CHAPTER 10

Financing Building Renovation: Financial Technology as an Alternative Channel to Mobilise Private Financing

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Abstract Access to capital is one of the key barriers for deep renovation. This chapter presents the potential advantages and benefits that financial technology (FinTech) solutions such as crowdfunding and blockchain-based solutions such as tokenisation and smart contracts can provide to building owners and construction companies in terms of financing. Future avenues for research in this space are also presented.

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10.1 Introduction

Moves towards a long-term net zero emissions objective are complex and multifaceted. One part of this global picture that needs to be addressed effectively is the high level of energy inefficiency amongst a high proportion of buildings globally. For the EU, it was estimated, for instance, that (as of 2011) approximately 75% of the building stock in the EU required some form of energy efficiency upgrade in the form of retrofitting and renovation (Economidou et al., 2011). The Energy Efficiency Directive (Directive 2012/27/EU) of 2012 has been a key policy response by the EU to set the foundations for a significant programme of building renovation.[1] This legislation was partially revised in 2018. However, the European Commission has now commenced a process of overhauling the entire Energy Efficiency Directive,[2] seeking to leverage the Renovation Wave strategy announced in 2020.[3] This latter strategy aims to double annual energy renovation rates in the next 10 years. As well as reducing emissions, these renovations will enhance quality of life for people living in and using the buildings, and should create many additional green jobs in the construction sector.

Feedback in the Open Consultation on the Renovation Wave suggested that lack of or limited resources to finance building renovation is one of the most important barriers to building renovations. These barriers include a lack of financial incentives, access to mainstream financing products, and funding for publicly owned buildings. In response, ensuring adequate and well-targeted funding is central to the EU Renovation Wave strategy. Despite this, while the European Commission highlights the need for greater adoption of digital and innovative technologies in the construction sector and identifies specific digital tools and technologies, it is silent on financial technologies and how they might reduce barriers to building and renovation finance.

[1] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF.

[2] https://ec.europa.eu/info/news/commission-proposes-new-energy-efficiency-directive-2021-jul-14_en.

[3] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en.

Against this backdrop, this chapter will explore the financing of building renovation and how innovations in the financial technology (FinTech) space may serve to mobilise more private financing. The remainder of this chapter is organised as follows. Following a summary of recent literature on financing building renovation, we define and outline key FinTech concepts and technologies. We then explore two of the most prominent FinTech solutions—crowdfunding and blockchain-based solutions.

10.2 Deep Renovation Financing: Key Terms and Concepts

Economidou et al. (2019) provide an overview of the main financing instruments available to support energy renovations in the EU (Fig. 10.1). These are categorised by type of financing instrument, spanning (1) non-repayable rewards, (2) debt financing, and (3) equity financing, and by market saturation, spanning (1) traditional and well-established, (2) tested and growing, and (3) new and innovative financing mechanisms. A brief definition for each instrument is provided in Table 10.1 with other key terms and concepts used in this chapter.

Kunkel (2015) sets out the barriers to traditional investment in building renovation as follows: (1) upfront investment and the bankability of projects; (2) information asymmetry; (3) the quality of the on-site implementation and the trust in local partners and companies; and (4) split incentives and uncompensated benefits. These barriers have become even more significant following the COVID-19 pandemic due to an

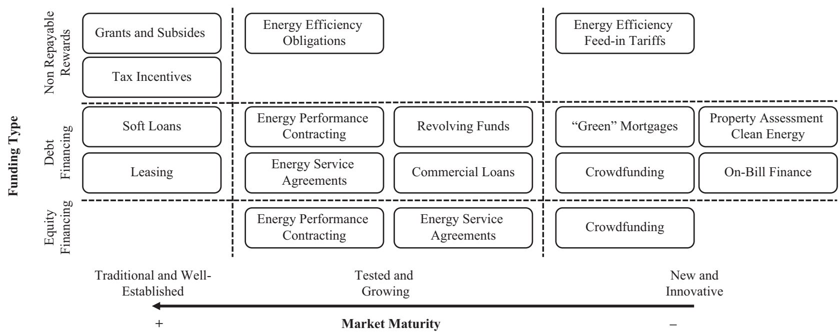

Fig. 10.1 Financing landscape in the EU for energy renovations according to market maturity and type. (Adapted from Economidou et al., 2019)

