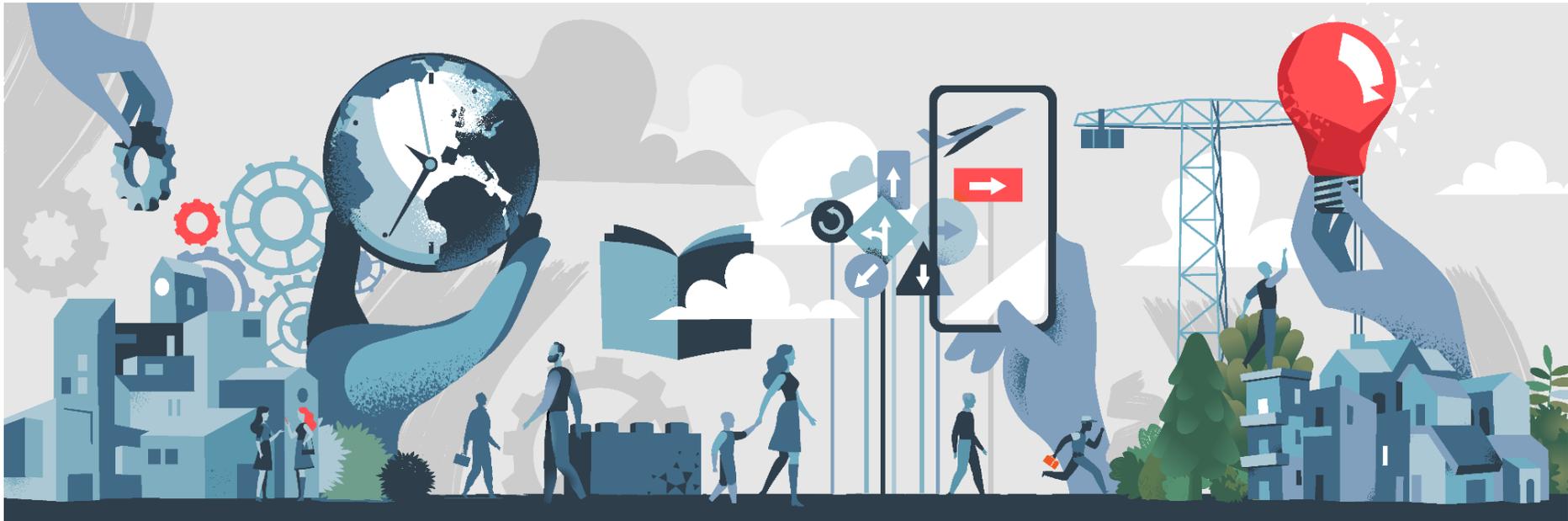# Business models for Digital Building Technologies

Policy support for business model innovation and best-practice recommendations for technology developers and users

Dr. Johannes Meuer
Malte Toetzke
Christina Nakhle
Otto Windeck

Group for Sustainability and Technology, ETH Zurich

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Background

Digitalization is rapidly transforming businesses across all sectors and industries. Disruptive technologies, such as artificial intelligence (AI) or the Internet of Things (IoT), enable new possibilities for businesses to create and deliver value but also have strong impacts on industry dynamics and competition. Hence, for policymakers, digitalization is a topic of high priority as decisions or failure to act have far-reaching consequences.

Digital building technologies (DBTs) applied throughout the building lifecycle from planning to end-of-life have enormous potential to spark innovations that tackle structural issues in the building industry. Effectively deploying DBTs may help mitigate issues such as over-budgeting and poor planning of construction projects, low productivity rates, and large energy consumption of buildings. Additionally, as the built environment accounts for 40% of primary energy consumption globally and about 36% of global CO2 emissions, many policymakers, industry experts and company representatives hope to capitalize on the power of DBTs to transition towards a more sustainable built environment.

