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**Decentralized protocol systems in the Real
Estate sector:**

analysis of the opportunities and challenges

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*Decentralized protocol systems in the Real Estate sector:
Analysis of the opportunities and challenges*

Table of contents

ABSTRACT	7
1.0 – OVERVIEW. HOW THE WORLD’S ECONOMY IS EVOLVING	10
1.1 – THE ANTIFRAGILE VALUE OF REAL ESTATE	20
First scenario – Black Swan 1	25
Second scenario – Black Swan 2	26
Evidence from the reality	26
1.2 – REAL ESTATE FACING CHANGES	30
Room for improvement	30
Value creation	35
Brief findings	39
2.0 – THE TECHNOLOGY THAT ENABLES CHANGE	41
2.1 - DLT Distributed Ledger Technology	41
2.2 - P2P Peer to peer technology	43
2.3 – DATA STORAGE	45
Blocks	45
Hashing	45
Data storage	45
2.4 – DATA INTEGRITY	46
Cryptography	46
Permissions	48

2.5 – STRUCTURAL ELEMENTS	50
Tokens	50
Smart contracts	51
Property passports	53
2.6 – FINAL REMARKS	54
Blockchain as an exchange or production technology	54
3.0 – THE CHALLENGE OF DECENTRALIZATION	55
3.1 - Forms of decentralization	57
Immutability	58
3.2 – Risks of decentralization	60
3.3 – Limitations and challenges to overcome	62
Governance and regulatory	62
Permissioned vs. public infrastructures	64
Storage of records	66
Scalability of the technology	67
Liquidity creation	69
3.4 ACTORS AND THEIR BEHAVIORS	73
Appraisers	75
Agents and brokers	76
Notaries	77
Critical considerations	78
3.5 – CHALLENGES: FINAL REMARKS	79
4.0 – IMPLEMENTATION OF THE TECHNOLOGY	81
4.1 – DRIVERS FOR ADOPTION	81
4.2 – BARIERS TO ADOPTION	84
Social barriers	86
Technological barriers	87
Regulatory barriers	87
4.3 – Cost of implementation	90

4.4 – Gradual rollout	93
The value of disruption	95
Short-term implementation	97
Implementation trials	99
Integrated property listing services	101
Automated transaction processes	101
Real Estate Marketing	102
Cross-border payments	102
Real Estate Units rental services	103
Digital ID Blockchain solutions	103
Smart contracts for Real Estate applications	104
Analytical services	104
Land titles and land registry	105
Real Estate conveyancing process	105
Mortgage through asset-backed NFT securities	106
Tokenization of Real Estate securities	106
Real Estate investments	107
Property management	107
Brief summary	108
5.0 – Outline conclusions	109
Possible outbreaks	109
Asset Quality Review (AQR)	110
Selection of the debtor pool	112
Determination of the Fair Value	112
Results	114
BIBLIOGRAPHY	115
Institutional and reports	115
Articles and websites	125
Definitions	130
Other cited sources	131
TABLE OF FIGURES	132

Abstract

The preparation of this Final Thesis work moves its foundations by trying to offer a critical outlook at the state of the arts as regards the technology linked to the decentralization of financial, legal and regulatory processes within the commercial Real Estate market, and the implications that social dynamics, market players and ongoing processes would have on their adoption. The very limits posed by the implications of the social sphere are those which seem to establish the greatest obstacles to their diffusion, represented by public trust, identities of the users, privacy and sensitive data storage, the confidence with the technology and the change of the work scope.

Having said that, flexibility and the ability to adapt to a profound and irreversible tilting of the Real Estate systems in society will be indispensable, but with the awareness that the human factor is an irreplaceable component of the process and that the very combination of soft and hard skills make it so.

Although the promises of industry experts are the most golden and the hypothetical benefits achievable through the use of peer-to-peer networks, Distributed Ledger technologies, Blockchain platforms and the ways in which to create the liquidity necessary to move commercial operations seem to lead to large and rapid developments for the sector. The concept of decentralization itself poses a series of challenges compared to the traditional paradigms through which Real Estate conveyance and management processes currently take place:

- the degree of application of decentralization and the management of related risks;
- the governance and regulatory context;
- the scalability of the infrastructure;
- the choice between the implementation of an open permissionless system or closed and permissioned, as well as their authorization by the central government bodies;
- the transition from a traditional finance mediated by various subjects to a decentralized one in which the notion of trust is placed among the network;
- not least, who has to finance and bear the costs necessary to support the development required for the coordinated implementation of decentralized systems.

All this keeping always in mind that the essential driver for all stakeholders to become involved and collaborate in the construction of such a revolutionary ecosystem is that it is truly capable of generating value and that this ability is widely recognized by the majority of them.

Attraverso la redazione del presente Elaborato di Tesi Magistrale muove le sue basi cercando di offrire uno sguardo critico allo stato dell'arte per quanto concerne la tecnologia Blockchain, legata alla decentralizzazione dei processi finanziari, legali e normativi, all'interno del perimetro rappresentato dal mercato immobiliare commerciale, e le implicazioni che le dinamiche sociali, gli attori coinvolti e i processi in corso avrebbero sulla loro ampia adozione. Proprio i limiti posti dalle implicazioni sociali sono quelli che sembrano stabilire i maggiori ostacoli alla sua potenziale diffusione, rappresentati dal capovolgimento del concetto di fiducia, dalle identità degli utenti, dalla privacy e dalla conservazione dei dati sensibili, dalla confidenza con la tecnologia e dal cambiamento nel work scope professionale.

La flessibilità e la capacità di adattarsi a un profondo e irreversibile capovolgimento dei processi dinamici del settore immobiliare e dal loro rapporto con la società saranno indispensabili, ma con la consapevolezza che il fattore umano sarà una componente insostituibile del processo, resa tale dalla combinazione di competenze personali ed esperienziali complesse.

Sebbene i dialoghi degli esperti del settore digitale sostengano che gli ipotetici benefici eccederanno il prezzo di tale rivoluzione, il concetto stesso di decentralizzazione pone una serie di sfide rispetto ai tradizionali paradigmi attraverso i quali avvengono attualmente i processi di transazione e gestione del patrimonio edificato; in particolare saranno coinvolti:

- il grado di applicazione della decentralizzazione e la gestione dei rischi connessi;
- il contesto di governance e normativo;
- la scalabilità dell'infrastruttura;
- la scelta tra l'implementazione di un sistema aperto o chiuso, così come la loro autorizzazione da parte degli organi centrali di governo;
- la transizione da una finanza tradizionale mediata da vari soggetti concreti ad una decentralizzata in cui la nozione di fiducia è riposta nella rete digitale;
- infine, il finanziamento e la sostenibilità dei costi necessari a sorreggere lo sviluppo necessario all'implementazione coordinata delle piattaforme decentralizzate.

Tutto questo tenendo sempre presente che il driver abilitante alla rivoluzione dell'ecosistema immobiliare è comprendere se la nuova struttura tecnologica sia veramente capace di generare valore e che esso venga ampiamente riconosciuto da tutta l'industria.

1.0 – Overview. How the world's economy is evolving

In recent years we are witnessing the most rapid and shocking evolutions and shifts in the world economy¹, changes that are deeply affecting every professional sphere and every activity carried out, in a way that was never happened before; this due to some social-demographic, macroeconomics dynamics and technological advances that lead experts to affirm that we are today at the cusp of a fourth industrial revolution². The "twin" forces of globalization and technology have brought profound changes to the labour market, and in the short term³.

Fast and systematic progresses in sectors that previously operated in a disjointed manner can be attributed to:

- Smart systems, ranging from the monitoring and management of housing units to more complex industrial settlements and entire city grids;
- Robotics and its applications in factories;
- Nanotechnology and biotechnology;
- genetics advancements;

and how they cooperate, interacting with each other, offering new ways to address problems and challenges, amplifying the opportunities they are able to offer individually. The field of use range from the global supply chain management to climate change implications [figure 1].

1 Wouda H.P., Opdenakker R., Department of Architecture Building and Planning, Eindhoven University of Technology, Eindhoven, The Netherlands and Deloitte, Amsterdam, The Netherlands, and Department of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, Eindhoven, The Netherlands, (2019). Blockchain technology in commercial Real Estate transactions. Retrieved from: Journal of Property Investment & Finance. Emerald Publishing Limited.

² World Economic Forum, survey partners, platform partners, (2020). The future of jobs report 2020. Retrieved from: World Economic Forum international website. World Economic Forum Press, Geneva, Switzerland.

³ Baldwin, R., Oxford University Press, (2019). The Globotics Upheaval: Globalisation, Robotics and the Future of Work. Retrieved from: Oxford University Press, 2019.

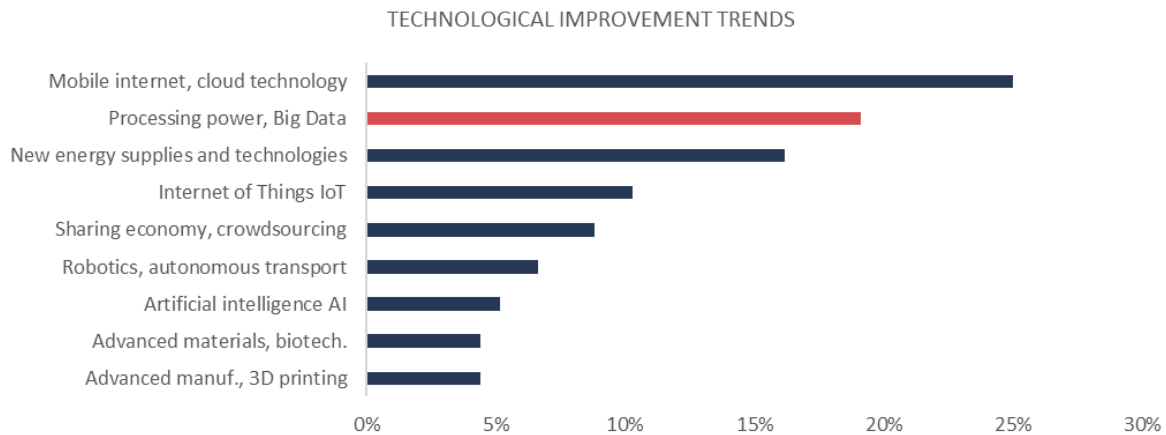


Figure 1: Technological improvement trends. Source of data: Future of Jobs Survey, World Economic Forum. 2020.

In recent years it has been possible to observe a radical change of pace in the adoption of new technologies: figure 3 presents a series of technologies organized according to the propensity for their adoption in a panel of multinational companies analyzed; cloud computing, the Internet of Things and the analysis of big data deriving from the use of these systems by users, represent a predominant and already established trend. However, it is possible to observe concrete growth in encryption linked to cybersecurity (+29% 2025 projection vs. 2018) and in Distributed Ledger applications, such as blockchain networks (+11% 2025 projection vs. 2018)⁴ [figure 2].

⁴ World Economic Forum, (2020). The future of jobs: Employment, skills, workforce strategy for the Fourth Industrial Revolution. Retrieved from: World Economic Forum international website. World Economic Forum Press, Geneva, Switzerland.

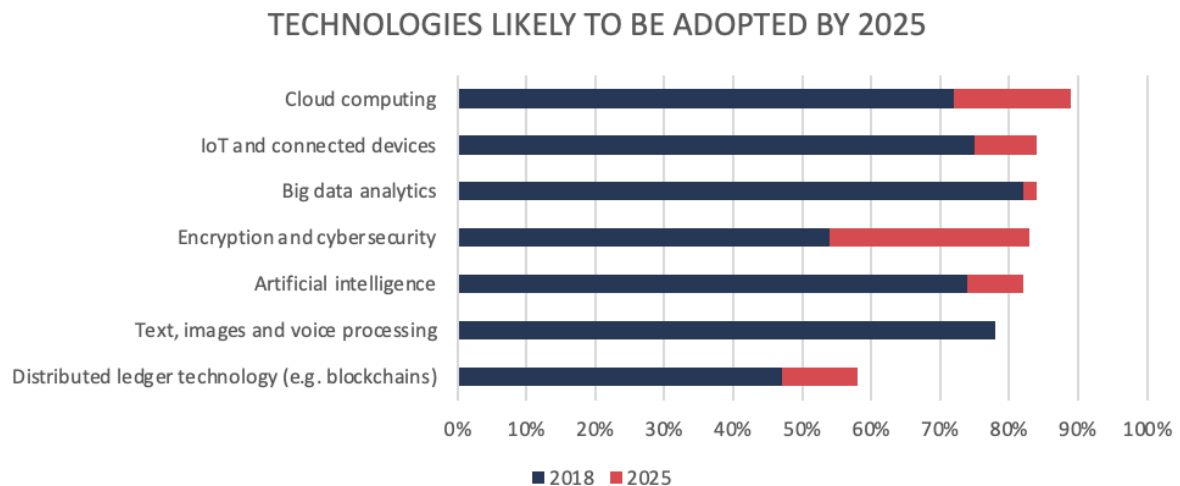


Figure 2: Technologies likely to be adopted. Source of data: Future of Jobs Survey, World Economic Forum. 2020.

Competing with the technological revolution there are a series of broad-spectrum socio-economic, geopolitical and demographic drivers of change, each one interacting with the others in multiple directions, intensifying their effects one on the other⁵ [figure 3].

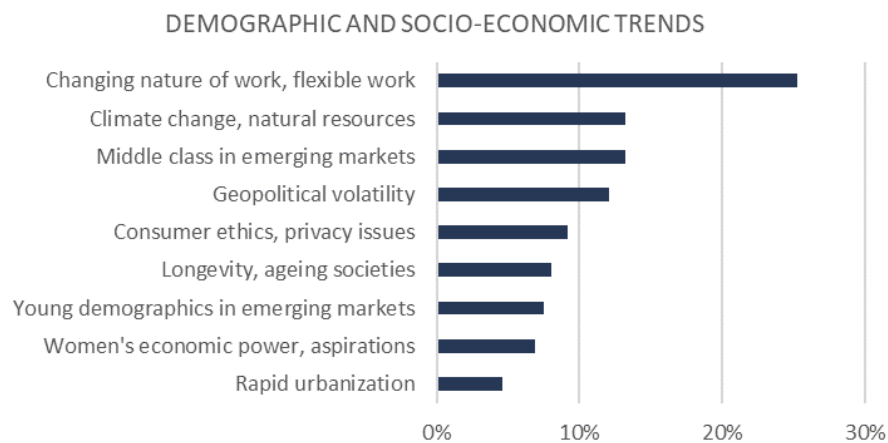


Figure 3: Demographic and socio-economic trends. Source of data: Future of Jobs Survey, World Economic Forum. 2020.

⁵ World Economic Forum, (2020). The future of jobs: Employment, skills, workforce strategy for the Fourth Industrial Revolution. Retrieved from: World Economic Forum international website. World Economic Forum Press, Geneva, Switzerland.

To this must be added the unexpected impact that the Covid-19 pandemic has had on a global scale on all production sectors; an unexpected recovery in terms of GDP per Capita is underway, but its extent is still irregular and subject to the vaccination programs of the states and the public health policies adopted by them⁶ [figures 4, 5].

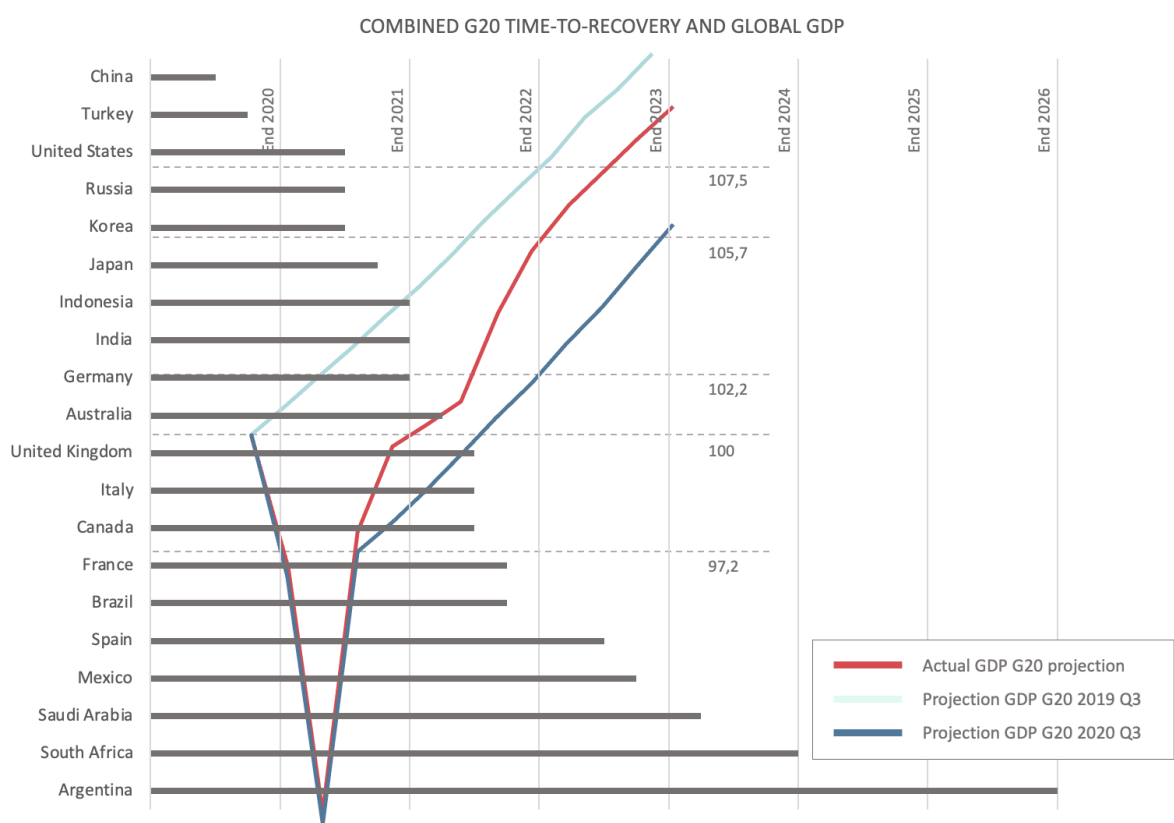


Figure 4: Combined G20 time-to-recovery and global GDP. Source of the data: Organisation for Economic Co-operation and Development OECD, OECD Economic Outlook, (2021). Coronavirus (COVID-19).

⁶ Organisation for Economic Co-operation and Development OECD, OECD Economic Outlook, (2021). Coronavirus (COVID-19). No ordinary recovery. Navigating the transition. Url of the article: <https://www.oecd.org/economic-outlook/>. OECD official website, Covid-19 section.

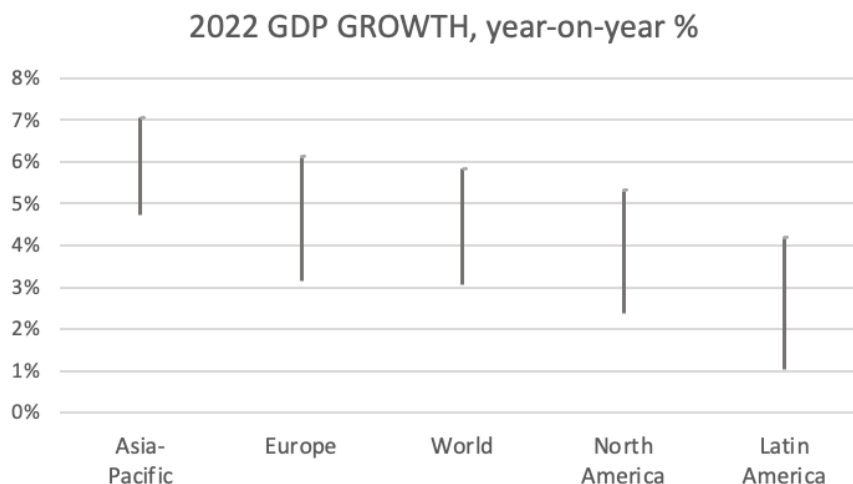


Figure 5: 2022 GDP growth, year-over-year %. Source of the data: Organisation for Economic Co-operation and Development OECD, OECD Economic Outlook, (2021). Coronavirus (COVID-19).

The period of forced lockdown and the closures envisaged by governments have led the population to new consumption patterns, profoundly changing the sensitivity of people towards spending channels and purchasing items [figure 6]; consequently, the production chain has also undergone huge and heavy transformations⁷ [figure 7].

The exponential increase in the attention and economic resources directed by families to the quality of food and to the issue of zero kilometre and the short supply chain⁸, have been compensated by a sudden drop in spending on furniture, clothing and footwear; people have rediscovered an individual dynamic, on foot, by bike and by car, to the detriment of public transport, trains and airplanes (the latter especially blamed the prolonged stops on international flights)⁹.

⁷ Open Financial Communication, ANSA Italia, (2020). Come cambiano i consumi dopo il coronavirus: i nuovi cinque macrotrend. Url of the article: https://www.ansa.it/sito/notizie/economia/ofc/in_evidenza/2020/09/08/come-cambiano-i-consumi-dopo-il-coronavirus-i-nuovi-cinque-macrotrend_b28fcf32-400d-4c79-99a3-00ccdbd46e0f.html. Ansa Economia.

⁸ Capgemini Research Institute, (2020). Consumer products and retail. How sustainability is fundamentally changing consumer preferences. Retrieved from: Capgemini sustainability website news, <https://www.capgemini.com/news/sustainability-in-cpr/>. Capgemini Research Institute Think Tank.

⁹ PWC, (2021). Italia 2021: competenze per riavviare il futuro. Il rilancio dei consumi. Retrieved from: PWC Italian website, report Italia 2021.

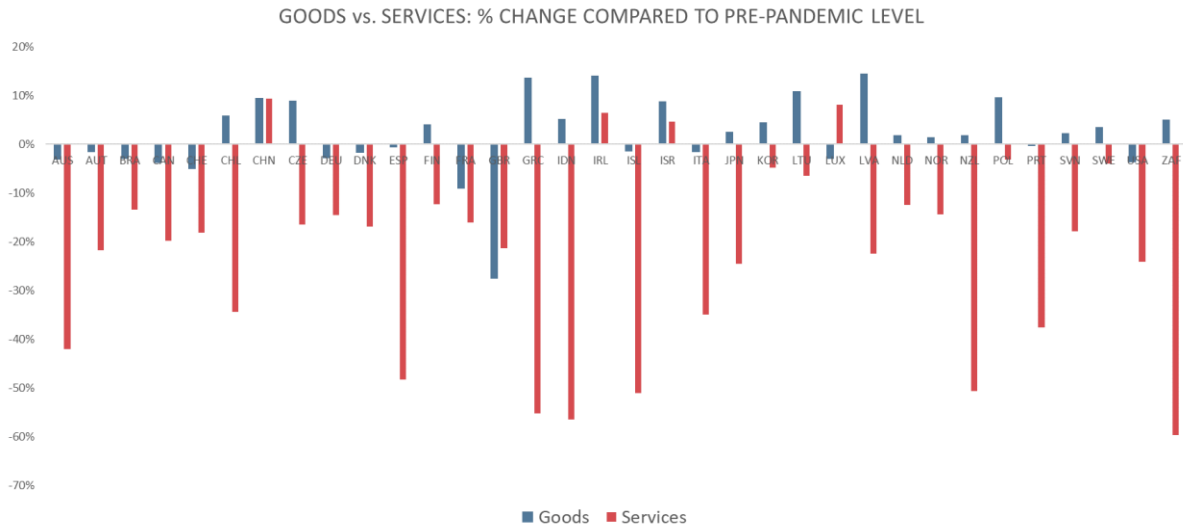


Figure 6: Good vs. services, % change in consumption compared to pre-pandemic level. Source of the data: Organisation for Economic Co-operation and Development OECD, OECD Economic Outlook, (2021). Coronavirus (COVID-19).

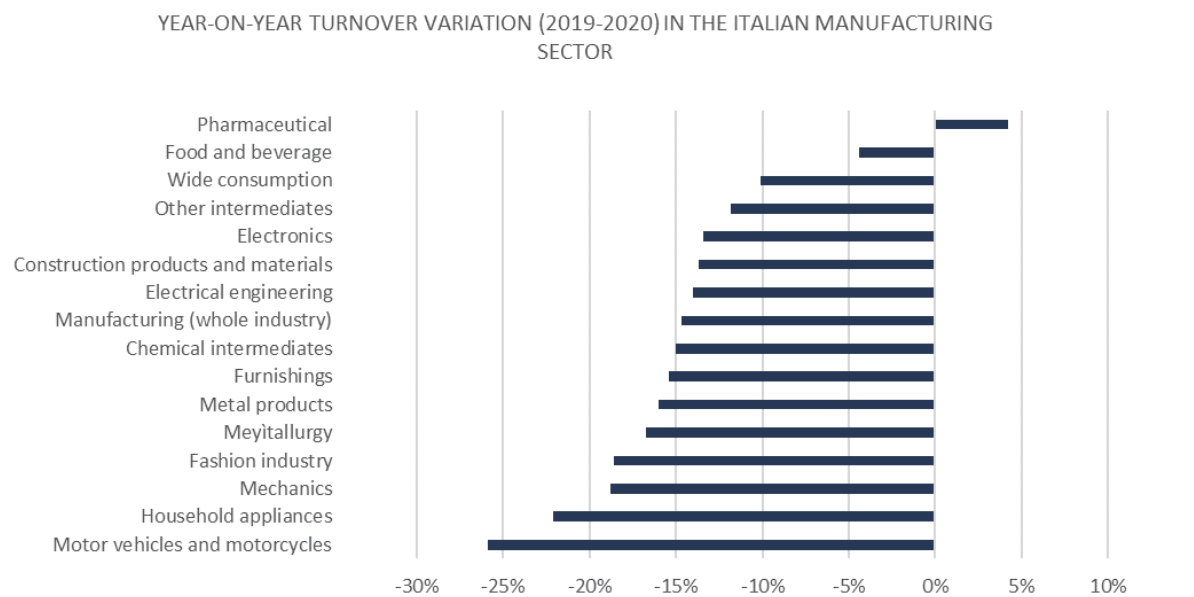


Figure 7: Year-on-year turnover variation (2019-2020) in the Italian manufacturing sector. Source of the data: PWC "Italia 2021 - Competenze per riavviare il futuro. Il rilancio dei consumi". PWC report, 2020.

A last but primary aspect concerns the push unto the digital solutions that the pandemic has accelerated considerably, upsetting the uses and exasperating a trend that was already underway, from online payments to distribution channels and marketing campaigns of companies. According to a McKinsey Global Survey of Executives, organisations have accelerated the digitalization of their customer and supply-chain interactions and of their internal operations by three to four years¹⁰ [figure 8].

The same research shows how digital and corporate strategies have reached perfect convergence within the dominant companies; this is due to the fact that if in the pre-pandemic era the alignment of objectives and a strong leadership were always recognized as the winning elements in moments of disruption and transformation, the strategic differentiating role of technology in this phase has become very stark¹¹ [figures 9, 10].

The results also indicate that along the multiyear acceleration of the digital revolution, the crisis has brought a sea of change in the executive mentality of organizations facing technology strategic importance, and this is particularly evident when comparing the data with the same research conducted in 2017, from which it emerges that cost savings were one of the top priorities in digital strategies pipeline [figure 9]. Today, more than half of the respondents state they are investing a lot of resources in digital to make it a competitive advantage on the relevant market or to refocus their own business processes around it. From the same 2017 report we can derive with what degree of risk the investment in the technological update was perceived in relation to the revenues to the activity dependent on it, deducing that in some sense it was already estimated that it could become a primary competitiveness driver¹² [figure 11].

¹⁰ McKinsey & Company, McKinsey Global Survey, (2020). How COVID-19 has pushed companies over the technology tipping point - and transformed business forever. Retrieved from: McKinsey Strategy and Corporate Finance website portal, McKinsey & Company Global Surveys.

¹¹ McKinsey & Company, McKinsey Global Survey, (2020). Ibid.

¹² McKinsey & Company, McKinsey Global Survey, (2017). How digital reinventors are pulling away from the pack. Retrieved from: McKinsey Digital Insights website portal, McKinsey & Company Global Surveys.

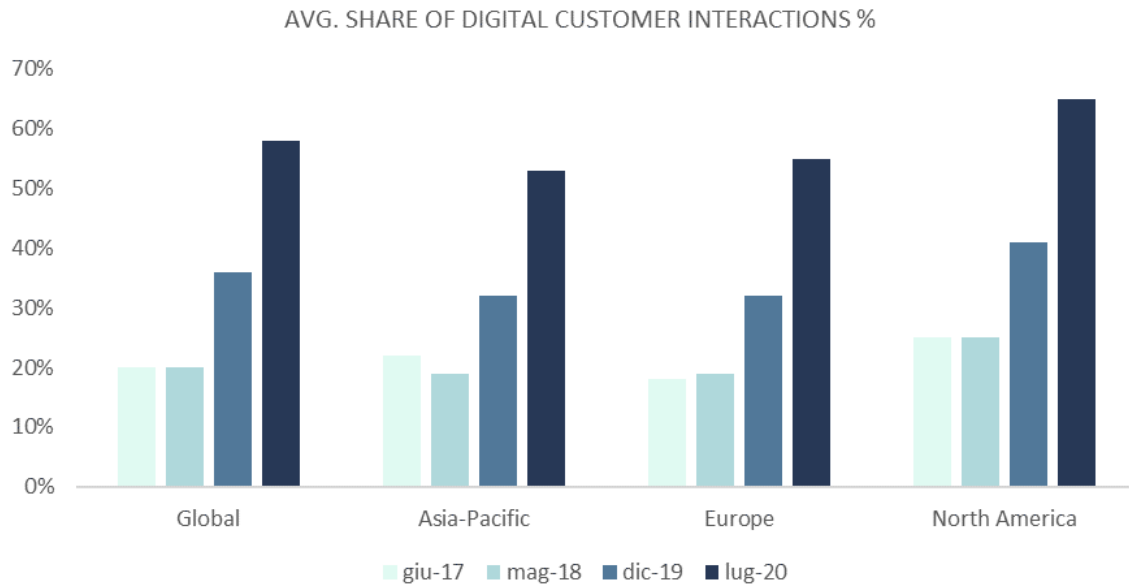


Figure 8: Average share of digital customer interactions, from June 2017 to July 2020. Source of the data: McKinsey & Company Global Survey, (2020). How COVID-19 has pushed companies over the technology tipping point - and transformed business forever.

EXECUTIVE CORPORATE MINDSETS ON TECHNOLOGY'S STRATEGIC IMPORTANCE
Organizations' current strategic posture toward technology

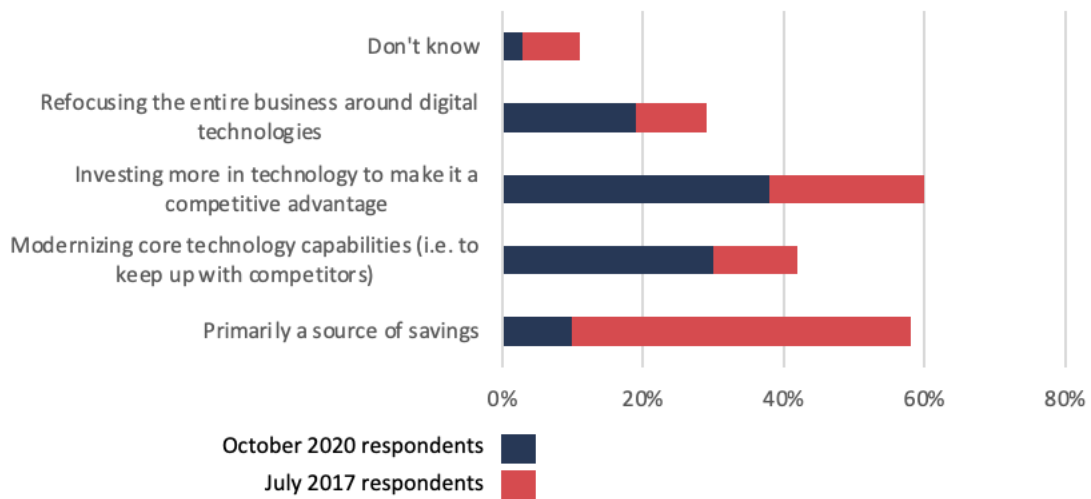


Figure 9: Executive corporate mindsets on technology strategic importance. Organizations' current strategic posture toward technology. Source of the data: McKinsey & Company Global Survey, (2020). How COVID-19 has pushed companies over the technology tipping point - and transformed business forever.

