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Technology "like a fork". How PropTech shapes real estate innovation

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Abstract

Purpose – PropTech has shown important implications for real estate; however, it remains a poorly understood phenomenon in both academia and practice. This paper aims to advance the understanding of PropTech by disentangling what the real estate sector needs from technology and, in parallel, observing closely the activities of PropTech businesses in two different countries.

Design/methodology/approach – The paper adopts a mixed-method approach relying on qualitative data collected through interviews with PropTech players and real estate operators, and quantitative data collected through multiple sources on the Finnish and Italian PropTech ecosystems. The analysis is exploratory and descriptive.

Findings – This study underscores the potential benefits that digital technologies, introduced by PropTech, can add to the real estate sector: data integration; decisions informed from data; balance of new and old approaches to problem-solving; change in vision; adaptability of technologies and business models; and new professional profiles. These benefits are obtained when technology enables innovation from cross-pollination of different sectors. This becomes evident through the analysis of NACE activities, which demonstrates that innovation not only depends on interactions between property and technology, but the phenomenon covers a much broader spectrum of activities and industries.

Originality/value – Our exploratory analysis brings up new evidence that not only the real estate sector and property sector are affected by PropTech but the phenomenon covers a much broader spectrum of activities and industries. This paper contributes to the debate on technology innovations and value chain in the real estate and construction sector, while adding a cross-country perspective.

Keywords PropTech, Real estate innovation, Technology, Activities, NACE

Paper type Research paper

1. Introduction and background

The pervasiveness of digital technology and Industry 4.0 has been affecting every sector of the economy (Ullah *et al.*, 2019; EIT Digital, 2021) yielding positive outcomes such as accelerated economic growth and increased productivity (e.g. El-Darviche *et al.*, 2013; Arsić, 2020). While Information and Communication Technology (ICT), media and professional services have been identified as "digital frontiers" within knowledge-intensive sectors, the

Digital Economy and Society Index [1] (DESI, 2022) reports that the construction sector is among the least advanced (alongside agriculture and hunting, and hospitality), with mining and real estate somewhat along the way (Gandhi *et al.*, 2016). Nevertheless, in the last couple of decades, digital technology has been integrated into real estate and construction processes at an ever-accelerating pace, solidifying its presence as a significant industry (Braesemann and Baum, 2020) under the umbrella definition of "PropTech" (Property Technology), which has become a broadly adopted term in both academic and professional discourses. Today, PropTech is understood as "one small part of the wider digital transformation of the property industry. It describes a movement driving a mentality change with the real estate industry and its consumers regarding technology-driven innovation in the data assembly, transaction, and design of buildings and cities" (Baum and Dearsley, 2021). Commonly identified with young enterprises backed by venture capital funds (Houlihan Lokey, 2022), PropTech has seen an increase of over 300% in the last 10 years and, to date, it counts more than 8,000 companies globally providing technology-focused solutions (JLL, 2021).

PropTech has already shown important implications for real estate. First, it increases the available information about buildings and the built environment, by enabling datafication (Meyer-Schonberger and Cukier, 2012; Braesemann and Baum, 2020). Second, it entails a transfer in the value of buildings from bricks-and-mortar (tangible assets) to data (intangible assets), thereby shifting what adds value for users (Landau-Ward and Porter, 2019; Braesemann and Baum, 2020). Third, PropTech brings new actors into play in the real estate and construction market, products and services (Shaw, 2018).

Nevertheless, PropTech still offers broad areas for investigation (Porter *et al.*, 2019; Tiwari and Shukla, 2022). Sizing and categorizing the phenomenon beyond local maps and local-specific interpretations remain uncertain. For example, the definitions and classification approaches differ significantly across countries and institutions (Tagliaro *et al.*, 2021). This inconsistency makes it difficult to conduct worldwide analyses and to compare companies, activities and solutions, especially across different geographical areas. This disparity is evident in variations in the number of firms and funding levels among different countries (see, for instance, Braesemann and Baum, 2020). Therefore, assessing technology value-add requires a closer look at companies' characteristics and activities. This affects, in turn, the understanding of PropTech's influence on the real estate sector and the economy at large.

Moreover, a limited understanding of the PropTech phenomenon on a global scale hinders the legal and policy response required to govern digitalization effectively, while network effects, interoperability and standardization are becoming urgent to encourage sane competition (Shaw, 2018; Landau-Ward and Porter, 2019).

Finally, attention tends to converge on the emergence of technologies more than on the expression of needs from the real estate sector. On the one hand, metrics such as the number of PropTech companies launched worldwide (Deloitte, 2022), the volume of venture capital funds fuelled into PropTech ventures and the number of acquisitions in different tech clusters serve as proxies for market demand (as in Braesemann and Baum, 2020). On the other hand, the questions of whether the available applications match the actual demand from real estate operators and what future novelties are urgent for the sector, often remain implicit. We argue that understanding the extent to which PropTech companies match market demand is central to assessing the value they bring to the whole sector.

The present study aims to advance the understanding of the PropTech phenomenon. Through a mixed-method approach which includes the analysis of interviews from PropTech players and real estate operators about the sector's needs and secondary data about the activities of PropTech businesses in two different countries, this paper explores how PropTech activities match the real estate demand for innovation. By doing this, we contribute to the debate on technology innovations (Baum, 2017; Baum *et al.*, 2020;

Braesemann and Baum, 2020) and value chain in the real estate and construction sector (Squicciarini and Asikainen, 2011), specifically leveraging on the demand for innovation from real estate operators (PwC, 2023). Besides, this paper adds to the already well-developed body of literature on cross-country analyses (Hoesli, 2021).

1.1 Real estate demand for innovation

Innovations are defined as processes that translate ideas into goods and/or services which users and customers are willing to pay for, namely, which create value (Trott, 2008). This definition involves a holistic approach to innovation; nevertheless, it does not help to disentangle common overlaps of innovation processes, product development and technology development (Kahkonen, 2015). Lately, the argument around real estate innovation has focused predominantly on technology development, disregarding the other two aspects. Technology, indeed, continues to be a primary catalyst for change across multiple industries (McKinsey & Company, 2022). Among others, real estate displays a high association of technology applications, especially concerning applied AI, immersive reality technologies, and sustainable consumption, followed by advanced connectivity, cloud and edge computing, machine learning, trust architectures and digital identity, web3, clean energy, and mobility. Besides newly available technologies, managing change and driving innovation is challenging for real estate players. According to CherryPickPeople (2022), the main challenges reported by innovation leaders are that: (1) culture lags behind; (2) innovation is a part-time role; (3) the innovator role titles and job descriptions do not reflect their real work; (4) most of the work deals with operating technologies as such rather than strategic change and digital transformation; and (5) innovation responsibility lays in the hands of low-level positions within organizations rather than top management.

Therefore, being able to distinguish between the three different elements of innovation (i.e. processes, product and technology development), even if they are still complementary, would contribute to facilitating innovation and stakeholder management within the process while creating a culture and enhancing the innovators' role.

Innovations in the construction and real estate sector are typically "systemic innovations" (Kahkonen, 2015). This means that the new solutions have a wide and deep impact among the stakeholders, also entailing that their diffusion happens slowly (Slaughter, 1998). Attention, in the case of systemic innovation, should be directed towards understanding the business case, its size and the relevance it may have to the involved stakeholders. With this goal in mind, research is called to address a few issues (Kahkonen, 2015): (1) the added-value and cost models of innovation; (2) the potential extent of the change brought by innovation; (3) innovation implementation and change management strategies; (4) stakeholder engagement; and (5) the need for new competences and skill profiles.

