



November 2017

The technological revolution and the future of residential property



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Report for Royal Institution of Chartered Surveyors

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Published by the Royal Institution of Chartered Surveyors (RICS)

RICS, Parliament Square, London SW1P 3AD

www.rics.org

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Contents

Foreword by RICS	3
About Houzen	4
Executive summary	5
1.0 Definitions	6
2.0 The current landscape	7
2.1 Property technology in the UK – the evolution.....	7
2.2 Property technology in the UK – the lay of the land	8
2.3 International ‘superstar’ cases	10
3.0 Research findings and recommendations	12
3.1 Interview findings	12
3.2 Recommendations	15
4.0 The application of technology solutions in real estate	16
4.1 Blockchain	16
4.2 Artificial intelligence, machine learning, deep learning and big data.....	17
4.3 Internet of things.....	18
4.4 Conclusions.....	18
5.0 What next for residential real estate?	19
5.1 How will demographics and consumer behaviour change in the next few decades?	19
5.2 What will the real estate world look like in 2035?	22
6.0 The relevance of PropTech for residential real estate	23
6.1 Why should I care?.....	24
7.0 Implementation framework – what should I do next?	26
7.1 Are you a tech leader, tech friendly or tech fearing?	29
8.0 Conclusion	33
8.1 Be sensible not sexy	33
9.0 Summary	34
9.1 Getting started with deep tech solutions.....	34
9.2 How to build using deep tech within a lean product framework?	35
10.0 Further reading	36
11.0 Further acknowledgements	38

Foreword by RICS

Unprecedented urbanisation, changing demographics and the rise of new economic powers are among the trends reshaping the world in which we live and work. New business models, innovative work dynamics, greater connectivity and technological advances mean that we need new skills and different ways of working.

It is clear we are undergoing a technological revolution and the pace of change is accelerating. This change is driving demand for key data analytics and related skills for existing professionals.

The way of conducting business is also changing; many of the roles that will exist in 2030 will combine skills in ways not imagined today. It has been clear from employers of all types – big and small, public and private – that a stronger emphasis on technology is going to be needed as an enabler of business performance. How our industry reacts to all these changes will be crucial to how the sector develops in the coming years.

We asked Houzen, a residential lettings and management platform, to look at the impact property technology may have in the residential property sector following their

survey of ‘deep technology’ experts from other industries, and the lessons the residential real estate industry can learn from it. We hope this report can be used as a tool to create debate and help strategic planning in your own organisation or firm.

Discussion on the role and impact of technology always generates a mix of apprehension, concern and excitement regarding different ways of doing business, new skills and pioneering approaches to doing business.

This paper seeks to explain what PropTech means for the residential sector, provide insights from other industries and make recommendations as to how technology solutions may be applied for residential firms. It is intended to provide insight and stimulate debate among professionals working in the built environment.

I would like to thank the team at Houzen for their commitment to creating challenging and thought provoking insight.

Paul Bagust

Global Property Standards Director



About Houzen

Houzen is a tech and data driven intelligent lettings platform. They connect properties to their ideal tenants, enhancing the tenancy experience to deliver longer lasting, higher yielding rents. Houzen is now harnessing deep technologies, big data, and operators' existing skills to build the next generation residential asset management platform. The Houzen team brings together best practices from their personal exposure to over 20 industries across 4 continents over the course of their careers.



Executive summary

There has been much speculation about the impact of information technology on society. This has ranged from the effect of robotisation and artificial intelligence on employment, driverless cars and trains on transport, and the use of data on traditional processes and business models. The rise of portals and algorithm-based valuation models has focussed attention on the property sector. A recent report¹ in the trade press estimated that 20% of estate agents are at risk of losing their jobs over the next 5 years.

Whatever your views, there is no doubt PropTech is here to stay. Globally, property technology received \$2.67 billion of funding in 2016, up from only \$186 million in 2011.²

It is clear there is tremendous scope for the adoption and evolution of technology-driven solutions in the residential real estate industry for the following areas:

- Property management.
- Building Information Modelling (BIM).
- Research and business analytics.
- Listing services and tech-enabled residential broking services.
- Building mobile applications for stronger business integration.
- Residential lending and mortgages.

The research in this report from other industries demonstrates the value and opportunity of looking more deeply into PropTech solutions to open new revenue streams. A residential real estate professional should care about implementing change for several reasons: it will increase your engagement with your existing customers, while also helping you improve your client value proposition and open new revenue streams. New tech-led processes will lead to operational cost optimisation and enable you to develop and deliver new products faster.