Companies operating in the building industry, such as architecture or construction firms, have been increasingly adopting and integrating DBTs into their business processes. However, in comparison to other industries, such as finance or retail, the pace at which companies in the building industry digitalized is rather slow typified by incremental instead of radical changes. DBTs of highly disruptive potential, such as Building Information Models (BIM), seem to be stuck between technological development and first piloting applications, while applications at large scale constitute exceptions. Consequently, to date, digitalization has been less impactful in the building industry compared to what is observed in other sectors.

One reason for the low adoption rate of DBTs in the building industry is that both technology developers and potential users of DBTs lack experience with viable business models for DBTs. Many companies' digitalization efforts focus on existing business models and processes. However, as other industries show, successfully adopting digital technologies requires technology developers and users to reinvent their business models to reap the benefits of digitalization and create competitive advantages for their businesses.

Based on a series of interviews with developers and users of DBTs in the building industry, we show how companies try to manage the transformational processes from traditional to digital business models. Together with our interview partners, we also discussed how policymakers could support the development of business model innovation for DBTs to make the building industry more transparent and environmentally sustainable. In this White Paper, we have summarized our insights in the form of best-practice recommendations for developers and users of DBTs and of policy recommendations to support business model innovation for DBTs.

Recommendations for technology developers

The number of DBTs that are currently under development is rising. Nowadays, there are also many newcomers to the industry: global technology giants such as Amazon or Google as well as many young start-ups with high digital competencies. Two things appear to be common for incumbents, newcomers, and start-ups: the challenge to develop digital business models that match the needs of the building industry and, consequently, the struggle to successfully commercialize their DBTs. Based on our interviews, we outline five recommendations to developers of DBTs for overcoming these challenges.

Leverage capital, digital capabilities, and networks to identify suitable target markets

Technology developers need to find suitable partners with complementary skills and resources. The strengths of incumbents lie in their large network of technology adopters across the industry. In contrast, newcomers to the industry often possess substantive capital resources, marketing and sales expertise, and experience with digital technologies in other industries. Finally, start-ups often offer promising ideas and a highly innovative workforce. Synergizing the strengths of incumbents, newcomers, and start-ups can boost the development and commercialization of DBTs. Developers of DBTs with products or services targeting the end consumer market (B2C) appear better off when collaborating with incumbents (for their network and access to customers). In contrast, those developing DBTs with products or services that target the business-to-business market (B2B) fare better by collaborating with newcomers (for capital endowments and marketing expertise). Start-ups offer creative solutions across the building lifecycle and are particularly useful for identifying and developing technologies for innovative services. In short, DBT developers should carefully select partners with complementary skills and resources to successfully access their end-market.

Design user-friendly technologies and support applications through comprehensive training

New digital technologies offer almost too many possibilities to develop DBTs and technology developers too often make almost unrestrained use of these possibilities. Yet, many users in the building industry are not used to the interfaces of DBTs, feel overstrained by the plethora of available DBTs, and thus prefer holding on to established working routines, with reliable short-term outcomes. To avoid this 'digital overkill,' technology developers could focus more strongly on developing user-centric designs through extensive prototyping and user testing, resulting in visually appealing user interfaces with appropriate levels of sophistication and simplicity. To accelerate the adoption of DBTs, developers may also offer integrated user training to explain functionalities and to continuously adapt their technologies to the processes and business logic of the adopters. Designing user-friendly interfaces combined with training and support to adopters is essential to successfully commercialize DBTs.

Create value through services that meet expressed and unexpressed needs

Many technology developers suffer from two demand-related challenges. First, they mistake the expected user needs with the expressed user needs. Many technology developers design value propositions based on what they consider important (the expected user demand), not what their potential users may find valuable (the actual and expressed user demand). In particular, DBTs with value propositions focusing on sustainability (e.g., energy- or resource-efficiency) often fail to find a market. Second, many developers simply digitalize traditional services and then realize that they do not generate sufficient sales to cover the investments. A common approach is to collect and visualize data for monitoring or reporting purposes. Yet, successfully commercializing DBTs only

starts with collecting and visualizing data, it does not end at this point. Instead, major value propositions occur when developers begin identifying and meeting customers' unexpressed needs rather than only their expressed demands. Overall, successful technology developers reach out at early stages to potential customers to test their value propositions (ensure they meet actual demand) and then begin using data to identify unexpressed needs through new and additional services.

