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RESEARCH ARTICLE

REVISED Navigating the shift towards sustainable digital building permits and building logbooks

[version 2; peer review: 1 approved, 3 approved with reservations]

Rita Lavikka[1], Judith Fauth[2], Mayte Toscano[3], Gonçal Costa[4], Thomas Beach[5], Pedro Meda Magalhães[6], Jantien Stoter[7], Stefanie Brigitte Deac Kaiser[8], Jeroen Werbrouck[9]

[1]Built Environment and Mobility, VTT Technical Research Centre of Finland Ltd, Espoo, Uusimaa, 1000, Finland
[2]University of Cambridge, Cambridge, JJ Thomson Avenue 7, CB3 0RB, UK
[3]Open Geospatial Consortium EU, Seville, Spain
[4]Human Environment Research (HER), La Salle, Ramon Llull University, Barcelona, Spain
[5]School of Engineering, Cardiff University, Cardiff, UK
[6]CONSTRUCT/Gequaltec, Faculty of Engineering, University of Porto, Porto, Portugal
[7]Delft University of Technology, Delft, The Netherlands
[8]Politehnica University of Timisoara, Timișoara, Timiș County, Romania
[9]Ghent University, Ghent, Flanders, Belgium

v2 **First published:** 31 Mar 2025, **5**:90
https://doi.org/10.12688/openreseurope.18553.1
Latest published: 04 Aug 2025, **5**:90
https://doi.org/10.12688/openreseurope.18553.2

Abstract

The architecture, engineering, construction, and operation sectors face significant sustainability challenges. These include high greenhouse gas emissions, resource depletion, worker safety concerns, and difficulties balancing cost efficiency with sustainable practices. Digital solutions, such as Digital Building Permits (DBP) and Digital Building Logbooks (DBL), are increasingly promoted as enablers of sustainable construction and building management. However, there is limited research on how they contribute to sustainability in practice. This study applied the United Nations Sustainable Development Goals (SDGs) as an analytical framework to assess the sustainability impacts of DBP and DBL. A four-phase methodology was used: (1) expert elicitation to identify relevant SDGs, (2) mapping of DBP and DBL practices to SDG targets, (3) documentation of supporting practices, and (4) validation through a hybrid stakeholder workshop involving 38 participants from across Europe. The study identifies DBP and DBL practices that contribute to ten SDGs, including Good Health and Well-Being, Affordable and Clean Energy, Decent Work and Economic Growth, Industry and Innovation, Sustainable Cities, and Climate Action. The automatic code-compliance checking of DBP speeds up approval times, reduces errors, increases

Open Peer Review

Approval Status ? ? ? ✓

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version 2 (revision) 04 Aug 2025			? view	✓ view
version 1 31 Mar 2025	? view	? view		

1. **Rupesh Kumar**, Jindal Global University, Sonipet, India
2. **Muhammad Shafique**, Brunel University London, Middlesex, UK
3. **Adrian Wildenauer**, Bern University of Applied Sciences, Bern, Switzerland
4. **Jan Holmstrom**, Aalto University, Espoo, Finland

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transparency, and supports carbon reduction, operational efficiency, and equitable access to permitting. It streamlines housing approvals, aiding affordable housing development. DBL facilitates energy-related data management, including the issuing of Energy Performance Certificates and comparing theoretical versus actual energy use. DBL also supports recyclability assessments and design for disassembly, aligning with the principles of the circular economy. This study provides a structured and replicable framework for evaluating the sustainability contributions of digital building permitting and logbooks. It demonstrates how DBP and DBL can be aligned with global sustainability targets, offering a foundation for future empirical research and policy development. Further work is needed to quantify long-term impacts and extend the analysis beyond the European context.

Plain language summary

The Architecture, Engineering, Construction, and Operations sector faces several big challenges when it comes to sustainability. Environmentally, it is a major contributor to greenhouse gas emissions and uses up a lot of natural resources. Socially, it needs to ensure worker safety and consider the impact on local communities. Economically, the sector often struggles to find a balance between keeping costs low and adopting sustainable practices.

Digital solutions are seen as a way to help make construction more sustainable. Two examples of these solutions are digital building permits (DBP) and digital building logbooks (DBL). These tools are designed to make the construction process more efficient and transparent. However, there isn't much research on how well these tools actually promote sustainability.

To fill this gap, a study was conducted using the United Nations' Sustainable Development Goals (SDGs) as an analysis framework. The research was done in four phases. First, experts identified which SDGs were relevant to DBP and DBL. Then, they pinpointed specific targets within those Goals. After that, the experts specified DBP and DBL practices supporting the relevant targets. Finally, a workshop was held to confirm how DBP and DBL practices support these goals.

The study found that DBP and DBL practices contribute to achieving several SDGs, including good health and well-being, affordable and clean energy, decent work and economic growth, industry innovation and infrastructure, sustainable cities and communities, responsible consumption and production, climate action, peace, justice, and strong institutions, and partnerships for the goals. The study concludes that DBP and DBL practices can enhance energy management, reduce carbon emissions, improve resource utilisation and reduce waste. They also support creating a built environment that is user-friendly and remotely accessible, as well as offering financial benefits and improving efficiency and transparency while minimising errors from human interpretation through automation.

Keywords
Digital building logbook (DBL), digital building permit (DBP), sustainable construction, sustainable building management, sustainable development goals, SDG, data-driven

This article is included in the Sustainable Places 2024 collection.

Corresponding author: Rita Lavikka (rita.lavikka@vtt.fi)

Author roles: Lavikka R: Conceptualization, Formal Analysis, Funding Acquisition, Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Fauth J**: Conceptualization, Formal Analysis, Funding Acquisition, Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Toscano M**: Conceptualization, Formal Analysis, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Costa G**: Conceptualization, Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing; **Beach T**: Conceptualization, Formal Analysis, Validation, Writing – Review & Editing; **Meda Magalhães P**: Formal Analysis, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Stoter J**: Formal Analysis, Writing – Original Draft Preparation, Writing – Review & Editing; **Kaiser SBD**: Formal Analysis, Writing – Review & Editing; **Werbrouck J**: Methodology, Validation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreements No 101056973 (Automated Compliance Checks for Construction, Renovation or Demolition Works – ACCORD), No 101058559 (Change toolkit for digital building permit project - CHEK) and No 101058541 (Digital environment for management of permits and compliance in building and construction - DigiChecks). This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101034337 (FUTUREROADS). The UK Participant Cardiff University in Horizon Europe Project ACCORD (grant agreement No 101056973) is supported by UK Research and Innovation grant No 10040207.
The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Lavikka R, Fauth J, Toscano M *et al.* **Navigating the shift towards sustainable digital building permits and building logbooks [version 2; peer review: 1 approved, 3 approved with reservations]** Open Research Europe 2025, **5**:90 https://doi.org/10.12688/openreseurope.18553.2

First published: 31 Mar 2025, **5**:90 https://doi.org/10.12688/openreseurope.18553.1

REVISED **Amendments from Version 1**

In response to peer review feedback, the article underwent several key revisions to enhance clarity and academic rigour. First, the authors incorporated new and relevant literature, including a 2024 study on digital building permits and logbooks, as well as a 2023 paper on digital sustainability in horticulture. These additions aim to strengthen the theoretical foundation and contextual relevance of the study.