Within such a complex framework for research, it is important to acknowledge the impact of innovation as a cooperative process, which happens thanks to professional networks where knowledge circulates. It is worthwhile noting that often innovation does not happen explicitly, also due to the lack of innovation management as a function in company management (Kahkonen, 2015; CherryPickPeople, 2022). Indeed, business model innovation (i.e. innovation process) requires intense exchange of both codified and non-codified knowledge. Studies on real estate network structure demonstrate that the size, density and actor centrality within a network are important determinants of its innovation effects (Yderfält and Roxenhall, 2017). Density shows a positive correlation with innovation, although dense networks are difficult to penetrate and tend to show relative closeness to new ideas and dynamics. Whereas incremental real estate business model innovations are favoured in tight networks, radical innovations are more difficult to embrace. This makes real estate a slow mover (Tiwari and Shukla, 2022) in developing and absorbing new

technologies, products and business models. Meanwhile, real estate needs to react fast to priorities like the Environmental, Social, and Governance (ESG) agenda, climate change, changing customer demands, technological innovation, decarbonization, real estate as a service, digitisation and robotics, and geopolitics, while dealing with construction costs, availability of resources, availability of finance, increased regulations, disposal of suitable assets and asset obsolescence (PwC, 2023).

1.2 Understanding PropTech

Currently, the academic discussion on the PropTech phenomenon seems to be divided into two contrasting perspectives. On the one hand, the analysis of innovation in real estate has focused mainly on the types of technology that are involved in this evolution, following the lines of a technology development perspective with the underlying assumption that it improves construction and real estate business processes. Baum (2017) and Baum et al. (2020) described the technology-driven innovation in real estate as occurring in three subsequent waves: (1) PropTech 1.0 introduced data and computing power (such as AutoCAD software); (2) PropTech 2.0 focused on aligning market demand with real estate supply through e-commerce and social network approaches; and (3) PropTech 3.0 is driving the integration of exogenous technologies, including Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML) and Blockchain. Baum et al. (2020) discuss technologies applied in real estate based on three main areas of innovation: FinTech - regarding investment, payments and tenancy management aimed at reducing transaction costs; Sharing Economy - facilitating optimal space utilization; and Smart Buildings - converting physical processes around real estate into digital data. Following this approach, several contributions, especially within academia, focus on a few specific technologies and analyse them in depth, mostly through case studies, to disentangle their functioning for the sector. For instance, some studies analyse the degree of transparency introduced by PropTech solutions (Siniak et al., 2020; Jinmin et al., 2022); others (Wainwright, 2023; Ullah and Al-Turjman, 2023) investigate specific technologies for optimising real estate operations, such as AI, IoT and Blockchain. Nevertheless, the same concept of "technology" seems rather blurred. For instance, Brozovsky et al. (2024) identify 38 technologies in the Architecture, Engineering and Construction (AEC) sector, whereas FMgoesDIGI (2022) counts 25 technologies in the Facility Management (FM) field, with only a few technologies common to both lists. Additionally, Unissu provides a different list of technologies including 43 items (Unissu, 2023). Moreover, this focus on technology has drawn criticism for overlooking the socio-technical implications of the industry's digital transformation and for inadequately supporting academic research (Shaw, 2018).

On the other hand, several associations (such as RICS), networks (such as Unissu) or professional services companies (such as KPMG and PwC) are monitoring the integration of PropTech solutions in the real estate sector. This stream approaches innovation from a product development perspective. These publications (e.g. Report) are aimed at showcasing innovative applications for the real estate sector and informing the operators about the latest market trends. However, their commercial scope confines interpretive insights, which could offer a broader look at the path taken by PropTech companies in introducing digital innovation in the real estate sector, thus encouraging the adoption and implementation of new solutions. Braesemann and Baum (2020), along these lines of reasoning, propose six tech clusters, expressing aggregations of the most important 30 technologies used in PropTech, namely: Smart Real Estate (sensor technology, mostly), Data Analytics (automated valuation, mapping, big data, AI and more), Modelling (including digital representation of buildings, such as BIM and VR/AR), Real Estate Fintech (crowdfunding, blockchain, cryptocurrency, etc.), Business Processes (CRM, workflow management and chatbots) and ConTech

(prefabrication and modular building). Remarkably, little attention has been directed towards identifying the sources of such innovation. It remains unclear whether these innovations are solely the result of interactions between property and technology, or if other determinants are involved. Most importantly, limited attention is given to the value added by technologies to the real estate sector, particularly, in terms of how digitalization enhances performance.

1.3 PropTech value
While literature in innovation science and management underscores that an innovation event, such as the introduction of a new product or process, initiates a value creation process within a firm (Roper *et al.*, 2008) and grows its competitive advantage (Porter, 1985), evidence remains scarce regarding how the implementation of technology-driven solutions adds value (i.e. enhances performance) to the companies that adopt them. Even though new opportunities and re-engineering initiatives are considered crucial to achieve, sustain and expand profitability (Roulac, 1999), and, thus, create value, most of the debate on innovation in real estate takes a life-cycle perspective, without providing evidence of its added value. This is probably because value chains in real estate tend to be closely related to life cycles. Indeed, the structure of the real estate value chain (along with the roles and actors involved in the value creation and/or adding processes) corresponds to the real estate life cycle (Mladenow *et al.*, 2015). Various perspectives highlight conceptual overlaps on this matter. European standards divide the building's life cycle into four phases: building materials production stage, construction process, building use stage, end of the building's life and disassembly stage (EN 15978:2011, 2011). Mladenow *et al.* (2015) take a wide outlook, assessing the impact of cloud computing on the real estate sector by examining its potential value and the effect on the life cycle and/or value chain of real estate assets, interchangeably. Block and Aarons (2019) identify 8 value chain "functionalities": analysis and financing, space identification and listing, site selection and negotiation, diligence, development and construction, process automation, space usage and management, and payments and services. Maududy and Gamal (2019) define 16 stages that represent value-creating activities from the property developer's point of view, divided into Pre-, Post- and Construction-phases. The pre-construction phase consists of: Idea, Site study, Site selection, Market study, Site Acquisition, Feasibility study, Design, Planning, Financing, Permits, Negotiating contract and Commitment. The construction phase consists of Implementation. The post-construction phase consists of the Promotion, Exit strategy and Property Management stages. Similarly, industry reports categorize PropTech solutions based on the activities they support. KPMG (2021) lists six positions that innovation takes in the real estate value chain, namely Sourcing (materials, products and technology), Design and Planning, Construction, Property and Facility Management, Transaction and Leasing, and Investing and Financing. Moreover, 40 "Fields of Expertise" describe the core competencies supported by digitalization (e.g. Air quality, Building automation, Predictive maintenance, Robotics and more). Unissu (2023) simplifies the asset life cycle into three main stages: (1) build (corresponding to ConTech – Construction Technology sub-sector); (2) manage; and (3) demolish. The second stage is then subdivided into buy, move, rent/lease and sell. Whereas no PropTech company deals with demolition, according to Unissu, they seem to apply to one or more of the other stages. In addition, Unissu (2023) identifies 47 "Job Functions" which PropTech solutions can help to improve or adjust such as compliance, document management, mortgages, property management and similar.

The plethora of available definitions of the value chain overlapping with that of the life cycle within the real estate, property and built environment realms complicates the interpretation of the value added by PropTech. This variety makes it difficult to compare businesses with each other, categorize activities and recognize the competitive advantage that innovation brings for different stakeholders. The building life cycle necessitates a

multifaceted examination to illuminate the benefit of PropTech in value creation for the real estate sector. In fact, Squicciarini and Asikainen (2011) argue that, to grasp the actual value chain of the construction sector, a broader view of business activities is needed, which is especially true when it comes to the innovativeness and the potential of digitalization applied to the sector. Therefore, in this paper, we examine a sample of PropTech companies and their definition of core activities to understand how they address the real estate sector's demand for innovation through digital technology and, in turn, the value they contribute to the entire sector.

