

From Transitions to Transformation: A Brief Review of the Potential Impacts of COVID-19 on Boosting Digitization, Digitalization, and Systems Thinking in the Built Environment

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Abstract

In a short time, during the early phases of the COVID-19 pandemic outbreak, we managed to shift rapidly to use digital technologies and replace some of our daily operations with virtual modes. This shift happened so instantly and widely that it enables us to argue that the COVID-19 became a valid reason to boost some of the gradual and ongoing transitions towards faster transformations. In this study, we use gray literature to delve into arguments around the boost for digitization, digitalization, and systems thinking in the development of the built environment. This is mostly discussed from the influence of COVID-19 on some of the existing practices or the business-as-usual of the built environment sector. From technological advancement to technology use, these arguments are put forward to discuss what is likely to be the major driver of technological adoption and the shifting paradigms that are yet to be revealed. The study concludes that the current push towards new directions and development pathways are likely to be widely accepted in a shorter time. The findings of this brief study feed into existing arguments on transformative pathways due to the COVID-19 pandemic.

Keywords

Digitization, Digitalization, Information-Based, Systems Thinking, Development, Built Environment, COVID-19

1. Introduction

For the last two decades, the growing technologies and the growing demand for technologies have made significant but gradual progress in the development of the built environment. From the use of virtual reality applications for the built environment [1] [2] to integrated methods for decision-making processes [3]-[8], we can see gradual progress that is changing our cities and the built environments. To name a few, some of these integration methods indicate simple but effective strategies, such as bike-sharing systems [9], methods of disaster risk reduction [10] or disaster management [11], off-site construction [12], resilience enhancement [13], waste treatment approaches [14], and some that have led to the development of smart city initiatives globally [15]-[20]. Some of these have promoted urban systems design [21], which are utilized for enabling technologies and various techniques [22] [23] [24] in the development of the built environments. Amongst many examples, some of these technologies include Internet of Things (IoT) [25] [26] [27] [28], internet+ platforms [29] [30] [31], the use and the integration of artificial intelligence (AI) [32] and informatics from communication technology views [33] [34] [35], such as big data, the application of cybersecurity [36], algorithm-based methods [37] [38] [39] [40], machine learning (ML) deep learning (DL), cognitive computing and big data analytics [20], automation methods [41], etc. So far, the primary challenges for these have been the integration of the so-called urban innovation through policies [42] [43], adaptability to the use or integration with our existing networks [44], acceptance of information technologies [45], and financing of those high-level technological initiatives [46] that are transformative in many ways.

The opportunities that are discussed above are seen from the perspective of socio-technical transitions [47] [48] as well as effective enhancement of cities [49] [50] or enhancing technologies for cities [51], city management [52] [53], and the operation of the built environment [54]. In all cases, we see transformative opportunities that require a larger demand for progression. One clear thing is that technology provides an opportunity for transformation and structuring of the built environment and the way we develop. In recent months, this has been experienced widely and globally, across multiple scales and multiple progressions. As we face a major global challenge due to the COVID-19 pandemic outbreak, we see a growing demand for such technologies from various perspectives. Hence, this time can be regarded as the push in increasing the demand for such transformative opportunities in the development of the built environment. It is believed that the time has come to elaborate further on the available technologies, tools, and techniques and boost some of these for the future development of the built environments.

By reflecting on this once-in-a-century outbreak event, we could look into the critical position of the available technologies and technological opportunities that have already been changing the practices of the built environment at a gradual pace. Hence, this study aims to reflect on this unique opportunity that is al-

ready boosting the use of many digital platforms, and some that are happening in the name of safety and security enhancement [55]. This is looked at from three main perspectives of digitization, digitalization, and systems thinking (in sub-sections 2.1 to 2.3).

2. Transition in Development or Faster Transformation?

The position of information and communication technology (ICT) is recognized as systems of networked infrastructural, technological conditions [56], and development of smart cities [18]. In light of the boosting situation, we are at this stage, the study provides an overview of a faster transformation rather than what was believed to be happening in a gradual transition. The position of innovation, if to be taken from the technological dimension [57] or technological innovation [58] [59], is clear in many of the recent operations that are no longer ad hoc [60] [61] [62] and is become more of the new normals of the practice [55]. The recent adaptability to the business-as-usual practices enabled many sectors to push towards innovative solutions, most of which were highly dependent on technological advancement and the use of technologies [63], new virtual tools, and digital platforms [55]. This is argued as the standpoint for the digital revolution [64], which is mainly based on enabling the technologies during the time of minimized contacts, lockdown, and disruptions across many sectors. During this time, methods of integrating technologies in the built environment, such as the ICT, smart apps, AI, and GIS [55] [65] [66] [67] [68], are perceived as sudden improvements or new development paradigms. Hence, COVID-19 is seen as a major driver of the use of technology [69] as well as technology integration. In the following three sub-sections, we reflect on some of these advancements during the COVID-19 pandemic to date. These are selected based on their influence and impact on the built environment, as well as the growing demand and trends that are already highlighted in the gray literature of the study.