Table 10.1 Deep renovation financing key terms and concepts

Financing instrument	*Definition*
Blockchain	A decentralised, transactional database that enables validated, tamper-resistant transactions across a large number of participants (i.e., nodes) in a network (Glaser, 2017; Beck et al., 2017). It is the technology underpinning Bitcoin (Nakamoto, 2008), but its applications extend beyond digital currencies (Rosati & Čuk, 2019).
Commercial loans	Loans provided by commercial banks that are issued through standardised project appraisal and loan processing processes (Economidou et al., 2019). As such, they reduce uncertainties regarding access to capital and reduce transaction costs.
Crowdfunding	An open call, typically through the Internet for the provision of financial resources from a group of individuals or organisations (Belleflamme et al., 2014). In the context of building renovation, these calls typically aim to attract funding from a large number of either retail or institutional investors in exchange for a share of the property or for future revenue streams in the form of interest and principal repayments.
Energy efficiency feed-in tariffs	An instrument that aims to reduce energy use through a reward-based system (Economidou et al., 2019). While relatively simple to implement, it is typically based on a fixed price system which may ultimately favour cheap energy efficiency interventions (Eyre, 2013).
Energy efficiency obligations	Market-based instruments that can be put in place by governments to achieve energy savings through investments obligations placed on energy companies (Economidou et al., 2019).
Energy performance contracting (EPC)	A contract between an energy services company (ESCO) and a client whereby the ESCO is responsible for completing a renovation project and to deliver energy efficiency improvements on a given building owned by the client and it uses the costs savings generated by energy efficiency measures implemented to repay the costs of the project over a given time period (Lee et al., 2015).
Energy service agreements (ESA)	Represent a variant of EPC "that involve integrated financing measures, backed by a long-term performance guarantee" (Brown et al., 2022, p. 7). In this type of contracts, the ESCO bears both the financial and performance risk of the project. As such, ESAs are particularly attractive for building owners.

(*continued*)

Table 10.1 (continued)

Financing instrument	*Definition*
Grants and subsides	Grants represent a direct monetary contribution towards a building renovation project and serve as direct investment subsidies which may partially or fully cover the cost of the renovation. Grants and subsides are typically provided by government agencies and, as such, rely on limited resources and cannot represent a sustainable solution or support massive market uptake programmes (Economidou et al., 2019).
Green mortgages	Loans provided by commercial banks and other credit institutions that provide borrowers with the opportunity to finance the cost of energy-efficient upgrades and to benefit from preferential mortgage terms (e.g., better borrowing terms, higher debt-to-income ratios) (Economidou et al., 2019).
Leasing	A lease can be defined as a contract between the owner of an asset (lessor) and the user of such an asset (lessee), whereby the lessor provides the asset for use by the lessee for a certain time period in exchange for a payment with an understanding that, at the end of such period, the asset will either be returned to the lessor, purchased in full by the lessee for a pre-defined amount, or disposed as outlined in the contract (Oracle, 2016). In the context of building renovation, leasing contracts may incorporate clauses whereby the lessor and the lessee take on specific obligations with regard to the sustainable operation and occupation of a given property (Kaplow, 2008). These include, for example, the implementation of energy efficiency measures and waste reduction.
On-bill finance	A financing mechanism that reduces the upfront cost of energy renovation projects by linking repayments to the utility bill. As such, it allows customers to pay back the cost of the investment over time. These mechanisms can be promoted by local governments as well as utility companies (Economidou et al., 2019).
Property assessment clean energy	This instrument aims to finance energy renovations through the use of specific bonds issued by municipal governments to investors. The funds raised through the sale of these bonds are used to provide loans to building owners who want to implement energy renovations in either residential or commercial buildings. The loans are typically repaid over 15–20 years via an annual assessment on property tax bills (Economidou et al., 2019).

