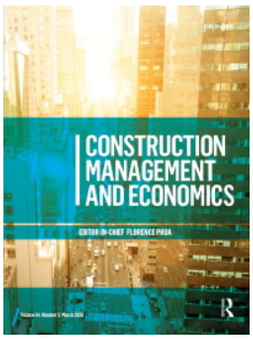

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How digital platforms enable sustainability transitions in the built environment

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ABSTRACT

Digital platforms are transforming sustainability transitions in the built environment by enabling collaboration, transparency, and efficiency. This study examines how these platforms are implemented, adopted by practitioners, and create value for industry stakeholders using the DART (Dialogue, Access, Risk-benefit, Transparency) co-creation framework. Using ethnographic methods and semi-structured interviews, we consider the case study of a Dutch digital platform provider specializing in modular wooden construction. The findings highlight major challenges in sustainability transitions, including industry complexities, inefficient practices, and resistance to change. Five key practices emerged: defining a clear platform vision, improving processes, leveraging digitalization, ensuring scalability, and fostering co-creation. These practices are synthesized into an iterative framework that extends the DART model, illustrating the interplay between digital, social, and physical elements in construction. By embedding DART within a sector-specific model, this study offers a novel perspective on digital platforms as enablers of sustainability. Ultimately, these platforms promote stakeholder collaboration, enhance transparency, and contribute to sustainability goals, such as carbon reduction and circular construction.

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KEYWORDS
Sustainability transition; digital platforms; co-creation; built environment; DART framework

Introduction

The world is on a 2.9 °C temperature rise trajectory, with the most optimistic scenario involving achieving the net-zero pledges that would only limit the temperature rise to 2.0 °C according to the UN 2023 Emissions Gap Report (UNEP 2023). The construction sector accounts for ~40% of global energy use (Hong *et al.* 2016), around 30% of greenhouse gas emissions (Escamilla *et al.* 2016), and is noted in the report (Garner 2024) along with fuel, agriculture, fashion, and transport as one of the most polluted industries. The report also points out that roughly half of all the resources extracted globally come from the construction industry (UNEP 2023). Thus, the construction industry needs to embrace sustainability transitions, reduce the impact on the environment, and depart from the traditional take, make, and dispose approach (Ortiz *et al.* 2009, Murtagh *et al.* 2020). At the same time, Industry 4.0 and digitalization in the modern digital age have the potential to be a significant change in the built environment (European Commission 2020), and therefore, sustainability can be achieved through innovative digital technologies (Rohn *et al.* 2021). In this context, digital technologies, with their potential to integrate numerous tasks and standardize work methods, can bring about a sustainable transition in the sector (Han *et al.* 2025).

The need for adopting digital technologies in the construction sector, such as platforms and digital twins for built assets, has been stressed in earlier reports (Latham 1994, Egan 1998), with recent reports calling for more focus on manufacturing and platformization (HM Government 2020). A new trend in the construction industry's digital transformation involves the increasing use of digital platforms to manage tasks and connect suppliers and demand-side participants within the sector, similar to platforms such as Uber for the transportation sector, Airbnb for the hospitality sector, or Amazon for the retail sector (Chan 2020). The European Commission (2020) records that the construction sector lacks knowledge and is missing out on the benefits of using a digital platform. Platformization can allow sustainability improvements to be carried out on a larger scale and provides opportunities to optimize and expand the

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implementation capacity (Prijadi *et al.* 2024). Digital platforms in construction can include multiple data models, repositories, and stakeholders, offering possibilities for increasing value throughout the lifecycle of construction projects (Kovacic *et al.* 2020). While the promise of digitalization is well-documented, the mechanisms through which platforms catalyze sustainability transitions in fragmented industries like construction remain underexplored (Oti-Sarpong *et al.* 2022, Sánchez-García *et al.* 2025).

Even when digital platforms present a significant opportunity to enable sustainable transitions and kindle innovations in promoting greater harmony between the built and natural environments (Dana *et al.* 2022), their ability to make a difference in the construction sector could be better (Charef and Lu 2021). The sector is infamous for lagging in digital transformation, adopting Building Information Modelling (BIM) and platformization (Etminan *et al.* 2019). In addition, established digital transformations such as BIM have demonstrated both the potential and the limits of digital integration, particularly when extending beyond project-level coordination toward sectoral transformation (Grilo and Jardim-Goncalves 2010). Moreover, the adoption of technologies such as digital twins and smart sensors in the construction sector introduces tensions with acknowledged benefits and growing interest among different stakeholders on one side and limited training and poor technology acceptance on the other side (Oti-Sarpong and Burgess 2020, Wang *et al.* 2025). At the same time, construction scholars are debating what "platformization" actually means in practice with inquiries into platform definitions, platform typologies, and their value chain impacts highlighting that platforms are emerging as more than digital tools by shifting how stakeholders collaborate, share data, and organize supply chains (Antai *et al.* 2025, Zhang *et al.* 2025). Positioning our study within these debates, there is a need to understand how digital platforms are implemented in practice, used by practitioners, impact sustainability transition, and how they can offer value to the industry actors (Çetin *et al.* 2022, Wang *et al.* 2024).

To address this gap, our research seeks to elucidate the practice of implementing a digital platform to enable sustainability transitions in the construction sector. We specifically ask (1) What are the challenges for sustainability transitions in the built environment? and (2) How can digital platforms address these challenges to enable sustainability transitions? In addressing these questions, we examine how the co-creation DART (Dialogue, Access, Risk-benefit, Transparency) framework (Prahalad and Ramaswamy 2004) informs the strategies employed by digital platforms, particularly through fostering iterative collaboration and mutual value creation among stakeholders. While "dialogue" is critical in the multi-actor construction environment where continuous negotiation among the divergent priorities of stakeholders are necessary, "access" enables practitioners to reduce reliance on siloed expertise and tacit knowledge, "risk–benefit" dimension is central in a sector characterized by high uncertainty, and "transparency" helps mitigate information asymmetries that undermine trust in construction projects. The DART framework was selected as it has the potential to operationalize value co-creation processes among stakeholders in digitally enabled multi-actor contexts with an emphasis on iterative stakeholder engagement (Leng *et al.* 2020).

The paper is structured as follows. We reviewed existing literature on sustainable transitions, digital platforms, and their application in the construction industry to identify areas where the literature lacks coverage. To address our research inquiries, we opted for a case-study approach. We collected data through ethnographic methods and semi-structured interviews with employees from a digital platform provider who use wooden elements for construction and is specialized in sustainability transitions in the Netherlands. In the findings section, we highlight the challenges for sustainability transitions in the built environment, such as the uniqueness of the construction context, inefficiency in construction practices, and resistance to change, followed by a discussion on how digital platforms address these challenges through an iterative framework in close collaboration with stakeholders. Finally, in the conclusion section, we summarize the findings, theoretical contributions, limitations, and future scope of work.

Literature review

Sustainable transitions

Sustainability transitions research aims to explain long-term and multi-dimensional transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption (Markard *et al.* 2012). The Multi-Level Perspective (MLP) is a popular and valuable framework for analyzing these processes, as its concepts accommodate both radical change and dynamic stability (Ninan *et al.* 2025). It captures influences from technological niches, entrenched industry regimes, and broader landscape contexts and highlight its impact in bringing about sustainability transitions (Geels 2002). The MLP does not merely foreground technological

innovation, but also incorporates changes in consumer behaviour, policies, cultural significance, and business models (Smith *et al.* 2010). The framework has gained significant traction for explicating transitions in diverse domains such as energy (Eitan *et al.* 2023) and mobility (Bohn and Braun 2021), and therefore can be considered pertinent for understanding sustainability challenges in the construction sector.

Whereas early applications of the MLP often depicted transitions as arising from niche innovations scaling up to challenge regime incumbents, recent research recognizes the vital role of projects and strategic initiatives as sites for transition activities (van Bueren and Broekhans 2013, Ninan *et al.* 2025). Strategic projects are not limited to narrow agendas of efficient execution but rather contribute to broader societal and institutional change by inciting radical innovation, fostering new inter-organizational collaborations, and experimenting with novel ways, such as digital platforms to meet societal needs (Gasparro *et al.* 2022). Through the co-evolution of diverse actors and iterative programs of related projects, organizations, and sectors can build the knowledge and capacity required to realize sustainability transitions (Sengers *et al.* 2019). Sustainability transitions need to consider the path dependencies, such as persistently linear, waste-intensive construction logics and potential futures shaped by circularity, low-carbon innovation, and systemic change (Ortiz *et al.* 2009). In line with this perspective, the current study recognizes the urgent need of the construction sector to reconfigure its deeply entrenched practices and explores the transformative potential of digital platforms for sustainability transitions (Hosseini *et al.* 2025).

Digital platforms

According to the European Commission (2016), digital platforms are characterized as software systems that utilize the Internet to facilitate interactions among two or more separate yet interconnected user groups with the aim of creating value. Platforms have a sturdy base of knowledge, different components, and distinct processes (Robertson and Ulrich 1998). It is a digital artifact that structures, mediates, and integrates different stakeholders around a socio-technical infrastructure, thereby enabling them to exchange information, coordinate communication, or organize work (Bogusz *et al.* 2019). It can create a multi-sided network effect through the exchanges of goods and services following layered modular systems with standardized interfaces or design rules enabling interoperability between modules (Yoo *et al.* 2010). From an organizational perspective, it is an evolving organization or meta-organization with a focus on agency and structure as it matches different groups of users to exchange goods and services (Gawer 2014).