In the instance of property technology for the residential asset management space, this comes in a variety of guises, but we believe the 2 most impactful categories are:

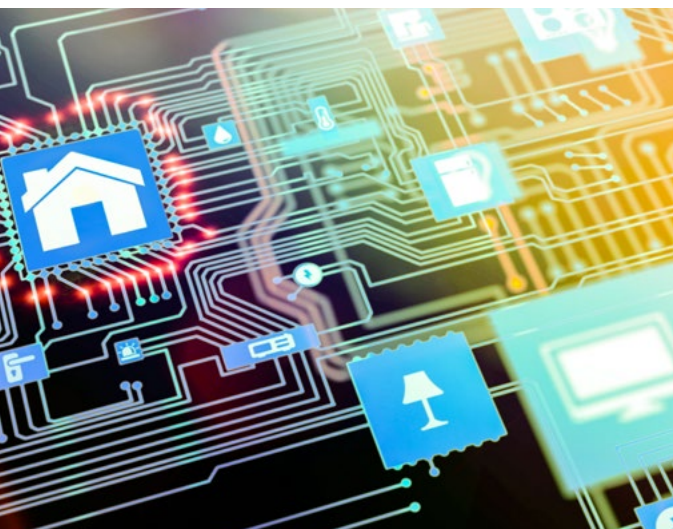
- 1.** Maximising lettings/management efficiency per FTE within the firm.
- 2.** Maximising retention of entire potential rental income into bottom line profit.

It is important for the residential real estate industry to wake up to the possibilities of deep property tech, and the possible risk for those stakeholders who fail to recognise its potential for the future. To develop such solutions you must assess your company-specific propensity towards innovation and deep technologies and implement change appropriately, and you should do it now.

If you are not exploring how to make better use of technology in your business, you can be sure someone else is in theirs.

The question readers of this paper should now ask themselves is: 'can I afford not to do this?'

¹ <https://www.moorestephens.co.uk/news-views/july-2017/19-of-uk-estate-agents-are-at-risk-of-going-bust> ² <https://www.cbinsights.com/research/residential-real-estate-tech-market-map-company-list/>



1.0 Definitions

Before we embark on an analysis of deep technology (deep tech), it is important to define what this term really means. There are a few main deep technologies on the market:

Blockchain: A blockchain is a distributed database that maintains a continuously growing list of records, called blocks, secured from tampering and revision. Each block contains a timestamp and a link to a previous block.

Artificial Intelligence (AI): Coined in 1956 by Dartmouth Assistant Professor John McCarthy³, AI is a general term that refers to hardware or software that exhibits behaviour which appears intelligent. In the words of Professor McCarthy, it is *'the science and engineering of making intelligent machines, especially intelligent computer programs.'*

Intelligence Augmentation (IA): This aspires to give humans tools and information to eliminate dull and mundane tasks so they can focus on their core and experiential activities, thereby amplifying user productivity, creativity, and gratification.

Machine learning (ML): Machine learning is the subfield of computer science that, according to Arthur Samuel in 1959⁴, gives *'computers the ability to learn without being explicitly programmed'*.

Deep learning (DL): Deep learning is an approach to AI that aims to solve real-world problems through mimicking our own decision-making processes. It is best explained in the words of Andrew Ng⁵, chief scientist at Baidu. He said, *'Using brain simulations, [we] hope to make learning algorithms much better and easier to use, make revolutionary advances in machine learning and AI. I believe this is our best shot at progress towards real AI.'*

AI, ML and DL are deeply interlinked. Machine learning and deep learning are sequential explorations of deep tech, stemming from Artificial Intelligence.

Big data analytics: Big data refers to data sets so large or complex that traditional data processing applications are inadequate. According to Gartner⁶, big data is *'high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation.'*

Computer vision: This is defined as a technological or scientific discipline.

*'As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences, views from multiple cameras, or multi-dimensional data from a medical scanner. As a technological discipline, computer vision seeks to apply its theories and models for the construction of computer vision systems.'*⁷

The internet of things (IoT): IoT is broadly defined by Forbes⁸ as *'a giant network of connected "things" (which also includes people). The relationship will be between people-people, people-things, and things-things'*. It allows for virtually endless opportunities and connections to take place.

PropTech: PropTech is the fusion of the words 'Property' and 'Technology' and refers to all aspects of technology and how it impacts the built environment. This may include software, hardware, materials or manufacturing. PropTech is a general all-encompassing term, but is often used to specifically refer to the small start-ups that are using technology to address market problems.

