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Post-pandemic residential forms in dense urban areas:

Potential sustainable adaptation of Budapest historical buildings courtyards as semi-private spaces for the well-being of residents.

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Abstract

Social distancing and lockdown measures induced by Covid-19 pandemic have caused a major change in the nature and whereabouts of many human activities. Our daily routine shifted from close physical interactions to distance non-physical ones and from occurring in public and semi-public spaces to private and semi-private spaces. This change has affected the well-being of urban dwellers living in high density urban areas. The technological adaptation to remote communication during the pandemic provides a possibility for a more sustainable existence of virtual enterprises that require no physical space and has less impact on the environment. The Covid-19 experience has made it self-evident that we need to re-think how we plan and design residential forms in dense urban areas and how existing ones can adapt to achieve urban resilience. This paper investigates how residential forms in dense urban areas can be more sustainable, resilient, and less dependent on the public realm, providing more spatial opportunities and exposure to natural environment, through utilizing the potentials of the courtyard form. It also studies adaptation of existing residential forms in dense urban areas, focusing on the potential of the courtyard space in typical Budapest historical residential buildings to provide good quality semi-private outdoor space for the well-being of residents. The courtyard space emerged as an urban planning and design response to residential and urban density needs in Budapest in the late 19th and early 20th century. These buildings can be described as medium height; multi-flats attached buildings with central voids that substitutes internal spaces exposure to natural light and ventilation denied by the attached facades. These voids hidden behind the facades can behave as an extension to the public realm in times that require the dense urban areas to be resilient and provide more space for inhabitants. This research is based upon literature review and author personal experience.

Keywords: Covid 19 pandemic, Residential forms, Urban density, Courtyard, Semi-private, Well-being, Adaptation, Sustainability, Urban resilience

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I- Introduction

Covid-19 pandemic will go down in history as one of the major events that forced us as human beings to change our normative way of living. Throughout all of our natural and social evolution as a specie, the needs to adapt to challenges and survive have continuously motivated us to think, innovate and change. The built environment, which stands as a concrete representation of human spatial behaviors and culture, has always responded to such challenges, and evolved to aid the prosperity of its creators.

Historical epidemics forced urban scientists to create and continuously reevaluate the processes of planning, regulating, and operating human settlements. These processes have adapted to the nature and characteristics of each epidemic. Nevertheless Covid-19 pandemic immerged at an unprecedent point in history in which relatively dense human settlements house the majority of the also unprecedent number of humans. Additionally, technological advancement and globalization eliminated many physical, social, and cultural barriers between geographically distinctive locations and groups. These circumstances helped the Covid-19 virus to spread and become a global threat. Experts predict that this would not be the last pandemic, or even the last of the Coronaviruses.

The immediate response to the novel virus advised by experts (WHO) was to apply a new set of spatial standards and social restrictions that altered the nature and location of many human activities and events. Social distancing and lockdown measures changed the way urban dwellers interact with the city moving many human affairs from occurring in public and semi-public spaces to private and semi-private ones. This shift in the spatial patterns of use of cities, the restrictions on social interactions and the shortage in accessibility to open public outdoor spaces negatively affected the well-being of residents in dense urban settlements. It also demonstrated a lack of private and semi-private open spaces in the city challenging the sustainable aspects of notions such as compactness, accessibility, high density, and minimum spatial standards. Many residential forms planned according to normative spatial needs and measurements proved to be insufficient to house an extra set of activities that may be required as a response to future pandemics. They

also demonstrated a lack of exposure to the natural environment that can substitute the role of an open public space in similar scenarios.

During the peak of global lockdowns scientists could witness a decrease in the negative effects of civilization on the natural environment due to eliminating what is not necessary from our lives. What we have learned and possibly gained from the Covid-19 experience is an opportunity to direct our civilization towards a sustainable future by reducing this mass non vital consumption of all sorts of energy forms. Adapting to remote and tele-work during the pandemic granted many human enterprises the chance to exist in a more sustainable and economical manner by utilizing the residential spaces and minimizing the needed footprint. This adaptation extended to another major human activity which is education. Remote learning and educational facilities adaptation to this hybrid system opened the door for a possible increase in usage of residential spaces for learning activities.

Reflecting on lessons learned from the Covid-19 experience, this paper argues the need for more decentralized, densely balanced, independent, multi functioning residential forms with updated standards and spatial paradigms able to house different activities and be flexible and adaptive in face of natural challenges. This will provide an opportunity of a mass reduction of energy consumption caused by the built-up spaces for activities that can be conducted remotely in an efficient manner and the daily commute that urban dwellers go through to reach these spaces. The research reviews approaches, guidelines and strategies of urban planning, urban design, and architectural scales that aim to achieve sustainability and resilience of residential forms. Analysis of morphology and potentials of the urban scale courtyard form and its ability to integrate these strategies into a resilient and sustainable residential block typological model will be illustrated through comparison of case studies against the framework concluded in the review.