To address concerns about theoretical depth, the Introduction was revised to provide a more precise explanation of the study's contribution: a replicable method for mapping digital construction practices to global sustainability targets and identifying DBP and DBL practices that advance sustainable construction and building management. The Discussion and Conclusions sections were expanded to emphasise the unique contribution of the study, namely, the first systematic mapping of Digital Building Permit (DBP) and Digital Building Logbook (DBL) practices to specific UN Sustainable Development Goals (SDGs).

Methodological transparency was improved by detailing the purposive sampling of experts, the rationale for the four-phase research design, and the tools used (Slido and Miro) for data collection and validation. Clarifications were added regarding the qualitative nature of the study, the absence of data normalisation, and the anonymisation of workshop responses.

Language and formatting were also refined. Grammatical errors were corrected, long sentences shortened, and citation formatting reviewed. The figure and the table were verified for proper citation.

Finally, the revised Conclusions section now explicitly acknowledges the study's limitations, including its European focus, the use of single-point-in-time data collection, and the qualitative nature of its findings.

Any further responses from the reviewers can be found at the end of the article

Introduction

The architecture, engineering, construction, and operation (AECO) sector faces several sustainability challenges. Environmentally, it contributes significantly to greenhouse gas emissions and the depletion of natural resources (Kanafani *et al.*, 2023). Socially, the AECO sector faces issues such as ensuring worker safety and minimising negative impacts on local communities (Zhang *et al.*, 2020). Economically, the sector often struggles to balance cost efficiency with the adoption of sustainable practices (Alaloul *et al.*, 2022; Hussain & Hussain, 2023). These challenges underscore the need for a systemic transformation toward sustainable construction and building management.

Digital transformation has been shown to support sustainability transformation by enabling data-driven decision-making, process automation, and enhanced transparency (Chatzistamoulou, 2023). In the AECO sector, digital building permit (DBP) processes and digital building logbooks (DBL) can contribute to supporting sustainable construction and building management (Crisan *et al.*, 2024). The DBP process utilises digital tools and online building permitting and compliance services to streamline and automate the preparation, review, and approval of building permits (Ataide *et al.*, 2023; Fauth *et al.*, 2024; Ullah *et al.*, 2022). The DBP process is found to be more efficient, faster, and transparent (Noardo *et al.*, 2022). On the other hand, DBL encompasses all pertinent building-related data throughout the building's entire lifecycle, providing various stakeholders with the specific information they need for different purposes at the appropriate times (Malinovec Puček *et al.*, 2023).

DBP and DBL concepts are intertwined throughout the building lifecycle (Mêda *et al.*, 2024a). For instance, DBL can provide datasets required for DBP initiatio digital model of the Earth, on top of which n, while DBP outputs can be automatically recorded in DBL, ensuring continuity and compliance documentation from the outset. This interoperability is further strengthened by their shared reliance on Building Information Modelling (BIM), which serves as a foundational layer for digital twins and lifecycle analytics (Mêda *et al.*, 2021). As the building enters the in-use phase, several services and purposes are expected to be provided by the DBL, whereas real-time data are captured and versioned if required, reflecting any changes or inspections related to the permit (European Commission, 2021; Mêda *et al.*, 2024a; Mêda *et al.*, 2024b; Volt & Toth, 2020).

The availability of consistent and reliable building data can contribute to better design, construction, and management of buildings. Currently, data regarding the physical characteristics of buildings, including information on environmental performance, sustainability, and the data necessary for checking building code compliance, remains unreliable, scarce, and inaccessible. Together, DBP and DBL can establish a common approach that aggregates all related data on a building, such as building materials and energy usage, helping to identify inefficiencies and to take corrective measures to reduce waste (Mêda *et al.*, 2024a). Building-related data can also help better manage building maintenance by identifying potential risks associated with the lifespan of building systems and materials (European Commission, 2021; Mêda *et al.*, 2024a; Mêda *et al.*, 2024b; Volt & Toth, 2020). Additionally, non-digital or paper-based systems require extensive paperwork, multiple physical copies, the consumption of other resources for their generation, and numerous in-person visits to various government offices. By contrast, a digital system eliminates the need for physical documents, reduces paper usage, and conserves the resources—such as trees and water — used in paper production. Moreover, by streamlining administrative tasks, digital systems can reduce the energy consumption associated with running a physical office.

Thus, DBP and DBL have the potential to enhance the efficiency, transparency, and sustainability of the construction and building management processes. They promise more precise planning and efficient resource utilisation, reduced waste, and improved building energy management (Crisan *et al.*, 2024; Mêda *et al.*, 2024a; Mêda *et al.*, 2024b; Noardo *et al.*, 2022). However, despite their theoretical promise, empirical evidence on the sustainability impacts of DBP and DBL remains limited. Several studies have mentioned that DBP processes enhance sustainability (Amor & Dimyadi, 2021; Malinovec Puček *et al.*, 2023). Still, these studies treat sustainability as an implicit

outcome rather than a measurable objective; they do not explicitly investigate how and to what extent this is the case. Instead, they considered it to be an implicit consequence of the DBP process and DBL implementation. This presents a key research gap, as no study has yet empirically examined the sustainability impacts of DBP and DBL.

To address this research gap, this study poses the following research question: *What are the sustainability impacts of DBL and DBP, and how can those impacts be achieved?* The study answers this question by applying the UN's Sustainable Development Goals (SDGs) (United Nations, 2024) as an analytical framework to examine the sustainability of DBP and DBL. This approach enables a structured evaluation of how DBP and DBL practices can promote environmental, social, and economic sustainability. The study extends prior work by providing a replicable method for mapping digital construction practices to global sustainability targets and validating them through expert and stakeholder engagement. The study also contributes to sustainable construction and building management by identifying DBP and DBL practices that support global sustainability objectives. Unlike previous studies that treat sustainability as an assumed outcome of digitalisation, this research systematically maps specific DBP and DBL practices to the SDG targets. This offers a structured, replicable methodology for evaluating sustainability in the digitalisation of construction permitting and lifecycle management.