³ <http://www.aisb.org.uk/public-engagement/what-is-ai> ⁴ https://www.cims.nyu.edu/~munoz/files/ml_optimization.pdf ⁵ <http://machinelearningmastery.com/what-is-deep-learning/> ⁶ <http://www.gartner.com/it-glossary/big-data> ⁷ https://en.wikipedia.org/wiki/Computer_vision ⁸ <https://www.forbes.com/forbes/welcome/?toURL=https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/&refURL=&referrer=#11cd79b31d09>

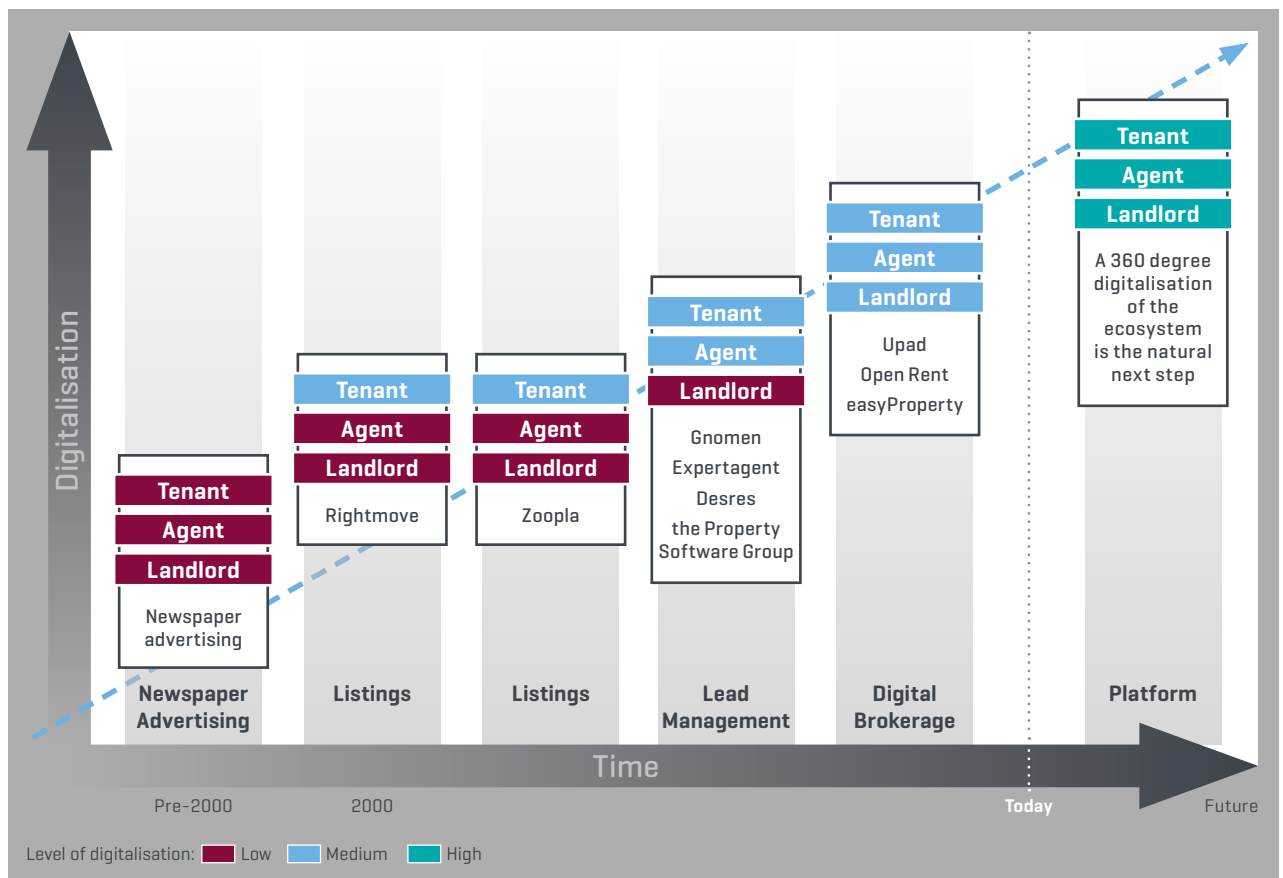
2.0 The current landscape

In this part, we will define the current PropTech landscape both in the UK (section 2.1) and internationally (section 2.3). The goal is to set the scene for our research by detailing the evolution and achievements in property technology. This will also highlight the opportunities for further progress in the space, for which we will build a framework and give recommendations later in the paper.

2.1 Property technology in the UK – the evolution

Real estate has always been a highly popular investment avenue in the UK. According to a recent study, in 2015-16 around 47% of the UK population used property portals to search for properties⁹. Rightmove.co.uk and Zoopla Property Group were the first step on the ladder for digitalisation, as we can see in figure 1, and have changed the way people of the UK conduct property searches.

