Chapter

# Introductory Chapter: Intelligence, Sustainable and Post-COVID-19 Resilience Built Environment: An Agenda for Future

*Samad Sepasgozar, José David Bienvenido-Huertas, Sara Shirowzhan and Sharifeh Sargolzae*

## 1. Introduction

Digital communication and information technologies were the core of businesses during the COVID-19 pandemic. Many businesses and tasks have been done remotely, such as business meetings, education, and e-commerce. There are many reports that show technology played an essential role in response to the pandemic and is predicted to be the core strategy for long-term resilience.

The recent reports show that the use of digital technologies and further technical advances occurred due to COVID-19 in different sectors, including infrastructure and transportation [1]. The initial readiness for adopting the Fourth Industrial Revolution concept [2, 3] in the architecture, engineering, and construction (AEC) sector was helpful for industry resilience during COVID-19. The current reports show that the adoption process of Industry 4.0 technologies will be accelerated due to the community's higher demand in terms of working remotely with less human close interactions [1]. The current investigations show that site managers and operational teams in the construction, transportation, and infrastructure sectors need to monitor the progress of tasks and keep track. In addition, they should assist their team members and ensure they will achieve the project objectives, including time, cost, and quality. However, the investigations show that the lockdown caused many difficulties to managers' tasks and attending the construction site or infrastructures [1]. However, designers using digital technologies such as Building Information Modeling (BIM) [4–6] or Geographic Information System (GIS) [7–9] experienced much less difficulties. This chapter aims to provide an insight into the recent literature of COVID-19 in the built environment. Then, suggestions for future studies are presented.

## 2. Scientometric analysis of COVID-19 in the built environment

The scientometric analysis technique is adopted to identify key knowledge themes and map them to identity overlaps, gaps, emerging topics and monitor the growth of the literature with the included patterns. This is a recommended approach since many studies in the field used scientometric analysis techniques in different contexts such as lean construction [10], additive manufacturing [11], carbon emission [12], smart home [13], delay analysis [14].