Platforms appear in different organizational settings and have modernized industry ecosystems in multiple ways (Hadizadeh *et al.* 2024). They solve business problems for many organizations and end users in the industry, and their integrated information systems can even provide solutions for a broader technological system (Gawer and Cusumano 2014, Kovacic *et al.* 2020). These platforms have the capacity to link demand-side users with supply-side providers, thus democratizing the production process and fostering value creation (Leong *et al.* 2019) and address problems in the sector, such as failures in the market (Chan 2020). They also give temporary access to the idle capacity of resources, as in the case of Airbnb in the accommodation sector, without transferring the ownership, by being a sharing platform (Ranjbari *et al.* 2018). Finally, as more users and suppliers engage with a platform, its appeal increases, highlighting a network effect (Gawer and Cusumano 2014).

Research on digital platform processes highlights how they develop integrative dynamic capabilities in the process of growing their pool of active users (Helfat and Raubitschek 2018). This process, known as platformization, emphasizes viewing platform development as an ongoing process rather than a static endpoint (Islind *et al.* 2019). It extends beyond simply enabling benefits for organizations and end users, delving into the boundaries and boundary work within platforms to understand how they are dynamically influenced by network-level and multi-sided innovation effects (Gawer 2014, Leong *et al.* 2019). Continuous innovation is essential among and across involved parties to foster complementary innovations, thus enhancing the platform's overall value (Gawer and Cusumano 2014). In addition, capturing business value from digital transformation requires orchestrating generative change in culture, governance, and leadership across the entire organization (Petani *et al.* 2023). The Platformization is evident in market leaders, such as Apple, Amazon, Alibaba, Google, Facebook, and Microsoft, resulting in a "platformania" (Cusumano *et al.* 2019), though their impact on the built environment has been less.

Digital platforms in construction

Chan (2020) conducts a review on digital platforms in the built environment highlighting that the digital

platform concept is growing in the sector. In the construction sector, platforms act as a boundary object that integrates numerous tasks and activities while standardizing work methods and allowing for contingencies and local situations (Styhre and Gluch 2010). Platform-based project delivery within the construction sector is reshaping design and construction practices, as well as professional methodologies. This transformation is achieved by altering on-site construction practices, integrating design for manufacture, adopting a platform-centric approach, and fostering openness for manufacturing processes, thereby reconfiguring production systems and transforming skills requirements in the industry (Oti-Sarpong and Burgess 2020). It is relevant for sustainability transitions in the sector as it shares materials, products, and services between actors in value chains and has the potential to reduce waste, promote reuse, and repurpose or recycle materials (Benlian *et al.* 2015).

The platform concept has been applied in different areas of the built environment sector. Platforms radicalize the documentation across the sector through web- or cloud-based systems enabling document-based collaboration across disciplines and supply chains (Singh *et al.* 2011). Collaboration platforms like Building Information Modelling (BIM) serve as a nexus for bringing together project stakeholders, enabling efficient sharing of information and transparent coordination throughout the project lifecycle (Honic *et al.* 2019). The interoperability of BIM in collaborative digital platform environments enables electronic procurement along the supply chain (Grilo and Jardim-Goncalves 2010). The Infrastructure Industry Innovation Partnership (i3P) platform serves as a catalyst for driving innovation within the UK infrastructure sector as it provides a space where diverse organizations to come together, share ideas, form partnerships, and collaborate on innovative solutions aimed at improving the industry as a whole (Ninan *et al.* 2022). Additionally, the UK government has a platform strategy for the delivery of social infrastructure buildings with a focus on standardized kits of components in construction (Wood 2018). In the sustainability front, material reuse and narrowing or closing of the circular loops is possible through digital marketplaces, where materials from maintenance, renovation, and demolition in the built environment find a new home utilizing these platforms (Çetin *et al.* 2022). However, many platforms in the construction industry struggle to achieve success because of the complex nature of their system architecture and the challenges involved in effectively involving a diverse range of stakeholders (Yu *et al.* 2023).

The balance between technology and people is generally complex in organizing a platform with the particular term—platform ecosystem—referring to the organization of stakeholders around a platform (Jacobides *et al.* 2018). This gets even more difficult in a construction platform that requires collective value creation and knowledge management along the value chain (Kovacic *et al.* 2020). For understanding the complexities in working with stakeholders and how digital platforms can enable sustainability transitions, we turn to the value co-creation DART framework.

Value co-creation DART framework

The value co-creation DART framework by Prahalad and Ramaswamy (2004) revolutionizes the understanding of value creation, shifting it from a firm-centric to a customer-centric perspective. They emphasize that value is no longer embedded solely in products or services but is co-created through personalized consumer experiences. This approach marks a significant departure from traditional value paradigms, advocating for interactive and collaborative engagements between firms, consumers, and consumer communities (Fernandes and Remelhe 2016). In this context, the market is redefined as a dynamic forum for conversations, interactions, and shared experiences, where multiple stakeholders contribute to the co-creation of value (Frow *et al.* 2016). The framework highlights that empowered, connected, and informed consumers now play a critical role in scrutinizing, analyzing, and reshaping traditional value creation processes (Chandra and Rahman 2024). With the advent of digital platforms and ubiquitous connectivity, consumers are no longer passive recipients of value but active participants who leverage consumer-to-consumer dialogues and alternative information sources (Svarcaite and Gadeikiene 2023). This empowerment challenges firms to reconfigure their strategies, moving away from isolated decision-making to inclusive and interactive approaches (Rydén *et al.* 2021). Companies must acknowledge that they cannot autonomously design products or dictate marketing strategies without integrating consumer input, as contemporary consumers have the agency to choose relationships based on shared value perceptions (Matarazzo *et al.* 2021).

To operationalize this shift, Prahalad and Ramaswamy (2004) introduced the DART framework, which outlines four key building blocks of consumer-company interactions: Dialogue, Access, Risk-benefits,

and Transparency. Dialogue fosters active engagement between firms and consumers, promoting shared problem-solving, equitable partnerships, and shared learning. Access ensures that consumers can obtain critical information, reducing the dependency on firm-provided data leading to shared information. Transparency addresses the information asymmetry traditionally exploited by firms, requiring openness about risks, costs, and processes, leading to shared trust. Finally, understanding risk-benefits enables consumers and firms to make informed decisions, fostering collaboration and shared risk. In the digital era, these principles are particularly relevant. Dialogue, for instance, manifests through social media platforms where consumers voice their preferences and critiques (Williams *et al.* 2024), influencing product design and service delivery (Rydén *et al.* 2021). Transparency and access are enabled by digital tools that allow real-time updates and direct interactions between firms and consumers (Leng *et al.* 2020). Thus, the DART framework underpins value co-creation and aligns seamlessly with the dynamics of digital platform ecosystems as shown in Figure 1.

While the DART framework offers a robust structure for analyzing value co-creation in digital platform ecosystems, alternative frameworks such as Service-Dominant Logic (SDL) (Vargo and Lusch 2008) can offer distinct perspectives on stakeholder interactions, network formation, and value delivery. SDL positions service systems with configurations of people, technologies, and institutions connected by value propositions, as the fundamental unit of analysis, emphasizing resource integration and value-in-use as central to economic exchange (Vargo *et al.* 2008). While SDL provides a powerful philosophical foundation for understanding co-creation, its abstraction makes empirical application challenging in sectoral contexts like construction. DART, with its four actionable dimensions capture how interactions unfold in practice and have widely been employed to analyze value co-creation at the interactional level (Payne *et al.* 2008). In this study we position DART as complementary to SDL: whereas SDL explains co-creation conceptually as resource integration within service systems, DART provides an operational lens to investigate the mechanisms through which digital platforms in construction enact co-creation under real-world conditions. Thus, DART is favoured here for its pragmatic alignment with value co-creation and platform-based organizations, and its frequent application in construction sector (Lavikka et al 2017).