Figure 1: Property technology evolution in the UK



⁹ Silva, 2016 – <https://www.estateagenttoday.co.uk/features/2016/6/the-current-state-of-play-in-the-property-portal-market>



Digitalisation is not confined to the purchase of IT equipment/software. It pertains to the way companies use digital technologies by integrating them into their ever-growing business processes. Moreover, it is not just restricted to the property search process, but is relevant across the entire life cycle of the asset. Digital technologies are beginning to change the way real estate companies plan, build, maintain and use the social and economic infrastructure¹⁰.

That said, technology penetration in the entire real estate industry, which includes commercial/residential real estate and hotels, is low compared to that in other sectors. The MGI Industry Digitization Index clearly shows how capital-intensive industries such as construction, hotels, and residential/commercial real estate rank low in digital adoption¹¹.

Companies have begun converting digitalisation into a 'competitive advantage'. In fact, the huge gap that exists between companies, also known as digital 'haves' and 'have-mores' has become a major factor that shapes industry competition¹². Therefore, companies that act as prime movers in adopting digitalisation swiftly and effectively often succeed in increasing market share and profitability. Some companies are even succeeding in reshaping the entire industry to their benefit through better operational efficiency¹³. Digitalisation is an invaluable tool, yet few players in the market have adopted it or are using it to its full potential.

It is essential for stakeholders in residential real estate to grasp the value that adopting digitalisation can bring to their profitability and competitiveness. In design and project management, for example, paper drawings gave

way to CAD designs over the years. Recently, residential real estate has transitioned beyond CAD designs into Building Information Modelling (BIM). BIM helps real estate players integrate visual information with the data pertaining to project specifications, material requirements, project functionalities and property maintenance, lending a competitive advantage through better operational efficiency. It is an invaluable tool, but again few players in the market have adopted it or are using it to its full potential. It is essential for stakeholders in residential real estate to grasp the value that adopting digitalisation can bring to their profitability and competitiveness.

2.2 Property technology in the UK – the lay of the land

The UK's property technology industry has grown substantially over the past 2 years. In June 2014, Zoopla listed itself on the LSE for a whopping £1bn¹⁴. However, the growth story of property technology in the UK is not just confined to Zoopla.

There was no property technology specialist VC funder until the recent emergence of Pi Labs¹⁵, which invests exclusively in early-stage property technology ventures. A plethora of start-ups serving different parts of the value chain have emerged in recent years. The ultimate residential goal, which is always to extract the highest yield from an asset, can be broken down into 6 cyclical steps, as illustrated in figure 2. For each step, we have identified key start-ups in the space that operate in the UK, or will soon. There is a market opportunity with regards to technology that facilitates the rental market across the life cycle of an asset.