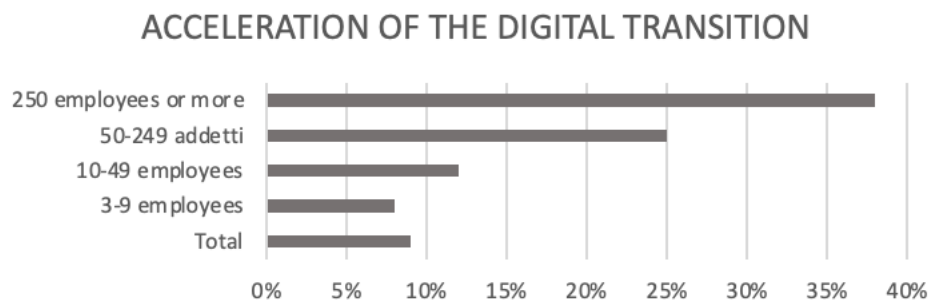
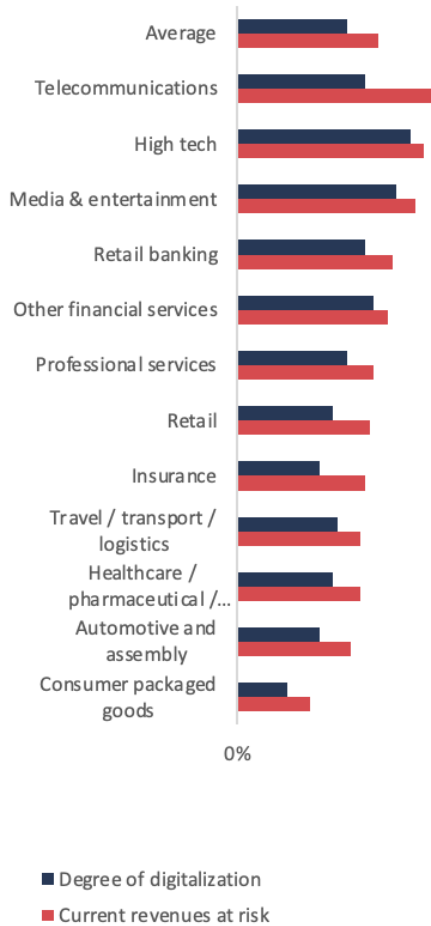


Figure 10: Acceleration of the digital transition. Source of the data: PWC, (2021). *Italia 2021: competenze per riavviare il futuro. Il rilancio dei consumi.*

DIGITIZATION RISK

Risk expected from companies to their revenues from digitization if they take no action in the years ahead



RESOURCE ALLOCATION TO DIGITIZATION

The share of budgets and people that companies invest in digitization is proportional to the revenues earned from it

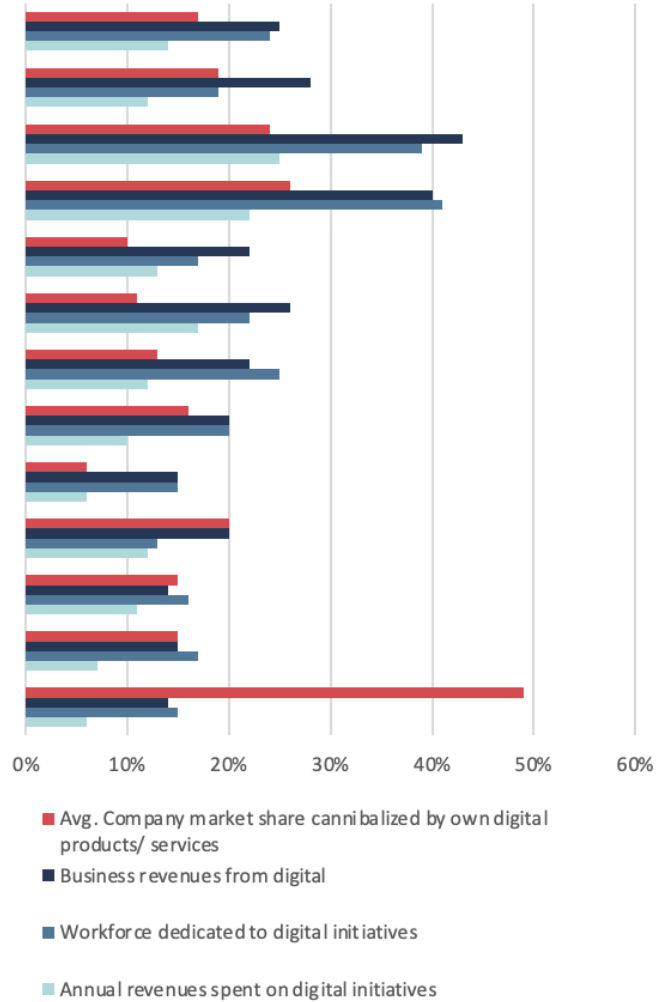


Figure 11: Corporate digitization risk (left scheme) and resource allocation to digitization (right scheme). Source of the data: McKinsey & Company, *McKinsey Global Survey*, (2017). How digital reinventors are pulling away from the pack.

1.1 – THE ANTIFRAGILE VALUE OF REAL ESTATE

Real Estate constitutes the single largest asset class in the world, representing about 60% of the total assets according to some estimates [figures 12, 13], as well as being particularly complex and unique compared to any other category of tangible or intangible products. Real estate has played a fundamental role in world economies and is recognized to withstand the crises and systematic changes of the societies that go through it [figure 14], and it seems to be quite "allergic" in adopting new technologies¹³. Its significance lies in the fact that nowadays it represents one of the three largest asset classes in the world in which insurance companies and pension funds like to invest in, either directly (through equity vehicles such as management funds, Real Estate companies, Investment Trusts) or indirectly (when properties are used as mortgage-backed collateral for the disbursement of financing and liquidity)¹⁴, thereby strongly affecting the financial markets and the economy in general¹⁵.

¹³ Wouda H.P., Opendakker R., Department of Architecture Building and Planning, Eindhoven University of Technology, Eindhoven, The Netherlands and Deloitte, Amsterdam, The Netherlands, and Department of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, Eindhoven, The Netherlands, (2019). Blockchain technology in commercial Real Estate transactions. Retrieved from: Journal of Property Investment & Finance. Emerald Publishing Limited.

¹⁴ Wouda H.P., Opendakker R., Ibid.

¹⁵ Bank for International Settlements (BIS), Monetary and Economic Department, (2020). BIS Quarterly Review - International banking and financial market developments, September 2020. Retrieved from: BIS international website, Bank for International Settlements 2020.

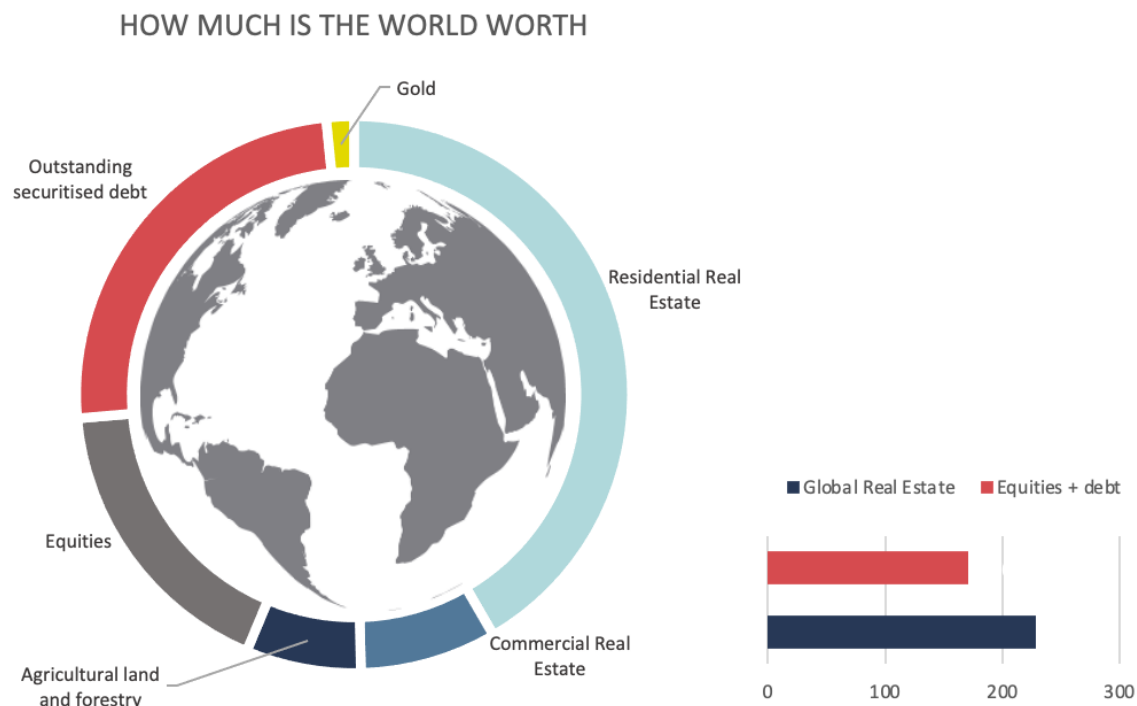


Figure 12: the graph on the left shows the proportional value of the various asset categories. Source of the data: *The Savills UK Blog, (2017). How much is the world worth?*

Figure 13: the graph on the right shows the overall valuation of safe-haven and real estate assets, expressed in trillions of US dollars. Source of the data: *Euro-Phoenix International Corporate Finance LPP, (2019). Key global asset universe in 2019.*

As we can see from the histogram below [figure 14] the "brick" was the economic segment that best absorbed the impact of the Covid-19 pandemic, reporting the lowest credit loss rate only after the information market¹⁶. This was possible because, although some categories of properties that are instrumental to specific economic activities (such as offices) partially lost their usefulness during the pandemic period, thanks also to forms of hybrid work that made possible to limit contacts between people, in other cases, some asset classes have even increased their demand and the speculative slice on the overall investments (think of last-mile and city logistics¹⁷) [figures 15, 16]; the pandemic and confinement in our homes has also

¹⁶ Bank for International Settlements (BIS), Monetary and Economic Department, (2020). *BIS Quarterly Review - International banking and financial market developments, September 2020*. Retrieved from: BIS international website, Bank for International Settlements 2020.

¹⁷ JLL (Jones Lang LaSalle), (2019-2021). *Logistics Snapshot EMEA, Q4 2019- Q2 2021. The last trends of logistics market*. Retrieved from: JLL official website, Trends and Research section. Jones Lang LaSalle IP, Inc.

made it possible to rediscover the importance of the spaces in which we live, reviving a sort of "second golden age" for the residential sector [figures 17, 18].

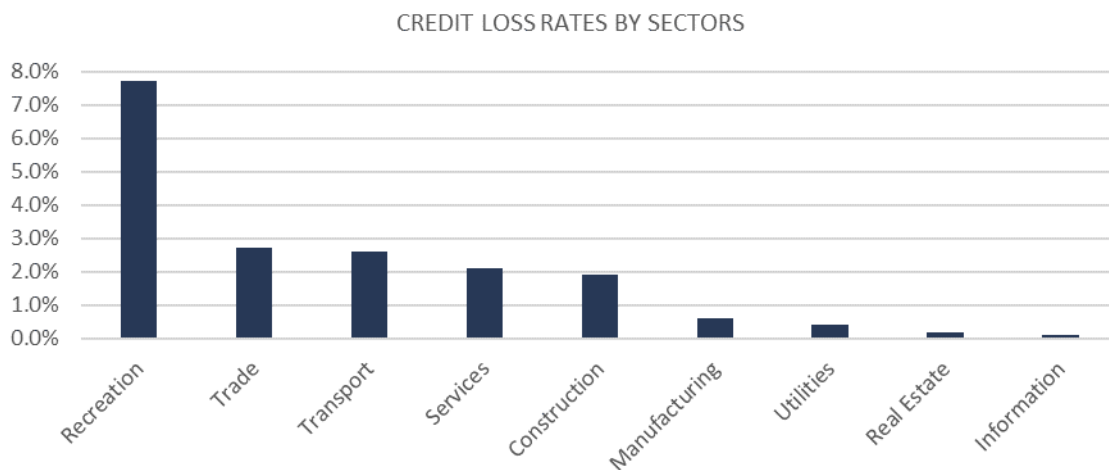


Figure 14: percentage of credit loss during the pandemic period, allocated by sector. Source of the data: Bank for International Settlements, (2021). Annual Economic Report, June 2021. The outlook for corporate credit losses.

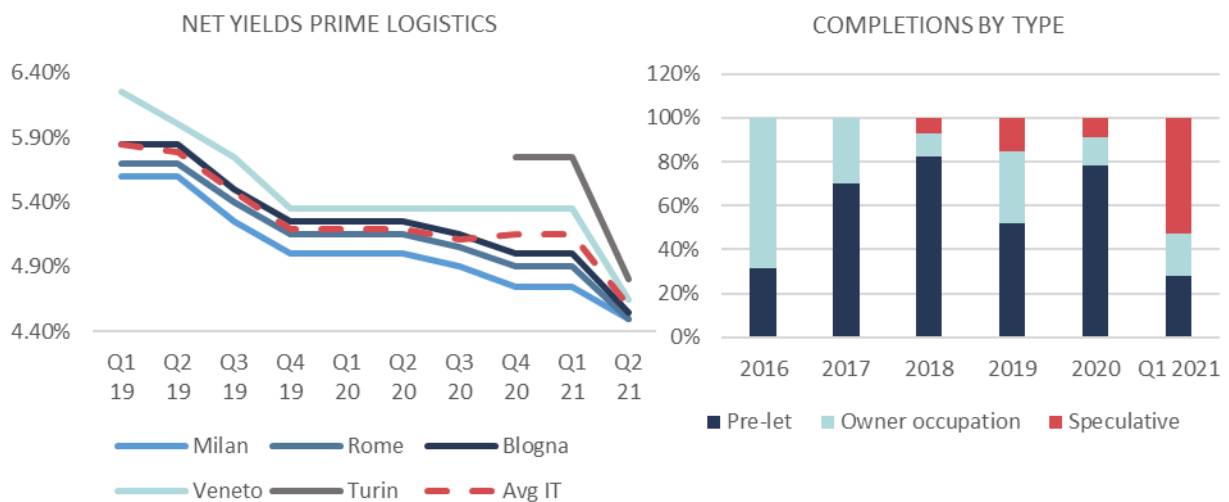


Figure 15: (left side) net prime yields for logistics sector. Source of the data: JLL Logistics Snapshot Italy, Q2 2021.

Figure 16: (on the right side) Logistic completions by typology. Source of the data: JLL Logistics Snapshot Italy, Q1 2021.

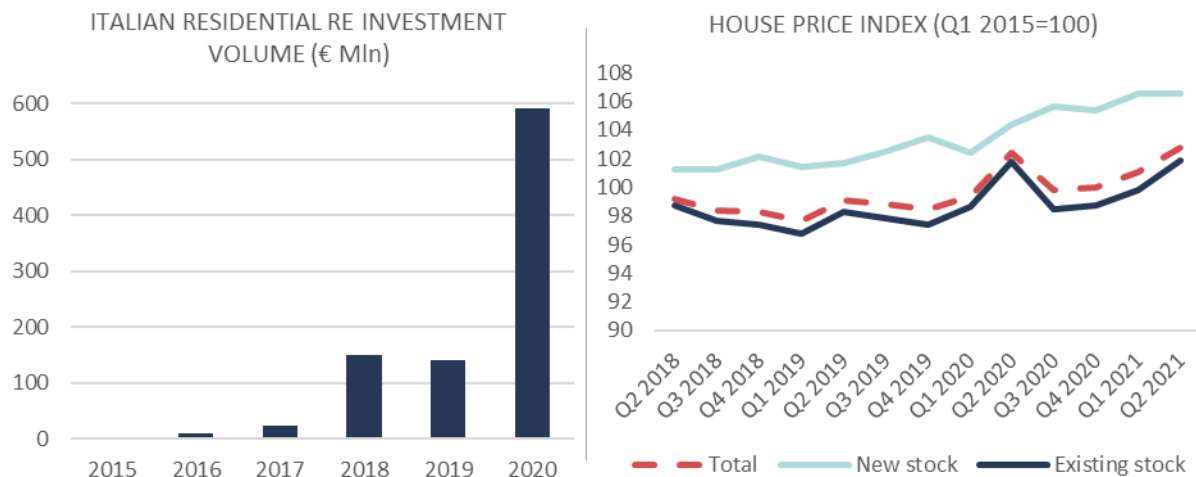


Figure 17: (on the left side) Residential Real Estate investments in Italy. Source of the data: CBRE Research and Reports, (2021). Italy Real Estate Market Outlook.

Figure 18: (on the right side) Italian house price index (100pts baseline= Q1 2015). Source of the data: Istituto Nazionale di Statistica ISTAT. Prezzi delle abitazioni (Ipab). OECD.

In the academic text "*Antifragile: things that gain from disorder*" the Lebanese essayist and mathematician Nassim Nicolas Taleb coined a specific term to outline all those phenomena and processes that are able to benefit from the succession of one or more adverse events that have effects on a macro-territorial or global scale, defining these observations as *antifragile value*¹⁸ and summarizing them into the following quote: "*some things benefits from shocks; they thrive and grow when exposed to volatility, randomness, disorder and stressors and love adventure, risk and uncertainty*"¹⁹.

To illustrate in more detail through an empirical example how this concept of *antifragile* has an effect in the Real Estate industry, it is necessary to compare the supply and demand behaviours upon the occurrence of two negative macroeconomic scenarios that we will define as "Black Swan²⁰ 1", of a smaller entity (similar to an economic crisis due to an unpredictable but

¹⁸ Taleb N. N., (2012). *Antifragile: Things That Gain from Disorder*. New York: Random House, 2012.

¹⁹ Taleb N. N., (2012). *Ibid.*

²⁰ The contemporary use of the expression Black Swan in reference to an unexpected but influential event is attributed to the mathematician, essayist and trader Nassim Nicholas Taleb, who first introduced it in his literature. Taleb argued that the stock market was unpredictable and could be affected by rare events or Black Swans, a

endogenous event. i.e. a recession due to a lack of market confidence, as the one occurred in 2008-2012) and "Black Swan 2", of greater magnitude (comparable to the economic effects of a pandemic on a global scale, such as Covid-19).

The assumptions of this model, developed by G. Tcheau and N. Miller²¹ on the basis of the Neoclassical macroeconomic theory²², lie in the fact that the demand (AD, s.f. aggregate demand) function is composed of the customers of the Real Estate sector are represented by the occupants, who, net of localized events and socio-political upheavals, will always increase in the long horizon, resulting in that its oblique line will always move to the right. Supply (AS, s.f. aggregate supply), on the other hand, is the driving force of the sector, in other words the cycles of explosion and contraction are driven more by overproduction than by a movement in demand (e.g. the recent collapse of the Chinese development industry moved by the crisis of the Evergrande company²³).

The two scenarios are analysed starting from the initial market equilibrium conditions, in the short run (*Black Swan 1 and 2 event*) and in the long term, with decreasing volatility (economy that has regained its solidity).

The final clarification concerns the fact that the Real Estate sector is being examined in terms of aggregate segments, and therefore its dynamics are observed in an aggregate manner.

controversial view that turned out to have some consistency in light of the ensuing economic crisis. Retrieved from: Macmillan Online Dictionary.

²¹ G. Tcheau, N. Miller, Burnham-Moores Center for Real Estate affiliate with University of San Diego School of Business, (2020). Antifragility of Real Estate Investments in a World of Fat-Tailed Risk. Retrieved from: San Diego University, Educational resources section. 2021 University of San Diego.

²² MIT - Massachusetts Institute of Technology, (2009). Principles of Macroeconomics lesson, Fall 2009. Retrieved from: Mit Open Course Wave. Massachusetts Institute of Technology 2001-2021.

²³ Toh M., Cnn Business, Markets Now section, (2021). 5 things to know about the Evergrande crisis: A simple breakdown. Url of the article: <https://edition.cnn.com/2021/09/24/investing/china-evergrande-group-debt-explainer-intl-hnk/index.html>. 2021 Cable News Network.A Warner Media Company.

First scenario – Black Swan 1²⁴

Starting from the initial balancing conditions with Price = P_e and Quantities = Q_e , we observe that in quadrant 1.1 the quantity of demand falls to the D_1 level due to the shock in aggregate demand, while the decline in supply (S_1) is relatively small: in the brick market the level of supply falls due to obsolescence and the withdrawal of some properties, while its increase is always very slow due to the supply times necessary for the production of new assets.

At the new spot equilibrium the price drops to $P_e > P_1$ and the supply also: its capacity is dampened as development capital providers become significantly risk averse and policy makers institute anti-risk measures; the result is that the response of S_2 supply is relatively low compared to the new levels of demand in the long-term recovery period, which is also increasing thanks to the natural demographic increase.

The price balance now definitely moves to $P_2 > P_e > P_1$ [figure 19].

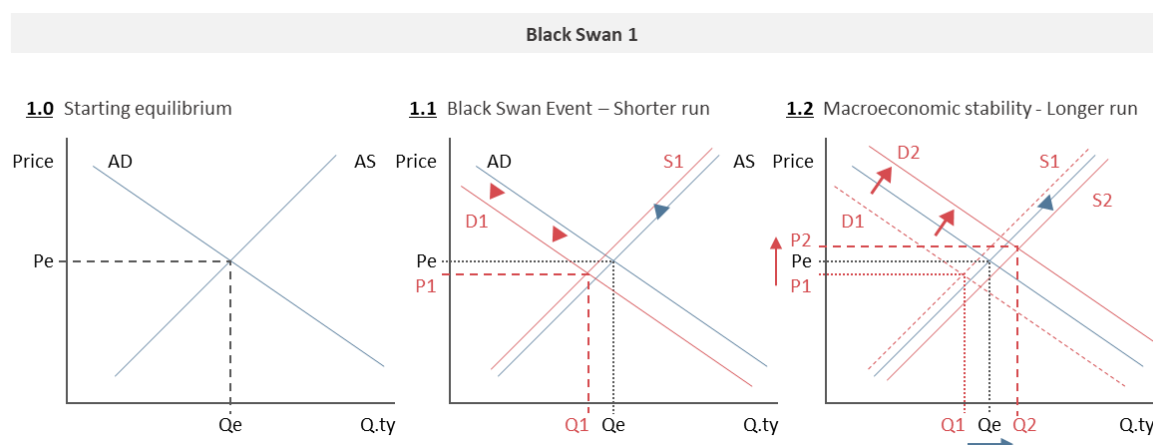


Figure 19: smaller entity macroeconomic event, impact on Real Estate supply and demand curve. Source of the illustrations: *Antifragility of Real Estate Investments in a World of Fat-Tailed Risk*. Retrieved from: San Diego University, Educational resources section. 2021 University of San Diego, 2020.

²⁴ G. Tcheau, N. Miller, Burnham-Moores Center for Real Estate affiliate with University of San Diego School of Business, (2020). *Antifragility of Real Estate Investments in a World of Fat-Tailed Risk*. Retrieved from: San Diego University, Educational resources section. 2021 University of San Diego.

Second scenario – Black Swan 2²⁵

Paradoxically, the more rigid the event that triggers the negative macroeconomic trend, the greater the contraction of the new Real Estate offer in the long term.

Within an intense Black Swan event, demand falls much more strongly in quadrant 2.1 at D3 and prices at $P3 < Pe$ with $P3 < P1$ as the shock is more devastating. The tenacity of the shock means that capital providers are even more averse to taking financial risks and therefore to injecting money into the construction industry, and the measures to deal with the emergency are draconian. Although the demand in quadrant 2.2 recovers to level D4, the very reduced supply compared to the previous scenario causes $P4 > Pe$ with $P4 > P2$, meaning that in the long run the prices will be the higher the harder the macroeconomic crisis will be and the Black Swan event that triggers it (and the reference here is directly to the post-pandemic scenario of Covid-19 in progress today²⁶) [figure 20].

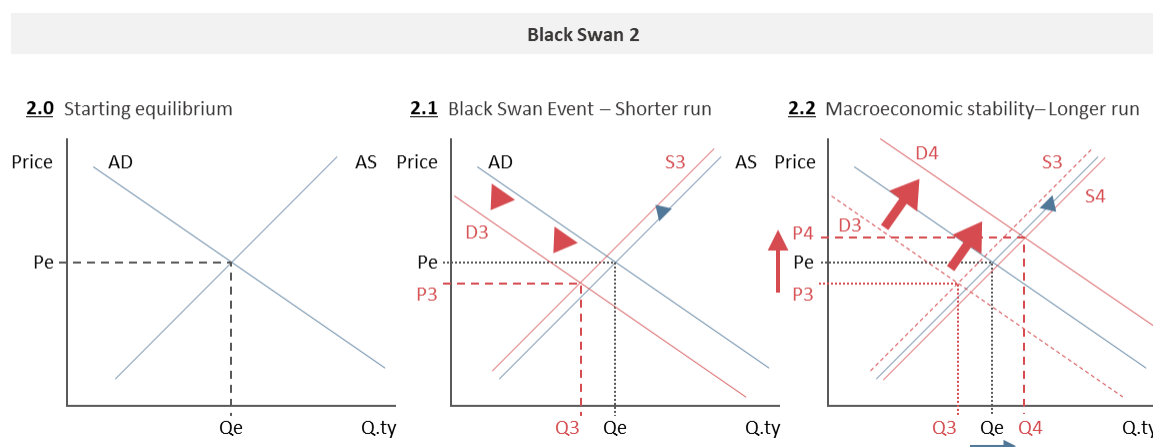


Figure 20: smaller entity macroeconomic event, impact on Real Estate supply and demand curve. Source of the illustrations: *Antifragility of Real Estate Investments in a World of Fat-Tailed Risk*. Retrieved from: San Diego University, Educational resources section. 2021 University of San Diego, 2020.

Evidence from the reality

²⁵ G. Tcheau, N. Miller, Burnham-Moores Center for Real Estate affiliate with University of San Diego School of Business, (2020). *Antifragility of Real Estate Investments in a World of Fat-Tailed Risk*. Retrieved from: San Diego University, Educational resources section. 2021 University of San Diego.

²⁶ Vanini C., Cushman & Wakefield, Technology and Research Americas departments, (2021). *Italy Real Estate Market View*. Url of the article: Kushman & Wakefield website, insights on Commercial Real Estate Market, <https://www.cushmanwakefield.com/it-it/italy/insights/covid-19-impacts-italy-real-estate>. Copyright of Cushman & Wakefield 2021.

As discussed and highlighted in the previous paragraph, the Real Estate sector seems to benefit in some form from all those adverse events of the macroeconomic, geopolitical and social-demographic system that characterize the environment in which it constitutes one of the savings and investment classes²⁷; Although Taleb's scientific and narrative production lays its foundations in a solid economic theory, it should also be specified that if there were no real-world evidence to confirm what he argued, this would not invalidate all his research activity but would significantly devalue it. To show how the phenomenon defined by him as antifragile value has concrete implications in the concrete economy, it is possible to analyze in an aggregate manner two performance indicators of the Italian Real Estate market, namely the historical series of the unit price of the offices in the Milanese market (offices in good state, according to Institutional Sources) with the price index of the entire property sector, in the same period (H1 1988- H1 2021) [figure 21]:

²⁷ Taleb N. N., (2012). *Antifragile: Things That Gain from Disorder*. New York: Random House, 2012.

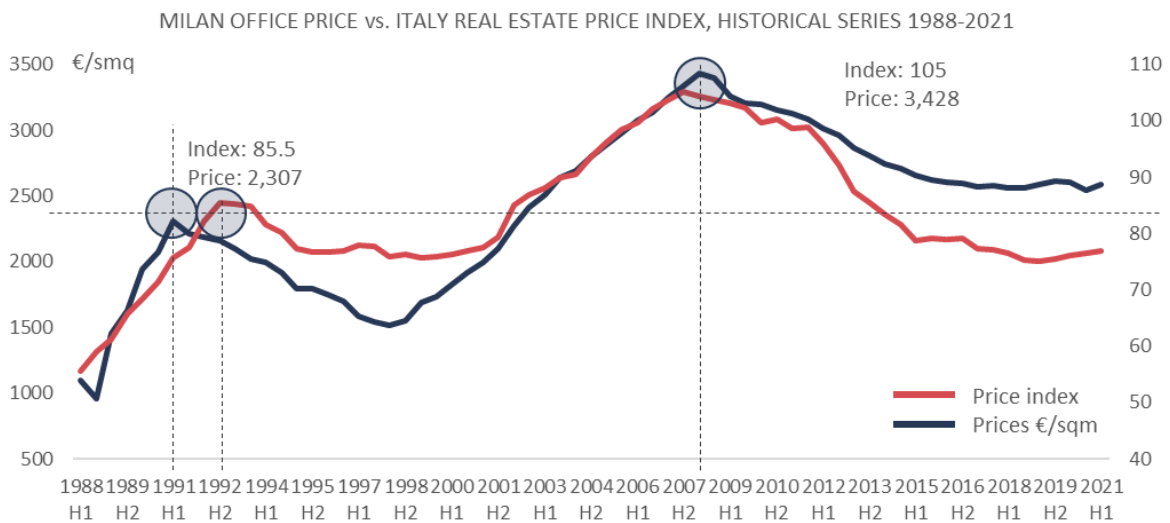
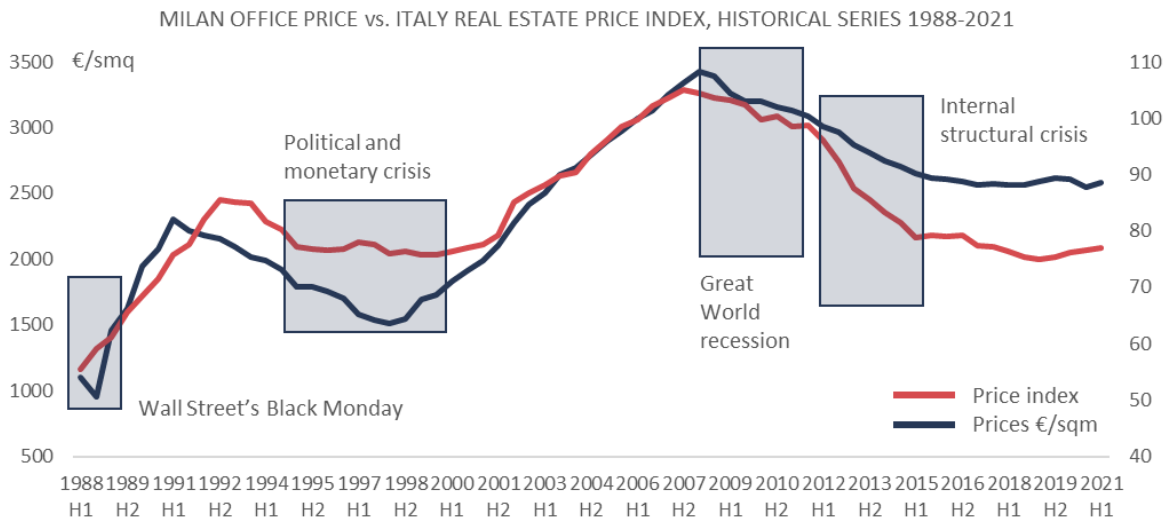


Figure 21 Milan office prices historical series (good state offices, €/sqm) compared to the overall country's Real Estate price index (all property segments, 2010= 100 bps). Sources of the data: Nomisma, Real Estate Italian Observatory (offices), Federal Reserve Bank of St. Louis, Economic Research (RE index).

