Buildings' Sustainability after COVID-19

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The concept of sustainability, or sustainable development, was introduced in 1987 through the UN Brundtland Report, in which it is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The link between COVID-19 and sustainability is made up of a variety of psycho-sociological and perceptual aspects, such as the fact that the occupancy pattern of buildings is one of the determining factors in assessing the energy performance and sustainability of buildings.

Keywords: sustainability ; climate change ; COVID-19 ; impacts ; architecture ; building

1. Introduction to Sustainability and Sustainable Development

The concept of *sustainability*, or *sustainable development*, was introduced in 1987 through the UN Brundtland Report, in which it is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1].

The strong and proper impetus included in the aforementioned report to protect countries in crisis or developing countries has not, however, distracted the attention of the Urban Crisis Commission from what was and is happening in the cities of the industrial world, given that these "represent a high share of global resource use, energy consumption, and environmental pollution". Indeed, due to their behaviour and needs, many of these cities have an impact that goes beyond their urban boundaries by sourcing "resources and energy from distant territories, with enormous overall impacts on the ecosystems of these lands" [1].

2. The Construction Industry and Approaches to Sustainability in the Global Context

The construction industry is a complex and articulated machine and, at the same time, decisive for the world economy (and, consequently, for each individual nation). For a clearer reading of these statements, let us look at the data on the volume of business sustained in 2021, the year of recovery after the advent of the SARS-CoV-2 virus. The market value of the construction industry in that year was valued at USD 7.8 trillion, and with a production expenditure volume of USD 13.2 trillion and more than 180 million workers employed worldwide, it recorded revenues of more than USD 12 trillion. According to industry experts, these numbers are expected to increase in the coming years, and it is predicted that in 2030, with an expenditure volume of USD 14.4 trillion, revenues will exceed USD 22 trillion [2][3][4]. In Italy alone, driven by the tax incentives proposed by the state, such as *Bonus 110*, the construction sector grew by 27% in 2022 [5].

In order to tackle the issue of sustainability—a concept that is in itself far too vast, even if restricted to the field of construction—over the years, an attempt has been made to simplify it by breaking down the *problem* into several variables or areas of intervention. For this reason, although the ultimate aim is always to reduce the impact generated by the construction sector, in specific terms, it has started to refer to three different types of interconnected sustainability: *environmental*, *social*, and *economic–financial*. The CEN (European Committee for Standardisation) has also tried over the years to make its own contribution by supporting the various professionals involved in the AEC sector by dictating the rules of this new way of perceiving architecture. For example, the latest updates of the standards UNI EN ISO 14008—*Monetary assessment of environmental impacts and related environmental aspects* and UNI EN ISO 14006—*Environmental management systems—Guidelines for the integration of ecodesign* date back to 2019 and 2020, respectively [6][7].

3. The intersection between sustainability, climate change, and COVID-19

The concept of sustainability is closely linked to climate change issues, and for this reason, in 2022, the European Commission "committed to supporting the integration of climate resilience considerations into the construction and

renovation of buildings", by commissioning the Danish consultancy Ramboll and the CE Deft, a Dutch research and consultancy centre, to undertake "a study to collect and synthesise existing methods, specifications, best practices, and guidelines for climate resilient buildings" with the final aim of drafting guidelines entitled *EU-level technical guidance on adapting buildings to climate change* [8].

One of the main goals of these guidelines will be to mitigate the priority risks that may affect buildings due to climate change so as to achieve an in-depth review of vulnerability and climate risk assessment methodologies (see **Figure 1**, RAMBOLL infographic).

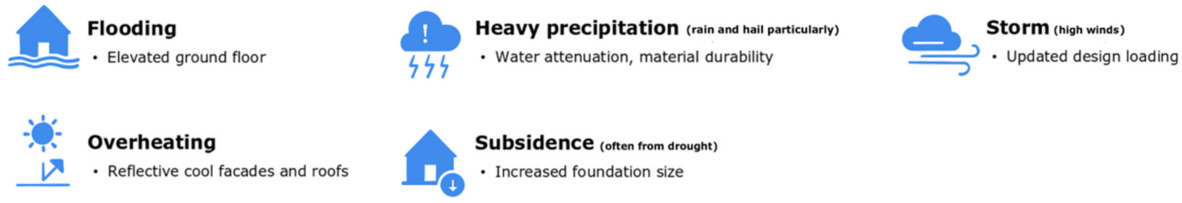

Figure 1. Infographic on priority risks that can affect buildings.