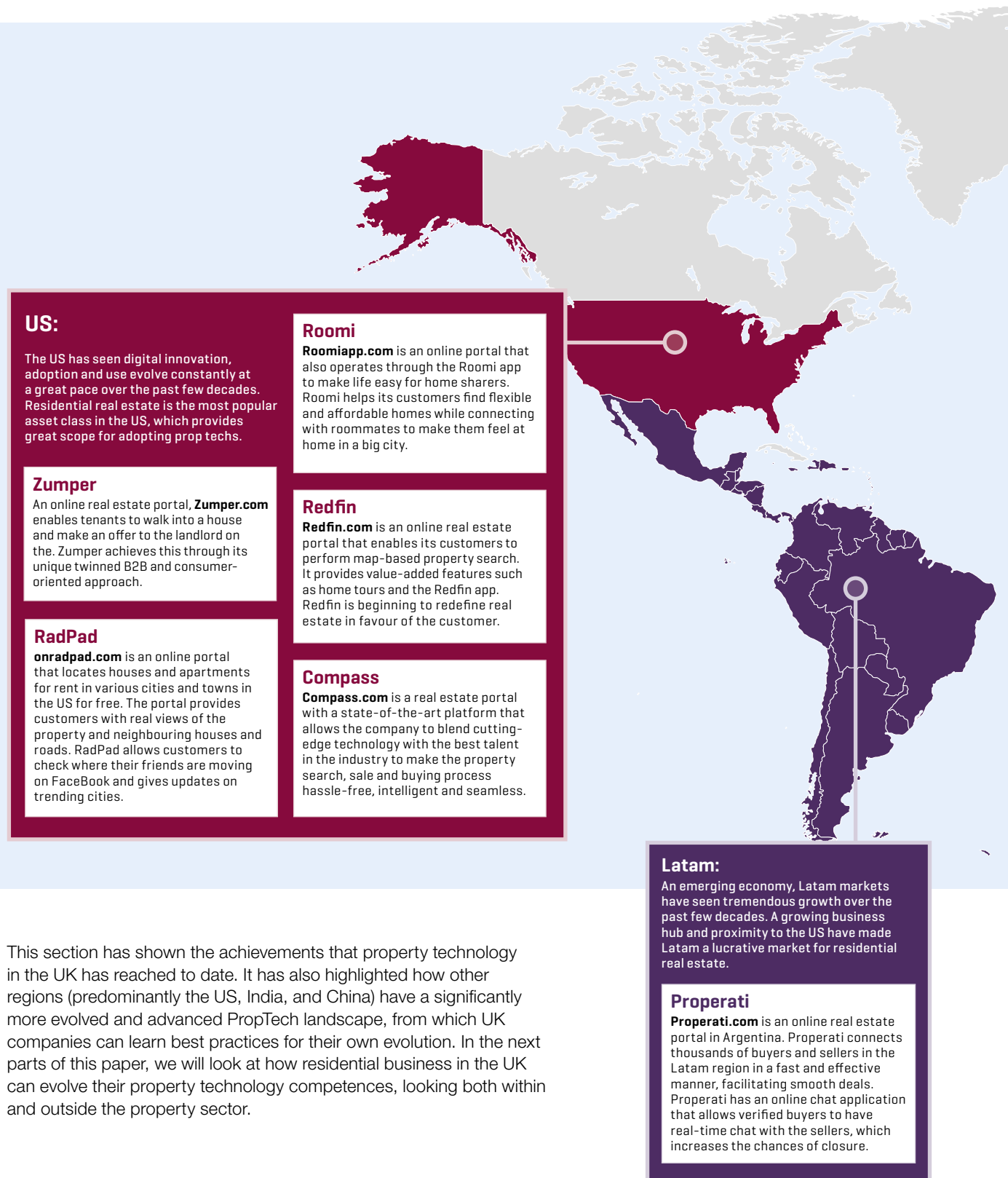
10 RICS, 2017 – <http://www.rics.org/in/tag/bim/> 11 McKinsey Global Institute, 2015 – <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-construction-digital-future> 12 McKinsey Global Institute, 2015 – <https://www.mckinsey.com/industries/high-tech/our-insights/digital-america-a-tale-of-the-haves-and-have-mores> 13 WhatIs, 2017 – <http://whatIs.techtarget.com/definition/building-information-modeling-BIM> 14 Gibbs, 2015 – <http://www.cityam.com/230499/tech-battling-inertia-shake-britain-s-property-industry> 15 Pi Labs – <http://pilabs.co.uk/>

Figure 2: Property life cycle



2.3 International 'superstar' cases

Below we have highlighted the most innovative companies from the most innovative countries. These on their own paint a roadmap of the opportunity for potential innovation in property technology in the UK.



This section has shown the achievements that property technology in the UK has reached to date. It has also highlighted how other regions (predominantly the US, India, and China) have a significantly more evolved and advanced PropTech landscape, from which UK companies can learn best practices for their own evolution. In the next parts of this paper, we will look at how residential business in the UK can evolve their property technology competences, looking both within and outside the property sector.

Germany:

The Federal Republic of Germany is a developed country in central-western Europe. High class infrastructure and proximity to the UK make Germany a popular residential real estate hub.

Nestpick

Nestpick.com is an online real estate portal that lists furnished apartments for people to buy. It provides customers with a wide selection, fast search results, and the best possible prices for furnished apartments in top cities including London, Paris, Berlin, Madrid, Barcelona and Rome.

Dubai:

Well-developed infrastructure, world class business facilities and abundant oil resources mean Dubai is a top international smart city with growing demand for residential real estate.

Propertyfinder

Propertyfinder.ae helps customers find properties that fit their requirements. The company lists top class properties, allowing customers to easily browse through them and shortlist their choices. Propertyfinder aims at making its customers' browsing experience smooth and easy, whether on PC or smartphone, sale or letting.

China:

The People's Republic of China is the world's most populous country. Best-in-class infrastructure, growing urbanisation, supportive government and increasing demand for residential real estate make China an attractive destination for PropTech.

Mogoroom

Mogoroom.com is a real estate portal that provides a rental online-to-offline [O2O] platform for customers to find a house to rent easily and quickly. It provides verified property listings of landlords at highly affordable rental prices.

Fangdd

Fangdd.com is an online real estate portal that provides customers with a strong platform where they can buy, sell and rent out properties. It allows customers to search for rooms for rent and second-hand homes as well as top class properties.