The change of behavior and spatial use of private and communal spaces in residential forms during the pandemic demonstrated the need for them to adapt and change. This paper also investigates the potential of existing residential forms in dense urban areas to provide residents with new spatial opportunities and private exposure to natural light and ventilation through the adaptive re-use of neglected communal open spaces. Dew to the author personal experience, the adaptive use

potential of Budapest historical residential buildings courtyards as semi-private open spaces for the wellbeing of residents will be presented as a model of the ability of an existing heritage residential building in a relatively dense urban environment to respond to pandemical scenarios and the ever-lasting changes they may have on the spatial usage patterns of existing residential typologies in similar environments. Morphological and historical review of Budapest courtyards buildings physical, social and cultural aspects is conducted and analyzed to conclude factors that may affect this potential adaptive use model which might motivate and be a part of an urban regeneration framework of the historical city of Budapest.

II- Post pandemic built environment

Ever since arguably female homo sapiens discovered farming the need to settle and take care of crops presented itself to this conscious specie who used to mostly inhabit natural made shelters. This need urged haunter gatherers communities to start building shelters and initiate the creation of the built environment. Around 10,000 years later the built environment became our normative safe place of existence. What used to be the secondary environment for an average human is now housing almost all of their activities. For hundreds of thousands of years natural environment and natural selection have been shaping us to be the dominant specie on earth overcoming many challenges that faced us. Our intellectual faculties and consciousness are the tools we evolved to have to aid us in surviving and flourishing. Now that we inhabit mostly man-made environments it is our duty to utilize these intellectual faculties and shape the built environment for the purpose of the prosperity of humankind.

The last 100 years witnessed an exponential growth in the number of human beings and a significant increase in the percentage and densities of urban landscapes. These circumstances motivated urban scientists and innovators to find and develop practices of urban planning and urban design and apply them on human settlements to accommodate this explosive population growth in a manner that satisfies present needs. These practices evolved to respond to emerging requirements and challenges that face urban fabrics and dwellers, such as historical epidemics. The biggest challenge of our time may be that massive urbanization of the natural environment

resulted in disturbing the balance of natural eco systems. An effect that scientists have been witnessing and measuring intensively in the past decades. We cannot forget that it was this balance of ecosystems that induced the Holocene geological epoch roughly 12,000 ago which was a necessary precedent for the prosperity of our specie and the ability to even construct artificial environments. As a result, sustainable cities and communities is listed as a sustainable development goal by the UN and is continuously researched and evaluated by experts for the goal of reducing the negative impact of urban landscapes on nature and ensuring the welfare of current and future generations.

Covid-19 experience drew attention to some notions being promoted as sustainable in urban planning and design, forcing professional to re-think these notions in the context of this new unprecedent challenge. It also directed perspectives towards an older more people based sufficient and sustainable model of living highlighting what may be unsustainable, negative, and unnecessary in our built environment. Potential everlasting positive changes in the urban fabric use patterns caused by this historical event should be analyzed and further studied to conclude frameworks and models of a healthy, sustainable, resilient, and adaptive post pandemic-built environment. It is a crucial point in history where we have a relatively short amount of time to act collectively and spare our descendants the struggle of adapting to what will only be a hostile environment for the survival of humans.

1- Historical epidemics and the urban environment

Historically epidemics played a great role in the evolution of our modern-day city, radical urban improvements, and urban renewals of the renaissance in Europe were inspired by the bubonic plague in the 14th century, planning less dense living quarters, more open public spaces, and the deployment of professionals in the process of planning and building cities were all novel tools responding to the bubonic plague. Yellow fever, cholera and smallpox outbreaks of the 18th and 19th century urged the innovations of broad boulevards, citywide sewer systems, indoor plumbing, disease mapping and the early formations of suburbs. Third plague pandemic in 1855 introduced a change in the design of several components of buildings such as drainpipes, foundations, and doors thresholds. Epidemics of the

20th century such as the Spanish flu and tuberculosis prompted the practice of urban planning, clearing dense unplanned areas, reformation of residential units and waste management. It encouraged modern design principles and strategies like single use zoning, the transparency of architecture leading to more open well naturally lit and ventilated spaces and the introduction of new cleaner building materials and surfaces such as glass and steel. The need of cleanliness of materials and forms reflected symbolically in the modern architectural language that promoted purity of forms and materials and rejected ornamentation and what it perceived as unnecessary. Urban response to the Covid-19 pandemic should increase security layers to prevent infections by increasing the spatial flexibility of cities to apply social distancing measures in times we need to leave extra physical space between each other.

2- Post pandemic cities: lessons learned from Covid-19

What is unique about the Coronavirus is that it's an airborne high infectious rate disease and the fact that it affected human beings in an era where global networks and technological advancement transformed the planet into small village. It exposed vulnerable aspects of modern urban planning and design concepts against such events. Generally dense urban areas were affected more by the disease. The notion of high urban density relation to sustainability, resilience and adaptation of cities was questioned in matters of spatial flexibility, comfort, and exposure to the natural environment. Some experts started reminiscing suburban developments models and lesser densities urban formations as a solution that can implement better social distancing measures. Others argued for the benefits of higher density models. Such models can act in a sustainable manner by decreasing natural landscapes consumption, create social culturally rich atmospheres, decrease independency on individual more energy consuming vehicles by facilitating public transportation means, and create safer, more walkable, and inclusive built environment.

The transition towards digital platforms of communication and the adaptation to remote work and education that social systems were able to achieve may be among the biggest insights of the pandemic experience. Around 25-30% of jobs are predicted to remain functioning remotely even after the pandemic uncertain end.

