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REVIEW / DERLEME

Can Sustainable Neighborhoods Contribute to Reducing the Impacts of Pandemics Like COVID-19? An Evaluation in the Context of LEED-ND System

Sürdürülebilir Mahalleler, COVID-19 Benzeri Pandemilerin Etkilerini Azaltmaya Katkıda Bulunabilir mi? LEED-ND Sistemi Bağlamında Bir Değerlendirme

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ABSTRACT

The COVID-19 pandemic, which emerged at the end of 2019 and is expected to continue for a few more years, is continuing to seriously affect people's lives socially, psychologically, and economically from many aspects. This process showed us that designing the built environment to reduce the impact of the pandemic is crucial since the pandemic spread as a result of people's contact with each other within the built environment. This study was conducted with this point of view, and it examined whether the "Neighborhood Sustainability" concept, which promises economically, socially and environmentally sustainable built environments, can contribute to reducing the impact of future pandemics. For this purpose, firstly, the built environment design elements related to the spread of the pandemic were identified. Through a comprehensive literature review, suggestions for the improvements and changes related to the urban design elements in the context of the pandemic were determined. Then, how these issues are handled in the LEED-ND system, which is currently the most known and widely used neighborhood sustainability assessment system, were examined, and some suggestions for the adaptation of LEED-ND were presented. The study is thought to make significant contributions to the literature to reveal the importance of sustainable neighborhood design and construction in terms of pandemics and shed light on the development studies of Neighborhood Sustainability Assessment (NSA) systems.

Keywords: Built environment; COVID-19; LEED-ND; pandemic; sustainable neighborhood.

ÖZ

2019 yılı sonunda ortaya çıkan ve birkaç yıl daha devam etmesi beklenen COVID-19 salgını, insanların hayatlarını sosyal, psikolojik ve ekonomik olarak birçok yönden ciddi şekilde etkilemeye devam ediyor. Bu süreç, salgının yapılı çevre içerisinde insanların birbiri ile teması sonucu yayılması ve alınan tedbirlerin doğrudan veya dolaylı olarak yapılı çevre üzerinde etkileri olması nedeniyle, yapılı çevrenin pandeminin etkisini azaltacak şekilde tasarlanmasının çok önemli olduğunu göstermiştir. Bu bakış açısıyla gerçekleştirilen bu çalışmada, ekonomik, sosyal ve çevresel açıdan sürdürülebilir yapılı çevreler vaat eden Mahalle Sürdürülebilirliği kavramının gelecekte ortaya çıkması muhtemel pandemilerin etkisinin azaltılmasına katkı sağlayıp sağlamayacağı incelenmiştir. Bu amaçla öncelikle pandeminin yayılması ve pandemi önlemleri ile ilgili yapılı çevre tasarım unsurları belirlenmiştir. Sonraki aşamada kapsamlı bir literatür taraması yapılarak pandemi bağlamında kentsel tasarım unsurlarına ilişkin iyileştirme ve değişiklik önerileri tespit edilmiştir. Ardından, şu anda en çok bilinen ve yaygın olarak kullanılan mahalle sürdürülebilirlik değerlendirme sistemi olan LEED-ND sisteminde söz konusu önerilerin nasıl ele alındığı incelenmiş ve LEED-ND sisteminin uyarlanmasına yönelik bazı önerilerde bulunulmuştur. Çalışmanın, sürdürülebilir mahalle tasarımı ve inşasının salgınlar açısından önemini ortaya koyması ve Mahalle Sürdürülebilirlik Değerlendirme (NSA) sistemlerinin geliştirilmesi çalışmalarına ışık tutması açısından literatüre önemli katkılar sağlayacağı düşünülmektedir.

Anahtar sözcükler: Yapılı çevre; COVID-19; LEED-ND; pandemi; sürdürülebilir mahalle.

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Introduction

Urban areas and public health are intrinsically interlinked. Throughout human history, issues threatening health, especially epidemics, have caused major changes in urban areas; and changes were made in architecture, cities, infrastructure, interior designs, and construction materials to reduce the risk of infectious diseases (Alirol et al., 2011; Matthew & McDonald, 2006). In the 14th century, the bubonic plague caused to death of at least 30 percent of Europe's population and resulted in radical urban improvements during the Renaissance (Lubell, 2020). Similarly, the outbreaks of yellow fever in the 18th century and cholera and smallpox in the 19th century resulted in developments, such as indoor plumbing, citywide sewer systems, broad boulevards, the early suburbs, and disease mapping (Lubell, 2020). To defeat the pathogens causing cholera and typhoid, modern sanitation and water systems were established during the industrial era (Budds, 2020). Famous architect Le Corbusier stated that a house was only habitable when it was full of light and air (Chang, 2020), and Frederick Law Olmsted convinced New York City to build Central Park by referring to public health and considering open spaces as the lungs of a city (Budds, 2020).

