities and services include food and retail outlets, a park, a cinema, events, fairs and exhibitions spaces, restaurants and catering services, and a nursery. Park Tour & Taxis is one of the largest city parks in central Brussels, which provides accessible recreational space to the surrounding neighbourhoods (for a total of 9 hectares of open space for relaxation and leisure) and hosts cultural events, agricultural, social, educational and ecological activities open to anyone.

The provision of accessible amenities and services has positive implications for the development of the neighbourhood. On top of that, the model also proved that it can adapt to and be resilient in face of exogenous shocks like pandemics. Indeed, it adopted measures to limit the spread of the virus, like limiting the number of people allowed on site, ensuring sanitation measures, and dedicating registration areas and isolation rooms.

Sources: WEF, https://tour-taxis.com/

Model C2: Limited number of services, reserved to specific users

	Living	Working
Description	It is a model characterised by a limited number of services within the building or the narrower neighbourhood, which are only accessible for and used by specific users; service closure can be achieved by means of restrictions like membership to a club or community.	It is a model characterised by a limited number of services offered within the workplace environment, which are only accessible for and used by specific users (e.g. people working for a firm or firms using that building/hub).
Type of services	Some examples of services provided can include: residential, recreational (e.g. green spaces, playgrounds), commercial (e.g. laundry), education and culture, health (e.g. convention with healthcare workers or health clinics for on-site visits), administrative (management of the contract, condo app), transport, work, sharing services (e.g. car sharing, co-working spaces), personal care services (e.g. childcare, eldercare).	Some examples of services provided can include: workplace, recreational (sports centres), commercial (cafés and restaurants), personal care services (e.g. for personal beauty, hairdresser, barber shops), residential, education and culture (kindergartens), health (convention with MDs), administrative, transport, including amenities to stimulate creativity and create comfort/wellbeing for employees.
Field of application	It is a model that resembles some typical current residential settings, which mainly provide a residential function.	It is a model that resembles some typical current office settings, which mainly provide an office-based function but integrate in the building a limited number of additional services.
Objectives	to provide housing and satisfy a limited number of needs, for a limited number of users.	to provide a place to carry out office-based work and satisfy a limited number of needs, reaching a limited scope of users.
Benefits	In terms of COVID-prevention, it is a residential setting which can be easily monitored and managed.	In terms of COVID-prevention, it is an office-setting which can be easily monitored and managed.
Critical aspects	• Residents have to commute to other places to access further services. This might be problematic if new physical restrictions are put in place (e.g. for COVID). • There can be difficulties associated with implementing restrictions to some services (e.g. commercial), especially when considering the economic case/rationale for setting some restrictions.	• Employees have to commute to other places to access further services. This might be problematic if new physical restrictions are put in place (e.g. for COVID). • There is no incentive to come to the office, therefore employees might prefer (if possible) remote-working and work from home.

	• Some people are excluded from the use of services.	

Model D2: High variety and number of services, reserved to specific users

	Living	Working
Description	It is a model characterised by a high variety of services within the building or the narrower neighbourhood, which are only accessible for and used by specific users; service closure can be achieved by means of restrictions like membership to a club or community.	It is a model characterised by a high variety of services offered within the workplace environment, which are only accessible to specific users (e.g. people working for a firm or firms using that building/hub).
Type of services	Some examples of services provided can include: residential, recreational (e.g. green spaces, playgrounds), commercial (e.g. laundry), education and culture, health (e.g. convention with healthcare workers or health clinics for on-site visits), administrative (management of the contract, condo app), transport, work, sharing services (e.g. car sharing, co-working spaces), personal care services (e.g. childcare, eldercare).	Some examples of services provided can include: workplace, recreational (sports centres), commercial (cafés and restaurants), personal care services (e.g. for personal beauty, hairdresser, barber shops), residential, education and culture (kindergartens), health (convention with MDs), administrative, transport, including amenities to stimulate creativity and create comfort/wellbeing for employees.
Field of application	It is a model that can be advantageous in a (post-)pandemic setting where physical restrictions are still in place, characterized by high uncertainty regarding possible lockdowns. With this model, people can benefit from a wide variety of services beyond the residential function, and are therefore able to meet their needs without the need to commute for long, having contacts with a limited number of people, e.g. a co-living community, or residents of a given community.	It is a model that can be advantageous for firms to attract and retain the best talent pool, which is looking for an enhanced experience going beyond staying in the office all day-long.
Objectives	to provide a variety of services and create an almost independent, safe-sufficient, community which, if external conditions impose it, can shelter itself from the outside world (e.g. during a pandemic).	to provide a whole variety of services to enhance user experience and attract and retain talent.