This technological achievement is allowing many services providers and companies to exist virtually with employees working remotely cutting much of the usual cost spent on providing space, services, and utilities. Using residential spaces for extra activities that used to occur in public and semi-public spaces would aid in decreasing crowdedness in the public realm and help reduce emissions and energy consumption.

Attempting to reach a balanced outcome between maintaining the advantages of dense urban formations while making them adaptive, resilient, and able to provide extra spatial opportunities, research, and generation of theoretical models of residential block typologies is necessary. Residential buildings constitute most of the built environment and thus these models can act as independent and resilient units borrowing social characters of older settlements more sustainable lifestyle and exist in dense urban fabrics by granting residents a ratio of the public realm and what it provides such as extra spaces for activities, social interaction opportunities, and more exposure to natural environment. The sufficiency of these formations can have positive impacts on the environment by reducing building footprint, daily commute trips, crowdedness, traffic and pollutive emissions.

Covid-19 experience also revealed some weaknesses of dense urban environment networks. Although public transportation means are self evidently friendlier to the environment that individual motor vehicles in matters of saving space and reducing pollutive emissions it was far from flexible and adaptable to social distancing. It was in fact a stimulus for infectious interactions. This means in order for an urban network to be resilient it has to theorize risks of pandemics and a need for more space. Planning and encouraging use of bikes is now a necessity for a city to be resilient providing more options for residents and still having no negative impact on the environment and a positive one on human health.

To be able to reduce transportation use, daily commute and increase the tendency to use environment friendly means of transportation the notion of multi functioning residential environments presents itself as a tool to achieve walkable and 15-minutes cities concepts. We need to adapt the urban network to be able to isolate parts of it while still functioning on a global level. These parts would behave as sustainable micro networks with higher degrees of sufficiency and independency

while still highly connected and accessible to the public network. These micro networks will be highly dependent on environmentally friendly individual means of transportation to be resilient against similar disease by creating bikes and pedestrian friendly environments.

Biophilia hypothesis suggests that humans have an urge to connect with nature and other life forms. Natural environment was our home for almost all of our existence on this planet. Although fabricated environments enabled us to prosper, still we always sought after having a piece of nature in our built environments. Covid-19 experience demonstrated a lack of more distributed decentralized network of open public spaces in cities. Public space's role of acting as a social incubator was clearly missed during the lockdowns, humans need for social interaction is crucial for their mental and physical health.

Smaller more private open spaces can help the public realm be resilient against pandemics and still provide exposure to natural environment. Due to the level of privacy of these spaces they have a potential to provide the necessary setting for a people based agricultural practices in the middle of the dense city. It would encourage urban farming and community gardens as a potential tool for creating more green natural elements in dense urban environments, increase food resilience and motivate healthy sustainable practices. These private and semi-private open spaces will allow for more private social interactions among a limited number of people and thus increase social cohesion and help creating micro resilient communities by providing the physical setting for them to prosper. Creating these small social networks within the bigger networks can help enhance social resilience, identity, and sense of place.

During the pandemic electronic means of data collection aided in monitoring the spread of the disease. Data driven decision making using imperial facts and recorded patterns of behaviors predicts better chances of efficiency and communal acceptance of urban planning process, especially when participatory approaches merges with these smart city tools into a democratic inclusive planning process. A smart city predicts a resilient city by enlightening better data-based planning decisions and monitoring urban environments for better response to challenges such as pandemics.

3- Post-pandemic residential forms in dense urban areas

Whenever people used to imagine how the future would look like they used to imagine that we gained an ability to go anywhere and be connected in a global network. They would imagine different innovative means of transportation that would take us to the highest skies and the deepest oceans. This turned to be true, but the tool that we did not imagine would grant us this ability was not some kind of magical ship, it turned to be a screen that unlocks a window to a virtual world where all of us humans can be freely connected. Predicting a future scenario whether a utopian or a dystopian one for the ultimate potentials of this network haunts the mind of creative writers and movie makers. We can access markets, educational institutions, nonphysical social gatherings, restaurants, official institutions, and many other functional groups of human activities from a small device connected to this virtual network. This may have an effect on urban mobility and the physical need to be in other places. These futuristic productions also always envisioned the future residential unit as high tech, small and standardized, compact with a virtual access to the natural environment. This way of imagining the future that is subconsciously motivated by our current lifestyles may turn to be also a false one. Maybe we need to look back into how sustainable earlier communities lived and extract insights to apply on our modern communities. A more sustainable densely balanced existence of man made and natural environments in the same fabric.

Covid-19 experience proved that these forms are not resilient against such challenges. During the pandemic residential units in many cases failed to provide a living setting that maintained well being of residents. Housing strategies and regulations, social and economic challenges and inequalities are still major factors in defining the residential unit's quality. The need to eliminate slums, raise poverty and help imply social and economical justice are self-evident tools to achieve equal housing and residential opportunities. But even though medium and high-quality residential units also proved to be non-resilient against the pandemic. These units need to evolve to accommodate this technological evolution and increase their level of sufficiency and resilience. Densities of residential forms may have to take a step back towards less dense shorter buildings while maintaining a sufficient level of population density to be sustainable and provide livability, safety, social

interactions opportunities and potentials for cohesive communities. This would reflect on regulations governing the construction of residential units by assessing densities indicators like floor are ratio and implementing policies to increase open green spaces percentages and motivate urban farming and other sustainable practices.