The DART value co-creation framework offers a robust lens for analyzing how digital platforms in the construction sector facilitate co-creation with diverse stakeholders, thereby addressing sectoral challenges like inefficiencies, stakeholder resistance, and the need for sustainability (Oke *et al.* 2024). By applying the DART principles, this research aims to explore how co-creation

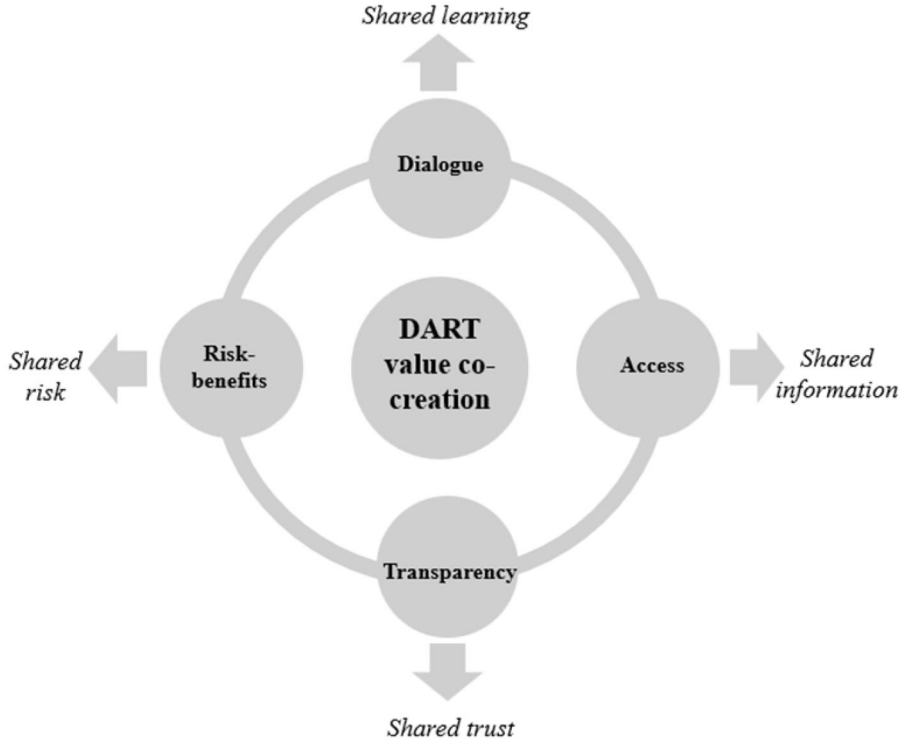

Figure 1. DART co-creation framework (adapted from Prahalad and Ramaswamy 2004).

strategies can be integrated into platform ecosystems to foster innovation and sustainability transitions. This perspective bridges theoretical insights from Prahalad and Ramaswamy (2004) with empirical findings, offering actionable pathways for enhancing collaborative practices in digital platforms. This study extends the DART framework by integrating it into the dynamic and iterative construction sector, highlighting its potential to address industry-specific challenges such as resistance to change and inefficiencies. Thus, in this research, we try to understand the challenges for sustainability transitions in the built environment and how digital platforms can address these challenges and enable sustainability transition through the value-creation framework with a qualitative study of a digital platform provider in the Netherlands.

Research setting and method

A qualitative approach, a single case study method, is used in this research to develop an understanding and create a theoretical framework on how digital platforms can bring about sustainable transitions in the built environment. Researchers argue that conducting a qualitative study focused on a single case provides valuable chances to deepen contextual understanding as it allows for thorough data collection and analysis, enabling researchers to delve deeply into the intricacies of the subject (Lundin and Steinthórsson 2003). The primary goal of single in-depth case study is analytical rather than statistical generalizability, with lessons transferable to comparable contexts where digital platforms mediate sustainability transitions (Yin 2017).

We chose the case study of a platform provider in the Netherlands that has only recently entered the market for the following reasons. First, the company represents an early-stage platform provider that is still experimenting with scaling and market entry, offering a valuable case to study the opportunities and challenges of platform adoption in construction. Second, the company has developed a digital building system platform that enables sustainable construction through prefabricated modular timber elements with detailed digital twin models, where every component is parametrically defined to support purchasing, planning, and quality control. Third, they have a strong emphasis on collaboration with architects, contractors, and clients makes it a particularly suitable case for examining how co-creation principles, as articulated in the DART framework, are enacted in practice. Finally, the Netherlands has an ambition to transform the construction sector and therefore has diverse stakeholders in the supply chain willing to adopt technologies such as digital platforms. Thus, the chosen digital platform provider operates at the frontier of modular, sustainable construction within the Netherlands, thereby enabling a critical case study (Flyvbjerg 2006).

Data was collected through ethnographic methods and semi-structured interviews. One of the researchers was embedded with the company for three months, collecting data on the company's practices. A normal week at work would include a Monday stand-up where everyone shares the personal highlights of the weekend and gives a short plan for the week ahead. Throughout the week, there are additional team meetings to discuss progress and updates, as well as fun breaks during the day where groups enjoy a cup of coffee together or a game of foosball. Through this, the researcher is embedded within the company, often discussing research with the company, enabling engaged scholarship where respondents are actively involved in the research journey and providing guidance (Van de Ven 2007). During fieldwork, daily field notes were kept by the researcher embedded in the platform provider (Deggs and Hernandez 2018). These notes included observations, informal conversations, and reflections on interactions to capture context and nuance, beyond what scripted interviews record (Oswald and Dainty 2020). To manage bias, we used reflexive journaling, including recording the researcher's own assumptions and how prior experiences might influence interpretation, and discussed these in regularly (Subramani 2019). Triangulation was performed by cross-checking field note narratives with semi-structured interview transcripts to ensure consistency of themes. Ethical approval was obtained from the Institutional Ethics Board and participants were assured of confidentiality, and identifiable data were anonymized in transcription and reporting. The use of ethnographic methods allowed for a nuanced understanding of day-to-day interactions, which is crucial for capturing the co-creation dynamics central to the DART framework.

Additionally, we conducted semi-structured interviews with members from the platform provider company to identify the challenges for sustainability transitions and how digital platforms address these challenges to create a theoretical framework. Eleven interviews were conducted with specialists from different departments, so unique points of view could be compared and analyzed. The interviewees were selected based on their position in the company and their department so that each of the existing departments (business development, engineering, and

software) inside the company would have representatives. This diversity ensured that both technical and strategic dimensions of platform adoption were represented. Thus, we interviewed four people from business development, four people from engineering, and three people from software departments. We asked open-ended questions such as, what are some steps you take towards achieving sustainability? What are the challenges you face? How was this challenge resolved? The general semi-structured interview questions were designed to elicit general experiences and in-depth follow-up with "why" and "how" questions (Adams 2015) probed specifically into the sustainability transition barriers, drivers, platform-enabled solutions, as well as approaches to circularity, carbon reduction, and co-creation with stakeholders. The same interview questions were used in a semi-structured format with multiple people from the same department to find a common ground of understanding and thereby reduce the subjectivity and enable fact-checking of the findings. Interviews and ethnographic engagement continued until thematic saturation was reached with the recurrence of core themes and the absence of new insights (Boddy 2016). This follows the recommendation of 6 to 12 in-depth interviews for theoretical saturation in single case qualitative research studies by Guest *et al.* (2006). The details of the interview respondents are shown in Table 1.

We employed a qualitative thematic analysis to inductively discern, compare, and contrast recurrent themes within the dataset (Braun and Clarke 2012). Throughout the coding process, we carefully examined ethnographic notes and interview transcripts. Our focus was on identifying challenges related to sustainability transitions within the built environment and how digital platforms attempt to tackle these challenges. We categorized each incident based on patterns that emerged from our data. This approach allowed us to develop overarching themes pertaining to the identified challenges, such as the "uniqueness of the construction context", "inefficiency in construction practices", and "resistance to change". We also created broad categories of how digital platforms address these challenges, such as "vision for the platform", "better processes", "digitalization and automation", "scalability", and "co-creation with stakeholders". For example, statements concerning future-oriented sustainability ambitions and integrative goals were grouped under "vision for the platform", while accounts of streamlining workflows, reducing errors, and minimizing rework informed the "better processes" category. We then systematically linked emergent themes from the data to the DART framework by examining how practices identified by respondents corresponded with the four dimensions of Dialogue, Access, Risk-benefit, and Transparency. This step ensured that our interpretation of data was grounded in theory, rather than remaining at a purely descriptive level. Thus, by systematically categorizing data, we compiled a comprehensive list of challenges and examined how digital platforms tackle them as shown in Table 2.

Subsequently, we engaged in multiple rounds of coding, cross-referencing, and theoretical review, following the approach outlined by Strauss and Corbin (1998). In doing so, we adhered to Eisenhardt's (1989) guideline on "building theories from case study research", which emphasizes grounding new theories in existing literature, enhancing internal validity, and facilitating generalizability.

Table 1. Details of interview respondents.

Sl. No.	Designation	Duration of interview (min)
1	Head projects and partnerships	20
2	Head business developer	25
3	Engineering team employee	20
4	Business developer	34
5	Buildings systems engineer	27
6	Head engineering team	21
7	International business employee	29
8	Head software developer	25
9	Software developer employee	30
10	Parametric designer	45
11	International projects employee	41

Findings

In this section, we present the different challenges for sustainability transitions in the construction sector and how digital platforms addresses these challenges. These are discussed below.

Challenges for sustainability transitions

The challenges for sustainability transitions include the uniqueness of the construction context, inefficiency in construction practices, and resistance to change.

1. Uniqueness of the construction context: The construction industry is different from other industries because of its unique nature characteristics resulting from customized products and endogenous design, due to which it ends up with different-looking buildings based on different systems (Luo and Chen 2023). The business developer respondent highlighted,

> *"Well, it is one thing to have the knowledge of that in our company … but then figuring out a way that you*

Table 2. Coding structure.