This research examines a multitude of documents of various types and provenance from recent studies undertaken by the European Union and academic studies, until the regulatory instruments that guide the building sector in each individual country, "will consider any variation required for different scales of buildings, from the individual to the whole block, providing feedback on the impact, ease of use, and synergies/conflicts of the methodologies" [8].

4. COVID-19 Implications of Environmental and Economic Sustainability

In the field of *environmental* sustainability, with regard to the problem of climate change, research has already been trying to make its contribution for several years, but three years ago the world was shaken by a totally unexpected event, the COVID-19 pandemic.

This worldwide pandemic upset and transformed, in the space of just a few months, the way people behaved and the way they perceived the world around them, drastically altering their perception of the spaces and environments in which they daily lived, worked, or simply spent their free time [9].

The link between the advent of COVID-19 and sustainability consists of a multiplicity of psycho-sociological and perceptual aspects, such as the fact that the occupancy pattern of buildings turns out to be one of the determining factors in assessing the energy performance and sustainability of buildings [10].

During the pandemic, due to the lockdown, there was an almost complete emptying out of offices, resulting in an improvement in the sustainability rating of the buildings that housed them and a profound decrease in transport pollution, both public and private, at the disadvantage of a consequent worsening of the sustainability rating of individual buildings in the residential sector.

As shown in **Figure 2**, in fact, considering that the minimum cubature of a classic office room, e.g., that of a public administration, must be at least 10 cu. m. per employee, multiplying by the number of employees present (4) and dividing by the mandatory minimum height (2.7 m for residential), we obtain approximately 15 sq. m. per employee. This size turns out to be the same as required for the living room (minimum 14 sq. m.) of a residential building [11][12]. Assuming for approximation that both rooms (office and living room) have a similar number of radiant elements, it can be assumed that during the periods spent working at home, the energy consumption required to heat the classic office room is no longer shared by the four colleagues but must be multiplied by four, i.e., to heat each individual room, in this case the living room, in which each employee worked. (NB: this is of course only an example estimate, but it is intended to quickly show the effects of the lockdown and the impact on individual homes.)

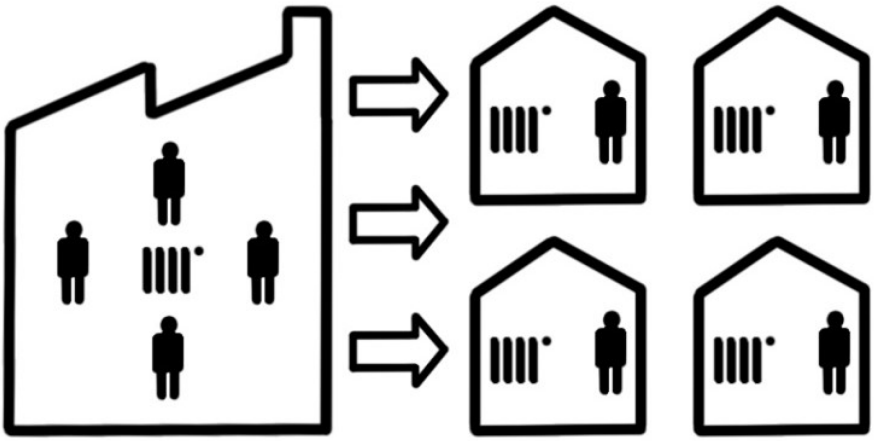

Figure 2. Diagram of the evolution of energy consumption attributable to 4 employees before and during the COVID-19 pandemic.

Professionals and workers were not the only ones who had to quickly change their work habits, transforming their homes into private offices from which to interact by video call with colleagues. In many of those home offices, students also had to coexist and find their own space while busy trying to attend classes, study, and interact with their peers through online classes and courses. On the level of *social* sustainability, it should be noted that some students, for example, those engaged in the transition from middle school to high school or from high school to university, found themselves interacting for at least a year with colleagues they had never met except in virtual spaces. The future will allow us to understand how much such an event may have affected young minds in the midst of physical, intellectual, and hormonal development and what kind of social side effects it may have caused [13][14].

5. Renovations and Energy Efficiency Improvements in the Construction Sector

Once the lockdown period had passed, the slow return to normal occupation of workplaces began, which at the same time had often been subjected to a complete redesign of spaces and a strict separation of internal pathways.

Certainly, if compared regarding the concept of sustainability, the impacts resulting from climate change and that due to COVID-19 appear to be travelling on parallel tracks but at completely different speeds. Compared to the disruptions caused by the pandemic, the impact attributable to climate change appears to have effects on buildings and their users that can be observed more in the long term. In both cases, however, the more or less significant consequences of these impacts will lead to non-negligible changes in the behaviour and perception of re-occupied spaces [15][16].