In the late 1800s and early 1900s, with the discovery of germ theory arguing that microorganisms cause disease, the healing effects of light, air, and nature were cared for while designing the buildings and buildings with balconies, large windows, and flat surfaces were constructed. (Budds, 2020; Chang, 2020). One of the reasons for urban renewal and housing reform experienced between the 1930s and 1970s was infectious diseases. Tuberculosis, polio, Spanish flu, and typhoid breakouts in the 20th century resulted in urban planning, tenement reform, clearance of the slums, and waste management systems (Chang, 2020; Budds, 2020; Lubell, 2020)

The COVID-19 pandemic, which has been ongoing for almost two years, is considered one of the most important challenges and largest tragedies experienced by humanity after the Second World War (Gautam, 2020). The novel SARS-COV-2 coronavirus emerged in Wuhan, China, in late December 2019, and as of 23 August 2021, there have been 211.730.035 confirmed COVID-19 cases and 4.430.697 deaths in 215 countries (WHO, 2021). In order to decrease the infection and mortality rates, efforts worldwide have focused on a combination of vaccination, treatment, containment, and mitigation strategies (Ferguson et al., 2020). The affected countries are trying to slow down the transmission of the virus by stay-at-home orders, lockdowns, school closures, quarantine, limitations on the gatherings, social distancing, isolation, and testing (Aloi et al., 2020; Budds, 2020). All these measures are directly or indirectly related to the built environment, and epidemics that occurred throughout history proved that interventions associated with the design and planning of urban built environments also have a major role in the effective prevention and management of epidemics (Lai, 2020). Despite this fact, literature on the relationship of COVID-19 with urban planning and urban design is quite limited. In the globalized world, the transport networks and the configurations of neighborhoods may reduce/increase infection transmission rates and influence their severity and frequency; thus, the built environment has a significant role to play before, during, and after epidemics (Megahed & Ghoneim, 2020; Dietz et al., 2020). The built environment possesses therapeutic potential in maintaining emotional resilience and mental well-being, and it is also significant in terms of enabling adequate levels of physical activity, especially among the elderly, to maintain their cognitive and physical functional capacities (Galea et al., 2020; Homes et al., 2020). According to Lai (2020), an effective strategy is required to implement changes in urban planning and design to make the built environment more resilient to pandemics. The use of the environment could also be reorganized by synchronizing working, recreation, shopping, etc. times. Many changes that occurred in architecture and urban built environments throughout history were derived from similar measures implemented during pandemics and epidemics to ensure the hygiene, health, and comfort of urban residents and that the built environment has always demonstrated the capacity to evolve after the crisis (Chang, 2020; Muggah & Ermacora, 2020). In this context, the quality and type of housing, physical morphology, infrastructure quality, the level of services provided, jobs and services, and population-level mobility and social networks are among the key attributes that should be carefully considered in the struggle with epidemics.

This study aimed to evaluate whether the possible changes and innovations to be realized in the planning and design to fight possible future pandemics can be met with the sustainable neighborhood concept introduced at the beginning of the 21st century. The concept of neighborhood sustainability has emerged from the idea that it would not be possible to reach sustainable cities only by constructing sustainable buildings, instead the sustainability of people's lives ongoing in these buildings and in the areas among these buildings, should also be considered. Sustainable development at the neighborhood level refers to the development of communities with consideration of three interconnected dimensions of sustainability (environmental, social and economic dimensions) in a balanced manner (Churchill and Baetz, 1999). In the first stage of the study, of which the theoretical framework is presented in Figure 1, practical design ideas, trends, and planning theories that may pre-

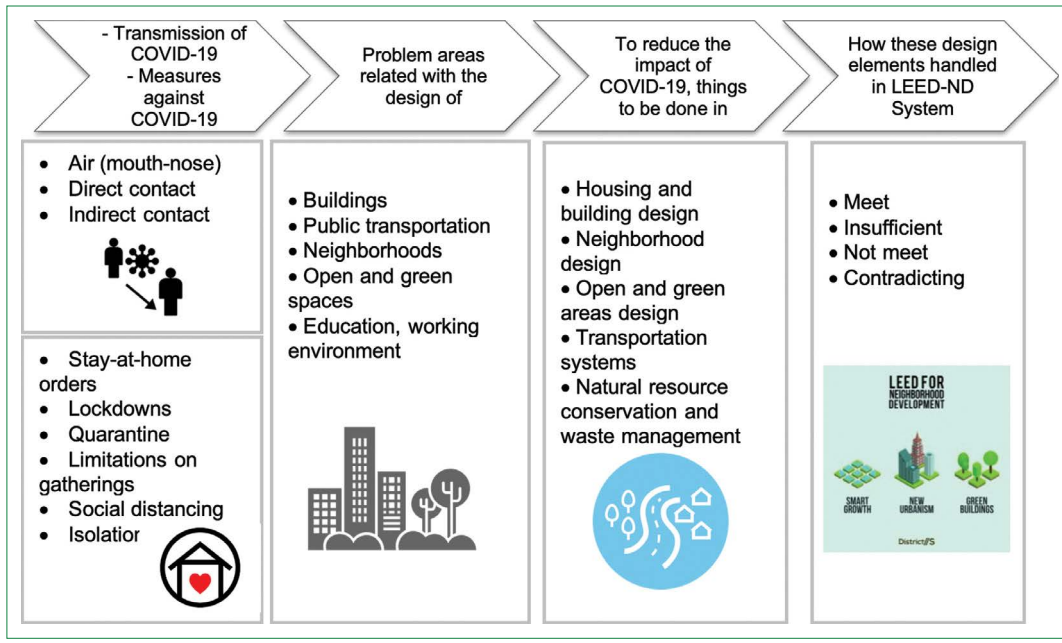

Figure 1. Theoretical framework of the study.

vent the transmission of viruses and add more layers to the built environment's defense system were studied. In the second stage, the extent to which the LEED-ND (Leadership in Energy and Environmental Design- Neighborhood Development) system meets the identified design requirements was investigated. In this context, this study revealed whether NSA systems would effectively reduce the impact of pandemics.