1st order concepts	2nd order themes	Aggregate dimensions
Each project has unique requirements making standardization difficult	Uniqueness of the construction context	Challenges for sustainability transitions
Fragmentation of construction industry	Uniqueness of the construction context	Challenges for sustainability transitions
Implementing projects in someone else's routine is complex	Uniqueness of the construction context	Challenges for sustainability transitions
Design comes first in construction followed by how to build it	Uniqueness of the construction context	Challenges for sustainability transitions
System is too complicated to keep track of and doing it manually is inefficient	Inefficiency in construction practices	Challenges for sustainability transitions
Construction projects are manual and inefficient	Inefficiency in construction practices	Challenges for sustainability transitions
Adding sustainability to the already complex system will make it more complicated	Inefficiency in construction practices	Challenges for sustainability transitions
Stakeholders resist change, preferring traditional methods	Resistance to change	Challenges for sustainability transitions
Complex regulatory environment for sustainable materials	Resistance to change	Challenges for sustainability transitions
Vision of building faster, safer, sustainable, flexible, and easier	Vision for the platform	Digital Platform addressing challenges
Vision of balancing multiple objectives with automation and platformization	Vision for the platform	Digital Platform addressing challenges
Vision for the future considering future carbon footprint of built environment	Vision for the platform	Digital Platform addressing challenges
Vision to integrate everything from raw material to final product	Vision for the platform	Digital Platform addressing challenges
Streamlining work processes for sustainability efficiency with fewer mistakes	Better processes	Digital Platform addressing challenges
Standardization and process optimization to reduce personnel dependence	Better processes	Digital Platform addressing challenges
Better processes can address inefficiencies and complexities in the industry	Better processes	Digital Platform addressing challenges
Implementing automation and AI for design and construction	Digitalization and automation	Digital Platform addressing challenges
Investments in automation is their company's strongest selling point	Digitalization and automation	Digital Platform addressing challenges
Automation reduces overheads in planning	Digitalization and automation	Digital Platform addressing challenges
Ensuring scalability for multiple users and global markets	Scalability	Digital Platform addressing challenges
Platform value is realized only when scaled	Scalability	Digital Platform addressing challenges
Create a loop between front end and back end for information flow	Co-creation and stakeholders	Digital Platform addressing challenges
Engaging stakeholders through participatory design	Co-creation and stakeholders	Digital Platform addressing challenges
Continuous dialogue with stakeholders to refine platform design	Co-creation and stakeholders	Digital Platform addressing challenges

> *can implement that in someone else's company … it is not as easy as selling a product as in an iPhone or something. Or selling software like Photoshop. There is a very specific way people do this – to do projects in the building environment, with different regulations, and groups."*

This quote illustrates how path dependency in construction practices constrains sustainability transitions: while platforms promise efficiency, their success depends on embedding within entrenched workflows that are resistant to external imposition. Unlike in more standardized industries, this sectoral uniqueness creates additional barriers to scaling sustainability innovations across regions. Thus, construction projects have to be implemented in someone else's routine, which makes implementing sustainability in a digital platform structure complex. There is also uniqueness in the construction processes, with construction activities being client-driven rather than design/optimization-driven. The head of the engineering team remarked that the design comes first in the building industry, followed by how to construct it, which is very different from other engineering branches, as noted below,

> *"The details of a building like a traditional building we sort of say first like … okay this is what we're gonna build and now we're gonna figure out how … and that doesn't happen in other engineering branches … like you don't just haphazardly draw a plane and then figure out how you're gonna make it fly"*

In the Dutch context, the uniqueness of construction processes is further compounded by diverse municipal regulations on sustainable materials and building

permits. Working in one municipality may not easily translate to another, making platform adoption complex. Thus, the construction context is complex because of the unique nature of the construction product and also due to the uniqueness in construction processes.

2. Inefficiency in construction practices: Construction processes have traditionally been handled by people with manual systems, and these processes are subjective, time-consuming, and inefficient (Yang *et al.* 2020). A respondent highlighted that the building system is too complicated to manage by a person, and automation can assist people in keeping track of combinations that one cannot remember, as noted below.

> *"The building system is too complicated for a person to keep track of too many parts with too many small differences between them that like you will miss them so you need machines to assist you so that they can see the details that you can't and keep track of combinations that you cannot remember"*

Construction processes are inefficient with large numbers of errors, changes, and reworks (Ding *et al.* 2019). Rather than simply reflecting technical shortcomings, these inefficiencies point to structural weaknesses, where fragmented responsibilities and manual practices amplify complexity. The reliance of the respondent on automation as a solution underscores how digital platforms can shift the locus of expertise from tacit, individual knowledge to codified, collective knowledge, which is a prerequisite for systemic sustainability transitions.

Adding sustainability to building systems would make them more inefficient as it adds to existing complexity, and this is where digital platforms can contribute. For example, regulations mandating energy performance standards in the Netherlands often create more inefficiency in construction practices and digital platforms can help practitioners document compliance more systematically and enable sustainability transitions.

3. Resistance to change: The construction industry includes many stakeholders who are resistant to change including owners and contractors who express dissent by slowing, opposing, or obstructing a change management effort (Lines *et al.* 2015). A respondent highlighted that construction has worked in a particular way for years and stakeholders are comfortable in those practices and resistant to sustainability transitions, as noted below,

> *"There is always resistance from the more traditional builders. A lot of them are very profitable companies, and they are doing fine and coming in and saying, you should be more sustainable was a very confronting and fundamentally challenging thing for a lot of these companies."*

This resistance should not be dismissed as conservatism alone but can be understood as a rational response to uncertainty: established actors perceive sustainability transitions as threatening existing profit models. Digital platforms, therefore, must not only demonstrate technical benefits but also reshape incentive structures to make sustainability a competitive advantage. Stakeholders need to be engaged to understand their concerns and value propositions in sustainability transitions through a strategic and sensitive process.

Digital platform addressing challenges

From our study on the digital platform for sustainability transitions in the Netherlands, we found five different practices that addressed the challenges and enabled a sustainable transition: vision for the platform, better processes, digitalization and automation, scalability, and co-creation with stakeholders. These are discussed below,

1. Vision for the platform: Vision for the platform refers to the articulation of a shared, future-oriented narrative that aligns sustainability goals across diverse stakeholders. One respondent highlighted the platform's vision in this case as building faster, safer, sustainable, flexible, and easier. Another respondent recorded that they are trying to balance the multiple objectives in the construction sector with automation and platformization, as noted below,

> *"We try to really create this integrated design process … that it's suddenly possible to also assure quality interface for the users but also for the builders and also from a climatic perspective, from an aesthetic perspective, …. so we try to do it on many areas … what you do see is if you optimize one quality of housing it usually means that the other ones decrease slightly and we are always trying to find the sweet spot and I think automation allows you to have this more integrative design process."*

The emphasis on balancing multiple objectives reflects the contested nature of sustainability transitions, where trade-offs between aesthetics, cost, and carbon reduction cannot be eliminated but must be negotiated. Here, the platform functions as a boundary object, facilitating dialogue across professional silos. Along with a vision for the platform, there should also be a vision for the future. In one instance, the international projects employee highlighted that a lot of carbon footprint in the built environment is after the project is built, and a service architect should have a vision to reduce this as noted below.

> *"A lot of the carbon footprint is actually after it's being built … that's where it accumulates, and I think the architect or the builder should be responsible for that … so I'm really in favour of this service architect as a service but we are not there yet I think."*

This vision aligns strongly with national ambitions in the Netherlands for circular construction and carbon neutrality by 2050, which respondents saw as legitimizing their strategy. In another case, a respondent recorded that "*the end game is to supply the chain that integrates everything from the raw material to the final product and makes sure of the circularity*." Such narratives of the future are instrumental in creating the organization's brand and giving an identity that employees can resonate with while moving towards the goals of the sector (Sergeeva and Ninan 2023). The vision of the platform encapsulates its intent to harmonize sustainability and performance by integrating diverse objectives like speed, cost, aesthetics, and climate considerations. This alignment exemplifies dialogue within the DART framework (Prahalad and Ramaswamy 2004), fostering collaborative engagements among stakeholders. The platform serves as a forum where architects, engineers, and business developers actively negotiate and align on a shared vision for sustainable construction. This approach not only streamlines expectations but also strengthens the platform's ability to meet the unique demands of diverse projects.

2. Better processes: Better processes refer to the reconfiguration and standardization of construction workflows to reduce errors, waste, and coordination inefficiencies that hinder sustainability transitions. Sustainability transitions are only possible in the construction sector by identifying waste, analyzing the production of this waste, and acting on it to reduce it through better processes (Serpell and Alarcon 1998). The head of projects and partnerships underlined that a sustainable transition to better materials in construction is only possible with a flawless project process resulting in fewer mistakes, downtime, and money spent, as below.

> *"One of the ways we can make this transition away from concrete and steel is to show that our buildings are just as good – if not better than their traditional counterparts. It also means flawless project process – so, it is less mistakes, less downtime, and less money spent."*

Better processes also involve streamlining how work is done so that it is no longer personnel intensive. A respondent highlighted that through a change to the process-based system, construction is no longer personnel intensive, and more work could be possible, as noted below.