2.1. Digitization in the Future Development

The relationship between digital and smartness has been developing since the inception of the smart city concept [70] and much earlier [71]. Sassen [72] debated this as part of the progress in the contemporary city development. As the conversion from analog to digital, digitization in the built environment is mainly used for data processing, storage, and transmission. The push for digital information-based methods is already shaping in the construction and management of buildings as well as for the purpose of infrastructure development, particularly in the development of a smart built environment. The information-based models are also seen to be boosting fast in other sectors in facing the COVID-19 [73] [74] [75] [76], indicating the opportunity to take a faster speed in some other sectors, such as the built environment [77] [78]. The rapidly increasing demand for off-site meetings and construction management procedures of these few months indicates a paradigm shift towards digitized methods that are in-

formation-based, interactive, and integrated. Initiated from the rapid development of emergency facilities [55], we can see a wider appreciation of information-based approaches that are for long struggled to be adapted in the current practices of construction and the built environment. Hence, we see this boost for information modeling methods [79], enabling the intelligent technologies for better operations [80] and development of integrated building systems [81]. Altogether, the push for a faster process of digitization is just started.

2.2. Digitalization in the Future Development

Somehow associated with digitization and as part of digital transformation [82], the overall picture of digitalization is based on the use of digital technologies and their integration in the development of the built environments. This is aimed to change a business model of the built environment sector and towards more off-site and rapid construction modes of development. The same trends are seen across other sectors that include the use of digital data that could include transport and health [83], cost analysis [84], workflow digitalization [85], digital pedagogy [86], as well as the use of IT-enabled services in healthcare [87], and integrated methods. For instance, in development of universal data sharing standards [88], we see progress in revealing the role of digital standardization and communication across cities and regions. Other examples include the successful utilization of digital health datasets [89], contact-tracing apps [90], provision of monitory and controlling measures [55], resource assessment [91], real-time case information [92], and the faster emergence of AI in detection procedures and towards policy formation [65]. From the rapid and sudden growth of data and digital platforms [55], we can see a growing demean in the use of such technologies in the built environment sector, specifically from the perspectives of urban health strategies [93], risk assessment [94], transport [83], as well as automation, building regulating, and management perspectives [95]. The reliability of digitalization elements [96] were tested in a way that allowed for more optimized methods of operation. In this regard, the use of big data, and more specifically in the form of integrated methods, will indicate a paradigm shift to further multi-dimensional assessments and collaborative analytical methods on the use of technological strategies that promote digitalization in the built environment.

2.3. Systems Thinking in the Future Development

The two earlier areas of digitization and digitalization lead us to the argument of systems thinking methods that are yet to be explored further in the association with the post-COVID-19 development. Nevertheless, the multi-system and multi-sectoral approaches [55] are the ones that suggest boosting future development based on integrated methods and directions. Based on reflexive views, the use of data and reflective learning through systems thinking could help us to respond more effectively to complex problems like a pandemic event. In doing so, we can generate more integrated decision-making tools, like the one developed

by the World Economic Forum [97] on detecting and assessing the COVID-19 global issues that are based on eight primary areas of 1) the media role, 2) response and recovery, 3) workforce impact, 4) avoiding infection and spread, (5) finding a vaccine, 6) impact on trade, 7) impact on travel, and 8) impact on financial markets. A systems approach is already identified to be an effective approach to prevent and respond to the complexity of COVID-19 [98], which is aimed to enhance collaborative work [55] [99], and towards better containment and management [100]. As the systems thinking idea indicates, the method includes the built environment issues in relation to other sectors, an approach that is likely to help to boost the idea of multi-sectoral mechanisms [55] [101]. In doing so, the emerging systems thinking methods could be more collaborative to take into consideration the complexity of urban systems, construction management, building performances, etc. The emphasis on complex systems and creating reflexive and vertical systems are likely to become trendy in future development. This will not be specific to the built environment but will include the sector in a larger eco-system of various sectors [55].

3. Summary of Discussions

Through a rich literature review of already progressing transitions in the built environment sector, this study provides an overview of the potential impacts of COVID-19 on boosting “digitization”, “digitalization”, and “systems thinking” in the built environment. Serves as an essay review, and not a systematic review, the intention here is to highlight how transitions are or will be developing towards a faster pace of transformations in the built environment sector. However, such envisaged changes may be context-specific and subject to the current status of progress on digitization and digitalization advancements. For digitization, as summarized in Section 2.1, we anticipate faster progress in four areas of 1) “digital and smartness”, particularly for the use of digital data in smart city and buildings (e.g., related to health, resilience, and operations); 2) “data processing”, particularly in progressive use of digital data collection, collective data assessments, and data monitor; 3) “data storage”, in a form that has already shaped experimental examples of smart city development but now towards integrated use of digital data in practices and/or applications; and 4) “digital transmission”, specifically for interactive systems, AI-augmented platforms, smart apps, and smart operations. Besides, for digitalization (summarized in Section 2.2), we anticipate earlier transformations towards 1) Digital technologies and their integration in the urban and building systems, especially for data monitor, accessibility, safety, and security; 2) Digital integration, which will include new modes of digital design, digital construction, and digital thinking in the built environment; 3) IT-enabled services, specifically with the use of AI technologies and ICT-mediated platforms for data monitor, assessment, and management; and 4) Digital datasets, which are likely to become more popular for real-time models, sharing platforms, collaborative systems of building optimization and enhanced design and construction