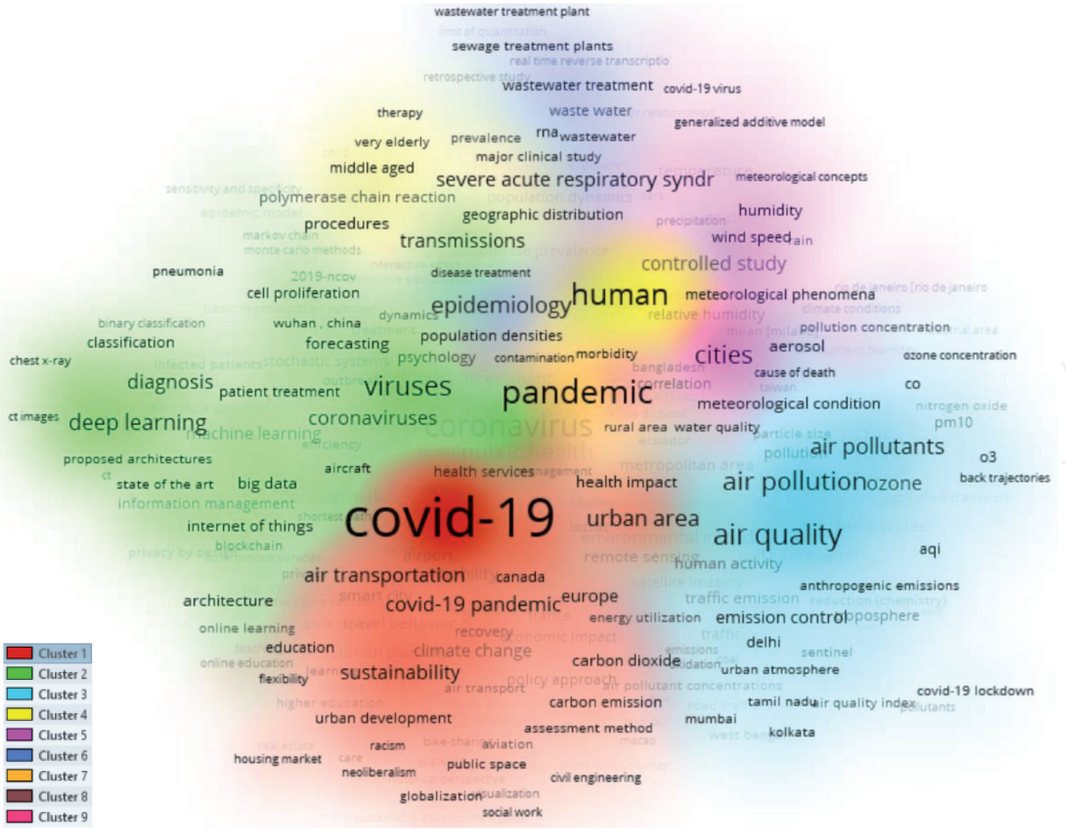


**Figure 1.**
*Co-occurrence analytical map of keywords created on the COVID-19 literature (see the first set of strings in appendix). A total of 1308 keywords out of the sample of 9460 keywords are shown since they meet the threshold with the minimum co-occurrence of 3.*

**Figure 1** shows nine clusters of keywords in the recent publications that appeared on the Scopus database, including 2,185 journal articles. The main cluster has a strong co-occurrence with COVID-19 and refers to different themes such as sustainability, urban development, and public spaces. Other important clusters refer to humans, cities, and deep learning. The air quality, humidity, wind speed, and other environmental attributes received significant attention. However, some other themes, such as the role of digital technologies for post-pandemic and improving the resilience of the country and cities, are slowly developing.

## 3. An agenda for future studies

This chapter reviewed the current literature of COVID-19 and post-COVID-19 to understand the literature's themes and directions. However, more detailed investigations are required to use different databases and identify the suggested solutions for post-COVID-19 in the businesses relevant to the built environment, including transportation and construction. The impact of the pandemic on the construction industry has been evaluated in different contexts and countries such as Oman [15], Jordan [16], the United Kingdom [1, 17], Seri Lanka [18], South Africa [19], Japan [20] and Argentina [21]. However, most of the publications are affiliated with authors from developed countries such as the United States of America, the United Kingdom, Canada, Italy, Germany, and Spain, including a few developing countries (see **Figure 2**).

Besides the growing literature of 'impact' evaluations, there will be many industry and government reports available providing evidence of affected firms and