Research process

The research consisted of four phases that combined expert elicitation, literature synthesis, and validation through a stakeholder workshop. This approach integrates both academic and practical perspectives, ensuring that the identified sustainability impacts are grounded in real-world practices and validated by a diverse group of professionals (Figure 1).

In the first phase, the authors, considered as an expert group, searched for literature on the relationship between sustainability and DBP and DBL. The expert group was selected using purposive sampling, targeting individuals with at least two years of experience in research or implementation of DBP and/or DBL. Most experts were actively involved in ongoing European research and development (R&D) projects related to these topics. The authors applied the UN SDGs as a structured sustainability analytical framework to assess the sustainability impacts of DBP and DBL practices.

The SDGs comprise 17 goals, each with specific targets to be achieved by 2030. In total, there were 169 targets across all SDGs. During this first phase, the expert group analysed the relationships between DBP processes and SDGs, as well as between DBL and SDGs. Following an autoethnographic approach (Grosse, 2019), the expert group used their experience and knowledge to identify which SDGs were related to DBP and DBL.

The first round of analysis yielded some dissenting opinions among the expert group; however, after discussions, ten SDGs were selected as being related to DBP and/or DBL: 3, 7, 8, 9, 10, 11, 12, 13, 16, and 17.

The second phase focused on identifying relevant targets of the selected SDGs. The selected Goals 3, 7, 8, 9, 11, 12, 13, 16, and 17 have a total of 95 Targets. The expert group also searched for evidence-based sources – reports, scientific articles, and regulatory documents – to support their claims on the relationships. This phase provides a list of selected targets for the selected SDGs.

In the third phase, the expert group specified DBP and DBL practices to support the relevant targets, underlined with references where possible. The references ranged from scientific literature and project reports to practical and project experience.

In phase 4, the expert group organised a single-point-in-time assessment workshop to enhance the empirical robustness and stakeholder relevance of the results and validate them. The hybrid workshop had 38 participants, approximately half of whom participated onsite and the rest online. The workshop was

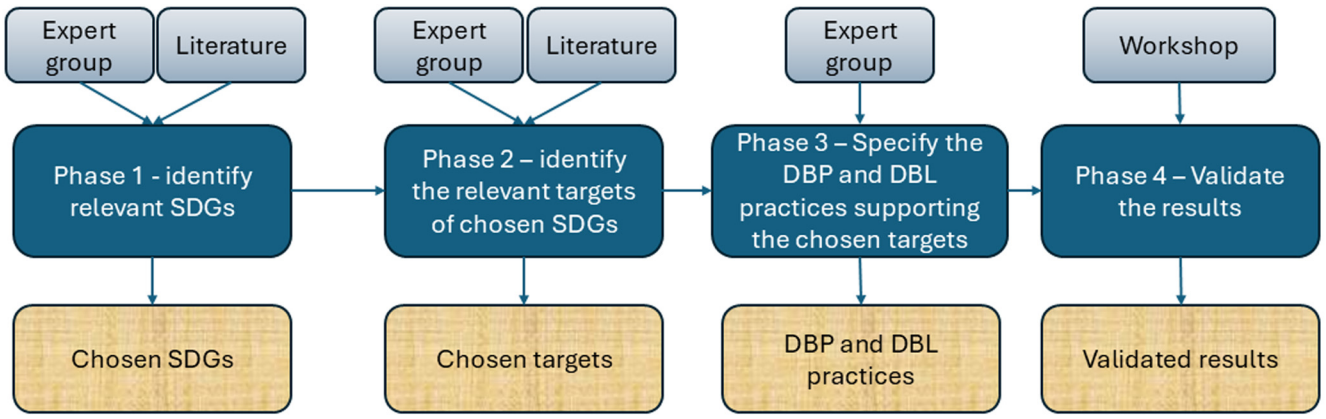

Figure 1. Research process: data collection methods, research phases and outputs.

conducted on September 24, 2024, at the Sustainable Places 2024 conference in Luxembourg. Participants were provided with a research information sheet that explained the research and their rights. Personal or sensitive data were not collected; however, some background information on the participants was collected anonymously using a Slido online tool[1] to ensure that participants were competent in validating the study results. All responses were aggregated to ensure participant privacy. The participants were asked about their country of origin, professional title, and level of knowledge of DBP and DBL. Most of the participants worked in R&D related to the built environment. The professional titles included project managers, research associates, researchers, R&D directors, and a professor. On a scale of 1 (no knowledge), 2 (some knowledge), 3 (lots of knowledge), and 4 (experts in the field), participants' levels of knowledge of DBP and DBL varied. However, most participants had a significant understanding of either DBPs or DBLs. The participants came from the following European countries and regions: Luxembourg, Portugal, the UK, the Netherlands, Spain (including Catalonia), France, Italy, Poland, Germany, and Belgium.

The workshop consisted of two parts. The first part, lasting 1.5 hours, included an introduction consisting of a research information sheet (10 minutes), a presentation of the SDGs (20 minutes), and six project presentations on DBP and DBL from ongoing R&D projects (60 minutes). After the first part, there was a 30-minute break for coffee. The second part of the workshop began with collecting background information on the participants using Slido (20 minutes). Then it continued with group discussions to validate the connection between SDGs and DBP processes and DBLs (70 minutes). The participants were not shown the analysis that the expert group had done. Still, they had the opportunity to make their observations, which the expert group then compared with its findings after the workshop. During the group discussions, participants could select from three options to indicate their perception of the relationship between each SDG and DBP, as well as between each SDG and DBL: 0 (no relationship), 1 (implicitly related), or 2 (explicitly related). The exercise was conducted on an online Miro tool[2], which allowed both in-person and remote participants to contribute in real-time. Miro included two tables: one for analysing the relationship between SDGs and DBP and one for analysing the relationship between SDGs and DBL. Both tables' columns included the scale numbers (0, 1, and 2), and rows included the 17 SDGs. Mainly, the discussion facilitators made notes on tables based on the group discussions. However, the participants could also access the tables themselves, but only a few added any content there.

The Slido and Miro tools were chosen for their accessibility and ability to support hybrid participation. All data were processed manually by the research team individually and then cross-validated together in a group discussion among the research team. As the study was qualitative and based on expert judgment and group consensus, no numerical data normalisation or standardisation was required.

Results

This section reports findings regarding the relationship between SDGs and DBP and/or DBL. SDGs 7, 9, 11, and 13 had the most evident relationship to DBP and DBL practices. The results originated from the expert group and workshop discussions. The workshop participants agreed that DBP processes and DBLs can enhance sustainability in the AECO sector. They highlighted how DBP and DBL can enhance the traceability of materials, mitigate environmental impacts, and foster circularity in construction. The participants strongly emphasised data transparency and interoperability, which could further streamline sustainable practices. These workshop findings were aligned with those of the expert group.