Relationship Between COVID-19, Built Environment Design and LEED-ND System

COVID-19

Although vaccination has begun and a few countries have made significant progress in vaccination, the COVID-19 virus with new mutations continues to spread and cause deaths. Thus, countries are still trying to slow down the virus transmission by social distancing, lockdown strategies, and restricting large gatherings. Research has shown that COVID-19 is transmitted to individuals by air and also by direct and indirect contact. Viral particles can accumulate directly on surfaces or be suspended depending on natural and mechanical airflow patterns or other turbulence sources in the indoor environment (Cirrincione et al., 2020; Dietz et al., 2020; Horve et al., 2020). When an infected person sneezes, coughs, or talks, saliva, respiratory secretions, or secretion droplets are released from his/her mouth or nose, those in close contact with him/her can catch COVID-19. Therefore, to avoid getting these droplets, self-distancing, cleaning the hands frequently, and covering the mouth with a mask are important issues (Bourouiba, 2020; Setti et al., 2020).

Problems Related to Planning and Design of the Built Environment

The COVID-19 outbreak appears to be one of the largest global crises experienced by the modern world. It is of great importance to identify the planning and design elements that contribute to or reduce the transmission and reduce the effects of the pandemic to manage the current situation well and to make the built environment more prepared against possible pandemics in the future (Megahed & Ghoneim, 2020; D'alessandro et al., 2020; Amekudzi-Kennedy et al., 2020).

Buildings

Since the pandemic began, people have been spending more time in their homes. For this reason, housing is the most important building category that should be evaluated concerning pandemics. Thus, whether the housing has the physical capacity to protect the residents' physical and psychological health is an important factor. Although it varies greatly according to the countries' development level, the housing conditions, most of which are already poor in underdeveloped countries, also seem insufficient in developed countries for pandemic conditions. According to TURKSTAT (2019) data, 36.9% of Turkish citizens have houses with problems such as leaky roofs, damp walls, and rotten windows, 39.3% of them can not heat their houses due to insulation problems, and 17.6% of them have houses with dark rooms which do not receive enough light. D'alessandro et al. (2020) stated that up to 415,400 apartments had no running water, 250,600 no water heating, 35,900 no toilet, 138,100 no shower/bathtub, and up to 6,458,400 had no separate kitchen according to

the 2011 census in Italy. These overcrowded apartments are not suitable for the "individual isolation" of people to avoid reciprocal viral shedding via air (Diez et al., 2020), contact, or fomites (Rothan & Byrareddy, 2020). The problem for other types of buildings, like workplaces, commercial buildings, and public buildings, is that mechanical ventilation, overcrowding due to lack of physical space, and open offices cause the virus to transmit easier and worsen the situation.

During the pandemic, another issue that appeared about the interior design of buildings, especially housing, has been tele-activities. COVID-19 pandemic caused the people, who were confined to their homes to transform their homes into places where they work, study, do physical activity, recreate, etc. From these activities, working and studying is started to be applied as teleworking and teleschooling. Distance learning, which is initiated mandatory during the pandemic period, can be expected to continue at a certain level after the pandemic. Besides this, using the internet for other activities like online shopping, entertainment, information sharing, and webinars for knowledge is widely adopted during the COVID-19 pandemic (Chick et al., 2020; Goniewicz et al., 2020). All these require the built environment, especially the housing, to have a suitable technological infrastructure. Internet and Wi-Fi connections' presence has become more strategic and fundamental. Furthermore, COVID-19 has demonstrated the cyberinfrastructure's criticality for continued operations in pandemic situations (Amekudzi-Kennedy et al., 2020). Another issue related to this situation is that family members cannot find suitable places within their homes, especially for working from home and education from home due to the small size of the houses, crowded households, and open-plan designs of the houses.

Transportation

Transportation is one of the most important elements of urban planning and design. Sustainable transportation refers to any low-impact transport system, such as walking, cycling, public transport-oriented development, green transport, and fuel-efficient transport. In this context, suggestions such as reducing the use of automobiles per capita, increasing activities such as walking and cycling, reducing the average commuting time, reducing parking spaces in central business districts, increasing the number of bicycle paths, and increasing pedestrian-friendly streets are made (Newman and Kenworthy, 1999). However, in terms of public transportation, one of the most confusing effects of the COVID-19 pandemic is its impact on transportation. COVID-19 has dramatically changed the encouragement of public transportation for urban mobility, and its use has been limited or discouraged (Tian et al. 2020) since it has been identified as a means of spreading infection. Until nowadays automobile has been considered an unsustainable means of transportation due to its carbon-based energy consumption and emission, but it becomes during COVID-19 a safer and more sustainable mode of transportation (Amekudzi-Kennedy et al., 2020). The cities are being forced to adapt their public transit systems to the risks originated by the coronavirus. In the middle of a major decrease in ridership, they should balance discouraging people from using public transport and convincing those who do not have any other transportation opportunity that their buses and trains are safe. On the other hand, walking and cycling seem to be the preferred and sustainable means of transportation since the transmission of the virus in the open air is limited, provided that the social distance is maintained.