(*continued*)

Table 10.1 (continued)

Financing instrument	*Definition*
Revolving funds	An energy efficiency revolving fund provides financing and related services to its clients to facilitate energy efficiency investments (Lukas, 2018). These funds are designed to be self-sustainable as a portion of the savings generated by supported investments is used to replenish in part the fund therefore allowing for reinvestment in future projects (Lukas, 2018).
Security Token Offering (STO)	Security Token Offerings are regulated token offerings whereby the token issuer raises capital by selling to qualified investors crypto tokens that are defined as securities (Lynn & Rosati, 2021).
Smart contracts	"Self-executing electronic instructions drafted in computer code" (O'Shields, 2017, p. 179). More specifically, blockchain-based smart contracts are signed by the parties involved using cryptographic security, are stored on the blockchain, and self-execute the stipulations of an agreement when predetermined conditions are met (O'Shields, 2017).
Soft loans	Government-supported loans which may be offered at below market interest rates or allow for longer repayment periods (Karakosta et al., 2021).
Tax incentives	Aim to promote building renovation by reducing the cost of the energy efficiency improvement through reduced taxes for households and organisations (Economidou et al., 2019). Tax incentives can be designed in a number of ways such as accelerated depreciation, tax exemptions, income tax or VAT reduction, and so on.
Tokenisation	Tokenisation is one of the main applications enabled by blockchain which allows users to digitise tangible and intangible assets. Each token represents a certain share of an asset's ownership and it can be recorded and exchanged via digital means (Tian et al., 2020).

exceptional increase in governments' fiscal deficits and the consequential decrease in governmental funds available for incentivising the transition to more energy-efficient buildings (Tian et al., 2022).

Traditional funding mechanisms (e.g., government grants and incentives, loans) have demonstrated that they cannot cope with the growing demand for and need of capital to finance building renovation, so it is not surprising that the entire sector is constantly trying to attract more private investments (Tian et al., 2022). However, this is quite challenging given the scale of the investment required for these kinds of projects and the challenges associated with measuring the impact of "green" investments (United Nations, 2019).

Recent developments in the area of financial technologies (FinTech) have demonstrated how digital technologies can be leveraged to benefit both capital seekers (entrepreneurs, firms, and project promoters) and capital givers (investors), and therefore foster innovation in many sectors (Lynn & Rosati, 2021). FinTech can be seen as "a co-evolution and convergence of finance and technology" (Lynn et al., 2019, p. V) where new service providers typically leverage customer-centric platform-based business models enabled by the Internet and different degrees of disintermediation to overcome the limitations of the traditional financial system in terms of supply and access to capital, and the barriers to entry typical of traditional capital markets (Tönnissen et al., 2020; Lynn & Rosati, 2021; Sánchez, 2022). In so doing, they provide both small retail investors and large institutional investors with access to new investment opportunities, and capital seekers with additional funding they would not receive otherwise. In fact, in many cases, projects that seek funding through these alternative channels do not meet the requirements of traditional financial institutions in terms of credit history or are at an early stage of development, and therefore are not attractive to venture capitalist or investment funds. As such, these alternative sources of finance generate clear benefits not only for the parties involved in the transactions but for the economy as a whole (Sánchez, 2022).

While alternative sources of finance that are enabled by FinTech have gained significant traction in many sectors, the construction sector is still lagging behind in terms of adoption and is still mostly reliant on debt-based solutions (Ziegler et al., 2020). This suggests that FinTech solutions may play a pivotal role in supporting building renovation and therefore contributing to the ambitious sustainability targets that have been set by the EU and the United Nations (Economidou et al., 2019; United Nations, 2019).

In this chapter we focus on two main alternative sources of finance, namely crowdfunding, which is more established, and blockchain-based solutions, which are more novel and fast-growing.