Spatial standards and ratios may have to increase to accommodate the space the people have in the public realm. Modular constructions and universal design standards could be a solution to increase spaces flexibility and adaptability to emerging spatial needs while still providing an opportunity for a personalized residential space increasing feeling of belonging. Covid-19 experience challenged the modern open plan concepts. It illustrated the need for residential spaces to create isolated buffer zones and be able to sufficiently quarantine members of the people inhabiting these spaces. These buffer zones can act as a security layer between the outside and the inside with characteristics that prevents infectious diseases and allow residents to decontaminate. The pandemic also emphasized the need of indoor spaces for natural exposure and adjusting thermal comfort levels to be able to provide better settings, natural light, ventilation, and air quality helping to increase levels of physical and mental wellbeing and decrease disease transmission rates. Communal spaces in residential developments being the semi-private spaces that allow limited accessibility and at the same time some social interactions and exposure to nature environment proved to be as necessity for residential forms to be resilient and increase wellbeing. Other architectural elements that extract some of the outside inside residential forms like balconies, courtyards, terraces, and roof gardens proved to uplift wellbeing of inhabitants in times of confinement.

Increasing efficient consumption of energy and materials for building systems and integrating renewable energy systems can increase sustainability and self-sufficiency of residential forms and thus the sustainability of the urban realm. This would create more energy efficient units in the urban fabric revamping the whole energy network infrastructure to be more decentralized and resilient. Rainwater collection strategies and interventions on a residential block level can increase water sufficiency of these decentralized units and also enhance water infrastructure networks.

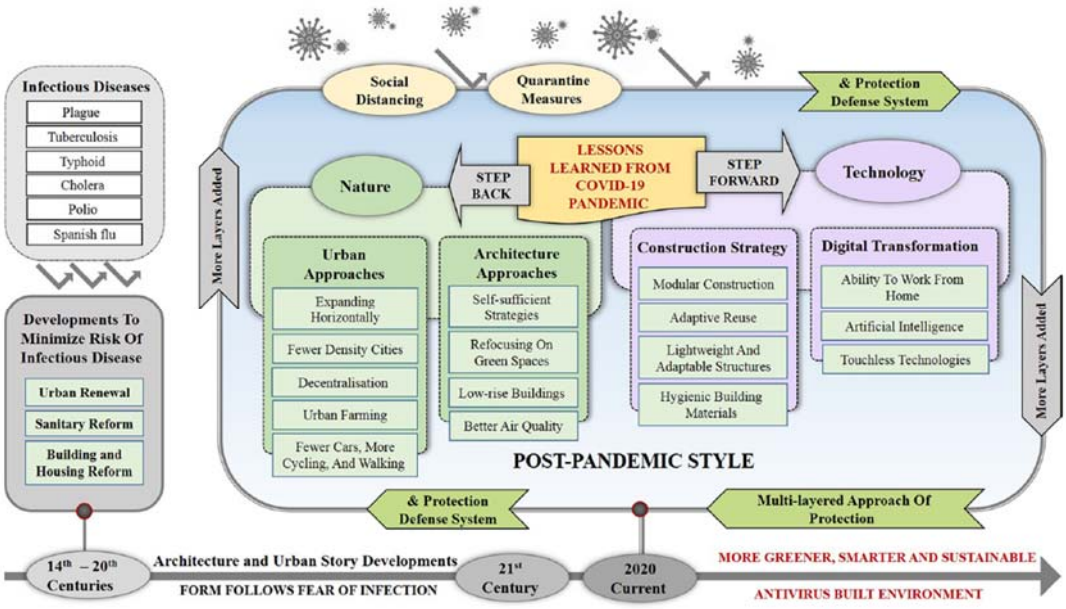

Fig1. The proposed vision about the future of the antivirus-built environment. Adapted from "Antivirus-built environment: Lessons learned from Covid-19 pandemic" by N.A. Megahed and E.M. Ghoneimb, 2020. *Sustainable cities and societies, 61(1).* Copyright 2020 by N.A. Megahed and E.M. Ghoneimb.

4- Potentials of the courtyard form

The courtyard form has been an element of architectural and urban residential morphology for thousands of years now, its special features transcended time and made it resilient to social change and the different ideologies of architecture and urbanism that evolved through human history, many of which utilized this element in their architectural languages. The notion of having a controlled piece of the natural environment with a private accessibility always seemed appealing to us. This microclimate provides natural light and air exposure while still providing security and safety, which were the primary motifs for us to even start building shelters. We needed to be connected to the world but still we needed our own piece of it. Courtyard's existence, shape and morphology in different cultures and different locations were always dictated by climatic, social, and economical factors of each era and place. In hotter climates it was a tool to cool down the residential spaces and in other cases it was an extra layer of privacy for residential spaces due to cultural norms. In different contexts it was un urban planning tool to supply the emerging population densities needs in the new industrial cities while maintaining exposure to natural light and air.