Neighborhood Design

Pandemic revealed the significance of the mixed-use principle of urban design. There have been restrictions like the complete abolition of public transport or allowing a limited number of passengers, as well as some of the citizens, do not want to use public transport, and sometimes the citizens were allowed to move a certain amount of distance from their homes. Thus, to access areas such as shopping places, workplaces, public buildings on foot or by bicycle becomes almost impossible in urban areas where the mixed design principle is not applied. The study of Gargiulo et al. (2020) demonstrated that the transmission of COVID-19 is closely related to the socio-economic structure of the urban population. People in deprived neighborhoods have less qualified jobs, these neighborhoods are more densely occupied urban spaces, and physical distancing requirements and the need for public transportation are too much in these neighborhoods. Thus, residential segregation and neighborhood effects cause existing negative externalities to be exacerbated (Gutierrez et al., 2020).

Green and Open Spaces

Green and open spaces are areas used by people for entertainment, recreation and contact with nature. Green and open spaces are very important in terms of urban planning and design since they provide: an enriched quality of life that includes social and physical well-being; a place to relax, meet and exercise; the possibility to meet local needs, such as children's playgrounds; a link between built areas and rural areas; the residents the opportunities to foster a sense of community and manage their own environment (Kent Association of Local Authorities, 2000). Virus transmission is more difficult in open spaces compared to closed spaces. Thus, open and green spaces become more important during the COVID-19 period. However, urban green and open spaces are nowadays under strong pressure, especially in big cities. The increased urbanization and spatial planning policy, which aim densification, cause more people to live in less green residential environments, especially those from low economic strata.

The parks in neighborhoods where disadvantaged groups live are often small, unsafe, not well maintained, or ill-suited for community needs. (Groenewegen et al., 2006; Rigolon, 2016). These areas are not sufficient for people to use by protecting their social distances, and it is known that they are also not distributed equally throughout the city. Another problem experienced during the pandemic is that the lockdown of people inside their homes contributes to worsening other diseases, such as cardiovascular diseases and diabetes, anxiety, insomnia, depression, and learning problems in children. According to researchers, the reasons for this are overcrowding, a sedentary lifestyle, an increased intake of food and beverages, and an increase in tobacco smoking and the consumption of drugs (Reynolds, 2020). These problems can be alleviated through an urban design that increases open and green space areas used for recreational walking, cycling, and sports in the built environment.

LEED-ND System

In recent years, ensuring urban sustainability became one of the key elements of reaching sustainable development goals worldwide (Sharifi, A., Murayama, A., 2015), and assessment tools assessing the sustainability of neighborhoods and cities were developed. Assessment at the neighborhood scale means assessing the buildings, areas between buildings, the services provided, and the synergies and activities between the people, other creatures living there, and all this wide range of elements (Cole, 2010). LEED assessment system is a green building assessment system known worldwide and used widely in North America and many other countries (Panahi, 2014). U.S. Green Building Council, U.S. Natural Resource Defense Council, and the Congress for the New Urbanism came together and developed the LEED for Neighborhood Development (LEED-ND) system in 2007. According to U.S. Green Building Council, LEED-ND was engineered to inspire and help create better, more sustainable, well-connected neighborhoods, and it looks beyond the scale of buildings to consider entire communities. LEED-ND promotes smart growth by:

- Maintaining natural regions and making "smart location" decisions to protect and conserve habitat, wetlands, water bodies, and prime agricultural lands.
- Promoting neighborhood design and location that reduces automobile trips
- Developing areas where jobs and services are easily accessible by foot or public transportation
- Promoting a variety of green building and green infrastructure practices, with a focus on energy and water efficiency (USGBC, 2016).

Assessment titles and scores of the LEED-ND system were presented in Table 1.

Although there isn't any change in the Leed ND system checklist, U.S. Green Building Council recently introduced eight "LEED Safety First" pilot credits in response to the COVID-19 pandemic. Six of these credits, which are "Cleaning and Disinfecting Your Space", "Re-enter Your Workspace", "Building Water System Recommissioning", "Managing Indoor Air Quality During COVID-19", "Design for "Indoor Air Quality and Infection Control", and "Maintenance of HVAC Systems During COVID-19", may be used by already certified LEED projects or by the projects that are undergoing certification. The other two credits are released for LEED for Cities and Communities projects. From them, "Pandemic Planning" credit aims to assist cities and communities in preparing for, controlling, and mitigating disease spread during a pandemic that is significantly risky to people. The second one, "Social Equity in Pandemic Planning" credit, systematically analyzes equity implications across the whole process, including preparation, planning and fighting (USGBC, 2021).

Design Elements to Reduce the Impact of Pandemic

This section presents the changes, developments, and innovations that can be made in the built environment design to reduce the direct and indirect effects of COVID-19. Meanwhile, how the same issue is dealt with in the LEED-ND system was also examined. During this examination, some aspects of buildings were examined within the scope of "LEED v4 for Building Design and Construction (BD+C)" (USGBC, 2016) since the certified green building is a prerequisite in the LEED-ND system.