Benefits	• easier access to services elsewise more difficult to access (e.g. health: longer waiting lists) (but only for specific users) • saved time and costs for commuting needs • strong sense of community at the "hyperlocal" level • enhancement of local economies • access limitations facilitate COVID prevention measures	• easier access to services elsewise more difficult to access (e.g. health: longer waiting lists) (but only for specific users) • saved time and costs for commuting needs • strong sense of belonging and affinity with firm culture that promotes employees' wellbeing • access limitations facilitate COVID prevention measures
Critical aspects	• There can be difficulties associated with implementing restrictions to some services (e.g. commercial), especially when considering the economic case/rationale for setting some restrictions. • Furthermore, some people are excluded from the use of services. • Integrating many services implies higher investments and management costs. If services are provided by external suppliers, there would be coordination costs • High number of available services can make COVID prevention measures more complex to manage.	• Integrating many services implies higher investments and management costs. If services are provided by external suppliers, there would be coordination costs. • The presence of many amenities can be a source of distraction for workers • High number of available services can make COVID prevention measures more complex to manage.

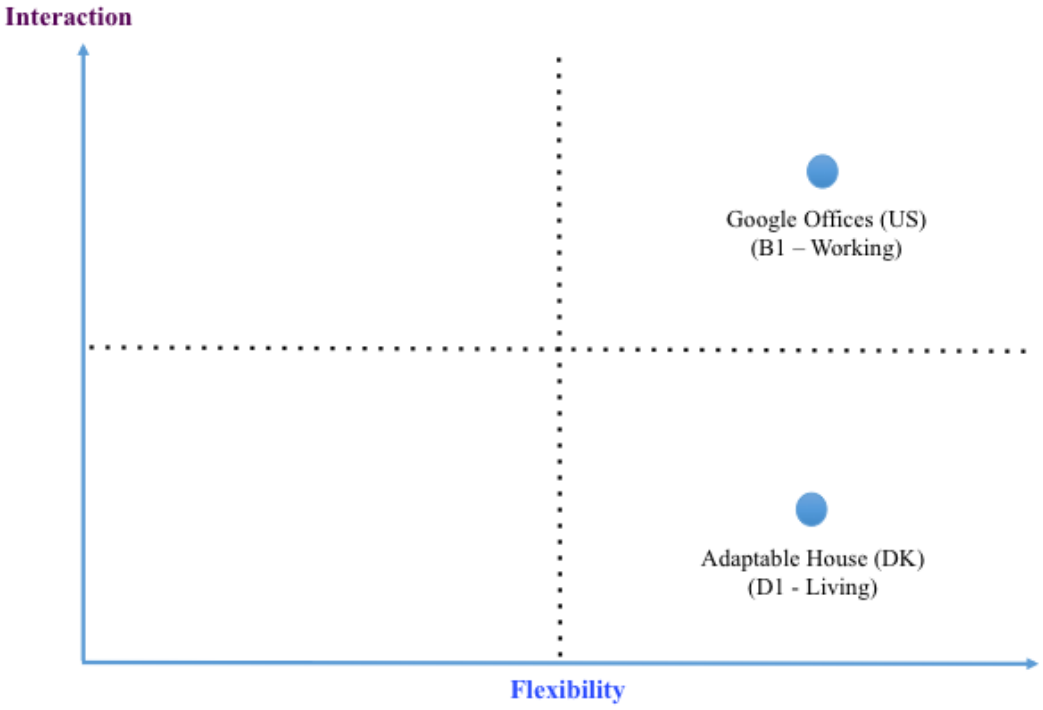
Case study description – "Parco Vittoria – Flat Tower", Milan – model D2 Living

Parco Vittoria – Flat Tower is a residential development located close to the CityLife area in Milan. The modern Built-to-Rent building offers apartments for rent which vary in size and typology, with a minimum duration of one year but can be managed online in a flexible way. The site has a dedicated focus on high-tech aspects, energy efficiency and tenants' health and wellbeing, and offers solutions that can respond to the new needs that emerged stronger after the COVID-19 pandemic. Private dwellings offer wide internal spaces, modern furniture, private terraces, advanced technologies (including home automation), and additional services include a car park and extra packs like cinema, curtain, décor, linen and cutlery.