2. Methodology

This paper adopts a mixed-method approach, combining the analysis of interviews with PropTech players and real estate operators and descriptive analysis of secondary data on PropTech companies. First, the interviews served to grasp the "demand side" perspective from the sentiment of PropTech and real estate professionals and understand real estate needs when looking for digital innovation; second, we explored the "supply side" perspective by analysing what value the technology-driven solutions provided by PropTech companies bring to real estate and whether there is a match between the two sides.

2.1 Interviews with professionals

We interviewed thirteen professionals during a one-day event called "PropTech Day" organized in November 2023 in Milan. The selected interviewees represent both Italian and international companies that were actively involved in the event, either by being well-established PropTech companies showcasing their technology-driven solutions or by being real estate companies sponsoring the initiative and interested in those solutions. Table 1 reports interviewees' description. Similarly to the approach adopted by CherryPickPeople (2022), the selection of interviews for this study was intentionally skewed towards PropTech companies rather than other real estate players. We acknowledge that this research is just a first preliminary step in understanding the PropTech phenomenon and that future studies should expand the sample. However, in this research, access to interviewees was facilitated by convenience sampling, allowing for efficient data collection from those companies most involved in and knowledgeable about the current trends and developments in real estate digital innovations, thereby ensuring a focused and relevant data set for the study.

ID interview	Role of the interview	Type of company
INT-01	General Manager	Sponsor
INT-02	Head of Real Estate Services	Sponsor
INT-03	Head of Capital Markets Italy	Sponsor
INT-04	Chief Strategy Officer	PropTech
INT-05	CEO	PropTech
INT-06	Co-founder and CEO	PropTech
INT-07	Country Manager and International Expansion	PropTech
INT-08	Co-Founder and CEO	PropTech
INT-09	Co-Founder and COO	PropTech
INT-10	Head of IT and Product + Responsible for Business Development	PropTech
INT-11	Country Manager	PropTech
INT-12	Business development manager	PropTech
INT-13	Key Account Manager	PropTech
Source(s): Authors' own work		

Table 1.
Description of interviewees

Additionally, the relative homogeneity of the interviewees enabled us to achieve data saturation with a small number of interviews, ensuring that the main innovative dynamics in the real estate sector were adequately represented while the market demand for innovation was acknowledged from secondary sources (i.e. market reports and literature review) and, indirectly, from the interviews.

The objective of the interviews was threefold. First was the attempt to identify the most relevant transformations in the real estate sector according to the insiders' perspective. Attention was posed to discussing innovations independently from the latest socio-economic disruptions induced by a number of exogenous events (including the COVID-19 pandemic, the Ukraine–Russia and Palestine–Israel wars, the oil and gas crises, etc. – for an analysis of the effects of different exogenous effects on the real estate market see, e.g. Yudaruddin and Lesmana, 2024; Hoesli, 2021). The second objective was to dig into the specific role of technology in the real estate industry. Finally, we intended to discuss the need for policy and strategy development in order to foster the digital transition. The professionals were given a specific appointment during the PropTech Day event for a 20-min video-recorded interview to answer same three questions: (1) What are the key needs in the real estate sector emerging already before the COVID-19 pandemic? (2) What is the role of digital technology in addressing these needs and supporting the evolution of real estate? (3) What are the perspectives for progress?

Given the limited number of interviews at this stage of the research, we opted for an interpretative qualitative analysis by aggregating the text into codes (Strauss and Corbin, 1998). Three members of the research team independently coded the text in parallel, agreeing on synthetic themes. We ensured the reliability of our analysis through comparisons between researchers. Discrepancies were resolved through discussion and occasional recoding, ensuring internal consistency.

2.2 PropTech data

Beyond the interview data, we collected secondary data on PropTech companies based in Italy and Finland from several sources.

We collected data on companies based in Italy and Finland because we wanted to observe Italy as a good case of dynamism in supporting innovation over the years compared to Finland, a country that has always been among the frontrunners of technology integration. Indeed, these two countries show opposing performance in innovation capabilities and the emergence of PropTech businesses. According to DESI (2022) and the European Innovation Scoreboard - EIS [2] (EIS, 2022), Finland appears to be the best-performing country in terms of innovation (it is among the innovation leaders within Europe), whereas Italy appears in the cohort of moderate innovators but is the best-performing country for innovation growth in the long term. Concerning specifically the development of PropTech, even though in both countries PropTech has picked up already a few years ago, the current state of business activity in the sector demonstrates a severe misalignment of performances. Both Italy and Finland are not the biggest PropTech markets in Europe, Finland registers the highest number of PropTech per capita while Italy is the smallest (Table 2). The high number of PropTech startups (per capita) in Finland indicates a strong startup culture (Koskinen, 2020) supported by government and private sector-led initiatives, among which, for example, Business Finland [3] (see, e.g. Nordea, 2021).

A common database of Italian and Finnish PropTech companies was composed of multiple pre-existing lists and sources, trying to overcome current limitations in information availability. An extensive list of Finnish PropTech companies was available on Unissu platform. It was the most comprehensive list of PropTech companies available freely in Finland at the time of data collection [4]. Unissu provides access to Italian Proptech Companies, too. However, the authors have access to the database provided by the Italian

PropTech Network (Bellintani *et al.*, 2020), which compiles every year a list of the Italian PropTech businesses. Therefore, this list was chosen to replace the shortest list available on Unissu, including only 42 Italian PropTech companies with no precise correspondence with the list of the Italian PropTech Network.

The list of companies from these two sources was integrated with data from Orbis, the largest worldwide repository of company data provided by Bureau Van Dijk. Through Orbis, we collected information on company name, status of activity and general information on their financial performance to check on the existence of the business; company size and year of foundation to track the development stage; and industry section and core code (NACE rev. 2) to describe the type of business (Table 3). This last information was the main variable used in our analysis. The NACE classification system of the European Community (European Commission, 2008) allows the official identification of main activities in a certain industry sector (Squicciarini and Asikainen, 2011) and ensures harmonized statistics to enable international comparisons (Schnabl and Zenker, 2013) [5].

To ensure the rigor of the methodology, data was collected simultaneously for the two countries. Since plausible exogenous effects in PropTech markets were possible in the last three years due to the recent COVID-19 pandemic and other socio-economic disruptions, the paper relies on data from 2020. The data collection process was performed from March to June 2021. Over this period, 121 companies in Finland, and 159 in Italy were detected. However, this sample required cleaning. According to the Orbis database, only 120 Finnish and 139 Italian companies were active at the time of analysis. One Italian company was dropped from analysis because Orbis did not report any data about it, except the name. Moreover, the study considered only companies that are legally established in the two countries respectively. All 120 Finnish companies were established in the same country, whereas only 114 out of the 138 Italian companies were relevant for this study due to their legal entity being registered elsewhere. In total, the analysis was carried out on 234 active companies, of which 120 companies for Finland and 114 for Italy.

The analysis of this dataset primarily relies on descriptive statistics. Quantitative analysis was used to complement the interview analysis and provide insights into the industry sectors and business activities of these companies. The goal was to determine whether the activities performed by PropTech firms align with the identified emerging needs.

