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Editorial: Design quality: what we learned from evidence-based design and post-occupancy evaluation research during the COVID-19 pandemic

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Editorial on the Research Topic
Design quality: what we learned from evidence-based design and post-occupancy evaluation research during the COVID-19 pandemic

The COVID-19 pandemic has resulted in 6.8 million deaths worldwide, and millions more have been infected, suffered symptomatic illnesses or hospitalizations (WHO, 2023). The pandemic required, and still requires, massive societal and organizational shifts to prevent or reduce the further spreading of the virus. Lockdowns and mandatory remote work and study at home greatly impacted people's daily lives. "Prior to the COVID-19 crisis, most workers had limited familiarity with remote working" (Battisti et al., 2022, p.1). According to (Wang et al., 2021), before COVID-19, only 2.9% of the total US workforce and around 2% of that in Europe engaged in emergency remote working. As a result, "the pandemic abruptly upset normal work routines and accelerated previously ongoing trends relating to the migration of work to online or virtual environments (Kniffin et al., 2021; Battisti et al., 2022, p. 1).

Remote working and online education are not new, but previously were mainly done voluntarily. Due to COVID-19, the development and adoption of digital and information and communication technologies (ICTs) have increased dramatically. As such, the pandemic can be perceived as a giant real-life human experiment, from which many lessons can be learned about the impact of a pandemic on people's quality of life, wellbeing, performance, sense of belonging to a particular community or organization, and social cohesion. Organizations and governments now ask themselves what measures are needed in a post-pandemic period and how to cope with future pandemics.

For *Frontiers in Built Environment*, a particular question is what policymakers, designers, corporate real estate and facility managers can or should do to design and manage a built environment that supports people's wellbeing, performance and quality of life during a pandemic and in a post-pandemic context. Relevant challenges for practitioners and related research questions are:

- What is the impact of a pandemic on efficient space management?
- How to cope with lower occupancy rates due to remote working and studying?
- How to get people back to the office or classroom, and to what extent is this relevant for organizations and individuals? What services or amenities are relevant? Are mandated in-person "anchor" days needed or warranted?
- Who prefers to work or learn at home? Who returns to the office or school, and why?
- What are the influences of personal characteristics (life situation, education, gender, age), organizational characteristics (vision and mission, organizational structure, culture, staff), workplace (e.g., activity-based) or classroom characteristics (e.g., flip classroom) on staying at home or returning to one's office building or a learning environment?
- How to facilitate homeworking, tele-learning, and e-health?
- How to design and manage buildings that support user satisfaction, positive user experiences, labour productivity, engagement, social cohesion, a sense of belonging, personal development, an optimal work/learning life balance, and reduce stress, absence due to sick leave, and burnouts?
- Are offices a significant place for mentorship between new and established employees/management?
- How to avoid social isolation?
- What remote research methods may help to incorporate social distancing in Post-Occupancy Evaluation (POE)? If remote or hybrid methodological procedures are implemented, how reliable would POE results be, traditionally based on field surveys, observations, interviews, and field measurements?

Many questions, and so far, quite limited "evidence-based" answers!

To contribute to a body of knowledge on these topics, we decided to disseminate a Call for Papers on "*Design quality: what we learned from evidence-based design and post-occupancy evaluation research during the COVID-19 Pandemic*." We were mainly interested in recent research findings, empirical data, and new research methods that cope with social distancing, pandemic implications for design and management strategies, theories on experience and use of the built environment, and future research. Therefore, we invited submissions based on research carried out mainly in 2020–2021 that used multiple methods and instruments, in virtual mode or hybrid with in-person, of Evidence-Based Design (EBD) and Post-Occupancy Evaluation (POE). As a result of this effort, we are pleased to present this Research Topic with five peer-reviewed articles from four continents: Europe, Asia, and North and South America.

The first article, "Functions and relevance of spatial co-presence: lessons-learned from the corona pandemic for an evidence-based workplace and human capital management" by Windlinger and Gerber, used five focus groups comprising 19 employees of a Swiss software engineering and consultancy company with a total of 300 employees. The authors conclude that the individual performance of employees has increased, partly due to less commuting and travelling time to clients. Furthermore, others and supervisors were more easily accessible. Leadership and internal processes remained at similar levels compared to the period before the pandemic. However, the employees participating in the research reported a deterioration of organizational collaboration culture and the transmission of culture to new employees, interpersonal relationships, and identity (identification with the company), due to the substantial reduction in co-presence, because of remote working at home imposed during the pandemic. Formal meetings were more focused and shorter when conducted online. Concurrently, social contacts became more formal and less personal and social, scheduled online meetings provided less nonverbal and visual feedback, and integration in the client organization has become more difficult, as has the onboarding of new employees. The authors suggest that even in a medium-sized company that is very experienced with distributed working, in-person encounters between people should be carefully managed to facilitate social cohesion, group dynamics, commitment, innovation, and contextual performance, i.e., organizational effectiveness and team performance.

The second article, "Preventing the spread of COVID-19 through environments design in Thai community hospitals" by Waroonkun and Prugsiganont, demonstrates that many Thai community hospitals' outpatient departments (OPDs), designed and built in the 1990s, have become outdated in terms of their physical infrastructure. To identify difficulties during COVID-19, the authors assessed three case study hospitals in the Northern region of Thailand. The qualitative approach includes observation techniques, interviews with 30 healthcare employees, and three focus groups with the same participants to evaluate preliminary design recommendations from the observations and interview analysis. The participants were satisfied with the hospital architecture, proposing only small interventions and improvements. The findings provide design suggestions for improving the physical settings of outpatient clinics, divided into different zones, and how to prevent the spread of respiratory infectious diseases. For instance, by improved (natural) ventilation, applying higher hygiene standards, and incorporating the guidelines and cleaning protocols of the Thailand Ministry of Public Health Centers for Disease Control and the Thailand Ministry of Public Health. The authors emphasize that the required environmental renovations must be adequate for each building's budget.