Aiwujiwu

Aiwujiwu [iwjw.com] is a popular online real estate portal that lists top-class properties and individual homes for buying, renting and selling. The company also helps in procuring mortgages to buy a property.

India:

With a population nearing the 2 billion mark, the young demographic dividend and higher disposable income, and being part of the BRICS nations, India is an emerging economy with an ever-growing demand for real estate.

Housing.com

One of the fastest growing companies in online real estate business, **Housing.com** focuses on simplifying the home search process for people through its state-of-the-art web platform. The company's mission is to make the process of buying, selling and letting homes swift, smart and simple for all its customers.

Commonfloor

Commonfloor.com provides homebuyers, sellers and real estate agents with a cutting-edge online real estate ecosystem, helping them to simplify key property decisions. Some of the benefits include exhaustive search options, simple analytics, attractive property/locality views, and a strong and verified pan-India property database.

NoBroker

NoBroker.in is an online real estate portal that connects its customers directly to verified property owners, removing the need for a broker while saving brokerage for its customers. NoBroker has made the property listing process very easy for owners and even allows listing through WhatsApp. NoBroker assists its customers in preparing rental agreements and other government paperwork.

PropTiger

Proptiger.com is a highly popular online real estate adviser. PropTiger helps those wanting to buy, sell or let out homes on a turnkey basis. The web portal enables people to shortlist their favourite homes and check attractive visuals of properties along with details of the neighbourhood. Moreover, PropTiger assists its customers in getting home loans and completing their property registration process.

Singapore:

Well-developed infrastructure, world class business facilities and abundant oil resources mean Dubai is a top international smart city with growing demand for residential real estate.

Property Guru

One of Asia's leading property portals, **PropertyGuru.com** provides its customers with the edge they require when conducting their property search, and helps them take well-informed decisions on property purchase, sale or letting.

3.0 Research findings and recommendations

In this part, we are taking a step out from the real estate industry. First we will look at the big picture on deep tech from our respondents' areas of expertise. Then we will summarise the recommendations the 30 experts have for the residential real estate industry.

3.1 Interview findings

Houzen asked 30 respondents to answer a series of questions pertaining to 'deep tech' that they had direct experience with, as applied to their sector of expertise.

The respondents and their companies use AI, big data, blockchain, computer vision, IoT and machine learning. Their solutions fall into one or more of the following groupings:

- **algorithms**
- **database**
- **analytics**
- **asset and testing**

A significant majority of people Houzen spoke to are working on developing algorithms for their businesses (table 1). The second most common use class is for solutions centred around customer databases. The data set included just 2 real estate professionals, and both their companies use deep tech to build solutions centred around the asset. It will be interesting to see if this trend is confirmed as Houzen collect more real estate data points through primary research.

The 2 key points real estate professionals should be mindful of are:

1. Corporations are investing in deep technology professionals with a generalist approach and who can implement strong logic skills, to develop smart algorithms for the business. They are not unduly concerned with seeking extensive domain knowledge to find disruptive solutions.
2. Most algorithms are being developed in the machine learning space, with AI, big data and blockchain coming second. For database solutions, AI is the most exciting space.

Table 1: Which deep tech solutions are you working on?

	AI	Big data	Blockchain	Computer vision	IoT	ML	Grand Total
Algorithms	3	3	3	2	-	5	16
Database	3	2	1	1	1	1	9
Analytics	2	-	-	-	-	-	2
Asset	-	2	-	-	-	-	2
Testing	-	-	-	-	1	-	1
Grand Total	8	7	4	3	2	6	30

Table 2: What part of the business is your tech focused in?

	B2B	B2B2C	B2C	Grand Total
AI	4	1	3	8
Big data	6	-	1	7
ML	2	-	4	6
Blockchain	-	2	2	4
Computer vision	2	-	1	3
IoT	2	-	-	2
Grand Total	16	3	11	30

For this part, we classed the business segments as being business-to-business (B2B), business-to-business-to-consumer (B2B2C) or business-to-consumer (B2C) (table 2). Most of the respondents focus on the B2B space irrespective of the specific tech they implement. In contrast, the clear majority of today's PropTech is consumer-centric. This sector should perhaps take note that there exists an opportunity in the untapped B2B space that is seeing a deep tech proliferation in other industries. This warning comes in light of the fact that there are higher failure rates of B2C businesses when compared to B2B. In some markets, B2C start-ups have a failure rate that is twice that of B2B companies¹⁶. Further, B2B models have more stable revenue bases, lower costs to customer acquisition and higher user switching costs, which inherently makes them more stable than their B2C counterparts¹⁷. The high capital investment and relatively longer lead times required for a business to implement deep tech make the B2B space a safer environment to do so.