3. Results

3.1 Real estate demand for innovation

3.1.1 Emerging real estate needs. The shared opinion among the interviewees is that the real estate sector is constantly evolving, which already shows an important shift compared to the

Country	PropTech per capita per million inhabitants
Finland	19
Switzerland	16
The Netherlands	14
Sweden	14
UK	12
France	8
Spain	6
Germany	4
Italy	0,7

Source(s): Elaboration of the authors based on data from Unissu (2023)

Table 2.
Ranking of EU countries by number of PropTech per capita

REVCode	FI	IT	Total
Administrative and support service activities	**2**	**5**	**7**
Combined facilities support activities	1	1	2
Combined office administrative service activities		1	1
General cleaning of buildings	1		1
Other business support service activities n.e.c.		2	2
Other reservation service and related activities		1	1
Construction	**2**	**4**	**6**
Construction of residential and non-residential buildings	1		1
Development of building projects	1	3	4
Electrical installation		1	1
Financial and insurance activities	**2**		**2**
Other activities auxiliary to financial services, except insurance and pension funding	1		1
Other financial service activities, except insurance and pension funding nec	1		1
Human health and social work activities	**1**		**1**
Other human health activities	1		1
Information and communication	**76**	**57**	**133**
Computer consultancy activities	6	3	9
Computer programming activities	59	22	81
Data processing, hosting and related activities		3	3
Motion picture, video and television programme production activities	2		2
Other information service activities nec	1	2	3
Other information technology and computer service activities	3	7	10
Publishing of newspapers	1		1
Web portals	3	20	23
Wired telecommunications activities	1		1
Manufacturing	**2**	**4**	**6**
Manufacture of electronic components		1	1
Manufacture of games and toys	1		1
Manufacture of instruments and appliances for measuring, testing and navigation		1	1
Manufacture of metal structures and parts of structures	1		1
Manufacture of other electrical equipment		1	1
Manufacture of wiring devices		1	1
Professional, scientific and technical activities	**32**	**18**	**50**
Advertising agencies		3	3
Architectural activities	2	1	3
Business and other management consultancy activities	4	3	7
Engineering activities and related technical consultancy	19	3	22
Other professional, scientific and technical activities nec	5	2	7
Other research and experimental development on natural sciences and engineering		1	1
Photographic activities		1	1
Professional, scientific and technical activities	1		1
Public relations and communication activities		1	1
Specialised design activities	1	3	4
Public administration and defence; compulsory social security		**1**	**1**
General public administration activities		1	1
Real estate activities	**2**	**22**	**24**
Buying and selling of own real estate		3	3
Management of real estate on a fee or contract basis		2	2
Real estate agencies	2	14	16
Renting and operating of own or leased real estate		3	3
Transportation and storage		**1**	**1**
Other transportation support activities		1	1
Wholesale and retail trade; repair of motor vehicles and motorcycles	**1**	**2**	**3**
Retail sale of hardware, paints and glass in specialised stores	1		1
Retail sale of second-hand goods in stores		1	1
Wholesale of furniture, carpets and lighting equipment		1	1
Total	**120**	**114**	**234**

Source(s): Elaboration of the authors

usual perception of the sector as slow-moving (Tiwari and Shukla, 2022, among many others). One of the interviewees predicts that: "The real estate sector will change more in the next 5 years than it has changed in the past 50" (INT-02). The most radical change in the real estate operations and market is recognized in a competence shift from more technical and

vertical skills to more digital and transversal ones. This is reflected in the manifestation of the following complementary needs.

First, typical information available on real estate assets increasingly asks to be collected, manipulated and cross-referenced with information of a different nature (INT-02). Land registry, topography, as well as graphics and marketing, are only a few examples of new data sources that overcome the usual working methods based on vertical silos (INT-04). Based on this data, statistical and mathematical integration allows for the elaboration of predictive models (INT-02; INT-03). This requires multidisciplinary teams, made up of web developers, data scientists and engineers, product developers, user experience managers, prompt designers and more. Teamwork is, therefore, a prerogative to dominate complexity through inter-cultural and inter-disciplinary exchanges.

Second, data management is underlined as one of the most prominent potentials of real estate innovation. "Data science and data management are the new frontiers to bring insights and inform business strategies" (INT-01). This is of utmost importance, especially in Italy (INT-04), where the shortage of data requires fundamental organizational capacity to make informed decisions which can be strongly aided by AI helping to fill data gaps.

Third, the sector requires balancing up the contribution of new technologies and the traditional approach. Ideally, the ongoing digital transition should occur without excessively disrupting current operations, which characterize the business-as-usual (INT-03). An active propensity for change will therefore lead to a positive combination of a client-oriented approach complemented by data science inputs. In this context, the workforce needs a solid knowledge of the market along with technological and data-analysis skills to interpret new trends (INT-05).

Fourth, a change in vision is occurring (INT-01). This happens through an enhanced capacity to observe what has been happening in different worlds and other contexts. This resonates with Braesemann and Baum's (2020) statement that PropTech is a global phenomenon, able to connect previously detached markets from remote parts of the planet. Such change calls for flexibility and the ability to adapt in light of forthcoming new needs (INT-09; INT-07). Dynamism, proactivity and curiosity allow us to solve problems with new approaches, in a sector that typically has long lead times. Divergent thinking helps to see the potential transferability of technologies from other sectors into the real estate industry.

Fifth, business models themselves need to innovate by becoming increasingly flexible and adaptive, to keep up with a constantly changing sector. In the words of one of the interviewees: "Space-as-a-Service is a constant mantra: it expands the ways in which people utilize and 'consume' spaces, therefore we, as providers, need to adapt" (INT-01). The technologies must be easy and scalable to allow a large margin of flexibility since continuous rethinking has become the prerogative of today's ever-changing world. This can be favoured by more transversal training of operators; in particular, people with business skills should also acquire technological skills to be able to manage competition at a European and global level with greater awareness.

Finally, the job market is adapting. Among the professions of the future: the green building certifier, the modeler of decarbonization scenarios, the living manager of residential buildings, the expert in AI applications for reducing consumption of the built environment and more (INT-05). In a world where using digital tools is no longer a choice but a must, it is necessary to always be available to relearn again because nowadays "professions are no longer those that are taught in school" (INT-10). It should be considered that technology can make some professions more attractive, such as those in real estate, which tend to be far from the work objectives of the new workforce, especially among the younger generations (INT-02).

In sum, the key needs in the real estate sector emerging already before the COVID-19 pandemic are data integration; data management for informed decisions; balancing new and old approaches to problem-solving; change in vision through openness to transferability

from different geographical and industry borders; adaptability of technologies and business models; and new professional profiles.

3.1.2 The role of digital technology in addressing emerging needs. Many interviewees expressed the idea that technology is pervasive, but it is not a substitute for human value. Moreover, introducing technology is not innovation *per se*. In the interviews, technology is interpreted as a tool to make information more accessible, with the warning that the quest for technology cannot be the objective of a real estate business. One interviewee expressed this concept with an interesting metaphor, arguing that: "Everything we do is infused with technology, where technology is a tool, like a fork" (INT-04). Humans must be able to delegate to the machine: what can be done today by a machine allows humans to focus on activities with greater added value, such as consultancy for customers (investors, buyers, etc.) by automating some repetitive tasks. This puts an accent on the need for research to switch from technology focus to value-added focus. Indeed, the important questions to answer are those about new value propositions and the additional value that technology can bring to real estate products, processes and market, especially through the elaboration of newly available data. From the interviewees' experience, it was possible to identify the key roles that the technology is playing in addressing those pressing needs.