10.3 Crowdfunding for Building Renovation

Economidou et al. (2011) provide an early identification of equity and debt crowdfunding as new and innovative sources of financing for building renovations. Crowdfunding is ideal in the manner in which it circumvents the constraints that exist in traditional bank financing, providing instead a new marketplace that allows for the pooling of financing from many retail investors ("the crowd") to support the building renovation project (Kunkel, 2015). Panteli et al. (2020) note that communities can become shareholders in energy efficiency projects through the mechanism of crowdfunding markets, allowing for greater buy-in from communities in the roll out of renewable energy and energy efficiency initiatives. Crowdfunding markets provide flexibility through connecting investors and beneficiaries directly, while offering lower costs of financing resulting from the use of the technology to facilitate the marketplace (Bertoldi et al., 2021). There are, of course, certain disadvantages to crowdfunding as articulated by Economidou et al. (2011): (a) the risk for beneficiaries in not securing the required level of funding, and (b) and the risk for investors in assuming all of the associated risks with extending the financing. It is within the latter context that the marketplaces for crowdfunding are less regulated than traditional markets.

In terms of project scale, Panteli et al. (2020) position crowdfunding as an ideal source of private financing for small-scale energy upgrading. Crowdfunding has the potential to form an important part of the funding mix, along with private-public and fully public funding mechanisms. An identified barrier to scaling up the amount of crowdfunding for building renovation is the wider public's understanding of crowdfunding markets.

Kunkel (2015) argues the merits for crowdfunding as a source of financing for building renovation as follows:

- The issue of information asymmetry is ideally mitigated through crowdfunding channels as crowdfunding platforms are effectively social networks that allow beneficiaries to engage directly with investors and reveal required information in an effective, low-cost manner. Indeed, beneficiaries often benefit from the collective expertise of the crowd, informing the project design, development, and implementation.
- Crowdfunding can also address concerns over implementation quality and trust in local partners and companies, as the crowd is likely to be local themselves and familiar with the parties. The crowd may be much better positioned than conventional banking institutions to appraise the implementation risks pertaining to the project in question.
- Finally, the local demographic of the crowd means that they are likely to benefit directly from the building renovation project beyond the

financial return and will be well placed to appraise the broader non-financial benefits, particularly in terms of the societal and environmental impact.

There are no studies, to the authors' knowledge, that empirically examine the crowdfunding of building renovation projects specifically. There is a more established literature however, albeit somewhat limited, that has studied the crowdfunding of real estate and renewable energy projects, which provides some useful insights.

In the context of real estate investment, Montgomery et al. (2018) use Disruptive Innovation Theory as a setting to appraise the potential for crowdfunding to be a disruptive source of financing. Based on a systematic literature review, the authors provide arguments for real estate crowdfunding as a disruptive innovation. Real estate crowdfunding is identified as offering cost and process efficiencies through technological innovation, having lower performance in certain areas (e.g., cybersecurity risk) relative to conventional financing channels, creating and facilitating a new marketplace for financing, and having less appeal among mainstream large real estate developers, while appealing to existing and new small- to medium-sized real estate developers. Shahrokhi and Parhizgari (2019) underscore the disruptive nature of real estate crowdfunding with a comparison against traditional financing, emphasising how the emergence of specialised crowdfunding platforms has overcome the high barriers historically to investment in real estate. Indeed, the authors note the explosion of platforms over recent years and the step change in real estate crowdfunding in the US from \$1bn in 2009 to \$17bn in 2015. Mamonov et al. (2017) confirm that real estate ventures are by the far the most successful proportion of the equity crowdfunding market in the US, constituting approximately 51% of all ventures that reached their minimum capital commitment target in the 2013–2016 period.

Through an empirical analysis of real estate crowdfunding campaigns in Italy, Gigante and Cozzio (2021) are able to identify the important determinants of successful crowdfunding campaigns, where success is defined as achieving (or exceeding) the target funding amount. Leveraging potential determinants from the general crowdfunding literature, the authors focus on the funding type (lending or equity), the duration of the investment, the minimum investment level for investors, and the expected annual return on investment. Duration is found to be important in that the longer the project the more difficult it is to secure the required funding. It is also found that higher expected returns attract investors and increase the chances of successfully securing the required funding. Borrero-Domínguez et al. (2020) conducted a similar study in the Spanish market. This study corroborates the findings of Gigante and Cozzio (2021) in showing that longer projects are less successful in securing funding, while projects that offer higher expected return are more successful. The authors also show that buy-to-sell projects are less successful than development loan projects, while greater levels of risk act as a deterrent for investors and impeding funding success.