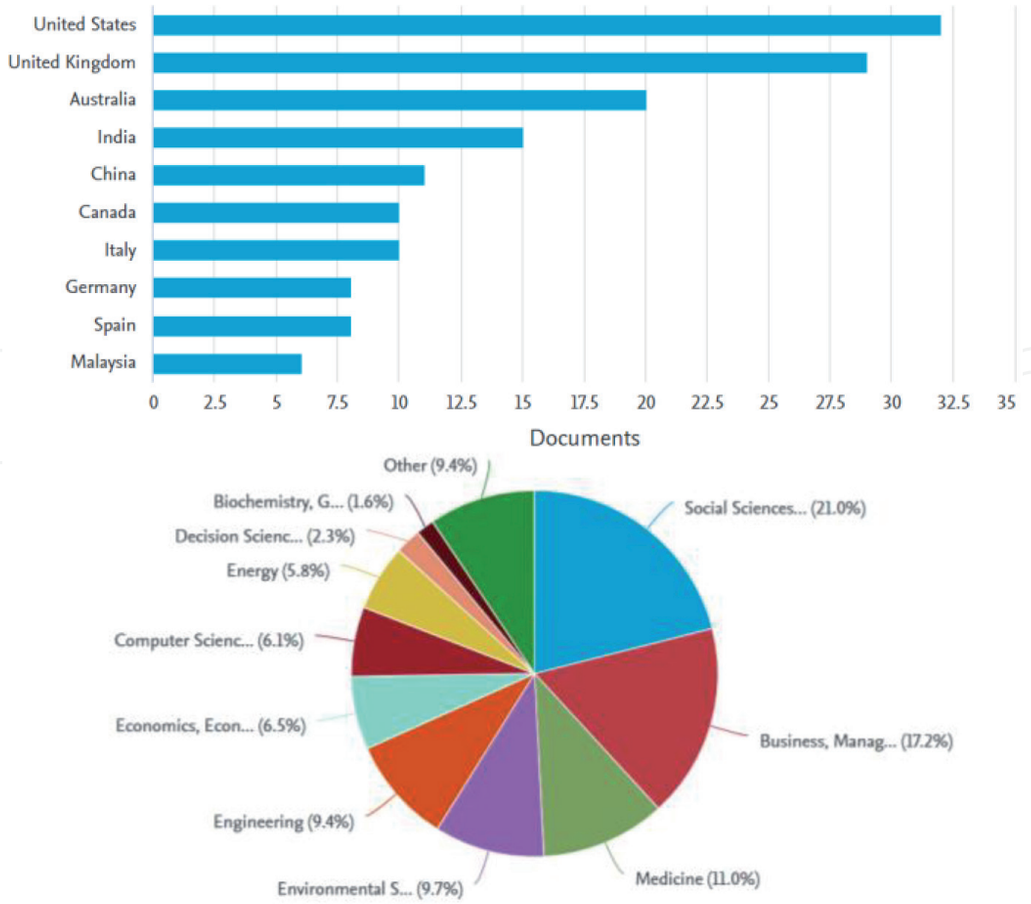


**Figure 2.**
*The selected literature analysis is based on countries and subject areas (see the second set of strings in appendix).*

people. However, some studies suggest that the impact analysis investigations are not enough yet, and some other affected areas should be evaluated. For example, Zheng, Chen [22] suggest that the pandemic's impact on construction productivity should be evaluated since it helps practitioners plan alternative solutions.

The literature of post-COVID-19 is limited. Using 'post-COVID-19' in the relevant journals and subjects resulted in only 344 documents (see the second search string in Appendix). This chapter suggests focusing on the post-COVID-19 period by offering new solutions, resilience strategies, and developing digital technologies, suggesting new applications and use cases, particularly from technical perspectives. **Figure 2** shows that most published papers focused on social science, business management, and health issues (see the third search string in Appendix). While digital technologies play a critical role in distance communication, monitoring, tracking, and e-management, less than 10% of the papers focused on digital development from an engineering perspective.

In line with the recovery plan and post-COVID-19 resilience strategies, the following topics are suggested to be investigated in the future:

- Risk management for continuity of tasks in construction and other relevant businesses. The need for scenario modeling and simulations as well as contingency planning is increased. Some digital tools will be helpful such as data mining and visualization, machine learning, and digital twinning. There is a wide range of risks that should be considered, such as suicide risk in construction [23], labor market during COVID-19 [24], safety measures in construction projects [19], specific sectors with tunneling and underground activities [25].

- The resilience of critical infrastructure at the national or regional levels will be one of the demanding topics.

- Remote operation, particularly in transportation or construction sites, is difficult, but it is demanding. Robotics, 3D Printing [3, 26, 27], autonomous systems, computer vision, and detection algorithms [28], monitoring and sensing technologies [29–31], the internet of things (IoT), geospatial intelligence, and analytic systems [28, 32, 33], intelligent contract administration [34], smart city technologies [35, 36] and cybersecurity tools should be further developed for different tasks. The role of Internet Of Things, drones, artificial intelligence, blockchain, and 5G technologies for pandemic management in healthcare was reviewed recently by Chamola et al. [37].