Supplementary Table 1[3] lists those SDGs and targets (target descriptions are directly quoted) that were identified as linked to sustainable DBP or DBL practices through evidence-based references (marked after the name of the goal), the expert group and/or workshop discussions. The right column of the supplementary Table 1 describes the DBP and DBL practices that contribute to achieving ten SDGs: 3 (Good Health and Well-Being), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), 10 (Reduced Inequalities), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), 16 (Peace, Justice, and Strong Institutions) and 17 (Partnerships for the Goals).

The following paragraphs briefly summarise the findings regarding the relationship between DBP and DBL to the targets of the selected SDGs and sustainable practices.

Regarding SDG 3, "Good Health and Well-Being," and its chosen targets of 3.4, 3.6, 3.8, and 3.9, it was found that DBP processes can support universal health coverage by ensuring that health facilities are safe and comply with health standards (Soliman-Junior *et al.*, 2020; Soliman-Junior *et al.*, 2021). DBL, a Digital Twin enabler, captures data related to soil properties, toxicity of used materials, and building air quality, thereby supporting users' health and safety. The role of DBL as a digital twin enabler is further elaborated in a recent study that highlights how lifecycle data can be leveraged to support circular construction and sustainability goals (Mêda *et al.*, 2024c). In general, digital services have ensured access to public services despite physical restrictions during the COVID-19 pandemic, underscoring the importance of digital systems in times of crisis.

Regarding SDG 7, "Affordable and Clean Energy," and its chosen Targets 7.1-7.3, it was found that DBPs, while not directly related to energy services, influence the planning and construction of energy-efficient buildings, and the incorporation of

[1] https://www.slido.com/

[2] https://miro.com/app/dashboard/

[3] https://zenodo.org/records/15078988

renewable energy sources such as geo-energy (Majuri *et al.*, 2020). Building codes and regulations within the permit process can mandate energy-efficient designs, materials, and technologies, thereby reducing energy consumption. However, research indicates discrepancies between the permitted energy consumption calculations and actual measurements (Ruusala *et al.*, 2018). Permits also facilitate the installation of renewable energy systems, thereby contributing to a sustainable energy mix (Chen *et al.*, 2024; Li & Feng, 2023). Regarding the SDG7 targets, 7.a and 7.b, DBP processes are national mechanisms with some similarities (Bloch & Fauth, 2023; Fauth *et al.*, 2023a; Fauth *et al.*, 2023b; Fauth & Soibelman, 2022; Noardo *et al.*, 2022). They can facilitate knowledge transfer and capacity building, which are essential for deploying energy efficiency and renewable energy technologies. Enforcing regulations for energy-efficient materials and technologies through building permits promotes the adoption of clean energy and supports investment in energy infrastructure.

Regarding SDG 8, "Decent Work and Economic Growth," and its chosen Targets 8.1–8.5, it was identified that DBP processes ensure safety and regulatory compliance while also boosting economic productivity by fostering innovation, efficiency, and the use of sustainable materials (Fauth *et al.*, 2024). Digital technologies can streamline the permitting process, reduce bureaucratic barriers, and facilitate SME growth (Ataide *et al.*, 2023; Beach *et al.*, 2024; Beach *et al.*, 2020). This can boost economic activity and job creation (World Bank Group, 2020; World Bank Group, 2024). Digitalisation enhances transparency and efficiency, making regulatory navigation easier for entrepreneurs and simplifying compliance. Digitalising the building permit process reduces paper usage and streamlines operations, leading to efficient resource use. It enhances data collection and analysis, informing sustainable urban planning and construction. Digitalisation also enhances the monitoring and enforcement of environmental regulations, creates tech job opportunities, and improves access to services for a wider range of people.

Regarding SDG 9, "Industry, Innovation, and Infrastructure," and its chosen targets 9.1–9.5, it was discovered that DBP supports resilient infrastructure by enhancing project efficiency and transparency and reducing delays and costs. This ensures that new constructions meet modern sustainability and resilience standards, foster innovation through smart technologies, and ensure compliance with building codes and safety regulations. Automated code compliance checks verify adherence to seismic and sustainability standards (Amor & Dimyadi, 2021; Patlakas *et al.*, 2024). DBP processes support digital transformation, improve resource-use efficiency, and encourage clean and environmentally sound technologies and industries (Ataide *et al.*, 2023; Crisan *et al.*, 2024). Innovations such as applied computing for code compliance checking can boost the R&D workforce and increase public and private R&D spending (Amor & Dimyadi, 2021).

Regarding SDG 10, "Reduced Inequalities," and its chosen Targets 10.2 and 10.3, it was found that DBP processes and DBL provide insights into the built stock, its condition, occupancy, and costs, aiding decision-making. Thus, they enhance transparency, reduce discriminatory practices, and ensure equal opportunities.

Regarding SDG 11, "Sustainable Cities and Communities," and its chosen targets 11.1–11.7, and 11. a. The analysis revealed that DBP processes streamlined housing project approvals, facilitating the development of affordable housing and access to basic services, which in turn led to more efficient resource utilisation and faster housing delivery. Digitalising the permit process enhances urban planning efficiency and transparency, facilitating citizen participation and developer compliance (Eirinaki *et al.*, 2018). Digital processes enhance transparency and accountability, ensuring that buildings meet sustainability and resilience standards. Streamlining the permit process reduces time and cost, aiding developers in the least-developed countries. This fosters efficient use of local materials and sustainable building practices (cdbb, 2019; Olanrewaju Yusuf *et al.*, 2021).

Regarding SDG 12, "Responsible Consumption and Production", and its chosen Targets 12.2 and 12.5-12.8, it was discovered that a digital permit process reduces the environmental impact of construction by minimising waste, optimising material use, and ensuring efficient resource use. It also provides better data for resource management and mandates the reuse of materials. Enhanced accessibility and transparency promote awareness of sustainable practices and regulations (Hradil *et al.*, 2024), aligning with development goals. Selective demolition permits the reuse of recoverable materials based on data availability and DBL.

Regarding SDG 13, "Climate Action," and its chosen Targets 13.1–13.3, digitalising the permit process can reduce construction's environmental impact by minimising waste, optimising material use, and ensuring efficient resource use. It also provides improved data and analytics for resource management (Gillingham *et al.*, 2021; Hradil, 2023; Hradil *et al.*, 2024).