In terms of the performance of real estate investment via crowdfunding markets, Schweizer and Zhou (2017) provide evidence that equity-based projects offer better returns, while higher levels of leverage are also associated with better returns. Other characteristics that lead to higher returns include provision for later payments to investors and higher minimum investment amounts.

In respect of the energy efficiency dimension to building renovation, it is worth exploring the literature that has examined the crowdfunding of renewable energy technology. Cumming et al. (2017), for instance, consider the determinants that drive crowdfunding. The authors show that price of oil is an important factor in determining the level of crowdfunding, with higher oil prices associated with a greater prevalence of crowdfunding directed at clean technology. The authors also show that the use of soft information (e.g., photos, video pitch, and text descriptions) is more prevalent in renewable energy-based crowdfunding campaigns and that this is used as a tactic to mitigate information asymmetry concerns for investors. It is shown further that the success of these crowdfunding campaigns is more sensitive to the use of soft information around the projects.

Slimane and Rousseau (2020), in a similar study, seek to identify the factors that can lead to a successful crowdfunding campaign. Financial characteristics of the renewable energy project are found to be important, including the interest rate applied, the funding amount requested, the size of the firm in question, and the overall financial performance of the firm. Non-financial characteristics such as age and gender of the entrepreneur, in addition to the size of their social network, are found to be relevant.

While such studies demonstrate that crowdfunding can be successful from the beneficiaries' perspective, what is the impact of such crowdfunding? Appiah-Otoo et al. (2022) provide evidence to support the tangible impact that crowdfunding can have on renewable energy development. The authors demonstrate that on a cross-country basis a 1% increase in crowdfunding bolsters actual renewable energy generation by 0.35%. Indeed, the authors further show a very interesting bi-directional causal relationship between crowdfunding and renewable energy generation. This suggests that the development of crowdfunding markets helps to channel the financing to expand renewable energy generation, while the expansion of renewable energy generation helps to attract investors to crowdfunding markets who are looking for investment opportunities.

Of course, the above insights are on the demand side of crowdfunding (i.e., the beneficiaries). One also needs to consider the supply side of crowdfunding (i.e., the investors). Understanding investor perceptions and behaviours is pivotal here. Bergmann et al.'s (2021) study, for example, is one such study that provides qualitative cross-country survey evidence that a significant majority of those surveyed have a strong awareness of the existence of crowdfunding markets, with almost half having invested in such marketplaces previously. A significant minority (~40%) indicated an intention to invest in renewable energy projects through crowdfunding channels over the next three years.

Literature also tells us that the platform has a central role to play in the successful mobilisation of crowdfunding to renewable energy projects. For example, De Broeck (2018) studies best practices in respect of platforms servicing investment in renewable energy projects. The qualitative analysis provides insights across a number of key dimensions of crowdfunding activity around renewable energy projects: the impact of regulation, risk exposures resulting from the underlying platform business models, and the platforms' attitude towards risk.

De Broeck (2018) finds that crowdfunding activity around renewable energy projects is strongest in jurisdictions where there is strong policy support for renewable energy, citing premium tariffs and/or feed-in-tariffs, which offer better long-term certainty over the cash flows associated with the renewable energy projects. When assessing the platforms on the basis of credit risk, De Broeck (2018) is able to identify a set of platforms that work to a combination of low risk supports (such as feed-in-tariffs) and low risk instruments (secured business loans, bonds/debentures, and senior bond loans), while another set of platforms works to a combination of very low risk tariff premiums and high risk instruments (subordinate profit participating loans). The presence of strong support is seen as an important measure for the mitigation of credit risk for investors, which encourages more crowdfunding activities. De Broeck (2018) also finds that due diligence procedures are deemed to be the most significant measure that platforms can take to mitigate the credit risk exposure of investors. Platforms that reduce credit risk exposure ensure greater and more persistent levels of engagement from investors, protecting the resulting supply of funding to renewable energy projects.