> *"Before that, we were just an architect that does design and our own engineers sort of analyse and so on. But that was very personnel intensive, and it wasn't spread out as much. When we made the change to a process-based system, we realized that more is possible."*

The software developer employee recorded that the company needs to convince users that they needn't build their own house rather, it would be possible to buy an efficient one because it has better processes. Better processes in platformized construction directly address the inefficiencies and complexities inherent in the industry. The shift toward streamlined and automation-aided workflows highlights the principle of risk-benefit assessment within the DART framework (Prahalad and Ramaswamy 2004), where stakeholders mitigate risks through well-designed and reliable systems. By eliminating redundancies and errors, these improved processes provide a foundation for trust among users and underscore the platform's role in risk minimization.

3. Digitalization and automation: Digitalization and automation denote the embedding of sustainability-relevant knowledge into software tools and automated systems to improve performance across projects. Better processes need to be digitalized and automated to improve sustainability and the overall development of the sector (Olawumi *et al.* 2022). In an instance, a respondent highlighted that by using software, they were

able to implement projects faster, more efficiently, and more sustainable compared to traditional methods, as noted below,

> *"One of the biggest developers had a building that they had to repeat a lot of times … It was built using traditional methods – concrete and steel and a bit of wood … And it is very cheap and very efficient. And then to build it for repetition, they needed at speed … We were able to rebuild their projects in wooden modules, and we were able to show to them that it is cost-efficient, it is faster, and it is more sustainable to do the same thing in a more sustainable way … It was because of the software that we produce these things faster."*

Importantly, the claim of efficiency gains extends beyond cost-saving rhetoric: it demonstrates how automation reconfigures the distribution of agency in construction projects. By embedding sustainability criteria into software, platforms effectively normalize sustainable options, reducing reliance on individual champions and making transitions more systemic. Another respondent highlighted that investing in software and automation is part of platform building, and their company's strongest selling point is their investment in them, as noted below,

> *"I think automation is a very big part of that which separates us from most building companies … that we take the automation like the amount of money that we put into automating and creating software is I think ten times higher than any other building company out there … so that's I think our strongest selling point"*

The parametric designer recorded that investing in automation allows reducing overheads in the planning since one does not need too much time to understand priority areas of the system for optimization. Digitalization and automation enhance access by democratizing information flow and reducing the dependency on traditional knowledge silos. The platform's capability to provide real-time data, optimize workflows, and scale operations fosters transparency, a critical element in co-creation in the DART framework (Prahalad and Ramaswamy 2004). By integrating tools like digital twins and automated design systems, the platform reduces ambiguity, empowering stakeholders to make informed decisions that align with sustainability goals.

4. Scalability: Scalability highlights the ability of the platform to apply standardized yet adaptable solutions across multiple projects, organizations, and geographic contexts. Platforms are generally organized differently to improve their efficiency. A respondent highlighted that being able to transform to different teams, skills, and organizing styles is vital for platforms to bring sustainability transitions in the built environment, as below,

> "The company had more people in the past … it was an architecture office … we grew into a software and engineering team, and we shifted from private clients to business clients"

Scalability also entails being integrated into a platform society, where social and economic interactions are increasingly facilitated through a network of interconnected digital platforms (de Waal *et al.* 2017). The business developer highlighted that because they have a scalable business, they were able to expand to multiple markets with fewer people compared to a traditional architectural firm, as noted below.

> *"In a traditional setup, an architectural firm, if they wanted to spread out, as much as we did – they need hundreds of people … we manage to do it with 20-something people. So having scalable business … that you can implement a technology at many different places, so people of any country can use the technology for their market – because they do business and we are just providing the tools"*

Value for a digital platform is realized only when it is scaled appropriately. The scalable aspect of platforms in the construction sector is an under-researched topic and future research should examine how platforms create, sustain, and grow the number of users rather than updating and refining new features (Chan 2020). Scalability, as a critical feature of platform functionality, aligns with access within the DART framework (Prahalad and Ramaswamy 2004), by ensuring that solutions are applicable across diverse contexts and regions. The ability of the platform to adapt its tools for various markets and clients ensures that its benefits are not confined to a specific set of users but are distributed widely. This ability to grow with minimal overhead signifies a robust strategy to proliferate sustainable practices globally.

5. Co-creation with stakeholders: Co-creation with stakeholders involves the continuous involvement of diverse actors in shaping platform features and processes. The construction sector has a lot of subjectivity, and components can mean something different to everyone, thereby necessitating

Table 3. Platform practices and DART principles.

Platform practices	DART principles	Example from case
Vision for the platform	Dialogue	Shared sustainability vision with architects, engineers, and developers to balance cost, aesthetics, and embodied carbon.
Better processes	Risk-benefit assessment	Standardized workflows enabling automated checking reducing rework and on-site errors in timber projects.
Digitalization and automation	Access and transparency	Use of digital models of timber elements that automatically generate material quantities and sustainability-related information.
Scalability	Access	Deployment of the same parametric building system across multiple projects such that local teams could configure buildings using standardized component libraries without increasing staff.
Co-creation with stakeholders	Dialogue	Iterative feedback loops where client-specific requirements are incorporated into the platform by adjusting design parameters to build trust and align expectations.

close collaboration with stakeholders to deliver value. One respondent highlighted that stakeholder requirements are different, and platforms should listen to them to feed it back to the system, thereby creating a loop between the front end and the back end, as noted below,

> *"A private developer might have different requirements than a certain housing corporation or some other company … so listening to these requirements and understanding what it means to our systems and feeding that back into system makes it a better system offering in total …. So, it is like creating this loop between the front and the back end."*

This highlights that co-creation is not merely about participation but about mediating competing priorities. In sustainability transitions, stakeholder diversity often leads to contestation rather than consensus; platforms provide a structured space where transparency and iterative dialogue can convert potential conflicts into shared design logics. Similarly, one respondent observed that Dutch clients are increasingly asking for transparent data on lifecycle emissions, which strengthens the co-creation dynamic. This might not be the case in other markets where such data disclosure is not demanded, and co-creation may revolve more around cost and speed rather than sustainability. The parametric designer exclaimed that rather than radical changes, co-creating with stakeholders would include more communication, skill building, and collaboration with stakeholders to improve the system little by little, as noted below,

> *"We are starting very recently through simple more human communication … more skill building … more collaboration with stakeholders … we are improving the system of work, and we should do it little by little"*

Constant communication, transparency, and asking the right questions to make the right value proposition are some tactics that can be applied to re-iterate and have continuous improvement in the platform. Success often comes in the form of high-quality results and reliable partnerships that are not always quantifiable, such as a sense of satisfaction for the business partner or equitable advancement for all involved stakeholders (Salamzadeh *et al.* 2024). The principle of dialogue underpins co-creation with stakeholders in the DART framework (Prahalad and Ramaswamy 2004). Continuous communication and iterative feedback loops enable platforms to refine their offerings in response to user needs. By fostering a participatory approach, the platform not only resolves stakeholder resistance but also builds long-term partnerships. Such iterative collaborations ensure that the platform evolves dynamically, responding to both immediate and future sustainability challenges.

These practices in the digital platform can be anchored in the DART principles as shown in Table 3.

Our analysis demonstrates how the five practices identified in the case study operationalize the DART framework. Vision building fosters dialogue, better processes mitigate risk-benefit imbalances, digitalization enhances transparency and access, scalability extends access across markets, and co-creation maintains dialogue with diverse stakeholders. This mapping illustrates how the abstract DART principles can be enacted in practice within construction sustainability transitions.

Discussion

Iterative framework for sustainability transitions

While prior studies have demonstrated the potential of digital platforms to improve coordination and efficiency in construction (Chan 2020, Kovacic *et al.* 2020), limited research has examined the mechanisms through which platform-based collaboration and value co-creation actually unfold in practice. To address this gap, Figure 2 presents a circular and iterative framework, demonstrating how platforms embed the four dimensions of DART into five

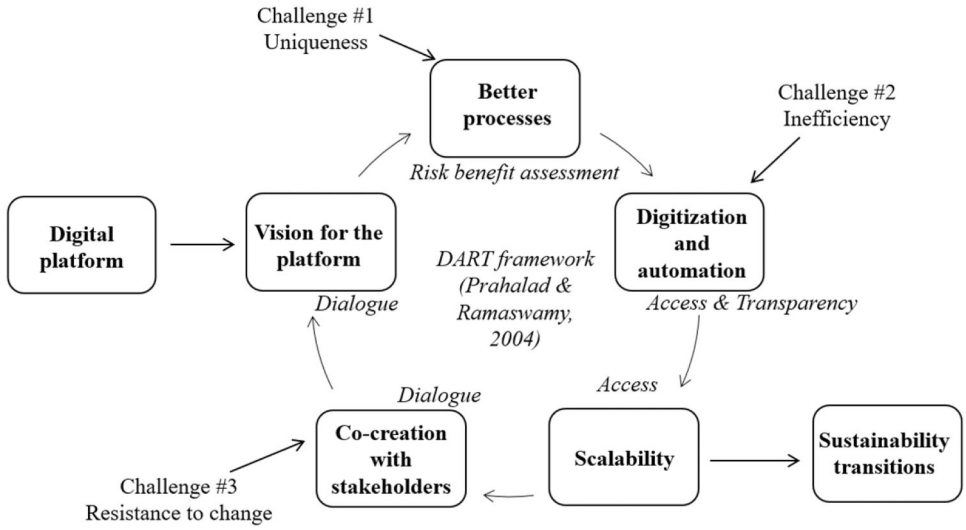

Figure 2. Framework of the digital platform enabling sustainability transitions.

platform practices: vision for the platform, better processes, digitalization and automation, scalability, and co-creation with stakeholders.