What emerges from the reading of the aggregate price / index trend is that every negative conjecture that leads the real estate asset sector to a loss of value on the market is followed in the short term by a stabilization of the same values, which in the medium term regain their own solidity and consistency returning to increase to higher levels than of the previous values; to summarize the phenomenon in one sentence it can be said that *“the larger the dislocation the stronger the ensuing performance in the long run”*²⁸.

The direct effect of the manifest and confirmed solidity of Real Estate investments (in particular private equity) against fluctuations and losses suffered by all other types of financial assets is represented by the greater allocation of liquidity spent by pension funds in tangible assets, such as properties (particularly through indirect vehicles, such as REITs), private equity and infrastructures (that all together constitute the so-called Growth Assets²⁹), since this type of institutional investors prefer products that hold value over the very long term to protect firstly the devoted capital from inflation³⁰ [figure 22].

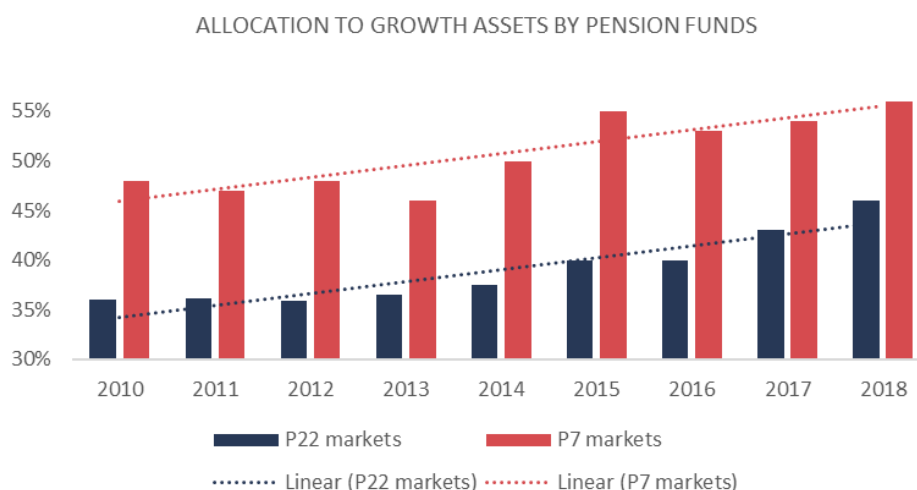


Figure 22: Allocation to Growth Assets, overall mean value for the P22 countries and for P7 markets, which include only Australia, Canada, Japan, Netherlands, Switzerland, UK and US. Source of the data: Pham, N., Monash University and Australian Centre for Financial Studies, (2019). *Asset allocation of Pension Funds*.

²⁸ G. Tcheau, N. Miller, Burnham-Moores Center for Real Estate affiliate with University of San Diego School of Business, (2020). Antifragility of Real Estate Investments in a World of Fat-Tailed Risk. Retrieved from: San Diego University, Educational resources section. 2021 University of San Diego.

²⁹ Pham, N., Monash University and Australian Centre for Financial Studies, (2019). *Asset allocation of Pension Funds*. Retrieved from: Monash University website, Education Resources. ACFS Group, Monash University.

³⁰ Idea Fimit Sgr and Itinerari Previdenziali, (2013). *L'investimento immobiliare indiretto di fondi pensione ed enti previdenziali. Trend in atto e prospettive future di asset allocation*. Retrieved from: Itinerari Previdenziali online resources, download area. Itinerari Previdenziali, Milano.

1.2 – REAL ESTATE FACING CHANGES

Room for improvement

What makes Real Estate properties distinctly different from all other categories of exchangeable assets is the inefficiency of the information that characterizes it, mainly due to its heterogeneity and immobility, not least by its fragmentation³¹, from which derive very high transaction costs, long-term commitment, complex and erratic regulations, and other barriers to entry into the market³². To give an example of this data fragmentation, we can use the information relating to professionally managed Real Estate portfolios and investments, which include:

- HNVI (high-net-worth individuals);
- pension funds;
- sovereign wealth funds;
- unlisted funds;
- open-end and closed-end funds.

In a perfect reality, all information relating to known real estate investment portfolios should be surveyed and updated on an annual basis, but in practice this is impossible³³ [figure 23]. This limit is primarily attributed to the reluctance that the Commercial Real Estate sector (CRE) has always shown towards innovations and the adoption of new technologies, remaining anchored to consolidated processes over time and appearing to be scarcely flexible to their renewal, misaligning itself to the reality of the investment sector³⁴.

³¹ CBRE Research and Reports, (2021). Italy Real Estate Market Outlook. Retrieved from: <https://www.cbre.it/it-it/research-and-reports/Italy-Real-Estate-Market-Outlook-2021-in-Italian>. CBRE ITALY Research and Reports.

³² Wouda H.P., Opdenakker R., Department of Architecture Building and Planning, Eindhoven University of Technology, Eindhoven, The Netherlands and Deloitte, Amsterdam, The Netherlands, and Department of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, Eindhoven, The Netherlands, (2019). Blockchain technology in commercial Real Estate transactions. Retrieved from: Journal of Property Investment & Finance. Emerald Publishing Limited.

³³ Morgan Stanley Capital International (MSCI), (2021). Real Estate Market Size 2020/2021. Annual update on the size of the professionally managed global Real Estate Investment Market. Retrieved from: MSCI official website, market reports & insights. 2021 MSCI Inc.

³⁴ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buting process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Jpurnal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

The main factors that determine or favour this phenomenon are:

- standardised digital data and information asymmetries. Technological efficiency relies on up-to-date, accurate, digitalised data;
- the portion of digitized information and its accessibility. A significant portion of the information available is still archived in paper documents registered in archives characterized by difficult access and consultation, or stored into a series of private data servers, poorly catalogued and impossible to consult;
- the difficulties of the transfer of ownership process related to the transactions. These technical, legal, taxation and bureaucratic issues lead to high transaction costs³⁵.
- The time required for the transfer of ownership of the assets. The data necessary to close a transaction need to be collected and viewed by a multitude of subjects, including owners and hypothetical interested parties, legal consultants, property managers and intermediary brokers; the experts have identified 150 passages that characterize a typical Real Estate sale, with a dozen major obstructions to the timing-proof closure of procedures³⁶.
- disintermediation. Some participants in current conveyancing systems might be replaced by digitally mediated transactions and management processes;
- trust in innovation. Unclear functionality, benefits and associated risks of novel solutions can reduce trust and hold back investments and private sector data collaborations³⁷;
- particular and strategic knowledge held by some subjects of the process. We can think about the notary that verify and complete the transactions or the experience accumulated by the agency salesmen and the strategic nature of their relationships;

³⁵ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

³⁶ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

³⁷ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

- the work scope change. Meaning that involved parties in the process need to change their working activities to be relevant in the process³⁸;
- higher priorities. Precedence and marginality in investment planning [figure 24];
- solution fragmentation. The technology made available by companies is often perceived as too fragmented to provide “soup-to-nuts” solutions³⁹.

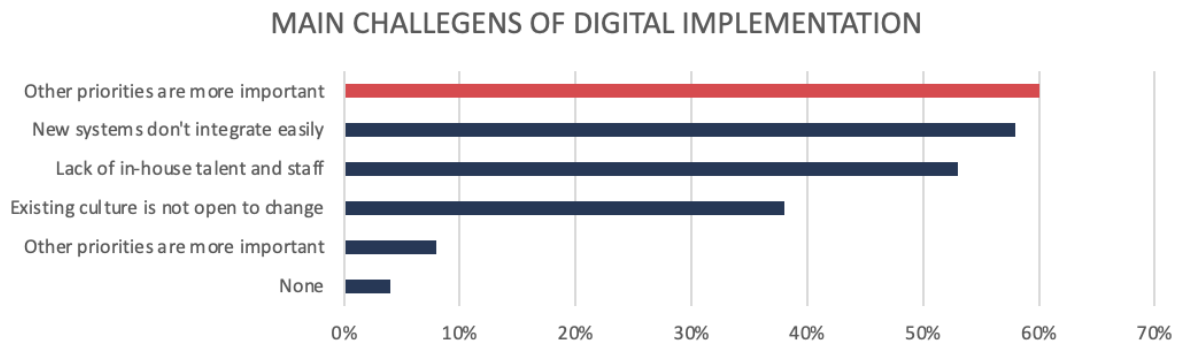


Figure 23: the biggest obstacles that companies face regarding digital implementation. Source of the data: Ernst & Young LLP, (2020). *Tech adoption in Commercial Real Estate demands a robust corporate strategy.*

³⁸ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: *Journal of Property Investment & Finance*, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

³⁹ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buting process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: *International Jpurnal of Applied Science*; Vol.2, No.2, 2019. Ideas Spread Publications.

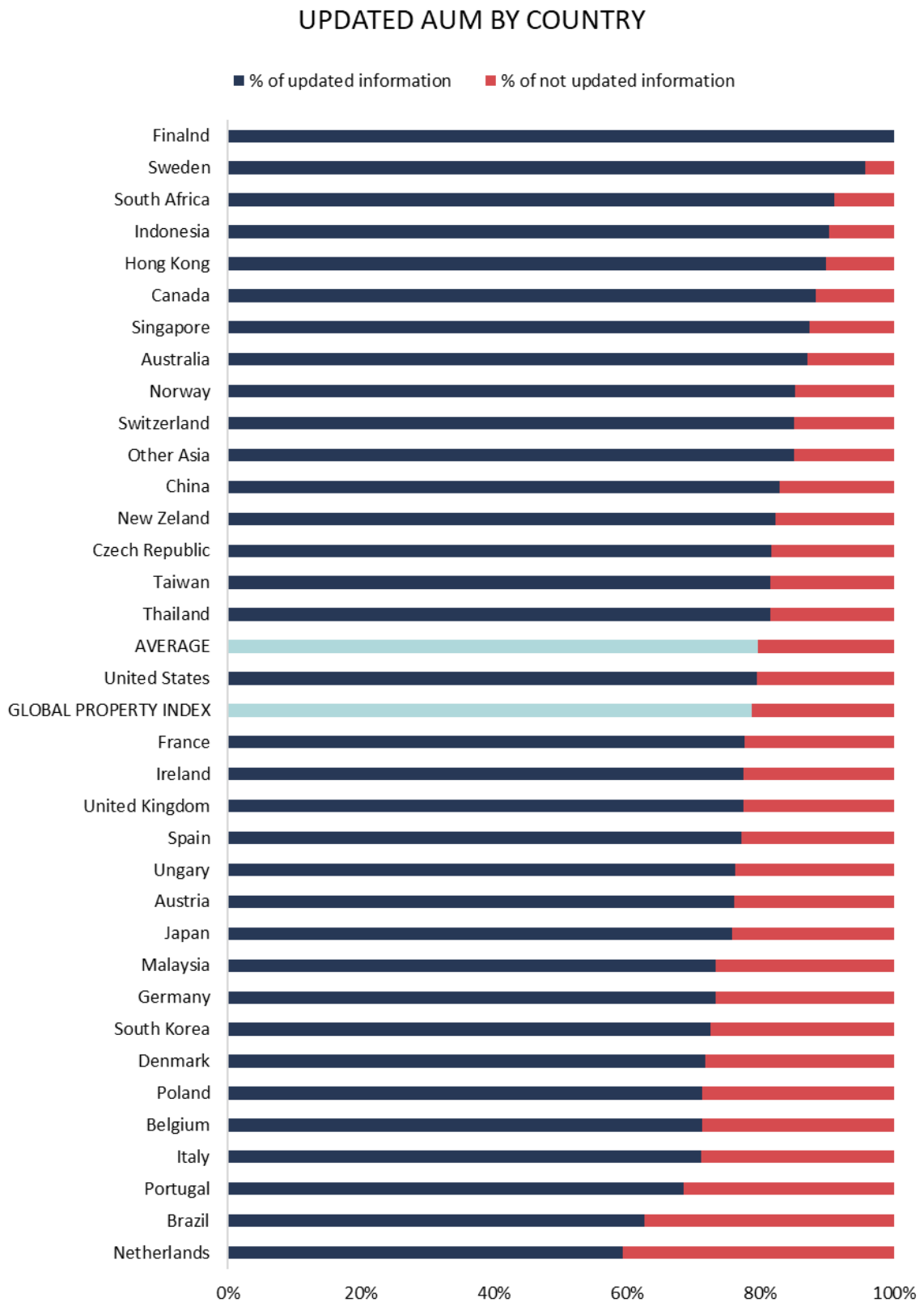


Figure 24: percentage of updated and not updated information on the Real Estate asset under management as part of the global professional managed portfolios. Source of the data: Morgan Stanley Capital International (MSCI), (2021). Real Estate Market Size 2020/2021. Updated AUM by country, 2020 data.

The planning of a strategy aimed at an operational technological update represents a real transformative process; it requires much more than specific and targeted steps (e.g. hiring a strategy specialist or sourcing a particular salesperson). It requires questioning and reviewing the management approach to ensure that the technology strategy correctly aligns the business structure with its overall strategic vision. The real challenge lies in the management of the transformation, supported by issues in the implementation of the new systems and in the research for human resources with the right IT skills⁴⁰.

Furthermore, technology and the digitalization of processes have the potential to increase market transparency, improve its liquidity and lower transaction timing and costs; this would have a positive impact on the absolute value of the Real Estate assets affected by the investments⁴¹.

⁴⁰ Ernst & Young LLP, (2020). Tech adoption in Commercial Real Estate demands a robust corporate strategy. Retrieved from: EY Real Estate, Hospitality & Construction website. Ernst & Young Global Limited.

⁴¹ Trofimov, S., Szumilo, N. and Wiegelmann, T., (2016). Optimal database design for the storage of financial information relating to real estate investments. Retrieved from: Journal of Property Investment and Finance, Vol. 34 No. 5, pp. 535-546.

Value creation

The strong push to digitize the commercial Real Estate sector is sponsored by some economic and time gap issues, which afflict industry processes and which need updating in order to stimulate the efficiency and effectiveness of operations and create value throughout the whole chain⁴². The economic efficiency can be defined as «*the relationship between the monetized means of production (inputs) and the product realized (outputs)*»⁴³; according to the theory of neo-institutional economics that takes its cue from the classical theories of Adam Smith in his “*Wealth of Nations*”, the organizational structure that performs optimally in a given context is the one that leads to maximum economic efficiency⁴⁴.

By focusing on the part of the process that is more fragmented, involves the most resources, has the greatest impact on the value of the property and is time-intensive, i.e. the conveyance process (that is composed by a series of steps, as follow: preparation and marketing, definition of the asking price, administrative processes, due diligence period, post-exchange period, land registry issues) and the consequent transaction of the asset, two major criticalities can be highlighted which constitute the greatest "Achilles heel" of the acquisition and disposal path:

- the lack of a single updated pool of standardized property information, which considerably increases the time required for operations to be completed;
- the absence of technological systems that can lead the parties involved to the closing of the transactions in a guided and coordinated way, acquiring the necessary documentation during the process and collecting all the necessary feedback and information until the closing of the deal⁴⁵.

⁴² Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

⁴³ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

⁴⁴ Ter Bogt, University of Groningen, Faculty of Economics and Business, (1998). Neo-institutionele economie, management control en verzelfstandiging van overheidsorganisaties: overwegingen voor verzelfstandiging en effecten op efficiëntie en financieel-economische sturing. Url of the article: Research output section of the University of Groningen website. University of Groningen.

⁴⁵ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

From this point of view, a technological platform for managing the exchange of data between market players, the agencies involved in assisting them in the process and the institutional parties, consisting of the banks (in the event that the provision of liquidity is necessary) and the Public Administration (in the case of a transaction, the Land Registry Agency) would redesign the roles of the players and the course of the transaction, in terms of the time required for closure and the costs necessary to bring it to a successful closure. This type of digital solution is referred to as e-conveyancing and consists of a single application platform that connects all parties involved in the delivery of information involved in the transfer of ownership⁴⁶ [figure 25].

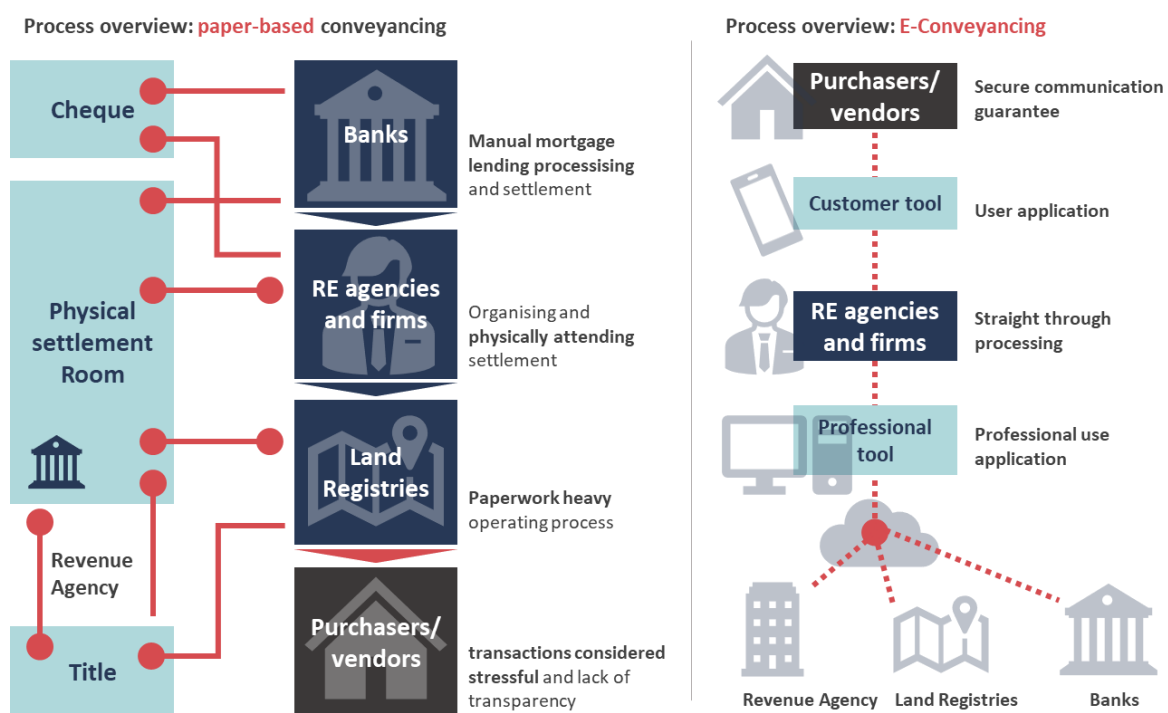


Figure 25: the chart illustrates the differences between a traditional (left side) and digitized (rightward) transaction process. Own elaboration based on the original graphics: Pexa – Property Exchange Australia, IPO prospectus.

⁴⁶ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

According to Saul, Baum and Braesemann, the success of a real property transfer can be assessed by measuring how close to initial expectations the conveyancing process has performed, based on the time it has taken (since the cost factor is only a derivative of the time it has taken)⁴⁷. As can be seen from the graph [Figure 26], it is interesting to observe how all the delays accumulated by the Public Administrations and the State Registries as a result of the Covid-19 pandemic have significantly impacted the time to sell the Real Estate stock, with increases ranging from 51 to 90 days.

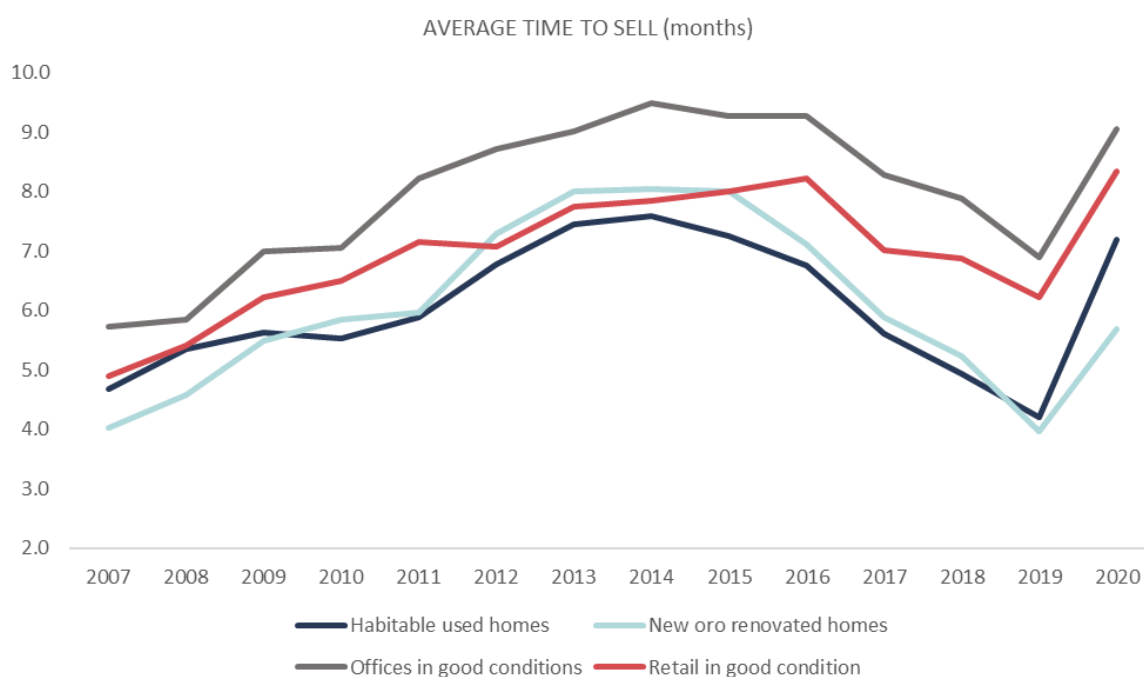


Figure 26: Average time to sell in Milan, expressed in months, for habitable used homes, new or renovated homes, offices in good condition, retail in good condition. Own elaboration based on the data extracted from: Nomisma, Real Estate Italian Observatory.

⁴⁷ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

Academics Sullivan, Cassidy, and Ermer have observed in their scientific model on transaction costs how the high charges resulting from the complex and lengthy time required for transactions are also negatively reflected in the valuation and profitability of properties; specifically:

- the level of transaction costs depends on the liquidity of the investment;
- the liquidity of the investment depends on the completeness of the information concerning it, the costs associated with their collection and the accessibility of the market.

Although transaction costs are ignored when property prices are assessed, it is noted that by adding the observable and hidden costs we will find a percentage range of incidence on the price between 6% and 10%⁴⁸. The graphical representation of the theory is shown:

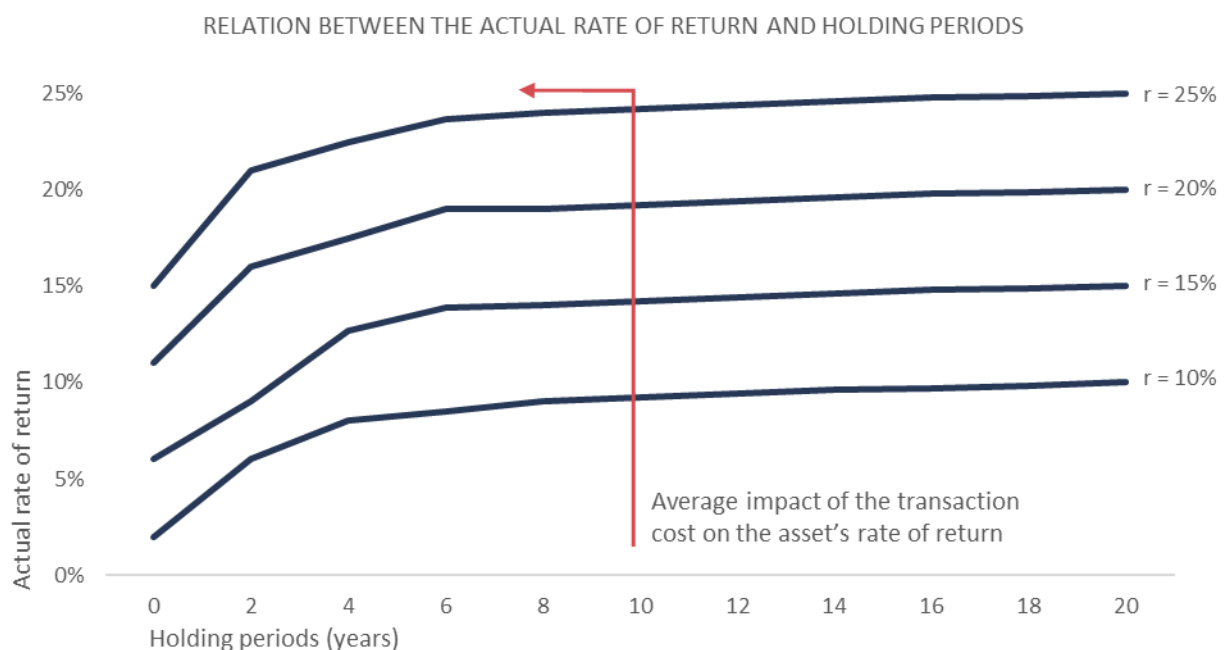


Figure 27: Relation between the Actual Rate of Return and Holding Period. Source of the data: Sullivan, Cassidy, Ermer, *The Journal of Real Estate Research*, (1991). A Note on the Effect of Transaction Costs on Real Estate Investment Returns.

⁴⁸ Sullivan M. J., Cassidy S. M., Ermer C. M., *The Journal of Real Estate Research*, (1991). A Note on the Effect of Transaction Costs on Real Estate Investment Returns. Retrieved from: *The Journal of Real Estate Research* Vol. 6, No. 1 (Spring 1991), pp. 113-117. Taylor & Francis, Ltd.

In a model representing the costs that an asset incurs every time it is traded, the impact of transaction costs is greater than their percentage incidence on the price of that property, since it incurs them every time an exchange takes place; for the construction of this graph, transaction costs are assumed to be 8%, and the effect on the rate of return is observed through different holding periods, ranging from one year to 20.

The conclusion is that the incidence of transaction cost sensitivity on the gross rate of return is high for periods of property retention in the portfolio of less than 10 years⁴⁹.

Brief findings

⁴⁹ Sullivan M. J., Cassidy S. M., Ermer C. M., The Journal of Real Estate Research, (1991). A Note on the Effect of Transaction Costs on Real Estate Investment Returns. Retrieved from: The Journal of Real Estate Research Vol. 6, No. 1 (Spring 1991), pp. 113-117. Taylor & Francis, Ltd.

In conclusion, the delayed or lack of adoption of digital technologies that support the entire Real Estate process, from sale/purchase to retention of properties for investment or capital protection purposes, leads to a substantial loss of value of "the brick" over time due to dynamics both endogenous (poor data tracking) and exogenous (long bureaucratic times and cumbersome processes) to the sector. These issues induce:

- to an increase in the timeframe required to transfer properties;
- the exponential increase in costs required to support a transaction;
- reduced returns over time;
- erosion of property valuations (due to the *appraisal smoothing*⁵⁰) and prices;
- the lack of liquidity in the Real Estate sector as a result.

The direct consequence of these assumptions is to ask whether real estate really has the value it possess, or whether it could be much greater⁵¹.

Starting from the following chapters we analyze a recently diffused technology that seems perfect to remedy to such deficiencies of the sector, allowing it to recover the lost value and increasing it further, simplifying and streamlining all the processes that involve it at 360 degrees, with a total and overwhelming grade of implementation.

⁵⁰ Baum A., Crosby N., McAllister P., Gallimore P., Gray A., Dept of Land Management and Development, University of Reading School of Business and Dept of Surveying, Nottingham Trent University, (2002). Appraiser behaviour and appraisal smoothing: some qualitative and quantitative evidence. Retrieved from: Central digital Archive of the University of Reading. Routledge, Informa UK Limited.

⁵¹ Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: Facilities, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

2.0 – THE TECHNOLOGY THAT ENABLES CHANGE

This chapter aims to briefly and simply explain how Blockchain technology operates today and what features directly correlate its operation with the current needs of the Real Estate industry. All of its component parts will be analyzed and how they interact with each other and how they could be applied in the various processes of the property sector, particularly with respect to transaction completion and tenant relationship management.

This technology is composed of five core elements that form its basic architecture⁵², and they are:

- The Distributed Ledger Technology (DLT);
- A Peer-to-peer network;
- The cryptography;
- The Consensus mechanism and
- The Validity rules.

2.1 - DLT | Distributed Ledger Technology

An infinite number of definitions have been given to the Blockchain; According to Froystad and Holm, it is a globally distributed ledger that facilitates the movement of assets around the world, with minimal transaction cost and in few seconds⁵³. Its operation is based on the replication of a database along a network, the distributed ledger, which is nothing more than the transcription of a series of data shared on multiple memories through a series of copies; all network participants have a copy of the ledger, and they are called nodes⁵⁴.

⁵² Hileman G., Rauchs M., London School of Economics and University of Cambridge, Centre for Alternative Finance, with the support of Visa and Ernst&Young, (2017). Global Blockchain Benchmarking Study. Retrieved from: SSRN research network, University of Cambridge - Cambridge Centre for Alternative Finance, 2017.

⁵³ Froystad P., Holm J., Evry Financial Services, (2015). Blockchain: Powering the Internet of Value. Retrieved from: Tieto Evry Oyj corporate website.

⁵⁴ Hileman G., Rauchs M., London School of Economics and University of Cambridge, Centre for Alternative Finance, with the support of Visa and Ernst&Young, (2017). Global Blockchain Benchmarking Study. Retrieved from: SSRN research network, University of Cambridge - Cambridge Centre for Alternative Finance, 2017.

The technology enables and allows the various nodes of the platform to propose, validate, and record changes and updates that have occurred within the database consistently across the network, most importantly without the need to rely on a central trusted party to enable the circulation of validated information⁵⁵ [figure 28].

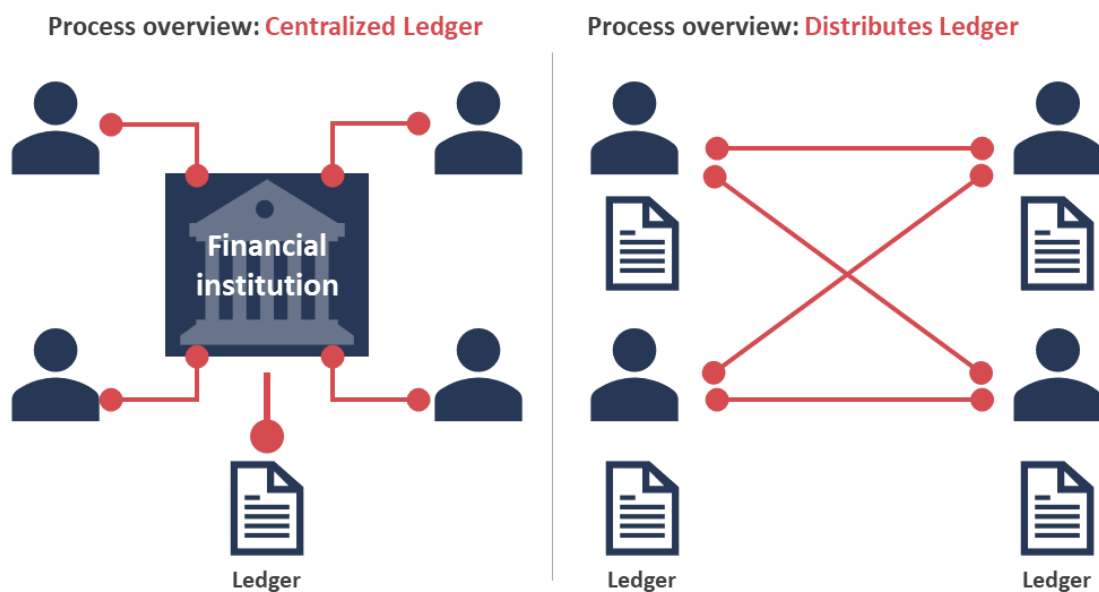


Figure 28: comparison between the current paradigm of centralized finance, with ledgers validated and owned by a central authority, and decentralized finance, with the ledger shared among network participants (nodes) and validated by all. Source of the graphic: own elaboration based on proposed literature.