Regarding SDG 16¸ "Peace, Justice, and Strong Institutions," and its chosen targets of 16.6, 16.7, and 16.10, it was identified that digitalising the permit process improves transparency in government spending and budget implementation, ensuring effective use of resources for sustainable development (World Bank Group, 2020; World Bank Group, 2024). It enhances citizen engagement and inclusivity in local governance, promoting transparency and accountability. Digital platforms offer improved access to information and facilitate informed public participation in decision-making (Eirinaki *et al.*, 2018).

Regarding SDG 17, "Partnerships for the Goals" and its chosen Targets 17.1 and 17.6, it was concluded that DBPs and DBLs enhance global collaboration in the building sector by offering a unified platform for data sharing throughout the building lifecycle. This standardisation promotes interoperability and cooperation, thereby aligning sustainability and efficiency efforts worldwide. (World Bank Group, 2020; World Bank Group, 2024)

These findings not only reveal which SDGs are affected but also demonstrate how specific digital practices contribute. For example, automatic compliance checking (DBP) directly supports SDG 9.4 (upgrade infrastructure and retrofit industries to make them sustainable) by ensuring that buildings meet efficiency and resilience standards from the outset. Similarly, the integration of the Energy Performance Certificate (EPC) in DBL supports SDG 7.3 (doubling the global rate of improvement in energy efficiency) by enabling comparisons between theoretical and actual energy consumption and identifying corrective actions. These concrete examples illustrate the operational mechanisms by which DBP and DBL advance sustainability, moving beyond high-level assumptions into actionable pathways.

Discussion

In general, digital technologies can support the achievement of the SDGs (Mantovani Ribeiro *et al.*, 2021). They can help identify and agree on the most sustainable ways to work, build appropriate skills across stakeholder groups, attract finance, and ensure practical processes for multi-stakeholder engagement at all stages of building construction. This study supports these findings in the context of DBP and DBL technologies, which provide opportunities for environmental, social, and economic sustainability. Environmentally, these technologies can help enhance energy management, reduce carbon emissions, and improve resource utilisation and waste reduction. Socially, they can promote social inclusion by creating an accessible, user-friendly, and remotely accessible built environment. Economically, they can offer cost savings and long-term financial benefits by streamlining permit application and building management processes, improving efficiency and transparency, and minimising human error or differences due to human interpretation through automated data handling. However, it is worth noting that digitalisation also has negative environmental impacts. For example, data storage has environmental impacts due to the high energy and water usage. Although solutions such as using renewable energy to power data centres are being studied to counteract this impact, more research is needed to understand the environmental impact of digitalisation.

Research conducted in the horticulture industry has also identified that digitalisation has the potential to support sustainability; however, we do not yet have evidence to support this claim, and thus, monitoring and evaluating the impact of digitalisation is needed (Sharma *et al.*, 2023). To this end, this study is the first to systematically map DBP and DBL practices to specific Goals and Targets of the UN SDGs, providing a structured and replicable framework for future sustainability assessments.

Although this paper has envisioned a future in which digital means support the achievement of sustainable construction, challenges exist in the implementation of DBP processes and DBLs. These challenges can be grouped into initial implementation costs, data security, user adoption, and interoperability and provide the corresponding legislative framework for its correct deployment. The initial setup costs, which can be significant, include software development, hardware installation, and staff training. Data security and privacy concerns may arise owing to the storage of sensitive building data in a digital format. The digitalisation of building permits varies across Europe. Some regions adopt Artificial Intelligence (AI), whereas others use PDFs. The need for harmonisation at the European level is crucial for efficiency. Furthermore, ensuring compatibility and seamless data exchange between software platforms and building systems presents interoperability challenges. Therefore, solutions are needed to create strategies that support stakeholders in adopting digital solutions, ensuring the protection of sensitive information, addressing potential user resistance, and enhancing digital literacy. Thus, solutions for seamless data integration across platforms are needed, especially when considering multi-asset DBLs (e.g., for infrastructure), consisting of multiple lower-level DBLs. A lack of familiarity with digital tools among building controls, permit applicants, and management staff can also hinder user adoption. The digital divide, which affects people living in poverty (SDG 1), especially in rural areas and developing countries, is also a challenge. Thus, an improved digital infrastructure is crucial to ensure equitable access to DBPs and DBLs.

As data-driven concepts, DBP and DBL can reshape the way production, consumption, and living occur. However, data infrastructure platforms and governance frameworks are required to facilitate data pooling, access, and sharing. In the European Union, data spaces will play this role. In line with Europe's strategy for the digital age, the legal framework is being revised. Concerning the built environment, the Common European Green Deal Data Space[4] is developing a highly accurate digital model of the Earth, on top of which all other layers will stand. Currently, there are no common data spaces for construction or built environments. This situation may not be an issue if the required data is captured, stored, and managed in several data spaces. Nevertheless, understanding these boundaries may be challenging and raises several issues. However, if a construction or built environment is set in a similar situation with boundaries, defining the borders of this data space may be extremely difficult. All these ongoing discussions are relevant and constitute challenges for the system architecture and data management systems of DBP and DBL. The Rolling Plan for ICT Standardisation 2024[5] considers four key processes for all actions: "Data Governance", "Data Discovery", "Data Sharing", and "Data Usage". All these need to be evaluated from the data spaces and DBP/DBL perspectives. This paper primarily focuses on the "Data Usage" process, specifically supporting the achievement of the UN SDGs' targets; however, it is essential to work in conjunction with other processes to address the challenges.

[4] European Green Deal Data Space, https://green-deal-dataspace.eu/, accessed 23.10.2024.

[5] Rolling plan for ICT standardization, https://digital-strategy.ec.europa.eu/en/policies/rolling-plan-ict-standardisation, accessed 23.10.2024.

Conclusions

This study addressed the following research question: "*What are the sustainability impacts of DBL and DBP, and how can those impacts be achieved?*". To this end, this study applied the UN Sustainable Development Goals (SDGs) as a structured analytical framework to assess the sustainability impacts of DBP and DBL practices.

The findings regarding the first research question, "*What are the sustainability impacts of DBL and DBP?*", are that DBP and DBL contribute, both directly and indirectly, to 10 out of 17 SDGs: 3 (Good Health and Well-Being), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 13 (Climate Action), 16 (Peace, Justice, and Strong Institutions), and 17 (Partnerships for the Goals). This study documents how these sustainable impacts of DBP and DBL can be achieved. These findings indicate that digitalising building permits and logbooks provides environmental, social, and economic sustainability.