Properly Designed and Constructed Housing and Buildings

In the period of COVID-19, people seem to spend their time largely or entirely at home, either compulsorily due to curfews or voluntarily to avoid infection. Besides, some public buildings such as hospitals, police stations, fire stations, municipalities, and due to economical reasons, some production facilities like factories should continue to stay open. For this reason, buildings should be designed to minimize the transmission of viruses and help people protect their physical and psychological health. Measures that can be taken in this context and how they are handled within the LEED-ND system are listed as follows:

- Instead of mechanical ventilation that facilitates the transmission of the virus in closed areas, natural ventilation systems that will provide "Indoor Air Quality" should be preferred (Constable, 2020; Lubell, 2020; D'alessandro et al., 2020). In the LEED BD+C system, providing minimum indoor air quality for all types of buildings through mechanical or natural ventilation is a prerequisite to contributing to building occupants' com-

Table 1. LEED v4 for Neighborhood Development Plan Project Checklist

Smart Location & Linkage		28
P	Smart Location	Req.
P	Imperiled Species and Ecological Communities	Req.
P	Wetland and Water Body Conservation	Req.
P	Agricultural Land Conservation	Req.
P	Floodplain Avoidance	Req.
C	Preferred Locations	10
C	Brownfield Remediation	2
C	Access to Quality Transit	7
C	Bicycle Facilities	2
C	Housing and Jobs Proximity	3
C	Steep Slope Protection	1
C	Site Dsgn. for Habitat or Wetl. Water Body Cons.	1
C	Restoration of Habitat or Wetl and Water Bodies	1
C	Long-Term Conserv. Mngmt of Habitat or Wetl.	1
Neighborhood Pattern & Design		41
P	Walkable Streets	Req.
P	Compact Development	Req.
P	Connected and Open Community	Req.
C	Walkable Streets	9
C	Compact Development	6
C	Mixed-Use Neighborhoods	4
C	Housing Types and Affordability	7
C	Reduced Parking Footprint	1
C	Connected and Open Community	2
C	Transit Facilities	1
C	Transportation Demand Management	2
C	Access to Civic & Public Space	1
C	Access to Recreation Facilities	1
C	Visitability and Universal Design	1
C	Community Outreach and Involvement	2
C	Local Food Production	1
C	Tree-Lined and Shaded Streetscapes	2
C	Neighborhood Schools	1
Green Infrastructure & Buildings		31
P	Certified Green Building	Req.
P	Minimum Building Energy Performance	Req.
P	Indoor Water Use Reduction	Req.
P	Construction Activity Pollution Prevention	Req.
C	Certified Green Buildings	5
C	Optimize Building Energy Performance	2
C	Indoor Water Use Reduction	1
C	Outdoor Water Use Reduction	2
C	Building Reuse	1
C	Historic Resource Pres. and Adaptive Reuse	2
C	Minimized Site Disturbance	1
C	Rainwater Management	4
C	Heat Island Reduction	1
C	Light Pollution Reduction	1
C	Solar Orientation	1
C	Renewable Energy Production	3
C	District Heating and Cooling	2
C	Infrastructure Energy Efficiency	1
C	Wastewater Management	2
C	Recycled and Reused Infrastructure	1
C	Solid Waste Management	1
Innovation & Design Process		6
C	Innovation	5
C	LEED® Accredited Professional	1
Regional Priority Credits		4
C	Regional Priority Credit: Region Defined	1 each
Project totals (certification estimates)		110

Source: USGBC, 2014; P: Prerequisites; C: Credit.

fort and well-being. Besides, since the system aims at reducing the environmental and economic harms of excessive energy use, preferring natural ventilation should be a priority. Regarding this issue, three new credits have been released by the USGBC within the scope of LEED BD+C. In this context, "Design for Indoor Air Quality and Infection Control" credit encourages the design of HVAC systems to take into account the avoidance of airborne transmission of SARS-CoV-2 and/or other airborne infections. "Managing Indoor Air Quality During COVID-19" credit requires the building teams to check that indoor air quality systems are working properly and make any necessary adjustments to ventilation to prevent the spread of disease. "Maintenance of HVAC Systems During COVID-19" credit aims to preserve the well-being of occupants by resolving indoor air quality issues that could contribute to the spread of the coronavirus by encouraging business HVAC systems to be inspected and maintained regularly (USGBC, 2021).

- Adequate sunlight and thermal comfort should be provided in housing and buildings for the well-being of the residents. LEED BD+C allocated credit for thermal comfort to promote occupants' productivity, comfort, and well-being and for daylight to connect them with the outdoors.
- Open spaces, such as terraces, balconies, floor gardens, or direct gardens, which both improve psychological health and increase air quality, should be included in building design (Guy & Farmer, 2001; Makhno, 2020; Wainwright, 2020; D'Alessandro et al., 2020). Such a design item is allocated only for healthcare facilities in the LEED BD+C system.
- Construction strategies such as modular structure, adaptive reuse, lightweight and adaptable structures, hygienic

building materials to meet the needs of emergency health facilities and hospitals that emerged in the pandemic period should be used (Constable, 2020; Lubell, 2020). LEED BD+C system credits building life-cycle impact reduction to encourage adaptive reuse and optimize the environmental performance of products and materials.

