Applied IT in real estate crowdfunding

Master thesis

International Master of Science in Construction and Real Estate Management

Joint Study Programme of Metropolia UAS and HTW Berlin

Submitted on 31.10.2020 from

Alejandro Gómez Zaldívar

567940

First Supervisor: MSc. Ari Koistinen

Second Supervisor: Prof. Dr.-Ing. Markus Krämer

para el Juli ♡

THANK YOU, KIITOS, DANKE, GRACIAS:

a Mamá y Papá, por darme todo lo que necesita un hijo y mucho más

Estefanía, Gabriel y el ajonjolí, Sebastián, Mariajosé y toda mi bonita familia

Pati y Chava

FIDERH y mi querido México

Old and new friends, specially ConREMs, I'm so lucky to have you.

ConREM and ICT teachers and classmates, it was a terrific group!

the folks in the companies that provided valuable information on their practices: Charlotta, Paloma, and Rodrigo from CHAOS architects, Thomas Eden from Fundrise, Keren Flavell from Kasaba, Michael Thomsen from Almenr, Daniel Sherman from CrowdStreet, Jorge Castellar from Bricksave, y el equipo Briq

Ari and Mr. Krämer, thank you for your guidance and support in making this thesis.

Metropolia and HTW, Finland and Germany

and all the people who made this possible, I am forever grateful.

Metropolia

htw.
Hochschule für Technik und Wirtschaft Berlin
University of Applied Sciences

International Master of Science in Construction and Real Estate Management
Joint Study Programme of Metropolia Helsinki and HTW Berlin

date 25.06.2019

Conceptual Formulation
Master Thesis for Mr. Alejandro Gómez Zaldívar
Student number 567940

Topic: **Applied IT in real estate crowdfunding**

The research seeks to evaluate how IT is applied in crowdfunding platforms on the internet that have recently made disruptions in the real estate market. This research, along with an assessment of the viability of alternative destinations that differ from housing and some commercial developments common in these platforms, will be used to evaluate a business model. International destinations will be evaluated.

The work will analyze academic literature on topics of general real estate finance, IT in real estate, and trends in tourism and housing to have a background from where to build a proposal. Data analysis techniques will be studied. Topics of relevance include:

- Analysis of different crowdfunding platforms in the real estate market: EU, US, Mexico
- Other methods of funding: company shares, subscriptions
- Financial considerations in real estate: risk analysis, bankruptcy backup, cryptocurrencies
- Possible locations in Spain (Galicia, Asturias), the Balkans, Mexico, Chile, India
- Data mining and neural networks for price estimation
- AI and Machine learning to identify opportunities
- Market study: location and cost, clients (investor and buyers)
- Trends in tourism: sustainable, alternative, slow, soft, responsible
- Co-housing and timesharing options
- Renovation projects
- Startup funding: Finland, Estonia, Germany
- Design thinking

Research will be done in academic papers, and articles in publications. Market studies and interviews to experts in the field are considered.

The expected results should comprise defined targets and scope for a crowdfunded real estate company, the general architecture of its platform and an outlined 10-years business plan.

Signature of the Supervisor

Abstract

This work initiated by analyzing the ways on which real estate crowdfunding (RECF) recently entered the personal finance and construction sectors. From the observation of certain RECF platforms on the internet and studying topics of sustainability in the built environment, the scope of the work incorporated notions of applied technology in the PropTech realm, namely the fields of data science, artificial intelligence and blockchain and cryptocurrencies, as well as trends in the real estate and tourism sectors where these concepts could be applied. The interactions of these topics were studied, as well as the projections or possibilities of its expansion beyond the urban limits.

The methodology followed a rational thinking of the topics using multiple case studies and grounded theory as research strategies which resulted in a pragmatic approach. Broader topics were generated in a thematic analysis and insights were identified from a semantic perspective from the primary and secondary literature, including primary data from communication with industry representatives.

The results show an increasing adoption of ICT tools in all areas and phases of real estate and tourism, and a steady interest in RECF as a financing and investment tool, especially for amateur investors. Numerous examples of interactions among the tools and its field of application were registered, but no evidence of RECFs ventures in non-urban location was found. It is expected, though, that this RECF could expand its scope and business models since it is a very recent phenomenon.

Keywords: *PropTech, real estate crowdfunding, coliving, coworking, coownership, regenerative design, sustainable tourism*

List of Abbreviations

AI	Artificial Intelligence
B2B	Business-To-Business
C2B	Consumer-To-Business
DA	Data Analysis
DL	Deep Learning
DS	Data Science
GDP	Gross Domestic Product
I4	Industry 4.0, I4.0, Fourth Industrial Revolution
ICO	Initial Coin Offerings
ICT	Information and Communication Technology
IoT	Internet of Things
LLC	Limited Liability Company
LTV	Loan To Value
ML	Machine Learning
P2P	Peer-To-Peer
RECF	Real Estate Crowdfunding
REIT	Real Estate Investment Trust
ST	Sustainable Tourism
TF	Trend Following
UNSDG	United Nations Sustainable Development Goals
VC	Venture Capital
WFH	Working From Home

Table of Contents

List of Figures

List of Tables

1. INTRODUCTION

1.1 Background and Rationale

Although not regarded as a field particularly advanced in technology, the real estate sector has been giving more importance in recent years to the role that the Information and Communication Technology (ICT) is playing in it. To keep up with the pace of technological development shaping the current times, to account to its competitiveness, because of the sheer weight it has in the global economy, and to anticipate its evolution, it is worth analyzing the current trends and technological developments that are changing the real estate industry and its relationship with travel.

An important innovation in the field is Real Estate Crowdfunding (RECF), a way of funding real estate developments made more accessible for developers and investors alike on the basis of the *sharing economy*. The interest in this topic came from the observation of RECF platforms first in Mexico and later in other countries, and during the first year in the ConREM MSc, topics from mathematics, sustainability, renovation, and other courses from ICT summer school complemented this vision, in particular sustainable tourism. This led to formulating a basic question of whether RECF could be applied on non-urban projects intended for sustainable tourism, and the scope expanded already in the process to cover related topics in applied technology in real estate, or *PropTech*.

With the advent of the COVID-19 pandemic, perceptions about its economic impacts, particularly regarding real estate also arose. In this current situation, the real estate and travel sectors have been particularly affected and their recovery is uncertain, but what is true is that many of the latest trends that had been developing in them have had an acceleration as an adaptation response.

The significance of the research lies in the exploration of convergent areas among technologies and their applications in contemporary trends of living and traveling, as well as elaborating on possible future developments. This is not a trivial manner since a significant amount of the built environment lies outside the cities, despite the diverse forms of urban growth. Comparing it to rural development, urban planning usually draws much more attention than what its sheer scale would justify, but it is in the former

where issues which have not been sufficiently addressed and could be solved in a more attentive manner, and this work seeks in part to find examples that could point in that direction.

1.2 Objective and Research Questions

In broader terms, the objective of this work is on one side, to understand how technology (including data science, artificial intelligence, blockchain, and cryptocurrencies) is making the real estate market more competitive, and how RECF is widening its investment possibilities, and on the other, what opportunities can the latter create in developments beyond the urban realm, with alternative models in property ownership, habitability, work, and travel. For this purpose, the following research questions are formulated:

- What is the technology driving PropTech and what is its effect on real estate?
- How are crowdfunding and other financial schemes making investing in real estate more accessible?
- What are some ongoing trends in the real estate and travel sectors and how do they relate to technology?
- Where are the intersections and opportunity niches among these topics, specifically for non-urban developments?

1.3 Assumptions, Methodology and Structure

It can be generalized that real estate agencies and RECF platforms focus on the urban markets, and although it can be justified on the very nature of urban growth, it is also worth asking why a proportional interest in the countryside is not happening.

As for the structure of the work, the chapter corresponding to the analyzed literature and Research Materials covers three parts: PropTech, RECF and trends in habitability and travel. In the first one, the technological background of the real estate related tools used by companies, agencies, finance, developers, and clients is analyzed. The second part deals with the investment tools enabled to the general public by the sharing economy and FinTech, in the context of an asset class as significant as real estate. In the third part, the travel sector appears as another preeminent player of the

world economy, and as a parallel topic, the trends in tourism and everyday living and working are studied to assess their being subject to RECF and showing how they complement each other in light of the flexibility that customers and economic slowdown demand. Finally, there is a brief section covering some practicalities of the business environment and practices these platforms are part of.

In the Methodology chapter, the research problem is addressed in light of the different philosophical approaches to academic research, explaining which were more adequate to tackle the problem. The techniques that were used to obtain and analyze the data, and finally draw conclusions are also mentioned.

In the Results chapter, the research questions are answered drawing from the analysis of the Materials as a summary of the findings. The intersections among topics are further illustrated with examples from the industry that cover particular cases. A discussion of the topics is conducted with the generated insights.

Finally, the Conclusion summarizes the discussion of the findings having gone through the methodological filters. A perspective on the future developments is presented along with recommendations for upcoming research.

There are additional appendixes that include complementary information as well as the materials used to obtain primary information from companies.

2. RESEARCH MATERIALS

2.1 PROPTECH

The automation of processes is cited as the main characteristic of what is called the *Fourth Industrial Revolution*, *Industry 4.0*, or simply *I4.0* or *I4*, which builds on the availability of digital technologies left by its predecessor, the Third Industrial Revolution, and is expected to evolve in the intersections of digital, biological and physical innovations (Schwab, 2018). Is in this context that real estate technology or *Property Technology* (PropTech) has arisen, referring to a wide variety of cross-industry Information and Communication Technologies being used in the real estate sector, that are helping and changing the way of researching, commercializing, operating, managing, and maintaining property (Wong, 2018). Based on a sample of more than 600 companies, Baum (2017) defines and illustrates PropTech as the technology that facilitates the *verticals* across the industry *horizontals*, as seen in the following Table 1:

Table 1: PropTech verticals and horizontals (Baum, 2017)

	Real Estate FinTech	***Shared Economy***	***Smart Buildings***
Information	yes	yes	yes
Transactions / marketplace	yes	yes	
Management / control			yes

Global consultants 4S (2020) map important PropTech ecosystems around the world, relevant locations in European being Spain (with more than 2,000 companies), the United Kingdom, and the Netherlands. Classifications of the different areas of PropTech vary depending on countries or areas and sources, but an average classification would include categories like marketplace, big data analytics & valuation, investment, marketing, crowdfunding (crowd financing), blockchain, visualization, construction, smart home / IoT, property management & operation, leasing, and others (PropTech Switzerland, 2020) (Wong, 2018). It is worth noting that since the

commercial and residential real estate markets have significant differences, and are practically two separate sectors, their PropTech classifications also vary with representative companies generally specializing in one of the two, as seen in the next Figure 1:

Figure 1: American Real Estate Tech Market Map by CBinsights (Wong, 2018)

The business models of these companies also vary. In some places, nearly half of companies are B2B-oriented, a lesser percentage has a hybrid model of both B2B and C2B, and in about one third of the total there is a strong focus to a CRMs (Costumer Relationships Management) approach (Goron, et al., 2020).

Although a sector on its own, Construction Technology or ConTech is also categorized under PropTech by Baum (2020) and others (UDISUU, CBRE), and it includes the planning, design and building phases. In order to link the construction progress to the financial development that investors and clients are interested in, construction scheduling and monitoring through BIM and related 5D software like iTOW and Allplan give the developers accurate insights, including time projections and financial

information. A higher degree of task automation, scheduling and responsibilities assignation can be obtained with more precise Construction Project Management web-based software like Sablono (2020), which can provide the real time status of thousands of *activities* and *deliverables*. Apart from its use in the building phase, BIM models facilitate the sales phase through visualization and provide the blueprints for the managing and operation phases.

Domotics or home automation is an important part of the PropTech universe, where Internet of Things (IoT) and *smart houses* are common terms referring to the automation of whole systems in buildings with remote communication intended to signal flaws and needed repairs which ultimately represents important savings in energy resources, time and cost. The current pandemic has strengthened the health reasons for making air quality a primary concern, so more attention is being paid to the development of systems of air and climate monitoring (Goron, et al., 2020).

In the maintenance and operation phases following the construction lifecycle there is an increase in the provision of property management and housekeeping services, in which currently up to 75% PropTech companies are engaged in (depending on the location) (Goron, et al., 2020). This is in accordance with the fact that facility management has been increasingly growing in recent years as a field on itself, with the current projections still being high (Jordan, 2018).

Virtual reality (VR) is a thriving industry across many sectors, and in real estate it includes different areas. The development of *augmented reality*, now enhanced by prosthetics like goggles, scrolling floors and sensory fusions is enabling even richer user experiences. The relevance of VR can even be weighed in the gaming industry, where a whole real estate marketplace exists (Weikal, 2020). The work done in BIM and 3D scanning with photogrammetry and *point clouds* contribute to the *digital twin* of the built object being developed, not only for practical purposes in the operation phase, but also for the commercialization and sales. Software running with machine learning along with neural networks and augmented reality, is used to show the properties to customers (Azati, 2019), and many real estate firms are using visualization tools like Matterport and Virtual Tours in this respect, to the point that VR is becoming an essential tool to be competitive in the brokering sector (Goron, et al., 2020). Clients are buying property even without physically knowing the places, relying on renderings, statistics and the information provided by the brokers and companies

like Redfin (Nicolas & Triana, 2020) or eXp Realty (2020), the first brokerage firm where the whole sales transaction process takes place virtually in a cloud-based 3D environment.

The COVID-19 pandemic has not had a direct negative impact on the PropTech industry in general, actually the contrary has happened, and in particular for the *bootstrapped* or not publicly funded companies, which will be more resilient in dealing with it, or any other crisis (Goron, et al., 2020). Reactions from PropTech firms to complex economic environments like this one include the use of econometric models and Big Data, whose historic relations models are used to obtain information on the future development of economic activity, particularly how is the recovery expected to behave. (CBRE, 2020)

2.1.1 Data Science and Artificial Intelligence

Though not necessarily having a standard definition there is general consensus that *Big Data* has the characteristics of the three Vs: volume, velocity, and variety. Also, it requires collection and analytical efforts, and must be socially meaningful. (Barkham, et al., 2018) Services, science, and businesses of all sorts increasingly rely on the information produced from data with ever evolving techniques and methods. The availability of data itself is hardly an issue, the real challenge is to understand it. Having too much data can actually be counterproductive, Big data can become *bad data* when it is gathered not purposefully, as an offshoot of some process (Skiena, 2017). The handling of data must evolve rapidly as databases grow in exponential terms, but most companies lack preparation and resources to adapt new tools for this challenge, and they keep the “spreadsheet mentality” as a default (Chaillou, et al., 2017)

Usefulness of data can be assessed according to its relevance, quality, timeliness, and completeness. Chaillou, et al. (2017) classify the data in four groups: people, place, infrastructure, and wealth, and identify three waves of disruption: aggregation, analytics, and prediction. After its collection, the data is thus visualized, filtered, and analyzed for the assessment of financial assets, trends in the market, and design decisions. Scenarios can then be simulated to estimate prices and predict investment outcomes.

Web scraping, *web data extraction*, *web harvesting*, *database scraping* or simply “collecting data from web pages” is the process of downloading data from a website, which along with database filtering started having an impact in various fields in the 1990s. Common methods for this extracting of information use Python with the BeautifulSoup package (Amos, 2020), very appropriate to web-scrape real estate websites (Sulce, 2020). Excel is also a very powerful but often times underestimated tool which can be used to handle web scraping and other complex operations like statistical analysis, qualitative data analysis, databases querying, simulations, and optimization, instead of various different pieces of software (Guerrero, 2019).

With regard to related concepts, *Data Analysis* uses correlation and causation to make sense from huge amounts of data, and it is the science behind fields like Product Design, where A/B tests and live products are managed (Erikssonn, 2014). *Data Mining* doesn’t exactly reflect the true concept of the subject, which could more accurately be called "knowledge mining from data" (Han, et al., 2012). When data is sufficiently analyzed it produces information, which then generates *business intelligence* used to provide explanations in order to make sound decisions (Zikmund, et al., 2010). *Crowdsourcing* is the collective production of data on particular issues, one form of it being *citizen science*, where volunteers make registries that ultimately contribute to urban initiatives (Barkham, et al., 2018). Enabling the automatic aggregation of data into databases eases data crowdsourcing and allows huge datasets to be assessed (Chaillou, et al., 2017).

As stated by Dr. Andrea Chegut, director of the MIT Real Estate Innovation Lab, data integration is considered “the most important thing for real estate right now”, and big opportunities in the industry are expected to arise from the big, wide available data and the computer power to process it. This is a reason why leading educational institutions offer Data Science programs specifically tailored to real estate applications, like gathering insights from statistical analysis and measuring uncertainty, where the programming language *R* is especially useful. (MIT, Get Smarter, 2020)

With *Artificial Intelligence* and *Machine Learning*, the gathered data is processed to produce valuable information. The concept of Artificial Intelligence (AI) refers to computer systems that perform actions after making decisions themselves based on environmental perception. For this purpose, accurate sensor data is needed in large sets, along with *Machine Learning* (ML) and *Deep Learning* (DL) algorithms. The

algorithms are the set of rules given to the model as training to perform as intended, and the model is the program itself, which predicts outcomes from the given inputs. (MathWorks, 2020)

Implementing AI can be summarized in three stages: gathering high quality data, running experiment to assess what works, and putting the latter in practice though infrastructure (Yates, 2019). Some of the advantages of using AI are the reduction of manual work (automation), simplification of tasks, and smarter decision-making. (Maramganti & Rajyalakshmi, 2019) (Esri, 2018)

Machine Learning is the field of Artificial Intelligence that focuses on the study and construction of algorithms that learn automatically from pattern recognition in the data and make predictions based on it, without explicitly being programmed to do so (Azati, 2019) (Chaillou, et al., 2017) (Kurilyak, 2019). In ML, the model is trained with manually selected features and common ML techniques, like *decision trees*, *support vector machines* and *ensemble methods* (MathWorks, 2020). ML is used in a wide variety of areas, a few examples being task automation, awkward behavior detection, and suggestion making (Azati, 2019).

There is a big overlapping of the fields of application of Data Mining and Machine Learning: the latter focuses on prediction based on the *known* properties from training the data, while Data Mining focuses on the discovery of previously *unknown* properties in the data (language discovery in databases).

The Deep Learning methods are a subset of ML roughly modeled on the human brain's neural pathways, based on learning data representations, and used to improve representations from unlabeled large-scale data. *Deep* is a reference to the many layers existing from the input to the output ones, where the algorithms automatically learn the useful features, and the models analyze data and solve problems without needing to be trained (Chaillou, et al., 2017) (MathWorks, 2020). Some of the most common DL techniques are convolutional neural networks (CNNs), recurrent neural networks (like long short-term memory (LSTM)), and deep Q networks (MathWorks, 2020). Regarding construction and real estate, deep learning techniques have been developed in neural network algorithms, for example in the automated detection of defects from video footage (Yin, et al., 2020).

Neural Networks (NN) is a ML technique that belongs to the category of Universal Function Approximators (Baldominos, et al., 2018). It was developed from mimicking nervous systems in biology in their information processing as part of a learning process. Widely applied in pattern recognition (e.g. from images) and data classification (Chaillou, et al., 2017), NN use data to outline relationships between inputs and outputs. Many variables with no linear relationship among them can affect an outcome, even though a lot of information can be incomplete at the same time. Neural Networks are able to perform assessments in a non-linear manner and consider input that can be rendered more subjective and difficult to translate into traditional mathematical terms. (Chiarazzo, et al., 2014)

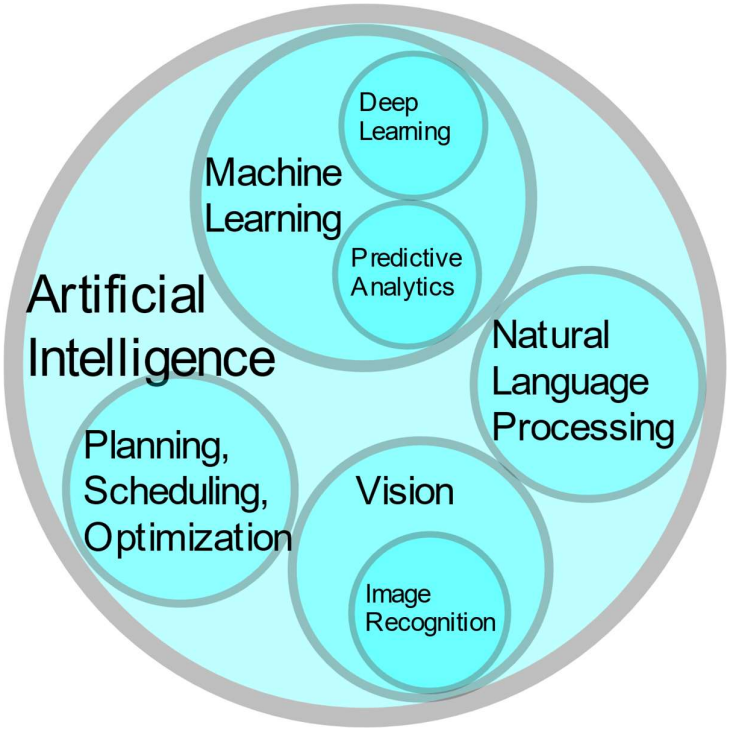

Figure 2: Some fields of AI applied in PropTech (by author)

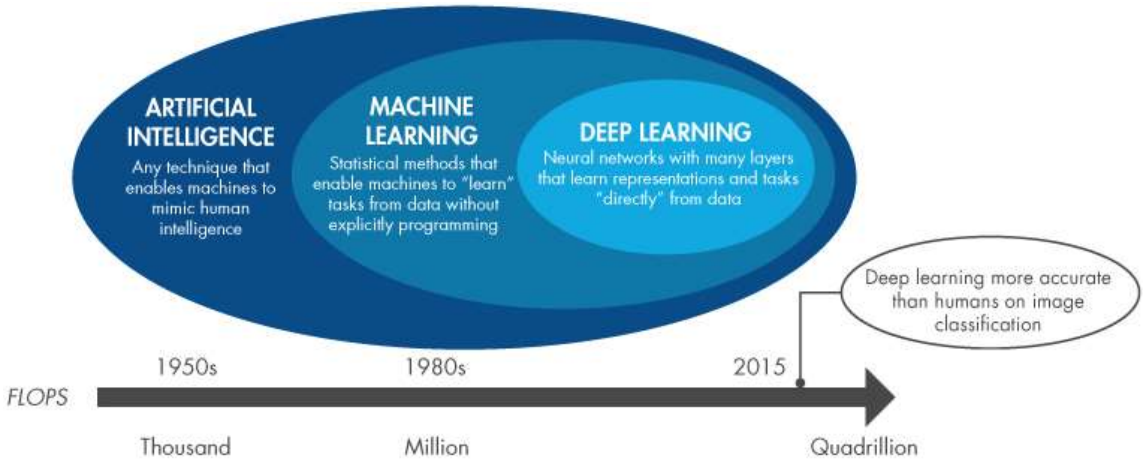

Figure 3: AI in time and complexity as per Floating Point Operations per Second (MathWorks, 2020)

With respect to the adoption of AI in the real estate industry, in Deloitte's (2019) prospect survey for commercial real estate for 2020, 31% of respondents already utilized AI, while 63% were planning to. To have an idea of the rapid trend of AI adoption, this is a sharp contrast with the same survey two years before where just a 6% of the companies reported having a "smooth ride" with AI. Given that AI is at least since 2018 (Seitz) a top-priority in corporate spending, from 2019 (Maramganti & Rajyalakshmi) on, the investment volume in AI in all branches of businesses was expected to grow annually by half, to reach $57.6 billion in 2021.

Application and Examples in Real Estate

Apart from retrospective data, real estate has traditionally relied on expertise and intuition to make investment decisions, but nowadays it is necessary to use DS and AI to make sense of the huge amounts of data available and produce valuable insights. Areas currently involving data usage in the real estate sector are improving investment decisions and return optimization through cost assessment and practical evaluations from years of market data, and data analytics to review the performance of competitors: trust evaluation, marketing strategies, customer ratings, sales etc.

In real estate, AI can aid in automating of feasibility studies (Chaillou, et al., 2017), conducting demographic market research, financial and environmental analysis, and streamlining data management to obtain predictions, buying patterns, and insights on the conditions that lead to successful deals (Azati, 2019), as well as providing insights

into portfolio management through large data sets (Skyline, 2019). Deal sourcing aided by AI directs investors to the zip codes or areas with most potential: by performing periodical analysis of key market indicators, like loan maturity, vacancies, occupancies, anomalies in rents or concessions, operational strategies, the investors stay informed about coming opportunities (Zipori, 2019).

With the “lowest fees in industry”, REX uses AI to target clients with ads and features like robots answering questions directly from visiting clients in open properties. With these advantages in savings, they can charge commissions of around 2% for a closing deal, instead of the typical 5 – 6% of a broker, and thus saving the average buyer $20,000 in fees (Rex, 2020). As said by its founder and CEO: “There are dozens of pieces of data, each of which changes the probability by one or two percent” (Zhao, 2018). In domotics there are many applications of AI, an example being tour planning of cleaning appliances done by companies like Soobr.

Other applications of AI and ML in real estate include Finding the Market Value of a Building, Predicting Long Term Value, Predicting Customer Lifetime Value, Image Recognition, Classify User Needs (with NLP), Profile Matching (ML is used to analyze past deals and interactions), Automated Underwriting Process, Predicting Value of Property (with ML through Data Analysis), Targeting Real Estate Markets (according to their performance, applying ML called Extremely Randomized (ER) Trees), Predicting Where to Focus Marketing (with ML), Effective Lead Management (ML analyzing historical sales to predict probable ones), Automated Property Valuations (with ML), Predict Zoning Developments (with ML), Buy and Sell Properties (analyzing potential buyers with ML from their clicks in ads and recent purchases), Maximize City Space (analysis of Big Data with ML), Enhance Building Automation (with IoT). Natural Language Processing (NLP) is used in tasks like Automatic Document Scanning, Predicting Customer Language (with ML), and Chatbot Assistants (Kurilyak, 2019).

Future developments of AI in real estate could focus on topics like Predict Market Bubbles (with ML), Report Generation (with ML and Natural Language Generation (NLG)), Risk Monitoring (with Deep Learning), Answer Questions Using Chatbot Assistants, Investor Analytics (of risk and financial projections through ML), Deal Matching (with ML), Construction Automation (specially for materials purchase), Property Management (prediction of systems’ maintenance and replacement with ML), and Enrich CRM Data. (Kurilyak, 2019)

Predictive Analytics

Used in market research, identification of opportunities, price estimation and risk assessment, predictive analytics is a form of machine learning that represent the latest (2012) disruption in the real estate industry, where novel algorithmic logic in statistical techniques like linear regression, decision trees, support vector machines (SVMs), neural networks, and association rules (MathWorks, 2020) is used in tasks like gaining market research, location analytics, opportunities identification and price estimation from accumulated datasets (Chaillou, et al., 2017). This historical and current data, such as sensor, timestamped and numeric, is the source of output predictions using machine learning.