Taking climate emergencies into account during the design phases becomes a fundamental aspect of the new way of conceiving sustainable architecture, and professionals must be an active part of this radical change in perspective. Driven by these motivations, a number of researchers initiated a project to direct students towards these issues even before they became professionals. By working on teaching methods and students, in fact, it is possible to ensure that they, through their academic careers, acquire the appropriate tools to implement the changes in perspective that the AEC sector needs in order to pursue better sustainable architecture [17].

In the construction sector, the desire or need to converge efforts as much as possible to achieve ever greater levels of sustainability is also dictated by purely economic and practical aspects.

In recent years, both in the Italian and international contexts, the desire to pursue the *economic* and *environmental* sustainability of buildings has encouraged the preservation of the existing heritage with respect to possible demolition, reconstruction, or new construction. Renovations aimed at preserving the aforementioned building heritage have the main objective of improving the building's performance in various aspects, mainly energy.

In Italy, for example, considering only the hospital sector, 85% of healthcare facilities were built before the early 1900s, with the consequent result that 80% of operating theatres today are non-standard in terms of minimum suitability requirements [18].

The data for the residential sector are no longer comforting. The Italian government, with the aim of restarting the economy and overcoming the problems that had emerged due to the coronavirus, by exploiting the flywheel of sustainability, proposed significant tax breaks for renovation work in the residential building sector with the purpose of

improving energy efficiency. In order to obtain these reductions, renovations had to aim for a mandatory improvement of two energy classes of the building compared to the situation at the beginning of the work.

According to the report of the Italian National Agency for New Technologies, Energy, and Sustainable Economic Development (ENEA), as of September 30, 2021, the number of renovations attributable to the *Bonus 110* tax break exceeded 46,000 properties, for a total of EUR 7.5 billion in investments [19].

Concerning the issues related to the sustainability of the existing building heritage, in 2013 researchers from numerous European universities and research institutions, thanks to the European Union's Intelligent Energy Europe programme (IEE), began to be concerned and deal with "making transparent and effective energy refurbishment processes in the European housing sector", first through the cataloguing of building types present in Europe (Project TABULA), which then extended to the "development of building stock models to assess renovation processes and predict future energy consumption", leading to the drafting of an "agreed set of energy performance indicators that will allow key actors and stakeholders to ensure, at different levels, a high quality of energy renovations, compliance with regulations, to monitor and guide renovation processes in a cost-effective way and to assess the energy savings actually achieved", the ultimate goal of the EPISCOPE project [20].

6. COVID-19 and Its Impact on the Global Supply Chain

Environmental sustainability and *economic* sustainability, although they both serve the same purpose, due to the different domains in which they operate, may find themselves making choices in opposition to each other. A glaring example, which emerged during the pandemic and has largely persisted up to the present day, is the negative impact of COVID-19 on the global supply chain. This problem has an even more serious impact when materials produced in one country are denied the shortest route to their destination site. This interruption makes it impossible to implement a sustainable supply chain, the ultimate aim of which is to try to reduce greenhouse gas emission levels by designing the fastest link between supply and demand. A link was, indeed, impossible to make during a pandemic with entire nations in lockdown [21].

Moreover, global supply problems are exceedingly difficult to address, not only for highly developed nations but especially for small developing states. Within this category, for example, the Small Island Developing States (SIDS), basing their economy purely on the tourism sector (e.g., the Seychelles' GDP is 67% due to tourism), in addition to suffering from the negative impacts of climate change for years, have suffered dramatic drops in their GDP due to COVID-19, on average 7.3%, with peaks of 16% for the Maldives and Seychelles. Furthermore, the obligation to deal with disasters caused by the increasingly frequent occurrence of extreme weather events has deeply undermined their already fragile economy, hampering their ability to deal with further natural disasters. In the same year as COVID-19, for example, the pandemic and quarantine prevented SIDS from providing the necessary health and humanitarian assistance after Cyclone Harold struck.

The scientific community, through the International Science Council (ISC), set up a scientific committee to support these small states as early as 2020, while the Organisation for Economic Co-operation and Development (OECP) has initiated studies to map the disastrous consequences on the economies of these states due to the advent of COVID-19. According to the UN, SIDS face substantial challenges in terms of sustainable development from the pandemic, climate change, and the political choices of the rest of the world and therefore require urgent support—financial, technical, and material—from the entire international community, scientific and otherwise [22][23][24].

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