Digital technology serves multiple purposes related to data collection and management, from filling data gaps: "Often in real estate we work by comparison, but this approach is very ineffective due to various gaps and uncertainties in the data source. Today, the comparisons are much more reliable" (INT-04), to increasing transparency: "[Technology] can make the real estate industry safer and more transparent" (INT-10).

Also, technology supports the human mind in managing large volumes of data: "Technology today allows us to manage volumes of data unimaginable by the human mind. However, without human reasoning, one cannot find the meaning, the history, the interpretation of the data, nor can one use the data for useful purposes" (INT-06); "It makes the profession easy" (INT-07); "Directing must be human" (INT-08).

Technology is helpful also in re-shaping stakeholder interactions, for instance, by facilitating sharing messages, communicating and handling conflicts: "Digital allows you to share information" (INT-05); "Managing contrasts is always difficult but, thanks to technology, conflicts can be defused through improved communication" (INT-08).

Finally, technology has an impact on multiple sustainability and optimization issues. Technology concurs to speeding up times, reducing costs and monitoring sustainability objectives: "Technology reduces the time needed to be competitive in the real estate sector" (INT-07); "Technology helps reduce costs and make the real estate market more accessible even for people with reduced purchasing capacity" (INT-09); "The technological component makes the workflow more efficient and supports sustainability in ESG terms" (INT-13).

3.1.3 Perspectives for progress. The real estate sector requires innovation to be promoted and channelled (INT-01). Contributions to the growth of a PropTech "ecosystem" can lead to the desired result of meeting the needs expressed above. Nevertheless, the industry must undergo a proper change management operation and a switch in organizational culture (INT-01). Some actions and commitments should be prioritised for moving towards the future, with the overarching objectives of environmental protection and sustainability.

The first point of discussion was the need for definitions and shared guidelines. It is urgent to start a regulatory and mandatory process for the introduction of digital technology, as was the case for sustainability issues (INT-11). This cannot prescind from the development of guidelines to distinguish what is PropTech from what is not PropTech and channel supply and demand (INT-12).

Then, a human touch is considered essential. Investing in young people "by calling them to the expert table" is important for their ability to interact with technology (INT-03; INT-13; INT-02). "Chatting with others" (INT-03), working together with professionals from various

sectors is seen as the only way to accelerate the innovation process, along with moving towards a "human-tech model" (INT-05) where innovation follows human-made decisions and is not pulled by the latest tech trend.

Finally, a new mindset driven by evidence-based decisions is required. To do this, it is critical to identify market needs and adopt research strategies to interpret them: "Applying solid methodological models helps understand new trends and find effective solutions to problems" (INT-06).

3.2 How PropTech matches the demand

To understand whether the activities performed by PropTech firms are aligned with the emerging needs, in the following paragraphs we describe the sampled companies in Italy and Finland and their main activities. Specific attention was given to the NACE sections in which PropTech companies are registered and their current activities.

3.2.1 PropTech companies. Some companies that are currently active as PropTech were founded already in the 1980s, which indicates that they converted their business and progressively integrated digital processes (Figure 1). 7% of the Finnish companies and 10% of the Italian ones were founded before the year 2000. This evidence shows that associating the PropTech business only with startup companies (as, for instance, Houlihan Lokey, 2022) is not always appropriate, nor wanted. Indeed, as emerged from the interviews, what has been happening and is considered a positive dynamic is a relatively progressive merge of the contribution of new technologies with the traditional approach. However, it is still true that, if we stick to the definition of startup based on the year of foundation within the past 10 years, as suggested by the European Startup Monitor (2020), most of the existing PropTech companies can be considered startups in 2020. In fact, 80% of the Finnish and 78% of the Italian companies were founded in 2010 or after. More specifically, 39% of Finnish companies and 57% of Italian companies were founded in 2015 or after, with most of them between 2015 and 2018.

It is interesting to note that Figure 1 displays a similar path in the development of the sector in both Finland and Italy, which would confirm the occurrence of subsequent PropTech waves (Baum, 2017). However, the waves appear as shifted by two years in the two countries. A misalignment emerged between the time when the PropTech phenomenon
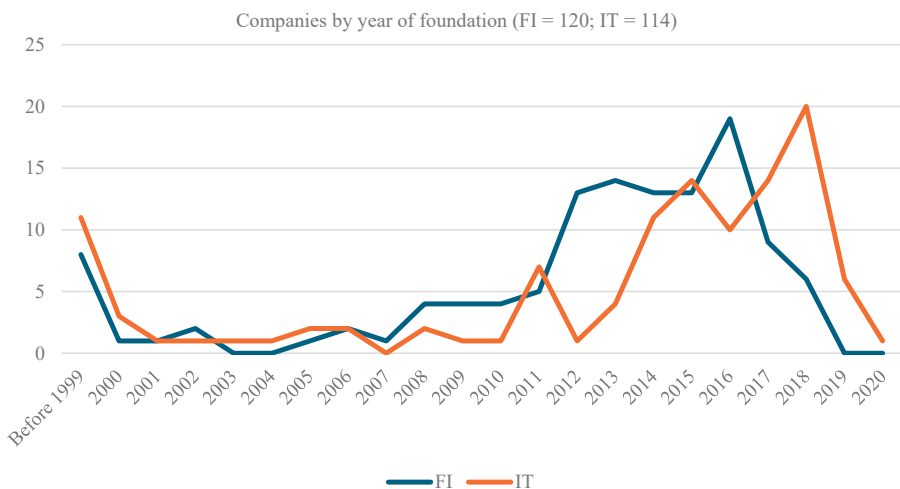
Figure 1.
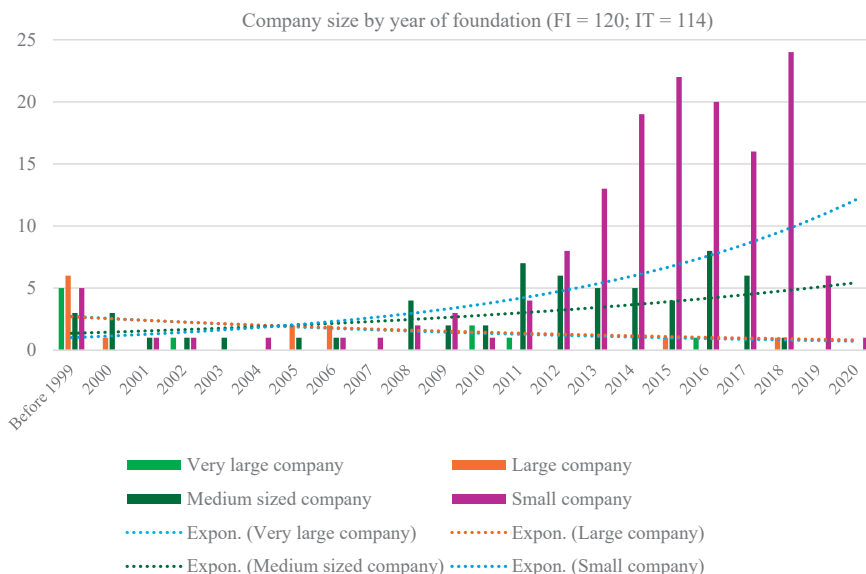Number of PropTech companies in Finland and Italy by year of foundation

Source(s): Elaboration of the authors

started picking up in Finland and when it developed in Italy, which might contribute to the misalignment in the number of PropTech companies per capita in the two countries.

While looking at the size of PropTech businesses, most companies fall under the small-medium enterprise (SME) category (Italy: 68% of companies are small and 18% are medium size; Finland: 59% are small and around 30% are medium). This mimics the general trend of EU businesses around 99% of which are SMEs [6] (Figure 2). Nevertheless, this resonated with the above-mentioned need for businesses themselves to innovate by becoming increasingly flexible and adaptive. Clearly, small companies are more agile in keeping up with a constantly changing sector.