By systematically mapping platform practices to DART, this study extends the framework beyond the consumer—company contexts in which it was originally developed (Prahalad and Ramaswamy 2004). In construction, Dialogue involves not only bilateral communication but the negotiation of shared visions among diverse professional groups. Access and Transparency are realized through digitalization tools such as digital twins, which help mediate complex regulatory and design requirements. Risk-benefit is embedded through automation and process optimization that minimize uncertainty and error. These insights show how DART can be re-contextualized for multi-actor, project-based settings such as construction, where coordination and trust are critical (Svarcaite and Gadeikiene 2023).

Vision for the platform, better processes, digitization and automation, scalability, and co-creation with stakeholders are interwoven with dialogue, access, risk management, and transparency, forming a self-reinforcing framework of continuous improvement. Co-creation fosters mutual value generation by involving stakeholders in the development and governance of the platform, thereby reducing information asymmetries and enhancing collaborative innovation (Matarazzo *et al.* 2021). The iterative nature of digital platforms allows them to evolve dynamically as users provide feedback and as new technologies and regulations emerge. This adaptability is essential in a sector characterized by project uniqueness and regulatory diversity (Oti-Sarpong and Burgess 2020). Embedding feedback loops ensures sustained stakeholder engagement and operational resilience (Robertson and Ulrich 1998).

Mechanisms of platform-based co-creation

Co-creation is central to how digital platforms transform construction practices. Our findings reveal that effective platform-based collaboration relies on continuous feedback between digital tools, organizational processes, and stakeholder relationships. Dialogue facilitates the negotiation of visions among architects, engineers, and developers, while Access and Transparency enable real-time data sharing and collective decision-making. Through digital tools such as automated design systems and digital twins, stakeholders can jointly evaluate sustainability outcomes, thereby reducing inefficiencies and enhancing trust. Having a feedback loop between platform strategies and stakeholder input is crucial for responding to the sector's inherent diversity. Recognizing and incorporating stakeholder perspectives enhances service quality and user satisfaction, increasing the legitimacy of the digital platform (Bakardjieva 2019). Successful platforms are therefore not necessarily the most technologically advanced, but those that cultivate participation and shared ownership among users (Rietveld *et al.* 2019).

Sustainability transitions in construction emerge through the interaction of digital, physical, and social elements (Bernsteiner and Ninan 2024). The digital layer, which is manifested in platforms and digital twins, interfaces with the physical layer of modular timber components and prefabricated processes. Both are embedded in the social layer of stakeholder collaboration, regulatory incentives, and cultural

acceptance of sustainability. The studied platform acts as a socio-technical mediator among these dimensions: digital tools embed sustainability criteria into design and production, physical systems enable material efficiency and circularity, and social processes of co-creation reduce resistance and promote adoption. We thus argue that the digital, physical, and social elements do not simply coexist, rather they co-evolve through tightly coupled feedback loops in which digital artifacts encode physical constraints and social priorities.

Thus, we argue that platform-based co-creation operates through both technological mediation and social negotiation. Digital infrastructures shape how actors collaborate, while stakeholder engagement defines how technology is used and improved. This dual process explains the mechanics of platform collaboration that are often overlooked in existing research on construction digitalization, moving the discussion beyond potential benefits to the actual mechanisms that enable value co-creation in practice.

Policy and practical implications

The effectiveness of the iterative framework depends not only on firm-level practices but also on the policy and institutional context that supports digital transformation. In the Netherlands, initiatives such as digiDeals (Pol 2023), led by the Bouw Digitaliseringsraad, have brought together 61 supply-chain partners committed to accelerating digitalization through data sharing and interoperability. These efforts reinforce the emphasis of the framework on process efficiency and collaboration. Similarly, national housing policy promoting modular and prefabricated construction supports the scalability of digital platforms (Wood 2025). At the same time, fragmented municipal building codes and varying subsidy schemes can constrain platform scaling across regions, since solutions optimized for one context may require adaptation elsewhere (Oorschot and Asselbergs 2021). This tension illustrates how government agendas can both reinforce and hinder platform adoption in the process supporting experimentation and diffusion in some areas while creating compliance hurdles in others. Additionally, the scalability of digital platforms is constrained with the localized nature of construction projects. These tension highlights that platform scalability is not frictionless but depends on the careful alignment of digital standards with local socio-technical environments.

The Dutch context, with its strong regulatory commitments to circularity and carbon neutrality, provides both enabling and constraining conditions for digital platforms. In more centralized or coordinated markets, scaling may be faster, while in regions with weaker policy incentives, adoption may be slower. Nonetheless, the insights from this study have broader relevance. Sustainability transitions involve interactions between niche innovations, established regimes, and broader landscape pressures (Geels 2002) and digital platforms function as strategic projects, simultaneously delivering localized efficiencies and catalyzing broader socio-technical change through iterative learning (van Bueren and Broekhans 2013, Sengers *et al.* 2019).

To translate these insights into actionable practice, we propose several implementation strategies. First, to address project uniqueness, platforms can provide configurable modular product libraries and standardized BIM families that allow site-specific customization while maintaining interface standardization. Second, to reduce inefficiency, integrating BIM with life-cycle assessment (LCA) plug-ins can make embodied-carbon and material-use trade-offs visible during design and automatically link outputs to prefabrication schedules, reducing rework and manual translation errors. Third, to overcome resistance to change, platforms can employ participatory design workshops, in-platform training, and phased pilot projects that demonstrate measurable improvements in speed, cost, and carbon performance. Finally, to resolve data-sharing barriers, data governance protocols such as tiered access or anonymization (Turner *et al.* 2020) can balance transparency with commercial confidentiality.

Platforms can also facilitate modular procurement and supplier matchmaking to reduce fragmentation and promote sustainable materials (Durgam and Ramani 2025). These strategies collectively foster the continuous stakeholder engagement necessary for long-term success. By applying the DART framework to the construction sector, this study contributes to understanding how co-creation principles can address inefficiency, resistance, and fragmentation. The iterative framework provides a practical roadmap for platform providers to enhance collaboration and for policymakers to craft supportive environments. By emphasizing vision for the platform, better processes, digitalization and automation, scalability, and co-creation with stakeholders, digital platforms can evolve into active agents of sustainability, thereby aligning industrial efficiency with environmental and societal goals.

Conclusion

The research sought to explore the challenges for sustainability transitions in the built environment and how digital platforms can address these challenges to enable sustainability transition. From the case study of a digital platform provider using wooden elements for construction and specializing in sustainability transitions in the Netherlands, we highlighted different challenges, such as the uniqueness of the construction context, inefficiency in construction practices, and resistance to change. These challenges are effectively addressed through the application of co-creation principles. By fostering dialogue, the platform engages stakeholders in iterative design processes; access ensures stakeholders can leverage critical information to align with sustainability goals; risk-benefit frameworks minimize project uncertainties; and transparency builds trust across diverse stakeholder groups. We observed five different practices, which addressed the challenges and enabled a sustainable transition—vision for the platform, better processes, digitalization and automation, scalability, and co-creation with stakeholders. These practices align with the DART framework of co-creation, highlighting how interactive stakeholder engagement and iterative improvement cycles enable platforms to bridge the gap between traditional practices and sustainable innovation. The relationship between the challenges and how digital platforms address these challenges is depicted through a circular, iterative framework.

This research makes multiple contributions to the digitalization of the built environment. First, we highlight how the integration of stakeholder voice is central to the construction industry, considering the unique nature of projects. Second, we highlight how the iterative nature combines digital, social, and physical elements and how these shape each other. Third, we record how platform digitalization and automation can address inefficiency in the sector. We thus created a framework of digital platforms enabling sustainability transitions. For policymakers, this study provides insights into how digital platforms can be promoted through incentive structures that encourage co-creation among stakeholders, while practitioners can adopt the iterative framework to navigate challenges like inefficiency and resistance to change.

We offer multiple directions for future research. First, investigating how platforms can be organized and scaled in different built environment markets is necessary with an exploration of micro-practices of how different stakeholders are engaged in a construction platform. This could include a more detailed and explicit examination of power asymmetries among stakeholders and their influence on digital platform adoption and sustainability outcomes. Such work would extend the foundations laid in this study and deepen the understanding of the socio-political complexities underpinning sustainability transitions in construction. Second, while this single case study is grounded in the Dutch context limiting broader applicability of the contextual findings, the iterative and co-creation-centric design of the theoretical framework allows it to be adapted to other regions with similar challenges in the construction sector. Future research could strengthen validation through multi-case comparisons across different platform providers and cross-cultural studies which could reveal how variations in regulatory regimes, market incentives, and cultural attitudes toward digitalization shape the enactment of dialogue, access, risk–benefits, and transparency. This research, therefore, tries to inspire researchers to shed light on the evolving landscape of sustainable construction practices facilitated by digital platforms considering the interaction between digital, physical, and social elements. Finally, our findings are largely qualitative with respondents observing tangible proxy improvements such as fewer reworks, faster assembly, improved alignment in production, etc. There is a need for future research to systematically capture metrics like embodied carbon per m^2, waste percentage, and cost savings to empirically substantiate claims about sustainability transition enablement.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

Adams, W.C., 2015. Conducting semi-structured interviews. In: *Handbook of practical program evaluation*. London, UK. 492–505.