The third article, "Post-Occupancy Evaluation and Codesign in Mental Healthcare buildings: User's input as a driver for functional and technical adaptations in post COVID-19 reality," developed by Goulart and Ono, discusses mental healthcare facilities in Brazil that reopened their community rooms with reducing contamination by COVID-19 as a new challenge. The authors adopted hybrid and face-to-face POE multi-methods in three psychological care centers for alcohol and drug addicts (CAP-AD) in Sao Paulo, including observations, applications of the Perceived Hospital Environment Quality Indicators Questionnaire filled in by 100 employees, walking interviews with facility administrators and 12 patients, and codesign activities with 25 employees and 12 patients, based on physical and customized models of the buildings under study. The authors report that patients were more interested in telling stories and said they did not have enough knowledge to

contribute to the research. In turn, CAPs workers recommended increasing natural ventilation, more efficient environmental adaptations to prevent COVID-19 and more significant aggregation of new information technologies to allow better patient interaction. This research project resulted in a long list of suggested adaptations, clustered in five characteristics of the built environment that prevented or increased the risk of COVID-19 spread: places that support risk mitigation procedures, access and circulation control, extended use of outdoor spaces, natural and artificial air renovation systems, and materials resistant to terminal cleaning.

The fourth article, "Innovating digital POE platforms during the COVID-19 Pandemic: A Case study of co-production in Brazilian social housing" by Barbosa Villa et al., discusses a research project in Uberlândia city that applied a multiple-stage approach and multiple methods to explore the relationship between the incidence of arboviruses, COVID-19, dengue and mosquito nuisance, the occupants' practices, and (self-)management of the built environment. The research identified four behavioural archetypes, i.e., accumulator/recyclers, self-builders, hygienists, and gardeners. The authors highlight the need for a greater understanding of how social housing users and residents can be engaged with tools that are not face-to-face. A hybrid POE approach is recommended that combines face-to-face methods with digital ones, such as the use of smartphones, social media (i.e., closed Facebook groups and WhatsApp), and web-based digital interfaces (i.e., in the form of digital home walkthroughs and interactive guided video calls between residents and the team). Gamification is shown to help act as a form of decision support within a larger framework model for a user-oriented digital design system.

Finally, the fifth article, "Applicability of BIM-IoT-GIS integrated Digital Twins for Post-Occupancy Evaluations" by Tripathi et al. conducts challenging research towards significantly expanding the use of data and visual technologies supported by digital twin and georeferencing. High-level use case scenarios are developed to derive system requirements for a digital twin platform. Four tests are conducted that provide a step-by-step procedure for Building Information Modeling (BIM)-Internet of Things (IoT)-Geographical Information System (GIS) integration. Geo-reference, data transfer, and visual checks are done to test and validate the integration. Based on the tests, a streamlined workflow is recommended for similar/future projects. The new tools enable applying POEs with great confidence without necessarily being present in the study case. This allows the researcher to develop different strategies regarding Indoor Environment Quality, particularly regarding environmental comfort requirements.

The five articles have several merits in common, such as a robust theoretical and bibliographical review, methodological procedures that offer clues for hybrid research, and refined use of tools like BIM and IoT, in addition to improving the application of (remote) questionnaires, interviews, focus groups, and automatic data processing. Some articles also incorporate co-design activities by using physical models and the participation of end users in developing and testing prototypes.

The findings may be used for the advancement of research in the fields of EBD and POE and to provide guidelines for environmental adaptations and new design processes that must and will consider the protocols for mitigation of airborne and contact viral contamination, not only in healthcare environments, but in any environment and buildings. The articles show that design strategies to prevent or reduce the risk of COVID-19 spread may conflict with humanization policies. Practitioners must also find an optimal balance between working at home and returning to the office or classroom to support social cohesion, a sense of belonging, engagement and team performance. Spaces for socializing, meeting, and chance encounters are needed, both with functional qualities and for providing services and experiences. This asks for new forms of cooperation between workplace and facility managers and human resource managers. Practitioners should not only focus on designs for future corporate and school environments, but also pay attention to (re)designs for remote work and e-learning at home. In summary, new design requirements are emerging in a world of rapid ICT adoption and hybrid living.

The limitations of some studies described in articles in this Research Topic, among other things, are mainly due to the use of more qualitative instruments and the relatively small numbers of participating users involved, which are compensated by robust systematic reviews of the literature and critical reflections on the results that open doors for more specific, comprehensive and detailed future researches. The findings show that the use of traditional and face-to-face instruments in POE and EBD, such as observations, walkthroughs, questionnaires, interviews and card-sorting techniques, in a well-thought order, and combining these instruments with Co-creation or Co-design, are valuable means to offer facility managers, corporate real estate managers, architects and consultants evidence-based diagnoses, design guidelines and decision support. The potential of new information, communication and interface technology applied in research that is conceptually and traditionally based on *in situ* field surveys is important to be further explored because living with pandemics on a smaller or larger scale and even with the reduction of their impacts due to the expansion of vaccination, will continue as a trend that cannot be ignored by those involved in research, design and management of the built environment. A significant effort is needed to develop user-friendly instruments in information technology to collect and analyze valid and reliable data remotely. Technologies such as Building Information Modeling, Internet of Things, Geographical Information System and BIM-IoT-GIS-integrated Digital twins have the potential to address existing challenges for data collection, analysis, and visualization in POE.

Author contributions

SO editorial writing and general review; TV editorial writing and review; SM-H editorial writing and review. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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