⁵⁵ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

2.2 - P2P | Peer to peer technology

The online Peer-to-Peer (P2P) is a system that allows the voluntary or indirect pairing of two or more users in the network [figure 29] in order to perform transactions that are validated through a specific standard defined consensus mechanism, which allows to obtain validation of the eligibility and correctness of the transaction; this approval is conferred through adherence to a set of validity rules⁵⁶. A feature of this type of technology functionality is that the P2P mechanism solves the well-known problem of double spending: the network records the value movements by adding them to a chain containing also the data of other transfers which, in order to be modified, requires the whole validation process to be repeated; if an error is identified within it, it is completely invalidated⁵⁷.

In this aspect lies the real revolution brought about by this technology, as it provides for the total absence of third trusted parties in order to carry out the transfer of information or any kind of value; in this sense the technology is very challenging towards actors that are today very involved in the processes, such as banks, financial and credit institutions, notaries and public registers⁵⁸.

⁵⁶ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

⁵⁷ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

⁵⁸ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

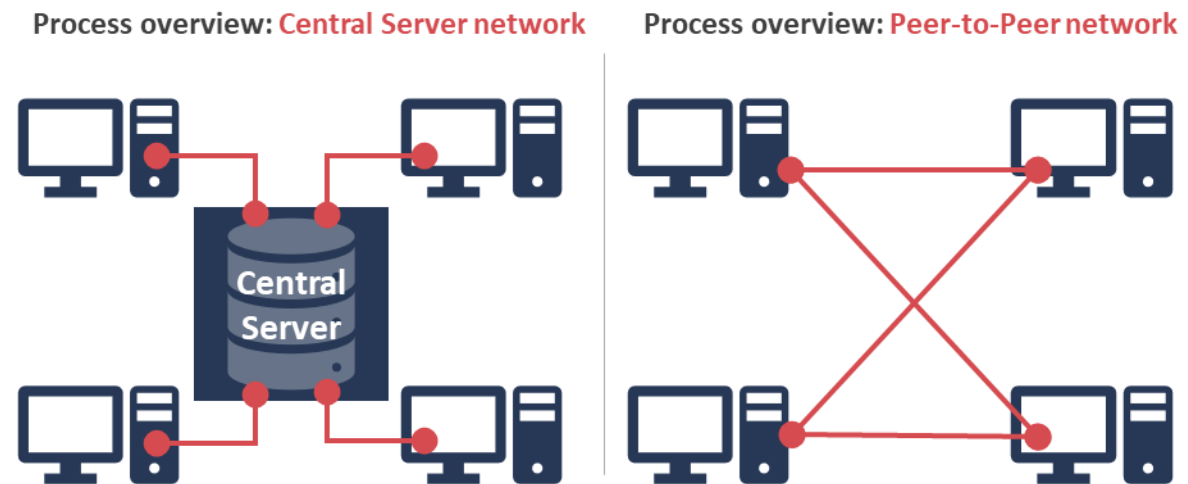


Figure 29: comparison between a central server network, in which all kind of data pass through a central server, and a P2P network where the transmission of information takes place directly between the users. Source of the graphic: own elaboration based on proposed literature.

2.3 – DATA STORAGE

Blocks

The information inserted in the Distributed Ledger, once validated by the set of rules established by the network, composes a new element called Block; every time data are verified and authorized, they compose a new Block that is added to an already existing chain. Hence the name of the technology as "Chain of Blocks"⁵⁹.

Hashing

A cryptographic hash is a unique code used as a reference to personal data contained in one or more blocks, published on a DLT as immutable evidence over time, but which is stored on the user's device or on a third-party server. In essence, the data in narrative form are compressed into an alphanumeric code created specifically by an algorithm, which can only be decrypted through certain permissions that allow to overcome the encryption that preserves the confidentiality, and which occupies considerably less memory than the original source. The requirements for deciphering such code and tracing user inputs are maintained by a single algorithm that takes care of their privacy; the result is an efficient and streamlined way of storing data online across multiple memories, without worrying about its security⁶⁰.

Data storage

Basically, a Blockchain is a type of shared database in which the contents, before being inserted, are verified and agreed upon by a network composed of independent nodes (peers). For a new set of information to be added, the independent verifiers must come to a consensus that determines its validity⁶¹. Entering data in a time-immutable memory manner is the main

⁵⁹ Carlozo L., Qwoted Journalistic Sources, (2017). Why CPAs need to get a grip on blockchain. Url of the article: Journal of Accountancy website, <https://www.journalofaccountancy.com/news/2017/jun/blockchain-decentralized-ledger-system-201716738.html>. Association of International Certified Professional Accountants.

⁶⁰ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

⁶¹ Zheng Z., Dai H.N., Chen X., Wang H., School of Data and Computer Science, Sun Yat-sen University, Faculty of Information Technology, Macau University of Science and Technology, Insitute of Advanced Technology, Sun Yat-sen University and National University of Defense Technology, Changsha, (2018). Blockchain Challenges and

feature of that complex technology, but from its tech-father creator Nakamoto it is not even mentioned among the fundamental benefits of the system as he was interested in promoting it as the new frontier of online payments⁶². The data entered within the shared database (DLT) is immutable over time and therefore can be considered fraud-resistant and proof-of-ownership; for this reason this information repository makes up a historically consistent database. But if users need files that can be updated but equally secure, they must opt for other solutions, such as Smart Contracts (discussed later in the paper)⁶³.

2.4 – DATA INTEGRITY

Cryptography

Nakamoto has theorized and concretized a method of data exchange (which in his idea should be used as a technology for electronic payments) that is not based on trust (today represented by banking and governmental bodies) but on cryptographic proof⁶⁴. Technically speaking, a cryptocurrency is a record attached to an address (public key) that can be managed through a private key; public and private keys constitute what is known as asymmetric cryptography. For example, a cryptographic hash is published as immutable evidence in a distributed ledger and provides a link to personal data, but the constituent information is stored in the memory of the user's device or on a private cloud server⁶⁵.

Opportunities: a Survey. Retrieved from: Lingnan University online resources. *International Journal of Web and Grid Services*, Vol.14, No. 4, 2018.

⁶² Nakamoto S., (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from: Bitcoin.org.

⁶³ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

⁶⁴ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: *International Journal of Applied Science*; Vol.2, No.2, 2019. Ideas Spread Publications.

⁶⁵ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: *Journal of Property, Planning and Environmental Law* Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

Trust is thus created and based on cryptographic proof; once consensus has been reached on the validity of a transaction or data entry, a new block containing the relevant information is added to the chain of blocks and can no longer be manipulated, altered, or deleted based on the cryptography applied to it, which protects its integrity⁶⁶.

Process overview: data entry validation

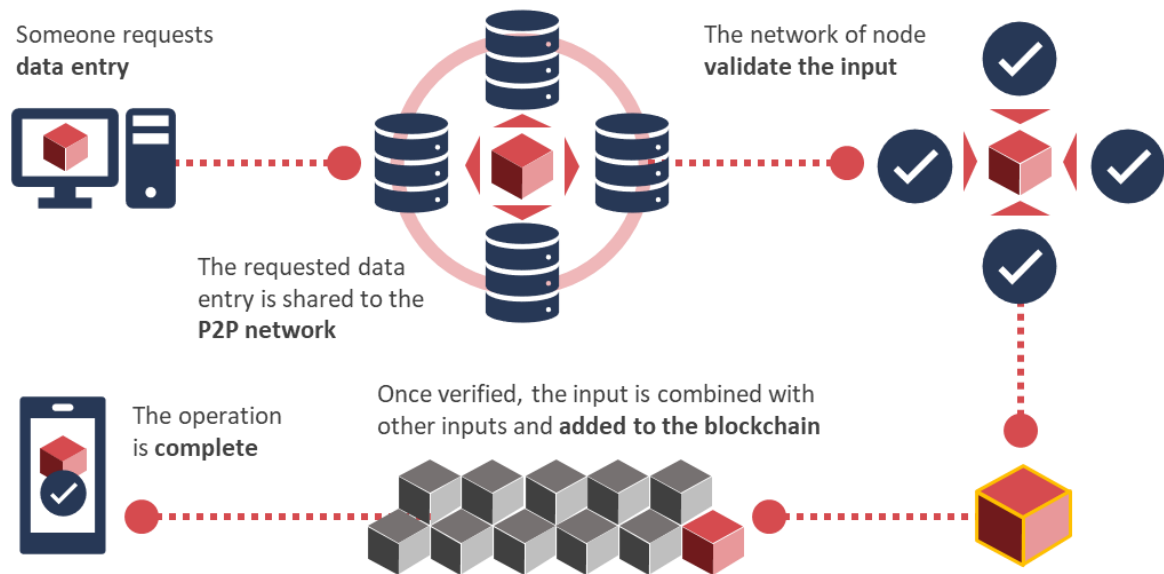


Figure 30: the illustration shows the process of validating a block of data. Source of the graphic: own elaboration based on proposed literature.

⁶⁶ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

Permissions

The broadest distinction that can be made about the types of blockchain is between the private and the public ones; the public ones (for example the Bitcoin currency, that is traded and used on an open platform) allow any user to connect to the network to validate the information and data entered in it, while the latter ones allow only some to access it and are managed by a central authority (represented by a user of the same chain). In addition, the private ones can distribute their ledgers publicly, but they cannot decentralized their consensus mechanism because the authority to do it is reserved to only one component of the network⁶⁷.

Generally, this distinction can be traced back to the method of validation of the various blocks that make up the chain: a Blockchain is permissionless when any user contributes to the validation of the blocks themselves, while it is permissionless when only certain domains can perform the operation. Usually, private chains are permissioned, while public ones are permissionless. The choice between one and the other type and hybrid forms depends on the functionality that the network needs to perform through the technological infrastructure⁶⁸.

In any case, since this digital tool is born and spread to create trust between subjects who do not know each other, private chains are to be considered less destructive in terms of technological revolution and less innovative: if a central authority has control over the entrance in a network or over the possibility to validate or not the information inserted in it, the functionalities of this tool are less useful because in the current paradigm (whether it is a matter of transactions or validation of documents) it is already a central authority the one who provides to procure such trust⁶⁹.

⁶⁷ Preukschat A., Kuchkovsky C., Lardies G.G., Elñigo Molero D.D.G., Blockchain. La revolución industrial de internet, (2017). Blockchain. La revolución industrial de internet. Retrieved from: Centro Libros PAPP, ISBN: 978-84-9875-448-3. Dirijase a CEDRO (Centro Español de Derechos Reprográficos).

⁶⁸ Garcia-Teruel R. M., Department of Private, Procedural and Tax Law, UNESCO Housing Chair, Universitat Rovira i Virgili, Tarragona, Spain, (2019). Legal challenges and opportunities of blockchain technology in the Real Estate sector. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 129-145. Emerald Publishing Limited.

⁶⁹ Gabison, G., University of Virginia School of Law, (2016). Policy Considerations for the Blockchain Technology. Public and Private Applications. Retrieved from: Science and Technology Law Review, Volume 19, Number 3, 2016. Law Journals , SMU Scholar.

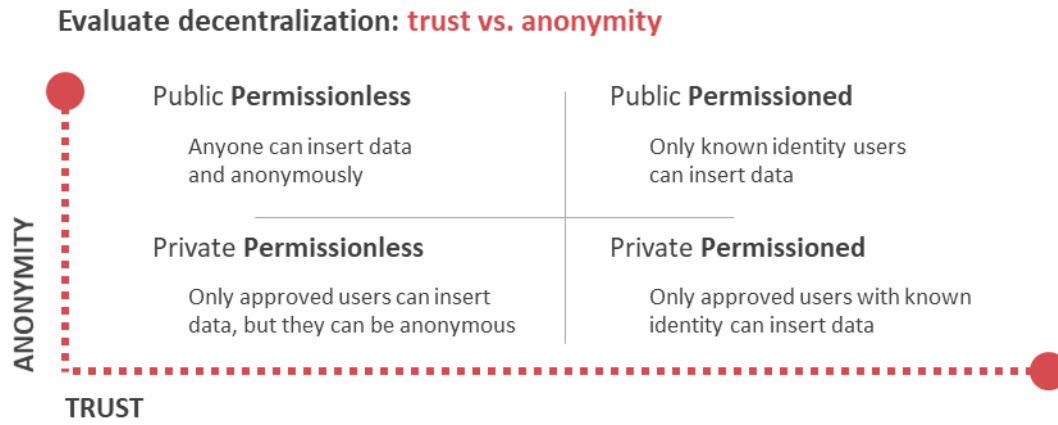


Figure 31: The different degrees of decentralization and control of blockchains on the network. Source of the graphic: own elaboration based on proposed literature.

2.5 – STRUCTURAL ELEMENTS

For the development of blockchain and especially to imagine its implementation in the Real Estate sector, tokens and smart contracts are milestones because they allow the digitization of property titles, the drafting of contracts of various nature and the processing of transactions⁷⁰.

Tokens

Tokens are an overlapping technology to cryptocurrencies and smart contracts within blockchains; although this, they can represent isolated records within the system⁷¹. In this sense the tokens constitute the record in the ledger and each is a unique piece that is distinct from its address (the unique code called hash) and owned by a user; whoever owns the relevant private key can carry out and authorize the transfers of the same within and outside the blockchain in which it was minted⁷².

Through their use, individuals active within the chain can establish legal relationships related to real-world assets, attaching to the token the property titles of the asset itself; starting from this assumption it is easy to imagine what wide use they could have inside the Real Estate market (those that include title to real economic assets are also referred to as asset-backed tokens or non-fungible tokens, as they represents something unique)⁷³.

The minting⁷⁴ of tokens representing Real Estate properties and mortgages has been tested through various projects (Homeland, Pangea, Atlant, which will be discussed in subsequent chapters): the term "tokenization" is used to describe the procedure by which a certain right

⁷⁰ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

⁷¹ Raval S., (2016). Decentralized Applications: Harnessing Bitcoin's Blockchain Technology. Retrieved from: Siraj Raval Technology School website, <https://sirajraval.com/>. O'Reilly Media, 2016.

⁷² Mint: [verb] to produce something new; [noun] a place where the new coins and paper money of a country are made. Source: Cambridge University Press 2021.

⁷³ Androulaki E., Karame G.O., Roeschlin M., Scherer T., Capkun S., ETH Zurich and NEC Laboratories Europe, (2013). Evaluating User Privacy in Bitcoin. Retrieved from: Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), Vol. 7859 LNCS, p. 596, <https://eprint.iacr.org/2012/596.pdf>. Springer-Verlag Berlin Heidelberg, 2013.

⁷⁴ Mint: [verb] to produce something new; [noun] a place where the new coins and paper money of a country are made. Source: Cambridge University Press 2021.

to use a property is included within the token, such that the exchange of the same involves the movement of that right⁷⁵.

Smart contracts

Smart contracts are an application of distributed ledgers for automating transaction processes in digital form; they use protocols and algorithms to execute, verify, and constrain the performance of an agreement⁷⁶. In doing so, they could automate the process of decision-making by allowing self-executing codes to take actions at specific time intervals or based on reference to the occurrence or non-occurrence of events in the external world. Hypothetically, they can completely replace traditional financial intermediaries in the functions of collecting payments and verifying the compliance of the parties involved⁷⁷.

The change towards smart contracts and self-executing programs opens a specific debate with respect to precise questions of governance and responsibility: in general, the issue is how much, and with what degree, software developers and programmers, as well as the users of blockchain systems, can be held responsible for failures and malfunctions of the same; in no country has a specific branch of "smart" law been created yet, and new rules and laws will have to be developed to protect the parties and allow their use⁷⁸.

⁷⁵ Houben R., Snyers A., European Parliament, Policy Department for Economic, Scientific and Quality of Life Policies, (2018). Cryptocurrencies and blockchain. Legal context and implications for financial crime, money laundering and tax evasion. Retrieved from: European Parliament website, /www.europarl.europa.eu, p.23. Study requested by the TAX3 committee.

⁷⁶ Konashevych O., University of Bologna, (2019). Cross-Blockchain Databases for Governments: The Technology for Public Registries and Smart Laws. Retrieved from: SSRN research network, Emerald Insight.

⁷⁷ CFTC Commodity Futures Trading Commission, (2018). A primer on smart contracts. Retrieved from: US Federal website, Commodity Futures Trading Commission Section, <https://www.cftc.gov/LabCFTC/News-Events/labcftcprimersmartcontract112718>. LabCFTC.

⁷⁸ Dawes S.S., Center for Technology in Government, University at Albany, (2008). The Evolution and Continuing Challenges of E-Governance. Retrieved from: University of Alaska Anchorage, College of Business and Public Policy educational sources, <http://faculty.cbpp.uaa.alaska.edu/afgjp/padm610/Evolution%20and%20continuing%20challenges%20of%20E-Governance.pdf>. Public Administration Review, Vol. 68, pp. S86-S102.

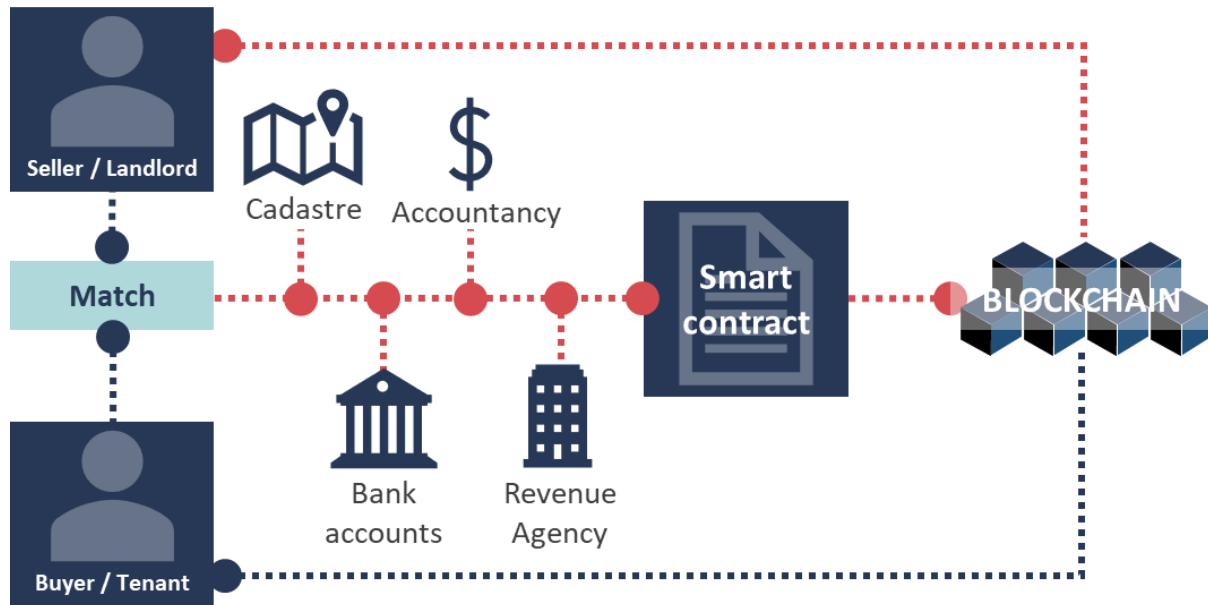


Figure 32: the diagram shows how a smart contract applied to Real Estate might work. Source of the graphic: own elaboration based on proposed literature.

Property passports

The concept of property passport stems from the opportunity offered by smart contracts and consists in the possibility of storing all the information relevant to a property in its own personal digital data file; this document should be kept by the asset's owner and transferred over time when it is sold⁷⁹.

Although current technologies and processes can already lead to the introduction of this type of document, a comprehensive, transparent, up-to-date, and economically viable report will require the integration of digital technologies and sensors interconnected to BIM models, and automated tools to manage tenants. This type of registry could have the potential to store accumulated data in a standardized and pre-determined manner, reducing the lengthy timelines and significant costs incurred today for an appropriate technical and economic due diligence phase⁸⁰.

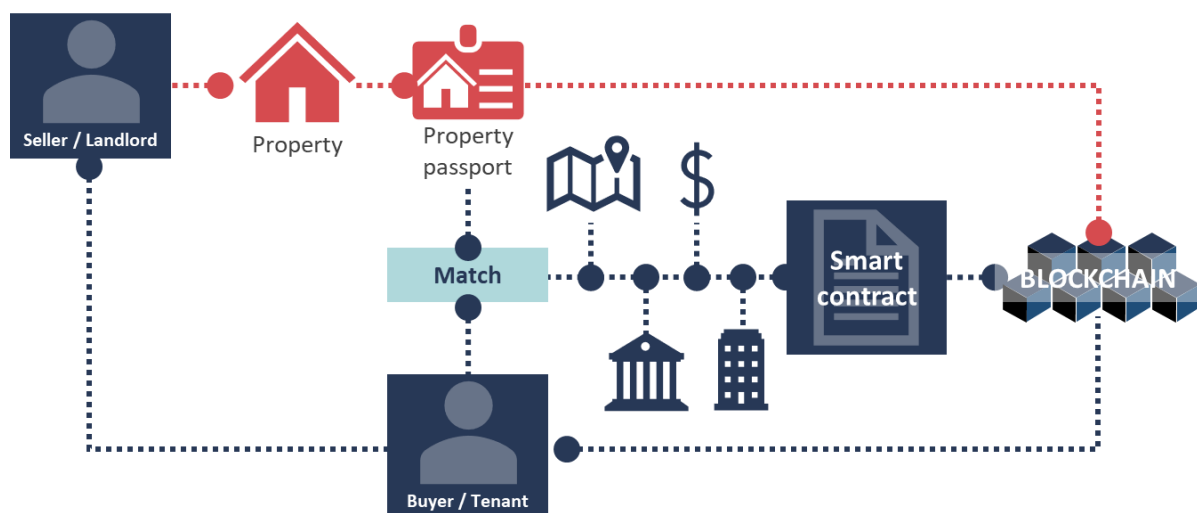


Figure 33: the diagram shows how the property passport fits into the Real Estate process. Source of the graphic: own elaboration based on proposed literature.

⁷⁹ Sesana M.M., Salvalai G., Architecture Built Environment and Construction Engineering Department of Politecnico di Milano, (2018). A review on Building Renovation Passport: Potentialities and barriers on current initiatives. Retrieved from: Institutional Online Public Archive of Research Products of the Politecnico di Milano, <https://re.public.polimi.it/>. Energy & Buildings No. 173, pp.195-205. Elsevier B.V.

⁸⁰ Ganter M., Lutzendorf T., Karlsruhe Institute of Technology, (2019). Information management throughout the life cycle of buildings – Basics and new approaches such as blockchain. Retrieved from: IOP Conference Series Earth and Environmental Science publication, <https://iopscience.iop.org/article/10.1088/1755-1315/323/1/012110/pdf>. IOP Publishing Ltd.

2.6 – FINAL REMARKS

Blockchain as an exchange or production technology

Analyzing the elements that constitute this technology, already acclaimed for its ongoing diffusion, but still immature in developments other than its use as a means of exchanging economic value (the reference is to the universe of cryptocurrencies), the question that needs to be asked to imagine its deployment in the direction of possible new uses in the near future is "what kind of technology is the blockchain?"⁸¹.

De Filippi, Davidson, and Potts argue by pointing out that there are two types of scenarios that are forewarned: that it is a technology of general purpose, in the sense that it can be widely exploited and intensively deployed in various market segments, and it can contribute to "exponential production growth"⁸².

Not in opposition, but from a Coasian perspective⁸³, there are academics and researchers who place as a key issue how the blockchain could reduce transaction costs through very cost-effective verification processes and disintermediation from traditional administrative actors and financial institutions. The first view understands the blockchain as a production technology (general purpose view), while the second approach refers to it as an exchange related technology (market enhancing or Coasian view)⁸⁴.

There is no agreed answer on what is the correct vision to imagine a large-scale development in the medium term because all economic sectors are only beginning to test its functionality and the possibilities it can offer: think of the tracking of supply chains of perishable materials⁸⁵

⁸¹ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

⁸² Davidson S., De Filippi P., Potts J., University of Iowa and Erasmus University of Rotterdam, (1998). The So-Called Coase Theorem. Retrieved from: Eastern Economic Journal Vol.24, No. 3, <https://www.jstor.org/stable/40325879>. Palgrave Macmillan Journals.

⁸³ McCloskey D., University of Iowa and Erasmus University of Rotterdam, (1998). The So-Called Coase Theorem. Retrieved from: Eastern Economic Journal Vol.24, No. 3, <https://www.jstor.org/stable/40325879>. Palgrave Macmillan Journals.

⁸⁴ Davidson S., De Filippi P., Potts J., University of Iowa and Erasmus University of Rotterdam, (1998). Ibid.

⁸⁵ Franzosi M., La Repubblica newspaper, (2021). Processi produttivi e ingredienti: tracciabilità in blockchain per Birra Peroni. Url of the article: https://www.repubblica.it/economia/rapporti/osservabilia/osservabeverage/2021/06/03/news/birra_peroni_in_blockchain_dal_campo_alla_tavola-304065263/. GEDI News Network Spa.

and the cold chain⁸⁶, the decentralization of traditional finance (the so-called DeFi⁸⁷), the streamlining of operations related to the fossil fuel sector⁸⁸ and finally the retail investment activity for capital appreciation (The European Investment Bank has raised 100 million Euros from a digital bond issued with Ether blockchain technology)⁸⁹.

3.0 – The challenge of decentralization

Decentralization refers to the elimination, or reduction of the role, of one or more intermediaries or centralized processes that traditionally involve the provision of financial services, the registration of property titles and all activities typically performed by public administrations, e.g. record-keeping and public data storage⁹⁰. As a matter of fact, the public registers, which are monitored by centralized authorities, constitute an act of trust on the citizens' side who in fact have no alternative options; such organizational models represent an extreme point of fragility, as every system with a single point of failure is highly vulnerable as if bypassed it leaves a wide field of data leaks, manumissions and substantial losses of information (as also demonstrated by the recent hacker attacks on public administrations⁹¹ or the loss of data at the tax office of the Ukrainian government^{92,93}).

⁸⁶ Libow E., IBM CTO Asset Performance, (2021). IoT for blockchain cold chain. Url of the article: IBM Cloud Architecture website, <https://www.ibm.com/cloud/architecture/architectures/iot-blockchain-cold-chain/>.

⁸⁷ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

⁸⁸ Ernst & Young Global, (2021). How digitalization can streamline oil and gas operations. Url of the article: EY Global Insights website, https://www.ey.com/en_gl/oil-gas/how-digitalization-can-streamline-oil-and-gas-operations. EY Global.

⁸⁹ Bahceli Y., Reuters International, (2021). UPDATE 3-EIB uses blockchain for new 100 mln-euro bond sale. Url of the article: <https://www.reuters.com/article/eib-bonds-idUSL8N2ML346>. Reuters.

⁹⁰ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

⁹¹ Klein D., OCCRP - Organized Crime and Corruption Reporting Project, (2021). Italy Probes Cyber Attack as an Act of Terrorism. Url of the article: <https://www.occrp.org/en/daily/14967-italy-probes-cyber-attack-as-an-act-of-terrorism>. Published: 05 August 2021. OCCRP non-governmental organization.

⁹² UNIAN Information Agency, (2016). The fiscal service lost more than 500,000 documents. Url of the article: www.unian.ua/economics/finance/1322681-fiskalna-slujba-vtrabila-ponad500-tisyach-dokumentiv-zmi.html. Kyiv, 18 April. UNIAN.NET, 1998 - 2021.

⁹³ Press Service of the State Fiscal Service of Ukraine, (2016). SFS information systems operate normally. Url of the article: <http://sfs.gov.ua/media-tsentri/novini/245619.html>. State Fiscal Service of Ukraine.

Centralization also means the ability to be able to change, replace or modify certain portions of this information and their history tracking, and to be able to censor the contents⁹⁴.

Network types: from maximum concentration to maximum distribution

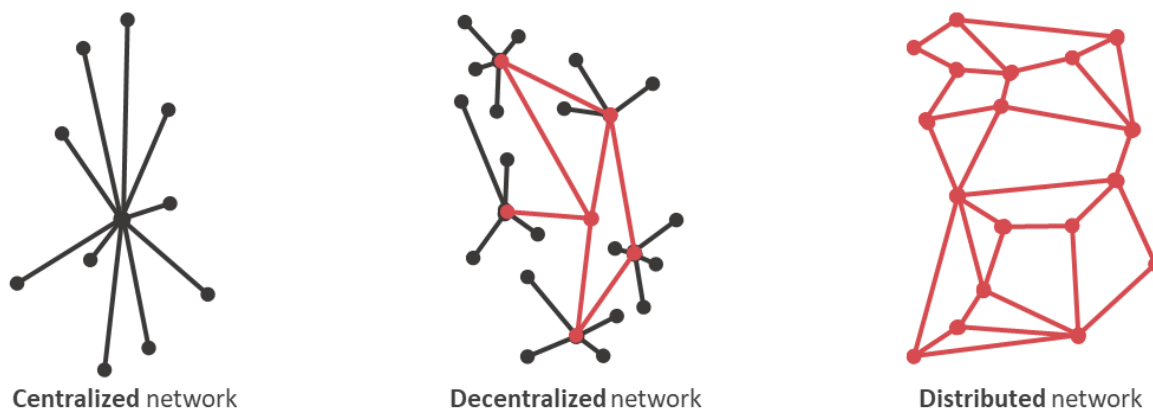


Figure 34: The types of networks: through this scheme the vulnerability of a centralized star system and the potential of a distributed one in which all nodes have the same importance emerges. Source of the scheme: Baran P., United States Air Force Project RAND, (1964). On distributed communications: introduction to Distributed Communication Networks. Retrieved from: RAND Corporation website, published research and memorandum, https://www.rand.org/content/dam/rand/pubs/research_memoranda/2006/RM3420.pdf. RAND Corporation Santa Monica.

We must specify that, although public administrations already constitute a form of decentralization of the Central Government, they always represent an extension of the Central Authority and of a single linear system; when we refer to decentralization in the field of Blockchain technology, we instead make reference to a distributed network whose nodes have the same weight and power on the validation and storage of the data entered in it⁹⁵.

⁹⁴ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

⁹⁵ Froystad P., Holm J., Evry Financial Services, (2015). Blockchain: Powering the Internet of Value. Retrieved from: Tieto Evry Oyj corporate website.

3.1 – FORMS OF DECENTRALIZATION

Although the possibilities and combinations offered by Blockchain technology are almost infinite, there are essentially three forms of decentralization⁹⁶ to which all existing networks can be traced⁹⁷:

- I. decentralization of decision-making processes. It involves stepping away from the presence of a single trusted intermediary or infrastructure towards systems in which a broad spectrum of users are able to make coordinated decisions with respect to the lawfulness of a transaction or information entered, and thus validate the block;
- II. decentralization of risk-taking. It involves moving beyond the holding of risk (e.g. credit and liquidity risk) from the accounting balance sheets of a single traditional institutional entity to a much more direct match between users and providers of financial and legal services;
- III. decentralization of record-keeping. With a shift away from the centralized holding of data and information records towards forms of organization in which the power to store data and the possibility of accessing it is extended to broad consortia of users, and in which these records can also be produced in a distributed manner through consensus mechanisms.

For applications to display all three of the above degrees of decentralization will take some time to develop, and they do not appear to be able to achieve considerable economic deployment in the short term, since most of the systems that are managing to find a way to implement them within current processes display only one or at most two of the degrees of distribution, mainly because of their potential of scalability to the masses and to maintain a level of trust among potential consumers at least similar to that of current centralized entities⁹⁸.

⁹⁶ Baran P., United States Air Force Project RAND, (1964). On distributed communications: introduction to Distributed Communication Networks. Retrieved from: RAND Corporation website, published research and memorandum, https://www.rand.org/content/dam/rand/pubs/research_memoranda/2006/RM3420.pdf. RAND Corporation Santa Monica.

⁹⁷ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

⁹⁸ Auer R., Monetary and Economic Department of Bank for International Settlements BIS, (2019). Beyond the doomsday economics of "proof-of-work" in cryptocurrencies. Retrieved from: Bis researches webpage: https://www.bis.org/forum/research.htm?m=5_23. Bank for International Settlements BIS.

The common feature of all these implementation attempts is the concept of decentralized consensus: the consensus protocol is the logic by which these services are created and legitimized within the network⁹⁹.