Considering the dimensions of integration and accessibility, this residential development model provides a wide variety of services (high level of integration) that only the tenants can benefit (low level of accessibility), which can improve their wellbeing and resilience in face of a shock like future waves of pandemics. Shared space and services can be booked by means of the "MyLiving" App, which can help manage overcrowding and provide an overall better experience. The app allows communication with the concierge, management of home maintenance, package and post delivert, etc. Among the services provided that can be purchased with dedicated, priced packages, there are: a condo gym, that can be accessed by tenants exclusively and where a training slotcan be booked in either a private or shared session; a coworking space , including both individual workspaces and meeting rooms, which can be rearranged as a room for condominium meetings; a kindergarten, where educators can be booked last-minute for a few hours in case of an emergency. This solution aims to meet the growing demand for workspaces within the living spaces, as flexible work is expected to continue even after the pandemic. This type of service can be optimal for those workers who prefer to leave their own dwelling spaces for the purpose of working; it can also provide a safer environment compared to an external co-working, as it is characterized by a lower turnover and enables wider control of presences and accesses.

Source: https://www.parcovittoriamilano.it/

The following images display the positioning of the four case studies along the dimensions:



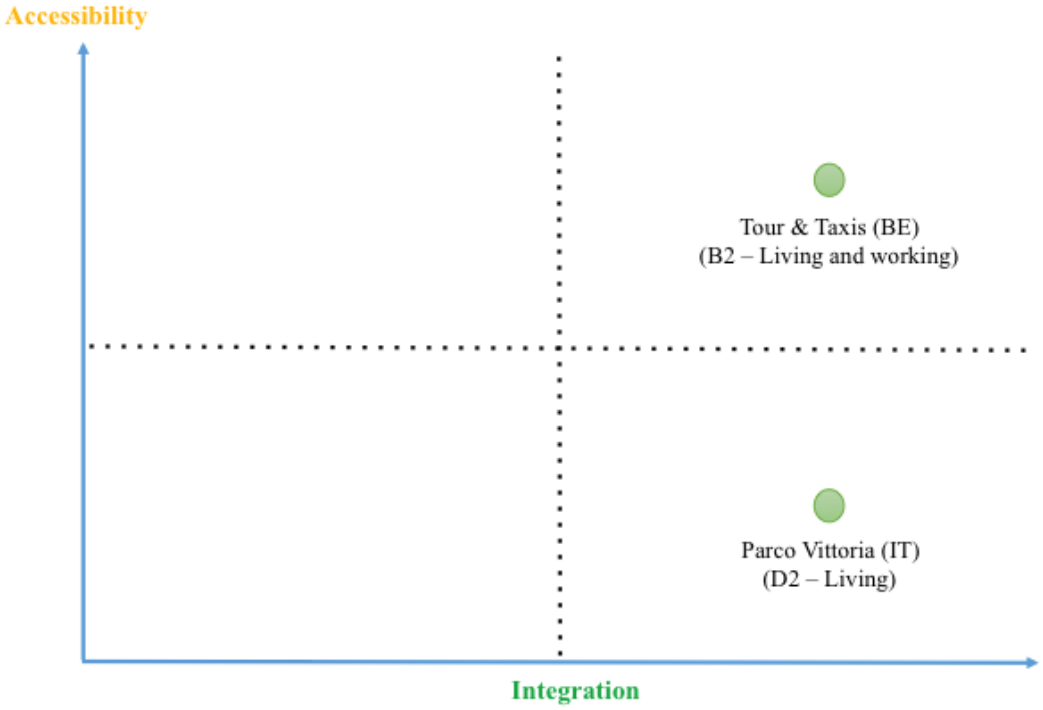


Figure 4: Positioning of the four case studies along the selected dimensions

5. Discussion and conclusions

Due to its global proportion and large-scale effects, the COVID-19 pandemic has posed unprecedented challenges in cities and exacerbated existing problems and inequalities, in the economic, social and environmental field. The pandemic is impacting society and economies at different levels and intensities, affecting human and social capital, institutions, communities, production, consumption and investments (Giovannini et al., 2020).