3.2.2 PropTech sectors. The study looks at the different NACE rev.2 (2023) sections in which PropTech companies are listed. We identified 11 sections (out of 21 NACE rev. 2 sections) as relevant to the PropTech companies (Figure 3), which suggests that PropTech is a much more complex phenomenon than what it seems by only interpreting it as the convergence of the property sector (i.e. Real estate activities) with the technology sector (i.e. Information and communication), as anticipated by Squicciarini and Asikainen (2011). Some minor differences between the two countries are detectable in regard to the distribution of PropTech companies across NACE sections.
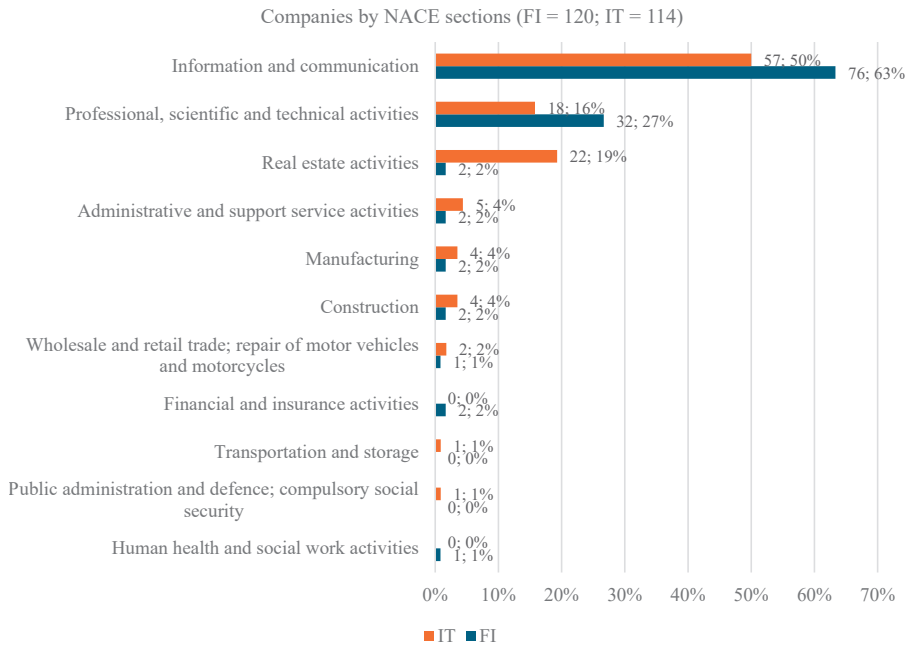
"Information and communication", "Professional, scientific and technical activities" and "Real estate activities" collect most of the companies in both countries. One difference to note is that, whereas in Finland, there are two prevalent sectors, namely "Information and communication" (63%, 76 companies) and "Professional, scientific and technical activities" (27%, 32 companies), in Italy, there is a more diversified panorama. Indeed, "Information and communication" (50%, 57 companies) confirms to be the dominant sector, but "Real estate activities" (19%, 22 companies) exceeds the relevance of "Professional, scientific, and technical activities" (16%, 18 companies). Italy reports higher numbers than Finland in minor sectors like "Administrative and support service activities" (4%, 5 companies), "Construction" (4%, 4 companies) and "Manufacturing" (4%, 4 companies).

Figure 2.
Number of PropTech companies in Finland and Italy by size and year of foundation

Source(s): Elaboration of the authors

Companies by NACE sections (FI = 120; IT = 114)

Information and communication — 57; 50% / 76; 63%

Professional, scientific and technical activities — 18; 16% / 32; 27%

Real estate activities — 22; 19% / 2; 2%

Administrative and support service activities — 5; 4% / 2; 2%

Manufacturing — 4; 4% / 2; 2%

Construction — 4; 4% / 2; 2%

Wholesale and retail trade; repair of motor vehicles and motorcycles — 2; 2% / 1; 1%

Financial and insurance activities — 0; 0% / 2; 2%

Transportation and storage — 1; 1% / 0; 0%

Public administration and defence; compulsory social security — 1; 1% / 0; 0%

Human health and social work activities — 0; 0% / 1; 1%

0%   10%   20%   30%   40%   50%   60%   70%

■ IT ■ FI

Figure 3.
Percentage of companies in Finland and Italy by NACE rev. 2 sections

Source(s): Elaboration of the authors

Overall, not a small percentage of companies operate in sectors other than "Information and communication", "Professional, scientific and technical activities" and "Real estate activities", namely, 16% of the Italian PropTech companies and 11% of the Finnish ones.

Besides, it is relevant to report that only less than 70% of companies, as a cumulative of the two countries, actually belong to sectors dealing with either technology or real estate, construction and similar. This could be related to the presence in Finland of support services for the creation of companies and startups. Anyway, for both Italy and Finland, the innovation brought to real estate is coming not only from the property and technology sectors but also from others. This recalls the interviewee's opinion about the need for data collection and merger from multiple sources, through mathematical and statistical integration. Additionally, a significant part of the analysed PropTech goes under the label of "Professional, scientific and technical activities". This suggests that the advancement of the sector is in the service industry.

3.2.3 PropTech activities. To better understand the value that PropTech provides in response to the manifested real estate needs, this study looks in-detail at the activities that the selected companies describe (Table 3). The activities collecting 10 or more records are Computer programming activities ($n = 81$); Web portals ($n = 23$); Engineering activities and related technical consultancy ($n = 22$); Real estate agencies ($n = 16$); Other information technology and computer service activities ($n = 10$). Most of the companies are working in "Computer programming activities" (59 Finnish and 22 Italian companies) and in developing or managing "Web portals" (20 Italian and 3 Finnish companies), within the "*Information and communication*" sector. Therefore, the participation of PropTech in the process of real estate datafication (Braesemann and Baum, 2020) is only partially evident since, if this was the case, one would expect a concentration of PropTech under the "Data processing, hosting and related activities", which only counts 3 companies out of 234. Still, data management was mentioned in the interviews as one of the most prominent needs of real estate addressed

through digital technology. However, the shortage of data, especially suffered in Italy, may explain why the business around data management seems underdeveloped.

Within the "*Professional, scientific and technical services*", the Finnish market seems much more compact around the activities related to "Engineering activities and related technical consultancy" with 19 companies, whereas Italy counts only 3 in this activity area and the other 15 are almost equally distributed across a range of other activities, including "Business and other management and consultancy activities" (FI = 4, IT = 3), "Other professional, scientific and technical activities" (FI = 5, IT = 2), "Specialized design activities" (FI = 1, IT = 3), "Advertising agencies" (FI = 0, IT = 3) and more (see Table 3). This evidence is coherent with the need reported by the interviewees to complement "business-as-usual" real estate information with graphics and marketing, thus overcoming siloed vertical competences. Multidisciplinary teams, made up of web developers, data scientists and engineers, product developers, user experience managers, prompt designers and more, are most likely composing the workforce of these PropTech companies, as anticipated in the interviews.