The courtyard form can be interoperated both on a unit scale and on an urban block scale where different units form a grander scale courtyard space. But in both cases qualities of enclosure, privacy, limited accessibility, and openness to natural environment still exist. These spatial formations allow internal spaces to have a dual exposure to both the public realm and the inner semi-private open space enabling

them to be private and connected to the urban fabric at the same time. This notion would provide the potential for these forms to act more independently of the public space in times of confinement and increase city resilience. The enclosure and direction of visual and physical axes towards the center would increase levels of safety and surveillance and stimulate social interactions which can act as a tool for increasing social sustainability and community resilience. Courtyard spaces can act as both microclimates to help control weather conditions and a green biophilic semi-private space sustaining some of the need for natural exposure. By creating social introverted spaces inside residential forms, the chances of a live ground floor layer increases and thus the ability to create a multifunctional semi-private ground floor layer that houses extra activities and can act as a representative of the residential form in the public realm also increases.

The notion of privacy and acoustical comfort may be affected negatively in this scenario which demands solutions and strategies in buildings design and construction. Vertical buffer zones and limitation of accessibility could be solutions to this issue. Another important issue that may rise is the social component of courtyard spaces. Notions like ownership, the right to personalize and change, and maintenance of these spaces demand a social strategy which can be implemented in both public and private housing sectors. These strategies can aid in achieving higher levels of communal resilience. Participatory design approach can be an important tool in these strategies to increase levels of communal responsibility, feeling of belonging and ownership and place identity.

Fig2. Courtyard form on both architectural and urban level. Adapted from "Romainville / Brenac & Gonzalez & Associés" by María Francisca González, 2017 (https://www.archdaily.com/899048/romainville-brenac-and-gonzalez-and-associes?ad_source=search&ad_medium=projects_tab). Copyright 2017 by Sergio Grazia. & "Polished, Private, and Passive: Traditional Courtyard Houses and their Timeless Architectural Features" by Dima Stouhi, 2021 (https://www.archdaily.com/966445/polished-private-and-passive-traditional-courtyard-houses-and-their-timeless-architectural-features?ad_source=search&ad_medium=search_result_all). Copyright Beit Rumman Hotel, Damascus. Image via Tumblr Account syrian-courtyard

5- Case studies: urban block courtyard formations

Le Familistère Guise or the social palace: The social palace (1884) designed by the French socialist and industrialist Jean-Baptiste André Godin (Born in 1817) was an early attempt of creating a self-sufficient community within the city utilizing the potentials of the courtyard form. This urban residential block form emerged as a response to industrial and economical needs of the era. Accommodating big number of factory workers in a good quality-built environment while granting them the opportunities of wellbeing and prosperity was the main motivation of the social palace. The name reflects its form inspirational roots in royal palaces and especially Versailles palace while being directed to a less fortunate social group in an attempt to endorse ideologies of equality and the right of a good quality accommodation and opportunities for social and intellectual activities. A pioneer notion of creating flexible and adaptable residential units can be seen in the structural form of the social palace accommodating different and emerging need of residents making them more resilient. The multi-functioning urban residential block environment that has its own semi-private open spaces and can serve its micro community needs for social gatherings was also an innovative strategy that helped this form to be sufficient and resilient. Concepts like urban farming, community gardens and extra spaces for communal activities can be traced back to this pioneering attempt in urban and social planning. "*There is no point in creating cheap housing, because cheap housing is the most expensive for people; what needs to be built is housing that allows real domestic economies, a place where human well-being and happiness can be nurtured"* (Godin, social solutions, 1871).

Fig3. Le Familistère Guise. Adapted from "Le Familistère Guise" by Hidden Architecture, 2021 (https://hiddenarchitecture.net/le-familistere-guise/). Copyright 2021.

Port-o-Prenz Apartments: This mixed-use urban block development by J. Mayer H Architects is an example of a contemporary urban residential block formation that lies in the post war urban fabric of the German capital Berlin. It tries to adapt to the limited space in the city, respect necessary densities of such urban environment, and maintain heritage and contextual values. The solution was an urban courtyard with residential units on the top floors and a mixed-use ground floor that behaves as continuous part of the public realm. This form provided internal space with maximum exposure to natural light and ventilation and created more spatial opportunities for residents. The development is flexible in matters of unit space and needs of each social group, it gives many options to different social groups creating this diverse environment. The urban courtyard space also granted more chances of social interactions between neighbors and thus helping community creation and resilience. Subtractions in the internal spaces forms around the urban courtyard create balconies, terraces and roof gardens increasing private exposure to natural environment.

Fig4. Port-o-Prenz Apartments urban clock layout. Adapted from "Port-o-Prenz Apartments / J. MAYER H " by Paula pintos, 2021 (https://www.archdaily.com/967444/port-o-prenz-apartments-jmayer-h?ad_source=search&ad_medium=search_result_all). Copyright 2021 by David Franck.

Romaiville: A medium density residential development by Brenac & Gonzalez & Associés in Romainville France that adopted the urban courtyard form to create rich semi-private internal spaces for residents. A multifunctional ground layer, urban farming and social interactions opportunities, subtraction, and addition to the masses of the urban courtyard surrounding units to create lodges and terraces are all similar characteristics to the proposed model of the urban residential block. This layout is more fragmented utilizing a physical barrier to induce privacy rather than the form itself suggesting that an ability to open to the public realm can also be an option increasing flexibility and adaptability potentials of the courtyard space.