Decentralization and the distribution of trust traditionally belonging to financial institutions and public administrative bodies is not a fixed state but represents a delicate and structured process that can end in centralization, and the stronger its structuration the less risk there is of this happening¹⁰⁰.

Immutability

One of the major advantages of using Blockchains, besides the idea of decentralization of the functions it covers, lies in the immutability of the information it contains: once written, a block is tamper-proof and registered in all the ledgers of the users of the chain, and they can consult the information it contains to verify its truthfulness, without the involvement of any central authority. This makes the technology perfect not only for recording cryptocurrency transactions, but also for storing property titles, property rights and contracts¹⁰¹; indeed, the common driving idea of most projects is to destroy and decentralizing the whole Real Estate industry by the implementation of digital land registries in Blockchains, developing transactions and liquidity and applying Smart Contracts¹⁰².

In the image below we try to reconstruct the functioning of the mechanism of immutability of the register and how it is tamper-proof: if a subject tried to alter the information contained in one of the blocks, he would be forced to modify all the blocks that make up the chain (and they can be from a few tens to tens of thousands), vice versa there would no longer be a reference

⁹⁹ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

¹⁰⁰ Australian Government Digital Transformation Agency, (2018). Blockchain overview: Australian Government guide. Retrieved from: Dta website, <https://www.dta.gov.au/help-and-advice/technology/blockchain/blockchain-overview-australian-government-guide>. Commonwealth of Australia. Licensed under the CC BY 4.0 license.

¹⁰¹ Preukschat A., Kuchkovsky C., Lardies G.G., Elñigo Molero D.D.G., Blockchain. La revolución industrial de internet, (2017). Blockchain. La revolución industrial de internet. Retrieved from: Centro Libros PAPP, ISBN: 978-84-9875-448-3. Dirijase a CEDRO (Centro Español de Derechos Reprográficos).

¹⁰² MyungSan j., (2018). Blockchain government. A next form of infrastructure for the twenty-first century. Retrieved from: Journal of Open Innovation: Technology, Market, and Complexity, 13 February 2018. SpringerOpen.

between the previous and the next one, making it invalid and removing the correspondence that it has with all the copies stored in the various nodes of the network to which it belongs¹⁰³.

This distinctive feature of Blockchains, which makes them particularly suitable for managing situations where there is no trust between the parties, is also a major limitation to their applicability in the Real Estate field: once data has been entered (e.g. quantitative information about the asset or property titles) it cannot be altered or changed over time if the traditional form of technology is assumed to be used¹⁰⁴.

How the Blockchain ensure the **immutability** of the ledger

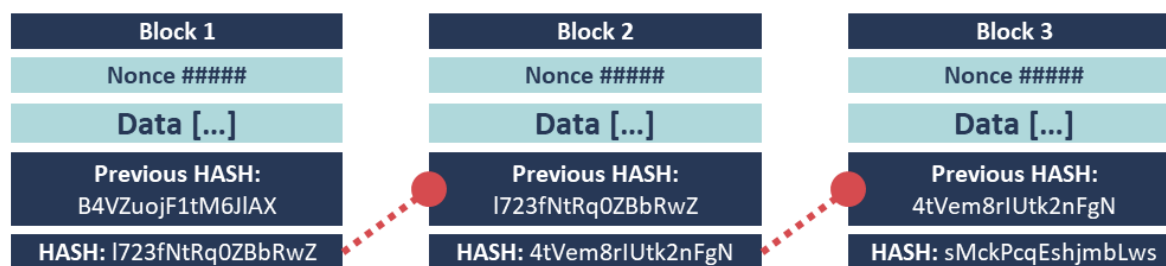


Figure 35: how the immutability process is guaranteed within the Blockchain. Source of the graphic: Larson B., Verizon Data Science, (2018). Blockchain: Immutable Ledger. Url of the article: An Analytics Education for All. Unraveling the Mystery Behind Big Data and Analytics, <https://analytics4all.org/2018/04/09/blockchain-immutable-ledger/comment-page-1/>. Analytics4All.

¹⁰³ Acheson N., CoinDesk Insights, (2019). Security Tokens vs. Tokenized Securities: It's More Than Semantics. Url of the article: <https://www.coindesk.com/markets/2019/02/02/security-tokens-vs-tokenized-securities-its-more-than-semantics/>. Feb 2, 2019. 2021 CoinDesk.

¹⁰⁴ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

3.2 – RISK OF DECENTRALIZATION

The use of decentralized technologies could affect the nature and significance of operational risk; on the one hand, decentralized systems may become much more resilient to cyber risks than highly centralized systems, particularly for record keeping and service exploitation functions. This is due to the way they disperse data and information records rather than concentrate them in a single node or system. On the other hand, even though the mechanisms and modalities through which most Distributed Registry systems record and verify the validity of the information entered in them are highly decentralized, the users participating in the network generally use very similar technologies for their storage, increasing their vulnerability to large-scale cybernetic and operational negative events¹⁰⁵.

In broad terms, we could summarize the risks that could arise from the use of these technologies into five main categories¹⁰⁶:

- some new forms of concentration risk could emerge from the circumstance that the activities that make a DLT operational (ownership of the platform, control over the source codes, operation of the network, forging of the crypto assets and development of the associated codes) would be in the hands of a very small circle of individuals or companies;
- there is a risk that greater procyclicality will emerge especially in the provision of credit to consumers and businesses, as peer-to-peer platforms are much more sensitive to economic cycles and hence their patterns of liquidity provision. This will matter especially where lending depends on automated algorithms whose performance depends on newly developed systems whose behavior is unknown in a recession¹⁰⁷;

¹⁰⁵ Aggarwal D., Brennen G.K., Lee T., Santha M., Tomamichel M., Cornell University Quantum Physics, (2017). Quantum attacks on Bitcoin, and how to protect against them. Url of the article: ArXiv Research Center, <https://arxiv.org/abs/1710.10377#>. Ledger Journal, [S.l.], v. 3, oct. 2018.

¹⁰⁶ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

¹⁰⁷ Braggion F., Manconi A., Zhu H., European Corporate Governance Institute (ECGI), Bocconi University, Erasmus University Rotterdam, (2018). Can Technology Undermine Macroprudential Regulation? Evidence from Peer-to-Peer Credit in China. Retrieved from: SSRN research network, CEPR Discussion Paper No. DP12668. Elsevier.

- "diffuse" or unclear responsibility and accountability may emerge when its allocation in highly decentralized and distributed systems is unclear or complex, particularly in those permissionless systems and where users may remain anonymous¹⁰⁸;
- difficult resolution and recovery undertakings may emerge, particularly in the financial aspects of the technology, where financial institutions today rely on highly centralized structures for their resolution, whose members are known users;
- Other operational and legal risks may come to light, as Distributed Ledger Technology relies on mechanisms for validation and consensus of information, they may be very vulnerable to adverse dynamics. For instance, a chain of validating users could agree to record illegal activities, putting further pressure on the systems based on decentralized consensus and its real applicability and effectiveness¹⁰⁹.

If the cumulative effects and interactions between these risks end up causing potential users of the system to lose confidence, this will seriously undermine the applicability of this technology; in particular, it is essential that the regulatory arbitrage and the regulations of the various countries adapt to the technological progress underway with the appropriate timing, eliminating the risk of *technological neutrality*¹¹⁰ of the laws currently adopted by the Governments; many initiatives in this sense have already been put forward, for example the *Virtual Financial Assets Act* in Malta¹¹¹ or *Law no.12/12019*¹¹² in Italy, which seeks to regulate the use of the DLT system and its relationship with the Public Administration.

¹⁰⁸ Nathan D., Pesok J., Orrick, Herrington & Sutcliffe LLP, (2018). A Foreboding View of Smart Contract Developer Liability. Url of the article: Lexology, <https://www.lexology.com/library/detail.aspx?g=a5018354-4a0c-4734-9e63-fce1e99ca708>. Law Business Research.

¹⁰⁹ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

¹¹⁰ Garcia-Teruel R. M., Department of Private, Procedural and Tax Law, UNESCO Housing Chair, Universitat Rovira i Virgili, Tarragona, Spain, (2019). Legal challenges and opportunities of blockchain technology in the Real Estate sector. Retrieved from: *Journal of Property, Planning and Environmental Law* Vol. 12 No. 2, 2020 pp. 129-145. Emerald Publishing Limited.

¹¹¹ Malta Financial Services Authority mfsa, (2018). Virtual Financial Assets. Supporting innovation and new technologies for financial services in the area of crypto-assets. Retrieved from: <https://www.mfsa.mt/our-work/virtual-financial-assets/>. MFSA.

¹¹² Gazzetta Ufficiale della Repubblica Italiana, Legge 11 febbraio 2019, n. 12. Tecnologie basate su registri distribuiti e smart contract: Conversione in legge, con modificazioni, del decreto-legge 14 dicembre 2018, n. 135, recante disposizioni urgenti in materia di sostegno e semplificazione per le imprese e per la pubblica amministrazione. Retrieved from: <https://www.gazzettaufficiale.it/eli/id/2019/02/12/19G00017/sg>. MEF.

3.3 – LIMITATIONS AND CHALLENGES TO OVERCOME

Governance and regulatory

The issues outlined above pose new challenges for all existing regulatory and supervisory frameworks, particularly because they are all focused on centralized intermediation systems. Increased decentralization makes a tailor-made regulatory approach more relevant and reinforces the significance of an activity-based regulation¹¹³, especially when trying to focus on services and activities that do not refer to specific entities and jurisdictions¹¹⁴.

Significant deployment of decentralized and distributed systems may have consequences for them in terms of being challenged by current policy frameworks focused on the presence of a central entity to refer to; especially for the control and governance of technological systems and their development, not least of their users, to check and control all those conditions that could lead to situations of financial and legal instability.

Blockchains in their purest scheme, leave no room for concrete possibilities to impose and justify any legal or legitimate decision by the authorities because normally retroactivity is impossible and no one except the custodian of the private key of a single token (and therefore of the underlying asset) can undermine or perform a transaction or movement¹¹⁵.

To give a more comprehensive perspective on the discussion, it is necessary to consider what kind of entity a token represents today, whether a title, a property right, a security or a new legal concept. First of all, a token is just an entry in a register, it does not necessarily have any legal aspect in the same way as a piece of paper does not create any legal relationship; to be valid, it must be linked to a law and a contract. To give a precise answer, it is therefore necessary to look at what lies within it: if the jurisdiction applicable in the context in which it is issued does not provide for the use of the same medium as a legal means, it is legally invalid

¹¹³ European Union Financial Stability Board FSB, (2018). Crypto-asset markets: Potential channels for future financial stability implications. Retrieved from: FSB Organization website, publications section, <https://www.fsb.org/2018/10>. EU Financial Stability Board.

¹¹⁴ European Union Financial Stability Board FSB, (2017). Financial Stability Implications from FinTech. Supervisory and Regulatory Issues that Merit Authorities' Attention. Retrieved from: FSB Organization website, uploads section, <https://www.fsb.org/wp-content/uploads>. EU Financial Stability Board.

¹¹⁵ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

or void. As a direct effect, a title can only be valid in the form of a token if performed in accordance with the law of the jurisdiction in which the token is minted (but to date no governmental address has dedicated a legal system for this). In other cases, however, they may be derivative in nature of a current property right, representing, for example, a “square meter” of Real Estate property to be fully converted into a token in the future¹¹⁶.

Government and Central Authorities nowadays act as the sole maintainers of the register of property (whether it be the Land Registry, the Register of Land Titles, or the Real Estate Registry) to provide for the unequivocal possession of title deeds by tracking transactions between citizens; the use of decentralized systems instead poses the problem of the so-called *Hardforks* or *Register Forking* [figure 36]: within the Blockchain a title could split into two or more branches as a result of an event (e.g. registration on two separate technological platforms of the title), and each of the two branches could exist independently of the other. The result of this division would be the existence of two tokens for the same property, which may be managed separately: they could be sold to two different users in parallel systems, creating legal collision¹¹⁷.

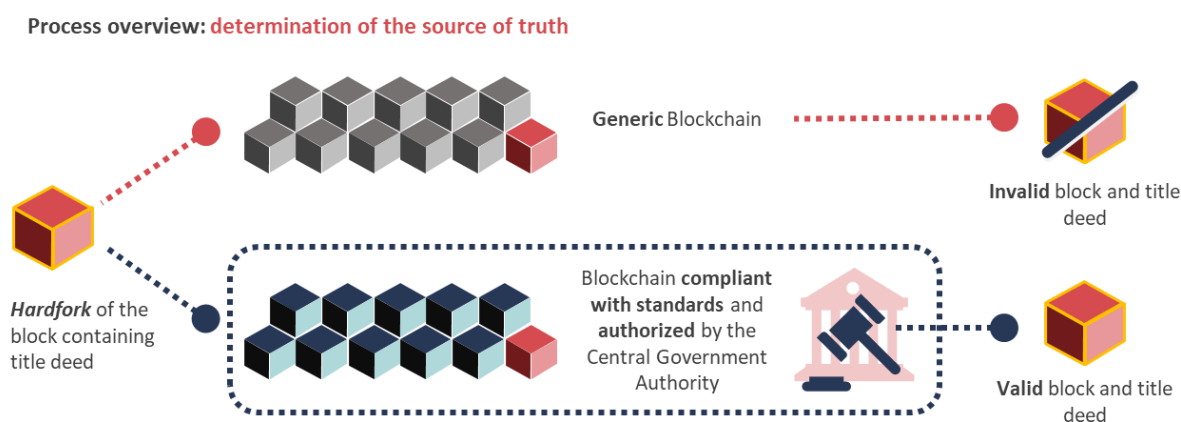


Figure 36: the diagram shows how the Central Government Authority can manage the so-called "hardforks" and the splitting of property titles. Source of the graphic: own elaboration based on proposed literature.

¹¹⁶ Konashevych O., Poblet M., Australian Institute for Digital Transformation, RMIT Blockchain Innovation Hub, (2018). Blockchain government-a next form of infrastructure for the twenty-first century. Retrieved from: *Frontiers in Artificial Intelligence and Applications*, Vol. 313 No. 1, pp. 195-199. Frontiers Media S.A.

¹¹⁷ Konashevych O., Università di Bologna, Università degli studi di Torino, Universitat Autònoma de Barcelona, (2020). Tokenization of real Estate on Blockchain. Retrieved from: AMS Dottorato, Institutional Doctoral Theses Repository of the University of Bologna. AlmaDL University of Bologna Digital Library.

Permissioned vs. public infrastructures

In describing the characteristics of this new technology, it was mentioned that the level of freedom in interacting with the Blockchain is defined by the type of permission needed to join it, in particular we find private chains (permissioned) and public Chains (permissionless). The former allow any user to connect to the network, verify the information inserted and validate the blocks, while the latter require a certain level of permission to guarantee accessibility and a central authority controls them¹¹⁸. Alternatively, there are hybrid models of this technology that combine elements of both (e.g., a privately maintained but publicly accessible system). The use of one or the other type of system depends on the functionalities that the network wants to obtain; however, since the technology was born as a tool to obtain trust between parties that do not know each other, those that are private (or with permission) are less disruptive and innovative: if a central authority controls the access to the system and the process of mining blocks and chains, the functionalities of the technology become less useful and versatile, since already in current systems it is a central body that provides this trust among unknown parties¹¹⁹. In this context, where would a government authority intervene to guarantee the correct use of the system and the respect and legality of the movements that take place in it?

Certainly, the intervention of the central government as a watchdog and supervisor should be guaranteed, as well as to settle disputes that would take shape within the network. First of all, the Government would have the role of validating not the blocks, but the records inserted in them (property titles, deeds of succession, deeds of ownership) freely by citizens, who would compete for the validation of the Government Authority to guarantee the credibility of their tokens [figure 37].

Secondly, the Government would be responsible for determining what would be the source of truth and the correct title in case of discrepancies in the records¹²⁰.

¹¹⁸ Preukschat A., Kuchkovsky C., Lardies G.G., Elñigo Molero D.D.G., Blockchain. La revolución industrial de internet, (2017). Blockchain. La revolución industrial de internet. Retrieved from: Centro Libros PAPP, ISBN: 978-84-9875-448-3. Diríjase a CEDRO (Centro Español de Derechos Reprográficos).

¹¹⁹ Gabison, G., University of Virginia School of Law, (2016). Policy Considerations for the Blockchain Technology. Public and Private Applications. Retrieved from: Science and Technology Law Review, Volume 19, Number 3, 2016. Law Journals , SMU Scholar.

¹²⁰ Konashevych O., Poblet M., Australian Institute for Digital Transformation, RMIT Blockchain Innovation Hub, (2018). Blockchain government-a next form of infrastructure for the twenty-first century. Retrieved from: Frontiers in Artificial Intelligence and Applications, Vol. 313 No. 1, pp. 195-199. Frontiers Media S.A.

In conclusion, as will be illustrated in the next chapter, policy makers should provide the one function that technology alone cannot perform, namely the authentication of the identities of the users operating within it.

Process overview: **data entry double validation**

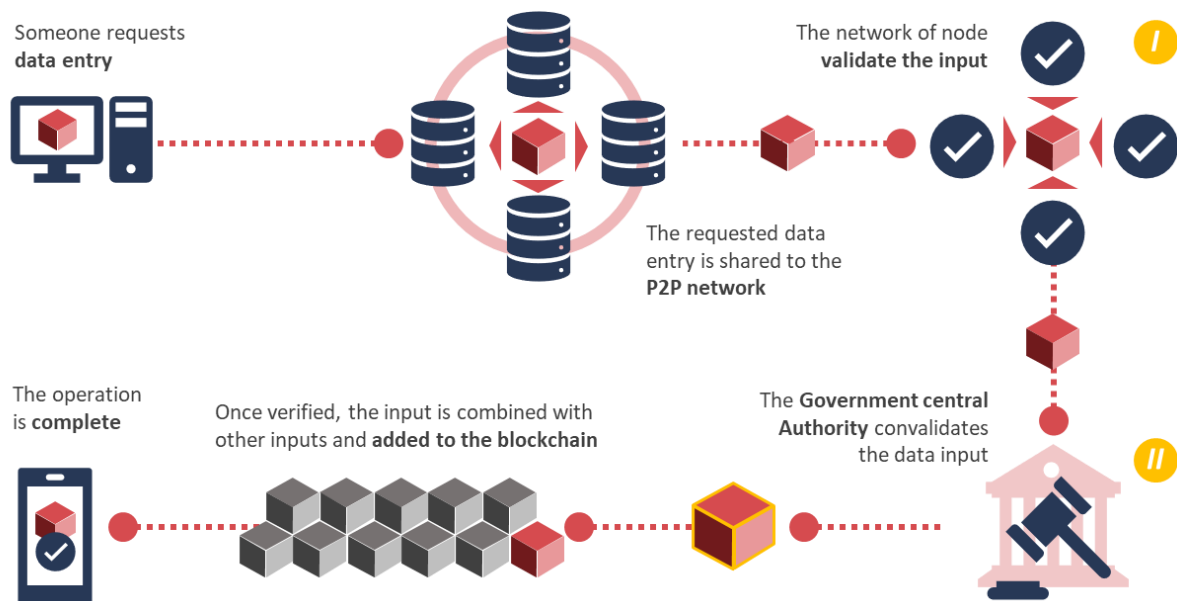


Figure 37: the diagram shows the logical process of double validation of the tokens by the nodes of the Blockchain and the Central Government Authority. Source of the graphic: own elaboration based on proposed literature.

Storage of records

The inclusion of data within the network as an immutable repository is the most established property of Blockchain technology; the published data, as mentioned, becomes public and irrevocable, and cannot be modified or change its historical course¹²¹. The protocols currently in use, however, do not restrict the insertion of junk data in the registries: since the underlying technology is not able to verify the truthfulness of the documents and their contents, but only the quantity of the records inserted in the block, the so-called "garbage in, garbage out" (GIGO) rule applies, potentially affecting the trustworthiness factor for its interested parties¹²². In fact, the network only makes sure that information is distributed in a secure, transparent and digital way.

In the Real Estate sector, the most delicate and critical phase and which requires the greatest deployment (and investment) of time is that of due diligence¹²³, as it requires not only to find all the information concerning a property, but furthermore to verify the correct updating of them on the basis of all the changes that have occurred over the years to the asset compendium itself: mutation in spaces, changes in the tenancy status and the rent rolls, shifts in the conditions of the concerned micro-market and the periodic updating of its value assessment for audit compliance reasons, as well as all administrative documentation. Particularly, when performed on a scale, this activity suffers all the negative circumstances due to the absence of a standardized and updated pool of data: if a homogenized and organized database existed, could be transmitted throughout the pre-marketing and conveyance process and the time spent would be extremely reduced and devoted to activities with the highest added value¹²⁴. Furthermore, legal, commercial and technical consultants would benefit greatly in the collaborative behavior of their operations.

¹²¹ Nakamoto S., (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from: Bitcoin.org.

¹²² Roio D.J., Planetary Collegium Ph.D. candidate, M-Node, (2013). Bitcoin, the end of the Taboo on Money. Retrieved from: Dyne digital resources, https://files.dyne.org/books/Bitcoin_end_of_taboo_on_money.pdf. Dyne.org Digital Press.

¹²³ McNamara P., TCU Investment Management, LKCM Center for Financial Studies at the Neeley School of Business, (1998). Exploring liquidity: recent survey findings. Retrieved from: Paper presented to 7th IPD Investment Strategies conference, Brighton. Investment Property Forum IPF.

¹²⁴ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

From these issues arises the idea of the so-called *property passport* [figure 33], which consists simply in the collection of information relating to an individual asset in a single digital file, kept by both the owner and tenants and transferred together with the title of ownership¹²⁵. Theoretically this digital logbook containing all physical and legal data has the potential to provide a standardized set of information to Real Estate experts and is identified as the first and foremost obstacle to be removed to rationalize and enforce more effective Real Estate processes by the authors Fields¹²⁶, Ganter and Lutzkendorf¹²⁷.

The added value of the Blockchain here lies in providing a sharing program that can add huge benefits by creating a safer and smarter way to transfer organized and trusted data sets¹²⁸.

Scalability of the technology

One of the issues that most affects technological solutions of any kind nowadays is their *scalability*¹²⁹, since in the era of globalization there are no longer any boundaries to digital systems for which the potential user base is represented by clients all over the world¹³⁰. It has been argued that the Blockchain technology does not have barriers to prevent the publication of unnecessary data in the logs, which also significantly affect the total volume of information exchanged and consequently the computing power and time required to process all the

¹²⁵ Sesana M.M., Salvalai G., Architecture Built Environment and Construction Engineering Department of Politecnico di Milano, (2018). A review on Building Renovation Passport: Potentialities and barriers on current initiatives. Retrieved from: Institutional Online Public Archive of Research Products of the Politecnico di Milano, <https://re.public.polimi.it/>. Energy & Buildings No. 173, pp.195-205. Elsevier B.V.

¹²⁶ Fields D., Department of Geography, University of Sheffield, UK, (2019). Automated landlord: Digital technologies and post-crisis financial accumulation. Retrieved from: EPA: Economy and Space 0(0) 1–22, SAGE Journals publications. <https://journals.sagepub.com/doi/pdf/10.1177/0308518X19846514>. SAGE.

¹²⁷ Ganter M., Lutzkendorf T., Karlsruhe Institute of Technology, (2019). Information management throughout the life cycle of buildings – Basics and new approaches such as blockchain. Retrieved from: IOP Conference Series Earth and Environmental Science publication, <https://iopscience.iop.org/article/10.1088/1755-1315/323/1/012110/pdf>. IOP Publishing Ltd.

¹²⁸ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

¹²⁹ Scalability: the measure of a system's ability to increase or decrease in performance and cost in response to changes in application and system processing demands. Source: Gartner Information Technology Glossary, 2021.

¹³⁰ Chen S., Dai W., Dai Y., Fu H., He H., Gao Y., Guo J., Liu Y., Beijing Thinkey Science and Technology Ltd., Georgia Institute of Technology, Santa Clara University, (2019). Thinkey: A Scalable Blockchain Architecture. Retrieved from: ArXiv Archive, <https://arxiv.org/abs/1904.04560v1#>. Cornell University.

operations performed by the DLT algorithms in the network¹³¹. The system overloads are reflected in high transaction costs needed to reward the miners for validating various blocks on top of previous ones and price volatility, creating further bandwidth problems¹³² and forcing even the largest Ethereum platform¹³³ to change its consensus mechanism in order to sustain such request of traffic.

As a matter of fact, through the most widespread consensus mechanisms, the higher the number of transactions, the higher the rewards given to the miners to ensure that the movements are consistently concluded¹³⁴.

With respect to price volatility, it can be said that since the valuation is still on the rise and is certainly very uncertain, the world of Blockchain belongs to the speculation of the media and investors, whose confidence causes the price of exchange with current currencies to fluctuate dramatically, shaking up the markets and making it impossible for any government to implement the use of the technology on a large scale; the only case that can serve as a school of thought is represented by the Republic of El Salvador, which on the 7th September 2021 made Bitcoin an official currency recognised by the State: due to the excessive increase in data traffic on the Ethereum network, the share price on the stock exchange and their exchange value collapsed for several days, before re-establishing itself above 60,000 dollars¹³⁵.

In order to find a common ground between legislators, already tested consensus mechanisms and today's available technology, the only evaluable solution seems to be that the government does not choose a single platform on which transactions can be carried out (as with Bitcoin in El Salvador) but a "bubble" of possibilities based on shared technical standards and supporting free competition between solutions: as a market-driven approach it is aimed at the resolution of scalability issues and freedom of citizens who could freely choose between a pool of

¹³¹ Roio D.J., Planetary Collegium Ph.D. candidate, M-Node, (2013). Bitcoin, the end of the Taboo on Money. Retrieved from: Dyne digital resources, https://files.dyne.org/books/Bitcoin_end_of_taboo_on_money.pdf. Dyne.org Digital Press.

¹³² Han Y., Li C., Li P., Wu M., Zhou D., Long F., University of Toronto, Department of Computer Science, (2020). Shrec: bandwidth-efficient transaction relay in high-throughput blockchain systems. Retrieved from: Conference: SoCC '20: ACM Symposium on Cloud Computing.

¹³³ Chavez-Dreyfuss G., Reuters International News, (2021). Explainer: Major Ethereum upgrade set to alter supply, fix transaction fees. Url of the article: Reuters International website, <https://www.reuters.com>. 2021 Reuters.

¹³⁴ Popov S., IOTA Foundation and University of Porto, (2018). The Tangle. Retrieved from: https://assets.ctfassets.net/r1dr6vzfxhev/2t4uxvslqk0EUau6g2sw0g/45eae33637ca92f85dd9f4a3a218e1ec/iota1_4_3.pdf.

¹³⁵ Kurmanaev A., Avelar B., Livni E., The New York Times, (2021). Bitcoin Preaches Financial Liberty. A Strongman Is Testing That Promise. Url of the article: <https://www.nytimes.com/2021/10/07/world/americas/bitcoin-el-salvador-bukele.html>. Oct. 7, 2021, The New York Times Company.

available systems, while the Central Authority would only provide the technical guide lines for their official adoption¹³⁶.

Liquidity creation

It was argued in chapter 1 that the major processes that could initially be invested by Blockchain technology in the Real Estate field concern the registration and processing of property titles, due diligence, the simplification of today's complex transactions which would cumulatively lead to a faster turnaround and increased liquidity in the market¹³⁷¹³⁸.

The impact of transaction costs on an investment class depends on the liquidity of the investment itself: it represents a function of the completeness of the information kit, the costs associated with the collection of such information, the level of market standardization (how much complex are the traded goods and the market conditions) and the possibility of market approach by various investors. When an investment does not meet these characteristics, the relative cost of the intermediaries compensating for illiquidity increases¹³⁹.

Although trading costs are very high for the Real Estate sector compared to publicly traded securities, these are generally ignored when performing a market value appraisal; they represent between 6% and 10% of the trading price [figures 38, 39], considering both hidden and observable costs, and include: research costs, broker's fees, transaction fees, mortgage broker fees (if any), legal fees, postage and title fees, registration fees¹⁴⁰.

¹³⁶ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

¹³⁷ Wesswls P., (2016). Blockchain will Have an Enormous Impact on the Real Estate Sector. Retrieved from: PropertyNL, Amsterdam.

¹³⁸ Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: Facilities, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

¹³⁹ Merton R.C., President of the American Finance Association, (1987). A Simple Model of Capital Market Equilibrium with Incomplete Information. Retrieved from: <https://doi.org/10.1111/j.1540-6261.1987.tb04565.x>. The Journal of Finance, Vol. XLII, No. 3, July 1987.

¹⁴⁰ Sullivan M. J., Cassidy S. M., Ermer C. M., The Journal of Real Estate Research, (1991). A Note on the Effect of Transaction Costs on Real Estate Investment Returns. Retrieved from: The Journal of Real Estate Research Vol. 6, No. 1 (Spring 1991), pp. 113-117. Taylor & Francis, Ltd.

Several private initiatives built on the Blockchain platform are already active today (to name a few, which will be explored later: Househodl¹⁴¹, Rentberry¹⁴², Homelend¹⁴³) and all agree on the potential impact of the new digital system, if implemented at scale, on the processes of Real Estate industry and the need to break away from its traditional organization to distance itself and get rid of expensive intermediaries; all agree that Blockchain technology is the best way to successfully adopt a shared economy by making transfers more transparent and management more smart wise, providing liquidity for asset trading.

The speed of the transaction process that new digital paradigms promise to reach would bring it possible to "make the traditional illiquid Real Estate market very easy to liquidate, with sellers and buyers who can quickly execute their trades"¹⁴⁴. The cumulative impact on the sector could be very significant given the weight of the industry on the economy: the European Commission¹⁴⁵ can be mentioned as a representative: "The contribution of the Real Estate sector to the production of national economies varies from 5.7% of Lithuania's total added value to 15.8% of Greece, and the sector is growing faster than the economy as a whole".

The table below [figure 38] shows the minimum and maximum percentage ranges of incidence of transaction costs for the 10 countries, chosen as an illustrative benchmark group, and categorized according to whether the costs are borne by the seller, the buyer, or both for a purchase and resale operation; the graph that follows [figure 39] shows the percentage ranges for a direct comparison.

¹⁴¹ HouseHodl is a world's first platform for securely buying & selling real estate with Bitcoin. Retrieved from Crunchbase, Venture capital investing: <https://www.crunchbase.com/organization/househodl>.

¹⁴² Rentberry is a fully operational long-term rental platform that leverages technology to ensure a seamless rental experience. <https://rentberry.com/>.

¹⁴³ HomeLend is a direct marketplace for high-quality non-Agency mortgages originated to investors' specifications. <https://homelend.com/>.

¹⁴⁴ Whitepaper Ethernity. Buy Investment Properties from Around the Globe. ICObench, <https://icobench.com/ico/etherty/whitepaper>.

¹⁴⁵ European Commission, (2014). Mutual evaluation of regulated professions. Overview of the regulatory framework in the real estate sector. Report based on information transmitted by Member States and on the meeting of 6 June 2014. Retrieved from: European Commission website, file:///C:/Users/QY741PJ/Downloads/150119-real-estate-report-final_en.pdf.