The mathematical background used in prediction includes notions such as statistics, correlation, regression models (e.g. hedonic), Monte Carlo simulation, etc. Traditional investment evaluations that use concepts like net present value and internal rate of return often they fail to consider uncertainties that may ultimately represent opportunities, and thus the concept of “real option” incorporated became widely used during the 1990s in the real estate decision making. These models, which objectively assess uncertainties, have also been further enhanced in their accuracy of project assessment results by the introduction of fuzzy sets. (Mao & Wu, 2011)

Simple regression models have been traditionally and widely used in real estate for short term analysis, but the increasing span of forecasting pushed by machine learning, which in 2017 was about a year, is now affecting the assessment of deal success. Apart from a longer duration, increased granularity in the predictions is sought after. Another foundation of predictive analytics in its real estate applications are traditional statistical methods which are taken to new levels by means of machine learning, deep learning, or neural networks. These methods rely on given datasets in a first phase of “training”, where the machine weighs the significance of each variable (e.g. location) in the final outcome (e.g. price). What follows is the “testing” phase of the algorithm against a dataset with a known outcome. The machine is then calibrated with a series of iterations to enter into the “prediction” phase, where the algorithm forecasts an unknown value. The next step is to gather users’ feedback from the User Interface (UI) and take it back to the training phase to improve the accuracy of the model. (Chaillou, et al., 2017)

In real estate, descriptive and predictive analytics are used to increase efficiency and reduce uncertainty (Chaillou, et al., 2017). With the use of ML, predictive analytics is used to understand costumers from their data and provide them with personalized offers and listings according to their profiles (Stub, 2020). Predictive analytics are also produced from properties' data to assess future rents and expenses and to mitigate risk in RE investments. In finding properties that match investment goals, time is saved, risk is reduced, and dependency on real estate agents is eliminated (Andreevska, 2018). The importance of information is evidenced in digital marketplaces where deals take place and benchmarking data for both deal structuring and asset pricing is available. Companies compile and analyze demographic and survey data, removing outliers and filtering data in the ML process, to then offer the generated insights on future prices and value to sellers, buyers, or brokers as scoring of prediction accuracy (Chaillou, et al., 2017) (Stub, 2020). Relevant companies utilizing predictive analytics in real estate as their core business service are Zillow, Enodo, Redfin and SpaceQuant.

For market research, streaming or static text data is used as input, with commonly used algorithms including RNNs, linear regression, SVMs, naïve Bayes, latent Dirichlet allocation, latent semantic analysis, and word2vec (MathWorks, 2020). Data like rent, occupancy and cap rates, key economic indicators, education, criminality, census, mobility, etc. is taken from real estate and government websites and used to train the algorithms, which enables the accurate generation of predictions to improve investment decisions. Meantime, the AI produces new types of data: web clickstream, cellular, geolocation, satellite image, etc. (Zipori, 2019). Companies develop these different forecasts, which can be related to price (e.g. Enodo), turnover from tenants (e.g. SpaceQuant), or default rate of mortgages. (Chaillou, et al., 2017)

Local demographic and market data is accessible in the field through smartphone apps like that of Zonda (Miles, et al., 2015). In the Realdax Real Estate Data Catalog, professionals and home buyers can access information at parcel level, like MLS feeds, public records, tax data and foreclosures. On top of it, census data, demographics, market intelligence, analytics and trends are displayed in the Professional Real Estate Platform (Realdax, 2020), shown in the next Figure:

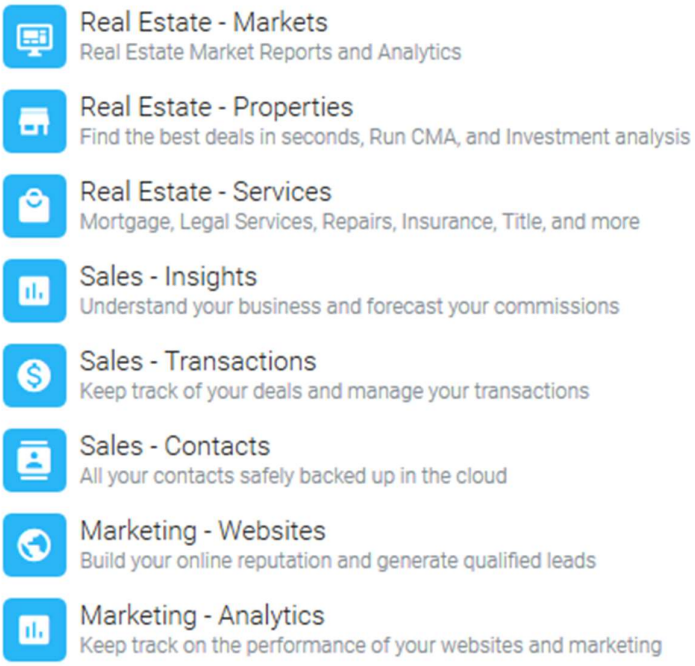

Figure 4: Realdax (2020) apps and services

Especially designed for the evaluation of multifamily deals, the Enodo (2020) underwriting platform and its *Data and Prediction APIs* can be used to gather market level insights like rent and expense analysis from over 60 different metrics (see Enodo's Property Analytics in Appendix), and compare with examples from millions of properties. Value-add opportunities and tracking of the competition can also be detected.

Figure 5: Metrics gathered in Enodo (2020)

Chaos Architects (2020) is an urban analytics and forecasting company from Helsinki specialize in providing *urban insights* to developers (investment opportunities) and authorities (development opportunities) through different dashboards, the first one being the most complete (see Figure 6):

- *CHAOS Liveability* is used for Investment and Divestment Decisions on potential areas from non-tangible urban factors. It provides insights on sustainability, transportation, connectivity, access to services. Its *urban indexes* are: *Living Convenience* score based on amount and quality of services, *Attractiveness for Living evaluated* from social, micro economic, and infrastructure perspectives, and *Urban Vibrancy* identify factors of attraction.
- *CHAOS Assets* for Portfolio Management draws from historic, traditional, and non-traditional data variables. It is used to *identify opportunities* from demographics, market dynamics, urban layout, and housing typology to invest, build and manage sustainably. Investment risk is decreased with data from future developments, services, and demographics, as well as occupancy rates. As a property management tool, it is useful to increase tenant retention rate and secure ROI monitoring renovation needs by identifying strengths and weaknesses. Its *urban indexes* are: *Upgradeability* forecasting modernization needs, *Property Rentability* from demand and provision of property, *Investability* to identify projects' locations.
- *CHAOS Essentials* is used for Concept Development and Validation, using *crowd insights* on urban dynamics and environments. It delivers socio-economic composition of areas, sentiments and transport preferences of citizens, visitors, and tenants, who can give feedback and insights, all oriented to a sustainable decision-making. Its *urban indexes* are: *City hubs and hangouts* from crowds' movement, *Engagement of the area* from digital surveying, and *Character of the area* from workplaces, density, building variety, and demographics.
- Through the free *Chaos Crowd* app, any person interested in providing insights can give ideas with geolocated pictures and answer geofenced surveys. Ideas of participatory design can be traced in these features, which added to data integration, allow citizen participation for the development of the *smart city* concept. (Chaos, 2020)

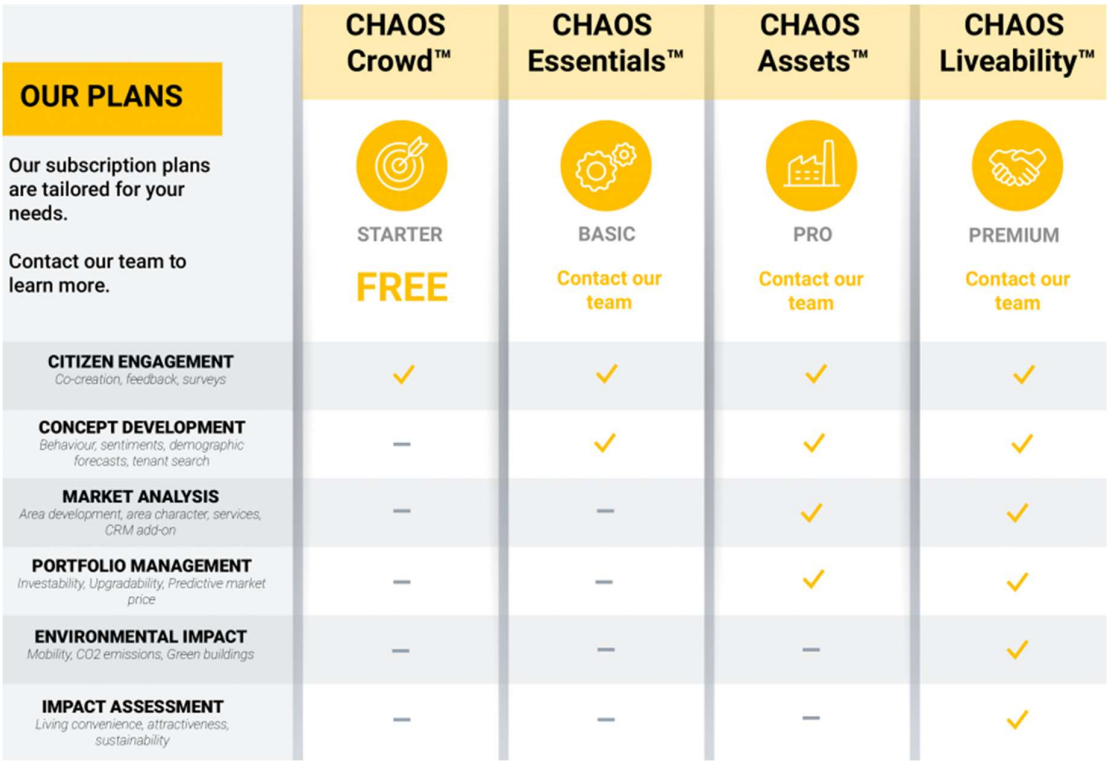

Figure 6: Chaos Architects' (2020) insights and forecasts

A partnership with Telia mobile company fuels some of the apps. Telia provides the anonymous data from crowd movement patterns, while Chaos provides the insights from location, urban infrastructure, and people. Chaos' machine learning and neural networks algorithms on Telia's mobile network data produce the insights useful both to commercial real estate developers, and infrastructure and transportation planners (Avellan, 2020).

Geographic Information Systems (GISs) are the canvas on which the real estate analytics are done. They are georeferenced maps with all kinds of natural, physical, demographic, social, economic, etc. information on it, that come from government, companies, other public and private sources, social media, mobile devices GPSs. *Heat maps* built on GISs provide insights on comparative market analysis and property valuation to make investment-based decisions. Filters include cap rates, occupancy rates, and cash returns both from traditional rental options and from Airbnb and other platforms. (Mansur, 2018)

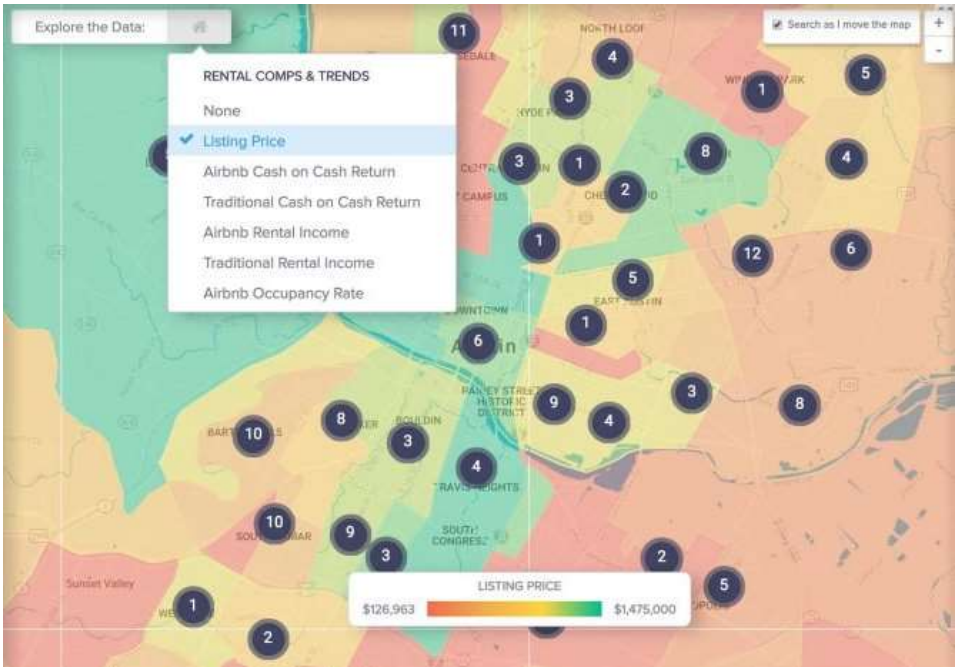

Figure 7: Heat Map Analysis (Mansur, 2018)

In a competitive market like the USA's, with over 150,000 commercial real estate professionals according to the CCIM institute, tools like Esri Industries' (2020) *Smart Map Search* can be of great help to instantly discover feasible markets nationwide. Among 17,000 different variables or attributes, demographics and data like homeowners, marriage status, age, housing age, consumer behavior, TV viewing, CAP rates in trade areas, etc. can be browsed. Then an Excel file with listings in coordinates can be imported and linked to maps in the *Business Analyst* browser (Figure 8). The data and the duration of the forecasts can be manipulated in the generation of infographics, customizable with *panels*, self-contained as HTML files and also connected with Adobe Creative Suite. With the *Webscene viewer oplichemetry* feature, datasets can be imported from different formats, and the information then visualized in dynamic webmaps. Other feaures include spatial statistics, location strategy, story maps to examine a neighborhood at any level of detail, and the possibility to build custom applications in the browser.

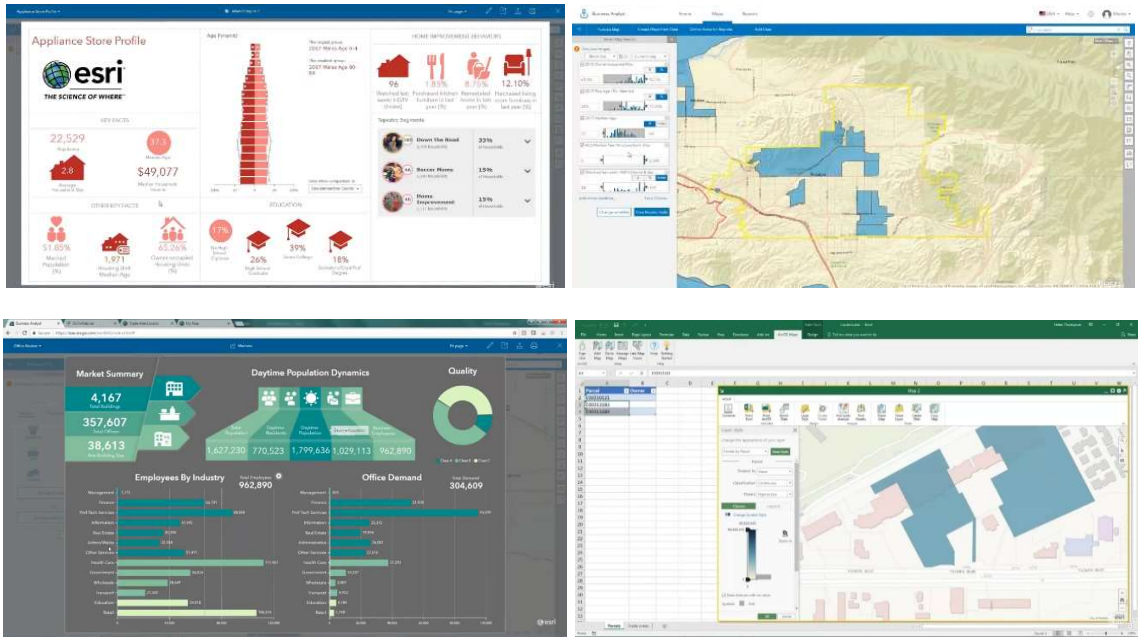

Figure 8: Esri's (2018) dashboards and its linking to Excel

Since the price of real estate property depends on many aspects, opportunities are detected when the actual prices are lower than the expected values. To identify unusually low prices in the market from public online listings, Baldominos, et al. (2018) developed an application handled as a regression problem and using machine learning algorithms like neural networks, regression trees, support vector machines, and k-nearest neighbors. The multilayer perceptron, a connectionist model and feedforward class of artificial neural network was implemented taking an input with fed values and hidden layers, where the hidden units or *neurons* were all individually connected to the following layer. For this price estimation, there was correlation of different variables, with several meaningful inputs in economic and statistical terms considered in a multi-variate Ordinary Least Squares model. A linear regression model considering just the most significant variables proved insufficient to predict final selling prices, therefore, a multi-variate regression model using machine learning was developed. The input consisted of binary (questions with yes/no answers like “is there a lift?”), categorical (location), or continuous (area) data.

The instant flow of data in the publicly traded real estate market is handled by companies like Zillow, SNL Financial, CoStar, GlobeSt, and LoopNet to assess financial conditions and provide clients with daily summaries of property listings and

expected prices (Miles, et al., 2015). In the present moment, some particular displays are the shortage of housing and the effects of COVID-19 on the inventory (Zillow, 2020). Zillow's *Zestimate* and Redfin's *Estimate* are popular tool used for home valuation, although not exempt from criticism.

Neural networks are utilized in the construction industry as well. For stakeholders to predict costs, Elfahham (2019) developed a tool using neural networks along with Linear Regression and Autoregressive Time Series, and with special consideration to existing Rates of Inflation. In determining property selling prices of real estate, where the logic in motivating reasons is hard to determine, the outlined relationship provided by neural networks can be very useful (Chiarazzo, et al., 2014).

The *iBuyer* (Instant Buyer) concept refers to the assessment of property deals (mainly housing) with Automated Valuation Models based on Big Data, machine learning and other technologies. These companies purchase in cash, and refurbish in order to immediately sell, all within a short period of time. With a model relying heavily on volume, they can make offers in 24 hours and the whole sale operation can last less than 90 days. (Villanueva, 2020) IBuyers appeared first in the USA in 2014, with companies like *Zillow*, *Redfin*, *Opendoor* and *Offerpad* leading the market (Levy, 2020). In Europe, the concept was introduced a few years later, and has developed steadily, with Spain being the country with the largest share of iBuyers present in its real estate market, although the proportion is still less there than in the USA. Tiko was one of the first iBuyers in the Spanish market entering in 2017, and since then their sales have increased threefold annually, with 13% of the Spanish sales going through their platform at some point. (Villanueva, 2020) As seen in Figure 9, the share of iBuyers in the market deals is constantly increasing, with some cities in the USA reaching 8%, the average top markets being around 3.4% and a total national share reaching 1%. (Redfin, 2020)

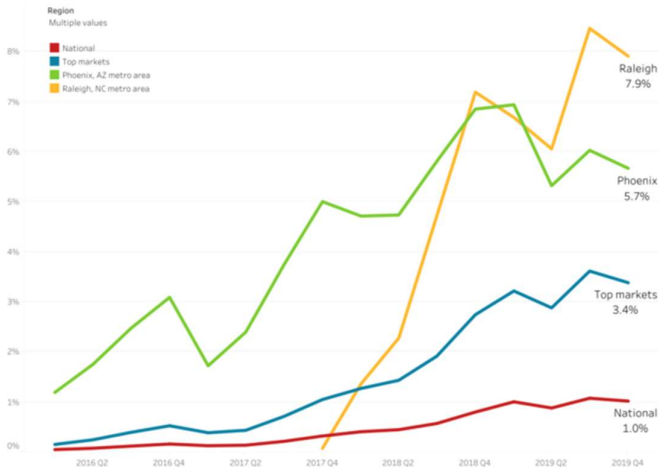

Figure 9: Share of homes purchased by iBuyers in the USA (Redfin, 2020)

Despite the cost that counting on disproportionate resources represent for feasibility studies, the traditional risk analysis is still considered a standard in the real estate industry (Chaillou, et al., 2017). Monte Carlo simulation, which uses random numbers in the modeling of probability distributions of outcomes for uncertain variables, is a technique widely used by investors for uncertainty modeling (resolution of uncertain events) (Guerrero, 2019) and strategic risk analysis (Kramer, 2001). Other common assessment tools in the investment decision making process include FAHP, neural networks, and probability statistics. In some cases these have proved to be limited in the analysis of the risk factor, and in the analysis and quantification of the risk impact on potential project value (Mao & Wu, 2011).

Underwriting

Underwriting, a process that can take weeks with traditional methods, can now be delivered in minutes using data analysis and AI. For an investor, having this advantage in time can be decisive in formulating bids and beating the competition (Zipori, 2019).

Smart Cities

In the smart cities' initiative, the innovative use of technology is aimed at optimizing resources, improving efficiency in governance, sustainability, and quality of life. An integration of physical and digital (*phygital*) space is also sought after, relying on physical infrastructure and its multifunctionality and high levels of connectivity (Gretzel,

et al., 2015). European cities leading the usage of tech in the built environment are currently London, Amsterdam, Berlin, Paris and Stockholm (Osborne Clarke, 2018).

2.1.2 Blockchain and Cryptocurrencies

The blockchain concept refers to a database of permanent records related to assets and its transactions, including events, contracts, patents, and permits. The whole series is mathematically bond from its inception, publicized and distributed in a decentralized network of internet nodes (Gilder, 2018). Since this digital record, a trusted ledger, is multiplicated in hundreds if not thousands of nodes around the world, it becomes unhackable and served as the foundation of bitcoin, the first cryptocurrency.

Having predicted the current digital age in *Life After Television*, Gilder (2018) makes the case for blockchain as more important that big data and technology's next meaningful disruption in *Life After Google. The Fall of Big Data and the Rise of the Blockchain*. Considering today's technology as a definitive human achievement from both Big Tech and Big Tech's critics is the same kind of mistake that Marxism did in the 19th century of the industrial revolution, regarding wealth creation as something finite. In today's situation, the overwhelming influence of Big Data and the almost total monopoly that Google and Silicon Valley have on the information and AI present in so many aspects of daily life blocks the imagining of further developments in technology that would be more horizontal and secure beyond the current network and computer architecture. This "new information architecture for a globally distributed economy" is (now) surfacing with blockchain and cryptocurrencies, is in this way also a response to privacy issues concerning the tremendous power that governments and corporations have acquired through the handling of private data, an issue that has been shed light upon by Snowden (2019) and others.

In real estate sector, blockchain also has high hopes. Steve Weikal, Head of Industry Relations at the MIT Center for Real Estate, argues in the same vein as Gilder "blockchain is to transactions what the internet was to information" (Stewart, 2020). Like real estate crowdfunding (RECF), blockchain is making the financing of real estate more widely accessible to individuals. Looking at its promising evolvement in the near future, companies like EquiSafe and Fortem Capital are focusing on a *tokenization*

process (Stub, 2020) which is the digital representation of an asset in order utilize it. In this regard, it is argued that more regulation regarding token offerings in blockchain is necessary and desirable to ensure the protection of investors from fraudulent issuers and to provide more funding for small to medium-sized enterprises (Tjio & Hu, 2020).

Cryptocurrency, also termed *digital currency*, is the interdisciplinary (see Figure 10) new concept of money operating independently from central banks, where encryption techniques regulate the generation of currency units and verify the funds transaction. It is inextricably related to blockchain, as the transactions need to be recorded there. Some cryptocurrencies are generated in the *mining* processes in the process that adds the blocks to the blockchain ledger, which is the basis of the blockchain functionality. Their value depends on their trading (supply-demand) and is extremely volatile (Basu, et al., 2018).

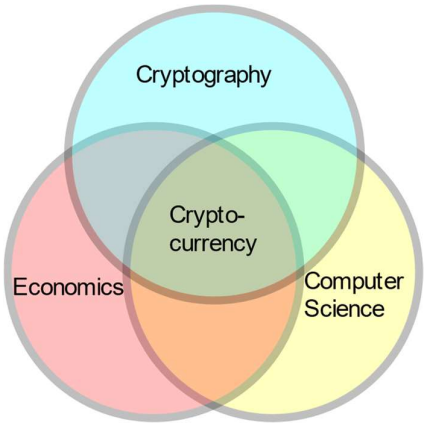

Figure 10: Interdisciplinarity of Cryptocurrency (by author, based (Basu, et al., 2018))

In real estate there already are transactions fully done with cryptocurrency, and the use of some like Bitcoin, Dash or Monero is being promoted to eliminate volatility and liability (Realdax, 2020), and to avoid excessive taxation in acquisitions.

As the use of blockchain, and also cryptocurrencies, are considered the new source of trust among strangers, its adoption in real estate follows a natural interest in transaction transparency (Botsam, 2017). The real estate market is already experiencing the adoption of blockchain and cryptocurrencies given its convenience in terms of trust and effectiveness, as well as time and costs saving. It is argued that blockchain can raise

the value of commercial real estate leasing (Kejriwal & Mahajan, 2017), and companies are already applying it transactions, property management and peer-to-peer financing (Daley, 2020), as well as in contract signing and title recording (Realdax, 2020).

Companies develop blockchain processes to optimize bulky paperwork in real estate (Saliou, 2020). EquiSafe is a FinTech company specialized in capital stock management that relies on blockchain technology and time-stamped smart ledgers to accelerate the investment processes of private companies (El Alamy, 2020). With this advantage, they made the first European real estate sale transaction through blockchain technology on 25 June 22, 2019. After working with Ethereum, they looked for more adaptability and scalability, for which they switched to a Tezos-based model (Saliou, 2020), for which they have built an opensource contract used to tokenize different entries, in which even credit card payments are accepted (El Alamy, 2020).

2.2 REAL ESTATE CROWDFUNDING

2.2.1 Investment in Real Estate

There is no doubt in the weight that real estate has in the global economy and finance. In MSCI's estimates, the real estate market grew globally 4.7% in 2018, rising from $8.5 billion to $8.9 billion, after having grown by 14.9% from the $7.4 billion of 2017 (Teuben & Bothra, 2018). This tendency started in 2015 in some markets (e.g. Spain) after the years of downfall following the financial crisis of 2008 (Baldominos, et al., 2018), in part fueled by a substantial increase in the share of international investment (Anghel & Hristea, 2015).

Jordà, et al. (2017) cover the global the history of investment across 150 years and many countries, showing that the rate of return on wealth has roughly doubled the growth rate of the economy, and that among all kinds of investment, real estate (although just the housing part) is the sector which gives more dividends in the long run, contrary to the belief that it is the stock market. In this study it is shown that housing and equity perform remarkably similar in overall return, with the difference that residential real estate involves less risk due to its lower volatility. A proof of this is that important institutional investors like the Yale University endowment (which consistently outperforms the market), are allocating around 20-40% of its portfolio in real estate, much more than with the traditional approach (Ippolito, 2018). This kind of data explains why the real estate market has traditionally been regarded as relatively safe in an investment perspective, still sought after nowadays in a globalized economy. The market is nonetheless not exempt of downfalls, like the one from the global 2008 crisis demonstrated with the plummeting of housing prices and insecurity that hit the investment the sector (Garcia-Teruel, 2019).