Fig5. Romainville by Brenac & Gonzalez & Associés. Adapted from "Romainville / Brenac & Gonzalez & Associés" by María Francisca González, 2017 (https://www.archdaily.com/899048/romainville-brenac-and-gonzalez-and-associes?ad_source=search&ad_medium=projects_tab). Copyright 2017 by Sergio Grazia.

III- Adaptive re-use of neglected spaces: The case of Budapest historical courtyards building.

An important concept that leads towards a more sustainable existence for humanity on planet earth is to decrease our consumption of all forms of energy. Re-using what can be re-used can be an important tool in the process of decreasing consumption. This also implies on the urban environment. Adaptive re-use of urban forms and spaces can be an important strategy in a grander holistic sustainable regeneration vision of existing urban fabric. The degree of success of the adaptive re-use approach depends highly on recognizing the values and characteristics of urban forms. Many of these forms still have a lot to offer, such as physical spatial opportunities in existing structural forms of buildings and their potential to adapt and be flexible, and intangible nonphysical values of heritage, culture, and the many stories these abandoned structures witnessed. The role of architecture transcends its physical boundary and becomes part of culture, and human culture is the shield we developed through time against uncertainties, culture gives us a normative way of life protecting us from the unknown and questioning the manner of existence. Thus, maintaining cultural architectural values through adaptation and re-use increases the communal level of safety and belonging. In a European context and contradictory to the population increase in the global south European cities are not expanding in an exponential manner. The need to adapt abandoned and under used spaces as a tool for urban regeneration presents itself as sustainable solution to the demographic characters and needs of European cities.

Observation of change of behavior of communal spaces in residential forms (like balconies, courtyards, roofs…) during times of confinement directed the perspective of experts towards the potential of adaptive re-use of these spaces. Value of communal semi-private open spaces in residential forms increased during the Covid-19 experience. Residents found in these neglected spaces opportunities of natural exposure and limited social interactions. The potential of these spaces to succeed in adapting to emerging needs and to be re-used and regenerated depends on many physical and social factors depending on the context of these residential forms. Nevertheless, an increase in the quality and economical value of these forms and well-being of residents is predicted if a holistic adaptive re-use approach was implemented.

Due to author personal experience living in the old part of Budapest during the peak of the lockdown where the accessibility to indoor public and semi-public spaces was highly limited the need to personalize and use the building communal space (courtyard) presented itself as a solution to increase well-being in times of confinement. Urban fabric of the old city of Budapest majorly consist of 19th and early 20th century courtyard residential buildings. This urban residential form was a typical planning a regulatory tool in the formation of industrial European cities where workers and population needs dictated a denser than usual residential forms with less ratio of space for the individual. The creation of these courtyards was an attempt to compensate denying internal spaces natural exposure by stitching the building into a continuous street façade through firewalls. This urban design strategy aimed at creating a monumental, livable, and vibrant public realm but neglected internal quality of residential units especially in matters of natural light exposure. These spaces constitute a significant part of the public realm as per Fig 6, a sample of old part of Budapest and particularly the 6th district, courtyard spaces are about 10% of the whole are of the sample. Strategies and frameworks of adaptive re-use and regeneration of these in many cases neglected spaces that start by identifying tangible and intangible factors that affect the quality of the courtyard space and its ability to adapt can be an important part in a holistic vision of urban regeneration of the old part of Budapest making it a resilient urban environment against future challenges such as pandemics.

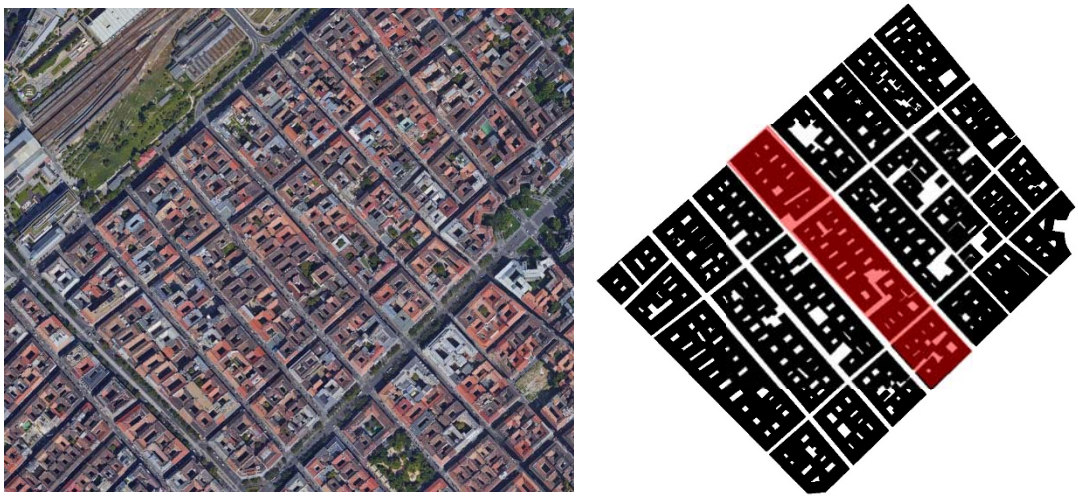

Fig6. Percentage of courtyards spaces out of total space sample in Terezvaros. 2021 By author. Adapted from Google maps