10.4 Blockchain for Building Renovation

Blockchain technology was originally proposed in 2008 by Satoshi Nakamoto as the technology underpinning Bitcoin (Nakamoto, 2008). While most of the attention around blockchain was initially devoted to payment and other transactional systems, a number of alternative use cases across different industries have emerged over time. With a specific focus on the built environment, for instance, Arup (2019) considers blockchain applications in the context of property, but also the wider and associated areas of smart cities, energy, transport, and water. Khatoon et al. (2019) note how blockchain is being considered in areas such as large-scale energy trading systems, peer-to-peer energy trading, project financing, supply chain tracking, and asset management. The focus of Khatoon et al. (2019) is on the application of blockchain in energy efficiency, where they show that blockchain-based smart contracting provides a solution to efficient and transparent trading of energy efficiency savings. Blockchain also offers potential for efficient building information management, with Liu et al. (2021) reviewing the literature towards addressing gaps in the smart city context.[4] Woo et al. (2021) provide a similar review with specific focus on building energy management. The remainder of this section focuses on three areas—energy performance contracting, building and renovation financing, and digital twinning.

We begin with energy performance contracting. An energy performance contract (EPC) is described as a creative financing mechanism that funds energy upgrades in, for example, building renovation works.[5] The EPC involves a contract with an assigned energy services company (ESCO) that designs and delivers on the energy efficiency plan, with the (future) revenues from the resulting costs savings being used to net off against the

[4] Relatedly, there is a literature that has considered the role that the Internet of Things can play in the real-time monitoring and management of building information. See, for example, Altohami et al. (2021) for a review.

[5] https://e3p.jrc.ec.europa.eu/articles/energy-performance-contracting#:~:text=Energy%20Performance%20Contracting%20(EPC)%20is,energy%20upgrades%20from%20cost%20reductions.

(primarily upfront) expenses around the project. Aoun (2020) notes that EPCs are suitable when funding sources are elusive, maintenance is lacking, or new equipment and technology is needed and requires unique skills. The EPC area has been well studied for a considerable period of time; Zhang and Yuan (2019) provide a comprehensive review of recent literature.

Blockchain is of interest in the area of energy performance contracting as the technology offers scope to introduce efficiencies into the process, while it also allows for trust to be established between the parties involved in the building renovation given the integrity of the blockchain. Schletz et al. (2020), for example, discuss how blockchain can provide an alternative channel through which to raise the required capital for the energy efficiency plan underlying an EPC. This utilises the process of tokenisation. Engineering digital tokens for sale to investors over a blockchain allows a way to pool funding from a large array of both retail and institutional investors. This is effectively a crowdfunding market, akin to what we met previously, but rather than being based on traditional debt and equity instruments, it is based on digital tokens[6] and fully decentralised. Schletz et al. (2020) propose the use of security tokens—which are more strongly regulated versions of digital tokens and which may reflect more closely traditional debt and equity instruments—under such blockchain applications.[7] Blockchain-based smart contracts then allow the automated transfer of the capital raised to the ESCO, while it also allows for income, as defined under the security token specification, to be transferred back to the investors. Aoun (2020) provides a wider discussion, proposing a blockchain model design suitable for energy performance contracting, which builds trust for the main players involved: customers, investors, and the ESCO. Exploitation of smart contracts is proposed for (1) the efficient recording of data collected from the implemented energy conservation measures, specifically logging data (via oracle technology) from external sensors in a smart contract (data logger smart contract); (2) the calculation of the daily adjusted baseline energy consumption based on the logged data and some agreed formulation, and the calculation of the

[6] While a discussion of digital tokens is beyond the scope of this chapter, the interested reader is directed to, for example, Tasca (2019) for a review of token-based business models.

[7] Stekli and Cali (2020) also consider the potential of security tokens as an equity crowdfunding channel for offshore wind energy, while Halden et al. (2021) do similarly for solar energy.

actual daily savings achieved with reference to this baseline (adjustments smart contract); and (3) the incrementing of the monthly savings record with the calculated daily savings (savings smart contract). Gürcan et al. (2018) similarly consider how blockchain can potentially reconcile, in the case of energy performance contracting, the requirement to process and analyse large volumes of data and the requirement to implement complex algorithms to determine the baseline energy consumption against which the actual energy consumption is benchmarked.