Diversify revenue models towards demand- and performance-adjusted schemes

Most developers of DBTs use product sales or licensing contracts as their dominant revenue model. Yet, for users, software fees and, more importantly, investments in cyber-physical technologies (e.g., construction robotics) represent substantive investments. The traditional revenue models thus pose a substantial financial risk for technology adopters and hamper the diffusion of DBTs. Technology developers need to innovate and diversify their revenue models. Performance-based contracts, contracts in which payment is directly tied to agreed-upon performance metrics, appear particularly promising for cyber-physical technologies, such as construction robotics. For software-based technologies, freemium models, in which the initial product is free of charge and additional services generate sales, are popular and successful revenue models across many industries when early and rapid adoption rates are important. Freemium models work particularly well because once the software is developed, every additional client comes at almost zero marginal cost but offers opportunities for future sales. For developers that draw on customer or product data to create, for example, customized services, data-driven revenue models that offer hardware at a lower costs in return for the use of data are successful and could be applied in the building industry.

Strategically manage the platform ecosystem

As DBTs increasingly diffuse across the market, interdependencies among technologies will become more pronounced. Currently, developers of both complementary and platform DBTs appear reluctant to push for a full integration of their DBTs in their broader ecosystem. Yet, the increasing interdependencies require developers to outline a strategy of how to manage and interact with other technologies and technology providers. For developers of platform technologies, ensuring the interoperability of technologies, for example, through standardized APIs, is a must. The strategic instrument of platform developers is the extent to which they manage the openness of their platform (i.e., extent to which developers restrict outsiders' involvement in the development, commercialization, or use of a platform). On the contrary, for developers of complementary technologies, a strategic question is whether to keep DBTs as stand-alone solutions or fully embed them into platforms. Thus, the key question for technology developers is how to integrate a complementary technology into a platform while remaining competitive (e.g., providing a unique and hard to imitate service) and retaining necessary profit margins.

Recommendations for technology users

For technology users, the selection and implementation of DBTs pose fundamental questions. The decision to select DBTs carries far-reaching implications, including if and how a company will survive in a digitalized building industry. Implementing DBTs then impacts a company's processes, competencies, partnerships, and long-term strategy. The use of DBTs also requires new capabilities and skillsets, in particular digital talents still rare in the industry. Possibly for these reasons, technology users in the building industry have so far only cautiously and reluctantly adopted DBTs. The transition of companies of the building industry towards digitalized businesses, therefore, requires well-founded and strategic decisions while convincing and motivating employees to support the implementation of DBTs. Based on our insights, we offer five recommendations for users of DBTs to overcome these challenges.

5 BUSINESS MODELS FOR DIGITAL BUILDING TECHNOLOGIES
BEST-PRACTICE RECOMMENDATIONS FOR **TECHNOLOGY USERS**

Implementing DBTs and transitioning towards a digital business impacts a company's processes, competencies, partnerships, culture, and long-term strategy and requires well-founded decisions. We offer 5 best-practice recommendations for users' business models for DBTs.

1 Avoid the digital overkill: Begin digital journey with selected and aligned technologies

DBTs users should avoid marginally implementing many technologies and focus on a portfolio of well-integrated DBTs that fit the firm's existing processes. Subsequently, users may follow up with more disruptive DBTs.

2 Nurture and attract digital talents

To avoid a diverging culture between new and existing employees, firms should not only attract digital talents, but also train new employees to gain knowledge of the building industry, as well as existing employees to develop the digital skills required by new DBTs.

3 Evaluate the risk of digitalization: The hidden costs of transparency

Increased transparency ensured by digitalization can disrupt many existing business models that rely on information asymmetries. Adopters of DBTs need to carefully evaluate the hidden costs of transparency before transitioning to a digital offer.