Cities are particularly affected, as urban life is based on proximity, which collides with the need for social distancing that is required to contain and limit the virus. The pandemic has altered urban lifestyles and behaviour in every sector, and this is reflected in trends that emerged in the living and working domain, as well as in the use of public spaces and services, as discussed in Chapter 3. Homes have gained a new role and now serve multiple functions, which requires rethinking domestic spaces and increasing their adaptability. Work, especially when office-based, is changing towards more flexible models, relying on the opportunities opened up by remote-working; new spaces, services and models are needed to accommodate hybrid working modes that have been increasingly adopted, combining virtual and in-place presence. Social interaction both in communities and at workplaces has been influenced by new rules and habits, and this will impact how spaces and services will be designed in the future. Different access policies and restrictions in the use of services have been put in place to contain the spread of the virus; on the other side, the use of digital services skyrocketed and enabled the fruition of some services. Public spaces have been adapted and repurposed to ensure prevention from the virus. Urban mobility patterns changed, with diversified consequences on congestion and environmental conditions.

Overall, living and working models have been changing and evolving over the past two years, also based on the sequence and intensities of the COVID-19 waves, as well as on rules and policies that governments have enforced to manage the crisis. In the paper, four main dimensions of change have been identified based on the literature to define new living and working models after COVID. These models do not necessarily exist in real setting, for several reasons: i) real cases might combine and include additional elements; ii) some of these models are not realistically implementable; iii) some of them are pre-pandemic models that are not suitable anymore to respond to the new trends emerged in the demand and supply of living/working solutions. Further dimensions could be detected and applied to elaborate different models.

The selected dimensions range from rigidity to fluidity in space configuration (Flexibility); from low to high social interaction in spaces (Interaction); from access restrictions to open access (Service accessibility); from low to high variety and number of services (Integration). Each model has benefits and critical aspects related to both the living and working models themselves and the management of COVID-19. These elements can influence and drive the decision to adopt a specific model.

Considering the use of space, models with high flexibility are able to adapt to changing circumstances and can be applied in settings where needs are expected to evolve significantly over time. At the same time, flexibility needs to be incorporated into the living/working solution since the planning and design phase, in order to reach its widest benefits. Models with high interaction are able to encourage collaboration, sense of community, and alleviate isolation, but are more complex in terms of COVID-19 management and control. On the other side, models with low interaction are more suitable to favour privacy and independence, and facilitate COVID-related

management, but may hamper socialization, collaboration and are less capable to stimulate creativity and discussion in workplaces.

Considering the use of services, models with high service integration are able to stimulate local economies and implement proximity models like the 15-minute city. At the same time, a high service variety implies more management and coordination. On the other side, models with low services are less capable of satisfying a variety of needs of communities (and in workplace settings, of employees), and require commuting to other parts of the city to access additional services. In terms of service accessibility, open access services can contribute to reach a wider scope of users, but are more complex in terms of COVID-19 management and control. On the other side, restrictions to service access can facilitate COVID-19 management, but imply the risk of exclusion for some user categories.

The implementation of each model is influenced by many factors: technological, cultural, political, legislative, economic. Depending on their priorities and strategies, city governments may decide to adopt specific policies to support the implementation of a model compared to others. For example, city governments may decide to incentivize a higher integration of accessible services in neighbourhoods or workplace environments, as a way to increase the liveliness of local economies and satisfy the demand for services on a proximity scale. Governments may decide to opt for more restrictive access policies in case further acute waves of the pandemic should emerge, or to ease them should the situation improve. Overall, the implementation of different models will respond to these dynamics.

The trends in the demand and supply side, as well as the main dimensions of change, should be considered in urban regeneration and real estate projects, as these developments will have to cope with new needs and habits and respond to the challenges that COVID-19 is posing. As the pandemic is still ongoing and there is uncertainty about its evolution, needs and trends might take different directions in the future. While the most restrictive measures (lockdowns) are currently less frequent in government policies to contain the virus, other measures like distancing and sanification are likely to remain relevant and will influence living and working models over time. This also set a possible direction for future research on post-pandemic living and working models.

The COVID-19 pandemic is a massive and transformative crisis, which is generating immense loss but opened up some opportunities to revise our living and working models and make them more resilient to current and future shocks. The pandemic should be leveraged as an opportunity to tackle some of the most urgent challenges of cities in our times.

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