1- History and morphology of the courtyard building

Urban courtyards in the old city of Budapest can be categorized into two main spatial formations, the single unit courtyard and the courtyard that encloses more than one residential unit around it. This first kind being the older typology constitutes the majority of the courtyards building in the old city center of Budapest. This typology was a planning and design response to dwelling needs of workers of the new industrial era in Europe. The needs of space optimization and the increasing population density in a pre-democratic class segregated context resulted in the spatial morphology of these buildings. This segregation reflected on the share of each residential unit exposure to the natural environment. Spaces level of quality depended on its spatial position in the building spatial system. Better quality spaces for higher classes where exposed to the public realm utilizing street façade while lesser quality spaces where exposed to the courtyard. Vertical segregation of spatial quality also existed as there were no mechanical lifts and ground floor exposed to courtyard spaces were lacking natural light. Side facades were stitched together creating continuous street facades that served formal needs of the public realm more than the residents themselves. Higher social classes and commercial activities were exposed to the public realm while hiding the unwanted lesser social groups behind these ornamented highly detailed facades. These spaces hidden behind the facades can act in a different manner now, they can be the motifs of social interaction and community creation. The rehabilitation of these buildings, time, and social systems evolution changed the social nature of the residents that occupy the buildings now, this can reflect on the ability of shared space to adapt by further investigating the social systems that inhabit these buildings at the present time. A lack of privacy can be a disadvantage in such forms, but it can also be an opportunity to adapt to this lack of privacy and transform it into community creation.

A common characteristic of this typology is the mixed-use ground floor, it gives these forms the ability to create a livable vibrant residential environment and provide needs of urban dwellers. These building are medium height three to five story residential buildings with central voids and residential unit's layout directed towards open spaces of the public realm and the inner courtyard. Their modular firewalls structural systems give them some ability to change and adapt internally. Circulation to indoor spaces is usually conducted through the inner courtyard and

vertical circulation units are found in different positions but connected to the courtyard horizontal circulation. It can be found near the entrance or at corners or in the middle. Street facades of these building reflects the artistic spirit of that era and also the vertical segregation in quality and function. Current quality of courtyards in these buildings varies drastically, the next section tries to theorize factors and methodology of measuring these factors to help identify the reason behind this variance.

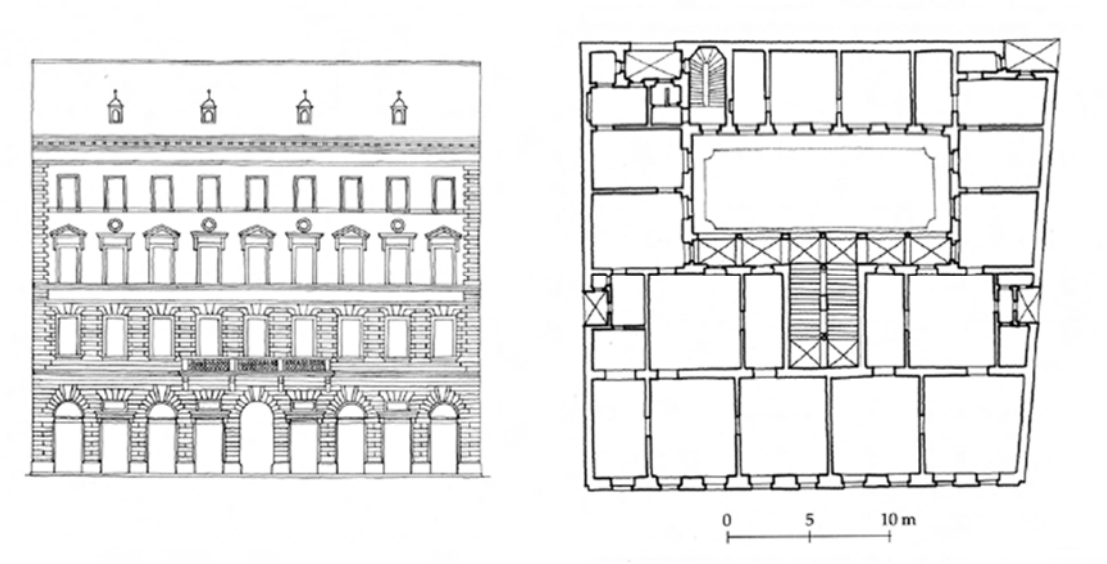

Fig7. Budapest courtyard building typology. The Delmedico house 1882 A historic courtyard tenement. Adapted from " BORROWİNG İDEAS: THE CHANGİNG FORM OF METROPOLİTAN HOUSİNG İN BUDAPEST" by Csilla V Gal, 2009. *International planning history society conference.* Copyright 2009 By Csilla V Gal.

2- Factors affecting quality of the courtyard space

In this section an observation on possible factors that may affect the quality of the courtyard will be discussed to try to identify and quantify these factors to be able to create a data-based methodology of adaptive re-use and regeneration of these spaces. The factors that may affect the quality of courtyard spaces are hypothesized in two main categories. Tangible physical factors and intangible social and cultural factors.