Antai, I., Lenka, S., and Achtenhagen, L., 2025. Digital platforms and the construction supply chain: trends and emerging themes in extant AEC research. *Construction management and economics*, 43 (2), 113–129.

Bakardjieva, M., 2019. Platform politics in Europe | A tale of three platforms: collaboration, contestation, and degrees of audibility in a Bulgarian e-municipality. *International journal of communication*, 13, 19.

Benlian, A., Hilkert, D., and Hess, T., 2015. How open is this platform? The meaning and measurement of platform

openness from the complementors' perspective. *Journal of information technology*, 30, 209–228.
Bernsteiner, J. and Ninan, J., 2024. Actor-networks in sustainable transport transformation: the case of the Catharijnesingel restoration. *ICE municipal engineer*, ahead of print, 1–13.
Boddy, C.R., 2016. Sample size for qualitative research. *Qualitative market research: an international journal*, 19 (4), 426–432.
Bogusz, C., Teigland, R., and Vaast, E., 2019. Designed entrepreneurial legitimacy: the case of a Swedish crowdfunding platform. *European journal of information systems*, 28 (3), 318–335.
Bohn, S. and Braun, T., 2021. Field-configuring projects: how projects shape the public reflection of electric mobility in Germany. *International journal of project management*, 39 (6), 605–619.
Braun, V. and Clarke, V., 2012. Thematic analysis. *APA handbook of research methods in psychology*, 2, 57–71.
Çetin, S., Gruis, V., and Straub, A., 2022. Digitalization for a circular economy in the building industry: multiple-case study of Dutch social housing organizations. *Resources, conservation & recycling advances*, 15, 200110.
Chan, P.W., 2020. Construction in the platform society: new directions for construction management research. In: L. Scott and C. Neilson, eds. *Proceedings of the 36th annual conference of the association of researchers in construction management*.
Chandra, B. and Rahman, Z., 2024. Artificial intelligence and value co-creation: a review, conceptual framework and directions for future research. *Journal of service theory and practice*, 34 (1), 7–32.
Charef, R. and Lu, W., 2021. Factor dynamics to facilitate circular economy adoption in construction. *Journal of cleaner production*, 319, 128639.
Cusumano, M.A., Gawer, A., and Yoffie, D.B., 2019. *The business of platforms: strategy in the age of digital competition, innovation, and power*. Vol. 320. New York, NY: Harper Business.
Dana, L.P., *et al.*, 2022. Urban entrepreneurship and sustainable businesses in smart cities: exploring the role of digital technologies. *Sustainable technology and entrepreneurship*, 1 (2), 100016.
De Waal, M., De Lange, M., and Bouw, M., 2017. The hackable city: citymaking in a platform society. *Architectural design*, 87 (1), 50–57.
Deggs, D. and Hernandez, F., 2018. Enhancing the value of qualitative field notes through purposeful reflection. *The qualitative report*, 23 (10), 2552–2560.
Ding, Z., *et al.*, 2019. A digital construction framework integrating building information modeling and reverse engineering technologies for renovation projects. *Automation in construction*, 102, 45–58.
Durgam, H. K., R., and Ramani, P. V., 2025. Green construction supply chain: Reviewing advancements, obstacles, and possibilities. *Cleaner Logistics and Supply Chain*, 100259.
Egan, J., 1998. *Rethinking construction*. London: Department of the Environment, Transport and Region (DETR).
Eisenhardt, K.M., 1989. Building theories from case study research. *Academy of management review*, 14 (4), 532–550.
Eitan, A., Fischhendler, I., and van Marrewijk, A., 2023. Neglecting exit doors: how does regret cost shape the irreversible execution of renewable energy megaprojects? *Environmental innovation and societal transitions*, 46, 100696.
Escamilla, E.Z., Habert, G., and Wohlmuth, E., 2016. When CO_2 counts: sustainability assessment of industrialized bamboo as an alternative for social housing programs in the Philippines. *Building and environment*, 103, 44–53.
Etminan, G., *et al.*, 2019. *Supporting digitalisation of the construction sector and SMEs including building information modelling European commission legal notice*. Brussels: European Commission.
European Commission, 2016. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions—online platforms and the digital single market opportunities and challenges for Europe.
European Commission, 2020. Digital platform for construction in Europe | DigiPLACE Project | Fact Sheet | H2020 | CORDIS | European Commission. Available from: https://cordis.europa.eu/project/id/856943.
Fernandes, T. and Remelhe, P., 2016. How to engage customers in co-creation: customers' motivations for collaborative innovation. *Journal of strategic marketing*, 24 (3–4), 311–326.
Flyvbjerg, B., 2006. Five misunderstandings about case-study research. *Qualitative inquiry*, 12 (2), 219–245.
Frow, P., McColl-Kennedy, J.R., and Payne, A., 2016. Co-creation practices: their role in shaping a health care ecosystem. *Industrial marketing management*, 56, 24–39.
Garner, P., 2024. Most polluting industries in 2024 revealed. Heatable. Available from: https://heatable.co.uk/boiler-advice/most-polluting-industries [Accessed 15 February 2024].
Gasparro, K., *et al.*, 2022. Vanguard projects as intermediation spaces in sustainability transitions. *Project management journal*, 53 (2), 196–210.
Gawer, A. and Cusumano, M.A., 2014. Industry platforms and ecosystem innovation. *Journal of product innovation management*, 31 (3), 417–433.
Gawer, A., 2014. Bridging differing perspectives on technological platforms: toward an integrative framework. *Research policy*, 43 (7), 1239–1249.
Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy*, 31 (8–9), 1257–1274.
Grilo, A. and Jardim-Goncalves, R., 2010. Value proposition on interoperability of BIM and collaborative working environments. *Automation in construction*, 19 (5), 522–530.
Guest, G., Bunce, A., and Johnson, L., 2006. How many interviews are enough? An experiment with data saturation and variability. *Field methods*, 18 (1), 59–82.
Hadizadeh, M., *et al.*, 2024. Digital platforms as a fertile ground for the economic sustainability of startups: assaying scenarios, actions, plans, and players. *Sustainability*, 16 (16), 7139.
Han, D., Li, M., and Lu, K., 2025. Digital platforms enabling carbon neutral technology innovation: based on market incentives and government constraints. *Humanities and social sciences communications*, 12 (1), 1–17.

Helfat, C.E. and Raubitschek, R.S., 2018. Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Research policy*, 47 (8), 1391–1399.

HM Government, 2020. *National Infrastructure Strategy: fairer, faster, greener*. London: HM Treasury.

Hong, J., *et al.*, 2016. Energy use embodied in China's construction industry: a multi-regional input–output analysis. *Renewable and sustainable energy reviews*, 53, 1303–1312.

Honic, M., *et al.*, 2019. Data-and stakeholder management framework for the implementation of BIM-based material passports. *Journal of building engineering*, 23, 341–350.

Hosseini, E., Salamzadeh, A., and Rahman, M. M., 2025. Exploring the role of social capital, digital transformation, and entrepreneurial orientation in the sustainable development of creative industries. *In*: *Insights into digital business, human resource management, and competitiveness*. London, UK: IGI Global Scientific Publishing, 103–126.

Islind, A.S., *et al.*, 2019. Co-designing a digital platform with boundary objects: bringing together heterogeneous users in healthcare. *Health and technology*, 9, 425–438.

Jacobides, M.G., Cennamo, C., and Gawer, A., 2018. Towards a theory of ecosystems. *Strategic management journal*, 39 (8), 2255–2276.

Kovacic, I., Honic, M., and Sreckovic, M., 2020. Digital platform for circular economy in AEC industry. *Engineering project organization journal*, 9, 1–16.

Latham, M., 1994. *Constructing the team: final report: joint review of procurement and contractual arrangements in the United Kingdom construction industry*. London: HMSO.

Lavikka, R.H., Lehtinen, T., and Hall, D., 2017. Co-creating digital services with and for facilities management. *Facilities*, 35 (9/10), 543–556.

Leng, J., *et al.*, 2020. Blockchain-empowered sustainable manufacturing and product lifecycle management in industry 4.0: a survey. *Renewable and sustainable energy reviews*, 132, 110112.

Leong, C., *et al.*, 2019. Platform leadership: managing boundaries for the network growth of digital platforms. *Journal of the association for information systems*, 20 (10), 1531–1565.

Lines, B.C., *et al.*, 2015. Overcoming resistance to change in engineering and construction: change management factors for owner organizations. *International journal of project management*, 33 (5), 1170–1179.