ROUNDTRIP TRANSACTION COSTS

HONG KONG

Ad Valorem Stamp Duty (AVD)		Special Stamp Duty (SSD)		Buyer Stamp Duty (BSD)		Solicitor's Fee		Real Estate Agent's fee		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
1.500%	8.500%	5.000%	20.000%	15.000%	15.000%	0.075%	0.125%	0.500%	1.000%	33.350%	0.750%	22.1%	44.6%
Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: B/S				Average:	33%

ITALY

Registration Tax		Value Added Tax (VAT)		Land Registry Tax		Notary and Legal Fees		Real Estate Agent's fee		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
3.000%	7.000%	4.000%	22.000%	1.000%	1.000%	2.220%	4.940%	1.830%	4.880%	25.935%	3.355%	12.1%	39.8%
Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: B/S				Average:	26%

LUXEMBOURG

Registration Tax		Notary fee		Real Estate Agent's fee		Transcript Tax		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
6.000%	10.200%	1.500%	1.500%	3.510%	3.510%	1.200%	1.200%	-	-	14.310%	0.000%	12.2%	16.4%
Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: -				Average:	14%

PRINCIPALITY OF MONACO

Registration Tax		Notary fee		Real Estate Agent's fee		Real Estate Agent's fee		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
4.500%	4.500%	1.500%	2.500%	3.588%	3.588%	5.980%	5.980%	-	-	10.088%	5.980%	15.6%	16.6%
Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: Seller		Paid by: -				Average:	16%

NEW ZEALAND

Registration Fee		Conveyancer Fee		Real Estate Agent's fee		-		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
0.035%	0.035%	1.000%	1.000%	4.025%	4.600%	-	-	-	-	1.035%	4.313%	5.1%	5.6%
Paid by: Buyer		Paid by: Buyer		Paid by: Seller		Paid by: -		Paid by: -				Average:	5%

QATAR													
Transfer Fee		-		-		-		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
0.250%	0.250%	-	-	-	-	-	-	-	-	0.250%	0.000%	0.3%	0.3%
Paid by: Buyer		Paid by: -		Paid by: -		Paid by: -		Paid by: -				Average: 0%	

RUSSIA													
Real Estate Agent's fee		Notary Fee		Registration Fee		Valued Added Tax (VAT)		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
2.000%	5.000%	0.700%	1.500%	0.010%	1.000%	20.000%	20.000%	-	-	5.105%	20.000%	22.7%	27.5%
Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: Seller		Paid by: -				Average: 25%	

UNITED ARAB EMIRATES - UAE													
Title Deed		Registration Fee		Real Estate Agent's fee		-		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
0.028%	0.028%	2.000%	2.000%	3.000%	7.000%	-	-	-	-	2.028%	7.000%	5.0%	9.0%
Paid by: Buyer		Paid by: B/S		Paid by: Seller		Paid by: -		Paid by: -				Average: 7%	

UK													
Stamp Duty		Legal Fees		Land Registry Fees		Agent's Fees		-		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
0.000%	12.000%	0.500%	1.000%	0.050%	0.050%	2.350%	4.113%	-	-	6.800%	3.231%	2.9%	17.2%
Paid by: Buyer		Paid by: Buyer		Paid by: Buyer		Paid by: Seller		Paid by: -				Average: 10%	

USA													
Title Search and Insurance		Recording Fee		Legal Fees		Real Property Transfer Tax		Real Estate Broker's Fee		Average cost paid by:		Roundtrip transaction costs	
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Buyer	Seller	Min	Max
0.500%	1.000%	0.200%	0.500%	0.500%	1.000%	1.000%	1.425%	6.000%	6.000%	1.850%	7.963%	8.2%	9.9%
Paid by: Buyer		Paid by: Buyer		Paid by: B/S		Paid by: Seller		Paid by: Seller				Average: 9%	

Figure 38: the transaction costs of a property split by country, area of expense and recipient; these percentage ranges were calculated according to the logic of a property purchase and resale transaction. Source of the data: Global Property Guide, (2021). Round-trip transaction costs: a key consideration when buying property. Retrieved from: <https://www.globalpropertyguide.com/transaction-costs>. GPG 2021. The original data sources of the study were the Local Government Agencies and the World Bank Doing Business website.

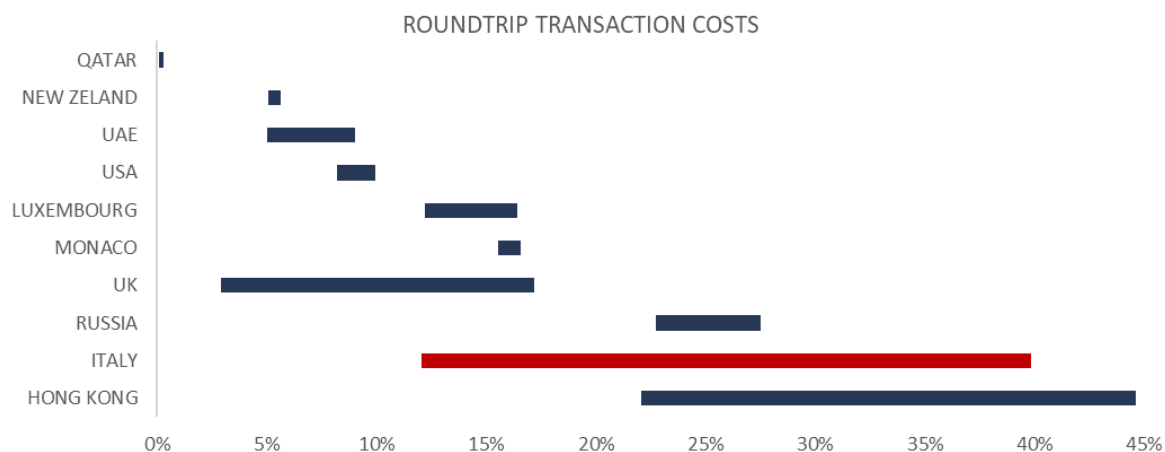


Figure 39: the graph presents the data collected in the table in figure 38. Source of the graphic: own elaboration based on presented data.

3.4 ACTORS AND THEIR BEHAVIORS

The founder of the Institute for Blockchain Studies Melanie Swan¹⁴⁶ describes this technology by arguing that we could think of it as another class of Internet-like things, a complete and comprehensive information technology with multiple layers and multiple segments of applications for all forms of recording assets and categorizing and even exchanging them, encompassing every area of finance and economics: from hard assets (physical properties) to intangible assets (votes, ideas, health data). But in reality Blockchain technology represents something even broader, it is a new organizational paradigm for the search, evaluation and transfer of all quanta (discrete units) concerning whatever, and potentially deployable for the organization and coordination of all human activities at a larger scale than ever before possible¹⁴⁷. The same author adds that the Blockchain can be used for much more than the information exchanges listed above: in the possible implementations she cites the so-called FREM (Facility Real Estate Management) as a field for the deployment of the system, with its potential capacity to completely reform structured processes and the involvement of various

¹⁴⁶ Institute for Blockchain Studies, Philosophy Department, Purdue University, West Lafayette, <https://www.blockchainstudies.org/contact.html>.

¹⁴⁷ Swan M., Institute for Blockchain Studies, (2015). Blockchain: blueprint for a new economy. Retrieved from: O'Reilly Media - Technology and Business Training. O'Reilly.

actors in them, bringing an absolute benefit to its users in terms of efficiency and immediacy of operations¹⁴⁸.

The Real Estate sector is in fact known for its non-transparent characteristics (as illustrated within chapter 1); these depend on the strategic purpose they have within the business, as this lack of clarity and the difficult traceability of information generates a strong "*competitive advantage*" for business actors and companies operating in the sector. The great demand for transparency and technological advances are slowly leading to greater usability and traceability of property data: in this sense reference can be made to the revolution that online listing agencies have been bringing to brokerage operations for some years now, providing (i) showcases with wide visibility, (ii) business support systems and (iii) advanced management programs to traditional agencies¹⁴⁹, which are also useful for organizing and accumulate administrative and technical documentation, which is still archived in pdf files and scans that are difficult to consult and in any case poorly systemized¹⁵⁰; these steps of improvement therefore converge into a lack of efficiency and accuracy in the purchasing processes and in the closing of transactions: according to Lifthrasir research paper¹⁵¹ and Deloitte's benchmark report¹⁵², Blockchain has the potential to address the current inefficiencies and inaccuracies in the Real Estate industry through various solutions depending on the stage of the process, whether it is research, due diligence, leasing and financing applications, administrating rental contracts, or managing the purchase process.

The three main subjects involved in the current processes of transfer of Real Estate assets are brokers or agents, as regards the sale and management of leases, notaries for the registration

¹⁴⁸ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

¹⁴⁹ Getrix Real Estate Management Software, owned by the online listing platform Immobiliare.it, <https://www.getrix.it/>.

¹⁵⁰ PricewaterhouseCoopers PWC, (2020). Emerging Trends in Real Estate. Retrieved from: PWC EMEA website, <https://www.pwc.com/sk/sk/assets/PDFs/pwc-emerging-trends-real-estate-europe-2020.pdf>. PWC and Urban Land Institute.

¹⁵¹ Lifthrasir R., RICS Organization, (2016). What is Blockchain And How Does It Apply to Real Estate. Retrieved from: Realcomm: the Intersection of Commercial and Corporate Real Estate, Technology, Automation and Innovation, <https://www.realcomm.com>.

¹⁵² Deloitte (2018). Blockchain in commercial Real Estate. Retrieved from: <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/financial-services/us-dcfs-blockchain-in-cre-the-future-is-here.pdf>. Deloitte Development LLC.

of property deeds and titles, and appraisers for estimating acquisition prices and rental values of properties.

Appraisers

The possibility of having an updated pool of referenced and geolocated data and information on Real Estate properties would bring to a new level the current role played by the so-called "institutional market sources", performed in Italy by a series of research companies (Nomisma Real Estate Observatory¹⁵³, Scenari Immobiliari¹⁵⁴ and related Real Value¹⁵⁵ platform) or from the analysis of data owned by the Public Administrations (Osservatorio del Mercato Immobiliare OMI Geopoi¹⁵⁶ of the Italian Revenue Agency) which today constitute the primary basin of market prices based on the real transactions that take place within the observed perimeters. A greater qualitative clustering and in-depth analysis of the intended use of the properties, with a deepening of the judgment on the constructive, structural and conservation characteristics of the analyzed assets would allow to finalize very reliable evaluations and estimation on the market value, at least where the geographical dispersion of the data was sufficiently concentrated (for example in large and medium-sized urban centers), making the presence of an independent expert subject to perform these analyses less useful and reducing costs and times (generally a structured valuation signature takes at least 2 weeks to deliver an ad-hoc Real valuation report¹⁵⁷). This proceeding could also be deployed in the context of auditing processes, and companies can automatically update the book values of their capital goods included in the corporate balance sheet and to be delivered to the Chamber of Commerce.

The presence and the overall weight of an independent evaluator involved in the processes would not, however, be easily questioned by this technology: his judgment, dictated by the experience and the ethical code of the profession, would in any case be indispensable in

¹⁵³ Nomisma Real Estate Observatory, <https://www.nomisma.it/servizi/osservatori/osservatori-di-mercato/osservatorio-immobiliare/>.

¹⁵⁴ Scenari Immobiliari Independent Institute of Studies and Research, <https://www.scenari-immobiliari.it/en/>.

¹⁵⁵ Real Value, database of the Italian Real Estate Market, <https://realvalue.scenari-immobiliari.it/home>.

¹⁵⁶ OMI Geopoi, Osservatorio del Mercato Immobiliare, Real Estate quotes bank, https://www1.agenziaentrate.gov.it/servizi/geopoi_omi/index.php.

¹⁵⁷ Data source: editor's analysis conducted on the basis of company data concerning the delivery times of the leading independent experts active in Italy.

confirming the results of these analyses and in all special situations that require in-depth analysis, therefore in those cases whose added value to the activity is greater. Rather, a Blockchain in the Real Estate valuation field would be useful in the Asset Quality Review processes of banks, where an automated impairment mechanism on properties guaranteeing mortgages and loans could provide the drafting of automated red flags and instantaneous reports in all critical situations for which is required an institutional oversight activity of asset-backed securities¹⁵⁸.

Agents and brokers

Real estate agents would certainly be the category most impacted by the technological revolution; their role already significantly challenged by the presence of online listing platforms, which allow complete disintermediation from traditional agencies for the sale and rental of Real Estate units in the retail market, while at the corporate level it has been a long time since they can no longer compete with the rise of large brokerage firms specialized in letting commercial properties composed of medium to large surfaces; even in the operations of the trophy segment it is now common practice that the societies that own the properties turn to the big names of specialized consultancy able to build business operations tailored to institutional clients and they can use their high standing to persuade potential investors to be involved.

The fit of their traditional role with the possibilities offered by the blockchain is of doubtful hypothesis, and their permanence in the market certainly remains conditioned by their ability to be able to question their position in the Real Estate supply chain, finding new space by leveraging what can be defined as *tacit knowledge*¹⁵⁹ of the market and its peculiarities¹⁶⁰.

¹⁵⁸ European Central Bank (ECB) Banking Supervision, (2021). Comprehensive assessments of financial health for the supervised banks. Retrieved from: European Central Bank (ECB) Supervisory practices tasks webpage, https://www.bankingsupervision.europa.eu/banking/tasks/comprehensive_assessment/html/index.en.html.

European Central Bank, 2021.

¹⁵⁹ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

¹⁶⁰ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

Tacit knowledge cannot be defined or expressed by definition, as it is assumed that this type of notions are not programmable in a blockchain algorithm; it is represented by the wealth of professional relationships, communication skills and deep knowledge of the reference market on the catchment area that an experienced agent possesses. The role of the professional agent could therefore be redefined in the validation of real estate data tracked by the system and entered freely by its users, as a function of trust and reliability of the advertised information in a highly automated digital platform.

The other function covered by the agencies is traditionally that of drawing up the sale and rental contracts; as detailed in chapter 2.5, the stipulation of *smart contracts* set within a hash of the Blockchain system would allow, in addition to their automatic stipulation based on the conditions of sale/ rent entered by the owner or landlord, to monitor their performance and to automate the payments and compensations provided for by it. The real element of fragility of these technologies is today constituted by their lack of legal enforcement by the authorities in the hypothesis of the onset of disputes between the involved parties.

Notaries

In the Latin notary system, the notary performs a series of different functions within the Real Estate market processes: (i) verifies the identities of the parties involved to prevent fraudulent sales, money laundering and the execution of illegal activities; (ii) generates and updates title deeds and verifies the effectiveness of a transaction by checking the presence of registered title deeds; (iii) provides independent legal advice to prevent premature bargaining with a view to consumer protection¹⁶¹. In the Anglo-Saxon and Northern European notary systems, on the other hand, their involvement is limited in the first case to specialized legal, financial and property title consultancy, while in the latter case they are not really contemplated as the entire process involving the stipulation of contracts and transactions is done by lawyers and Real Estate agents.

¹⁶¹ Sparkes P., Bulut D., Habdas M., Jordan M., et al., University of Southampton, ZERP - University of Bremen, University of Silesia, Southampton Law School, (2016). Cross Border Acquisitions of Residential Property in the EU: Problems Encountered by Citizens. Retrieved from: EU Law: Legal System and Acts, [https://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU\(2016\)556936](https://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU(2016)556936). European Parliament Think Tank.

It is precisely in the second and third scenario that it is possible to imagine the all-round and completely decentralized functioning of the Blockchain technology relating to the tangible property sector, since a transaction or a leasing contract between individuals would not require the participation of any actor outside the digital platform, except to notify the public authority of the exchange that has taken place downstream, which lends itself to updating the register of property titles¹⁶².

Since the technological platform would make it possible to eliminate the work that requires a lot of intellectual effort, notaries could concentrate on the most complex files by increasing the added value of their function; furthermore, in the Latin system of Southern Europe they would still be needed to validate the identity of the individuals involved¹⁶³.

Critical considerations

Although from a technical perspective the digital Blockchain model is very interesting for data and information management, contracts and processes in general, there are still many challenges that undermine its practical application; in general, human input is and will still be essential¹⁶⁴. Despite this, the desire to be engaged with this revolutionary technology must be deepened as it is only by fully understanding its characteristics that it can be useful.

Due to the specialized nature of the work carried out by multiple stakeholders, their involvement and interchangeability with artificial algorithms does not currently appear to be a viable option. The particular knowledge of the market and of the countless variables of the products it contains, make it mandatory to reflect more on their position within the processes redesigned by the Blockchains at the time of their implementation. The concept of total removal

¹⁶² Garcia-Teruel R. M., Department of Private, Procedural and Tax Law, UNESCO Housing Chair, Universitat Rovira i Virgili, Tarragona, Spain, (2019). Legal challenges and opportunities of blockchain technology in the Real Estate sector. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 129-145. Emerald Publishing Limited.

¹⁶³ Sladić G., Milosavljević B., Nikolić S., Sladić D., Radulović A., Faculty of Technical Sciences, University of Novi Sad, (2020). A Blockchain Solution for Securing Real Property Transactions. Retrieved from: International Journal of Geo-Information and MDPI. Int. J. Geo-Inf 2021, 10, 35. <https://www.mdpi.com/journal/ijgi>. Published: 15 January 2021.

¹⁶⁴ Wouda H.P., Opendakker R., Department of Architecture Building and Planning, Eindhoven University of Technology, Eindhoven, The Netherlands and Deloitte, Amsterdam, The Netherlands, and Department of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, Eindhoven, The Netherlands, (2019). Blockchain technology in commercial Real Estate transactions. Retrieved from: Journal of Property Investment & Finance. Emerald Publishing Limited.

of trusted third parties is currently conceptually false, like the total decentralization of operations: the role of the parties involved should be updated over time and change, but not disappear as they are fundamental¹⁶⁵.

3.5 – CHALLENGES: FINAL REMARKS

Analyzing the various constituent elements of Blockchain technology and trying to enter into the merits of how the current procedural paths and professional figures can integrate or find a new dimension within this revolutionary scheme, a theme emerges very clearly: it is not simply a matter of adapting and shaping the current network of activities and the technical-regulatory structure to make it suit the new digital tools, but basically of rethinking the entire supply chain of the Real Estate sector. In this sense, it seems utopian to apply Blockchain technology in the short term, unless through a logic of stand-alone functions and focusing on individual inefficiencies¹⁶⁶ that embraces piece by piece all its mechanisms in an asynchronous manner, and then recompose a new framework redesigning the dynamics with which the Real Estate industry operates and envisaging a new future for it, which still contains a great potential for unexpressed and destroyed value by the low efficiency of its current processes.

Although blockchain technology is proving in other application fields to be capable of building digital records of physical and contractual information in a secure and reliable manner, it also comes with challenges. These are the result of the immaturity of the technology, a lack of standardization and limited examples of successful application which currently make it complex to think about implementing the proposed model.

¹⁶⁵ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

¹⁶⁶ Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: Facilities, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

Paradigm shift: from title-centric to code-as-law

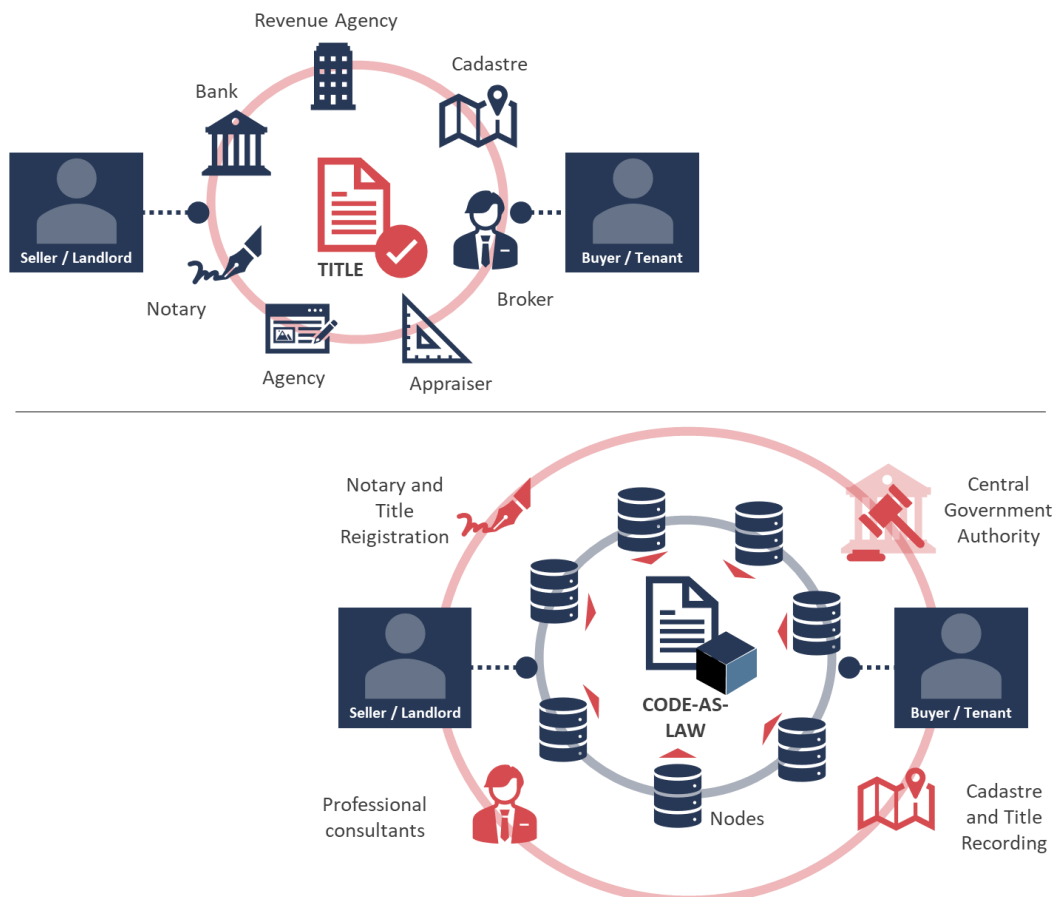


Figure 40: The graphic illustrates the paradigm shift that is being pursued through Blockchain technology, with an exchange of roles in the validation of official acts between Government Authorities and the network of digital nodes. Source of the graphic: own elaboration based on proposed literature.

4.0 – Implementation of the technology

There have already been a number of private initiatives to implement Blockchain technology in Real Estate and attempt to create a discontinuity with traditional processes and distancing from expensive intermediaries, increase liquidity in the industry, as well as simplify cross-border transactions and taxation. The first major obstacle they encountered is the incorporation of explicit rules to meet public policy objectives, such as data protection, money laundering and financial stability, and they are still searching for a Governmental tailor-made regulation that would allow Blockchains to operate in different contexts¹⁶⁷.

In this chapter we try to give an overall picture of the ongoing state-of-the-art of Blockchain adoption, try to outline future developments and provide some examples of attempts to understand how it can add value and make processes more efficient.

4.1 – DRIVERS FOR ADOPTION

The drafting of this thesis is based on a highly critical view of the possible deployment of a technology that is making a lot of talk about itself, as well as the promises it holds, in an attempt to analyse to what extent the enthusiasm that surrounds it, which is also the conveyor of good intentions and great promises, lays its foundations on really solid ground when Blockchain is approached to the processes of the Real Estate market. The method that is being pursued is that of design science¹⁶⁸, i.e. a process through which one tries to verify the acceptability of a hypothesis by resorting to pragmatic validation to verify that the digital model in question resolves the major weaknesses that have been detected; to give an institutional definition we can cite Dresch, Lacerda and Antunes, who state: "the premise of design science is that the research conducted under its paradigm, in addition to being rigorous and scientifically valid,

¹⁶⁷ Garcia-Teruel R. M., Department of Private, Procedural and Tax Law, UNESCO Housing Chair, Universitat Rovira i Virgili, Tarragona, Spain, (2019). Legal challenges and opportunities of blockchain technology in the Real Estate sector. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 129-145. Emerald Publishing Limited.

¹⁶⁸ Wouda H.P., Opendakker R., Department of Architecture Building and Planning, Eindhoven University of Technology, Eindhoven, The Netherlands and Deloitte, Amsterdam, The Netherlands, and Department of Industrial Engineering and Innovation Sciences, Eindhoven University of Technology, Eindhoven, The Netherlands, (2019). Blockchain technology in commercial Real Estate transactions. Retrieved from: Journal of Property Investment & Finance. Emerald Publishing Limited.

should also seek pragmatic validity, i.e., utility¹⁶⁹; in this context, pragmatic validity means trying to ensure that a proposed solution to a particular problem also works in practice, which implies the achievement of an expected result.

In addition to this, the usefulness of the means with which to achieve this result must also be proven; in the case of Blockchain, the usefulness that we are trying to reconstruct concerns the possibility of creating added value for the processes of the Real Estate sector by revolutionizing the operations currently underway.

The feasibility within the technology model directly determines the competitive strength of the sector and consequently the current and future valuation of its assets; the bricks and mortar industry is at a transitional turning point in which a number of competencies are important, such as continuous insight into customer behavior, process-oriented steering, dynamic skills, strategic alliances in a developed network and meaningfulness; furthermore, it is necessary that the administrative levels are well connected, the distances between the authorities are short and that the digital infrastructure is well developed, in order to allow flexibility oriented towards technological innovation¹⁷⁰. The table below shows the various steps of implementing the technology with the related facilitators and the elements that guide its added value within the processes:

¹⁶⁹ Dresch A., Lacerda D.P., Antunes Jr J.A., Federal University of Santa Catarina UFSC and Universidade do Vale do Rio dos Sinos, (2015). Design Science Research: A Method for Science and Technology Advancement. Retrieved from: ResearchGate Scientific Knowledge online portal, DOI: 10.1007/978-3-319-07374-3. Springer.

¹⁷⁰ Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: Facilities, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

Technology overview: **technological enablers and value drivers for its adoption**

TECHNOLOGY	ENABLERS	VALUE DRIVER
Blockchain 1.0	Decentralized consensus	Transaction costs
Blockchain 2.0	Smart contracts	Added services
Blockchain 3.0	Decentralized applications, storage and computing	Organization boundaries
Blockchain 4.0	Decentralized artificial intelligence	Autonomous decision-making

Figure 41: technological enablers and value drivers for its adoption at the various levels of process-integration. Source of content: Angelis J., da Silva E.r., (2019). Blockchain adoption: A value driver perspective. Retrieved from: Science Direct, Volume 62, Issue 3, May–June 2019, Pages 307-314.

4.2 – BARIERS TO ADOPTION

The presence of a number of facilitators that, together with the enthusiasm for a new technology, accompany its adoption is not sufficient to allow it to reach the critical mass of deployment that would allow it to gain the necessary confidence and credibility from the entire potential pool of users. Reaching that break-even point beyond which the diffusion and implementation of Blockchain in sectors other than electronic payments implies overcoming several major operational, social and regulatory obstacles:

- operational barriers identify changes in current processes and new investments needed in parallel in the operations and platforms used today in the Real Estate macro-sector;
- the regulatory barriers underlie the legal issues related to the new technologies, an issue that has already enabled the emergence and development of an entire economic industry from the activity of those companies dealing with the regulatory compliance of digital tools and applications (RegTech, Regulatory Technology compliance¹⁷¹);
- the social barriers include all the emotional and behavioral limits that accompany the 'new' and the novelties, and which can be observed concretely in the mistrust and lack of credibility that they have to overcome¹⁷².

The diagram below attempts to categorize these limits [figure 42]:

¹⁷¹ Deloitte, (2021). RegTech Universe 2021. Take a closer look at who is orbiting in the RegTech space. Retrieved from: Deloitte website, technology services and reports, archive 2021 october, <https://www2.deloitte.com/lu/en/pages/technology/articles/regtech-companies-compliance.html>. Deloitte Touche Tohmatsu Limited DTTL, 2021.

¹⁷² Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

Limitations overview: **barriers to implementation**

BARRIERS	OUTLOOK
OPERATIONAL BARRIERS	
Software integration	Integration with current systems and platforms
Standardised digital data	Deployment of accurate and up-to-date digital data on which the technological efficiency relies
Critical mass	Due to the network effect, new technologies are successful when used extensively
Transition costs	Considerable investments are needed to hope for the use of current software and for the up-skill workforce
Data security	Cyber-attack and potential data-loss resiliency
REGULATORY BARRIERS	
Legal framework	Compliance with current regulatory framework
Technology	The solutions adopted must be transparent in terms of data sources and processing
Transparency	
SOCIAL BARRIERS	
Expected benefits	New technologies should benefit users to provide them with an incentive to use
Disintermediation	Incentives for potential adopters must be aligned, no one should perceive the risk of being replaced by technology
Trust in innovation	The unclear features, dubious benefits and risks associated with new solutions can reduce their trust and limit their investments

Figure 42: the graph shown schematizes the main obstacles to the implementation of a new technological solution. Source of the scheme: Hoxha V., Sadiku S., (2019). Study of factors influencing the decision to adopt the Blockchain technology in Real Estate transactions. *Property Management*, Vol. 37, No. 5.

Social barriers

The social aspect of the Blockchain technology is mostly focused on changing the way of working and revolutionizing the processes and skills needed to be able to exploit the new digital platform to its full potential; this would lead in the short term to a change in the scope of work, which means that the involved parties would need to change their work activities to be still relevant within the process, and this seems to be a big challenge for the implementation of the technology.

On the other side of the consumers, the critical aspect is materialized in the understanding of the technology; most people do not yet understand the basic technique of the new digital medium and its fundamental characteristics, which makes it very difficult for them to see the good possibilities it offers. However, it has to be underlined that the technology is relatively new and this in itself results in a limited confidence with the tool¹⁷³.

In order for the real estate sector to remain viable, it needs to take on the groundbreaking “affront” for remaining connected to the social demand of its users and to its new patterns; if we try to draw a comparison with the development of the internet or smartphones and its impact on users and their behavior over time, with respect to the consumption patterns of commercial goods, it is impossible not to think that the current institutions and companies in the sector need to update themselves in order not to be replaced or to disappear completely from the market, as well as for the users themselves to be able to use the services in an ever better and more efficient way¹⁷⁴.

¹⁷³ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

¹⁷⁴ Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: Facilities, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

Technological barriers

Technology barriers are engaged in making the potential services of blockchain technology easily accessible and usable to the large mass of consumers. To make this possible, it is first of all necessary that the Real Estate market players find confidence and practicality in using the new digital skills related to digital decentralization, testing and challenging the new paradigms and enabling them to expand to the masses. Although large enterprises in the Real Estate industry have high resilience potential, as well as possessing in-house the know-how necessary for this technological transition and to undertake it through a planned and strategic transition, the market is actually driven by a multitude of disjointed realities on the territory and with scarce financial and workforce resources to be able to dedicate to investments other than their core commercial business¹⁷⁵; this makes it even more fundamental that innovative start-ups have a developed network of relationships with the realities of the local region to which they belong and through it seek the desired digital development, and this is because Real Estate is made up of tangible assets dispersed throughout the territory itself and find its usefulness in the relationships people build around it.

Regulatory barriers

The issue of regulatory compliance has already been addressed in the past, and in particular it concerns the introduction of regulations governing the relationships between users of blockchain networks; although to date government law enforcement agencies have drawn up their own codes of conduct and guidelines for the texts in use from a generalized point of view, it is appropriate that regulations concerning this technology could be drafted with a tailor-made, operations-based logic¹⁷⁶.

¹⁷⁵ PWC, (2021).Italia 2021: competenze per riavviare il futuro. Il rilancio dei consumi. Retrieved from: PWC italian website, report Italia 2021.

¹⁷⁶ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

The most challenging aspect is the legal issues related to privacy aspects, and the ongoing question is whether Blockchain is the best technology to preserve personal information and protect citizens' identities¹⁷⁷ [figure 43].

Among the major risks and limitations at government level we can mention:

- getting around of regulation through the digital platform and the occurrence of misconduct facilitated by it. Decentralized financial technologies have the potential to anonymize users and facilitate fraud and misconduct, the prosecution of which would be more difficult to comply with;
- raising enforcement issues, in a reality formed by hundreds of thousands of nodes each storing information and with decentralized decision-making;
- more jurisdictional uncertainty, as actors could quickly change locations and information related to their digital identities, making prosecution of criminal acts across multiple jurisdictions difficult¹⁷⁸.

The collaboration of platforms with local authorities is of fundamental importance for the tout-court application of blockchain platforms, since, as mentioned above, a moderate deployment of decentralization through hybrid forms is unthinkable, which would only represent a comparable alternative to the current possibilities of the network.

¹⁷⁷ Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

¹⁷⁸ Financial Stability Board FSB (2019). Decentralised financial technologies. Report on financial stability, regulatory and governance implications. Retrieved from: <https://www.fsb.org/wp-content/uploads/P060619.pdf> Financial Stability Board.