4 Outline a data strategy: How much and what kind of data does one need?

Despite the cheap costs of data storage, DBTs users often lose focus in the process of collecting and analyzing data. Firms should outline a clear data strategy with well-defined requirements and key performance indicators.

5 Make digital technologies an integral part of long-term planning

For technology users, the selection and decision to adopt DBTs may thus carry far-reaching implications for the business. To fully benefit from DBTs, users should align a portfolio of DBTs to their core capabilities.

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Avoid the digital overkill: Begin digital journey with selected and aligned technologies

The diversity of DBTs often challenges technology users to select the most appropriate technologies for their business. Additionally, the complexity of different brands of DBTs overstrains employees during their implementation. Many technology users experience episodes of 'digital overkill,' when too many technologies are only marginally adopted, resulting in internal resistance from its employees. To avoid such a digital overkill, technology users could carefully select a small number of centrally important DBTs that well align with their core business. The management, together with the company's digital talents, could take a clear strategic decision and select a homogenous portfolio of a few well-integrated DBTs for the company. A successful path to adopting DBTs begins with integrating DBTs into traditional processes. Once these have been fully integrated, users may follow up with more radical and disruptive DBTs.

Nurture and attract digital talents

Many companies in the building industry find it hard to attract digital talents with expertise in the building industry. A key challenge for technology users is thus to nurture and attract digital talents and to counter a possibly diverging culture between new and current employees. To overcome this challenge, technology users need to become attractive employers for digital talents (e.g., offering career opportunities with unique responsibilities) and to train new employees to develop expertise in the building industry and current employees to develop expertise in DBTs. Moreover, technology users could identify 'digital talents,' employees that possess strong digital skills and are keen on developing and applying their skills. These digital champions are not only helpful for successfully integrating DBTs but are also essential to help co-workers improve their skills and thus for managing the transition to a more digital business.

Evaluate the risk of digitalization: The hidden costs of transparency

Digitalization offers significant improvements in transparency across the entire industry. Transparency not only appears in digital twins, digitalized plans of a building in various dimension, but also in cost structures, schedules, and forms of usage. Increasing levels of transparency offer tremendous public benefits and opportunities. At the same time, many business models in the industry rely on information asymmetries that require levels of opacity. Technology users that rapidly and radically adopt DBTs often risk contracts and liquidity shortages. Thus, adopters of DBTs need to carefully evaluate the hidden costs of transparency and find strategies to transition from providing non-digitalized to digitalized products and services. Such strategies may involve carefully selecting market segments and niches of innovative projects (that require digital technologies), joining projects at an early stage to be able to influence other

project partners, and communicating and explaining how the additional upfront investment of DBTs help reduce risks and overall costs involved in building projects.

Outline a data strategy: How much and what kind of data does one need?

By adopting DBTs, companies automatically begin collecting, storing, analyzing, and using large volumes of data. Many technology users seek to collect as much data as possible at the highest levels of detail without considering what kind of data they need and for what purpose they might use it. The rapidly decreasing costs of storage seem to increase the desire to collect data. However, despite the cheap storage options, the costs and complexity of data-driven operations exponentially increase with the breadth and depth of data. Many technology users seem to get lost in the possibility to crunch data and in this process lose focus. Moreover, larger volumes and complexity of data, require more advanced IT and programming skills. Thus, rather than collecting vast volumes of data without a clear purpose, technology users seem to benefit from a data strategy that clarifies data requirements and key performance indicators.

Make digital technologies an integral part of long-term planning

The ability to effectively use digital building technologies may soon constitute an important entry barrier into more innovative profitable building projects. For technology users, the selection and decision to adopt DBTs may thus carry far-reaching implications for the business. Yet, currently many technology users seem to digitalize merely existing business processes and fail short to comprehensively integrate DBTs. For technology users to fully benefit from the potential of DBTs, they need to align a selected portfolio of DBTs with their core competences and thus with an overarching strategy. For example, building companies with a competitive edge in knowledge management will most comprehensively benefit from DBTs that extract organizational knowledge, for example using intranets, cloud computing, or AI.