Table 3: How big is the problem you are trying to solve?

	Large	Medium	Small	Grand Total
Start-up	1	7	5	13
Growth	1	7	2	10
Corporate	7	-	-	7
Grand Total	9	14	7	30

A 'large' problem is defined as one that is solved across multiple industries or encompasses the entire value chain of one industry. A 'medium' problem is either single industry or covers a broad part – but not all – of the value chain. Finally, a 'small' problem is one that focuses on a single aspect of an industry, a niche sector or a single use class.

The results of Houzen's investigation are crystal clear. Industry wide, large corporates invest in deep technology solutions exclusively to solve large problems (table 3). They have the funds and can plan for the long term to do so, a luxury smaller entities often cannot afford. Start-ups, the smallest of the small, have limited funds and a limited investment time frame, so they focus on the quick wins, bringing to market intelligent solutions to small problems that can be quickly deployed.

The key takeaway from this for the real estate industry is that large corporate entities are not at risk from the proliferation of small property technology start-ups. Therefore, we strongly encourage a more collaborative approach towards these, especially with regards to the sharing of scarce residential data.

Most start-ups and growth companies that were interviewed are excited about deep learning above all, followed by machine learning (table 4). As explained in the introductory definitions, deep learning is the most advanced in the AI/ML/DL sequence. Large corporates, on the other hand, are excited about big data. What does this tell us?

Table 4: What deep tech solutions are you most excited about?

	AI	Big data	Blockchain	Computer vision	IoT	ML	Deep learning	Grand total
Start-up	10%	3%	0%	3%	0%	7%	20%	43%
Corporate	0%	10%	3%	0%	7%	0%	3%	23%
Growth	3%	3%	3%	0%	0%	10%	13%	32%
Grand Total	13%	16%	6%	3%	7%	17%	36%	98%

¹⁶ <https://www.linkedin.com/pulse/20140529155604-41644279-israeli-startup-stats-you-haven-t-seen> ¹⁷ https://thenextweb.com/insider/2015/10/09/the-tech-bubble-is-only-a-b2c-problem/#.tnw_6rNJS31y

Though at table 3 above we exposed the fact that large corporates have the bandwidth to invest in large-scale, industry-changing solutions, this question exposes a shortcoming of theirs. With the large-scale investments, because of the long lead times, their tech is often not the most cutting edge. Smaller, leaner companies, are better equipped to find the next big thing, big data, for sectors outside of real estate, was truly cutting edge and innovative in 2009.

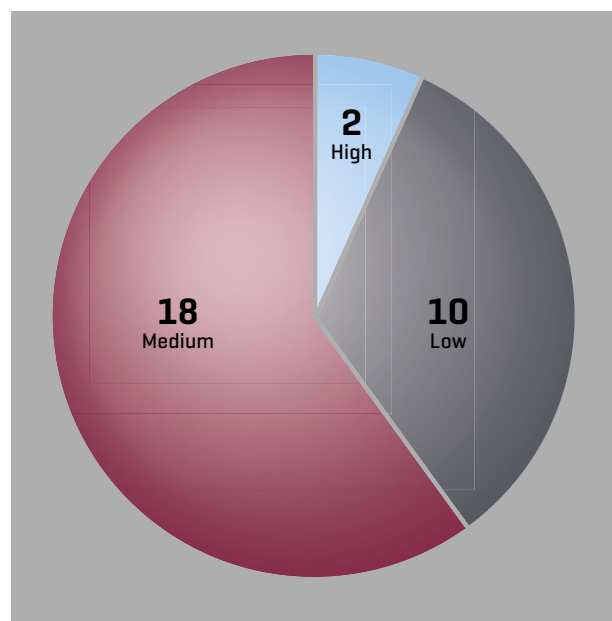
Houzen segmented the response group into age brackets, to assess whether confidence in deep tech solutions is at all linked to generational factors (table 5). They found that there was an overall strong level of confidence – respondents of all ages felt high conviction that the implementation of deep tech would strongly benefit their businesses and their bottom line. Perhaps unsurprisingly, this was exacerbated in the youngest demographic, where 94% of respondents in their 20s felt high confidence in deep technology solutions.

Finally, Houzen asked the respondents whether, from their knowledge and viewpoint, the real estate industry is ready for the implementation of deep tech solutions (figure 3). Responses were mixed, with most surveyed generalists stating their belief that real estate has a middling propensity towards these technologies. So, even from an outsider’s perspective, the industry is perceived as somewhat of a technological laggard in this respect. It is in the hands of all real estate stakeholders to buck this trend and explore the potential benefits that deep tech can deliver for their businesses. We explore this potential in section 6.