- Designing workplaces, housing, and other buildings more flexibly by considering working from home and preferring private spaces, less dense and more distant seating arrangements instead of the open office method will reduce the spread of the virus (Lai et al. 2020; Molla, 2020). Design for flexibility is credited in the LEED BD+C system only for healthcare facilities with the intent of increasing flexibility and easing the adaptive use over the building's life.
- Although they are not directly related to housing and building design and construction, "Cleaning and Disinfecting Your Space" and "Re-enter Your Workspace" credits have been released by USGBC as a part of the COVID-19 measures. These credits are about procedures on cleaning and disinfection, and preparing plans related to the following issues: Building or place preparation, workforce preparation, access control, social distancing, green cleaning, touch point reduction, and communication management and operations plan (USGBC, 2021).

There are no suggestions in the LEED-ND (or LEED BD+C) system regarding the changes and innovations in some design elements that are listed as follows:

- Considering that activities such as working from home and distance education have become widespread or compulsory, designing the housing multi-functionally so that family members can carry out these activities comfortably and provide well-being for individuals (Allam & Jones, 2020; Capolongo et al., 2020).
- Using construction materials, finishing materials, and furnishings that serve to health and the cleanliness of domestic environments in all buildings, including housing, and manufacturing highly touched surfaces (e.g., doors, door handles, windows, tables, light switches, toilets, etc.), from easily cleaned materials (Molla,2020), is important in reducing the transmission of the virus.
- It is required to make arrangements to limit the entrances to public buildings, workplaces, and shopping centers and design places such as waiting halls, corridors, and elevators in a wider and more spacious way to prevent overcrowding (Kembel et al. 2014).
- Establishing and maintaining sufficient technological infrastructure due to the widespread and intensive use of the internet is also vital. (D'alessandro et al., 2020).
- Spreading non-touching technologies such as automation, voice technology, facial recognition, sensors will reduce virus transmission (Molla, 2020; Wainwright, 2020; Priday, 2020).

Neighborhood Design

The following issues can be considered within the scope of designing the neighborhood to reduce the impact of COVID-19.

- Considering that transportation facilities are limited during the pandemic period, designing the neighborhoods as mixed-use will allow residents to meet their needs on foot or by bicycle (D'alessandro et al., 2020; Lai et al., 2020) Mixed-use is also credited in the LEED-ND system and this intends to reduce vehicle distance traveled and automobile dependence, to encourage daily walking, biking, and transit use, and to support car-free living.
- Pandemic is much more common in areas where citizens from low-level income and minority groups live (Liotta et al.,2020; Lai et al., 2020). The main reasons for this are that these people do not have the opportunity to work from home, continue to go to work by using public transport and live in more congested areas. Therefore, designing neighborhoods so that citizens from all economic groups can settle will alleviate this problem. "Housing types and affordability", which aims at enabling settling of residents from all economic levels, is a credit of LEED-ND.
- Streets should be designed in such a width that crowding is prevented (Slater et al., 2020; Lai et al., 2020). Establishing walkable streets is accepted as a prerequisite in LEED-ND since it promotes transportation efficiency and improves public health by comfortable street environments. LEED-ND evaluates this criterion over a large number of numerical data. For example, according to LEED-ND: "Continuous sidewalks or equivalent provisions for walking are available along both sides of the entire circulation network within the project. New sidewalks must be at least 3 meters wide on retail or mixed-use blocks and at least 1.5 meters wide on all other blocks" (USGBC, 2016).
- Designing the neighborhoods horizontally to maintain social distance; preferring low-rise buildings instead of multi-story buildings that increase the contact of people, especially in areas such as entrance stairs and elevators (Liu, 2020; Novakovic, 2020); creating less dense residential areas (Lai et al., 2020, Makhno, 2020; Wainwright, 2020) is suggested. In contrast to these suggestions, LEED-ND promotes compact development intending to conserve land, promote walkability and transportation efficiency, and improve health through physical activity. It is considered that this situation, which is considered a contradiction, can be overcome with more innovative solutions. Since high-rise residential buildings is considered to contribute to the spread of COVID-19 because of shared circulation areas within buildings, designing high-rise buildings with distributed and totally separated/individualized circulation patterns can counteract the COVID-19 spread.

- Providing urban farming opportunities by creating urban gardens that will provide food security and nutrition, reduce climate change impacts, and lower stress (Dmitriy & Alevtina, 2019) will be good for reducing pandemics' impacts. Similarly, the LEED-ND system credit local food production through "Neighborhood Gardens" and "Community-Supported Agriculture."
- Constructing self-sufficient buildings is also suggested as one of the measures against pandemics in terms of resource use (Greer, 2009; Priday, 2020). LEED BD+C involves using renewable energy systems and indoor and outdoor water use reduction.
- The two credits that can be evaluated within the scope of neighborhood design and released recently for LEED for Cities and Communities projects against COVID-19 are "Pandemic Planning" and "Social Equity in Pandemic Planning" credits. Requirements for the "Pandemic Planning" credit are convening and facilitating an interdisciplinary team, identifying risk and vulnerabilities, assessing pandemic preparedness and response, developing a comprehensive pandemic preparedness and response plan for the city or community, and educating and training. Requirements for "Social Equity in Pandemic Planning" are, having a local equity officer; convening a pandemic community advisory group; articulating reliable and relevant information about the pandemic, public health and health care facilities; basing policy decisions and operational procedures on analysis on the impact to low income, vulnerable or at-risk groups in the city or community, adopting policies that are supportive of low income, vulnerable or at-risk groups; and providing infrastructure and facilities to meet the priority needs of low income, vulnerable or at-risk groups (USGBC, 2021).