Curiously enough, only two Finnish companies operate within "*Real estate activities*", both of which focus on "Real estate agency", compared to 14 Italian companies in this activity. Among the other Italian PropTech in this section, three are in "Buying and selling of own real estate", three in "Renting and operating of own or leased real estate" and two in "Management of real estate on a fee or contract basis". Together with these, an extremely little compound of companies carry their business under the "*Financial and insurance activities*" – among them, one deals with crowdfunding (https://www.groundfunding.fi/) and one is an account-based multimodal mobile ticketing platform for transport operators and city event organizers (https://payiq.net/). This evidence particularly challenges the idea that one of the main PropTech innovations would lay in the so-called FinTech domain, thus entailing services in the transaction phase of property management (Braesemann and Baum, 2020). This may be a proof that, as hinted in the interviews, business models are changing. There is the possibility that business models leveraged by PropTech are somewhat independent from real estate. This would confirm what Meyer-Schonberger and Cukier (2012) and Landau-Ward and Porter (2019) argue about a progressive transfer in the value of buildings from tangible to intangible assets.

Among the outliers, some additional key activities can be detected. On the Finnish side, "*Human health and social work activities*" include a company that deals with indoor environmental quality monitoring through cloud-based solutions with analytics and communication solutions (https://720.io/en/). This company is the only one referring to the role of digital technology in supporting sustainability and ESG reporting, which was mentioned in the interviews among the purposes of PropTech. On the Italian side, "*Public administration*" includes a service offered by a large organization dealing with credit management, risk management and economic research. This service (https://beethecity.com/it) meets the needs of individuals who are searching for buying or selling their house or real estate agencies by profiling the clients and offering support through massive data management and location analysis. Finally, with "*Transportation and storage*", Italy counts a company that produces and installs smart lockers (https://www.smartlocker.it/) in support of delivery services in private houses and condominiums, company buildings and business centres, coworking spaces and other collaborative spaces.

Other sectors attract PropTech companies such as "*Administrative and support service activities*" and "*Construction*". In both these two sectors, companies are involved in a range of activities from facility management to business management. Under "Administrative and support service activities", Italy seems active in a wider array of activities. Finland concentrates on "General cleaning of buildings" especially home cleaning (i.e. https://www.freska.fi/en/) and "Combined facilities support activities". In this last activity the Italian and the Finnish companies deal with different job tasks, on one hand, Short Rent Apartments (i.e. https://www.italianway.house/) and, on the other, smart building control and maintenance through IoT (i.e. https://leanheat.com/). In addition, Italian companies operate also as

"Combined office administrative service activities" dealing with shared office management (https://offisquare.com/); "Other business support service activities", such as booking management, client customer care, check-in/check-out, cleaning and admin consulting (i.e. https://www.guesthero.com/ and https://www.cleanbnb.net/); and "Other reservation service and related activities" with self-check-in (i.e. https://www.keesy.com/en/). It must be pointed out that companies with similar businesses are allocated in different activity categories and seem to intercept different innovation areas, either Smart Real Estate or Sharing Economy (as per the definitions by Braesemann and Baum, 2020). This evidence reflects the need that has emerged through the interviews for a progressive integration of job profiles and competences.

The *"Construction"* sector includes activities from "Construction of residential and non-residential buildings" (i.e. https://www.fira.fi/en/), "Electrical installation" (i.e. http://www.gruppocaraglio.it/EN/index.html), to "Development of building projects" with companies dealing more broadly, in Italy, with non-performing loans (i.e. https://www.ncmspa.it/), temporary housing (i.e. https://www.esth.it/) and crowdfunding (i.e. https://www.rendimentoetico.it/), and in Finland, with the design, construction, management and refurbishment of dwellings and the related services (i.e. https://avainasunnot.fi/avain-yhtiot/). Overall, this sector would be more coherent with ConTech than with PropTech, considering that most of the included companies take care of construction (i.e. http://www.gruppocaraglio.it/EN/index.html and https://www.fira.fi/en/). However, they approach construction with a more integrated attitude and tend to follow not only the technical phase but also the design and operation of the buildings. They can be considered as an evolution of the construction industry towards the integrated management of the whole building life cycle. Aligning with Squicciarini and Asikainen (2011), the actual value chain of the construction sector entails multiple activities across sectors and stages of the building life cycle. Therefore, interpreting the innovativeness and potential of digital technologies applied to the sector requires an expansion of the current sector-specific and process-specific (i.e. life-cycle) perspectives.

All in all, it is evident that PropTech companies are contributing not only to activities traditionally belonging to the real estate sector but, in many cases, their role in the economy is accounted for in sectors other than real estate.

4. Discussion
The interviews highlighted that the technology discourse is not sufficient to exhaust the matter of real estate innovation, thus confirming what emerged from the literature review, namely, that different complementary elements of innovation should be acknowledged simultaneously: innovation processes, product development and technology development (Kahkonen, 2015).

This study underscores the potential benefits (i.e. the value) that digital technologies, introduced by PropTech, can add to the sector, considering the emerging demand.

The need for integrating information of different nature beyond vertical silos is addressed given the high level of multidisciplinary that is suggested by the diverse array of sectors involved in PropTech. Especially, expertise in "Information and communication" emerged as the predominant field. Indeed, information and communication provide *per se* cross-disciplinary applications and can be considered as a sector-agnostic discipline.

The need for data management and for the decision-making backed by data was found relatively weaker in the analysed sample. Indeed, the number of companies hosted in the "Data processing, hosting and related activities" is very little compared to the manifested urgency for data elaboration. However, it is not to be excluded that a similar activity is provided by companies in other sectors, especially those within the "Professional, scientific and technical services" dealing with consulting. One case of massive data management, for example, was found in the "Public administration" cluster. Future analysis should delve into

this issue, especially to bring up evidence about how the current innovative approaches to data management can help real estate react to the most urgent priorities well represented by PwC (2023).

The manifested need to balance new and old approaches to problem-solving definitely recalls the literature arguing that real estate is prone to incremental innovation rather than radical innovation. Analysed data suggests that PropTech companies are not only startups nor totally newborn businesses but often entail the progressive evolution of businesses over decades. At the same time, the variety of activities registered in the PropTech sample in both countries implies an expansion of the traditional real estate network to welcome newcomers from other sectors. This dynamic may gradually push radical innovations while counteracting the slowness of change typical of the construction and real estate sector (Yderfält and Roxenhall, 2017).

The need for change in vision going beyond the local market was not evident from the quantitative results. In fact, the penetration of international companies into the local markets of the two countries under examination was limited and exclusively concentrated in Italy. Those 24 companies that were excluded from the analysis because their legal entity was not registered in Italy may be a sign that international interactions are increasing thanks to PropTech. An in-depth investigation of the expansion of PropTech activities beyond the national context of origin would be beneficial to shed light on this matter. Nevertheless, the need for inter-sector transferability of technologies and models from other business areas was certainly confirmed by the variety of NACE sections in our sample.

Furthermore, the need for adaptability of technologies and business models, including the new "real estate as a service" approach, which emerged from both the interviews and the grey literature, is evident in the predominance of companies acting as "Professional, scientific and technical services." This proves that a transfer in the value of buildings from tangible to more intangible assets is happening, thereby shifting what adds value for users (Landau-Ward and Porter, 2019; Braesemann and Baum, 2020) in the advent of "real estate as a service" (PwC, 2023; CherryPickPeople, 2022). It is noticeable that most of the companies in the sample are small enterprises, which implies a more agile approach to adaptation. Still, the pace of both technology and business model modifications over time would deserve a dedicated focus in future studies.

Finally, the need for new professional profiles can be again answered by the wide sector diversity among the scouted PropTech firms. This indicates for sure the interaction of multiple professional profiles, which may support the creation of new job roles, as hinted in the interviews. However, this evidence should be verified with specific investigations about the background of PropTech employees.