Figure 11: Returns of the real estate market versus S&P 500, 2000-2015 (Blank, 2020)

From a financial perspective, advisors on investing suggest having between 10% and 26% of investments in real estate, as this provides stability to the overall portfolio since investment in real estate behaves differently than the stock market (Lyons, 2020). This is partly explained because the real estate market is a field with a high level of subjective components that affect it, and is more sensitive to socio-economic phenomena like unemployment, salaries, overall stability, and demographics, and moreover, to the psychological factor that price movements generate. For this and other reasons (technology, location, etc.), real estate products cannot be standardized, nor the customer's behavior accurately predicted. (Anghel & Hristea, 2015)

In real estate, equity investments are higher in risk and returns than those of debt (Patoka, 2020), and its funds represent around 40% of the total real estate investments. Equity investors take higher risks but in return tend to become property owners in the longer run. Big investors, such as Real Estate Fund Managers, rely for this on a few financial considerations, namely: low prices of land, prompt leasing, and properly structured capital, and then mitigate their development risk by portfolio diversification of the assets. (Chaillou, et al., 2017)

For real estate valuation, there is an internationalization of methodology of standardization procedures, such as the International Valuation Standards form the International Valuation Standards Committee, which define the best practices in the field and include standards from Europe, the UK, the USA, Canada, and Australia.

Some common methods of estimation are the cost approach method, the sales comparison approach, and the income capitalization approach. (Zujo, et al., 2014)

The global recession resulting from the COVID-19 pandemic is already having an impact on real estate, with selling prices having decreased even by 15-20% in some markets. As in every crisis, a situation where consumer confidence drops is bound to be capitalized by big players that would buy cheapened property for later profit. (Nicolas & Triana, 2020)

2.2.2 Crowdfunding in Real Estate

Democratization of the investment possibilities is a term often used to describe a main idea behind real estate crowdfunding (RECF), which is making the investment in real estate accessible to wider audiences. RECF developed following the financial crisis of 2007 when financing institutions lost capacity and confidence from the public and has ever since continued to increase its popularity. It can be inscribed in what is known as the *sharing economy* or *peer-to-peer economy*, and in real estate environment, also known as *communal economy*, where underutilized goods and services are shared by peers, and which has gained importance in many other areas of the global market, including finance and services. (Garcia-Teruel, 2019) Although it is argued that the sharing economy will increasingly play a role in the provision of goods and services, it is, nevertheless, not the promised utopia of a non-profit vision. It has had its downsides, its emblematic company in real estate and travel sectors, Airbnb for example being accused of de facto changing occupancy uses. Nevertheless, millennials and younger generations rely more on the sharing economy as many are financially limited despite their high education.

An important part of this environment is *crowdfunding*, a term which can be defined from different sources as an internet-based entrepreneurial initiative that collects funds from different individuals in relatively small amounts and without traditional financial intermediaries. Originally aimed at social projects through donations or loans, now it includes different ways of investing (Garcia-Teruel, 2019). Forms of crowdfunding according to their type of entry are: *donation* crowdfunding, *reward* crowdfunding, *peer-to-peer lending*, *equity* crowdfunding, and *loan-based* crowdfunding (*crowdlending*)

(Bogdanova, 2018). Other modalities include *investment-based* crowdfunding, *invoice trading* crowdfunding, and the mixing of all previous forms (Garcia-Teruel, 2019).

Crowdlending, or lending-based crowdfunding can be divided in three categories: business (P2B / B2B), consumer (or personal, can be P2P / B2P), and real estate (P2P / P2B / B2P / B2B).

Real estate crowdlending can in turn be *Buy to sell*, *Buy to let*, *Equity* or *Development* (Havrylchyk, 2018), and as shown in the next Figure, is not only done by private investors, but by a growing share of institutional investors:

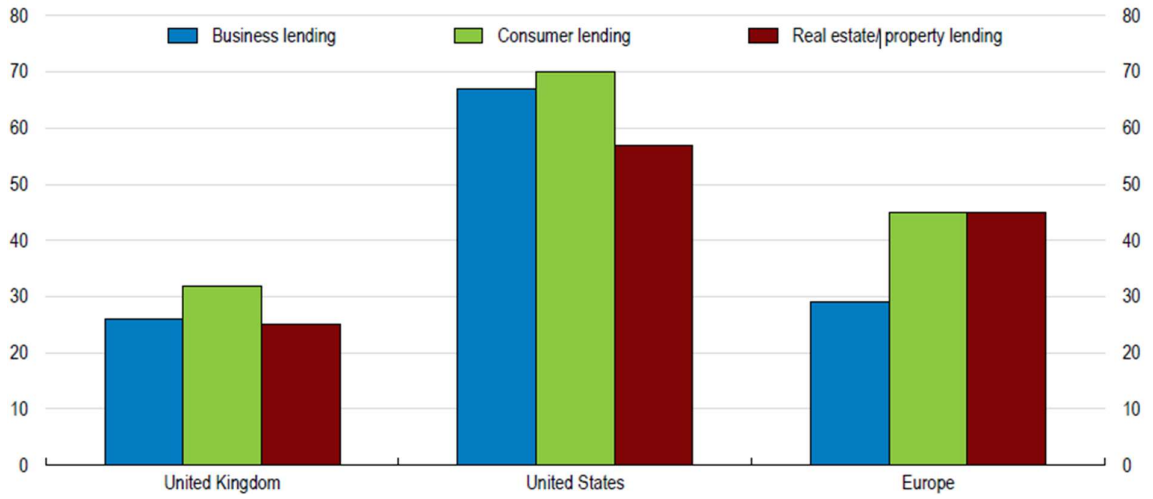

Figure 12: The share of institutional investors in lending-based crowdfunding platforms (Cambridge Center for Alternative Finance, s.f.)

Despite the COVID-19 pandemic, crowdfunding in general is booming: the second quarter of 2020 had the highest registered numbers of investments, new investors, money invested, and applications from founders to raise capital. This was reported by Wefunder, the biggest *Reg CF* (the smallest from three exemptions, allowed to raise up to $1.07 million) platform in the USA, covering all sectors. Similar statistics were also reported by several platforms in the UK. (Alois, 2020). *Statista* (2020) expects the worldwide transaction value of crowdinvesting to reach $8.1 billion in 2023, by having an annual growth rate of 11.4% from 2020 with $5.8 billion, a year that has so far seen 51,500 campaigns with an average funding of $112,615 each.

Real estate crowdfunding (RECF) is a form of crowdinvesting, where investors acquire a small ownership of the company (Tice, s.f.) (Garcia-Teruel, 2019). This specific crowdinvesting for real estate is also called *real estate debt investing* (PeerStreet, 2020). Crowdinvesting, particularly equity-based crowdfunding, was the first form of crowdfunding to develop in real estate and is still the most common. Here the promoter, the crowdfunding platform and the investor form an *ad hoc* company for each project, and the profits are shared accordingly through shares or bonds when the sales are performed. After crowdinvesting, other models have been developed: *lending-based*, *silent partnerships*, *real estate crowdfunding 2.0*, and RECF through a REIT. Under Spanish law, in the silent partnerships (*cuentas en participación*, also part of the investment-based category) modality, the investor does not receive shares, but profit depending on each individual agreement and the deal does not require formalities. RECF 2.0 uses Initial Coin Offerings (ICO) to raise money in blockchain-running cryptocurrencies that buy tokens through smart contracts. (Garcia-Teruel, 2019)

In crowdlending, another common modality in real estate, the developer returns the loan with the agreed rate of interest. Contrary to a bank loan, it is usually not required to be secured with a mortgage, which represents a significant reduction of costs to the developer but a reduction of rights to the lender. (Garcia-Teruel, 2019)

2.2.3 REITs and iREITs

Real Estate Investment Trusts (REITs) are publicly traded companies, which provide a means of owning real estate (Miles, et al., 2015). There are some important differences between traditional REIT and crowdfunding, between traded and non-traded REITs, and between equity and debt REITs.

REITs (2020) finance or own property that generates return from different real estate classes. A traditional REIT owns real estate, which rents out and pays dividends to its investors. Before CF, investing small amounts in real estate was only possible by trading stocks of REITs in the stock market. REITs trading like stocks means they have high liquidity, and even if the price fluctuates daily, the dividends remain the same (Patoka, 2020). REITs' investors are generally institutional due to its more complicated nature and higher expenses.

Before 1990, the market value of all REITs was less than $10 billion, but already in 2015 their equity market capitalization surpassed $650 billion and they had become part of many market indexes (Miles, et al., 2015). REITs have a good performance of return in the medium run and surpass some stock markets around a 10-year period, as shown in the next Figure 13:

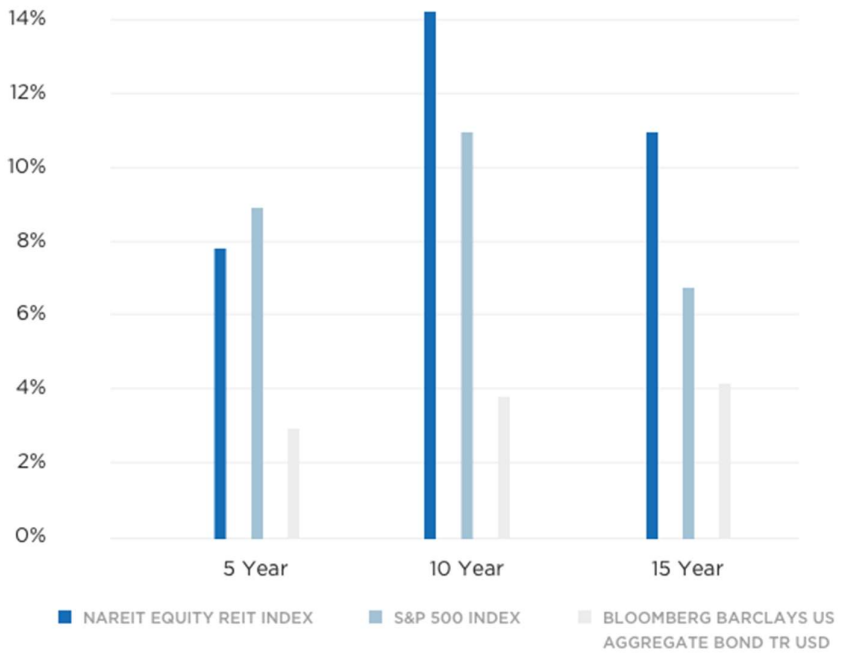

Figure 13: REIT performance history (RealtyMogul, 2020)

With crowdfunding, on the other hand, REITS are more easily managed through a website that is open to the general public (Bryant, 2020). eREITs, also called *Intelligent REITs*, or iREITs, are smart online real estate crowdfunding platforms that received their latest meaningful impulse from Information Technology. These platforms make REITs accessible to the public without the higher risk of the more unstable stock market. They are digital and smart finance instruments, where maximum profit is gained with instruments like *Trend Following* (TF), a machine learning algorithm for automatic trade (buy-sell). Basic TF can allow a yearly gain of 100% in an investment, and more advanced TF strategies can raise this amount to even 300%. (Hu, 2017). eREITs / RECF has different degrees of diversification by allowing the user to pick from

a basket of properties. It is not liquid, but this allows its returns to be higher than those of public REITs and is in general less volatile than the stock market. (Patoka, 2020)

2.2.4 Regulation

Due to the relevance it has in terms of resources and incumbency of stakeholders, real estate finance is a sector heavily regularized by the state, and naturally so are the RECF platforms.

The REIT is a corporation that uses capital from a multitude of investors in the purchasing and managing of real estate assets to produce income. Contrary to capital gain, income is considered taxable in the USA, but in the case of REITs, if it is distributed in at least 90% of its stakeholders and meets other standards, it then avoids paying taxes like other kinds of corporations, resulting in a low-cost investment option. RECF was first enabled in the USA as a result of the JOBS (Jumpstart Our Business Startups) Act of 2012, which loosened the regulations to raise capital.

Europe follows in general similar regulations. In Spain, RECF platforms are obliged to inform lenders about the project risks and unless they work as RE developers within their own projects, the investments have a top limit of €3,000. (Garcia-Teruel, 2019)

In Singapore, REITs could not be described as a collective investment scheme before 2002, when its definition in the law was modified. Now REITs are part of the Singapore Exchange with a representation of 10% of its market capitalization. (Tjio & Hu, 2020)

The Financial Conduct Authority (FCA) of the UK regulates its whole financial sector including the crowdfunding industry and has have established a parameter followed worldwide. Seen as a global player in RECF, Mexico was an example of this situation (Navarro, 2019) before enacting its own FinTech law in 2019, which establishes debt, equity, and co-ownership (royalties) crowdfunding categories (Blum, 2019).

2.2.5 Limitations

Although RECF might seem disruptive, the concept can be tracked back to the seventeenth century, and considering this it can be seen as an evolutionary process (Shahrokhi & Parhizgari, 2019). Following the theory of disruptive innovations, RECF can be considered as *potentially* disruptive in the real estate finance sector, but in order

to determine this, more thorough analysis from empirical data is still needed (Montgomery, et al., 2018).

RECF faces criticism on solid grounds: there can be risks in the lack of experience of investors in scrutinizing the deals, in the offered projections being unrealistic, in the lack of personal relationships with the sponsor (developers) and other investors (Vogel & Moll, 2014), and in what implies that developers turn to RECF after being denied loans from traditional sources. Other criticisms on RECF are: little control (no influence on the project or property management), disappointment (iREITs unlike REITs are not accountable of distributing 90% of income as dividends), high risk with low gain possibilities, and being seen as an easy way for unexperienced investors who can be victims of fraud, which has actually happened. Potential risks lie in the governance of the company, profits not being guaranteed, lack of liquidity (regarded as low security), bankruptcy of the RECF platform, and high risk and speculation in ICO and blockchain-run smart contracts, as confirmed by the European Securities and Markets Authority. (Garcia-Teruel, 2019) (Hu, 2017)

From an insightful investor's (Ippolito, 2018) perspective, there are other limitations of RECF. In comparison to other forms of crowdfunding, the high fragmentation of investment (having to rely on multiple platforms) due to low overall and core (40-70% of a portfolio) investments to diversify from in single platforms means higher risks. There are excessive requirements or effort to be put in financial education and due diligence, while other crowdfunding and investment options provide risk ratings and more accessible information. Considering the diversification desired, the minimums for investors are too high, since often times there are single or narrow property investments. Also, most investment projects are still limited to accredited investors, who have to be certified by the Securities and Exchange Commission (SEC) in the USA. (Bryant, 2020)

2.2.6 Investors' motivation

Although not much research has been done in consumers' behavior regarding RECF, Wiencke, et al. (2019) have shown that the novel investors' drive to invest in RECF does not come from a financial need, but from a desire to learn how companies are funded and wanting to live an "exciting experience" in the unknown field of investment.

The investment decisions this sector make are grounded more on intuition and subjectivity, contrary to the more objective way in which experienced investors analyze their deals.

2.2.7 Examples of RECF Platforms

It would be more exact to call these RECF platforms *crowdlending* or *crowdinvesting* instead of *crowdfunding*, but the latter term is now generalized in the sector. These platforms generally fund new developments in its many forms (commercial, residential, industrial, etc.), but there are also *flip* (buy-to-sell) and renovation schemes. To allow diversification, some sites provide multiple property (pooled) investments. For the common user, the main attractiveness of this FinTech companies is the higher-than-average revenue they offer, which is already inherent to real estate, but in the case of RECF, obtained through lower investments. Regarding the associated risks, the platforms inform about them in different levels and detail. They have strict selection processes for developers, evaluating professional experience, competence and capability, their financial statements, and references from end users. As for communication among investors and developers, only a minority of platforms allow P2P contact between them.

Following are some of the most renowned real estate crowdfunding platforms around the world, featured in various rankings in the USA (Patoka, 2020) (Friedberg, 2019) (Kan, 2019) (see Table 5 in Appendix). *The Real Estate Crowdfunding Review*'s (Ippolito, 2020) rating system accounts many aspects, including bankruptcy protection, accredited or non-accredited investors, fees, type of property, and minimal investment amount. After the American ones, platforms from different countries are mentioned due to some particularities.

CrowdStreet

CrowdStreet is currently focusing in 18-Hour cities (see next section) investments, a market with high potential (FinancialSamurai, 2020), and is one of the few platforms that allow direct investment in commercial RE. This means dividends of even more than 20%, but the higher risk this implies comes because the company cannot offset losses through other investment assets (Patoka, 2020). The *CrowdStreet Blended*

Portfolio allows diversification across 30-50 highly vetted deals with a single contribution (Friedberg, 2019). One can invest in individual deals, diversified funds, or a custom combination. As seen in the next Figure 14, there are multiple options to filter deals with:

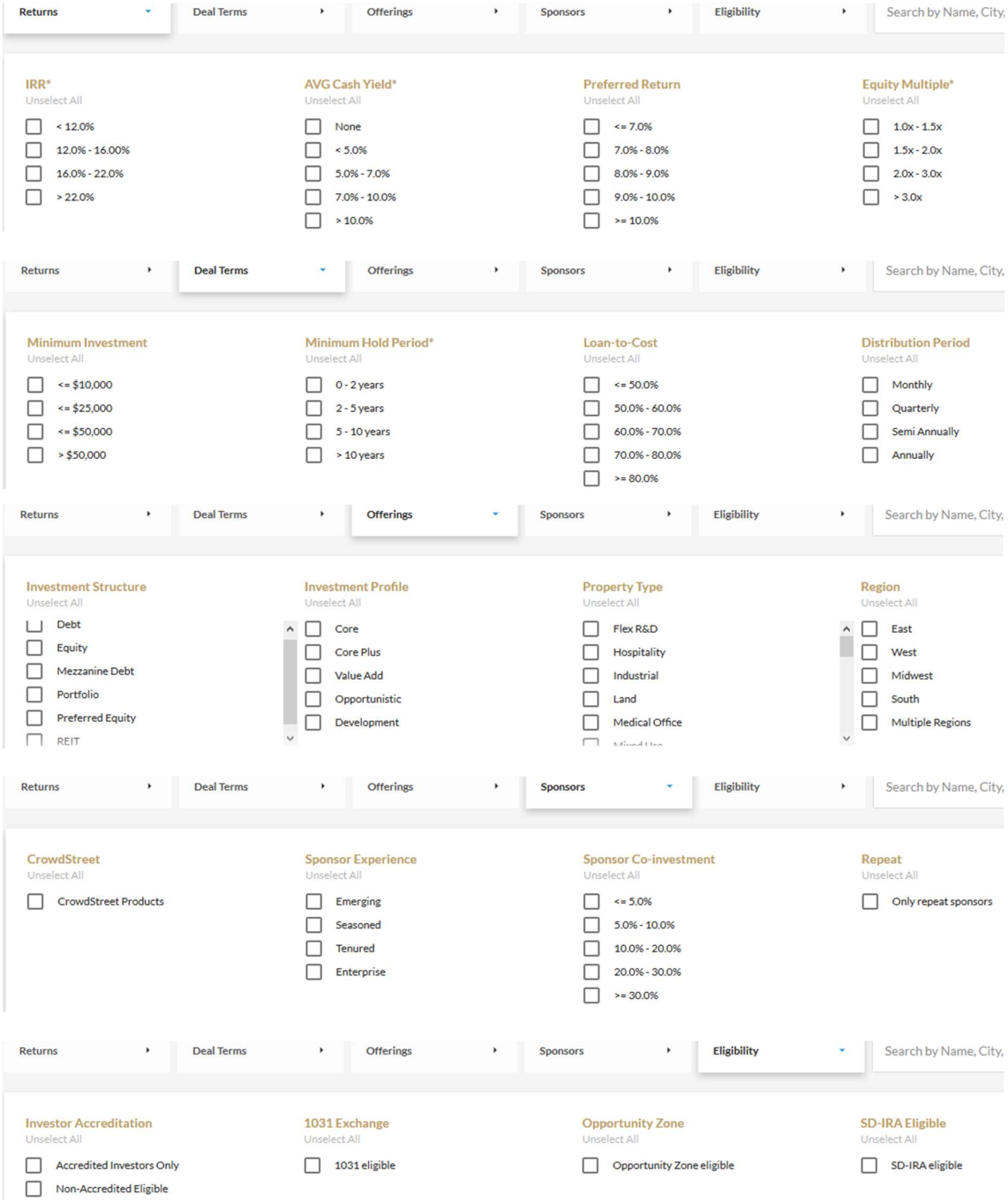

Figure 14: Filtering by Returns, Deal Terms, Offerings, Sponsors and Eligibility in CrowdStreet (2020)

The complete range of property types includes Flex R&D, Hospitality, Industrial, Land, Medical Office, Mixed Use, Multi-Asset, Multifamily, Office Residential, Retail Senior Housing, Storage Student Housing, Manufactured Housing, Built-to-Rent, Flex/Office, Data Center, Parking Garage, Coliving, Specialty. Investment profiles regarding risk range from core (lowest), to opportunistic (highest), and investment periods rage from 2 to 10 years. (CrowdStreet, 2020) Through a *screening process*, thousands of deals are picked based on the assets, its corresponding *sponsors* (developers), and the terms of the projects' approval. The selection of sponsors is done by the company's standards such as leverage, sponsor's equity, offering structures, or the sponsor's experience (*emerging* (<5 years), *seasoned* (>5), *tenured* (>10), *enterprise* (>15)) and more. The platform has an acceptance rate of 5% for *sponsor* (borrower) applications, lower than the average 5-10% (Patoka, 2020). Investment review sources such as the USA Securities and Exchange Commission, FINRA and Thomson Reuters' CLEAR data-based investigation software are also considered in this point. The information can later be reviewed by the investors when choosing their portfolio, and the information can be downloaded in Excel spreadsheets. (CrowdStreet, 2020)

RealtyMogul

Backed by various venture capital and real estate firms, RealtyMogul offers institutional quality investment and equity capital for developers, prioritizing quality over quantity of deals. For Miles et al. (2015) the leading crowdfunding platform in the USA, where contrary to REITs, both accredited and non-accredited investors play. Even when taking measures like background and criminal checks to mitigate risk of fraud, it clearly states (like many platforms) that no investment is 100% guaranteed since risk always exists, but having a physical asset as a collateral from the sponsor makes the situation better. The *hold* periods (time until the cash is available) differ on each investment. (RealtyMogul, 2020)

Users can choose individual projects to invest in from an *investor dashboard* featuring all available documents related to projects. They are guided by investment options: passive income, capital preservation, growth, *1031 exchange*, and by tolerance to risk: *conservative*, *moderate*, and *aggressive* (RealtyMogul, 2020). Investing in equity is typically done through the shares of a Limited Liability Company (LLC), established

specifically for RealtyMogul by the sponsor, who in turn invests/owns with the real estate company and other investors a share of another LLC / joint venture which holds title to the property. *MogulREITs* are public registered and non-traded REITs that invest in and manage different portfolios. The *MogulREIT I* trust is an LLC whose diversified portfolio includes loans and equity in commercial real estate and pays fixed monthly dividends of 7.81% on average (as of July 2019) from debt investments. *MogulREIT II* invests in preferred and common equity of multifamily, has a three-year minimum investment and more upside potential due to its more equity-focused approach which pays dividends when the sale takes place but a lower annual dividend of 4.5% (from June 2018). Finally, *1031 exchange* is designed to swap rented properties in a tax-advantaged way. (Patoka, 2020)

Apart from performing physical, financial, and legal due diligence before closing each deal, the company eases the investors' own due diligence (RealtyMogul, 2020).

Through the *MogulREIT* schemes, real estate companies (sponsors) for their part can borrow Preferred-, Joint Venture- or Co-General Partner Equity (RealtyMogul, 2020). The sponsors can use the platform to raise equity or secure a loan of between $2 and $10 million. To begin with, they must have 5 years minimum experience and $100 million worth of built real estate projects (Miles, et al., 2015), and the rest of the selection process is also very strict: on average, one deal out of a thousand meeting all of RM's criteria (RealtyMogul, 2020).

PeerStreet

With one of the lowest investment minimums in the United States ($1,000) (Friedberg, 2019), its returns are generally higher than bonds and sometimes higher than equities. With its *automated investment feature* opportunities can be filtered by factors like property type, loan maturity date, geographic region and borrower and investments can be made according to the personalized settings (Patoka, 2020). Other platforms like Bulkestate and Crowdestate have similar auto investment functions.

Fundrise

Main appeals of Fundrise to investors are the use of the *eREIT Portfolio Builder*, and the analysis of risks and returns of a particular project in the portfolio with the *Fundrise Rating Tool*, where the amount of interest can be chosen to easily generate diagrams, all of which has rendered a 13% proven earning (Hu, 2017) among varying rates of return. Although the minimum 90% of taxable income is maintained, the COVID-19 pandemic has lowered the distributed dividends, which are used with the asset values to quarterly update the eREITs. Investments are allocated to their so-called *eFunds* and since 2015, to eREITs (Kan, 2019). Forms of income are varied, including sales, rental, and interest payments. Property management is usually done internally, but also by the sponsor (Eden, 2020). A *redemption* (withdrawal) of the investment is in some cases possible, with a corresponding fee (Patoka, 2020) (Fundrise, 2020).

The Fundrise portfolio, designed to withstand prolonged periods of distress, is available for starters with $500 and 5-10 projects to diversify in, but a $1,000 investment gives access to the next level plans, which include supplemental income, balanced investing, and long-term growth. There are two higher account levels, from $10,000 and $100,000 where the target diversification in number of projects increases to more than 80 (Fundrise, 2020). For the eFunds, its historical performance is available in the platform. Regarding equity debt financing, the company is more conservative, entering only the multifamily sector, and in this respect, Fundrise stands between the senior lender and the equity holders. (Eden, 2020)

Fundrise does the Assessment of market value in-house in a hybrid manner mixing traditional methods like DCF (discounted cash flow) models with analytics tools like CoStar (see Predictive analytics). AI is not utilized at the moment, but it is being considered for the near future. (Eden, 2020)

eFunds are carried in renovations if the risk-adjusted returns make sense. Following the USA 2017 tax bill, which allowed investment in economically depressed markets with tax benefits, residential assets were being subdivided into multifamily or office space renovations. Other cases included warehouses turned into office spaces, of a more *creative* market. Distribution centers have also become a new asset. The company usually works with developers with whom they have previous experience and

are more likely to have positive results. For them, there are advantages like not having a predevelopment fee. (Eden, 2020)

Rich Uncles

The particularity of RU is that apart from commercial REITs, it offers student housing REITs, although barely from 2018 and limited to a few cases. The REIT is a triple net lease fund, which means the tenants pay for all expenses, therefore the investment expenses are low. Since it is not publicly traded, investors are required to audit to the SEC, which gives greater transparency but also makes trading more difficult. The initial investment amount is one of the lowest in the USA, with $500, and offers an annualized dividend of 6%, but it is not very liquid and there are not many options to choose from. (Patoka, 2020) (Voigt, 2020)

Property Partner

The vision of UK-based *Property Partner* is being a market similar to that of the stock exchange in a global scale. In its platform, where the common user can take part in investments, institutional investors like Seedcamp, Octopus, and Index Ventures are also attracted to a system that benefits from the scale economy when buying hefty properties worldwide. The properties are owned in shares which can be sold in a second market after five years, benefiting both types of investors. (Hu, 2017)

Housers

Housers (2020) focuses on Southern European buy-to-let and buy-to-sell developments. The platform has a marketplace functionality feature and a Direct Communication Channel (DCC) that allows to be in direct contact with the developers and other investors to share information.