Process overview:
evolution of digital identity

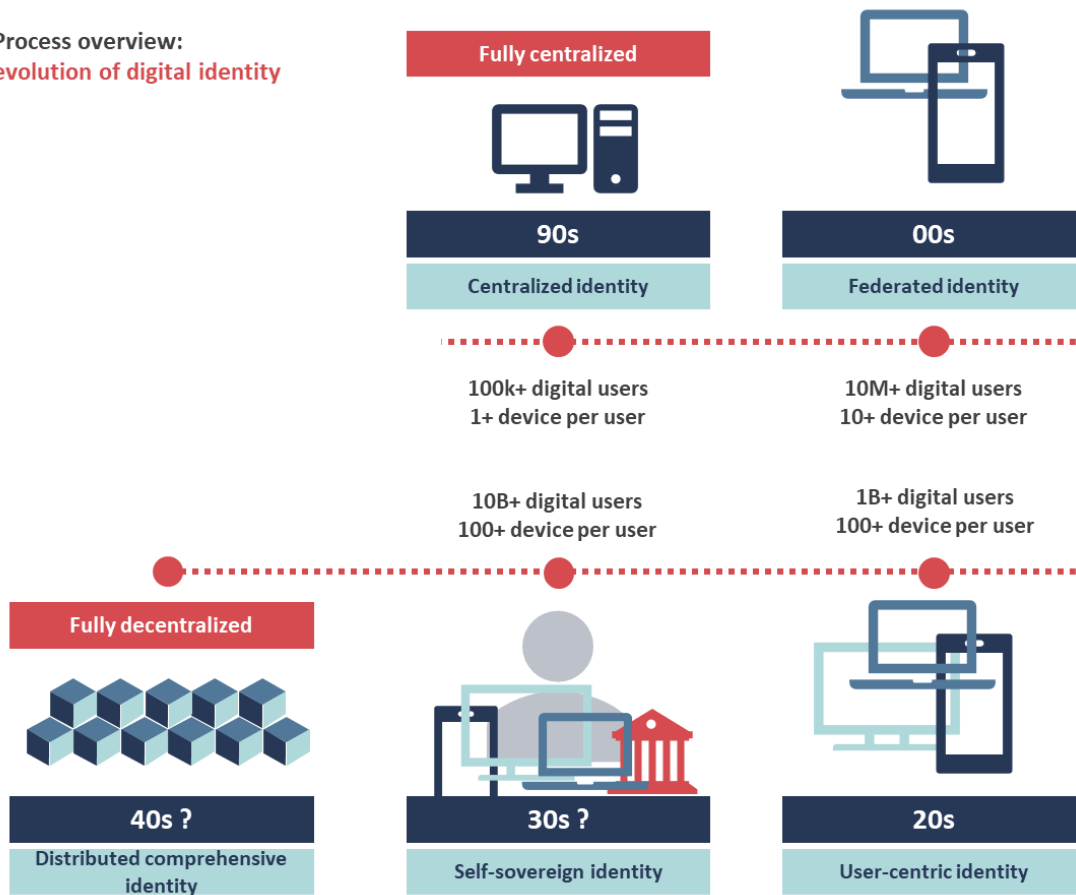


Figure 43: The diagram illustrates the evolution of the concept of digital identity from the advent of the Internet to possible future developments. Source of data entered: Arun J.S., Gutierrez C., Altoros IT Services and IBM Blockchain Services, (2017). *The Journey to a Self-Sovereign Digital Identity Built on a Blockchain*. Retrieved from: altoros.com, 2021.

4.3 – COST OF IMPLEMENTATION

Looking at the costs of implementing blockchain technology, the first factor to consider is the scalability of the technology and the opportunity cost of adopting it.

Currently, the scalability of the digital platform is very poor, and this is mainly due to two factors:

- the high bandwidth saturation index generated by the volume of activity on Blockchain networks; and
- the proportional increase of the cost share allocated to the miners according to the same volume of activity generated¹⁷⁹.

Bandwidth saturation is directly related to the effort required to validate the individual pieces of information included in the blocks; if, for example, we think of the amount of data that would need to be surveyed if the technology were used in the Real Estate field, with the digital structure currently in use it would be simply not sustainable to think of large-scale adoption¹⁸⁰. Currently, bandwidth saturation and associated energy consumption are far higher than any other digital platform [figure 44], placing serious operational limits on network growth and technology deployment.

¹⁷⁹ Garcia-Teruel R. M., Department of Private, Procedural and Tax Law, UNESCO Housing Chair, Universitat Rovira i Virgili, Tarragona, Spain, (2019). Legal challenges and opportunities of blockchain technology in the Real Estate sector. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 129-145. Emerald Publishing Limited.

¹⁸⁰ Preukschat A., Kuchkovsky C., Lardies G.G., Elñigo Molero D.D.G., Blockchain. La revolución industrial de internet, (2017). Blockchain. La revolución industrial de internet. Retrieved from: Centro Libros PAF, ISBN: 978-84-9875-448-3. Diríjase a CEDRO (Centro Español de Derechos Reprográficos).

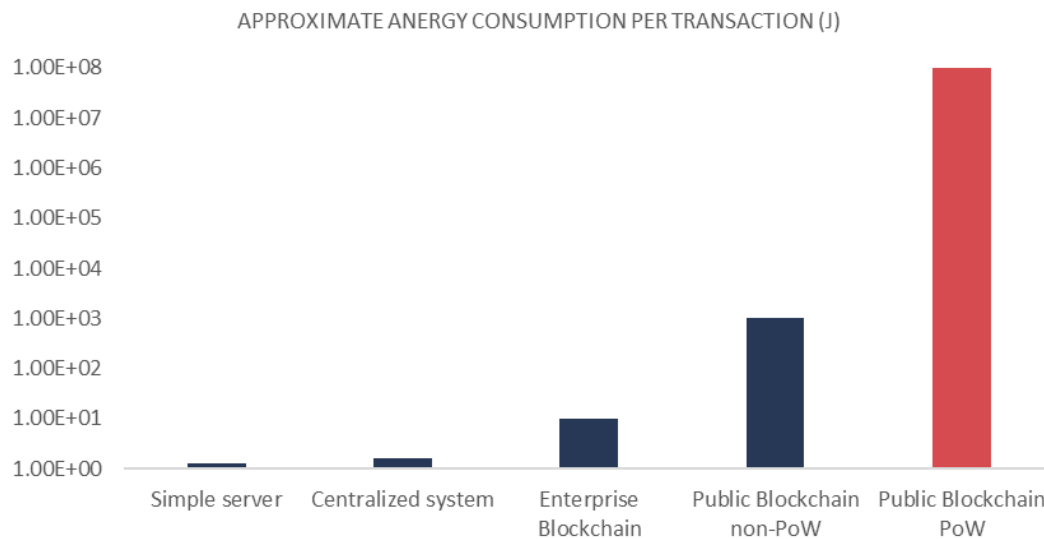


Figure 44: approximately energy consumed by the main digital networks for data exchange and storage. Data source: Sedlmeir J., Buhl H.U., Fridgen G., Keller R., (2020). Round-trip transaction costs: A key consideration when buying property. Retrieved from: *Business & Information Systems Engineering* volume 62, pages599–608 (2020), <https://link.springer.com/article/10.1007/s12599-020-00656-x>. Springer.

The increase in fees received by blockchain coiner is proportional to the activity of the network [figure 45] since the more competition between the node validators, the more they are rewarded for the validation of a new block to add to the previous ones; the direct consequence of this aspect is that the greater the diffusion and use of the platform, the greater will be - according to the current mechanisms- the percentage remuneration received by those who validate the information, potentially increasing exponentially the economic commitment necessary for the completion of each single operation¹⁸¹.

¹⁸¹ Garcia-Teruel R. M., Department of Private, Procedural and Tax Law, UNESCO Housing Chair, Universitat Rovira i Virgili, Tarragona, Spain, (2019). Legal challenges and opportunities of blockchain technology in the Real Estate sector. Retrieved from: *Journal of Property, Planning and Environmental Law* Vol. 12 No. 2, 2020 pp. 129-145. Emerald Publishing Limited.

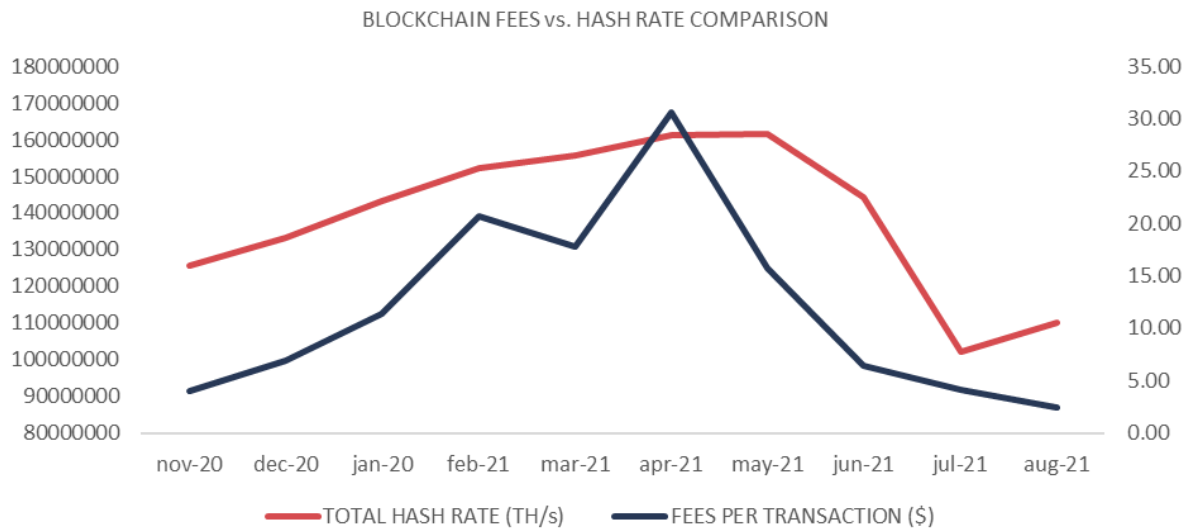


Figure 45: comparison between the bandwidth saturation in terms of the number of hashes completed per second by the blockchain network and the fees charged for each completed transaction. Data source: Blockchain.com, (2021). Total Hash Rate (TH/s) - The estimated number of terahashes per second the bitcoin network is performing in the last 24 hours.. Retrieved from: <https://www.blockchain.com/charts/hash-rate>.

In addition to the costs arising from the volume of transactions and the expense of validating them, the third and largest cost item relates to the actual adoption and implementation of the technology in the sector, as a real shift away from traditional systems; this cost would surely be entirely borne by the companies in the sector, adding to the current very high transaction costs already identified, making the Real Estate industry even less viable¹⁸² [figure 46].

¹⁸² Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

Cost overview: implementing Blockchains

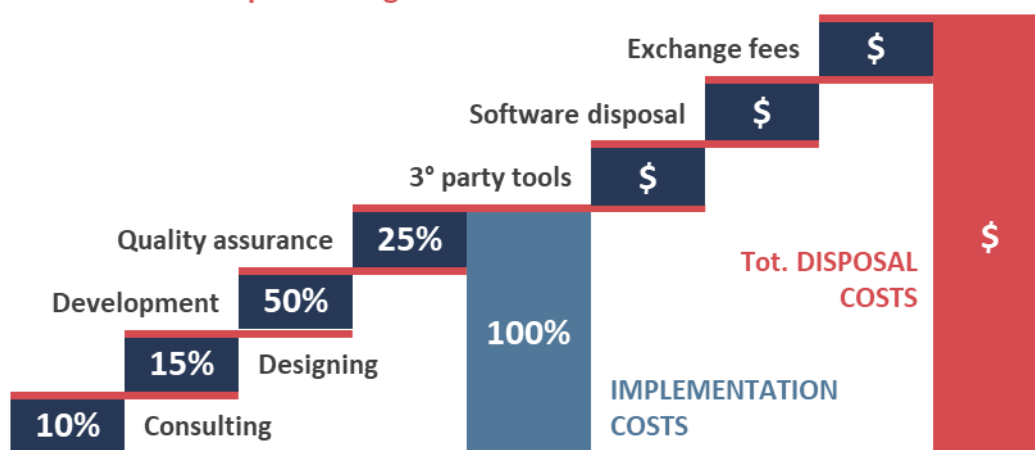


Figure 46: the main cost items for the implementation of a Blockchain platform within an activity. Data source: Takyar A., platforms construction specialist at LeewayHertz, (2021). How to determine the cost of Blockchain implementation? Url of the article: <https://www.leewayhertz.com/cost-of-blockchain-implementation/>. 2021 LeewayHertz.

4.4 – GRADUAL ROLLOUT

The possible gradual deployment of the Blockchain platform in Real Estate requires that primarily the platform outperforms conventional systems in order to be considered a suitable solution; the objective is that performance in terms of total transaction costs of properties and operational expenses for managing them are consistently reduced¹⁸³.

First of all, it must be considered that the current sources of transaction costs in the Commercial Real Estate sector are mostly caused by the need for knowledge, network, assessment and negotiation skills and professional experience of intermediaries. Blockchain technology, even in its most evolved forms, is not able to evaluate complex information and perform strategic considerations at the level of professionals in the field, but it can achieve at

¹⁸³ McKinsey & Company, Mckinsey Global Survey, (2020). How COVID-19 has pushed companies over the technology tipping point - and transformed business forever. Retrieved from: McKinsey Strategy and Corporate Finance website portal, McKinsey & Company Global Surveys.

best to support investors in ordinary accounting and structuring of documents and information¹⁸⁴.

The property owners fail in adequately maintaining all property-related documents in a coordinate and up-to-date way, and are only incentivized to do so at their best when the moment of disposition approaches. Blockchains are not the right solution to keep information up-to-date as they do not have the ability to assess when data entered is correct or incorrect: the concept of 'garbage in garbage out' applies. One must always assume that those who enter data and information are completely trusted.

Where property administration and management of the outflows and income flows of large multitenant properties (or portfolios) are very time-consuming in terms of administrative profile, the expectation is to be able to fully automate the processes of balancing rents and related expenses through the use of smart contracts automated through Blockchains; they could add value to the business by enabling landlords and managers to spend far less time reconciling income and expenses, promoting transparency and control for oversight and approval of expenses, and lowering the costs of accounting, compliance and property management.

The expectation is that the economic, time and complexity barriers of the processes for acquiring and holding properties can be significantly lowered, resulting in shorter throughput times and shorter intervals between transactions, encouraging more of them to go forward and increasing the liquidity and profitability of the world's most valuable asset class¹⁸⁵.

¹⁸⁴ CBRE Research and Reports, (2021). Italy Real Estate Market Outlook. Retrieved from: <https://www.cbre.it/it-it/research-and-reports/Italy-Real-Estate-Market-Outlook-2021-in-Italian>. CBRE iTALY Research and Reports.

¹⁸⁵ Seuren F. F., University of Technology, Delft - Faculty of Technology, Policy, and Management, (2018). Exploring the applicability of blockchain in lowering transaction costs in the commercial real estate due diligence process: a case study research. Retrieved from: Repository of Delft University of Technology. University of Technology, Delft.

The value of disruption

We talked in chapter 1 about the need for digital strategies and how they need to become true business strategies that take digital into account; and research in the sector shows that in leading companies, business and digital strategies are the same thing [figure 47]. The Covid-19 pandemic crisis has made this imperative more urgent than before in order to remain competitive in the market and keep their businesses profitable. Although alignment on overall strategies and strong leadership have always been markers of success during eras of transformation and *disruption*, the extent of technology's differentiating role in this global crisis is stark; organizations that tested new digital systems during the crisis and those that invested more capital in digital technology than their competitors reported dramatic revenue growth compared to other companies that did not change their plans¹⁸⁶.

The notion of a breaking point for technological adoption or digital disruption is not new, but Covid-19 was in this sense a disruptive event of historic proportions, and new changes will still be needed as social and economic situations evolve; the lesson to be absorbed by companies that want to remain competitive can be summarized in two steps:

- the importance of tactical study to bring about specific changes to business (what technology to implement and how); and
- organizational (how to manage change that occurs at a pace that largely exceeds previous experience)¹⁸⁷.

The question here is whether Blockchain is just a technological disruption or a real game changer, and how the entire Real Estate value chain can embrace it. Having trust in Blockchains is a prerequisite to drive an industry upgrade strategy where new businesses and start-up companies can offer equally or more robust alternatives to existing ones but at a lower cost and that can create more value than the current one in the medium term.

¹⁸⁶ McKinsey & Company, Mckinsey Global Survey, (2020). How COVID-19 has pushed companies over the technology tipping point - and transformed business forever. Retrieved from: McKinsey Strategy and Corporate Finance website portal, McKinsey & Company Global Surveys.

¹⁸⁷ McKinsey & Company, Mckinsey Global Survey, (2017). How digital reinventors are pulling away from the pack. Retrieved from: McKinsey Digital Insights website portal, McKinsey & Company Global Surveys.

Executive mindsets : **technology's strategic importance**

Organization's current strategic posture towards technology (%)

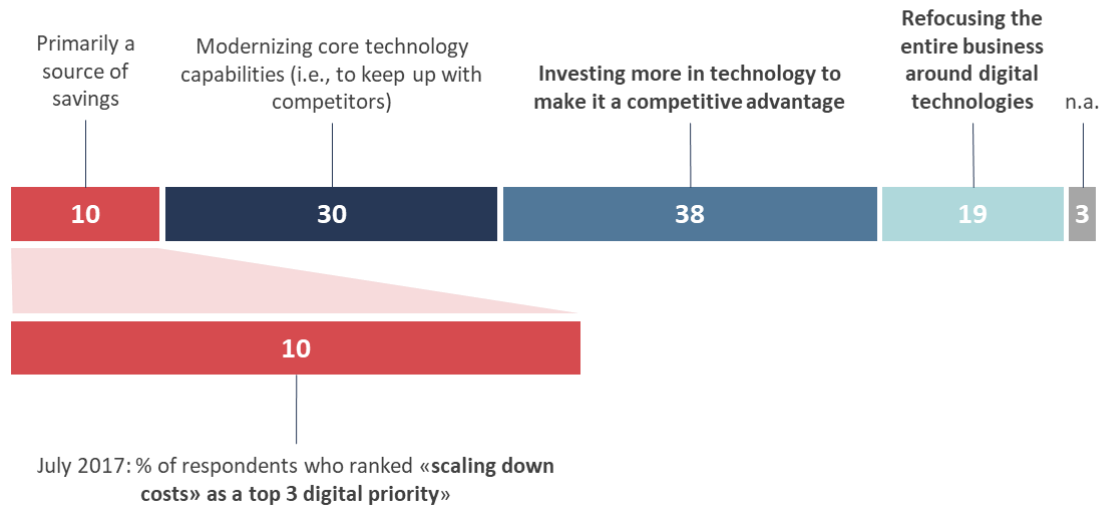


Figure 47: the attitude of a selected group of organizations with respect to technology expenditure within corporate strategies. Data source: McKinsey & Company, McKinsey Global Survey, (2020). How COVID-19 has pushed companies over the technology tipping point - and transformed business forever. Retrieved from: McKinsey Strategy and Corporate Finance website portal, McKinsey & Company Global Surveys.

The way in which disruption, Blockchain and the Real Estate sector will develop in the years to come are not only the only variables of this change, but its social impact and user behavior also belong to it. The companies that will offer these new and more dynamic services will clearly have to manage to maintain and increase the current viability of the built environment and determine a competitive force that will drive them to success; all this will clearly affect the current and future valuation of Real Estate assets.

To create such viability a range of skills such as continuous insight into consumer habits, process-oriented steering and strategic alliances will be essential¹⁸⁸.

¹⁸⁸ Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: Facilities, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

But what is meant by the 'value of disruption'? Disruption is a predictable pattern of all business sectors, within which a small innovative business uses technology and innovation to make it possible for "something small and new" to penetrate "something established and big", in a short period of time¹⁸⁹. As shown in the table below [figure 48], destruction occurs in four distinct phases in which the established order (incumbent) is challenged by a niche solution from which someone begins to take advantage (disruptor). Disruption is a tangible dynamic and involves physical change; an orientation towards this pattern by the Real Estate sector can be interpreted as evidence that the sector is able to innovate and stay aligned with digital development while remaining highly viable and improving its profitability¹⁹⁰.

Process overview: the four phases of disruption

PHASE	Challenger - DISRUPTOR	INCUMBENT
1_DISRUPTION OF ESTABLISHED ORDER	Introduces a new product that doesn't meet all the needs of the existing market	New product is not relevant to existing customers
2_RAPID LINEAR EVOLUTION	Quickly adds features and capabilities (users are represented by early adoptes)	Validation, the new products has lot of defects compared to existing one
3_CONVERGENCE	Broaden the customer base (slow movers) old features applied in a completely new way	Adds disruptive new feature that interferes with existing customers; doesn't see the value of the other
4_COMPLETELY NEW PRODUCT	Newcomers in the market take advantage of that product without considering the old one	Too late to respond, definition of new products (withdrawal phase, research of a new market base)

Figure 48: the four phases of the disruption process carried out through the comparison between the old product (incumbent) and the new entry into the market (challenger / disruptor). Data source: Veuger J., Research Centre of Built Environment, Hanze University of Applied Sciences Groningen, Groningen, The Netherlands, (2017). Trust in a viable Real Estate economy with disruption and blockchain Retrieved from: *Facilities*, Vol. 36, No. 1/2, 2018, pp.103-120. Emerald Publishing Limited.

Short-term implementation

¹⁸⁹ Vermeend S., Smit P., Nationale-Nederlanden NN Bank and Saxion University of Applied Sciences, (2017). Blockchain: de technologie die de wereld radicaal verandert (Blockchain, the Technology That is Radically Changing the World). Retrieved from: Einstein Books. Den Haag.

¹⁹⁰ Baldwin, R., Oxford University Press, (2019). The Globotics Upheaval: Globalisation, Robotics and the Future of Work. Retrieved from: Oxford University Press, 2019.

In the short term, it is unlikely that blockchain technology will be used on a large scale to implement current processes, as the operational and regulatory challenges are a major source of friction. For this reason, most of the initiatives move from the intention of focusing on a precise phase or operation rather than on an entire process, trying to improve it and make it more efficient, and finding fewer implementation obstacles¹⁹¹; several private initiatives or those favored by the governments of some countries have tried to shake up above all the conveyancing process, represented essentially by the sale and transfer of the acts and titles necessary to make it effective, with very different outcomes. Two reasons in particular make it impossible to find a guiding star within these experimental initiatives to date:

- police and regulatory barriers at national level, which are difficult to overcome and update;
- reaching a critical mass of adopters that would allow the rapid spread of the platforms and their wide use.

In addition, the lack of standardized and easily processable data pools constitutes a third element of weakness of the trials¹⁹².

In the following chapter, the main initiatives on the implementation side of the technology are considered in order to provide a clearer picture of the system's functionality and concrete possibilities.

¹⁹¹ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

¹⁹² Nijland M., Veuger J., Saxion University of Applied Sciences Enschede, Real Estate Hanze University and Foundation for International Blockchain Real Estate Expertise FIBREE, (2019). Influence of Blockchain in the Real Estate Sector - In which stage of the buying process of Commercial Real Estate can Blockchain provide added value for the stakeholders involved?. Retrieved from: International Journal of Applied Science; Vol.2, No.2, 2019. Ideas Spread Publications.

Implementation trials

The universe of start-ups and private initiatives in the field of Blockchain and Token technologies in the Real Estate sector currently numbers around 80 major or partially established companies, but the universe of ventures is much larger. Although there are so many of them, they do not yet constitute a significant user base, and this is largely due to the still small group of users active in this almost new digital sector of Blockchains. The diagram in figure 49 shows a synthetic cross-section of the services provided and the major companies in the specific segment: it is immediately clear that the various systems focus on a specific process in the general ecosystem, and that there is still little or no integration between them. It is, however, reasonable to think that the Blockchain platform structure may in the near future become the unifying force and general coordinator of this whole cosmos.

System overview: the Blockchain-based Real Estate services




Figure 49: the diagram shows the main Real Estate services that operate from the Blockchain platform and the major operators for each segment. Data source: personal processing on the sources cited.

Integrated property listing services

	NAME	Type of service provided	Country	Year
	REX - Real Estate Exchange, Inc.	Property listing: Showcase to sell and buy homes	USA	2018

The REX platform was born in 2018 in the United States with the aim of acting as a digital broker, uses artificial intelligence and machine learning to identify potential buyers and acts outside the Multiple Listing Service¹⁹³ (MLS) market; its strengths are the very low fees that allow exorbitant savings on transaction costs¹⁹⁴.

Automated transaction processes

	NAME	Type of service provided	Country	Year
	Propy	Automated cross-border transactions and titles registration	USA	2015

Propy is a US platform based in Silicon Valley which aims to carry out national and international transactions by automating the payment and registration processes of property titles and property deeds. The creators have been able to get the platform up and running by raising investments from the market of over \$ 15 million, and it is currently up and running¹⁹⁵.

¹⁹³ MLS: an MLS (Multiple Listing Service) is a private offer of cooperation and compensation by listing brokers to other real estate brokers. Source: National Association of realtors, <https://www.nar.realtor/nar-doj-settlement/multiple-listing-service-mls-what-is-it>. 2021

¹⁹⁴ Gomez J., UpNest, (2021). REX Real Estate Reviews: What You NEED to Know. Url of the article: <https://www.upnest.com/1/post/rex-real-estate-reviews/>. UpNest Reviews, 10 November 2021.


¹⁹⁵ Propy, (2019). What Is Propy? How Does Propy Work?. Url of the article: <https://propy.com/browse/what-is-propy-how-does-propy-work/>. April 2, 2019.

Real Estate Marketing

	NAME	Type of service provided	Country	Year
	Propify	Property marketing, close to RE agents and brokers	AU	2018

Propify is a marketing and advertising platform for Real Estate properties registered on the Blockchain, which aims to support traditional real estate agents and brokers in their operations. Currently it has succeeded to raise funds for the equivalent of \$ 150k and is active through social platforms; to date it has not met the desired success and has not reached the critical mass of users necessary to evaluate its benefits¹⁹⁶.

Cross-border payments


	NAME	Type of service provided	Country	Year
	Ripple	Cross-border payments via Blockchain	USA	2012

Ripple is a private Californian company active since 2012; in the development of a fast cross-border payment method without intermediaries, it has raised \$ 294 million to date and acts as a reference for the entire segment and has between 500 and 1000 employees¹⁹⁷.

¹⁹⁶ Crunchbase, (2021). Propify organization profile. Url of the article: <https://www.crunchbase.com/organization/propify>. 2021 Crunchbase Inc.


¹⁹⁷ Ripple, (2021). Our Story. Enabling the world to move value like it moves information today. Url of the article: <https://ripple.com/company>. 2013 - 2021 Ripple.

Real Estate Units rental services

	NAME	Type of service provided	Country	Year
	Rentberry	Automatization of rental tasks	USA	2019

Rentberry is an American company based in San Francisco that deals with equity crowdfunding to promote a short- and long-term rental of real estate units through the Blockchain platform. It has raised \$ 9 Million in funds and has approximately 50 employees; through its services it is possible to rent a house in major American and European cities, such as New York, Berlin, Rome, London, Paris. The development of the project continues and the user base is constantly expanding¹⁹⁸.

Digital ID Blockchain solutions

	NAME	Type of service provided	Country	Year
	Chromaway	Digital ID identity solutions for Blockchain platforms	SWE	2014

Chromaway manages a digital personal authentication system (digital ID) that allows you to connect a digital identity to be used on the Blockchain platforms to your personal information; the goal is to create a safe and inclusive digital ecosystem and to prevent financial fraud. Its strength is the close collaboration with other companies in the sector to seek a better and complete integration of the respective services¹⁹⁹.

¹⁹⁸ Crunchbase, (2021). Rentberry organization investment profile. Url of the article: <https://www.crunchbase.com/organization/rentberry>. November 2021.


¹⁹⁹ PWC Denmark, (2019). Chromaway. Building the Relational Blockchain for Enterprises. Url of the article: PWC Denmark official website, publications and reports, <https://www.pwc.dk/da/arrangementer/2019/chromaway.pdf>. PWC Dk.

Smart contracts for Real Estate applications

	NAME	Type of service provided	Country	Year
	Midasium	Smart Tenancy Contracts for landlords	UK	2015

Midasium is an English platform that offers contractual services for tenants and landlords, automating the bargaining processes and the management of mutual obligations through smart contracts on the Blockchain. Its advantages include short timeframes for stipulation, maximum transparency, reduction of registration and drafting costs, management of direct Real Estate costs. As this is a private initiative, there is little data and information about the company, but the platform is active and operational²⁰⁰.

Analytical services

	NAME	Type of service provided	Country	Year
	Bloq	Advanced analytics for enterprises Blockchain services	USA	2015

Bloq is a US company that operates in the field of digital infrastructure consultancy for companies, and deals with the scalability of their digital services; in particular, the core business consists of advanced analytics tools for Blockchain platforms and Smart Contracts. The organization is private in nature, was born in 2015 and has raised \$ 4 million in funds to date on the market²⁰¹.

²⁰⁰ Midasium, (2021). The Blockchain of Real Estate. Smart Tenancy Contracts. Url of the article: Midasium official website, <https://midasium.herokuapp.com/smart-tenancy>.

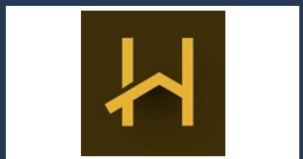
²⁰¹ Bloq, (2021). Managed infrastructure for building on blockchain networks. Url of the article: Bloq website, services portal, <https://www.bloq.com/solutions/for-enterprises/>. 2021 Bloq, Inc.

Land titles and land registry

	NAME	Type of service provided	Country	Year
	Bitland	Land registry Blockchain service for land titles securitization	GH	2013

Bitland is a Ghanaian start-up that deals with securing the ownership titles of the land plots of citizens through a digital system based on Blockchains and which operates through territorial geospatial identification systems supported by satellite and GPS technology; the system is directly related to the national registry of Ghana and is officially recognized by the country's government²⁰².

Real Estate conveyancing process


	NAME	Type of service provided	Country	Year
	Househodl	Conveyancing Real Estate processes though Bitcoin	LV	2017

Househodl was the first platform that took care of coordinating and making possible the entire conveyancing process on the Blockchain platform and using Bitcoins as a payment method for transactions. A network of professionals affiliated with the company deals with all financial and legal matters involving Real Estate transactions, actively supporting clients²⁰³.

²⁰² Miller M., The Borgen Project, (2020). Bitland. Property rights for the world's poor. Url of the article: <https://borgenproject.org/property-rights-for-the-worlds-poor/>. September 4, 2020.


²⁰³ Househodl organization profile, (2021). HouseHodl is a world's first platform for securely buying & selling real estate with Bitcoin. Url of the article: <https://www.crunchbase.com/organization/househodl>. Crunchbase, 2021.

Mortgage through asset-backed NFT securities

	NAME	Type of service provided	Country	Year
	BaconDAO	Asset-backed mortgages through Blockchain platform	JP	-

BaconDAO²⁰⁴ is an incubator of start-ups that develop digital applications that operate on the Blockchain; is developing an application to provide asset-backed mortgages through Blockchain networks. The process involves the Tokenization of the assets to be left as collateral, assigning them a monetary value in cryptocurrencies, after which the loan is disbursed. The distinctive feature is the speed of credit allocation and the automation of the process. There is no information regarding the success of the system, but previous attempts undertaken by Homelend²⁰⁵ and Pangea²⁰⁶ appear to have been unsuccessful and suspended at the moment.

Tokenization of Real Estate securities

	NAME	Type of service provided	Country	Year
	SolidBlock	Tokenization of fractioned Real Estate securities	IL	2017

The company deals with the tokenization of Real Estate assets through the standard Ethereum ERC20 protocol, aimed at creating digital tokens that contain fractions of the value of tangible properties. The system has as its direct commercial output through the collection of money to


²⁰⁴ Bourgi S., Cointelegraph, (2021). Bacon Protocol launches decentralized mortgage platform. Url of the article: <https://cointelegraph.com/news/bacon-protocol-launches-decentralized-mortgage-platform>. September 28, 2021.

²⁰⁵ Galal A., LinkedIn.com, (2018). Homelend, The Blockchain Based Mortgage Crowdfunding Platform. Url of the article: https://www.linkedin.com/pulse/homelend-blockchain-based-mortgage-crowdfunding-platform-ahmad-galal/?trk=articles_directory. August 2, 2018.