Policy support for business model innovation

Public policies and regulations may have a major impact on the digital transformation of the building industry. Policymakers can help bridge the gap between developers and users and spark innovation activities and processes. They may also considerably influence competitive dynamics and regulate data usage and privacy. These decisions come with considerable tradeoffs as policies serving one objective (e.g., platform growth) may harm another objective (e.g., competitive markets). Hence, possible outcomes of policy interventions and regulations should be carefully assessed to prevent unintended consequences. Based on our insights, we offer seven recommendations to policymakers to support the development of innovative business models for DBTs.

7 RECOMMENDATIONS FOR POLICY MAKERS
BUSINESS MODELS FOR DIGITAL BUILDING TECHNOLOGIES

Policymakers can help bridge the gap between developers and users and spark innovation activities and processes. We offer 7 recommendations to policy makers to support the development of DBTs .

1 Demand transparency in tendering through public e-Tender platforms

The lack of transparency and the information asymmetries that characterize the building industry may be addressed with the used of DBTs such as e-Tender platforms.

2 Encourage collaboration between incumbents, newcomers, and start-ups

For policymakers it is important to develop means to connect new players with established technology users as encouraging industry-wide collaboration will certainly accelerate the diffusion of DBTs.

3 Balance platformization and competitive market dynamics

Given the importance for advancing the digitalization of the building industry, policymakers need to outweigh the benefits and risks of a platform monopoly with those of a platform oligopoly.

4 Standardize data format and APIs for interoperability and prevention of lock-ins

Standardizing data formats and APIs improves interoperability between DBTs and accelerates their diffusion. To facilitate the adoption of DBTs, policymakers could define standards in data formats and APIs for DBTs.

5 Provide a legal framework for data privacy and third-party use of customer data

To incentivize the development of data-driven business models, policymakers need to provide a legal framework that ensures that data providers are informed about how their data is used.

6 Targeted support programs for DBTs

The rapid diffusion of DBTs faces several barriers. Policymakers may lower these barriers through the design of targeted programs supporting the adoption of those DBTs.

7 Accelerated digitalization through targeted public tenders

Policymakers could accelerate the digitalization of the built environment through targeted public tenders, as outlining specific conditions for public tenders may increase the demand and use of DBTs.

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Demand transparency in tendering through public e-Tender platforms

The lack of transparency and the information asymmetries in the building industry are important factors to explain structural problems such as over-budgeting, delays, and construction faults. In particular, platform technologies, such as BIM or e-Tender platforms significantly increase transparency and may thereby help address these issues. Policymakers may thus implement regulation that requires project partners of building projects to use open and publicly transparent e-tender platforms. Moreover, to avoid a strong dependency on single, privately held platforms, policymakers could seek to maintain a sufficient level of public control and ownership.

Encourage collaboration between incumbents, newcomers, and start-ups

There is significant untapped innovation potential as technology developers from the software, robotics, or energy sector enter the building industry. Yet, many developers underestimate the importance of an excellent network within the building industry to reach out to customers. For policymakers it is important to develop means to connect these new players with established technology users in the building industry. Collaboration may be encouraged by supporting and promoting startup and innovation fairs. Policymakers could also incentivize piloting projects between technology developers and users to bridge the gap between technology invention and implementation. Encouraging collaboration between incumbents, newcomers, and start-ups will certainly accelerate the diffusion of DBTs.

Balance platformization and competitive market dynamics

The primary driver of platform technologies are so-called 'network effects': the more users, data, and services operate on a platform, the higher its value. Yet, these dynamics also create winner-takes-all markets and in many other industries, creating a lock-in is often a strategy adopted by platform developers. Policymakers therefore may balance supporting platform growth with ensuring competitive markets by prevent lock-ins that happen not only due to high switching costs, but also due to platform developers doing that as a strategy. In the building industry, platform technologies have neither reached their full potential nor have they led to a dominant market player. Nonetheless, given the importance for advancing the digitalization of the building industry, policymakers need to outweigh the benefits and risks of a platform monopoly (with valuable public network effects) with those of a platform oligopoly (the co-existence of multiple dominant platforms for a lower risk of market abuse). Depending on the approach to platformization, policymakers need to address related questions about public control and ownership or established interoperability through standardized interfaces and data formats.