The findings regarding the second research question, "*How can those impacts be achieved?*", are illustrated by concrete examples of DBP and DBL practices documented in Supplementary Table 1. For example, DBP and automatic code-compliance checking speed up approval times, reduce errors, increase transparency, help reduce building carbon footprint, improve operational efficiency, promote equal access to permitting processes, and streamline housing approvals, facilitating affordable housing development. DBL, on the other hand, supports energy-related data management by streamlining the issuance of Energy Performance Certificates (EPCs) and enabling comparisons between theoretical and actual energy use. It also supports assessments for recyclability and design for disassembly, aligning with the principles of the circular economy. However, the quantitative effects of DBP and DBL remain to be determined. The value of digitalisation can only be measured once digital transformation has been completed and digitalisation is in place. During the transformation process, the impacts of DBP and DBL are challenging to measure, even though predictions can be made. Overall, the findings suggest that DBP processes and DBL are integral to a broader digital transformation that can support sustainability.

Additionally, the findings provide implicit evidence that DBP and DBL are increasingly aligned with the three current European initiatives and strategies. One of them is Europe's fit for the digital age. DBP and DBL support the EU's digital transformation by standardising data collection, management, and sharing across the construction sector. This harmonisation facilitates transparency, trust, and informed decision-making. Another initiative is the European Green Deal and its Renovation Wave, which aims to improve the energy efficiency of buildings. DBP and DBL can support the integration of data from energy performance certificates, smart readiness indicators, and building renovation passports, thereby supporting the Green Deal's goals of reducing carbon emissions and promoting sustainable building practices. Finally, DBL can contribute to the New Circular Economy Action Plan initiative by providing a comprehensive repository of building-related data. These data help track materials and resources, promote reuse and recycling, and support the lifecycle management of buildings.

The impact of this study is twofold. First, it introduces a structured and replicable framework for assessing the sustainability of DBP and DBL practices by explicitly mapping them to specific SDG targets. This goes beyond prior literature, which often treats sustainability as an implicit benefit rather than a measurable outcome. Second, the study demonstrates how expert-driven analysis and stakeholder validation can be used to identify actionable DBP and DBL practices that support environmental, social, and economic sustainability. By doing so, the paper lays a foundation for future empirical research and policy development, supporting the alignment of digital construction tools with global sustainability objectives. This will enable both the quantitative and qualitative assessment of DBP and DBL research as it enters adoption across Europe. However, key future work is needed in this area to develop further and validate methods for assessing DBL and DBP implementation against the relevant SDGs.

Despite the strengths of this study, several limitations should be acknowledged. First, the research is qualitative and based on expert elicitation and workshop validation, which may introduce subjectivity and limit generalisability. Second, the geographic scope of the workshop was primarily European, which may constrain the applicability of the findings to other regions with different regulatory or technological contexts. Third, the data reflect a single-point-in-time assessment conducted during the Sustainable Places 2024 conference and do not capture longitudinal changes or evolving practices. Fourth, while the online tools used for data collection facilitated data collection and collaboration, they limited the granularity of data and depth of interaction. Fifth, although this study identifies how specific DBP and DBL practices contribute to sustainability goals, it does not quantify the extent of those contributions. Measuring the actual sustainability impact—such as energy saved, emissions reduced, or time gained—requires future work with quantitative indicators, monitoring systems, and longitudinal data. These limitations highlight opportunities for future research to expand the scope, duration, and empirical depth of analysis. These limitations highlight opportunities for future research to expand the scope, duration, and empirical depth of analysis.

Declaration of AI-assisted technologies in the writing process

While finalising this article, the authors used Microsoft Copilot to edit the abstract and shorten some sentences. After

using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the published article.

Ethical consideration

Ethical approval and consent were not required.

Data availability

Extended data

Repository name: ACCORD project. https://doi.org/10.5281/zenodo.15078988

This project contains the following extended data:

Supplementary Table 1 (The selected targets of the selected SDGs and DBP and DBL practices with evidence-based references)

Workshop data (Data collected during a workshop on Digital Building Logbooks and Permit Processes for Sustainability. The workshop was held in Sustainable Places on the 24th of September 2024 in Luxembourg)

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0) (https://creativecommons.org/licenses/by/4.0/).

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Current Peer Review Status: ? ? ? ✓

Version 2

Reviewer Report 12 September 2025

https://doi.org/10.21956/openreseurope.22640.r59065

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✓ **Jan Holmstrom**
Aalto University, Espoo, Finland

The revised manuscript is acceptable. Based on a literature review, expert group workshops that paper examines the possible sustainability improvements that digital building permits and logbooks can have.
The challenge for researching the topic is that it is an emerging topic, with digitalization ongoing. Because of this the reliance on experts for assessing is appropriate.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and does the work have academic merit?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: expert in the digitalization of operations

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 04 September 2025

https://doi.org/10.21956/openreseurope.22640.r59062

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Adrian Wildenauer
Bern University of Applied Sciences, Bern, Switzerland

Thank you very much indeed for the opportunity to review this interesting paper, which brings up as one of the first papers the connection between digital building permits and building logbooks. This research paper by Lavikka et al. addresses an important gap in understanding the sustainability impacts of digital building permits (DBP) and digital building logs (DBL) by systematically mapping these technologies to the United Nations Sustainable Development Goals (SDGs). While the study makes a valuable contribution to this field, some aspects deserve a little more attention.
Strengths
The most important contribution of the paper is that it is the first to systematically map DBP and DBL practices to specific SDG goals. The four-phase methodology, which combines expert interviews, SDG mapping, practice documentation, and stakeholder validation through a workshop with 38 participants, is methodologically sound and demonstrates academic rigour.
The use of the UN SDGs as an analytical framework provides a structured, internationally recognized approach to sustainability assessment, which enhances the credibility of the study and its potential for broader application.
The research successfully identifies concrete links between digital building technologies and sustainability outcomes, going beyond the existing literature, which treated sustainability as an implicit benefit of digitalization. Validation through a hybrid European workshop lends empirical weight to the expert-based analysis.

Points for optimization
Study design and academic value (partially adequate): The study design is fundamentally sound, but limited by its European focus and one-off data collection at a specific point in time. However, it is naturally an important topic in Europe at present. The academic value is evident in the systematic approach and reproducible framework, but the novelty of the results is questionable. The geographical limitation and cross-sectional nature reduce the generalizability of the results. The title is probably poorly chosen here, as the study primarily deals with European issues. This gives it the nimbus of a comprehensive study.

Methodological details (partially adequate): The section on methodology provides an adequate overview, but important details for complete reproducibility are missing. The most important missing elements include specific procedures for selecting experts, data processing protocols, consensus-building mechanisms, and detailed analysis procedures. The lack of information on

data normalization, cleaning methods, and quality control measures significantly impairs reproducibility. Although the tools used (Slido, Miro) are mentioned, the specific analysis procedures are insufficiently documented.
Data availability (partially accessible): Although the authors provide a Zenodo repository with supplementary materials and workshop data under a Creative Commons licence, there are still gaps. The raw data of the expert opinions, detailed workshop discussions and individual responses of the participants prior to aggregation are not available, which limits the verifiability of the analysis processes. The anonymization process protects privacy, but reduces the transparency of the analytical validation. Nevertheless, an important contribution.