Bricks & People

In the Spanish market, Bricks & People (2020) offers medium rentability of 25% returns and minimum ticket of €50. It has three investment schemes: fixed rate, equity, and rents, the latter being a combination of the first two:

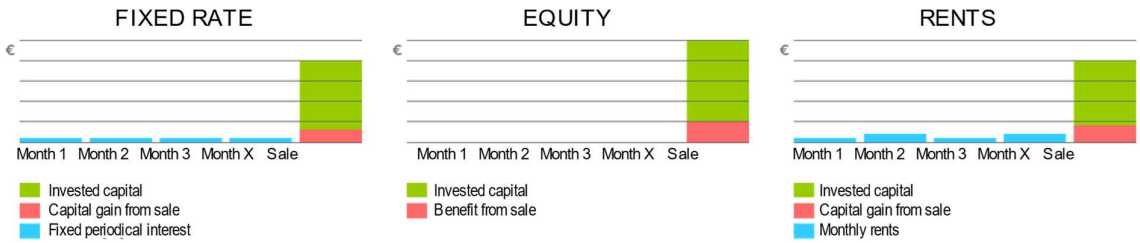

Figure 15: Bricks & People's (2020) Investment Typologies

Briq

Focused on residential projects but starting to incur in the commercial real estate and would consider sustainable projects if they met their parameters and had market absorption. There are no advanced analytics taking place in the project and market analysis tasks, which are done manually. (Ángel from Briq, 2020)

With investments starting at MXN$1,000 (€40, used to be MXN$5,000 before the COVID-19 crisis), the annual returns are between 13 and 20% depending on the project (Briq, 2020), of which the rates can be fixed or variable (Ángel from Briq, 2020).

For developers, the financing is more expensive, they resort to Briq when unable to get bank loans (Ángel from Briq, 2020). The company has thorough processes in different stages for their approval, though: Developer analysis, Project analysis, Funding analysis and structure, and Opinion and approval from the investment committee. The risk is stated for each development, and a higher valued building is left as a *collateral* guaranty. In case of noncompliance from the developer, the investors keep their investment along with the yield depending on the terms of the project. (Briq, 2020)

M2Crowd

The platform originally developed following the FCA's (UK) standards, and is since 2019 compliant with the Mexican FinTech regulations (Navarro, 2019). Investments start from MXN$5,000, with a 18% average annual return in two investment schemes:

Table 2: Comparison of Fixed Rate Debt and Payment Priority Debt investment schemes in M2Crowd (2020)

Fixed Rate Debt	Payment Priority Debt
periodical payments	payment at the end of the term
alternative building as guaranty	developed building as guaranty
yield agreed with developer	yield result of commercialization

M2Crowd (2020) is open for companies to invest in, and the investments can be withdrawn before the start of the development.

2.3 TRENDS IN REAL ESTATE AND TOURISM

2.3.1 Urban and Rural Demographics

Particular global trends regarding city growth, homeownership, workplace flexibility are changing with younger generations. The homeownership rates began declining after 2005, since millennials (or *Gen Y*) marry later and at lower rates. (Miles, et al., 2015). This has led to some situations like the *Double Income No Kids* segment being the largest one in rental markets of many places, including Latin America (4S , 2020).

In Europe, some current demographic trends are representative of global ones: the reduction of the average household size (already the world's lowest), the reduction of the property ownership rate (which in Germany, Switzerland Austria and Sweden is below 25%), the growth of the elderly population and the growth of the tertiary students amount (Jones Lang LaSalle IP, 2019).

As a result of the declining birth rates, *demographic winters* are seen in developed nations like Japan and Spain and Italy in Europe, where elderly people account for an increasing part of the population. In developing countries, on the contrary, younger generations account for the largest proportion of the population, and enormous city growth is expected in the coming decades as a result. This poses the challenge of having a 40% of the housing demand for 2030 not yet built (United Nations, 2020), a situation that has the risk of chaotic urban development if not properly planned. At least from a technology point of view, experts believe that innovation can aid in the housing supply through a wider utilization of limited spaces, more accessibility to cost effective housing, and the increasing of density at key locations (Osborne Clarke, 2018).

Ever since the industrial revolution, the trend in population mobility has been into the cities from the countryside following job opportunities and other improvements in the quality of life. In ten years from now, the total world population would be 8.5 billion, a 1.2 billion increase. Today, around half of the world population (3.5 billion people) already lives in cities, and according to predictions, this number would increase to a 60% (5 billion) in 2030 (Anton & Irene + Space10, 2020), and 68% (2.5 billion more urban residents) in 2050 (Woetzel, et al., 2018). A higher proportion of urban population is found in regions like Europe, where the percentage has increased from 72.6 to 74.5 in one decade and is expected to reach 76% in 2029 (Jones Lang LaSalle IP, 2019).

This increment in urbanization reaches a maximum as it approaches its 100% and the population ages, and then starts to decline, as seen in the next Figure:

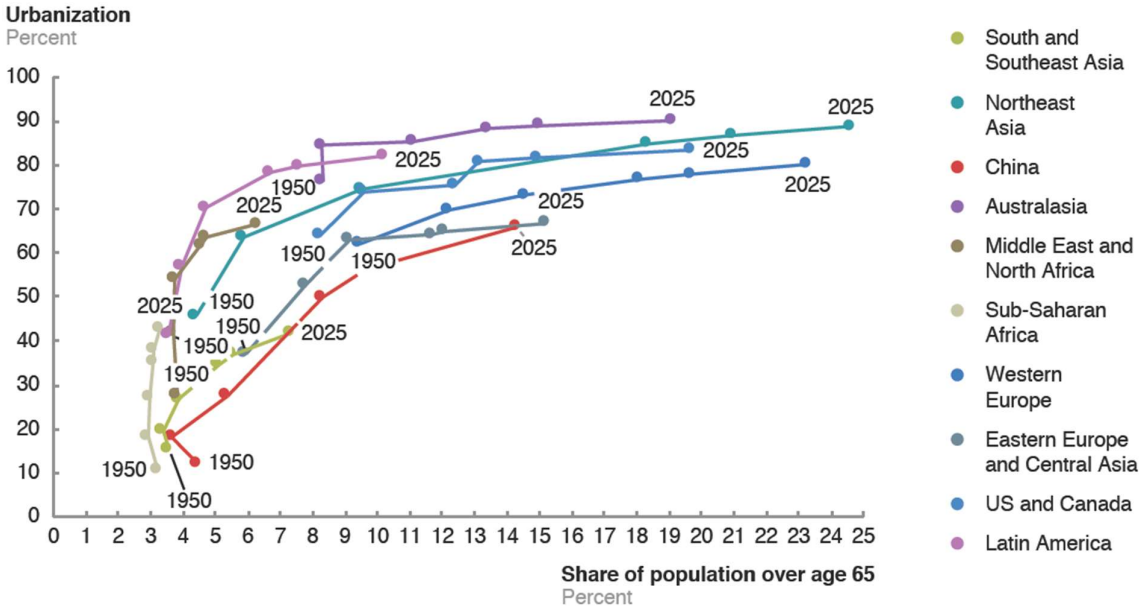

Figure 16: Regions by their urbanization and share of population over 65 years of age over time (Woetzel, et al., 2018)

The urban growth takes place partly in the so-called *18-Hour cities*, which are second-tier cities that can potentially become *24-Hour cities* due to higher-than-average population, job, and wage growth, as well as lower valuations and higher cap rates. Signals of this situation can be the quality of the cities' urban and transport infrastructure, stable government, existence of anchor companies, affordable housing, and lower cap rate compression. Investing in 18-Hour-City real estate can be overlooked by institutional investors, which can mean opportunities for individuals through platforms that specialize precisely in this market. (FinancialSamurai, 2020)

Regarding non-urban growth, cities grow by themselves on the one hand, but there is also an influx of people from rural areas. It is in the context of urban development, that villages are simply abandoned with their housing stock in favor of more prosperous urban centers. Extreme examples account for almost 1,900 villages in Spain practically doomed to become ghost towns in the next years, according to a recent study (Recaño, 2020).

This being stated, movements in the opposite direction can also take place due to different factors. Remote work gains popularity and allows people to live further away from city centers, which added to a longing of contact with nature from certain types, accounts for a renewed interest in the countryside from urban dwellers. Real estate

agents engaged in the rural sector say that in the past, the most important aspect that people looked for was communications, but today that is *tele*communications that allow many people to leave the cities, at least for a short term, as the pandemic has shown in places like New York. The search for better life quality and a fear of a pandemic's higher incidence in the cities also contribute to the ongoing and expected price rise in some rural areas. Although the prices are proportionately lower than in the city, due to the higher demand they are tending to increase, in places like Spain in around 35% in the first four months of 2020, as internet searches for rural properties show (López Letón, 2020). This urban-rural price ratio is independent from the fact that the whole real estate market is contracting.

2.3.2 Workplace

According to research by Jones Lang LaSalle (2018), top five kinds of spaces that have proven to be innovative, provided, tried, and expected in the workplace are: community spaces, co-working spaces, service desks, creative spaces, and incubator or accelerator. In the same study regarding trends and habits, the measurement of performed work shows that it increasingly takes place outside the traditional office, as seen in the following chart:

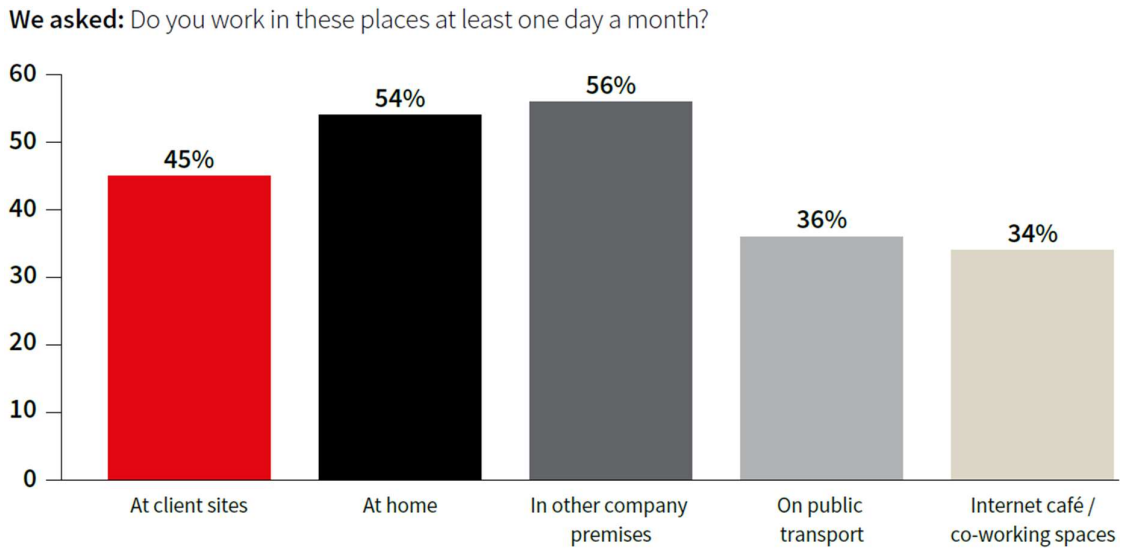

Figure 17: Workplace Mobility (Jones Lang LaSalle, 2018)

Both home office and coworking are necessarily allowed by digitalization, which implies having a greater flexibility in the workplace, especially in terms of location. Surveys among tech experts and common users show that the future demand for both trends depends heavily on IT (Osborne Clarke, 2018).

Apart from the flexibility in the workplace location, working hours are expected to decrease, and although it might not be as big a change in the near future, there are already some experiences reducing the common 40 hour working week. Companies are experimenting with less working days in the week or fewer daily working hours with positive results, derived from the conception that productivity declines in the latest hours of work.

Working From Home

Companies had been incorporating the practice of Working From Home (WFH), even before the COVID-19 pandemic sped up this trend. WFH has been linked to up to 13% more productivity, higher work satisfaction and psychological attitude scores, decreased job attrition, doubling of the gains for the employer due to the aforementioned, and the reduction of rental space (Bloom, et al., 2015). In the case of the current COVID-19 pandemic WFH is however not expected to have the same effect fundamentally because of the factors children, space, privacy and choice (Gorlick, 2020). Also, if WFH becomes a permanent situation, there comes a point where the practicality of physical engagement with colleagues is needed in order to be creative, all the more accounting for flexibility to be one of the most sought-after characteristics of the new working spaces (CBRE, 2020).

Collaborative Working

Known mostly as *coworking*, but also as *shared office*, or *hotdesking*, collaborative working stands for the rental of flexible, informal office space popular in cities that has arisen in part due to high rents and to satisfy the demand for part-time, temporary or variably located office space leasing (Wheaton & Krasikov, 2019). Popular among the millennial generation, it is a trend that has increased tenfold from 2013 to 2018 thanks to having individual space leasing and flexibility as its main characteristics and advantages (Chegut & Langen, 2019).

Landlords are now operating on-demand office space for co-working in otherwise underutilized space. Even big tech companies use external co-working providers to house their employees in flexible schemes, and the presence of this kind of spaces has proven to have the highest impact on talent retention. (Jones Lang LaSalle, 2018)

The feasibility of coworking has been studied from the financial point of view of landlords (Wheaton & Krasikov, 2019), coming to the conclusion that the conversion of traditional office space into coworking tenancy causes prices to fall and cap rates to rise. Regardless of these economic implications, having coworking tenants is mostly indifferent for landlords, according to Chegut & Langen (2019).

Although mostly an urban phenomenon, it is also offered in remote locations as part of a travel – coliving experience popular in the *digital nomad* environment.

Although used mostly in marketing, the term *phygital* space describes the combination of traditional physical space with the possibilities given by digitalization that can apply to many areas, including remote work. The *Berlin Wall* app and Pokemon Go and are examples of the technology incorporating digital elements in a referenced physical space. Many brick and mortar businesses are declining due to online markets, which impacts other areas of real estate, such as retail, but incorporating virtual reality experiences can be an innovative way of maintaining competitiveness.

2.3.3 Coliving

Cohousing and *coliving* are terms sometimes used indistinctly, although there are important differences among them. Cohousing generally refers to intentional communities designed and run by its residents. They consist of normal private spaces, for example clustered households ranging from 10 to 40, and also common facilities, like a common house with kitchen, gathering places, allotments, workshop, children's playground, etc. In terms of organization, they have a horizontal decision-making structure, and are open and part of a wider community. Some require community work from their members. (UK Cohousing, 2020)

Regarding coliving, *wellbeing*, *community*, and *sustainability* are its three "aspects of connection" established by Conscious Coliving (2020), an organization that assists in

the development of coliving projects throughout all feasibility, concept, planning, construction, and pre-launch phases.

There are strong economic grounds for choosing coliving as a way of life, given the organization of expense, the reduction of waste and sustainable technologies implemented by its members. But there are also other reasons perhaps more important are related to lifestyle and psychological factors, a proof of this being the increasing interest in coliving from high-payed professionals are increasingly looking for this kind of model (Wood, 2017). The millennial generation has some traits that make it particular, like being young professionals more urban-focused than ever and tending to move away from the desire of ownership (sharing economy). But as they become more independent, they also start suffering from loneliness, an ailment that has proven to have even physical effects in the health of adults, and is already a matter of concern in public health in the developed world (Howe, 2019). This situation has in a way fostered the interest in coliving, which has proven to have positive psychological effects. A study showed that children living in coliving environments were more "socially mature, confident, outgoing, competent, and verbal (and at far younger ages), than their non-community counterparts" (Wood, 2017).

There are many examples in modern architecture predating the contemporary idea of coliving, an early one being the boardinghouses for young women moving to the cities for work, which can be traced back more than a century in the USA (Gershon, 2019). Housing cooperatives have century-long history in German-speaking Europe, where due to its prices below the market average achieved through a socially responsible approach they comprise around 10% of the housing stock in Berlin and almost a quarter of it in cities like Zurich and Vienna (Lutz, 2019). They have been acknowledged by the German federal government as the *third pillar* of housing supply and are crucial players to achieve affordable rents, for which they are benefited with reduced prices in the acquisition of federal land. The Kreditanstalt für Wiederaufbau (KfW) supports the Residential property program by acquiring cooperative shares and aiding in the creation of new housing cooperatives. The concept of the cooperative is even declared as Intangible World Heritage of Humanity by UNESCO (Die Bundesregierung, 2017).

More recently, *hacker houses* for the tech community became popular some years ago in the San Francisco Bay area (Wood, 2017), to the point that nowadays the world's

largest coliving project is being built in San José for the Silicon Valley workforce by the startup Starcity, with rents starting from the low $2,000s (Holder, 2019).

Coliving is gradually becoming a formal housing typology with appeal in the market, a type of social entrepreneurship that promotes inclusivity, affordability, and sustainability, (Wood, 2017), with an especially vibrant market in southeast Asia and Australia, where startups like Hmlet are entering the sector with strong investments (Tan, 2019). The process of accessing urban properties for users is facilitated by companies offering coliving services like Common, Outsite and Ollie, although the service might be 20% more expensive than normal rates (Flavell, 2019). *Co-Liv* (2019) is a “do-tank” that operates as a “chamber of commerce” of the global coliving community with the mission of empowering the coliving phenomenon. It is a social network that brings together different actors for developments.

Efforts to predict the future of coliving from current input include the *One Shared House 2030* (Anton & Irene + Space10, 2020) survey, where the data provided by a slightly older than millennial average reflects interests which the market fails to attend in the most part: control whom to live with, having a share on the property rights, the appropriate size for a community being from 4 to 10 persons, and freedom of movement across multiple homes. In older-than-millennial generations, other reasons to start considering or preferring coliving is being able to “ask for help” in case of need/emergencies, something millennials do not have in mind. (Anton & Irene + Space10, 2020)

Intentional communities is a term based on coliving principles that is being used by organizations planning residential networks with social cohesion in mind. According to the Foundation for Intentional Community, the number of intentional communities around the world has increased significantly in recent years. A kind of these communities are the *eco-enclaves*, which seek to improve human and environmental well-being through sustainability, wellness, and land conservation. (Williams, 2020)

Generally in the housing sector, more flexibility is also sought after, and in the case of coliving this is eased by taking decisions early in the design phase. Having a collective approach at this point increases the appeal and sense of belonging to the future residents, as well as facilitating the work for the design team. Worth noting is that these ideas can be traced back to concepts of Participatory Design in more than fifty years.

2.3.4 Forms of Ownership

New generations and current economic conditions and habits have fostered new forms of ownership in common. While the concept of *shared ownership* could be seen as an intrinsic part of cohousing, the similar concept of *co-buying* is offered to people in transitioning situations involving study, work, or relationships (Flavell, 2019).

Fractional ownership refers to shared ownership of a resort or vacation property with right of use in a given period of time. Variations on these agreements include *private residence club*, *destination club*, *vacation club*, *quartershare*, *timeshare*, and *vacation home partnership*. Forms of timeshare now include *titled ownership*, but traditionally it only gave rights of access, not of property. Fractional ownership differs from timesharing in involving more rental time per year, having less owners and being more expensive. It is becoming popular among owners of vacation places who want their expenses to lower. For developers it represents an option to sell in difficult market situations. (Sirkin Law, 2016)

The *Tenancy In Common* form refers to coownership where the owner chooses his/her inheritors, with or without usage rights and other variants under these categories, involving combinations of time-assigned co-ownerships and equity shares (Sirkin Law, 2016).

The *rent-to-buy* model is the focus of startups like Divvy and Verbhouse, which apply it to particular deals between tenants and owners (Wong, 2018), and is managed as an option in many coliving projects.

2.3.5 Regenerative Design and Sustainability

Ecological awareness and concern over the Earth's limited resources has become a prevalent discussion in the public arena of mostly developed societies, where basic needs are already met. Therefore, the attention on topics like consuming habits is expected to grow as the living standards globally increase. The sustainable approach to development and design has been classified in two branches: technological sustainability (based on engineering) and ecological sustainability (based on living systems principles). Green buildings and eco-efficient design stem from the first, while *regenerative* development and design from the second. (Mang & Reed, 2013)

Regenerative design understands the ecosystems to foster regenerating life from its underlying support systems instead of depleting it, and is supported by regenerative development, which introduces systemic thinking to achieve stakeholders' involvement and commitment (Mang & Reed, 2013). Regenerative design addresses the problem of resource depletion in a holistic way from its inception, whereas the technological sustainability approach merely fixes the outcome in a more superficial manner. Figure 18 illustrates the concept:

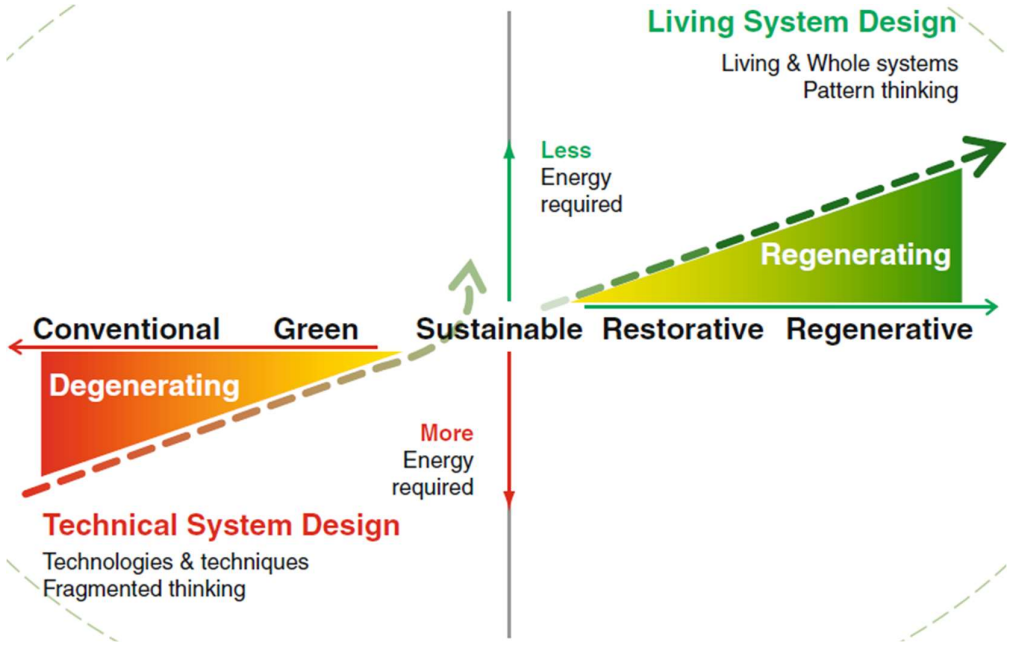

Figure 18: Technical System Design vs. Living System Design (Regenesis Group)

The term *regenerative* applies to processes that repair, recreate, or revitalize their own natural resources. In the concept of regenerative design, these processes represent sustainable systems where a *virtuous circle* coming from an appropriate design takes place, in which the consumed resources and products are replaced in identical quantity and quality. In the construction sector, the Cradle to Cradle (C2C) model is a certified standard with five principles that guide the implementation of regenerative design in the built environment: Safe and Healthy Materials, Materials Reuse, Renewable Energy and Carbon Management, Water Stewardship, and Social Fairness. (Attia, 2017)

Systemic thinking is a framework where the relationships and patterns of change among things are valued more rather that the things itself in explaining phenomena (Mang & Reed, 2013).

In the regenerative line of thought, *biophilic* design focuses on *positive*-impact design instead of just focusing on low-impact design (Calabrese, 2020), and is less about *greening* buildings and more about finding humanity's place in nature and natural space in human society (Kellert & Calabrese, 2015).

More than a decade ago, it was foreseen that the real estate market would have to meet sustainability criteria, which implies attention to the building materials, the construction processes, and the buildings' life cycle (Anghel & Hristea, 2015). Terms like *evolutionary economy* (dynamic and interdisciplinary) and *circular economy* started to be used, the latter about recycling the consumed resources. In the circular economy, the consumption rate is limited by the efficiency which approaches 100% as the consumed resources are returned in a useful form within a reasonable period of time (Kümmerer & Clark, 2016). Examples of this may be waste recovery of agricultural biomass to feed a biogas plant or a trigeneration system, rainwater recovery or reuse, and using recycled, renewable, or locally sourced materials. In the industrial sector, *industrial ecology* is in a way an application of the circular economy, where the waste can be used by others, creating *industrial ecosystems* (John, et al., 2016).

Sustainable Construction

Although there is increasing awareness and use of energy-saving systems, low impact materials and techniques, recycling, reusing, self-sufficiency etc., the interest in sustainably built construction is still far from being prevailing in the actual market development and depending on the location, not many developers are committed at a high level with this. In green building, even though the average marginal cost is low or even null, there are increases related to the design fees and the projects' duration (Chegut, et al., 2015). Although the initial costs are actually higher, the increased demand for sustainable criteria tends to lower the prices (Miles, et al., 2015). Worth noting is that apart from its environmental advantages, the appeal of sustainable construction can have an impact on the marketing, commercialization, and ultimate success of a project. Although the added value of using sustainable products and

processes is not easy to measure (since at times higher initial investments have to render positive returns in the long run), it can be done even just in terms of ROI, as proved by the research shown in Table 3 (Chegut, et al., 2016), which shows that certified energy-efficient affordable housing can sell from 1.9 to 7.2 % more than the non-certified.

