Evidence on the Role of Digital Technologies in Built Environment Projects

KEY POINTS

- This report explores how digital technologies reshape the innovation process and catalyse digital innovations in a highly project-based setting: the built environment (BE).
- There is a tension between the short- and long-term thinking of digital innovation in BE.
- The BE sector innovates at the boundaries of the projects it builds instead of the boundaries of the organizations who own and operate the built assets.
- The sector remains short-sighted in focusing on project innovations.
- We call for long-term strategic thinking in terms of digital innovation, including new business models and capabilities to purposely adapt an organization's resource base.

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Introduction

The built environment (BE) is a complex interdisciplinary field, where digital innovation affects individuals and organizations varyingly. Digital innovation is created by introducing or deploying digital technologies in the innovation process. The transition from innovation to digital innovation creates new challenges and transformations to individuals, organizations, and society. Viewing digital technologies through a digital innovation lens helps us define their managerial implications. The aim of this study is understanding how the evolution of digital innovation shapes project management in the BE.

Key research findings and conclusions

• There is a significant increase of publications on digital innovation over the last 7 years (Figure 1).
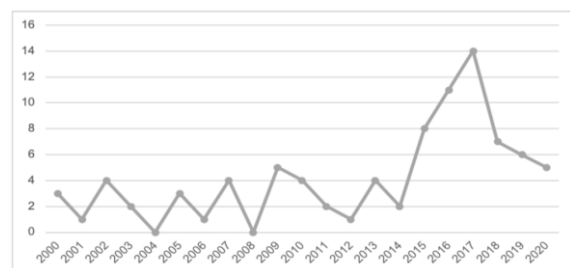

Figure 1. Publication year of data set of studies on digital innovation.

• Research is mainly focused on digital technologies such as: Building Information Modelling (BIM), augmented reality, virtual reality (VR), Internet of Things (IoT), cloud computing, and big data (Figure 2).
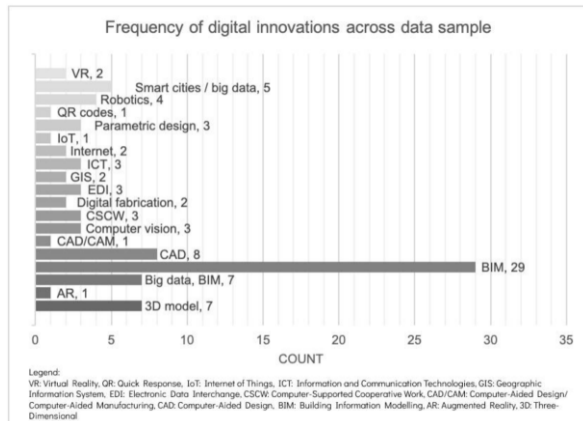
Figure 2. Frequency of digital technologies and combinations thereof in the data (ordered alphabetically).

• The concept of 'digital' evolves toward connected technologies such as BIM and big data and smart cities/big data. This trend shows that the BE finds solutions to its problems in the use of technologies that rely on big data.

• Unlike other sectors where big data is available, the BE is behind the curve in terms of digitization of assets, usage, and labour.

• Research is focused on the impact of digital innovation on projects, as opposed to other levels of analysis in the BE, such as the impact on of digital innovation on individuals and organizations.

• There is a clear scarcity of studies on digital innovation from an individual's perspective. Future research should explore the specific needs and impacts of digitalization on individuals, for example, those in leadership positions and key decision makers. Such research should explore the mutually adaptive relationship between users and technology.

• The BE sector innovates in the boundaries of the projects it builds instead of the boundaries of the organizations who own and operate the built assets.

Further analysis

Evolution of digital technologies and management of digital innovation

This study shows an accelerated pace of relevant studies around 2000 with marked interest in design/construction interfaces. We found a proliferation of digital innovation research from 2014 onward (Figure 1), with a focus on BIM, augmented reality, virtual reality (VR), Internet of Things (IoT), cloud computing, and big data (Figure 2).

Unlike other sectors where big data is available, the BE is behind the curve in terms of digitization of assets, usage, and labour. We found that the sector is slowly picking up. The concept of digital evolves toward connected technologies such as BIM and big data and smart cities/big data. This trend shows that the BE finds solutions to its problems in the use of technologies that rely on big data.