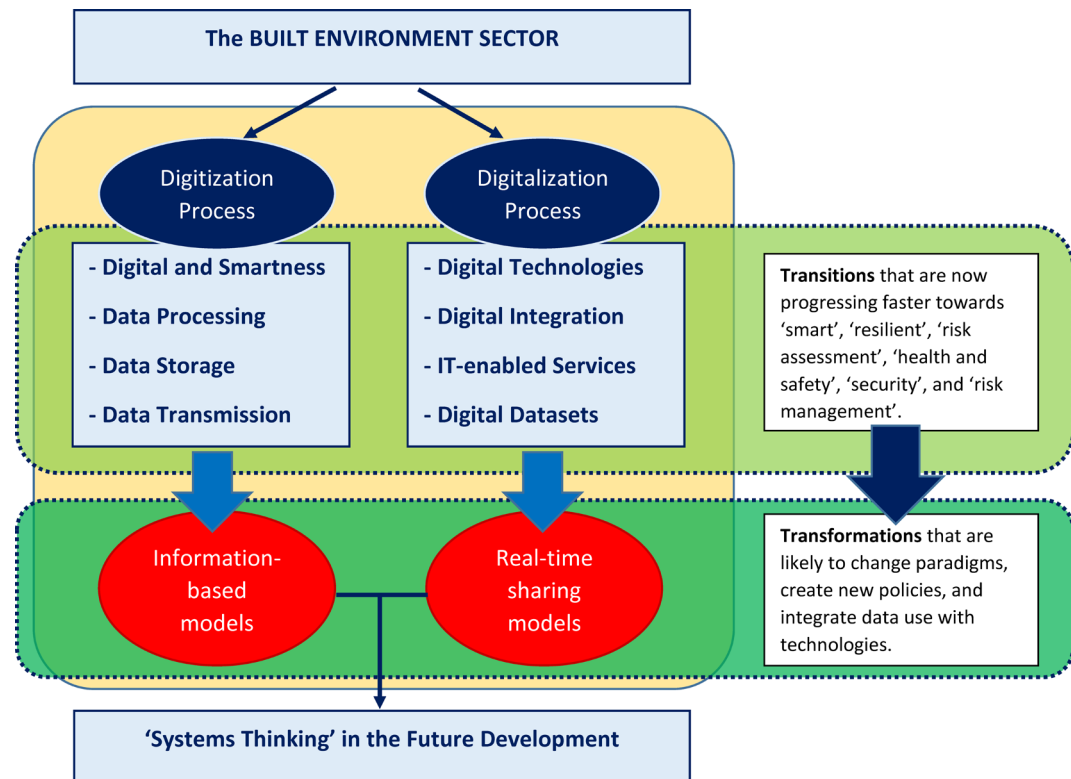


Figure 1. Summary of discussions on boosting digitization, digitalization, and systems thinking in the built environment.

processes. **Figure 1** summarizes these potential impacts as they feed into boosting new methods of development in the built environment.

4. Conclusions

In all contexts, regardless of the technological advancement levels, the use of technologies in managing COVID-19 and daily operations has been a tangible part of these recent months. There is no doubt that COVID-19 has become a drive to boost the use of technologies in all sectors. From the increasing popularity in e-commerce to the use of virtual and digital platforms for various purposes, new apps, and new communication modes, we see a growing demand for what could be a new chapter in the development of our systems. The built environment sector, being part of this development, would possibly utilize the available toolkits even further and push for new policy formation based on the use of digital technologies. The move from digitization to enhanced digitalization is likely to develop even faster to promote the possibilities for the integration of information-based approaches, and the development of regulations to adopt such methods in common practices. The boost to systems thinking in the built environment is likely to happen from what we described in this study as a multi-sectoral approach. The boost in project management is expected to be much faster than in the architectural design and on-site construction works. The speeding digitalization, however, will be perceived positively and would be

widely adopted in various regions. This is expected to boost some of the earlier initiatives, such as digital agenda, digital innovation in design, cyber city and cybersecurity, smart built environment, virtual education, and so on. After the current adversities of the pandemic are over, the chance for collaborative digital platforms will boost to a new level that includes more of detection and tracking tools, facial recognition technology, AI applications, future IoT, and digital security systems. In name of safety and security, some of these platforms will be pushed forward faster and are expected to be accepted by the general public sooner than anticipated. The role of the built environment will not be minimal as new paradigms are yet to emerge in the near future.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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