Table 3: Higher value of certified housing around the world (Chegut, 2016)

Study	Country	Transaction Type	Energy-Efficiency Measurement	Findings	Notes
Brounen and Kok (2011)	The Netherlands	Sales	Energy Performance Certificates	+15% for a G to A label jump	Dwellings with a high quality energy label, C and above, trade at a premium.
Cerin et al. (2014)	Sweden	Sales	Electricity consumption per sq. meter	+0.03% for -1% in consumption	Only the most energy-efficient homes benefit from a slight transaction premium.
Hyland et al. (2013)	Ireland	Sales and rental	Building Energy Ratings	+16.6% in price, +4.6% in rent for label G to A	The impact of a Building Energy Rating is stronger when selling conditions are more difficult
Feige et al. (2013)	Switzerland	Rental	Sustainability features	-2.9% for a +0.1 in the energy-efficiency rating	All sustainability features are positively related to the rent level of housing except for energy-efficiency.
Yoshida and Sugiura (2015)	Japan	Sales	Tokyo Green Building Program certification	-12% for certified buildings	Initially green apartments trade at a discount; slower depreciation rate leads to a price premium.
Deng et al. (2012)	Singapore	Sales	Green Mark certification	+4-6% for certified buildings	Transaction premium varies with the quality of the label. Most energy-efficient dwellings receive the highest premium.
Zheng et al. (2012)	China	Sales	"Marketing greenness" (Google Green Index)	+17.7% for the most green dwelling	Properties marketed as green sell at a premium, they resell and re-rent at a discount.
Dastrup et al. (2012)	U.S.	Sales	Solar panels	+3.5-4% for homes with a solar panel	Premium is higher in streets where fewer homes have solar panels installed
Kahn and Kok (2013)	U.S.	Sales	Energy Star, GreenPoint, LEED certification	+2-4% for certified buildings	Certification matters more in hotter climates and in areas with higher energy prices.

Certification from renowned instances like WELL, LEED, Net Zero Energy, Energy Star, GreenPoint, Building Energy Ratings, etc. can imply demonstrable premium valuations, although some of these ratings have not been exempted from criticism, as they can be seen as mere forms of *greenwashing* and marketing strategy.

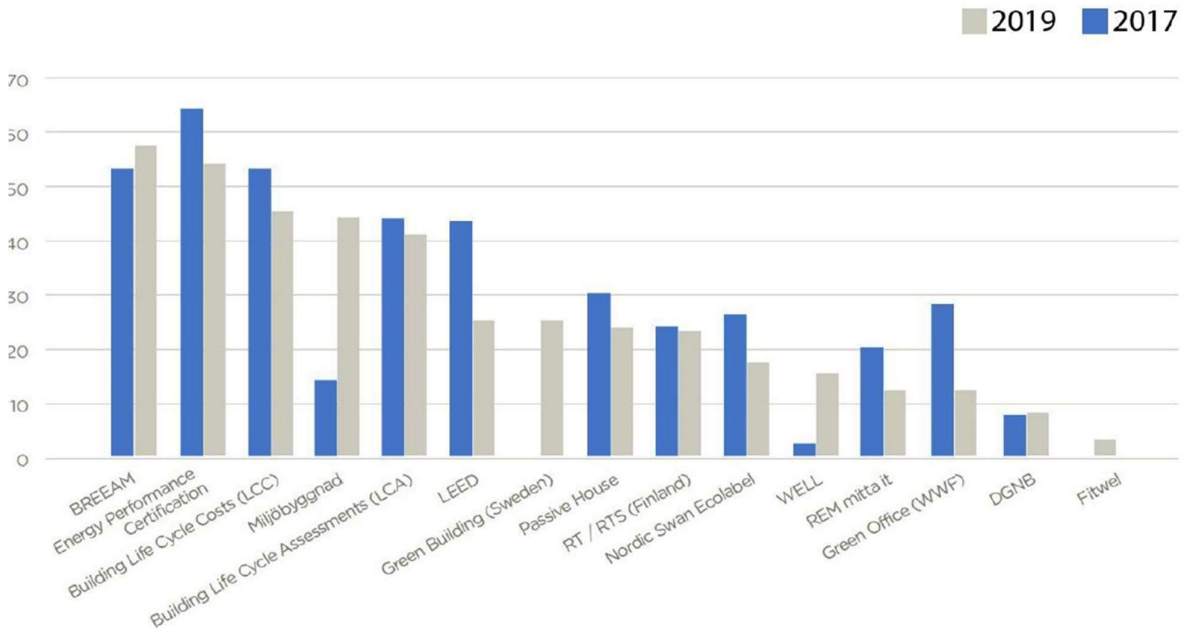

Figure 19: Major certification schemes in 2017/2019 (Ramboll Group A/S, 2019)

Regarding industry's initiatives, off-site prefabrication and recycling for construction can amount to sustainability by cutting expenses in the production line, a recent example being BoKlok, a company co-owned by IKEA and Skanska delivering low cost housing in the Nordics (Block, 2019).

The concepts of *lean production* are now used in the construction industry, where the aim of reducing of waste for economic reasons also has environmental implications. Although these are more difficult to valuate, Bae & Kim (2008) measure key impacts of utilizing Lean Methods for sustainability reasons in all *Lean Project Delivery Phases* (including prefabrication in *Lean Assembly*) and categorize them into economic, social and environmental perspectives.

Renovation

Although not necessarily intended to be sustainable, renovation by itself implies the renewing of existing structures and, as has been stated (Thornton, 2011), the most sustainable (or *green*) building is the one that is not built at all. Although the maintenance costs are higher, renovation of historical buildings does not imply high initial costs, they have aesthetic value and longer life cycles, and other advantages

that make their adaption, renovation and reuse the greener choice as well as the most cost-effective. The renovation and upgrading of the existing stock is in fact already an important part of the construction sector, including retrofits and additions (Saiz & Salazar, 2017).

Companies like Aldeas Abandonadas in Spain are specializing in the commercialization of abandoned rural property, actually whole villages (López-Letón, 2019). The buyers have different views ranging from rural tourism, agriculture, reselling, or simply residential or second home, but the majority of houses require retrofitting. The higher demand is making the prices increase at an annual rate of 5-10%. On the other hand, initiatives like these are supported by local and European subventions in the acquisition process.

2.3.6 Tourism Trends

The travel, tourism and hospitality sector plays an important role in the world economy. Tourism being “the world’s third largest export category” (UNWTO, 2018), its related economy represented 10.4% of the global GDP in 2017 and produced one in ten jobs in the world (313 million). In 2018 (WTTC) the travel and tourism industry had a 4.6% growth compared to 3% of the global economy, with the top spenders being China, the United States, Germany, the United Kingdom and France. On that year, it could be seen that Asia is the region with the highest growth of the last decade. In particular, the hotel industry had a significant growth in 2019, drastically contrasted with 2020, as the sector has been particularly affected by the COVID-19 crisis. In order to recuperate, more flexibility should also be sought after.

Sustainable tourism (ST) can be an umbrella term for a wide variety of forms, which can be divided in those contributing to nature conservation, and those more socially oriented, promoting fair and inclusive business. The nature-oriented address topics like ecology, nature preservation, energy-saving, sustainable urbanization, erosion control and the efficient use of water (in accordance with the UNSDG no. 6 & 14), and some of their forms are *ecotourism*, *geotourism*, *agritourism*, *ethical* tourism, *volunteer* tourism (Wearing, 2001). The socially oriented include models like *community-based* tourism, *social enterprise* tourism, *pro-poor* tourism (Sustainable Travel International & Mandala Research, 2017) (CREST, 2017), and have a wider scope in terms of

responsibility. In joining both the naturalistic and social concepts, the term *responsustable* was coined (Mihalic, 2016), arguing that *sustainability* in tourism lacks efficacy, while the term *responsible* gains attention in the academic and practical debate and action, but is based in the later, thus attempting to bring together theory (sustainability) and practice (responsibility), with a proposed 'Triple-A' model of Awareness, Agenda and Action.

Yet another novel tourism category is the health-oriented one. Some of its forms are *wellness tourism*, *healing eco-tourism* (El Shiaty, et al., 2016), and *forest therapy* (Ohe, et al., 2017), which include the *emotions* or *experience* concepts, not exclusive of tourism, but very closely related. Psychological studies have proven the health benefits of being in contact with nature: improved well-being, stress alleviation, mitigation of chronic diseases, and raising of life expectancy, and initiatives in this respect attempt to bring nature to people, and people to nature (Van den Berg, 2017). The *green care* concept considers horticulture, gardening and caring of farm animals, which are linked to improved mental health as well as rehabilitation improvement in patients suffering from depression and dementia (Leach, 2016). Moreover, prevention therapies are cost-effective in relation to treatment up to eight times, which raises the question if health professionals should be giving more *green* prescriptions (Van den Berg, 2017). The evidence-based WELL Building Standard published by the International Well Building Institute, is a measure to certify and monitor buildings and their performance affecting wellbeing and health (Miles, et al., 2015), which has been increasingly adopted since its launching few years ago (see Figure 19).

Considered instruments to address issues in ST (Mullis, 2017) are the implementation of complex collaboration and collective impact methodologies, circular economy principles, sharing economy, evidence-based policies and planning; simplified regulations, market-driven enterprise and product development strategies, measurement of economic, environmental and social impacts, and monitoring and reporting.

In its *Tourism Trends and Policies report*, the OECD (2018) calls to, among others: incorporate environmental and sustainability criteria into public financing and investment supports, and improving data and analysis on green finance and investment in sustainable tourism development

As proposed fields for future research, González-Reverté (2017) mentions *territorial intelligence* destinations, which is looking for technology-based alternatives for destinations to maximize benefits according to local needs; the *deep voyage* notion, questioning what do we really need from holidays and what can we give back to the places we visit and how to obtain a more personal and meaningful experience; *geolocal tourism*, focused on proximity travel; and *slow travel*, developing an interest in alternative transportation or by foot, related to *geolocal*, but with more sustainable transportation systems.

From a point of view of economic feasibility, Chen et al. (2011) demonstrate that the development of touristic or landscape engineering has positive effects on real estate development and the rising of prices, which in turn provides protection to these areas with the creation of a built periphery.

A technology-based approach includes 'intelligent systems in tourism' (Gretzel, 2011), or *smart tourism*, regarded both as a strategic tool for development, and as part of the general framework of the smart cities' initiative, and implying the incorporation of physical and governance dimensions. It goes beyond the earlier concept of *e-tourism*, where the groundwork of global distribution and reservation systems was laid by web-based technologies. Smart tourism produces value propositions from processed data with the emerging forms of Information and Communication Technologies (ICT) in different layers, from the destination (with physical infrastructure), business ecosystems (where public and private stakeholders are dynamically interconnected), and experience (with the active participation of the tourist). (Gretzel, et al., 2015)

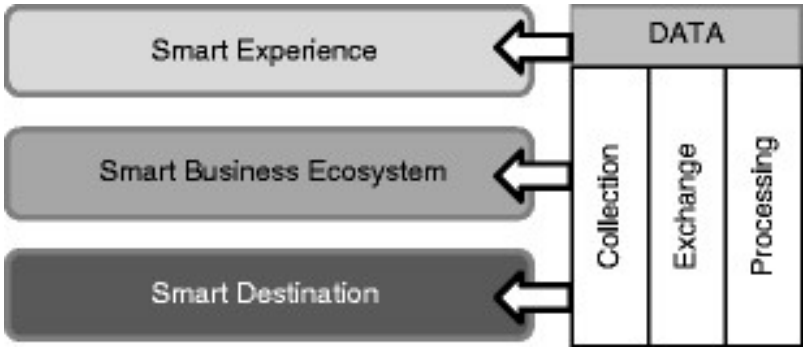

Figure 20: Components and layers of smart tourism (Gretzel, et al., 2015)

The increasing involvement of Big Data and Machine Learning in the travel and tourism sector affects the traditional roles of agencies and brokers, which have been diminished by a more direct relationship of the service provider with the end user, which gives the latter more power over their acquisitions (Chaillou, et al., 2017). An excess of technology can also be counterproductive as tourists often seek precisely to avoid it. Yet, the opportunities made possible by technology in tourism are found in the safety, convenience and sustainability aspects for residents and tourists alike. (Gretzel, et al., 2015)

2.4 PRODUCT IMPLEMENTATION

It is worth making a brief section illustrating the environment in which most of PropTech and RECF ventures have emerged, and the basic concepts to consider regarding a quality product development.

Product Design aims at identifying the problem, who has it, and what is the goal to achieve (Babich, 2018), all of which should be considered when thinking of a business model engaged in the previously analyzed fields.

Though it may seem obvious, it should be stated that none of the described technology and effort put in product development would be tapped without an appealing digital user experience (UX), in which a web-based, cloud sourced software, and all the more with a mobile app, is at this point almost mandatory in order to be competitive. “UX has the right tools to design something that is not only simple and effortless and puts real human beings in the center, but also make something that is beautiful and sustainable.” Irene Pereya (Wood, 2017). Tools like wireframe design with which to envision a user interface (UI) are not difficult to use for non-developers, and very useful in conceptualizing functions.

In real estate, like many other sectors, cloud-based platforms are replacing traditional and more expensive software due to their lower expenses, no need of updating and less resource consumption.

Applicable to any industry sector with no exception form real estate, present day sales and marketing rely heavily on information technology like SEO (Search Engine Optimization) for tasks like group targeting and play a fundamental role in the success of any business. Nowadays it is also relatively easy to find market niches, with tools like Google Trends that help in evaluating customer behavior.

The entrepreneurship driving the aforementioned ventures has stemmed mainly in the so-called startup ecosystems fostered by both private and public institutions, namely companies, universities, and governments.

The creation of real estate tech companies reached an unprecedented peak in 2013, and in 2014 venture capital funding in real estate startups surpassed $1 billion (Wong, 2018). In 2015 the development of city analytics and an increase in global capital investment propelled real estate tech startups with a record $1.5 billion of venture

capital investment (CB Insights, 2015). The growth continuously increased to reach $4 billion in 2018 (Wong).

Accelerators are environments that can mean connections and a network of security for emerging startups. Companies promote innovation and creativity through them, they function with grants and corporate funding, which makes them mostly free to join for entrepreneurs. There are nevertheless concerns over the true benefits of joining, especially when there is a fee for doing so (Founder, 2020).

Through an understanding of the importance of entrepreneurship, universities orient their students in the startup environment. Startup *ecosystems* that stem from educational institutions can be seen in the Startup Sauna of Aalto University, and *Entrepreneurship* in HTW. Stemming from Aalto (University) Entrepreneurship society, *Slush* is the largest European tech startup event, where prospects and investors network and expose their products and services.

Governments are increasingly conscious about of the importance of ICT and entrepreneurship in the economy. Some examples of efforts in this direction are the Berliner Startup Stipendium, Newco Helsinki and Startup Estonia, where startups originating there have been increasing their revenue 66% year on year (Mällo, 2020).

3. RESEARCH METHODOLOGY

Since the research questions are in the realm of technology and business, the most suitable approach to answering them was considered formulated following the research methodology principles stated by Saunders, et al. (2009) and McCombes (2020):

First of all, the conception of the topics came in part from rational thinking, examining own interests and strengths and looking into related literature and media. In a lesser amount, creative thinking came from preferences in past projects and brainstorming.

The applied research strategies were case studies and grounded theory. Given the different topics to study in the materials section, an example of its application is given following each of them. This strategy presents a *multiple* case study, which is *holistic* by the nature of the overviews, and serves as a basis for a qualitative approach. Grounded theory was used to predict and explain behavior based on the qualitative data, was used in the further analysis.

As happens in the real estate decision making, the nature of the topics required data of both quantitative and qualitative nature, for which research materials were gathered from different sources. The academic literature was accessed from scholar search engines in open sourced documents from sites like ResearchGate and ScienceDirect, and with student access from sites like SpringerLink. Relevant news affecting the real estate sector were gathered from the internet, and podcasts featuring specialists from different sectors related to real estate and finance were heard to have a holistic understanding of the topics. The materials were originally produced by a wide variety of authors and researchers all across the world, but in a rough order of quantity: Europe and USA, Asia, Latin America, Australia.

The primary (*grey*) literature accessed came from reports of companies and institutions, conference proceedings, and some government publications (White Papers). Also considered primary or *white* sources, were reviews and websites, and quantitative data from statistics. A lesser amount of primary data was collected through direct communication with companies' representatives in personal emails and calls. Consulted pieces of secondary literature were journals, books, newspapers, and some government publications.

A critical review of the literature was done considering certain characteristics, the most decisive in the selection of sources like reports and statistics was being a recent publication date, followed by the reputation of the source. As for academic publications, other aspect in consideration was the amount of citations of the reviewed articles.

A thematic analysis was done from the qualitative data to identify broader topics and patterns that needed explanation. Given the lack of a predetermined theoretical or conceptual framework developed at its starting point, and because of the change of context that the topics faced, the research followed an inductive approach (Caulfield, 2020). Other themes were generated from the initial analysis of RECF, such as its location in the broader scope of PropTech and its legal and financial connotations. The data was analyzed in its explicit content with following a semantic approach where clear insights could be identified. To a lesser degree, a latent approach was also needed to make assumptions and infer implications from the subtext of experts' opinions and more subjective data.

In general terms, the approach was pragmatical, meaning it is possible to work with variations in epistemology, ontology, and axiology, and to use mixed methods of quantitative and qualitative research within the study. From an epistemological approach regarding the acceptable knowledge in the studied field, the research leans more to an interpretivist rather than a positivist approach, meaning that the subjective underlying has to be explored in order to understand the results, in contrast with the hard data studied in natural science. In spite of that, the research is more in accordance with a realist position, that states that objects exist independently of the human mind and that what the senses show us is the truth, in contrast with the idealist position, that states that only the mind and its contents exist. An epistemology of critical realism takes into account the facts themselves plus the interpretation given to them, a position in accordance with the nature of real estate, where subjective value can also be measured as proved along the literature review.

In terms of ontology, explaining the nature of these topics' reality made more sense beyond the objectivist perspective where social entities exist independent of the social actors, and rather from a subjectivist perspective, since the perceptions and actions of the social actors give shape to these phenomena very differently depending on the location, moment in time and many other circumstances, which is why special attention was put to ongoing global developments. Furthermore, some definitions are variant in

time and place and there are no definitive answers to problems that themselves change continuously, which gives the research process a value in itself comparable to that of the results.

4. RESULTS AND DISCUSSION

4.1 Answers to Research Questions

The answers to the research questions summarize the analysis of the research materials:

4.1.1 What is the technology driving PropTech and what is its effect in real estate?

There are many aspects of technology involved in real estate, as well as PropTech areas. AI and ML are utilized mainly in the analytics of markets and locations, and also in the communication aspect regarding language processing and human interaction.

According to Baum (2017), information is the most prevalent area of industry in which PropTech is applied (Table 1). From some of the most depictive applications of IT in real estate, it can be seen that neural networks, but actually representing the whole set of artificial intelligence and data science, have a significant role. Blockchain and cryptocurrencies, on their part, are expected to have a greater significance in the near future, precisely given the downsides that a mishandled widespread of data can bring to privacy and security. (Table 4)

Table 4: Real estate tasks and utilized technology (by author)

Real estate task	***Utilized Technology***
Predictive analytics	Machine learning / Deep Learning / Neural networks
Cost calculation	Neural networks
Identification of opportunities	Neural networks: Multi-layer perceptron
Determine property selling price	Neural networks
Smart contracts	Blockchain
Acquisitions, transactions, tokenization	Blockchain / Cryptocurrencies

The infrastructure in the cities and the built environment allows the implementation of domotics an IoT to automatize processes and ultimately experiences. In the context of the I4 era, networks of all sorts, increasing computing power, and the input of millions of users produces the data that generates insights on all kinds of issues, which in the case of real estate is used in tasks related fundamentally to predictive analytics, opportunity identification, cost reduction and efficient handling of resources.

4.1.2 How are crowdfunding and other financial schemes making investing in real estate more accessible?

Real estate crowdfunding (RECF) is considered part of PropTech, but also of FinTech, and has points of contact with LegalTech, as can be seen in the next Figure:

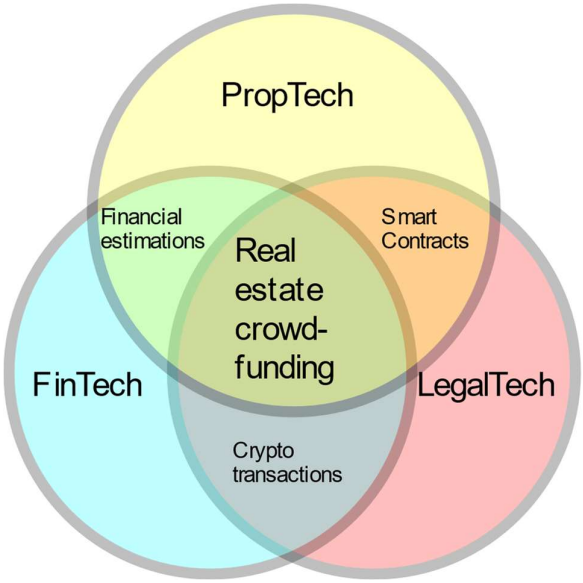

Figure 21: Interdisciplinarity of RECF (by author)

Loose regulations and the digitalization of financial services in the context of the sharing economy allow people to invest in real estate developments that would otherwise be exclusive of institutional or professional investors. Real estate *crowdfunding*, but more exactly *crowdlending* or *crowdinvesting*, is a concept from the last decade that gathers relatively low amounts of money from a pool of investors to finance developments with a return often above the average of other marketplaces.

Income and portfolio diversification are facilitated by RECF platforms, also known as Intelligent Real Estate Investment Trusts, to neophyte or experienced investors, for which they manage different schemes of investment.

In the typical RECF scheme for crowdinvesting, or equity-based CF, a company where the RECF platform, the developer (promoter or *sponsor*) and the investors agree to the terms is founded specifically for the project between the RECF. This can be described by the following Figure:

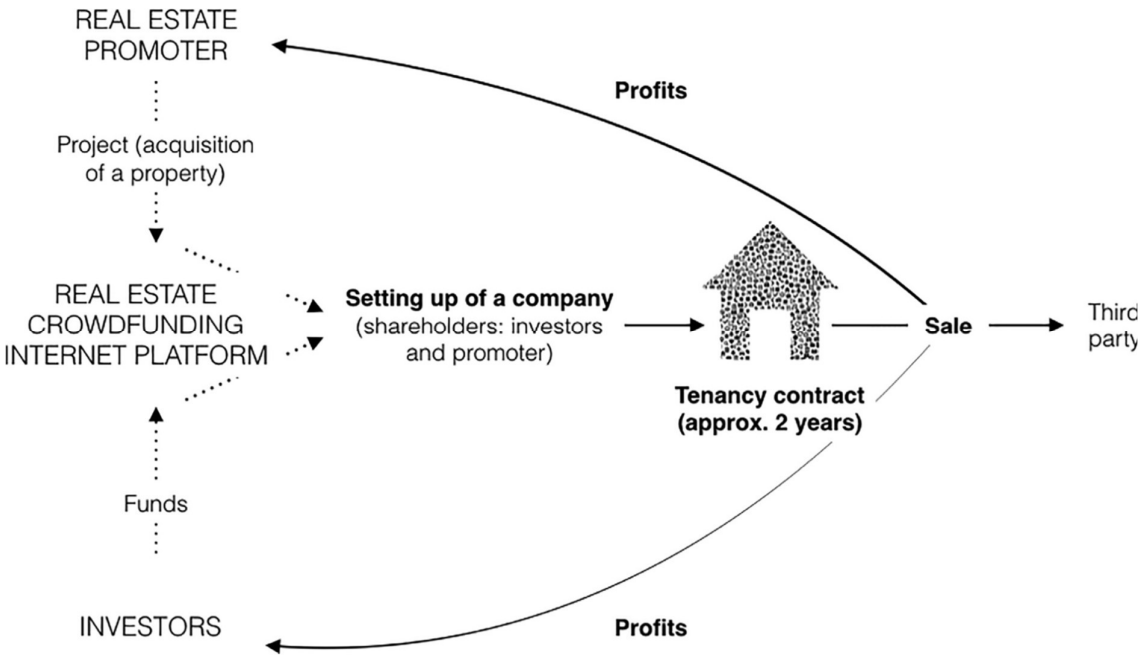

Figure 22: Equity-based real estate crowdfunding (Garcia-Teruel, 2019)

From the analysis of different platforms, it can be seen that their main target is commercial and housing projects. The following Table summarizes the findings in this respect from Chapter 2:

Table 5: Comparison of RECF platforms (by author)

NAME	LOCATION	TYPE OF PROPERTY	TYPE OF INVESTMENT DEALS	PORTFOLIO	MINIMAL INVESTMENT	AUTOMATED INVESTMENT	AVERAGE EXPECTED RETURN (%)	MARKETPLACE	FEES	PAYOUT TIME (years)	PAYOUT TYPE	NEEDED ACCREDITATION
CrowdStreet	USA	many, mostly commercial	equity / debt	blended: 30-50	$ 25,000		IRR 23.1					
Realty Mogul	USA	commercial, retail, multifamily	equity / loan (MogulREIT: public, non-traded)		$ 5,000 for first REIT, then $ 1,000		4.5 - 7.81		depending on investment	3 - 5 +	fixed monthly	for individual properties
PeerStreet	USA	residential / commercial			$ 1,000	yes	6 - 9.		0.25 - 1% annual			yes
Fund That Flip	USA	renovation ("flips") in residential			$ 5,000		9 - 10.					yes
RealCrowd	USA	commercial		single / multiple	$ 25,000				none	1 - 10 +		yes
Fundrise	USA	ONLY COMMERCIAL residential / commercial / renovation	5 eREIT options		$ 500, advanced plans with $ 1,000		12		annual investment advisory 0.15%, asset management 0.85%	5 +	quarterly dividends / appreciation at end of term	no
Rich Uncles	USA		REIT is a NNN fund		$ 500				3% of initial investment			no, but net worth requirements
100 Ladrillos	Mexico	mainly commercial, industrial			MXN$ 25,000			yes				
M2Crowd	Mexico	residential			MXN$ 5,000		18					
Briq	Mexico	residential			MXN$ 1,000		13 - 20					
Crowdestate	Estonia, Italy, Georgia, Romania, Latvia				€ 100	yes	13.68	yes				
Bulkestate	Estonia				€ 50	yes			none			
Housers	Spain, Italy, Portugal				€ 50			yes				

Though still not widely used in the RECF, blockchain and cryptocurrencies bring trust and safety as well as financial independence to customers who feel reticent about engaging in traditional ways of investing.

4.1.3 What are some ongoing trends in the real estate and travel sectors and how do they relate to technology?

As seen in section 2.3, ways of living can experience changes gradually. In particular, common housing are resorted to more communal lifestyles in the coliving environment.

Coliving is becoming a popular form of housing where its residents collaborate to have a more socially integrated, meaningful, healthy, sustainable environment, built in what is often identified as intentional communities influenced by regenerative design and circular economy principles.

The flexibility in the workplace characterized by coworking and remote work is enabled by digitalization. Although not yet significant enough, projections for the reduction of working hours would leave more time for leisure and travel, which would further increase the tourism market, already booming before the COVID-19 pandemic.