The data indicates significant research interest in the impact of digital innovation on projects, as opposed to other levels of analysis in the BE, such as individuals and organizations, making project management a dominant unit of analysis in digital innovation.

The BE sector chooses to innovate in the boundaries of the projects it builds instead of the boundaries of the organizations who own and operate the built assets. The data confirms persistent tensions between short- and long-term thinking in projects as they are inherently limited in temporal dimensions, but strategic thinking becomes increasingly crucial.

Future research directions for digital innovation in project management

The data on future research reveals a lack of emphasis on understanding the micro-foundations and individual-level attributes of digital innovation. The findings for future research (Table 1) also indicate a mismatch between individuals and digital technologies and how individuals need to develop "soft

An unexpected finding was the mismatch between heavily project-oriented results and suggested future research across the literature that are organization-oriented, e.g., dynamic capabilities and business models. Surprisingly, further research directions in the literature focused more on ecosystems and organizations and less on project management, which was the dominant unit

Table 1. Future Research Around Managing Digital Innovation in the BE

	Focus for Future Research	**Methodological Opportunities**	**Exemplar Existing Studies**	**Emerging Themes**
Individuals	• Mutually adaptive relationship between individuals and digital technologies • Effects of agency in different contexts, systems, and interorganizational settings • Use of strong theoretical frameworks to study digital innovation	Opportunities for novel methods and quantitative studies	Çıdık et al., 2017; Lavikka et al., 2018; Macrorie et al., 2021	• Pluralism of requirements • Reciprocity of digital technologies
Organizations	• Investigation of interfaces between organization and industry • Development of dynamic capabilities to manage technology adoption in organizations • The role national agencies play to facilitate uptake of digital technologies • Value capture across customer base • New methods for technology forecasting • New business models for smart cities	Qualitative methods (case studies) and quantitative methods (machine learning)	Lobo & Whyte, 2017; Papadonikolaki & Wamelink, 2017; Park et al., 2018	• Strategy • Supply-demand • Business models
Projects	• Development of dynamic capabilities in project teams • Quantified productivity and safety improvement from digital innovation • Relation between digital, procurement, and supplier selection • Integrating digital technologies for FM with advancements from computer science • Understanding the changing nature of digitally enabled coordination in project-based work • Alignment of digital technologies and cognition and its impact on communication and collaboration • Lack of digital capabilities in the public sector to procure/deliver projects	Qualitative methods (case studies and ethnography) and quantitative methods (business data analytics)	Pignataro et al., 2014; Braun & Sydow, 2019; Whyte et al., 2016; Wynarczyk, 2000; Moum, 2010; Poirier et al., 2017; Whyte & Lobo, 2010; Neff et al., 2010; Papadonikolaki et al., 2016	• Multilevel view • Procurement • Health & safety

skills" such as collaboration, flexibility, integration, boundary spanning for teamwork, experimentation, risk taking, and avoiding overreliance on commercial software.

of analysis in our data. This mismatch shows an interest in looking outside the tight boundaries of project-based considerations and traditional governance and business

models in the BE and engaging in business model innovation.

Most studies approached digital technologies from a technocratic and functionalist view and a one-sided view focusing more on how digital technologies affect project teams and less on how project teams influence them. Therefore, this shows room for future research into how project teams reorganize and contribute to shaping digital innovations.

A welcomed trend (by the industry) emerged that stresses the importance of business model change and how to align existing business models, partnerships, and procurement routes with digital work to maximize value capture.

Brief summary of research

This study performed a Systematic Literature Review to synthesize and compare findings from studies and answer specific research questions. The sample consists of research articles on digital technologies in the BE published since 1950 up until June 2020. We reviewed 3,903 articles and selected 87 articles to analyse in detail.

The study addressed three research questions:
1: How have digital technologies occurred and evolved in the BE since 1950?
2: How is current knowledge on managing digital innovation in the BE structured around
(i) individuals, (ii) organizations, and (iii) projects?
3: How does future research on digital innovation relate to project management theory and practice, and what future directions can be outlined?

Endnotes and further information

The full research paper can be accessed online at this link:
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