- Logistics and supply chain management needs to be redefined in the future as the core element of city resilience. The recent publications focused on the food supply chain [38], but construction and housing, real estate [39], and other sectors need to redefine or design alternatives for their supply chain management.

- Energy efficiency tools and technologies and developing alternative sources are demanding and should be investigated future. Reliable energy systems with lower costs and real-time optimization gird need to be extended further.

- Improve education and skills in the AEC sector, enabling the continuity of work using advanced or complex technologies

- Investigations on cross-sector collaborations need to be conducted. These collaborations and sharing data platforms will help practitioners learn from best and worst practices and work together to improve the supply chain process and increase resilience [1].

- Strategies should be developed to maintain the emission reduction in cities. The air quality improved in many cities due to the reduction of emissions [12, 40]. For example, Li, Li [41] reported that the PM2.5, NO2, and SO2 emissions decreased significantly due to the reduction of their concentrations by 31.8%, 45.1%, and 20.4% in pandemic at selected case areas of the Yangtze River Delta Region in China.

## Conflict of interest

The authors declare no conflict of interest.

## Appendix

The first search string used in Scopus resulted in 2,185 documents. The first string is:

(TITLE-ABS-KEY (COVID-19) AND TITLE-ABS-KEY (construction OR architecture OR city OR transportation)) AND (EXCLUDE (SUBJAREA, "MEDI") OR EXCLUDE (SUBJAREA, "BIOC") OR EXCLUDE (SUBJAREA, "IMMU") OR EXCLUDE (SUBJAREA, "AGRI") OR EXCLUDE (SUBJAREA, "PHAR") OR EXCLUDE (SUBJAREA, "NURS") OR EXCLUDE (SUBJAREA, "PSYC") OR

EXCLUDE (SUBJAREA, "NEUR") OR EXCLUDE (SUBJAREA, "HEAL") OR EXCLUDE (SUBJAREA, "CENG") OR EXCLUDE (SUBJAREA, "CHEM") OR EXCLUDE (SUBJAREA, "DENT") OR EXCLUDE (SUBJAREA, "VETE") OR EXCLUDE (SUBJAREA, "Undefined")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j"))

The second string used in Scopus resulted in 344 documents. The second string is:

TITLE-ABS-KEY (post-COVID-19) AND (EXCLUDE (SUBJAREA, "MEDI") OR EXCLUDE (SUBJAREA, "BIOC") OR EXCLUDE (SUBJAREA, "PSYC") OR EXCLUDE (SUBJAREA, "NURS") OR EXCLUDE (SUBJAREA, "AGRI") OR EXCLUDE (SUBJAREA, "NEUR") OR EXCLUDE (SUBJAREA, "IMMU") OR EXCLUDE (SUBJAREA, "HEAL") OR EXCLUDE (SUBJAREA, "DENT") OR EXCLUDE (SUBJAREA, "PHAR") OR EXCLUDE (SUBJAREA, "CENG") OR EXCLUDE (SUBJAREA, "CHEM") OR EXCLUDE (SUBJAREA, "MULT") OR EXCLUDE (SUBJAREA, "PHYS") OR EXCLUDE (SUBJAREA, "MATE") OR EXCLUDE (SUBJAREA, "VETE")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")).

The third-string used in Scopus resulted in 162 documents. The third-string is:

(TITLE-ABS-KEY (post-COVID-19) AND TITLE-ABS-KEY (construction OR architecture OR design OR "Built Environment" OR city OR transportation))

## Author details

Samad Sepasgozar[1*], José David Bienvenido-Huertas[2], Sara Shirowzhan[1] and Sharifeh Sargolzae[3]

1 The School of Built Environment, University of New South Wales, Sydney, Australia

2 Department of Building Construction II, University of Seville, Sevilla, Spain

3 Faculty of Art and Architecture, University of Zabol, Zabol, Sistan and Baluchestan, Iran

*Address all correspondence to: sepas@unsw.edu.au

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