This comes in the context of cities being far from losing their appeal and the proportion of people living in urban areas is still growing in most parts of the world, especially among younger adults looking for opportunities. There is also interest in the rural space from urban dwellers nonetheless, and in this respect, the generations that look for it tend to be older, particularly from the moment of forming a family onwards.

Forms of communal ownership are tried to have less financial attachment and more mobility. Flexible rent-to-buy models are particularly appealing for people who do are not certain about allocating all their resources in one asset.

Changes in consumers' behavior and ICT sparked the concept of the sharing economy, which allows the temporary use of products or services by different people, contributing to an economy of resources. In the case of real estate and tourism, this was front run by services like Airbnb, which has since its inception been subject to deeper analytics and more targeted business models.

Sustainability, circular economy are concepts rather assimilated by now. Certifications of sustainability metrics in buildings already have an impact in its commercialization,

and in tourism, trends already gravitate toward a more responsible and sustainable approach that includes orientations in nature, health, and social responsibility. The more profound regenerative design concept is not yet prevalent but is expected to have more influence in the coming years, since sustainability is limited in comparison. Fortunately, these concepts are having a positive influence on tourism, a very important industry but also responsible of a great amount of resource depletion.

4.1.4 Where are the intersections and opportunity niches among these topics, specifically for non-urban developments?

The aforementioned topics have multiple points of contact, which are covered in the practices of promising companies, in which technology has different levels of adoption.

First of all, analytics plays a fundamental role, providing the foundations for business decisions, but there is a variable degree of adoption and reliance on it. In the case of RECF, even the most consolidated platforms like Fundrise deal only partially with data and automation, let alone AI (Eden, 2020).

Regarding tourism, it is already seen as an alternative use for residential real estate following the principle of flexibility and the possibilities given by the sharing economy, started by Airbnb and similar platforms.

All in all, different aspects of the buildings complement each other, the *green*, *smart*, *connected*, and *healthy* aspects of buildings ultimately result in premium transactions and leasing in asset valuations. (Weikal, 2020)

The field is rapidly changing, some of these ventures already have a huge success while some are just starting. In the near future a lot of changes could be seen, especially with the abnormal situation of the pandemic. Some of the most significant encountered examples of companies whose business models engage in combinations of the researched topics are listed below:

Construction management – AI – ML – Analytics – 3D visualization

Spacemaker (2020) is an early stage planning cloud-based software that uses AI and ML to reduce risk and costs in the planning and first stages of building, through

feasibility studies, 3D visualization, generative design, rendering substantial reduction in time and costs.

Risk management – ML – Big Data –Sustainability

Sustainability metrics are provided via ESG (environmental, social and governance) analytics that work with machine learning and related Big Data capabilities. BNY Mellon's (2020) service combines over 200 sustainability metrics with data from over 7,000 companies and news signals from over 50,000 sources across the world to make informed investment decisions and monitor asset performance in portfolio management.

IoT – ML – Sustainability – Circular economy

Qflow is an environmental risk monitoring tool for the construction site that departing from the premise that these risks are silently killing project margins, to utilize IoT and ML in the management of the social and environmental impacts of construction. It draws from automated data collection and uses ML to identify the impact of the site activities in the environmental data, streamlining reports with real time insights to minimize risk of non-compliance. Waste is also managed following Lean principles, contributing to a circular economy in the projects. An example of reported savings derived from the platform use was Canary Wahrf Contractors with £200,000 in one year. (QualisFlow, 2020)

Construction management – BIM – Augmented reality

XYZ Reality (2020) is a tool that relies on real-time validation using augmented reality on site with the corresponding prosthetic equipment to deliver tasks up to 70% faster.

AI – 3D visualization

Client-oriented browser-based software like *Plans* from real estate services provider CBRE (2020) allows customization by the companies themselves including features of parametric design like room filling algorithms to customize office spaces within an

accessible UI of visualizations and 3D walk-throughs. Similarly, but oriented to the residential sales market, the Match platform from Habx (2020) provides suggestions in terms of layout, add-ons, and finishes that the users can evaluate from the previews. Its predictive data collection function evaluates the market demographics to make the best proposals.

Property management – 3D visualization

As a property management service, Vacasa (2020) places clients' properties in multiple platforms, such as Airbnb, Booking.com, Vrbo, and HomeAway. 3D tours of the properties are featured to promote their sale or rent. The platform also measures cap rates to assist in the purchase of vacation homes.

ML – IoT – Hospitality

Machine learning algorithms instantly adapt customer needs like booking alternatives, choosing the room layout, and providing feedback. Automation in the sector can be seen in the check in/check out tasks and is bound to become prevalent, and there are already robots assisting in reception desks and carrying luggage, let alone cleaning. (Saiz & Salazar, 2017)

Analytics – Rental

AirDNA (2020) provides analytics for properties listed in Airbnb, Vrbo, and other platforms. A simple dashboard shows key performance metrics like occupancy rates and revenues, and analysis of any address's potential in these terms. Price metrics include pacing, rate calendar and seasonality, and invest metrics *rentalizer*, top priorities and market comparison. Among other features, the Airbnb API allows the targeting of customers based on varying criteria.

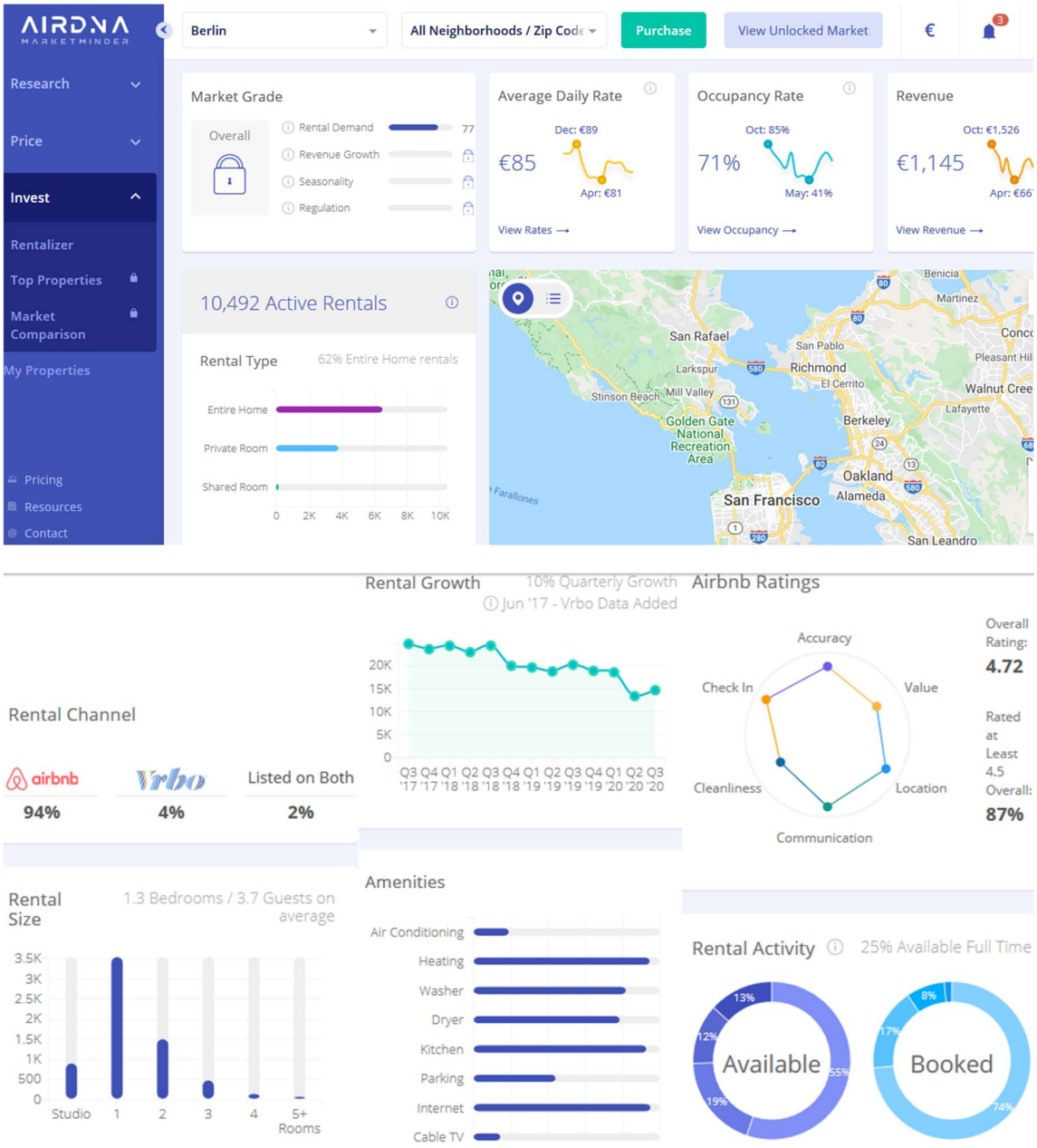

Figure 23: AirDNA's (2020) dashboard

Analytics – RECF

Some RECF platforms like Fundrise use services like CoStar's commercial real estate information to look for opportunities in developments (Eden, 2020).

RECF – Blockchain – Cryptocurrency

In RECF 2.0 the money is raised through a cryptocurrency tokenization bought through smart contracts on the blockchain, using Initial Coin Offerings, and some companies already working with it are Real, Alt.estate and Atlant (Garcia-Teruel, 2019).

StraightUp is a RECF company which has merged with the blockchain platform *Slice*. Arguably the first blockchain-based global REIT, it focuses on premium equity opportunities in cities across the USA for domestic and international investors (Alois, 2018), available in a platform where the properties and ownership status are easily identified, which allows their free exchange on the blockchain and to receive their return on real time (Pimentel, 2018). The main reason of adopting blockchain was to attract international investors while maintaining transparency and security as their core values. The system is based on tokens obtainable through crypto or fiat money.

RECF – Renovation – Blockchain – Coownership

Renovation as investment is one of the various kinds of investment (including art) that Mexican real estate developers Noox (2020) promote, in this case a renovation project of a castle in Mühlberg, Germany, where the shares allow certain annual stays. With a chosen scheme of investment (which can have an annual IRR of 12.5%), the Pixka Deutschland shareholders that own the property are in a *book*, or electronic registry backed in blockchain.

RECF – Renovation

Fund That Flip works mostly for residential debt investments, also known as hard money loans or *fix-and-flip* loans. It provides one of the lowest LTV (Loan To Values), which means less risk. This “flip” scheme is used mainly by borrowers who use the loan to renovate the property just bought to sell it immediately again. (Kan, 2019)

RECF – Coownership – Property Management

100 Ladrillos is a platform whose particularity is that the shares of the project (*bricks*) are divided equally among the investors and the profits come either in rental form in a

coownership scheme where the company does the property management, or from the sale of the shares in a dedicated market (Blum, 2019). Before the Mexican FinTech law came into force in 2018, the limit for such a co-ownership model was 100 parts, thus the name *100 Ladrillos* with a starting price of around MXN$180,000 for each brick, but now their price can start from MXN$25,000 (almost €1,000) or less. There are minimum and maximum numbers of bricks allowed to buy depending on the project and its acquisition is done in two forms. First there is a launching period with a minimum target amount to be reached in order to continue with the project. In case this is not reached, the investments can be refunded, otherwise, the discounts can be obtained at this moment, the earlier the greater. A banking administration trust is created for every finished project to provide security to the investment and further management, with the company representing the investors in the trust's committee. There is also a secondary market where the bricks can be resold at any given price with the corresponding capital gain once the construction is finished. (100 Ladrillos, 2020)

The deals are focused on commercial, industry and office spaces since those kinds give the highest proportional returns (16-30% annual yield) and do not require adaptation costs from the landlord. The due diligence process focuses on four kinds of viability: commercial, of the building, financial, and legal, and in this process, the company collaborates with specialized firms. Since it manages actual property, the FinTech law requires that the beneficiaries (heirs) be established in the platform. (Blum, 2019)

The dividends depend on the monthly rent (annually 8-10% of the property's value), annual rent increment (inflation and perhaps little more), capital gain and discounts given in the presale phase and/or by volume. The rents of the occupied facilities grow on an annual average of 9%. With the property management performed by the company, automatization in the transactions allows the co-owners to receive their share 15 seconds after the tenders pay the rent. (Blum, 2019)

The company charges fees from a) the property management, from 4 to 9.5% of collected rents, compared to an average 10% in the market, and b) the sale of the bricks, also 30% less of what the market, which is around 3-4% of the sale's price. (Blum, 2019)

Bricksave (2020) uses a similar concept of bricks, but in a global scale. With offices in Buenos Aires, New York and London, the platform operates properties in leading cities, focuses on low risk and immediate return in places with high rent/value ratio like Detroit, with investments amounts starting from $1,000. Bricksave performs macro and micro, and quantitative and qualitative analyses in-house, with which they make calculations and look for a developer that matches their proposal and proceed to performing due diligence and negotiations. The product is fully furnished residential property in a buy-to-let model, therefore the rental returns for investments are variable in the rental period, after which capital gain is earned in the moment of sale. There is no use of blockchain or cryptocurrencies at the moment. (Castellar, 2020)

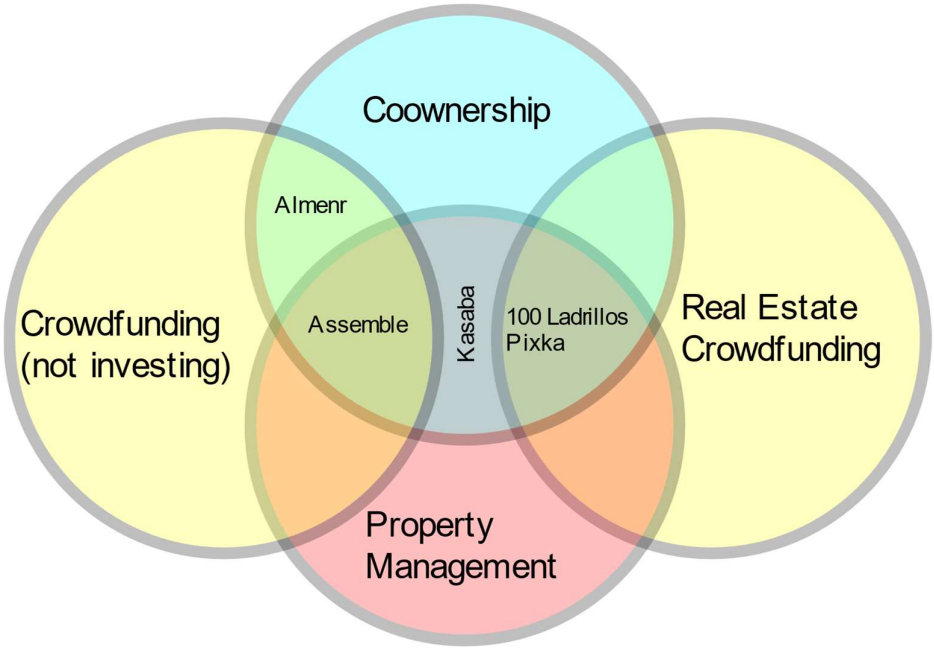

Figure 24: Interactions among Coownership, Crowdfunding, and Property Management (by author)

RECF – Travel – Rent

Brickstarter from Valencia focuses on RECF for vacation rentals, from which it receives less risky payments ahead of the stays, in the way of any hospitality facility like Airbnb or other booking services. The properties' selection is done from huge Spanish databases, but the particularity here is that this information is openly displayed in the

platform. Investing with credit card payments is possible. Yields are usually higher and less risky than from long-term rentals. (Schwartz, 2020)

Crowdfunding – Coliving – Coownership

Almenr is a Danish company specializing in coliving projects whose system is based on the century-old idea of the Commons as a way of collective ownership, which has advantages over other ownership models. It seeks to break the monopoly of the developer's model in financing with a crowdfunding (not investing) model, which added to the collective approach to design, conforms the two pillars on which the platform is built. (Almenr, 2018)

In their online platform, members are profiled and matched according to their similar interests with the help of machine learning analytics (Thomsen, 2020), so they can further congregate to work in a financial plan with the company's team, and engage from the design phase in the development of a project that can be open to different stakeholders (Almenr, 2020). With this pre-sale initiative comes another advantage over the traditional real estate market, which is staying ahead in the sale process (Stub, 2020). The concept designs are done internally in this way, but architects offices are hired for the later executables. Although currently the form of financing the project phase is mainly through crowdfunding (not investing) by the future inhabitants themselves, but for upcoming projects there are coownership schemes for the company's shares being developed, as well as the incorporation of blockchain and cryptocurrencies in the transactions. There are two projects on leisure communities, not exactly tourism but not far from it either, and plans about offering short-term stays in permanent dwellings and home swapping alternatives. The company is expanding to Sweden. (Thomsen, 2020)

Crowdfunding – Coliving – Sustainability

There are various examples of this kind of projects, like Cervo House (2020), in which a single lifetime fee gives access to a *unit*, comprised of a single room with access to the common facilities. They pursue to be the first European coliving project with an EU ecolabel certification.

Hub House (2020) is a community where its members have shared interests (coliving, coownership, coworking, sustainable tourism), make decisions democratically and crowdfund their initiatives with three investment options: acquiring access for a set time per year, buying a certain space or investing to get dividends (Flavell, 2019).

Coliving – Sustainability – Circular economy

The “mother of all ecovillages” (Liftin, 2014), the *Findhorn Ecovillage* in Scotland is a UN-best-practice-renowned coliving community that focuses on sustainable and holistic living. It is also an example of the application of the circular economy, where its community uses the *Eko*, a local currency used by more than 60 local organizations and businesses, including educational institutions that promote sustainability. (Findhorn Exovillage, 2020) It is an important part of a network of community-led initiatives, also known as *intentional communities*, which have an important component of research and demonstration. (East, 2018)

Coliving – Rent-with-option-to-buy model

Models bridging the gap between renting and owning property include the Australian Assemble, a property development and community management company offering design, sustainability, and community considerations in their developments. Apart from traditional planning roles, their team has *public programming* and *community engagement* professionals as well as financial advisors. Part of the Rockefeller Foundation’s *100 Resilient Cities* program, *The Assemble Model* is an alternative supportive pathway to home ownership, which lets users live up to 5 years in their buildings experiencing the coliving environment, having financial advice and participating in the design phase before committing to buying. A 2-year period for construction and a 5-year period for renting are established with the rent amount in order to permit saving for the buying deposit. To accomplish this saving, aid is received from the financial services community management initiatives like bulk buying for daily consumption. (Assemble, 2020)

Coliving – Investing

Some spaces like Haven Coliving offer members the earning of vested shares depending on the duration of their stays in their own property, incentivizing the longer commitment with future profits (Flavell, 2019).

Coliving – Coworking

By offering high quality spaces of coliving and coworking with all kinds of amenities combined with culture programming and event production, The Collective has become a massive success with more than 9,000 units in important business districts of mayor global cities. This includes Old Oak, UK's largest coliving facility with 546 units in Canary Wharf 705. It offers stays from one night to 12 months, with unit prices lowering as the stay period increases until reaching a 20% less of rental prices of similar studios in the area. (WA Contents, 2019) (The Collective, 2020)

Coliving – Coworking – Travel

The concept of *worcation* involves these three areas and is already an important trend in the travel industry, in some degree incorporating the feel of urban space and urban culture in rural landscape:

Outsite (2020) is a company providing coliving and coworking spaces around the world designed for *digital nomads*, a market of 4.8 million. For investors, including various venture capital entities, they offer an increase of up to 50% through "innovative marketing, management technology, and brand", as they develop and operate the spaces in top urban or close-to-natural-attractions destinations with benefits for its members and groups, like a networking environment and corporate retreats.

Unsettled (2020) has a similar scheme, offering retreats for personal and professional growth in global touristic locations which are not necessarily owned. The *Unsettled Global Passport* provides monthly access to a membership to stay in the different locations in *experiences*, where a series of events is programmed, and participants network in an experimental living and working environment for independent professionals. It is intended to foster a lasting community.

Selina (2020) offers wellness, co-work, and *experiences* to travel or stay indefinitely in more than 60 destinations from off-the-grid locations to *global* cities. The price range is wide, and discounts and membership can be obtained through its app.

Roam (2020) also has international locations, with weekly prices starting from $500.

Coliving – green tourism

Coliving and green tourism can both contribute to fostering wellbeing and mental health affections caused by the isolation provoked by remote connectivity.

Sustainability – Investment – Travel

The Chilean ZeroCabin (2020) sells, delivers worldwide, and installs prefabricated, fully auto-sufficient (zero impact) cabins in the wild. Additionally, there is the possibility of joining a tourism network of rental cabins, in which the company does the property management of the acquired product.

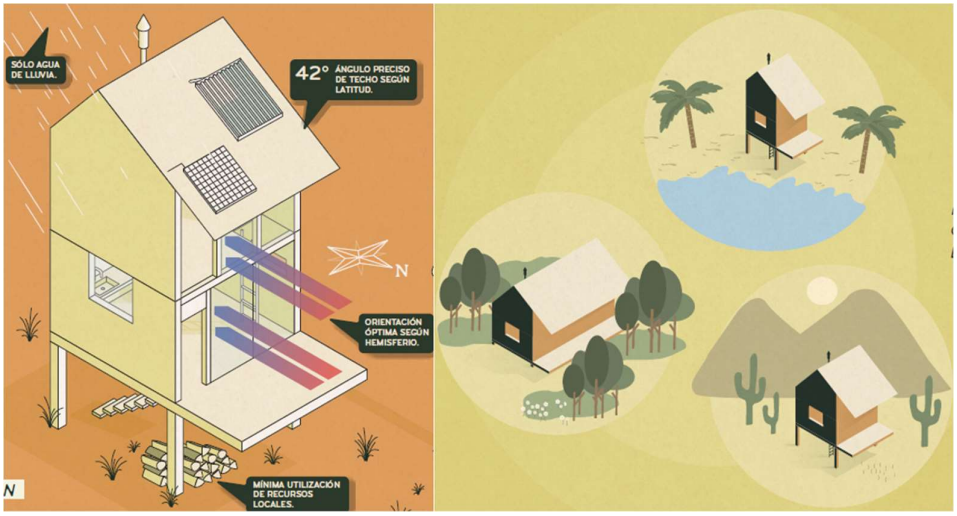

Figure 25: Zero impact cabins and tourism network (ZeroCabin, 2020)

Containerly lets members own and rent normally, but there's also a *share member option* in which a fixed number of nights per year are exchangeable with other locations or for rental income (Flavell, 2019).

In the *co-retreat* (from “cooperative”) concept of Kasaba (2020) the investors of a cabin village / retreat center can either make use of the property, share the rental profits managed by the company or own a part as a timeshare. Kasaba currently uses services like AirDNA to illustrate the short-term rental market, but could henceforth benefit from deeper insights in market potential (Flavell, 2020).

Travel – Alternative economy

Home exchange or *house swapping* can be seen as part of a “Collaborative Consumption” model, where no monetary transaction takes place (Forno & Garibaldi, 2013). This concept also implies lower environmental impact derived from the usage of existing resources.

Home Exchange (2020) is a platform for people to exchange each other’s houses in different parts of the world, charging an annual $150 fee for unlimited exchanges. The clients’ profiles are gathered in relation to travel age, education level, interests, etc. to facilitate the search and interchange. Other popular platforms are Love Home Swap, Home Link and Third Home for the luxury sector.

4.2 Discussion

The technological advances of the current I4 era become intrinsic to a great part of our daily lives, to the point that most probably, Fin*Tech*, Legal*Tech*, Prop*Tech*, etc. will be outdated terms since the technology available since the *digitalization* times of the I3 will come as a default in all branches of industry.

Overall, in the real estate sector, the fast advances in technology are reflected at a slower pace than in other fields, which can be explained by the particular complexity of its multidisciplinary nature and the impossibility to standardize it. Real estate valuation depends on many objective and measurable variants but ultimately, as a unique selling product, is very dependent on personal perception and human interactions. Of course, the measurable data provides the foundations to elaborate studies on, but the ultimate decisions on investments and transactions depend heavily on subjective feeling of the brokers and shareholders, especially given the still large flaws in accuracy of the most popular home valuation estimation tools. A common

opinion among many analysts is that the human component of personal relations is of the utmost importance in the whole real estate environment and therefore irreplaceable by technology.

As the recent history has shown, there are cycles characterized by world events that lead to economic crisis roughly every decade, the latest of these being caused by COVID-19 and before that the financial crisis of 2007-2008. Despite the uncertainty in all global markets, in times like this innovation tends to develop from the new arising challenges, and therefore it is expected that it will play an important role in the economic recovery of the following years. This is proven by the acceleration of digitalization and trends like diversification and flexibility prompted by the pandemic, which in the eyes of many analysts, are currently having an increasing importance.

Investing in RECF entails risk as every other investment venture but is regarded as a good option for starters, basically because of the low amounts required. The possibilities are many depending on the variables inherent to any real estate project, the kind of RECF investment, and the reputation of the platform itself. In any case it is a good option to achieve the diversification that every investor seeks.

RECF 2.0 should become much more prevalent in the coming years if Gilder and Weikal's prognostics are correct regarding the blockchain-cryptocurrencies disruption potential. As for non-monetary transactions for example in a coliving environment or in home-swapping, blockchain could also be implemented.

The limitations of RECF and some of the criticism it faces are understandable and can be excused on the short history of the concept, and by the same logic expected to diminish as the products refine. RECF has become an important player in the industry, but it is currently very limited to urban environments and traditional residential and commercial developments, since the data to make financial decisions, the building resources and the market are more concentrated in the cities. From the previous analysis, there does not seem to be significant interest in rural RECF, at least to offer in public markets. There are initiatives though, which use crowdfunding in rural locations, but are done by particular interest groups for own purposes, not for investment or lending. Until the rural locations have more amount of data and physical accessibility, it is expected that the same technology used at the moment in urban contexts will reach them. Regarding investment opportunities in the rural areas, the

risks associated to this kind of property can be higher than those of urban areas, due to factors like less availability of information and more difficulty to reach.

Flexibility is already regarded as a top quality and priority in real estate, in terms of ownership forms, mobility within living spaces and remote work. It can be argued that the most productive work model would be hybrid in terms of space, like half a week WFH, given the economic uncertainties affecting the office sector.

Due to the rising concerns about privacy and security, and given the overwhelming for some presence of technology in all aspects of our lives, there is also an opposition to an hyper-digitalization which could be counterproductive in the case of tourism when the customers look precisely to escape from the hectic daily life. On the other hand, IoT and language robotics can be even more useful in the case of remote locations where there is no easy access, and check ins and outs, to name an example of domotics application, can already be done without human intervention.

As the results from the research show, there are many ways in which the real estate, finance and travel industries can collaborate, and the business models combining services from these areas that can be generated are countless. There needs to be corresponding market demands at the right moment though, because in an ever-changing market the present niches may either gone or become mainstream in the future.