Support for conclusions (partially adequate): The conclusions follow logically from the study design, but go beyond what the data can fully substantiate. While the identification of relevant SDGs is well validated, there is a lack of empirical evidence for statements on specific implementation mechanisms and quantified benefits. The study documents which practices contribute to sustainability, but does not sufficiently explain how these effects can be achieved in practice. A gap remains between theoretical classification and practical implementation guidance.

Recommendation
This work makes a significant contribution to the interface between digital construction technologies and sustainability assessment by providing a structured framework for evaluation. However, the numerous limitations in the key assessment criteria leave considerable room for improvement.
The work establishes a foundation for future research, but requires improved methodological transparency, expanded geographical scope, and more robust conclusions that acknowledge the preliminary nature of the results while highlighting the valuable contribution of the framework.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and does the work have academic merit?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Information Management, Digital Building Permits, Digital Product Passports,

Building-as-a-Service

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Version 1

Reviewer Report 25 June 2025

https://doi.org/10.21956/openreseurope.20061.r55473

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Muhammad Shafique
[1] Brunel University London, Middlesex, UK
[2] Brunel University London, Middlesex, UK

OVERALL REVIEW RESULT
This is a well-structured and written article. However, as the main drawback, it isn't easy to recognise the importance of the research results. Reading the conclusions, the study has not contributed significantly to new findings that are not already available in the existing literature, and the overall outcome sounds trivial. For example, the authors have ended up stating: "The study documents how these sustainable impacts of DBP and DBL can be achieved"; but how these will be achieved are not explained in details. Also, I believe it is very important to highlight content on the importance of incorporating methods.
I hope that this feedback will be helpful as you look to strengthen your research efforts.

MORE SPECIFIC COMMENTARY
The paper aims to answer the following research question: *What are the sustainability impacts of DBL and DBP and how can those impacts be achieved?*

The aim is to explore sustainable construction and building management by identifying DBP and DBL practices that contribute to sustainability.

The structure of this paper is suitable.
The English language used in the manuscript is good enough to convey the idea of the paper without critical mistakes in grammar, word selection, and typing. Still, a second English proofread is suggested.

Title - It is reasonable.

Keywords - They are reasonable.

It is still unclear how the research questions relate to the statements in introduction section and how the current article goes beyond other existing literature in this area. To address this issue, please try to embed the questions into the body of the text presented in introduction section.

Research Process;
It is essential to elaborate on how the experts were selected and which sampling method was used to select experts?

It is important to clearly give detail information on methods selection for methodology section.

While the work appears technically solid and well-organized, with relevant features and structured categories, the data collection and processing protocols are not described in sufficient technical detail. The article lacks the following:
◯ Clarification on whether data were normalized or standardized.
◯ No mention of data cleaning, anonymization, or aggregation methods.
◯ Uncertainty regarding the temporal resolution of data.
◯ The tool or platform used for data processing and visual analytics is mentioned vaguely but not named or described.

Conclusion
Were there any limitations in your research work?

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and does the work have academic merit?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainability, Life-cycle Energy and Environmental Assessment (LCA), Circular Economy, Sustainable Construction

I confirm that I have read this submission and believe that I have an appropriate level of

expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 08 Jul 2025

Rita Lavikka

We thank the reviewer for the constructive comments, which helped us improve our article. Below, we provide our more detailed responses to each review comment. Review comment: “This is a well-structured and written article. However, as the main drawback, it isn't easy to recognise the importance of the research results. Reading the conclusions, the study has not contributed significantly to new findings that are not already available in the existing literature, and the overall outcome sounds trivial. For example, the authors have ended up stating: "The study documents how these sustainable impacts of DBP and DBL can be achieved"; but how these will be achieved are not explained in details. Also, I believe it is very important to highlight content on the importance of incorporating methods. I hope that this feedback will be helpful as you look to strengthen your research efforts.” Our response: We thank the reviewer for this thoughtful feedback. In response, we have revised the Discussion and Conclusions sections to more clearly articulate the novelty and significance of our findings. We now emphasise that our study is the first to systematically map Digital Building Permit (DBP) and Digital Building Logbook (DBL) practices to specific UN Sustainable Development Goals (SDGs), providing a structured and replicable framework for sustainability assessment. Please see also Supplementary Table 1. We refined the Conclusions section to answer both research questions explicitly and added a new paragraph on the study's impact: The impact of this study is twofold. First, it introduces a structured and replicable framework for assessing the sustainability of DBP and DBL practices by explicitly mapping them to specific SDG targets. This goes beyond prior literature, which often treats sustainability as an implicit benefit rather than a measurable outcome. Second, the study demonstrates how expert-driven analysis and stakeholder validation can be used to identify actionable DBP and DBL practices that support environmental, social, and economic sustainability. By doing so, the paper lays a foundation for future empirical research and policy development, supporting the alignment of digital construction tools with global sustainability objectives. This will enable both the quantitative and qualitative assessment of DBP and DBL research as it enters adoption across Europe. However, key future work is needed in this area to develop further and validate methods for assessing DBL and DBP implementation against the relevant SDGs. We also added more explanation about the uniqueness of our method to the Research process section. Review comment: “The paper aims to answer the following research question: What are the sustainability impacts of DBL and DBP and how can those impacts be achieved? The aim is to explore sustainable construction and building management by identifying DBP and DBL practices that contribute to sustainability. The structure of this paper is suitable. The English language used in the manuscript is good enough to convey the idea of the paper without critical mistakes in grammar, word selection, and typing. Still, a second English proofread is suggested.” Our response: We corrected grammatical mistakes, shortened long sentences and made a second English proofread. Review comment: “Title - It is reasonable. Keywords - They are reasonable. It is still unclear how the research questions relate to the statements in introduction section and how the current article goes beyond other existing literature in this area. To address this issue, please try to embed the questions into the body of the text