Lundin, R.A. and Steinthórsson, R.S., 2003. Studying organizations as temporary. *Scandinavian journal of management*, 19 (2), 233–250.

Luo, Y. and Chen, Y., 2023. Understanding the relationship between asset specificity and governance choices in construction projects: moderating role of uncertainty. *Journal of construction engineering and management*, 149 (3), 04022178.

Markard, J., Raven, R., and Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. *Research policy*, 41 (6), 955–967.

Matarazzo, M., *et al.*, 2021. Digital transformation and customer value creation in Made in Italy SMEs: a dynamic capabilities perspective. *Journal of business research*, 123, 642–656.

Murtagh, N., Scott, L., and Fan, J., 2020. Sustainable and resilient construction: current status and future challenges. *Journal of cleaner production*, 268, 122264.

Ninan, J., Sergeeva, N., and Winch, G., 2022. Narrative shapes innovation: a study on multiple innovations in the UK construction industry. *Construction management and economics*, 40 (11–12), 884–902.

Ninan, J., Stam, K., and van Marrewijk, A., 2025. Narratives and counter-narratives in sustainability transitions: a study on the Port of Rotterdam from a multi-level perspective. *International journal of project management*, 43(7), 102766.

Oke, A.E., *et al.*, 2024. Success factors of digital technologies (DT) tools adoption for sustainable construction in a developing economy. *Construction innovation*, 24 (4), 950–964.

Olawumi, T.O., *et al.*, 2022. Automating the modular construction process: a review of digital technologies and future directions with blockchain technology. *Journal of building engineering*, 46, 103720.

Oorschot, L. and Asselbergs, T., 2021. New housing concepts: modular, circular, biobased, reproducible, and affordable. *Sustainability*, 13 (24), 13772.

Ortiz, O., Castells, F., and Sonnemann, G., 2009. Sustainability in the construction industry: a review of recent developments based on LCA. *Construction and building materials*, 23 (1), 28–39.

Oswald, D. and Dainty, A., 2020. Ethnographic research in the construction industry: a critical review. *Journal of construction engineering and management*, 146 (10), 03120003.

Oti-Sarpong, K. and Burgess, G., 2020. Offsite manufacturing and construction industry transformation: a multi-level sociotechnical transitions perspective. *In*: L. Scott and C.J. Neilson, eds. *Proceedings 36th annual ARCOM conference*. Association of Researchers in Construction Management, 475–484.

Oti-Sarpong, K., *et al.*, 2022. Transforming the construction sector: an institutional complexity perspective. *Construction innovation*, 22 (2), 361–387.

Payne, A.F., Storbacka, K., and Frow, P., 2008. Managing the co-creation of value. *Journal of the academy of marketing science*, 36 (1), 83–96.

Petani, F.J., *et al.*, 2023. What will (and should) sustainable digital maturity look like in business ecosystems? A Delphi study on the best practices, barriers and regulation of digital transformation. *International journal of entrepreneurship and small business*, 49 (1), 87–122.

Pol, H.F., 2023. Bouw en techniek voert snelheid digitalisering op. Dutch IT Channel. Available from: https://www.dutchitchannel.nl/news/222031/bouw-en-techniek-voert-snelheid-digitalisering-op [Accessed 5 September 2025].

Prahalad, C.K. and Ramaswamy, V., 2004. Co-creation experiences: the next practice in value creation. *Journal of interactive marketing*, 18 (3), 5–14.

Prijadi, R., *et al.*, 2024. Enhancing resilience in digital multi-sided platform start-ups: an exploration of entrepreneurial logic and open innovation strategies. *Entrepreneurial business and economics review*, 12 (1), 35–53.

Ranjbari, M., Morales-Alonso, G., and Carrasco-Gallego, R., 2018. Conceptualizing the sharing economy through presenting a comprehensive framework. *Sustainability*, 10 (7), 2336.

Rietveld, J., Schilling, M.A., and Bellavitis, C., 2019. Platform strategy: managing ecosystem value through selective promotion of complements. *Organization science*, 30 (6), 1232–1251.

Robertson, D. and Ulrich, K., 1998. Platform product development. *Sloan management review*, 39 (4), 19–31.

Rohn, D., *et al.*, 2021. Digital platform-based business models–an exploration of critical success factors. *Journal of engineering and technology management*, 60, 101625.

Rydén, P., *et al.*, 2021. *Social media storms: empowering leadership beyond crisis management*. London, UK: Routledge.

Salamzadeh, A., *et al.*, 2024. Digital technology as a disentangling force for women entrepreneurs. *World*, 5 (2), 346–364.

Sánchez-García, E., *et al.*, 2025. Building the future through digital entrepreneurship and innovation. *European journal of innovation management*, 28 (7), 2873–2908.

Sengers, F., Wieczorek, A.J., and Raven, R., 2019. Experimenting for sustainability transitions: a systematic literature review. *Technological forecasting and social change*, 145, 153–164.

Sergeeva, N. and Ninan, J., 2023. Comparisons as a discursive tool: shaping megaproject narratives in the United Kingdom. *Policy and society*, 42 (2), 197–211.

Serpell, A. and Alarcon, L.F., 1998. Construction process improvement methodology for construction projects. *International journal of project management*, 16 (4), 215–221.

Singh, V., Gu, N., and Wang, X., 2011. A theoretical framework of a BIM-based multi-disciplinary collaboration platform. *Automation in construction*, 20 (2), 134–144.

Smith, A., Voß, J.P., and Grin, J., 2010. Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. *Research policy*, 39 (4), 435–448.

Strauss, A. and Corbin, J., 1998. *Basics of qualitative research techniques*. London, UK: Sage Publications.

Styhre, A. and Gluch, P., 2010. Managing knowledge in platforms: boundary objects and stocks and flows of knowledge. *Construction management and economics*, 28 (6), 589–599.

Subramani, S., 2019. Practising reflexivity: ethics, methodology and theory construction. *Methodological innovations*, 12 (2), 2059799119863276.

Svarcaite, A. and Gadeikiene, A., 2023. Exploring value co-creation in sharing platforms by applying DART framework. *Organizations and markets in emerging economies*, 14 (2), 347–365.

Turner, C.J., *et al.*, 2020. Utilizing industry 4.0 on the construction site: challenges and opportunities. *IEEE transactions on industrial informatics*, 17 (2), 746–756.

UNEP, 2023). Emissions Gap Report 2023. Available from: https://www.unep.org/resources/emissions-gap-report-2023 [Accessed 15 February 2024].

van Bueren, E. and Broekhans, B., 2013. Individual projects as portals for mainstreaming niche innovations. In: *Constructing green: the social structures of sustainability*. New York, 145–167.

Van de Ven, A. H., 2007. *Engaged scholarship: a guide for organizational and social research*. Oxford University Press.

Vargo, S.L. and Lusch, R.F., 2008. Service-dominant logic: continuing the evolution. *Journal of the academy of marketing science*, 36 (1), 1–10.

Vargo, S.L., Maglio, P.P., and Akaka, M.A., 2008. On value and value co-creation: a service systems and service logic perspective. *European management journal*, 26 (3), 145–152.

Wang, X., *et al.*, 2024. How does the internet affect regional sustainable development? Fresh evidence from China. *Humanities and social sciences communications*, 11 (1), 1–17.

Wang, Z., *et al.*, 2025. Sensor adoption in the construction industry: barriers, opportunities, and strategies. *Automation in construction*, 170, 105937.

Williams, N., Ninan, J., and Kwak, Y.H., 2024. Online firestorms in Twitter: exploring risks to large infrastructure projects from digital communities. *IEEE transactions of engineering management*, 71, 13963–13974.

Wood, B., 2018. Platforms: bridging the gap between construction and manufacturing. Construction Innovation Hub. Available from: https://www.cdbb.cam.ac.uk/files/platforms_bridging_the_gap_small.pdf [Accessed 15 February 2024].

Wood, L., 2025. Netherlands Prefabricated Construction Market Databook 2025 | Prefab housing could reach around half of residential builds by 2030, with panelized and modular systems becoming the dominant approach—ResearchAndMarkets.com. Dutch News. Available from: https://www.dutchnews.nl/businesswire/netherlands-prefabricated-construction-market-databook-2025-prefab-housing-could-reach-around-half-of-residential-builds-by-2030-with-panelized-and-modular-systems-becoming-the-dominant-approach/ [Accessed 5 September 2025].

Yang, R.J., *et al.*, 2020. Opportunities for improving construction health and safety using real-time H&S management innovations: a socio-technical-economic perspective. *International journal of construction management*, 20 (5), 534–554.

Yin, R. K., 2017. *Case study research and applications*. Thousand Oaks, CA: Sage.

Yoo, Y., Henfridsson, O., and Lyytinen, K., 2010. Research commentary—the new organizing logic of digital innovation: an agenda for information systems research. *Information systems research*, 21 (4), 724–735.

Yu, Y., *et al.*, 2023. Circularity information platform for the built environment. *Automation in construction*, 152, 104933.

Zhang, T., *et al.*, 2025. From platformization to ecosystem: how do third-party supply chain finance platforms develop an ecosystem? An inter-organizational network perspective. *International journal of production economics*, 281, 109521.