From an innovation process viewpoint, our analysis shows that technology enables innovation especially when it is not generated within the sector but as a result of cross-pollination from other sectors. With this understanding in mind, the invite is to create a new generation of innovation leaders by enhancing their role within organizations (CherryPickPeople, 2022). The interviews denote that this can be achieved by the contribution of research shifting from technology focus to value-added focus.

The interviewees attribute an impact on multiple sustainability and optimization issues to technology. Still, only one company was found in the sample to explicitly adopt digital technology in support of sustainability and ESG reporting. A step forward should be taken in order to verify how the abovementioned innovation dynamics helps to address the priorities for real estate in the upcoming years, including the combination of environmental sustainability issues, along with economic/financial issues (PwC, 2023).

On the whole, technology is perceived as a useful tool to facilitate the innovation process, which should be still led and steered by humans – "as a fork." Last but not least, the power of technology lays in the potential to re-shape stakeholder interactions. Therefore, technology

may enable the set-up of new innovation network forces, by altering the size, density and actor centrality of traditional construction and real estate networks (Yderfält and Roxenhall, 2017).

5. Conclusions

PropTech is a buzzword that is often simplified in the existing literature as a novel phenomenon involving the integration of technology in the real estate property sector. Nevertheless, by interpreting PropTech this way we risk underestimating its innovation potential while also making it difficult to assess its boundaries. This study seeks to surpass the most common approach to estimating PropTech value through a life-cycle analysis. The paper delves deeper into PropTech's value proposition in addressing emerging needs within the real estate sector. The results advance current knowledge of the PropTech phenomenon by collecting the opinion of PropTech players and real estate operators about the sector's innovation needs and, in parallel, observing closely the activities of PropTech businesses in two different countries, Italy and Finland.

On the one hand, this paper discusses the value added by PropTech to real estate by identifying a few innovation needs and matching these needs with the actual activities performed by existing PropTech enterprises. On the other hand, this paper stresses the importance of process innovation. We argue that the value of PropTech lies especially in the potential of stimulating new processes within the construction and real estate industry. Future studies should assess value-added by adopting this lens rather than focusing on a technology or product innovation perspective. Finally, despite the difficulty in data collection and comparability, this paper offers a unique approach to cross-country analysis by using NACE classifications to disentangle PropTech activity characteristics.

The analysis of NACE activities provided in this paper demonstrates that innovation in real estate depends not only on interactions between property and technology. Benefits can be obtained when technology enables innovation not solely generated within the sector but as a result of cross-pollination from other sectors. Our exploratory analysis shows that the PropTech phenomenon, in both Italy and Finland, covers "Information and Communication", "Professional, Scientific and Technical Activities" and "Real Estate Activities", with Finland having a higher concentration in the first two and Italy displaying more diversity. The presence of PropTech firms in varied sectors suggests a broader economic impact, answering the need for multidisciplinary integration. Moreover, the variety of activities implies an expansion of the traditional real estate network to welcome newcomers from other sectors. This trend may push radical innovations while counteracting the slowness of change (Yderfält and Roxenhall, 2017).

Furthermore, a change in vision is reported as necessary, which calls for the urgency to describe the phenomenon in broader cultural terms rather than only focusing on the technological component, as most of the literature proposes. It is probably a totally new set of questions that scholars need to ask in order to assess what kind of innovation PropTech entails in the real estate and construction fields and what value it brings, beyond the mere technology component. More research on systemic innovation is welcome, in line with the investigation directions outlined already by Kahkonen (2015).

An activity-driven approach helped reflect on the potential of PropTech in innovating the real estate sector. By applying this lens, it was possible to verify that most of the PropTech companies, both in advanced (e.g. Finland) and emerging (e.g. Italy) PropTech markets, are more inclined to define themselves as tech-companies or companies contributing in general to the service industry than as companies that work in construction and real estate. This demonstrates that the construction and real estate sectors are becoming more of a diversified industry and will need to merge with other fields in order to advance at a reasonable pace.

A partial inadequacy of the given body of theory and knowledge in the field was detected; from both interview and company data, the integration of different sectors came to light

multiple times. The body of literature currently available on PropTech mostly comes from the AEC area and therefore could not be sufficient to capture the breadth of the debate on digital innovations and their impact on real estate dynamics.

Through this exploration of the PropTech state-of-the-art in two opposing performing countries, it is possible to identify relevant concepts for study. Future research is required to elaborate on a clear definition of PropTech and an univocal categorization of the involved activities. An interesting development of research on PropTech could address its economic impact across multiple economic sectors and countries. Besides an evident, rather intuitive and mainstream technological impact, a social impact has been theorized by Shaw (2018). We argue that also the socio-economic impact on different sectors should be acknowledged and properly assessed.

This paper has some limitations, which open avenues for future research.

Among empirical constraints, data asymmetry is one of the crucial issues limiting research in the field. In this study, some inaccuracies are possible due to the fact that the list of companies from Finland was based on Unissu database whilst data from Italy was collected by using multiple sources. In general, retrieving lists of PropTech companies remains challenging, despite the number of entities and associations that are proliferating all over Europe and beyond. We call for future efforts to provide a unified mapping of PropTech solutions. Also, limited data uniformity entails inhomogeneous criteria to identify PropTech companies in the absence of international definitions. Standardization initiatives are welcome, as came across in our interviews, to encourage the progress of the PropTech phenomenon. Moreover, a new need emerged to make data collection up-to-speed with the fast changes in technology developments affecting real estate that, as underlined in the interviews, make it no longer a slow-moving industry. Besides, qualitative data collection through convenience sampling was skewed toward PropTech players, which inevitably reduces the representativeness of the results. Future research should expand the panel of interviewees including other stakeholders, especially those involved in traditional real estate businesses to understand why they are lagging behind in technology integration.

Among theoretical limitations, the same current definitions of PropTech remain insufficient, as these grasp only specific technologies or phases of the building life-cycle without capturing the complexity of this phenomenon. Literature on innovation management and stakeholder management could help expand the interpretive lens through which understanding the PropTech phenomenon specifically concerning its added value could be improved.

Notes

1. Published by the European Commission every year since 2014, the DESI index evaluates the innovation levels of the Member States by looking at four main targets: human capital's digital skills, secure and sustainable digital infrastructure, digital transformation of business and digitalization of public services. https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2022

2. The European Innovation Scoreboard provides a comparative assessment of the performance of Member States into four categories of incremental innovation (i.e. emerging, moderate, strong and leaders) based on several targets, such as the attractiveness of the research system, digitalization, firms' investments, innovators and intellectual assets. The Scoreboard can be retrieved from: https://op.europa.eu/en/publication-detail/-/publication/f0e0330d-534f-11ed-92ed-01aa75ed71a1/language-en/format-PDF/source-272941691

3. https://www.businessfinland.fi/en/for-finnish-customers/services/startup-companies/startup-companies

4. PropTech Finland provides a PropTech map which is updated yearly; however, it does not provide a list of companies, but company logos only. Other consultancy companies, such as KPMG, monitor the PropTech market periodically (e.g. KPMG, 2021), but they do not provide their lists free for download.

5. For example, in the Real estate sector (Group L), activities are categorized into the following (NACEv2, 2023): Buying and selling of own real estate; Rental and operating of own or leased real estate; Real estate activities on a fee or contract basis. However, other NACE categories include groups of activities that are complementary to Real estate, such as Construction (Group F), Waste collection activities (Group E), Accommodation and food service activities (Group I), Financial and insurance activities (Group K), Professional, scientific and technical activities (Group M), Administrative and support service activities (Group N), Arts, Entertainment and recreation activities (Group R) and Other services activities (Group S).

6. For EU statistics, see https://single-market-economy.ec.europa.eu/smes/sme-definition_en

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