Blockchain can, more generally, facilitate funding release in the real estate market. While the concept of real estate tokenisation is new, the market is developing and use cases are emerging. A widely referenced case is AspenCoin, the first real estate Security Token Offering (STO). Launched in 2018, it raised US $18 million within a 2-month period in exchange for 18.9% of the ownership of the St. Regis Aspen Resort in Aspen, Colorado (Carroll, 2018). Real estate tokenisation offers fractional ownership opportunities, widening the funding pool for real estate investments and creating liquid secondary real estate markets where the trading of real estate tokens can occur (Baum, 2021). In the context of commercial real estate, Smith et al. (2019) also emphasise the benefits of blockchain in terms of securitisation and trading, but extend the discussion to the potential application of blockchain to the real estate investment value chain and to the representation of the physical assets. Smart contracts are again core to these blockchain applications allowing for automation of processes. From an empirical perspective, Swinkels (2022) provides one of the first studies of the real estate token market in the US, providing evidence that tokenisation is indeed leading to notable fractionalisation of ownership. Furthermore, Swinkels (2022) documents an alignment between the prices of real estate tokens and the US house price index, showing an integration of virtual and real property markets.

Finally, blockchain has considerable potential in the area of digital twinning. Hunhevicz et al. (2022) consider how blockchain can be integrated and exploited leveraging a blockchain-based business model that relies on interaction between the physical building environment and the virtual building environment. The latter serves to simplify the connection between the real world data and the smart contracts, reducing the data storage requirement of the smart contract. Similar to the previous studies, the blockchain is shown to be useful in delivering funding into the building project via digital tokenisation, and in the automated execution of the main phases of the energy performance contract via a smart contract, while it further allows for trust in the transactions between all parties involved.

10.5 Conclusion

This chapter summarises the somewhat limited literature that exists addressing the intersection of the financial technology and the building renovation domains. This deficit of knowledge means that there is a tangible opportunity to advance research in the directions outlined in respect of non-blockchain-based crowdfunding and blockchain-based crowdfunding, although the latter will take some years for the required token-based marketplaces to emerge and mature. Given the EU's present focus on overhauling the existing Energy Efficiency Directive towards achieving its ambitious building renovation targets, the potential for meaningful policy impact from timely research is pronounced.

From our discussion of non-blockchain-based crowdfunding, it is evident that there is a deficit of knowledge and empirical evidence in respect of the crowdfunding of building renovation. Little is known on the demand side (crowdfunding beneficiaries) or the supply side (crowdfunding investors), or indeed on the responsibilities of crowdfunding platforms. The existing literature on crowdfunding for real estate investments and renewable energy projects literature provides some useful insights that are likely to be relevant in the building renovation space. However, dedicated empirical studies that track the crowdfunding directed at building renovation projects are required, while an understanding of whether and how crowdfunding platforms promote and support building renovation projects (relative to new building development projects) is needed in order to assess the funding landscape holistically in the context of the built environment. More insight is also required into customer views of crowdfunding as a channel to finance building renovation. There are idiosyncratic features to building renovation that require more thoughtful consideration to appraise how crowdfunding can be optimised to deliver on the required scale of building renovation. In the case of the EU, such tailored research would have the potential to impact building renovation policy.

In respect of blockchain-based crowdfunding, the nascent nature of these market innovations means that time will reveal much information on the success of such blockchain applications. Future studies may attempt to answer the question: how can tokenisation most effectively work as a funding release mechanism (beyond energy performance contracting) for building renovation specifically? Our exploration of blockchain in respect of energy performance contracting is clearly new and the literature sparse. As technical blockchain developments continue in practice, we will likely see the emergence of active token-based markets that will drive funding towards building renovation work. Similar to the knowledge gaps identified in previous sections, empirical evidence will need to be accumulated in respect of the demand side (beneficiaries) and the supply side (investors) of these token-based markets. What drives a successful Security Token Offering will be important to ascertain, while the comparison of such blockchain-based crowdfunding will need to be compared against existing non-blockchain-based equity and debt crowdfunding. Furthermore, as we see greater adoption of smart contracts in energy performance contracting, we will be able to appraise the effectiveness of the financing mechanism in terms of its return performance and risk profile.

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