The proposed methodology of excluding what really enhance the quality of the courtyard space suggests studying a variant sample of the courtyard building all over the parts of the city where there is a high density of this typology. This variance should be based upon criteria of variant locations, construction years and variances within the same typology. This sample is then categorized by levels of quality

according to experts' professional opinions and general impressions of community through a participatory approach. These categories are then compared against the hypothesized factors to identify which of them are real effecting factors in the quality of the courtyard space. The results would guide decision makers, urban developers, and designers on how to create tools and strategies for adaptive re-use and urban regeneration of Budapest courtyard spaces. Factors hypothesized include:

Physical tangible factors include:

- Location of the building in relation to its socio-economical context.
- Construction year of the building and it's implications on architecture language and spatial formation of the building.
- Spatial formation and typology of the building form.
- Quality of natural light and ventilation in the courtyard space.
- Artificial lighting quality and sufficiency in courtyard space and communal spaces accessible to it.
- Level of luxury, detailing, ornamentation and existence of highly esthetical decorative elements in the courtyard space.
- Landscape and natural vegetation existence in the courtyard and the quality of these elements.
- Maintenance level of the courtyard space and the whole building, renovation of facades and infrastructure.

Intangible social and cultural factors include:

- Average age of residents as it can be related to the levels of personalization and taking care of the courtyard space.
- Social status as existence of families or other social status groups may affect the levels of personalization and taking care of the courtyard space.
- Economical status as higher level of financial satisfaction may result in initiating in uplifting the quality of the common courtyard space and having the economical means to do it using a private fund.
- Gender of residents and its relationship to the levels of personalization and taking care of the courtyard space.

- Type of residency, as owning a place may change the behavior of an individual toward this place.
- Nationality, to try to measure if having a citizenship or higher level of belonging can affect the level of personalization and taking care of the courtyard space.
- Public services quality and cost.
- Occupation and interests of residents, creative fields and nature loving personnel may have a higher desire of personalizing and inflecting aesthetical changes on their built environment.

3- Tools and strategies for urban regeneration of the courtyard space

To implement grand scale adaptive re-use and urban regeneration of courtyard spaces a holistic approach should be followed that takes into consideration all tangible and intangible factors that may affect this process. This approach should utilize physical and social tools and strategies to try to implement this vision of vibrant souls of Budapest old buildings.

Social strategies of community creation through participatory approaches, official policies, and motivations for the regeneration of these spaces, increasing sense of ownership by giving the ability for residents to personalize the space, and encouraging initiatives can all be tools helping the process of uplifting the inner courtyards of Budapest. Design and engineering tools can also uplift the quality of these spaces. These tools include creating smartly energy generating shaded communal spaces, introducing more green elements and landscape into the courtyard space, uplifting and renovating the quality of the inner façade, introducing decorative and sculptural elements to the courtyards, creating a possible water feature and furniture layout for some external activities spaces, introducing hanging functional and aesthetical elements between the bridges connecting the courtyard space and changing the functional behavior of the inner ground floor layer spaces to accommodate communal activities rather than being poorly lit residential units.

This process will not only regenerate these spaces and make them livable, but it will also uplift residents wellbeing and help the dense urban fabric of old Budapest city center to be more resilient against future challenges like the Covid-19 pandemic.

Fig8. Good quality courtyard spaces. 1.Andrassy ut 52. 2.Kossuth Lajos utca 14. 3. Szentkiralyi utca 4.Rakoczi ut 80. Adapted from " Budapest courtyards" by YVES MARCHAND & ROMAIN MEFFRE , 2014-2015. Copyright By YVES MARCHAND & ROMAIN MEFFRE

IV- Conclusion

Covid-19 experience has demonstrated vulnerability of urban forms against global pandemic events. High-density well-connected cities proved to be non-resilient against the spread of such airborne diseases. It also directed perspectives towards a more technological smart sufficient built environment. The opportunities that the Covid-19 gave us could change the way we interact and use our cities. A chance for a more decentralized sustainable less consuming lifestyle presented itself to scientists and researchers. Lockdowns and confinement times revealed weaknesses in the design and articulation of residential forms. It proved to be insufficient and too dependent on the public realm and networks for it to exist and function. This reflected on the physical and mental wellbeing of residents. These forms illustrated its inability to be resilient against lockdown measures induced by the need for social distancing that is very likely to present itself in the future. Creating models of independent sustainable sufficient urban residential units that can provide privacy and majority of residents needs while still have a high connectivity level to the public realm can help implementing this vision of the sustainable futuristic city that learns from values of past models of living while directing urban dwellers towards a better future.

Courtyard spatial forms can be an important design and planning tool for these models. Their timeless qualities can be interpretated on an urban scale to try to create this model of better housing. Adaptive re-use and regeneration of neglected spaces in heritage and existing urban fabric is a major strategy in the sustainable resilient city vision. Their economical features of saving space, resources and human values make them a great opportunity for enhancing community resilience. Budapest old city is an example of such fabrics. Urban morphology of that part of the city mostly consists of courtyard buildings with neglected courtyards that have an opportunity to uplift the quality of the city if adapted and regenerated in a holistic methodology that takes into consideration quantitative data and methods of identifying factors that affect the quality of the courtyard space. This would aid planning social strategies and policies and physical tools and techniques that can be applied to uplift the hidden courtyards of Budapest.

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