There can be many kinds of adversities for the companies in the real estate sector. For starters or unexperienced, the analytics to identify opportunities or other tasks can be outsourced or done with less complex methods like web scrapping which are not necessarily very expensive. It can be difficult to acquire tech talent, since it is scarce and bigger companies are in better position of hiring it.

In the development of an unconventional RECF product, in opposition to a regular urban project, a kind of joining element of cohesion in the idea explained in a concise manner should exist in order for a *crowd* to fund a project. Other methods of funding, on the one hand company shares for investors, and subscription to temporary housing services where clients buy a membership or pay a rent, can also be good options. The income can come from sales or rental from in-house property management, in such case the RECF operating as the PM, as seen in some previous examples. To be

corroborated by market research, promising markets could be the slow travel, sustainable tourism or second homes-coliving instead of permanent residency.

In a mixed model for RECF, the investor could also be a buyer or become one after some period following the idea behind the rent-to-buy model, in this case *invest-to-buy*, where investment and rent could also be flexible. A variation of the regular RECF model is illustrated in Figure 26:

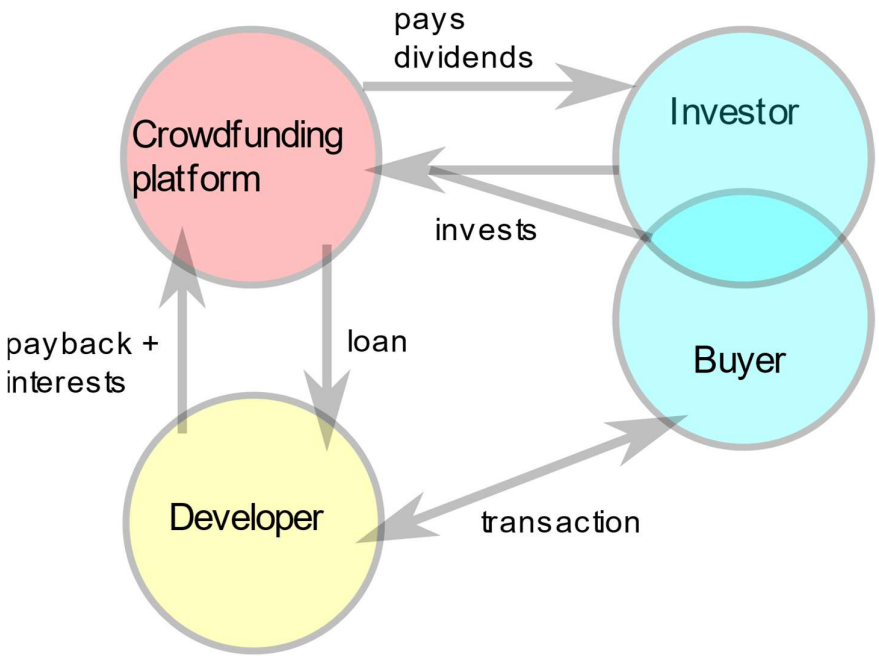

Figure 26: Mixed business model of a RECF platform (by author)

Since the segment of the population which would consider moving outside the city is people in their 40s upwards, and millennials are still very much attached to the city, it generally makes sense keeping non-urban destinations more oriented to permanent coliving for the older segment and more travel-oriented for the younger one. As stated before, market studies for ventures in these locations should include accessibility from urban areas or transportation nodes.

5. CONCLUSION AND RECOMMENDATIONS

The study covered many topics as it was ongoing, of which the relevance of each is variable in answering the formulated questions. The topics are closely related and therefore it is easy to drift among them, but as an outlook, it can be said that the expectations were fulfilled by understanding the processes with which the observed instruments and tools (ICT, RECF) work in the studied fields (RE, ST), although the results were not as expected in the first moment. Regarding the question of whether RECF developments can be carried out in rural areas, there were really no examples found of actual RECF platforms exactly operating outside of urban environments, but from personal opinions and feedback from interviewees there does not seem to be a valid reason for this other than a lack of data and interest in the market. To this it can be argued that as long as the product does not exist, the market will not be able to assess its appeal. When that moment comes, though, its success will depend on the feasibility and virtues of the projects and the reach they have to the public. More time would be needed to assess from a wider scope of experiences involving RECF in rural or even off-the-grid examples.

As for RECF, from the observations in more than one-year period, there seems to be an ongoing interest. Unfortunately, this particular moment in time will not be the best for both the real estate and tourism sectors, but as has been stated before, difficult times often bring innovation that we could look forward to.

Recommendations

RECF is popular among novel investors, but given the existing critiques, these platforms could develop more appealing schemes for experienced investors. Depending on their target group, perhaps a more serious-looking public image could be tried, as some of them do have rather informal looks in their UIs. Most of the inconveniences of RECF stated above in Limitations (risk in payments, illiquidity, low diversification) are difficult to overcome while the sector is still in its early stage, but some of them, like having direct communication with the sponsors, could be easy to overcome.

Real estate developers could be more aware of this relatively new form of financing. An increase in their demand would also raise the amount of RECF supply, which would render more competitive products. Until now the developers really do not have much very big an advantage in getting loans from RECF as opposed to banks.

In academia these topics could also have more weight in the Architecture and Engineering fields, especially the analytics applied to property search and urban and demographics metrics.

Future research could consider how could PropTech and Crowdfunding contribute to more regenerative or responsible projects.

Declaration of Authorship

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

31.10.2020 

Date Signature of the student

References

100 Ladrillos, 2020. *¿Cómo calculamos el rendimiento de tu inversión en 100 Ladrillos?.* [En línea]
Available at: https://blog.100ladrillos.com/rendimiento-de-tu-inversion/
[Último acceso: 11 August 2020].

4S , 2020. *For an understanding Urban Future.* [En línea]
Available at: https://4srealestate.com/
[Último acceso: 26 July 2020].

AirDNA, 2020. *Vacation Rental Data to Set You Apart. Insights to Keep You Ahead..* [En línea]
Available at: https://www.airdna.co/
[Último acceso: 12 August 2020].

Almenr, 2018. *Digital platform.* [En línea]
Available at: https://www.youtube.com/watch?v=nMpTYVo8rvs
[Último acceso: 24 April 2020].

Almenr, 2020. *Almenr.* [En línea]
Available at: https://www.almenr.dk/
[Último acceso: 1 June 2020].

Alois, J., 2018. *Real Estate Platform StraightUp Merges with Slice – a Blockchain based Cross Border Investment Site.* [En línea]
Available at: https://www.crowdfundinsider.com/2018/06/135512-real-estate-platform-straightup-merges-with-slice-a-blockchain-based-cross-border-investment-site/
[Último acceso: 5 March 2020].

Alois, J., 2020. *Wefunder Reports Significant Growth in Spite of COVID. March, April and May Have Been Biggest Months Ever.* [En línea]
Available at: https://www.crowdfundinsider.com/2020/06/162696-wefunder-reports-significant-growth-in-spite-of-covid-march-april-and-may-have-been-biggest-months-ever/
[Último acceso: 20 June 2020].

Amos, D., 2020. *A Practical Introduction to Web Scraping in Python.* [En línea] Available at: https://realpython.com/python-web-scraping-practical-introduction/ [Último acceso: 29 August 2020].

Andreevska, D., 2018. *The Power of Predictive Analytics in Real Estate Investing.* [En línea]
Available at: https://www.mashvisor.com/blog/power-predictive-analytics-real-estate-investing/
[Último acceso: 6 July 2020].

Ángel from Briq, 2020. *Email to Alejandro Gómez Re: [Article: "¿Cómo contactar al equipo de briq.mx?"].* s.l.:s.n.

Anghel, I. & Hristea, A. M., 2015. Some considerations regarding the international real estate market – present and future predictions. *Procedia Economics and Finance,* Volumen 32, p. 1442 – 1452.

Anton & Irene + Space10, 2020. *One Shared House 2030.* [En línea] Available at: http://onesharedhouse2030.com/resources/ [Último acceso: 6 August 2020].

Assemble, 2020. *Resilient communities in homes built to last.* [En línea] Available at: https://assemblecommunities.com/ [Último acceso: 8 August 2020].

Assemble, 2020. *The Assemble Model presentation | 15 Thompson St,* Melbourne: Assemble.

Attia, S., 2017. Design Principles of Regenerative Design. *Regenerative and Positive Impact Architecture,* pp. 19-32.

Avellan, C., 2020. *Email to Alejandro Gómez Re: CHAOS Essentials™ | Request.* s.l.:s.n.

Azati, 2019. *Artificial Intelligence (AI) and Machine Learning for Real Estate.* [En línea] Available at: https://azati.ai/artificial-intelligence-and-machine-learning-for-real-estate/ [Último acceso: 21 March 2020].

Babich, N., 2018. *A Comprehensive Guide To Product Design.* [En línea] Available at: https://www.smashingmagazine.com/2018/01/comprehensive-guide-

product-design/
[Último acceso: 23 February 2020].

Bae, J.-W. & Kim, Y.-W., 2008. Sustainable Value on Constructioon Projects and Lean Constructiion. *Journal of Green Building,* 3(1), pp. 156-167.

Baldominos, A. y otros, 2018. Identifying Real Estate Opportunities Using Machine Learning. *Applied Sciences,* p. 24.

Barkham, R., Bokhari, S. & Saiz, A., 2018. *Urban Big Data: City Management and Real Estate Markets,* Cambridge: CBRE | MIT Center for Real Estate and DUSP.

Basu, S., Saha, T. R. & Maity, S. K., 2018. Implications of Cryptocurrency: A New Business Proposition of Today's Entrepreneurial Horizon. *International Journal on Recent Trends in Business and Tourism,* 2(3), pp. 64-70.

Baum, A., 2017. *PropTech 3.0: the future of real estate,* Oxford: Saïd Business School, University of Oxford Research.

Baum, A., 2020. *PropTech 2020: the future of real estate,* Oxford: Saïd Business School, University of Oxford Research.

Blank, L., 2020. *Fundrise Review: Invest in Real Estate with Only $500.* [En línea] Available at: https://wellkeptwallet.com/fundrise-review/
[Último acceso: 30 March 2020].

Block, I., 2019. *IKEA is bringing its low-cost modular housing units to the UK.* [En línea] Available at: https://www.dezeen.com/2019/06/26/ikea-build-low-cost-housing-uk/
[Último acceso: 5 June 2020].

Bloom, N., Liang, J., Roberts, J. & Ying, Z. J., 2015. Does working from home work? Evidence from a chinese experiment. *The Quarterly Journal of Economics,* pp. 165-218.

Blum, H., 2019. *¿Qué es y cómo funciona 100 Ladrllos?* [Entrevista] (13 December 2019).

BNY Mellon, 2020. *BNY Mellon ESG Analytics.* [En línea] Available at: https://www.bnymellon.com/us/en/what-we-do/investment-services/asset-servicing/esg-analytics.jsp
[Último acceso: 13 September 2020].

Bogdanova, O., 2018. *Real estate crowdfunding in Finland: the drivers of campaign success and the.* s.l.:Saimaa University of Applied Sciences.

Botsam, R., 2017. *How the Blockchain is Redefining Trust.* [En línea] Available at: https://www.wired.com/story/how-the-blockchain-is-redefining-trust/ [Último acceso: 7 May 2020].

Bricks & People, 2020. *Inversiones Inmobiliarias Online.* [En línea] Available at: https://www.bricksandpeople.com/ [Último acceso: 26 March 2020].

Bricksave, 2020. *Real estate investing made easy.* [En línea] Available at: https://www.bricksave.com/ [Último acceso: 28 August 2020].

Briq, 2020. *Invierte en bienes raíces.* [En línea] Available at: https://www.briq.mx/ [Último acceso: 3 October 2019].

Bryant, S., 2020. *REITs vs. Real Estate Crowdfunding.* [En línea] Available at: https://www.investopedia.com/articles/personal-finance/071015/reits-vs-real-estate-crowdfunding-how-they-differ.asp [Último acceso: 20 February 2020].

Calabrese, L., 2020. *Hope Rises on Its Current: Defining Biophilia* [Entrevista] (5 October 2020).

Cambridge Center for Alternative Finance, s.f. s.l.: s.n.

Camilleri, M. A., 2018. *Travel Marketing, Tourism Economics, and the Airline Product. An Introduction to Theory and Practice.* Cham: Springer.

Castellar, J., 2020. *Email to Alejandro Gómez Re: Research questions.* s.l.:s.n.

Caulfield, J., 2020. *How to do thematic analysis.* [En línea] Available at: https://www.scribbr.com/methodology/thematic-analysis/ [Último acceso: 15 May 2020].

CB Insights, 2015. *Where Are The Top Smart Money VCs Investing In Real Estate Tech?.* [En línea]

Available at: https://www.cbinsights.com/research/smart-money-vcs-real-estate-tech/ [Último acceso: 24 August 2019].

CBRE, 2020. *Plans Pro. CBRE's Enterprise Test Fitting and 3D Visualization Tool.* [En línea]
Available at: https://www.cbre.com/about/tech-vantage/plans-pro [Último acceso: 5 July 2020].

CBRE, 2020. *Real Estate Tech. Flexibilidad y Resiliencia frente al COVID-19,* Madrid: CBRE.

Cervo House, 2020. *Acharming village house with warmth and views.* [En línea] Available at: https://cervo.house/ [Último acceso: 5. July 2020].

Chaillou, S., Fink, D. & Gonçalves, P., 2017. Urban Tech on the Rise: Machine Learning Disrupts the Real Estate Industry. *Field Actions Science Reports,* 31 December, Issue 17, pp. 38-43.

Chaos, 2020. *The urban forecasting company.* [En línea] Available at: https://chaosarchitects.com/ [Último acceso: 5 June 2019].

Chegut, A., 2016. *The Value of Innovation in Affordable Housing,* Cambridge: MIT.

Chegut, A., Eichholtz, P. & Holtermans, R., 2016. *Energy Efficiency and Economic Value in Affordable Housing.* Cambridge: MIT Center for Real Estate.

Chegut, A., Eichholtz, P. & Kok, N., 2015. *The Price of Innovation: An Analysis of the Marginal Cost of Green Buildings.* Cambridge: Center for Real Estate, MIT.

Chegut, A. & Langen, M., 2019. *The Financial Impacts of Coworking. Rental Prices and Market Dynamics in the Commercial Office Market.* Cambridge: Massachusetts Institute of Technology (MIT) | Maastricht University.

Chen, A.-j., Han, Y. & Tan, X., 2011. Analysis of Tourism and Landscape Engineering on Real Estate Impact Based on Correlation. *Systems Engineering Procedia,* Volumen 1, pp. 286-293.

Chiarazzo, V., Caggiani, L., Marinelli, M. & Ottomanelli, M., 2014. A Neural Network based model for real estate price estimation considering environmental quality of property location. *Transportation Research Procedia,* Volumen 3, p. 810 – 817.

Co-Liv, 2019. *CO-LIV.* [En línea] Available at: https://www.co-liv.org/ [Último acceso: 8 August 2020].

Common, M., s.f. [Entrevista] s.f.

Companisto, 2020. *Companisto Investment Club.* [En línea] Available at: https://www.companisto.com/en [Último acceso: 2019].

Conscious Coliving, 2020. *The Conscious Coliving Manifesto.* [En línea] Available at: https://www.consciouscoliving.com/the-manifesto/ [Último acceso: 2 August 2020].

CREST, 2017. *Trends & Statistics,* Washington: Center for Responsible Travel.

CrowdStreet, 2020. *Diversify your portfolio by investing online in commercial real estate..* [En línea] Available at: https://www.crowdstreet.com/ [Último acceso: 16 August 2020].

Daley, S., 2020. *17 blockchain companies boosting the real estate industry.* [En línea] Available at: https://builtin.com/blockchain/blockchain-real-estate-companies [Último acceso: 11 April 2020].

Deloitte Center for Financial Services, 2019. *2020 Commercial Real Estate Outlook,* s.l.: Deloitte Insights.

Die Bundesregierung, 2017. *Für bezahlbare Mieten unverzichtbar.* [En línea] Available at: https://www.bundesregierung.de/breg-de/aktuelles/fuer-bezahlbare-mieten-unverzichtbar-430250 [Último acceso: 8 August 2020].

East, M., 2018. Current thinking on sustainable human habitat: the Findhorn Ecovillage case. *Ecocycles,* 4(1), pp. 68-72.

Eden, T., 2020. *Videocall with Alejandro Gómez.* s.l.:s.n.

El Alamy, B., 2020. *Throwback Q1. CEO of Equisafe.* s.l.:s.n.

El Shiaty, R., Taalab, M. & Osama, I., 2016. Evaluating the Performance of the Healing Spaces in Outdoor Eco-Tourism. *Procedia Environmental Sciences,* Volumen 34, p. 461–473.

Elfahham, Y., 2019. Estimation and prediction of construction cost index using neural networks, time series, and regression. *Alexandria Engineering Journal,* 58(2), pp. 499-506.

Enodo, 2020. *Analyze Any Property with Unparalleled Data.* [En línea] Available at: https://www.enodoinc.com/data_api.html [Último acceso: 22 August 2020].

Enodo, 2020. *Welcome to Enodo, an AI-Assisted Underwriting Platform for Multifamily..* [En línea] Available at: https://www.enodoinc.com/ [Último acceso: 28 August 2020].

Erikssonn, E., 2014. *What is Product Design?.* [En línea] Available at: https://medium.com/@ericeriksson/what-is-product-design-9709572cb3ff [Último acceso: 09 12 2019].

Esri, 2018. *The Science of Where. Putting AI and Location Intelligence to Work,* Redlands: Esri.

Esri, 2020. *Real Estate Webinar Series.* [En línea] Available at: https://www.esri.com/en-us/industries/real-estate/webinars [Último acceso: 6 March 2020].

eXp World Holdings, 2020. *The eXp Realty Solution.* [En línea] Available at: https://expworldholdings.com/overview/ [Último acceso: 2020].

FinancialSamurai, 2020. *18-Hour Cities: An Attractive Real Estate Investment Opportunity.* [En línea] Available at: https://www.financialsamurai.com/18-hour-cities/ [Último acceso: 15 August 2020].

Findhorn Exovillage, 2020. *Findhorn Exovillage. New Frontiers for Sustainability.* [En línea]

Available at: https://www.ecovillagefindhorn.com
[Último acceso: 7 July 2020].

Flavell, K., 2019. *Will co-buying be the new co-living?.* [En línea] Available at: https://medium.com/@keren.flavell/will-co-buying-be-the-new-co-living-53a34e1239dc
[Último acceso: 7 August 2020].

Flavell, K., 2020. *Email to Alejandro Gómez Re: Hello from KASABA.* s.l.:s.n.

Forno, F. & Garibaldi, R., 2013. *My House is Yours - A Worldwide Study on Home Exchangers' Profiles and Motivations.* [En línea] Available at: http://homeex-ux.s3.amazonaws.com/affinities/1/pdf/homeexchange_bergamo_study_2013_EN.pdf
[Último acceso: 25 March 2020].

Founder, S., 2020. *Accelerators: friend or foe?.* [En línea] Available at: https://sifted.eu/articles/accelerators-pros-cons/
[Último acceso: 22 February 2020].

Friedberg, B., 2019. *7 Top Real Estate Crowdfunding Platforms.* [En línea] Available at: https://money.usnews.com/investing/real-estate-investments/slideshows/best-real-estate-crowdfunding-platforms?onepage
[Último acceso: 27 August 2019].

Fundrise, 2020. *Quality assets. Low fees. Smart technology..* [En línea] Available at: https://fundrise.com/how-it-works
[Último acceso: 10 September 2020].

Garcia-Teruel, R. M., 2019. A legal approach to real estate crowdfunding platforms. *Computer Law & Security Review.*

Gershon, L., 2019. *Co-Living, the Hot New Trend of 1898.* [En línea] Available at: https://daily.jstor.org/co-living-the-hot-new-trend-of-1898/
[Último acceso: 10 August 2020].

Gilder, G., 2018. *Life after Google: The Fall of Big Data and the Rise of the Blockchain Economy.* Washington(DC): Regnery Gateway.

González Reverté, F., 2017. La investigación en el ámbito del turismo sostenible. *Oikonomics. Revista de economía, empresa y sociedad*, May, pp. 35-44.

Gorlick, A., 2020. *The productivity pitfalls of working from home in the age of COVID-19.* [En línea]
Available at: https://news.stanford.edu/2020/03/30/productivity-pitfalls-working-home-age-covid-19/
[Último acceso: 26 April 2020].

Goron, A., Ignat, S., Pavlova, S. & Schwoerer, V., 2020. *Women in PropTech,* s.l.: PropTech Bulgaria, PrEXCELerator Bulgaria.

Gretzel, U., 2011. Intelligent systems in tourism. A social science perspective. *Annals of Tourism Research,* 38(3), pp. 757-779.

Gretzel, U., Sigala, M., Xiang, Z. & Koo, C., 2015. Smart tourism: foundations and developments. *Electron Markets,* Volumen 25, pp. 179-188.

Guerrero, H., 2019. *Excel in Data Analysis. Modeling and Simulation.* Second ed. Cham: Springer Nature Switzerland AG.

Habx, 2020. *Habx Match,* Paris: Habx.

Han, J., Kamber, M. & Pei, J., 2012. *Data Mining. Concepts and Techniques.* 3rd ed. s.l.:Morgan Kaufmann.

Havrylchyk, O., 2018. *Regulatory framework for the loan-based crowdfunding platforms,* Paris: OECD Economics Department.

Holder, S., 2019. *The Largest Co-Living Building in the World Is Coming to San Jose.* [En línea]
Available at: https://www.bloomberg.com/news/articles/2019-06-07/why-san-jose-may-get-a-co-living-mega-project
[Último acceso: 5 August 2020].

HomeExchange, 2020. *HomeExchange: How does it work?.* [En línea]
Available at: https://www.homeexchange.com/p/how-it-works-en
[Último acceso: 26 March 2020].

Housers, 2020. *Frequent questions.* [En línea]
Available at: https://www.housers.com/en/faqs/investors
[Último acceso: 1 September 2020].

Howe, N., 2019. *Millennials And The Loneliness Epidemic.* [En línea] Available at: https://www.forbes.com/sites/neilhowe/2019/05/03/millennials-and-the-loneliness-epidemic/#5db9c6027676
[Último acceso: 8 August 2020].

Hub House, 2020. *shared live+work spaces for people going places with purpose.* [En línea]
Available at: https://hub.house
[Último acceso: 6 December 2018].

Hu, S., 2017. *Intelligent REITs in the information age.* Macau, 8th International Conference on Advances in Information Technology.

Ippolito, I., 2018. *7 limitations of real estate crowdfunding sites.* [En línea] Available at: https://www.therealestatecrowdfundingreview.com/7-limitations-of-real-estate-crowdfund
[Último acceso: 9 November 2019].

Ippolito, I., 2018. *Investing Myths Debunked: Residential Real Estate Wallops Stock Market in Groundbreaking New Study.* [En línea] Available at: https://www.therealestatecrowdfundingreview.com/post/2018/01/09/investing-myths-debunked-residential-real-estate-wallops-stock-market-in-groundbreaking-n
[Último acceso: 11 April 2020].

Ippolito, I., 2020. *Top 100+ Real Estate Crowdfunding Sites.* [En línea] Available at: https://www.therealestatecrowdfundingreview.com/top-100-sites-ranked-and-reviewed
[Último acceso: 6 March 2020].

John, B., Möller, A. & Weiser, A., 2016. Sustainable Development and Material Flows. En: *Sustainability Science. An Introduction.* Dordrecht: Springer, p. 222.

Jones Lang LaSalle IP, 2019. *European City Dynamics,* s.l.: Jones Lang LaSalle IP.

Jones Lang LaSalle, 2018. *Workplace. Powered by Human Experience,* s.l.: Jones Lang LaSalle IP.

Jordan, D., 2018. *Life Cycle Analysis and Facility Management, Metropolia UAS lecture notes.* Helsinki: s.n.

Jordà, Ò. y otros, 2017. *The Rate of Return on Everything, 1870–2015,* San Francisco: Federal Reserve Bank of San Francisco.

Kan, I., 2019. *Top 7 Real Estate Crowdfunding Platforms in 2019.* [En línea] Available at: https://hackernoon.com/top-7-real-estate-crowdfunding-platforms-in-2019-2f1312fe4e19
[Último acceso: 16 August 2019].

Kasaba, 2020. *Welcome to Kasaba.* [En línea] Available at: https://www.kasaba.co/
[Último acceso: 31 August 2020].

Kejriwal, S. & Mahajan, S., 2017. *Blockchain in commercial real estate. The future is here!,* s.l.: Deloitte Center for Finantial Services.

Kellert, S. R. & Calabrese, E. F., 2015. *The Practice of Biophilic Design.* s.l.:www.biophilic-design.com.

Kramer, B., 2001. *Strategic Risk Analysis for Real Estate Investors.* Alicante, ERES.

Kümmerer, K. & Clark, J., 2016. Green and Sustainable Chemistry. En: *Sustainability Science. An Introduction.* Dordrecht: Springer, p. 53.

Kurilyak, S., 2019. *Artificial Intelligence (AI) in Real Estate.* [En línea] Available at: https://blog.produvia.com/artificial-intelligence-ai-in-real-estate-c809f9606ee0
[Último acceso: 5 January 2020].

Leach, J., 2016. *Green care: contact with nature can improve mental health.* [En línea] Available at: https://www.open.edu/openlearn/health-sports-psychology/health/health-studies/mental-health/green-care-contact-nature-can-improve-mental-health}
[Último acceso: 9 May 2020].

Levy, N., 2020. *These cities were the top markets for 'iBuyers' like Zillow and Redfin in 2019.* [En línea] Available at: https://www.geekwire.com/2020/cities-top-markets-ibuyers-like-zillow-redfin-2019/
[Último acceso: 2 May 2020].

Liftin, K., 2014. *Ecovillages: Lessons for Sustainable Community.* Cambridge: Polity Press.

López Letón, S., 2020. *El éxodo inmobiliario que viene tras el virus: de la ciudad al campo.* [En línea]
Available at: https://elpais.com/economia/2020-05-01/el-exodo-inmobiliario-que-viene-tras-el-virus-de-la-ciudad-al-campo.html
[Último acceso: 3 May 2020].

López-León, S., 2019. *Compre un pueblo abandonado en España y dese prisa porque sube de precio.* [En línea]
Available at: https://elpais.com/economia/2019/01/04/actualidad/1546595862_297914.html
[Último acceso: 7 April 2020].

Lutz, M., 2019. *Lived Solidarity: Housing Co-operatives.* [En línea]
Available at: https://assemblepapers.com.au/2019/11/20/lived-solidarity-housing-co-operatives/
[Último acceso: 8 August 2020].

Lyons, R., 2020. *Are REITs (Real Estate Investment Trusts) a Good Long-Term Investment?.* [En línea]
Available at: https://investorjunkie.com/real-estate/is-reit-good-long-term-investment/
[Último acceso: 26 March 2020].