Accessible Open and Green Spaces

The protection of ecosystems is greatly associated with the fight against pandemics (Berg, 2000; Taylor & Laville, 2020). Besides their social, environmental, and economic benefits, open and green areas also serve to the protection of people's physiological and psychological health (Engemann et al., 2019). On the other hand, activity-friendly environments and travel can play an important role in fighting COVID-19, considering the relationship between physical activity, improved immune defense, and low vulnerability to COVID-19 infections (Simpson & Katsanis, 2020). Furthermore, during the lockdown periods, various pathologies such as coronary heart disease, skeletal disorders, anxiety, depression, diabetes (Maas et al., 2009) increase, especially due to inactivity. Some studies highlight green spaces' contribution to reducing stress and mental fatigue and mitigating emotional states such as anger, anxiety, sadness, and depression (Cohen et al., 2015). To prevent the crowding and spread of the virus, open and green spaces and other public spaces such as squares, parks, or plazas should be big enough, well maintained, and well designed as defined in LEED-ND.

The LEED-ND system credits "Access to Recreational Facilities", while "Wetland and Water Body Conservation" and "Agricultural Land Conservation" are prerequisites of the system. Besides, "Tree Lined and Shaded Streetscapes" credit intends to encourage walking and bicycling, enhance air quality, and decrease urban heat island effects. All these credits are evaluated with concrete metrics. A few of them may be listed as follows:

"Locate or design the project so that a publicly accessible outdoor recreation facility at least 0.4 hectares in area, or a publicly accessible indoor recreational facility of at least 2325 square meters, lies within an 800-meter walking distance of 90% of new and existing dwelling units and nonresidential use entrances.

90% of new buildings have a functional entry onto the circulation network or other public space, such as a park or plaza. If the public space is a square, park, or plaza, it must be at least 15 meters deep, measured at a point perpendicular to each entry.

Provide shade from trees or permanent structures over at least 40% of the total length of existing and planned sidewalks within or bordering the project. For tree plantings, obtain a determination from a registered landscape architect that planting details are appropriate to growing healthy trees, taking into account tree species, root medium, and width and soil volume of planter strips or wells" (USGBC, 2016).

Conservation of Natural Resources and Waste Management

Worldwide 50% of the energy and 42% of the water are consumed in building construction or utilization processes, and 50% of greenhouse gases, 24% of the pollution in drinking water, 50% of chlorofluorocarbon, and hydrochlorofluorocarbon emissions arise from buildings related activities (Eryıldız, 2003). During the COVID-19 period, water consumption increased with people staying at home more, and the availability of properly treated and distributed drinking water, especially in underdeveloped countries, became a problem (D'alessandro et al., 2020). The management of both liquid and solid municipal wastes became crucial. COVID-19 caused online shopping of food or other products delivered to the home to increase, which caused an increase in both organic and inorganic waste production since all of them are all shipped or distributed packed. The wide use of personal protective equipment like masks and gloves caused medical waste to rise (Capolongo et al., 2020). The pandemic caused some U.S. and European cities to suspend recycling programs due

Table 2. Suggested arrangements to be done in LEED-ND system

Suggestions related to	Proposed changes in LEED-ND system
Housing design	- Inclusion of designing open spaces such as a terrace, balcony, floor garden or direct garden for housings. - Giving credit for "design for flexibility" and "design for multifunctionality" concepts in the system. - Emphasizing the establishment of all kinds of required technological infrastructure in housings.
Building design (Public buildings, workplaces, commercial areas, etc.)	- Inclusion of using healthier and easier to clean materials and furniture, using non-touching technologies, and designing some commonly used places such as waiting rooms, corridors, elevators and stairs, wider and more spacious. - Emphasizing modular structure, adaptive reuse, lightweight and adaptable structures, and hygienic building materials more clearly in the system. - Giving credit for "design for flexibility" and "design for multifunctionality" concepts in the system.
Open and green spaces including public spaces such as square, park, plaza	- Emphasizing that open and green spaces and public spaces should be sufficient to prevent overcrowding, well maintained and well designed.
Neighborhood design	- Revising the "compact development" element through optimizing issues such as designing high rise buildings with distributed and totally separated/individualized circulation patterns, decentralization, mixed-use, and horizontal growth with low-rise buildings.
Natural resource conservation and waste management	- Developing practical, applicable, repeatable strategies, which can be applied, especially in pandemic periods, and incorporating them into the Leed-ND system.
Transportation systems	- Increasing the scores allocated for transportation in LEED-ND under the titles of "access to quality transit," "transit facilities," and "transportation demand management." - Emphasizing flexible work arrangements with the goal of reducing vehicle trips during peak commuting hours more. - Inclusion of providing a flexible public transport system. - Emphasizing importance of green private vehicle ownership.
Overall	- Adding the suggested design elements, which are met by LEED BD + C, to the scope of LEED-ND to make them more clear and effective.

to concerns about COVID-19 spreading in recycling centers. The urban solid waste problem became crucial, especially in dense urban areas, where sanitation is significant in tackling the transmission of COVID-19 (D'alessandro et al., 2020).