presented in introduction section." Our response: We thank the reviewer for this insightful comment. In response, we have revised the final paragraph of the Introduction to explicitly embed the research question and clarify how it emerges from the identified research gap. We also added a sentence earlier in the Introduction to highlight the novelty of our approach compared to existing literature. These changes aim to improve the logical flow from problem identification to research objective and to better position our contribution within the broader academic discourse. Review comment: "Research Process; It is essential to elaborate on how the experts were selected and which sampling method was used to select experts? It is important to clearly give detail information on methods selection for methodology section." Our response: We appreciate the reviewer's request for clarification. In response, we have revised the Methodology section to provide more detail on both the expert selection process and the rationale for our methodological choices. We now clarify that the expert group was selected using purposive sampling, targeting individuals with at least two years of experience in research or implementation of digital building permits (DBP) and/or digital building logbooks (DBL). Most experts were actively involved in ongoing European R&D projects related to these topics. We have added a justification for using a four-phase mixed-method approach combining literature review, expert elicitation, SDG mapping, and stakeholder validation. This approach was chosen to ensure both theoretical grounding and practical relevance. The methodological approach was designed to bridge the gap between theory and practice. It began with a structured literature review and SDG mapping, followed by expert-driven identification of relevant targets and practices. The final phase involved a hybrid workshop with 38 participants from across Europe to validate the findings. This multi-phase design ensured that the results were both evidence-based and grounded in stakeholder perspectives. Review comment: "While the work appears technically solid and well-organized, with relevant features and structured categories, the data collection and processing protocols are not described in sufficient technical detail. The article lacks the following: ○ Clarification on whether data were normalized or standardized. ○ No mention of data cleaning, anonymization, or aggregation methods. ○ Uncertainty regarding the temporal resolution of data. ○ The tool or platform used for data processing and visual analytics is mentioned vaguely but not named or described." Our response: We thank the reviewer for highlighting the need for greater transparency in our data handling and processing protocols. In response, we have revised the Research process section to include the following clarifications: As the study was qualitative in nature and based on expert elicitation and workshop validation, numerical data normalisation or standardisation was not applicable. However, we have clarified this explicitly in the revised text. We now specify that no personal data was collected during the workshop. Background information was gathered anonymously using Slido, and all responses were aggregated at the group level to ensure privacy. We have clarified that the data collected reflects a single-point-in-time assessment conducted during the Sustainable Places 2024 conference on September 24, 2024. We now explicitly state that Slido was used for collecting participant background data, and Miro was used for collaborative SDG mapping during the workshop. These tools were chosen for their accessibility and ability to support hybrid participation. Review comment: "Conclusion - Were there any limitations in your research work?" Our response: Yes, we acknowledge several limitations in our research, which we have now explicitly stated in the revised Conclusions section. The study is based on expert elicitation and workshop validation, which, while rich in insight, may introduce subjectivity and limit generalisability. The workshop participants were primarily from European countries, which

may limit the applicability of findings to other regions with different regulatory or technological contexts. The data reflect a single-point-in-time assessment conducted during the Sustainable Places 2024 conference. As such, the findings may not capture evolving practices or future developments in DBP and DBL. The study does not include longitudinal tracking of DBP/DBL implementation impacts, which would be valuable for assessing sustainability outcomes over time. While tools like Slido and Miro facilitated data collection and collaboration, they also constrained the depth of interaction and granularity of data that could be captured.

Competing Interests: No competing interests were disclosed.

Reviewer Report 02 April 2025

https://doi.org/10.21956/openreseurope.20061.r52624

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Rupesh Kumar
[1] Jindal Global University, Sonipet, Haryana, India
[2] Jindal Global University, Sonipet, Haryana, India

Author needs to cite few important latest papers.
Author needs to support the theory with more explanation.
Author needs to compare the other studies to support its study with latest references.
Author needs to check for grammatical mistakes and avoid using long sentences.
Author needs to see their figures and tables are properly cited.
The method used by author should be unique and give explanation as compared to other work.
Author should check the format of using citations and references as per journal guidelines.
Author should address all the comments given earlier and should provide organized structure of their manuscript.

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Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and does the work have academic merit?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainable, Analytics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 08 Jul 2025

Rita Lavikka

We thank the reviewer for the constructive comments, which helped us improve our article. Below, we provide our more detailed responses to each review comment. Review comment: “Author needs to cite few important latest papers.” Our response: Thank you for suggesting that we add a few important, latest papers. We checked Scopus and Google Scholar and identified one new paper addressing the sustainability of digital building permits and logbooks, and added it to the paper: Mêda P, Fauth J, Schranz, et al.: Twinning the path of digital building permits and digital building logbooks – Diagnosis and challenges. Developments in the Built Environment. 2024. 10.1016/j.dibe.2024.100573. We also reviewed the ones suggested by the reviewer. The paper by Sharma et al. (2023) is relevant to our study, and we have added it to our paper since it examines digitalisation as an enabler of sustainability in fruit supply chains and proposes technological solutions that can contribute to sustainable horticulture practices. Please see the section Discussion. Three other papers appear to address different types of issues, not our topic: the sustainability impacts of digital building permit (DBP) processes or digital building logbooks (DBL), and strategies for achieving them. We will address each paper in more detail: The paper by Kumar & Kansara (2018) focuses on the optimisation and analysis of supply chain processes in the olive oil industry. This paper is not directly related to our paper in terms of subject

matter or methodology, but they are complementary examples of how digitalisation can support sustainability in different sectors. However, as we are not exploring cross-sectoral insights on digital tools for sustainability, we will not use it as a reference, even though Kumar & Kansara's paper is an interesting piece of research. The paper by Rajani et al. (2022) examines the relationship between selected supply chain risks, the utilisation of service redesign strategies, and their impact on companies. We couldn't find the connection to our paper's topic. The paper by Arora et al. (2023) examines the issues affecting the frozen food cold chain in India and proposes strategies to address these issues, without a primary focus on sustainability. Review comment: "Author needs to support the theory with more explanation." Our response: We appreciate the reviewer's insightful comment. We elaborated on the theoretical underpinnings of how digital transformation supports sustainability in the AECO sector. Please see the Introduction section. Review comment: "Author needs to compare the other studies to support its study with latest references." Our response: We added the reference to Sharma et al. (2023). This is the only comparable study that could be found despite conducting an extensive literature review.Otherwise, we couldn't identify new papers. Review comment: "Author needs to check for grammatical mistakes and avoid using long sentences." Our response: We corrected grammatical errors and condensed lengthy sentences. Review comment: "Author needs to see their figures and tables are properly cited." Our response: We have verified that Figure 1 and Supplementary Table 1 are properly cited, and the technical editors of Open Research Europe have also confirmed this prior to the first publication. Review comment: "The method used by author should be unique and give explanation as compared to other work." Our response: We added more explanation about the uniqueness of our method to the section Research process. Review comment: "Author should check the format of using citations and references as per journal guidelines." Our response: Citations and references have been checked. Also, the technical editors of Open Research Europe check this before publication. Review comment: "Author should address all the comments given earlier and should provide organized structure of their manuscript." Our response: All comments are addressed, and an organised structure of the manuscript is followed. Thank you once again for your review comments that helped us improve our paper.

Competing Interests: No competing interests were disclosed.