M2Crowd, 2020. *Preguntas frecuentes.* [En línea]
Available at: https://www.m2crowd.com/faq
[Último acceso: 6 September 2020].

Mällo, M., 2020. *Estonian startups continue to grow in the first quarter of 2020.* [En línea]
Available at: https://startupestonia.ee/blog/estonian-startups-continue-to-grow-in-the-first-quarter-of-2020
[Último acceso: 3 May 2020].

Mang, P. & Reed, B., 2013. Regenerative Development and Design. En: V. Loftness & D. Haase, edits. *Sustainable Built Environments.* New York: Springer, pp. 478-501.

Mansur, N., 2018. *Heat Map Analysis: Real Estate Investing.* [En línea]
Available at: https://www.mashvisor.com/blog/heat-map-analysis-real-estate/
[Último acceso: 27 May 2020].

Mao, Y. & Wu, W., 2011. *Fuzzy Real Option Evaluation of Real Estate Project Based on Risk Analysis.* s.l., Systems Engineering Procedia.

Maramganti, K. & Rajyalakshmi, N., 2019. The Role of Artificial Intelligence in Business Transformation. *International Journal on Recent Trends in Business and Tourism,* July.3(3).

MathWorks, 2020. *Deep Learning and Traditional Machine Learning: Choosing the Right Approach,* s.l.: MathWorks.

McCombes, S., 2020. *How to write a research methodology.* [En línea] Available at: https://www.scribbr.com/dissertation/methodology/ [Último acceso: 15 May 2020].

Mihalic, T., 2016. Sustainable-responsible tourism discourse - Towards 'responsustable' tourism. *Journal of Cleaner Production,* Volumen 111, pp. 461-470.

Miles, M. E., Netherton, L. M. & Schmitz, A., 2015. *Real Estate Development. Principles and Process.* Fifth ed. s.l.:Urban Land Institute.

MIT | SA+P, 2019. *Data Science in Real Estate. Online Short Course.* Cambridge: MIT | Center for Real Estate.

MIT, Get Smarter, 2020. *Data Science in Real Estae. Online Short Course,* s.l.: Massachusetts Institute of Technology - School of Architecture and Planning - Center for Real Estate.

Montgomery, N., Squires, G. & Syed, I., 2018. Disruptive potential of real estate crowdfunding in the real estate project finance industry: A literature review. *Property Management,* 36(5), pp. 597-619.

Mullis, B., 2017. *The growth paradox: can tourism ever be sustainable?.* [En línea] Available at: https://www.weforum.org/agenda/2017/08/the-growth-paradox-can-tourism-ever-be-sustainable/ [Último acceso: 1 April 2020].

Navarro, M. F., 2019. *México destaca como mercado para los fondos colectivos de bienes raíces.* [En línea] Available at: https://www.forbes.com.mx/mexico-destaca-como-mercado-para-los-fondos-colectivos-de-bienes-raices/ [Último acceso: 4 April 2020].

Nicolas, A. & Triana, M., 2020. *Revolution in Real Estate: Innovation in Disruption* [Entrevista] (23 April 2020).

Noox , 2020. *Castillo noox.* [En línea] Available at: https://www.nooxgermany.com/invierte [Último acceso: 26 February 2020].

OECD, 2018. *Tourism Trends and Policies 2018,* Paris: OECD Publishing.

Ohe, Y., Ikei, H., Song, C. & Miyazaki, Y., 2017. Evaluating the relaxation effects of emerging forest-therapy tourism: A multidisciplinary approach. *Tourism Management,* 62(October), pp. 322-334.

Osborne Clarke, 2018. *Future Proof Real Estate: Is the property sector ready for the 2020s?,* s.l.: Osborne Clarke.

Outsite, 2020. *Work anywhere. Live differently..* [En línea] Available at: https://www.outsite.co/ [Último acceso: 2 August 2020].

Patoka, J., 2020. *15 Best Crowdfunding Real Estate Companies.* [En línea] Available at: https://wellkeptwallet.com/companies-crowdfunded-real-estate/ [Último acceso: 15 July 2020].

PeerStreet, 2020. *How PeerStreet works.* [En línea] Available at: https://www.peerstreet.com/ [Último acceso: 16 August 2020].

Pimentel, D., 2018. *Blockchain Startup Slice Merges With Real Estate Platform StraightUp.* [En línea] Available at: https://blocktribune.com/blockchain-startup-slice-merges-with-real-estate-platform-straightup/ [Último acceso: 2 April 2020].

PropTech Switzerland, 2020. *Global Ecosystem of Proptech.* [En línea] Available at: https://www.proptechswitzerland.com/world-proptech-maps/ [Último acceso: 25 November 2019].

QualisFlow, 2020. *Data driven sustainability.* [En línea] Available at: https://qualisflow.com/ [Último acceso: 31 August 2020].

Ramboll Group A/S, 2019. *Sustainable buildings market study,* s.l.: s.n.

Realdax, 2020. *The Real Estate Data Dashboard gives you a one-stop shop to all your market and property search needs..* [En línea] Available at: https://www.realdax.com/real-estate-data/ [Último acceso: 21 April 2020].

RealtyMogul, 2020. *Invest in Real Estate.* [En línea] Available at: https://www.realtymogul.com/ [Último acceso: 16 August 2020].

Recaño, J., 2020. La despoblación que no cesa. *Dossieres EsF*, pp. 39-44.

Redfin, 2020. *Share of homes purchased by iBuyers.* [En línea] Available at: https://www.redfin.com/blog/ibuyer-real-estate-q4-2019/ [Último acceso: 20 July 2020].

REITs, 2020. *REITs. Real Estate Working For You.* [En línea] Available at: https://www.reit.com/ [Último acceso: 16 April 2020].

Republic, 2020. *Republic.* [En línea] Available at: https://republic.co/ [Último acceso: 21 March 2020].

Rex, 2020. *Everything you need to by or sell a home.* [En línea] Available at: https://www.rexhomes.com/ [Último acceso: 9 March 2020].

Roam, 2020. *About Roam Coliving.* [En línea] Available at: https://www.roam.co/about [Último acceso: 14 August 2020].

Sablono, 2020. *Digital Task Management for Complex Construction Supply Chains.* [En línea] Available at: https://www.sablono.com/ [Último acceso: 7 July 2020].

Saiz, A. & Salazar, A., 2017. *Real Trends. The Future of Real Estate in the United States,* Cambridge: MIT | Center for Real Estate.

Saliou, M., 2020. *Bilal el Alamy of Equisafe: We have chosen Tezos for its community, security, scalability and ability to adapt.* [En línea]
Available at: https://www.crowdfundinsider.com/2020/05/161418-bilal-el-alamy-of-equisafe-we-have-chosen-tezos-for-its-community-security-scalability-and-ability-to-adapt/?utm_content=130106528&utm_medium=social&utm_source=linkedin&hss_channel=lcp-13045333
[Último acceso: 3 June 2020].

Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research Methods for Business Students.* Fifth ed. Essex: Pearson Education Limited.

Schwab, K., 2018. The Fourth Industrial Revolution. *Encyclopædia Britannica*, 25 May.

Schwartz, M., 2020. *Review of Real Estate Crowdfunding Platform Brickstarter.* [En línea]
Available at: https://www.youtube.com/watch?v=2vGrztGCykM&list=WL&index=474
[Último acceso: 19 March 2020].

Seitz, P., 2018. *Artificial Intelligence Becoming Top Corporate Spending Priority.* [En línea]
Available at: https://www.investors.com/news/technology/artificial-intelligence-ai-spending/
[Último acceso: 31 July 2020].

Selina, 2020. *Unique Destinations Around the World.* [En línea]
Available at: https://www.selina.com/
[Último acceso: 11 August 2020].

Shahrokhi, M. & Parhizgari, A., 2019. Crowdfunding in real estate: evolutionary and disruptive. *Managerial Finance,* Ahead of print(Ahead of print).

Sirkin Law, 2016. *Clear and Complete Information from the Co-Ownership Experts.* [En línea]
Available at: https://andysirkin.com/
[Último acceso: 7 August 2020].

Skiena, S. S., 2017. *The Data Science Design Manual.* Cham: Springer.

Skyline, 2019. *Real Estate Investment Meets Artificial Intelligence.* [En línea] Available at: https://www.skyline.ai/
[Último acceso: 28 May 2020].

Snowden, E., 2019. *How Your Cell Phone Spies on You* [Entrevista] (23 October 2019).

Spacemaker, 2020. *Early stage planning. Re-imagined..* [En línea] Available at: https://www.spacemakerai.com/
[Último acceso: 3 April 2020].

Statista, 2020. *Crowdinvesting worldwide.* [En línea] Available at: https://www.statista.com/outlook/377/100/crowdinvesting/worldwide
[Último acceso: 11 April 2020].

Stewart, T., 2020. *How Blockchain Will Revolutionize Commercial Real Estate.* [En línea]
Available at: https://www.realcrowd.com/blog/2018/07/blockchain-will-revolutionize-commercial-real-estate-industry/
[Último acceso: 20 October 2020].

Stub, N., 2020. *Intro to the field: New Property Marketplaces.* [En línea] Available at: https://www.proptechdk.dk/proptech-insights/intro-the-field-of-new-market-places
[Último acceso: 26 May 2020].

Sulce, A., 2020. *The Python Mega Course: Build 10 Real World Applications.* [En línea] Available at: https://www.udemy.com/course/the-python-mega-course/
[Último acceso: 10 July 2019].

Sustainable Travel International & Mandala Research, 2017. *The Role of Sustainability in Travel & Tourism,* s.l.: Mandala.

Tan, Z., 2019. *Sequoia-backed Singaporean co-living startup Hmlet raises USD 40 million in Series B round.* [En línea] Available at: https://kr-asia.com/sequoia-backed-singaporean-co-living-startup-hmlet-raises-usd-40-million-in-series-b-round
[Último acceso: 4 August 2020].

Teuben, B. & Bothra, H., 2018. *Real Estate Market Size 2017—Annual Update on the Size of the Professionally Managed Global Real Estate Investment Market,* New York City: MSCI, Inc..

Teuben, B. & Bothra, H., 2019. *Real Estate Market Size 2018—Annual Update on the Size of the Professionally Managed Global Real Estate Investment Market,* New York City: MSCI, Inc..

Teuben, B. & Bothra, H., 2019. *Real Estate Market Size 2018—Annual Update on the Size of the Professionally Managed Global Real Estate Investment Market,* New York City: MSCI, Inc..

The Collective, 2020. *About the collective.* [En línea] Available at: https://www.thecollective.com/about-us [Último acceso: 5 July 2020].

Thomsen, M., 2020. *Email to Alejandro Gómez Re: Inquiry.* s.l.:s.n.

Thornton, B. J., 2011. The Greenest Building (is the one that you don't build!) Effective Techniques for Sustainable Adaptive Reuse/Renovation. *Journal of Green Building,* 6(1), pp. 1-7.

Tice, C., s.f. *Crowdfunding, Crowdinvesting, Crowdlending: Which Is Right for Your Small Business?.* [En línea] Available at: https://www.freshbooks.com/blog/crowdfunding-crowdinvesting-crowdlending [Último acceso: 2 October 2019].

Tjio, H. & Hu, Y., 2020. Collective Investment: Land, Crypto and Coin Schemes: Regulatory "Property". *European Business Organization Law Review,* Volumen 21, pp. 171-198.

UK Cohousing, 2020. *About Cohousing.* [En línea] Available at: https://cohousing.org.uk/about/about-cohousing/ [Último acceso: 6 August 2020].

United Nations, 2020. *Goal 11: Make cities inclusive, safe, resilient and sustainable.* [En línea] Available at: https://www.un.org/sustainabledevelopment/cities/ [Último acceso: 19 August 2020].

Unsettled, 2020. *Be Unsettled. Embrace the unknown.* [En línea] Available at: https://beunsettled.co/ [Último acceso: 4 December 2019].

UNWTO, 2018. *Annual Report 2017,* Madrid: World Tourism Organization.

Vacasa, 2020. *Vacation rental management.* [En línea] Available at: https://www.vacasa.com/real-estate [Último acceso: 25 March 2020].

Van den Berg, A. E., 2017. From Green Space to Green Prescriptions: Challenges and Opportunities for Research and Practice. *Frontiers in Psychology.*

Villanueva, A., 2020. *iBuyers: los nuevos protagonistas del mercado inmobiliario español* [Entrevista] (4 March 2020).

Vogel, J. & Moll, B., 2014. Crowdfunding for Real Estate. *Real Estate Finance Journal,* Issue summer-fall, pp. 5-16.

Voigt, K., 2020. *Rich Uncles Review 2020: Pros, Cons and How It Compares.* [En línea] Available at: https://www.nerdwallet.com/reviews/investing/brokers/rich-uncles [Último acceso: 4 September 2020].

WA Contents, 2019. *Reza Merchant of The Collective talks about communal living as a housing solution for big cities.* [En línea] Available at: https://worldarchitecture.org/architecture-news/ecnnh/reza-merchant-of-the-collective-talks-about-communal-living-as-a-housing-solution-for-big-cities.html [Último acceso: 20 August 2020].

Wearing, S., 2001. *Volunteer tourism: experiences that make a difference.* Oxford: CABI Publishing.

Weikal, S., 2020. *Exploring the Future of Real Estate* [Entrevista] (6 September 2020).

Wheaton, W. C. & Krasikov, A., 2019. *Will CoWorking Work?.* Cambridge: MIT Center for Real Estate | CBRE.

Wiencke, E., Madrazo-Lemarroy, P. & Reyna, L. E., 2019. How do investors invest in crowd-investing? A qualitative study in Mexico. *International Entrepreneurship Review,* 5(4), pp. 77-91.

Williams, G., 2020. *The Fancy Neighborhood of the Future Is an Earth-Friendly 'Intentional Community'.* [En línea]
Available at: https://www.bloomberg.com/news/features/2020-04-16/earth-friendly-intentional-communities-are-new-fancy-neighborhood
[Último acceso: 2 August 2020].

Woetzel, J., Rajadhyaksha, V. & Frem, J., 2018. *Thriving amid turbulence: Imagining the cities of the future,* Dubai: McKinsey & Company.

Wong, M., 2018. *The rise of real estate tech,* s.l.: CB insights.

Wood, H., 2017. *Co-living 2030: Are you ready for the sharing economy?.* [En línea]
Available at: https://archinect.com/features/article/150042590/co-living-2030-are-you-ready-for-the-sharing-economy
[Último acceso: 2 August 2020].

XYZ Reality, 2020. *Engineering Grade Augmented Reality.* [En línea]
Available at: https://www.xyzreality.com/
[Último acceso: 3 June 2020].

Yates, E., 2019. *3 Stages of an AI Project in Plain English.* [En línea]
Available at: https://towardsdatascience.com/3-stages-of-an-ai-project-in-plain-english-a4975c007cb5
[Último acceso: 06 April 2020].

Yin, X. y otros, 2020. A deep learning-based framework for an automated defect detection system for sewer pipes. *Automation in Construction,* Volumen 109.

ZeroCabin, 2020. *Donde quieras, vive la libertad de no tener cuentas, y no depender de nada, ni de nadie.* [En línea]
[Último acceso: 15 August 2020].

Zhao, H., 2018. *Artificial intelligence is the latest competition for real estate agents.* [En línea]
Available at: https://www.cnbc.com/2018/03/20/artificial-intelligence-the-latest-competition-for-real-estate-agents.html
[Último acceso: 22 March 2020].

Zikmund, W. G., Babin, B. J., Carr, J. C. & Griffin, M., 2010. *Business Research Methods.* Eighth ed. s.l.:South-Western Cengage Learning.

Zillow, 2020. *Why Aren't There More Homes for Sale?.* [En línea] Available at: https://www.zillow.com/resources/stay-informed/2020/07/06/why-is-housing-inventory-low/?utm_medium=organic-social-sm&utm_source=&utm_campaign=tw-econhousingshortage-7/9
[Último acceso: 3 August 2020].

Zipori, G., 2019. *The (Data) Science Of The Deal: How AI Will Transform Commercial Real Estate.* [En línea] Available at: https://www.forbes.com/sites/forbesrealestatecouncil/2019/01/23/the-data-science-of-the-deal-how-ai-will-transform-commercial-real-estate/#750937c54200
[Último acceso: 4 March 2020].

Zujo, V., Car-Pusic, D. & Zileska-Pancovska, V., 2014. Cost and Experience Based Real Estate Estimation Model. *Procedia - Social and Behavioral Sciences,* Volumen 119, p. 672 – 681.

Appendix

Other applications of Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP) and Natural Language Generation (NLG) in Real Estate

Generating Real Estate Listing Bios (ML using NLG), Commercial Property Segmentation (categorization with ML), Mortgage Backed Security Portfolio Analysis (ML to predict prepayments), Classification of Seller Score (ML), Predicting Time to Close (considering season and market cycles with ML), Predicting Time to Call (ML), Mortgage Fraud Detection and Prevention (ML), Title Defect Detection (or Cloud Detection), Title Fraud Detection (ML), and Title Insurance Policy Recommendations. (Kurilyak, 2019)

Enodo's Property Analytics

Table 6: Metrics available in the Enodo (2020) platform

Endpoint	API Name	Description
Name	Property	A properties advertised name, this is different than the street address
Company URL	Property	A properties website URL
Year Built	Property	The year in which construction was completed and units were available for rent.
Year Renovated	Property	The most recent year that substantial renovations were performed at the subject property.
Number Units	Property	The number of individual units present at the subject property.
Census Tract	Property	Statistical geographic areas within a county, typically including 1,200 to 8,000 residents.
Number Listing	Property	The number of times a specific property has been visited by Enodo
Is Multifamily	Property	Defines is a property is classified as multifamily residential
Number Floors	Property	The number of floors in a given building.
Street Address	Property	The address of a building comprising of the house number and street name.
City	Property	The city where a property is located.

State	Property	The state where a property is located.
Country	Property	The country where a property is located.
Latitude	Property	The geographic coordinate of the property.
Longitude	Property	The geographic coordinate of the property.
Parcel ID	Property	An ID assigned to parcels of property by the tax assessor of a particular jurisdiction for purposes of identification and record-keeping.
Property Type	Property	The classification of the subject property based on its physical construction. I.e. High Rise (10+ Floors), Mid-Rise (4-9 Floors).
Has Condos (Beta)	Property	Does the property have private residence owned by an individual or family?
Has Specials (Beta)	Property	Does the property offer any concessions?
Has Student (Beta)	Property	Does the property contain housing for students?
Has Affordable (Beta)	Property	Does the property contain affordable housing tenants? Housing is considered affordable if it costs about one-third or less of what the people living there make, and is regulated so the rent can't increase dramatically over time.
Unit Features	Property	Amenities or finishes within the individual units of the property.
Community Amenities	Property	Amenities or features within a property available to all tenants.
Property ID	Unit Type	Proprietary identification number used to assign unit types to a specific property.
Minimum Market Rent	Unit Type	The lowest recorded market rent for a given unit type within the last 30 days
Market Rent	Unit Type	Market rent is the advertised/asking rent detected from publicly available information or user uploaded rent roll.
Maximum Market Rent	Unit Type	The highest recorded market rent for a given unit type within the last 30 days
SqFt	Unit Type	Unit size (sqft) refers to the rentable square footage of the individual unit.
Bed	Unit Type	Number of bedrooms within the unit. Bedrooms defined as individual rooms with a closet. Dens are not counted as Bedrooms.
Bath	Unit Type	Number of bathrooms within the unit. Bathrooms defined as full-baths.
Half Bath	Unit Type	Number of half or partial bathrooms within the unit.
Frequency	Unit Type	The percentage of listings within the defined market area that have a particular community amenity or unit feature.
Count	Unit Type	The number of physical floorplans.
Number of Listings	Unit Type	The number of times a specific unit type has been visited by Enodo

Minimum Scrape Date	Unit Type	Defines the date range of information used to calculate the market rent for a unit type.
Maximum Scrape Date	Unit Type	Defines the date range of information used to calculate the market rent for a unit type.
Came from Property Website	Unit Type	Indicates if data was directly sources from the building website, this does not include data sources from listing sites.
Minimum Scrape Date	Units	Defines the date range of information used to calculate the market rent at a unit level.
Maximum Scrape Date	Units	Defines the date range of information used to calculate the market rent at a unit level.
Minimum Market Rent	Units	The lowest recorded market rent for a given unit within the last 30 days.
Market Rent	Units	Market rent is the advertised/asking rent detected from publicly available information or user uploaded rent roll.
Maximum Market Rent	Units	The highest recorded market rent for a given unit within the last 30 days.
Number of Listings	Units	The number of times a specific unit has been visited by Enodo
Came from Property Website	Units	Indicates if data was directly sources from the building website, this does not include data sources from listing sites.
Count of Listings	Market Statistics	The number of times a specific property has been visited by Enodo
Average Rent	Market Statistics	The average advertised rent of unit types located within the defined market area.
Median Rent	Market Statistics	Median advertised rent of unit types located within the defined market area.
Count of Units	Market Statistics	The number of times a specific unit has been visited by Enodo
Enodo Rent	Rent Prediction	The predicted rent that a unit can achieve based on the specific characteristics of the subject property and the defined market area.
Rent Breakdown - Base Rent	Rent Prediction	Base Rent represents the rental income value for simply being in a particular market (excluding building characteristics and amenities).
Rent Breakdown - Year Deviation	Rent Prediction	The impact of a property’s year built relative to the market.
Rent Breakdown - Community Amenities Deviation	Rent Prediction	The impact of a property’s community amenities relative to the market.
Rent Breakdown - Unit	Rent Prediction	The impact of a property’s unit features relative to the market.

Features Deviation		
Percentage of Total Operating Statement	Operating Expense Prediction	The percentage of predicted expenses off of a property's effective gross revenue.
Value per Unit	Operating Expense Prediction	The predicted expense value allocated to each unit of a property.
Value per NRSF	Operating Expense Prediction	The predicted expense value allocated to the net rentable size (sf) of a property.
Standard Error	Operating Expense Prediction	Confidence intervals are algorithmically defined based on the availability and density of data for a particular line item.
Value	Operating Expense Prediction	Average operating expenses based on properties in the same market with similar rent profiles, year built, number of units, and property type.
Gross Potential Revenue	Operating Expense Prediction	Derived from the annualized Enodo Rent.

RECF Ratings

Table 7: Selection of RECF platforms based on different rankings (by author)

United States															
100	https://www.therealestatecrowdfundingreview.com/top-100-sites-ranked-and-reviewed		14	https://wellkeptwallet.com/c		7	https://money.usnews.com/in		7		https://hackernoon.com/top-7-real-estate-crowdf				
	Peer Street	SBRE Funds (up-and-coming)		Fundrise			ArborCrowd				Fundrise	https://fundrise.com/			
	Crowd Street	9) Now Vacant		Rich Uncles: Student Housing / Con			RealCrowd				Realty Mogul	https://www.realtymogul.com/			
	FundThatFlip	10) Equity Multiple (up-and-coming)		PeerStreet			Groundfloor				CrowdStreet	https://www.crowdstreet.com/			
	1031 Crowdfunding	10) First Real Fund (up-and-coming)		RealtyMogul			CrowdStreet				Patch Of Land	https://patchofland.com/			
	Arbor Crowd	10) Yield Street (up-and-coming and investor complaints probation)		EquityMultiple			PeerStreet				RealtyShares	https://www.realtyshares.com/			
	Real Crowd	11) Realty Mogul (volume probation)		AlphaFlow			Small Change	socially conscic			RealCrowd	https://www.realcrowd.com/			
	Carlton Crowdfund	12) C.K. Mack (up-and-coming)		Fund That Flip			RealtyMogul				Fund That Flip	https://www.fundthatflip.com/			
	ShareStates	13) LendingHome (investor complaints probation)		CrowdStreet											
	Roofstock	14) (currently empty)		Senior Living Fund											
	Zeus Crowdfunding	15) Alpha Flow (up-and-coming)		Sharestates					4		Crowd Street				
		16) Currently vacant due to downgrade		Patch of Land					3+1		Realty Mogul				
		17) Holdfolio (up-and-coming)		DiversyFund							PeerStreet				
		18) CityVest (up-and-coming)		stREITwise					3		FundThatFlip				
non	https://www.thereal	19) Wilson Investment Properties (up-and-coming)		YieldStreet					3		RealCrowd				
Europe															
	https://jeangalea.com/best-european-real-estate-crowdfunding-sites/			https://factornerd.com/top-real-estate-crowdfunding-platforms-					2+1		Fundrise				
	Housers		lat	Housers	https://w	Au	Rendity								
	Property Planner		Est	Reinvest24	https://fe	Est	Crowdestate	https://crowdestate.eu/home							
	iFunded		UK	Property Planner		Est	Crowdestor								
Est	Crowdestate		UK	British Pearl		balt	Bulkestate								
	Bulkestate		UK	Brickowner		EU	EstateGuru	https://estateguru.co/							
			Lit	Profitus		Lat	Grupeer								
			UK	CapitalRise											
Mexico															
	https://www.m2crowd.com/										M2Crowd				
	https://www.briq.mx/proceso-selección										Briq				

Inquiries and Questionnaires

Emails were sent to different RECF platforms and other companies asking for more specific information. Following are the most relevant:

To Chaos Architects

…

I am currently in Mexico working on my thesis on the topic of IT and crowdfunding in real estate, so I would like to know if you are using any of this technologies (Data Analysis, Machine Learning, Web Scrapping, Neural Networks, etc.) and if you have experience with crowdfunding

…

To RECF Platforms

The following set of questions was sent to RECF platforms with some changes depending on the already available information of each recipient:

…

- From the location search to the sales, what is the extent the developer's involvement in the building project and which parts are you responsible for? Are the projects proposed only by the developers? Do you have some partnership with them or is it a service form your part?
- What kind of data analytics do you perform when looking for locations or property opportunities, and determining rates and prices? Do you do the analytics in-house or have it done by another specialized company? Do you use Machine Learning / Deep Learning / Neural Networks algorithms? What kind?
- What are the advantages of your financing for developers? Lower interest rates?
- Are rates of return for the investors fixed or do they vary in time?
- Are you incorporating blockchain and cryptocurrencies in the process?

- Have you considered or received applications for non-urban / touristic projects? How could an off-the-grid real estate investment be attractive? Is it not considered because of lack of data?
- What about coworking / coliving projects?
- Does the profit come just from sales or do you have rental options?

…

To Almenr

…

- Do you use some data analytics / AI services in processes like selecting locations and predicting costs or financial outcomes or is the process more traditional?
- I see you crowdfund the project phase, but in the external investors do you consider crowd investment as a source of construction founding?
- I am guessing you do the design and hire to build, is that correct?
- Are you open to handling cryptocurrencies and blockchain for transactions or smart contracts?
- Are the projects intended just for permanent living or could there be rental units for a sustainable tourism kind of thing?
- Do you intend to expand to other countries? If so, could there be a kind of home-swapping scheme?

…