Conservation of natural resources is one of the most important aims in the LEED-ND system. While "Certified Green Building," "Minimum Building Energy Performance," and "Indoor Water Use Reduction" are prerequisites of the system, some other issues, like "Outdoor Water Use Reduction," "Building Reuse," "Rainwater Management," "Solar Orientation" and "Renewable Energy Production" are also credited in the system with the aim of conservation of natural resources. "Wastewater Management" and "Solid Waste Management" are two issues credited in the system. The first intends to reduce pollution due to wastewater and encourage water reuse, and the second intends to decrease the volume of waste deposited in landfills and provide the suitable disposal of hazardous waste.

Transportation Systems

Since transmission is relatively easy during public transportation, post-pandemic urban planning studies should consider the protection of social distance in public transportation and pedestrian sidewalks for such situations (Lai et al., 2020). While services must be as much as flexible to satisfy the users' needs, limitations must also be placed on usage rates to ensure physical distancing. New technologies should be introduced in mass transport vehicles like buses and trains to reduce touching and make air renovation and filtering safer (Gutierrez et al., 2020). It is known that in many developed cities, transportation systems are arranged to use the maximal capacity of stations, interchanges, and tracks. Considering this, regulations such as creating multimodal systems and arranging working hours to prevent peak hours in public transportation may reduce the use of public transport. It will also be appropriate to make arrangements that allow outdoor travel such as pedestrian transport, bicycle, motorcycle, and

scooter. Thus, establishing a cycling network and establishing walkable, healthier, safer, greener, and more livable streets is required (Dreessen, 2020; Zhou et al., 2019).

"Access to Quality Transit" which aims at reducing motor vehicle use, thereby reducing greenhouse gas emissions and air pollution; "Bicycle Facilities" and "Walkable Streets" which aim at promoting bicycling, walking, transportation efficiency and reducing vehicle distance traveled; "Transit Facilities" which aims at encouraging transit use and reducing vehicle distance traveled by providing safe, convenient, and comfortable transit waiting for areas; and "Transportation Demand Management" which aims at reducing energy consumption, pollution, and harm to human health from motor vehicles by encouraging multimodal travel; are some of the design elements that are involved in LEED-ND system regarding transportation.

Results

An important part of the measures taken against the COVID-19 pandemic is related to the built environment. This study aimed to reveal whether these measures related with planning and design of the built environment are met by the LEED-ND system. As a result of the evaluation conducted, the LEED-ND system is generally observed to meet the proposals for built environment planning and design that aims to reduce the spread and impacts of the pandemic. On the other hand, a couple of the proposed planning and design elements are observed to be handled insufficiently or never addressed, and even a few of them conflict with the LEED-ND system. In this context, the changes that are proposed to be done in the LEED-ND system are summarized in Table 2.

Conclusion

As it was experienced throughout history, both COVID-19 and pandemics, which are likely to occur in the future, will seriously affect people's lives. Nowadays, fighting with pandemics has become much more difficult and complex than in the past as the population of the world increased too much, there are too many crowded cities in the world, developed transportation opportunities made the world a big village compared to a few centuries ago, and to travel between cities and countries become a necessity due to economic, educational, and health-related issues. While the transmission of the virus takes place in the built environment, the measures taken to prevent its transmission seriously affect people who are, in fact, a part of the built environment in which they live. What happened during the pandemic demonstrated that a wide variety of factors related to the design of the built environment, from congested urban areas to inadequate transportation facilities, facilitated the transmission of the virus. Similarly, it was observed that various measures taken cannot be implemented effectively or harmed people from other aspects due to the built environment's inadequacy. Authorities agree that it is possible to experience an epidemic or pandemic that spreads easier or is even more deadly than COVID-19 in the future; thus, it is extremely important to make the built environment prepared for possible epidemics.

On the other hand, it seems neither appropriate nor possible in terms of the issue's complexity to follow the implementation of the suggestions developed to design the built environment to fight the pandemic or establish a system solely for this. This study was carried out with the idea that it is possible to benefit from the neighborhood sustainability systems developed by basing on knowledge and experience generated with the studies conducted on sustainable buildings and cities. The examination conducted specific to the LEED-ND system, the most commonly used NSA system, revealed that the system largely meets the suggestions made in the literature and in this study regarding the built environment design within the scope of fighting the pandemic.

While curfews are imposed and people are confined to their homes due to COVID-19, the LEED-ND system requires buildings to be designed to increase human comfort. While restrictions are imposed on vehicle travel and public transportation due to COVID-19, according to the LEED-ND system, urban design should increase walkability and accessibility. The system promotes pedestrian and bicycle transportation, transportation efficiency that shortens transportation time by vehicle, and transportation demand management. While the restrictions imposed during the pandemic period threaten people's physical and psychological health, LEED-ND envisages an urban design that relaxes its residents and encourages them to move, with recreational opportunities, open and green spaces walkable roads. While the consumption of natural resources such as energy and water and the amount of waste in homes increase and recycling activities get more difficult during the pandemic period, LEED-ND aims to provide energy and water conservation and minimize the amount of waste.

Nevertheless, some of the proposals regarding urban design within the scope of fighting the pandemic were observed not to be met by LEED-ND. However, the study revealed that the system could be revised without major changes for the issues that are not already met by the LEED-ND system. In this way, LEED-ND and other NSA systems may also serve to create a more suitable built environment against pandemics besides sustainability goals.

In the future, it would be beneficial to carry out more extensive studies to find additional changes, developments, and innovations in the light of new experiences obtained from the fighting process against COVID-19.

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