Standardize data format and APIs for interoperability and prevention of lock-ins

Standardizing data formats and APIs improves interoperability between DBTs. Standardization is central to any platform technology. Standardization is equally important to accelerate the diffusion of a broad range of DBTs as it facilitates the communication between technologies. Currently, however, developers and users of DBTs suffer from lack of standardization. The lack of standardization already affects potential technology adopters in two ways. First, many companies postpone investment decision, hoping that one DBT will emerge as the dominant technology used by project partners, customers, and contractors. Additionally, many companies fear that, should they now invest in the wrong DTB, they may face substantive switching costs in the future. To facilitate the adoption of DBTs, policymakers could thus define and regulate standards in data formats and APIs for DBTs. Policymakers may do so by designing clear and more stringent regulations and norms that apply to all market participants. National and international standardization agencies may help to draft such regulation. By standardizing data forms, policymakers facilitate interoperability between DBTs and the digital infrastructure of a company and ultimately smoothen the transition from one digital building technology to another.

Provide a legal framework for data privacy and third-party use of customer data

The digitalization of products and services necessarily involves the collection and storage of large volumes of data. As in other industries, many companies, in particular start-ups and newcomers to the building industry are developing and experimenting with data-driven business models. Data-driven business models use data from customers or technical product data to create value for the customer (e.g., customized services). Many technology developers refrain from using customer data because they are uncertain about existing and newly entering laws and regulations. To incentivize the development and use of data-driven business models in the building industry, policymakers need to provide a legal framework that ensures that data providers (e.g., household owners, tenants) are informed about how their data is used and data owners have a long-term legal perspective about how they may use data for providing additional services.

Targeted support programs for DBTs

The rapid diffusion of DBTs faces several barriers. Policymakers may lower these barriers through the design of targeted programs supporting the adoption of those DBTs that offer significant public benefits. Software-based platform technologies, such as BIM, increase the transparency throughout the building lifecycle, potentially lowering delays, overall costs, and construction failures. By improving the quality during construction, BIM may also help to narrow the performance-gap (the discrepancy between the planned and the realized energy consumption of buildings). Policymakers may support potential adopters through programs that support investments in IT hardware, licensing fees, and the initial hiring of digital talents. In contrast, cyber-physical technologies,

such as robotics and drones used in prefabrication or onsite, improve safety and resource-efficiency during construction. Yet, the development and adoption of such technologies requires substantive capital investments. To support their use, policymakers may initiate investment support programs that offer long-term loans to developers and users of cyber-physical technologies. Finally, given the central and systemic importance of a public digital infrastructure, policymakers may support interface technologies that accelerate the integration of the built environment into other areas of social life.

Accelerated digitalization through targeted public tenders

Finally, public authorities themselves often participate directly in the building industry, in particular when they decide to develop and renovate public buildings (e.g., schools, hospitals, public administration). Policymakers could use this lever to accelerate the digitalization of the built environment through targeted public tenders. Outlining specific conditions for public tenders may increase the demand and use of DBTs. In particular, policymakers could select companies that follow many of the best-practice recommendations we have outlined above (e.g., strategic use of DBTs, training programs for nurturing and attracting digital talents). Channeling public demand in such a way will most directly support developers and users of DBTs and foster the development of business models for DBTs.

Funding

Contact

Dr. Johannes Meuer
Group for Sustainability & Technology
ETH Zurich | Department of Management, Technology and Economics
Weinbergstrasse 56/58 | WEV J 420 | CH-8092 Zurich
Email: jmeuer@ethz.ch
Web: www.sustec.ethz.ch

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