²⁰⁶ Pangea Digital Asset Group, (2021). Pangea Digital Asset Group is an investment firm focused on ventures, tokens, and projects related to blockchain tech, digital assets, and cryptocurrency. Url of the article: <https://pangeablockchain.ch/>.

finance development projects. It currently has around thirty employees and has raised funds for the growth of the company for a total of \$ 900k.

Real Estate investments

	NAME	Type of service provided	Country	Year
	Atlant	Real Estate investments through Blockchains	UK	2017

Atlant is a private organization that is trying to revolutionize the ecosystem of the Real Estate market on several fronts; in particular, it allows investments in real credit and debt, the exchange of tokens representing property titles of real properties and the rental of spaces. Among all the organizations it is the one that has the most revolutionary and total vision regarding the impact of Blockchain technology on the brick sector. Currently, the company has raised \$ 6 mln and is rapidly expanding its user base²⁰⁷.

Property management

	NAME	Type of service provided	Country	Year
	Crafty	Real Estate property and Facility Mgt services through Blockchain	BR	2016

Crafty is a decentralized platform that aims to tokenize the free-lance industry of property and facility management Real Estate services by revolutionizing it through artificial intelligence

²⁰⁷ Atlant Crunchbase organization profile, (2021). Blockchain Real Estate Platform | Tokenized Ownership | P2P Rentals. Url of the article: <https://www.crunchbase.com/organization/propify>. November 2021.

mechanisms that reward reputation and customer feedback. It started as a pilot from Brazil and is now present in 170 cities and has about 30,000 users²⁰⁸.

Brief summary

The microcosm of solutions and services operating on the Blockchain platform and gravitating in the universe of the Real Estate sector is large and fragmented; even if today these services do not find ample space for widespread application and to capture a significant share of the market, the potential of the individual systems and the vast nature of the Real Estate sector, together with the spread of Blockchain and cryptocurrencies, will allow for an increasing and widespread implementation of these platforms. A third element in favor of the cause is the capital mobilized by the industry and the liquidity that can still potentially be generated and/or unlocked in the short term.

In the medium term we have to expect that the consolidation of the services provided by the individual companies and their greater coordination and structuring will bring about a real and concrete revolution in the Real Estate sector: for operators and players to keep up to date is a necessity to remain competitive in the market also in the future.

²⁰⁸ IcoCrafty, (2021). Crafty is disrupting a \$200B self-employed industry. Url of the article: <https://ico.crafty.work/?detect=en-US>. 2017-2021 crafty.work.

5.0 – OUTLINE CONCLUSIONS

Possible outbreaks

The research conducted on the use of Blockchain technology in the field of Real Estate leads to the following arguments against a possible implementation in the short term:

- first of all, digital solutions to actually provide such services in an integrated, comprehensive and reliable manner would require complementary investments for legal adjustments. Such expenditures are currently under evaluation as funding in the sector is still coming in in a discontinuous and moderate manner;
- strong legislative updates on an international scale are necessary to allow new technological solutions to be tested and used without continuous compromises that undermine the possible good results;
- Blockchain technology is still in an embryonic phase, although it is making a lot of noise and attracting a large number of retail and institutional investors. Real estate applications are a derivative product of the cryptocurrency universe, and there is a need to properly regulate and structure the primary uses of Blockchains before successful applications can be achieved beyond intangible asset transactions²⁰⁹.

The examples given in Chapter 4 represent specific applications of individual services that leverage individual inefficiencies, thereby better managing the difficulties in developing the various applications; this is surely the best path to take in order to believe that they can overcome the various technical-administrative barriers and find a concrete output channel²¹⁰.

The writer is firmly convinced that the embryonic stage of development of the platforms together with the lack of regulation and bureaucratic obstacles do not allow to believe that the

²⁰⁹ Saull A., Baum A., Braesemann F., Said Business School, University of Oxford, Oxford, UK, (2019). Can digital technologies speed up Real Estate transactions?. Retrieved from: Journal of Property Investment & Finance, Vol.38, No. 4, pp.349-361. Emerald Publishing Limited.

²¹⁰ Konashevych O., Erasmus Mundus Joint International Doctoral Fellow in Law, Science and Technology, Research Centre of History of Law, Philosophy and Sociology of Law, Computer Science and Law, University of Bologna, (2019). Constraints and benefits of the blockchain use for Real Estate and property rights. Retrieved from: Journal of Property, Planning and Environmental Law Vol. 12 No. 2, 2020 pp. 109-127. Emerald Publishing Limited.

implementation in the Real Estate sector is viable in the short term and does not currently represent a solid structure on which to speculate on future developments.

Despite this, I believe there is a specific field of application that could be the optimal incubator for the Blockchain system in the Real Estate field for various reasons, including:

- a very clear and structured regulation of the field;
- an operational function of an easily automatable nature and traceable to outline schemes;
- the uniform structuring of data and information in the management systems of banking organisations.

These conditions compose the ideal universe in which to test and refine the potentialities of the Blockchain systems, as will be further discussed in the following paragraph.

Asset Quality Review (AQR)

The Asset Quality Review (AQR) is a process drawn up on Central European Bank regulations whose publication dates back to 2018 and the last update to 2021, and includes a series of directives to cover the effects of the Covid-19 pandemic on the internal operational flow²¹¹.

It has as its objective the assessment of the risk status in which a sample of selected banks is located and which includes the major national companies of the various countries belonging to the European Union, and the analysis is carried out by performing risk assessments and stress tests, in order to determine the probability of bankruptcy in the event of a macroeconomic event on a continental scale. Verification takes place on the following asset categories:

- fair-valued loan portfolios;

²¹¹ European Central Bank, Banking Supervision, (2021). Comprehensive assessment. Retrieved from: European Central Bank website, https://www.bankingsupervision.europa.eu/banking/tasks/comprehensive_assessment/html/index.en.html. 2021, European Central Bank.

- level 2/3 single-name bonds;
- level 2/3 securitisations;
- held real estate;
- participations and individual private equity investments.

For Real Estate assets, the properties subject to this review process are selected through a series of requirements aimed at cataloging the risk index that individual debtors hold against the repayment of the capital that they must give back within a pre-established time frame to the bank. in the form of leasing and financing. Once the less performing ones have been identified, the properties left as collateral for these loans are classified according to the following categories²¹²:

- residential property;
- commercial, income-producing;
- commercial, in development;
- land.

The documents of the selected properties are entrusted to a series of Independent Experts so that the valuation is performed again according to sector practice and the directives of the European Regulation in accordance with the permitted valuation methods (certain methods that include too many financial variables and assumptions by the Expert Evaluators are excluded, as the results considered too variable depending on the sensitivity of the same - this is the case of Discounted Cash Flow for Transformation and Reconstruction²¹³).

A Blockchain platform could help the process in various stages, listed below and detailed in the following paragraphs:

²¹² European Central Bank, Banking Supervision, (2018). Asset Quality Review - Phase 2 Manual. Retrieved from: European Central Bank Website, <https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.assetqualityreviewmanual201806.en.pdf>. 2021, European Central Bank.

²¹³ European Banking Authority, EBA, (2020). 2021 EU-Wide Stress Test. Methodological Note. Retrieved from: European Banking Authority website, https://www.eba.europa.eu/sites/default/documents/files/document_library/Risk%20Analysis%20and%20Data/EU-wide%20Stress%20Testing/2021/936417/2021%20EU-wide%20stress%20test%20-%20Methodological%20Note.pdf. EU EBA, 2021.

- phase of selection of the debtor pool;
- phase of selection of the properties under review;
- evaluation and determination of the Fair Value and comparison with the previously recorded values, subsequent analysis of the variance in the identified Market Value;
- reconciliation of data and issuing of specific alerts in function of the deviations in the identified value.

Selection of the debtor pool

The information of the identified debtor pool is automatically analyzed by the predefined Blockchain platform and the data and information cataloged; subsequently they are subject to various types of analysis by the aforementioned digital system, which on the basis of the parameters chosen by the reference Governmental Authority, are clean out according to the risk of default.

The various levels of risk are designed to define from which situations to start the portfolio review activity, proceeding from the more broad risk up to the risk level necessary and defined a priori.

The properties underlying the profiles of the identified debtors are then examined by the software to verify that the data and documentation are complete; in this segment the help of specialized personnel will be essential since, while the bank customer information are generally registered in an orderly and correct manner, the data rooms in which the documents of the properties are kept are composed of piles of documentation in PDF format and poorly organized. In this moment human intervention is inevitable and constitutes one of those added values that will hardly be eliminated even in the long term.

Determination of the Fair Value

For the determination of the most correct Market Value of the Property, the potential of the analysis and machine learning system to reach the most correct value would be contemplated. To obtain a correct output from this phase it is necessary that the quantitative and spatial data entered are accurate; the digital platform would continue by identifying:

- the weighting of the surfaces of the assets and their division by intended use;

- the geospatial positioning of the property,

and continuing by performing a market analysis carried out:

- on institutional market sources;
- on direct sources, represented by the data extracted from the listing platforms (asking prices and adequately recalculated considering the negotiation margins).

The output of the process would be assessed and computed to reach the most appropriate Market Value and compared with the previous one.

If this Value is within a predetermined and limited range of deviation, the analysis can be validated and archived by updating the borrower's financial data; otherwise, the system generates an alert for a Market Value that is very misaligned with the previous one, and subsequently analyzed by the Independent Experts appointed to analyze the sources of this gap.

Process overview: **Fair Value assessment process**

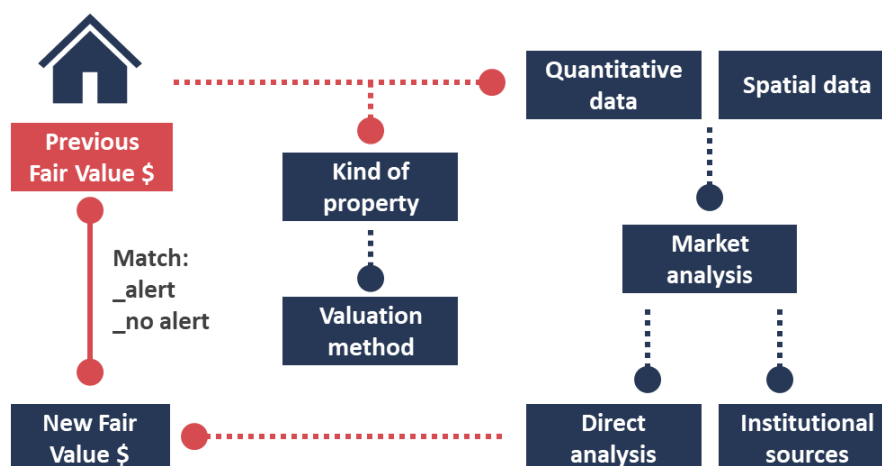


Figure 50: logical process of determining the Fair Value and variables involved in the impairment process. Data source: processing based on the proposed sources.

Results

Testing the platform within the limits of this medium-added value activity would allow to evaluate the precision and reliability of the platform, as well as the ability of the machine learning mechanisms to understand and study the dynamics of the Real Estate markets and provide appropriately evaluated results; moreover, the precise limits of the Asset Quality Review activity would make it possible to better understand the functioning and the margin of error of this digital system as the boundaries of action would be well delineated and distinct, allowing to refine a regulation tailored to the processes of Blockchain systems, leaving little room for regulatory holes and bad interpretations, spreading trust and the possibility of shareable standards for the diffusion of technology that has responded to new and completely innovating and unexplored network decentralization paradigms.

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Table of Figures

FIGURE 1: TECHNOLOGICAL IMPROVEMENT TRENDS. SOURCE OF DATA: FUTURE OF JOBS SURVEY, WORLD ECONOMIC FORUM. 2020.	11
FIGURE 2: TECHNOLOGIES LIKELY TO BE ADOPTED. SOURCE OF DATA: FUTURE OF JOBS SURVEY, WORLD ECONOMIC FORUM. 2020.	12
FIGURE 3: DEMOGRAPHIC AND SOCIO-ECONOMIC TRENDS. SOURCE OF DATA: FUTURE OF JOBS SURVEY, WORLD ECONOMIC FORUM. 2020.	12
FIGURE 4: COMBINED G20 TIME-TO-RECOVERY AND GLOBAL GDP. SOURCE OF THE DATA: ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT OECD, OECD ECONOMIC OUTLOOK, (2021). CORONAVIRUS (COVID-19).	13
FIGURE 5: 2022 GDP GROWTH, YEAR-OVER-YEAR %. SOURCE OF THE DATA: ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT OECD, OECD ECONOMIC OUTLOOK, (2021). CORONAVIRUS (COVID-19).	14
FIGURE 6: GOOD VS. SERVICES, % CHANGE IN CONSUMPTION COMPARED TO PRE-PANDEMIC LEVEL. SOURCE OF THE DATA: ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT OECD, OECD ECONOMIC OUTLOOK, (2021). CORONAVIRUS (COVID-19).	15
FIGURE 7: YEAR-ON-YEAR TURNOVER VARIATION (2019-2020) IN THE ITALIAN MANUFACTURING SECTOR. SOURCE OF THE DATA: PWC "ITALIA 2021 - COMPETENZE PER RIAVVIARE IL FUTURO. IL RILANCIO DEI CONSUMI". PWC REPORT, 2020.	15
FIGURE 8: AVERAGE SHARE OF DIGITAL CUSTOMER INTERACTIONS, FROM JUNE 2017 TO JULY 2020. SOURCE OF THE DATA: MCKINSEY & COMPANY GLOBAL SURVEY, (2020). HOW COVID-19 HAS PUSHED COMPANIES OVER THE TECHNOLOGY TIPPING POINT - AND TRANSFORMED BUSINESS FOREVER.	17
FIGURE 9: EXECUTIVE CORPORATE MINDSETS ON TECHNOLOGY STRATEGIC IMPORTANCE. ORGANIZATIONS' CURRENT STRATEGIC POSTURE TOWARD TECHNOLOGY. SOURCE OF THE DATA: MCKINSEY & COMPANY GLOBAL SURVEY, (2020). HOW COVID-19 HAS PUSHED COMPANIES OVER THE TECHNOLOGY TIPPING POINT - AND TRANSFORMED BUSINESS FOREVER.	17
FIGURE 10: ACCELERATION OF THE DIGITAL TRANSITION. SOURCE OF THE DATA: PWC, (2021).ITALIA 2021: COMPETENZE PER RIAVVIARE IL FUTURO. IL RILANCIO DEI CONSUMI.	18
FIGURE 11: CORPORATE DIGITIZATION RISK (LEFT SCHEME) AND RESOURCE ALLOCATION TO DIGITIZATION (RIGHT SCHEME). SOURCE OF THE DATA: MCKINSEY & COMPANY, MCKINSEY GLOBAL SURVEY, (2017). HOW DIGITAL REINVENTORS ARE PULLING AWAY FROM THE PACK.	19
FIGURE 12: THE GRAPH ON THE LEFT SHOWS THE PROPORTIONAL VALUE OF THE VARIOUS ASSET CATEGORIES. SOURCE OF THE DATA: THE SAVILLS UK BLOG, (2017). HOW MUCH IS THE WORLD WORTH?	21

FIGURE 13: THE GRAPH ON THE RIGHT SHOWS THE OVERALL VALUATION OF SAFE-HAVEN AND REAL ESTATE ASSETS, EXPRESSED IN TRILLIONS OF US DOLLARS. SOURCE OF THE DATA: EURO-PHOENIX INTERNATIONAL CORPORATE FINANCE LPP, (2019). KEY GLOBAL ASSET UNIVERSE IN 2019.	21
FIGURE 14: PERCENTAGE OF CREDIT LOSS DURING THE PANDEMIC PERIOD, ALLOCATED BY SECTOR. SOURCE OF THE DATA: BANK FOR INTERNATIONAL SETTLEMENTS, (2021). ANNUAL ECONOMIC REPORT, JUNE 2021. THE OUTLOOK FOR CORPORATE CREDIT LOSSES.	22
FIGURE 15: (LEFT SIDE) NET PRIME YIELDS FOR LOGISTICS SECTOR. SOURCE OF THE DATA: JLL LOGISTICS SNAPSHOT ITALY, Q2 2021.	22
FIGURE 16: (ON THE RIGHT SIDE) LOGISTIC COMPLETIONS BY TYPOLOGY. SOURCE OF THE DATA: JLL LOGISTICS SNAPSHOT ITALY, Q1 2021.	22
FIGURE 17: (ON THE LEFT SIDE) RESIDENTIAL REAL ESTATE INVESTMENTS IN ITALY. SOURCE OF THE DATA: CBRE RESEARCH AND REPORTS, (2021). ITALY REAL ESTATE MARKET OUTLOOK.	23
FIGURE 18: (ON THE RIGHT SIDE) ITALIAN HOUSE PRICE INDEX (100PTS BASELINE= Q1 2015). SOURCE OF THE DATA: ISTITUTO NAZIONALE DI STATISTICA ISTAT. PREZZI DELLE ABITAZIONI (IPAB). OECD.	23
FIGURE 19: SMALLER ENTITY MACROECONOMIC EVENT, IMPACT ON REAL ESTATE SUPPLY AND DEMAND CURVE. SOURCE OF THE ILLUSTRATIONS: ANTIFRAGILITY OF REAL ESTATE INVESTMENTS IN A WORLD OF FAT-TAILED RISK. RETRIEVED FROM: SAN DIEGO UNIVERSITY, EDUCATIONAL RESOURCES SECTION. 2021 UNIVERSITY OF SAN DIEGO, 2020.	25
FIGURE 20: SMALLER ENTITY MACROECONOMIC EVENT, IMPACT ON REAL ESTATE SUPPLY AND DEMAND CURVE. SOURCE OF THE ILLUSTRATIONS: ANTIFRAGILITY OF REAL ESTATE INVESTMENTS IN A WORLD OF FAT-TAILED RISK. RETRIEVED FROM: SAN DIEGO UNIVERSITY, EDUCATIONAL RESOURCES SECTION. 2021 UNIVERSITY OF SAN DIEGO, 2020.	26
FIGURE 21 MILAN OFFICE PRICES HISTORICAL SERIES (GOOD STATE OFFICES, €/SQM) COMPARED TO THE OVERALL COUNTRY'S REAL ESTATE PRICE INDEX (ALL PROPERTY SEGMENTS, 2010= 100 BPS). SOURCES OF THE DATA: NOMISMA, REAL ESTATE ITALIAN OBSERVATORY (OFFICES), FEDERAL RESERVE BANK OF ST. LOUIS, ECONOMIC RESEARCH (RE INDEX).	28
FIGURE 22: ALLOCATION TO GROWTH ASSETS, OVERALL MEAN VALUE FOR THE P22 COUNTRIES AND FOR P7 MARKETS, WHICH INCLUDE ONLY AUSTRALIA, CANADA, JAPAN, NETHERLANDS, SWITZERLAND, UK AND US. SOURCE OF THE DATA: PHAM, N., MONASH UNIVERSITY AND AUSTRALIAN CENTRE FOR FINANCIAL STUDIES, (2019). ASSET ALLOCATION OF PENSION FUNDS.	29
FIGURE 23: THE BIGGEST OBSTACLES THAT COMPANIES FACE REGARDING DIGITAL IMPLEMENTATION. SOURCE OF THE DATA: ERNST & YOUNG LLP, (2020). TECH ADOPTION IN COMMERCIAL REAL ESTATE DEMANDS A ROBUST CORPORATE STRATEGY.	32
FIGURE 24: PERCENTAGE OF UPDATED AND NOT UPDATED INFORMATION ON THE REAL ESTATE ASSET UNDER MANAGEMENT AS PART OF THE GLOBAL PROFESSIONAL MANAGED PORTFOLIOS. SOURCE OF THE DATA: MORGAN STANLEY CAPITAL INTERNATIONAL (MSCI), (2021). REAL ESTATE MARKET SIZE 2020/2021. UPDATED AUM BY COUNTRY, 2020 DATA.	33

- FIGURE 25:** THE CHART ILLUSTRATES THE DIFFERENCES BETWEEN A TRADITIONAL (LEFT SIDE) AND DIGITIZED (RIGHTWARD) TRANSACTION PROCESS. OWN ELABORATION BASED ON THE ORIGINAL GRAPHICS: PEXA – PROPERTY EXCHANGE AUSTRALIA, IPO PROSPECTUS. _____ 36
- FIGURE 26:** AVERAGE TIME TO SELL IN MILAN, EXPRESSED IN MONTHS, FOR HABITABLE USED HOMES, NEW OR RENOVATED HOMES, OFFICES IN GOOD CONDITION, RETAIL IN GOOD CONDITION. OWN ELABORATION BASED ON THE DATA EXTRACTED FROM: NOMISMA, REAL ESTATE ITALIAN OBSERVATORY. _____ 37
- FIGURE 27:** RELATION BETWEEN THE ACTUAL RATE OF RETURN AND HOLDING PERIOD. SOURCE OF THE DATA: SULLIVAN, CASSIDY, ERMER, THE JOURNAL OF REAL ESTATE RESEARCH, (1991). A NOTE ON THE EFFECT OF TRANSACTION COSTS ON REAL ESTATE INVESTMENT RETURNS. _____ 38
- FIGURE 28:** COMPARISON BETWEEN THE CURRENT PARADIGM OF CENTRALIZED FINANCE, WITH LEDGERS VALIDATED AND OWNED BY A CENTRAL AUTHORITY, AND DECENTRALIZED FINANCE, WITH THE LEDGER SHARED AMONG NETWORK PARTICIPANTS (NODES) AND VALIDATED BY ALL. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 42
- FIGURE 29:** COMPARISON BETWEEN A CENTRAL SERVER NETWORK, IN WHICH ALL KIND OF DATA PASS THROUGH A CENTRAL SERVER, AND A P2P NETWORK WHERE THE TRANSMISSION OF INFORMATION TAKES PLACE DIRECTLY BETWEEN THE USERS. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 44
- FIGURE 30:** THE ILLUSTRATION SHOWS THE PROCESS OF VALIDATING A BLOCK OF DATA. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 47
- FIGURE 31:** THE DIFFERENT DEGREES OF DECENTRALIZATION AND CONTROL OF BLOCKCHAINS ON THE NETWORK. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 49
- FIGURE 32:** THE DIAGRAM SHOWS HOW A SMART CONTRACT APPLIED TO REAL ESTATE MIGHT WORK. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 52
- FIGURE 33:** THE DIAGRAM SHOWS HOW THE PROPERTY PASSPORT FITS INTO THE REAL ESTATE PROCESS. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 53
- FIGURE 34:** THE TYPES OF NETWORKS: THROUGH THIS SCHEME THE VULNERABILITY OF A CENTRALIZED STAR SYSTEM AND THE POTENTIAL OF A DISTRIBUTED ONE IN WHICH ALL NODES HAVE THE SAME IMPORTANCE EMERGES. SOURCE OF THE SCHEME: BARAN P., UNITED STATES AIR FORCE PROJECT RAND, (1964). ON DISTRIBUTED COMMUNICATIONS: INTRODUCTION TO DISTRIBUTED COMMUNICATION NETWORKS. RETRIEVED FROM: RAND CORPORATION WEBSITE, PUBLISHED RESEARCH AND MEMORANDUM, [HTTPS://WWW.RAND.ORG/CONTENT/DAM/RAND/PUBS/RESEARCH_MEMORANDA/2006/RM3420.PDF](https://www.rand.org/content/dam/rand/pubs/research_memoranda/2006/RM3420.pdf). RAND CORPORATION SANTA MONICA. _____ 56
- FIGURE 35:** HOW THE IMMUTABILITY PROCESS IS GUARANTEED WITHIN THE BLOCKCHAIN. SOURCE OF THE GRAPHIC: LARSON B., VERIZON DATA SCIENCE, (2018). BLOCKCHAIN: IMMUTABLE LEDGER. URL OF THE ARTICLE: AN ANALYTICS EDUCATION FOR ALL. UNRAVELING THE MYSTERY BEHIND BIG DATA AND

ANALYTICS, [HTTPS://ANALYTICS4ALL.ORG/2018/04/09/BLOCKCHAIN-IMMUTABLE-LEDGER/COMMENT-PAGE-1/](https://analytics4all.org/2018/04/09/blockchain-immutable-ledger/comment-page-1/). ANALYTICS4ALL. _____ 59

FIGURE 36: THE DIAGRAM SHOWS HOW THE CENTRAL GOVERNMENT AUTHORITY CAN MANAGE THE SO-CALLED "HARDFORKS" AND THE SPLITTING OF PROPERTY TITLES. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 63

FIGURE 37: THE DIAGRAM SHOWS THE LOGICAL PROCESS OF DOUBLE VALIDATION OF THE TOKENS BY THE NODES OF THE BLOCKCHAIN AND THE CENTRAL GOVERNMENT AUTHORITY. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 65

FIGURE 38: THE TRANSACTION COSTS OF A PROPERTY SPLIT BY COUNTRY, AREA OF EXPENSE AND RECIPIENT; THESE PERCENTAGE RANGES WERE CALCULATED ACCORDING TO THE LOGIC OF A PROPERTY PURCHASE AND RESALE TRANSACTION. SOURCE OF THE DATA: GLOBAL PROPERTY GUIDE, (2021). ROUND-TRIP TRANSACTION COSTS: A KEY CONSIDERATION WHEN BUYING PROPERTY. RETRIEVED FROM: [HTTPS://WWW.GLOBALPROPERTYGUIDE.COM/TRANSACTION-COSTS](https://www.globalpropertyguide.com/transaction-costs). GPG 2021. THE ORIGINAL DATA SOURCES OF THE STUDY WERE THE LOCAL GOVERNMENT AGENCIES AND THE WORLD BANK DOING BUSINESS WEBSITE. _____ 72

FIGURE 39: THE GRAPH PRESENTS THE DATA COLLECTED IN THE TABLE IN FIGURE 38. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PRESENTED DATA. _____ 73

FIGURE 40: THE GRAPHIC ILLUSTRATES THE PARADIGM SHIFT THAT IS BEING PURSUED THROUGH BLOCKCHAIN TECHNOLOGY, WITH AN EXCHANGE OF ROLES IN THE VALIDATION OF OFFICIAL ACTS BETWEEN GOVERNMENT AUTHORITIES AND THE NETWORK OF DIGITAL NODES. SOURCE OF THE GRAPHIC: OWN ELABORATION BASED ON PROPOSED LITERATURE. _____ 80

FIGURE 41: TECHNOLOGICAL ENABLERS AND VALUE DRIVERS FOR ITS ADOPTION AT THE VARIOUS LEVELS OF PROCESS-INTEGRATION. SOURCE OF CONTENT: ANGELIS J., DA SILVA E.R., (2019). BLOCKCHAIN ADOPTION: A VALUE DRIVER PERSPECTIVE. RETRIEVED FROM: SCIENCE DIRECT, VOLUME 62, ISSUE 3, MAY–JUNE 2019, PAGES 307-314. _____ 83

FIGURE 42: THE GRAPH SHOWN SCHEMATIZES THE MAIN OBSTACLES TO THE IMPLEMENTATION OF A NEW TECHNOLOGICAL SOLUTION. SOURCE OF THE SCHEME: HOXHA V., SADIKU S., (2019). STUDY OF FACTORS INFLUENCING THE DECISION TO ADOPT THE BLOCKCHAIN TECHNOLOGY IN REAL ESTATE TRANSACTIONS. PROPERTY MANAGEMENT, VOL. 37, NO. 5. _____ 85

FIGURE 43: THE DIAGRAM ILLUSTRATES THE EVOLUTION OF THE CONCEPT OF DIGITAL IDENTITY FROM THE ADVENT OF THE INTERNET TO POSSIBLE FUTURE DEVELOPMENTS. SOURCE OF DATA ENTERED: ARUN J.S., GUTIERREZ C., ALTOROS IT SERVICES AND IBM BLOCKCHAIN SERVICES, (2017). THE JOURNEY TO A SELF-SOVEREIGN DIGITAL IDENTITY BUILT ON A BLOCKCHAIN. RETRIEVED FROM: ALTOROS.COM, 2021. _____ 89

FIGURE 44: APPROXIMATELY ENERGY CONSUMED BY THE MAIN DIGITAL NETWORKS FOR DATA EXCHANGE AND STORAGE. DATA SOURCE: SEDLMEIR J., BUHL H.U., FRIDGEN G., KELLER R., (2020). ROUND-TRIP TRANSACTION COSTS: A KEY CONSIDERATION WHEN BUYING PROPERTY. RETRIEVED FROM: BUSINESS &

INFORMATION SYSTEMS ENGINEERING VOLUME 62, PAGES599–608 (2020),
 HTTPS://LINK.SPRINGER.COM/ARTICLE/10.1007/S12599-020-00656-X. SPRINGER. _____ 91

FIGURE 45: COMPARISON BETWEEN THE BANDWIDTH SATURATION IN TERMS OF THE NUMBER OF HASHES COMPLETED PER SECOND BY THE BLOCKCHAIN NETWORK AND THE FEES CHARGED FOR EACH COMPLETED TRANSACTION. DATA SOURCE: BLOCKCHAIN.COM, (2021). TOTAL HASH RATE (TH/S) - THE ESTIMATED NUMBER OF TERAHASHES PER SECOND THE BITCOIN NETWORK IS PERFORMING IN THE LAST 24 HOURS.. RETRIEVED FROM: HTTPS://WWW.BLOCKCHAIN.COM/CHARTS/HASH-RATE. _____ 92

FIGURE 46: THE MAIN COST ITEMS FOR THE IMPLEMENTATION OF A BLOCKCHAIN PLATFORM WITHIN AN ACTIVITY. DATA SOURCE: TAKYAR A., PLATFORMS CONSTRUCTION SPECIALIST AT LEEWAYHERTZ, (2021). HOW TO DETERMINE THE COST OF BLOCKCHAIN IMPLEMENTATION? URL OF THE ARTICLE: HTTPS://WWW.LEEWAYHERTZ.COM/COST-OF-BLOCKCHAIN-IMPLEMENTATION/. 2021 LEEWAYHERTZ. _ 93

FIGURE 47: THE ATTITUDE OF A SELECTED GROUP OF ORGANIZATIONS WITH RESPECT TO TECHNOLOGY EXPENDITURE WITHIN CORPORATE STRATEGIES. DATA SOURCE: MCKINSEY & COMPANY, MCKINSEY GLOBAL SURVEY, (2020). HOW COVID-19 HAS PUSHED COMPANIES OVER THE TECHNOLOGY TIPPING POINT - AND TRANSFORMED BUSINESS FOREVER. RETRIEVED FROM: MCKINSEY STRATEGY AND CORPORATE FINANCE WEBSITE PORTAL, MCKINSEY & COMPANY GLOBAL SURVEYS. _____ 96

FIGURE 48: THE FOUR PHASES OF THE DISRUPTION PROCESS CARRIED OUT THROUGH THE COMPARISON BETWEEN THE OLD PRODUCT (INCUMBENT) AND THE NEW ENTRY INTO THE MARKET (CHALLENGER / DISRUPTOR). DATA SOURCE: VEUGER J., RESEARCH CENTRE OF BUILT ENVIRONMENT, HANZE UNIVERSITY OF APPLIED SCIENCES GRONINGEN, GRONINGEN, THE NETHERLANDS, (2017). TRUST IN A VIABLE REAL ESTATE ECONOMY WITH DISRUPTION AND BLOCKCHAINRETRIEVED FROM: FACILITIES, VOL. 36, NO. 1/2, 2018, PP.103-120. EMERALD PUBLISHING LIMITED. _____ 97

FIGURE 49: THE DIAGRAM SHOWS THE MAIN REAL ESTATE SERVICES THAT OPERATE FROM THE BLOCKCHAIN PLATFORM AND THE MAJOR OPERATORS FOR EACH SEGMENT. DATA SOURCE: PERSONAL PROCESSING ON THE SOURCES CITED. _____ 100

FIGURE 50: LOGICAL PROCESS OF DETERMINING THE FAIR VALUE AND VARIABLES INVOLVED IN THE IMPAIRMENT PROCESS. DATA SOURCE: PROCESSING BASED ON THE PROPOSED SOURCES. _____ 113