Table 5: What’s your confidence level in implementing deep tech solutions?

	High	Medium	Grand Total
20s	47%	3%	50%
30s	30%	7%	37%
40s	10%	3%	13%
Grand Total	87%	13%	100%

Figure 3: Is real estate ready for deep tech?

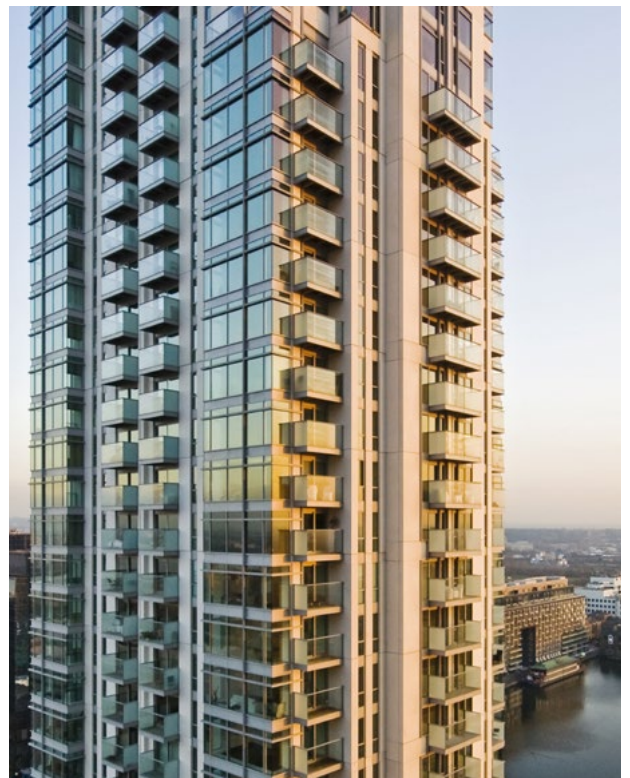
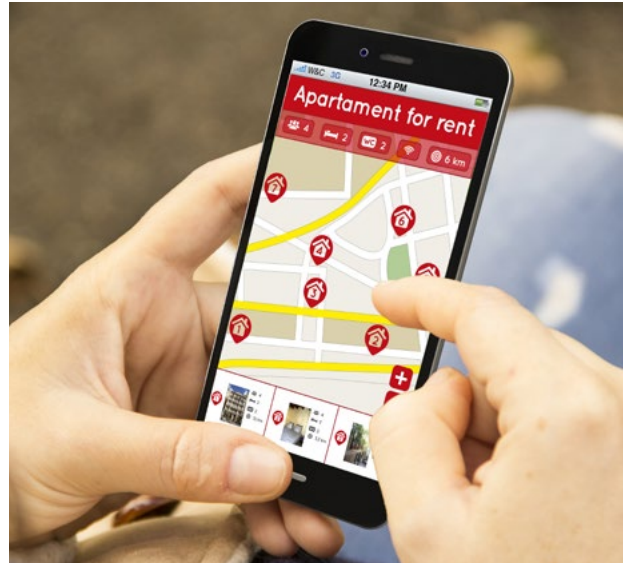


3.2 Recommendations

As part of the interviews, Houzen asked each respondent to express their recommendations for the optimal implementation of deep tech in the real estate industry. The top 10 best applications for real estate were:

1. Use big data and machine learning to predict hot and upcoming neighbourhoods in cities.
2. Machine learning and AI powered apps that show tenants the optimal places to live in.
3. Digitalise and secure land registry data via blockchain.
4. Intelligent architectural design using artificial intelligence and machine learning.
5. Use blockchain and virtual reality to take the agent out of the lettings value chain, through smart contracts and virtual viewings.
6. Create a digital identity for all actors in the lettings value chain: landlord-property-tenant, seller-buyer.
7. Engage interconnected smart devices and sensors to monitor and reduce energy waste, minimise utility bills for residents.
8. Real time property valuations derived from pictures and videos using computer vision and deep learning.
9. Intelligent property management driven by machine learning and artificial intelligence.
10. Asset optimisation for portfolio managers through machine learning.

Some clear themes emerged from the recommendations. Most people interviewed were convinced about the potential for use of deep learning, blockchain and computer vision in real estate. Many of the recommendations were made on the tenant/consumer side, as end user tech adoption is higher.





4.0 The application of technology solutions in real estate

Let us now look at the various deep technology solutions available to residential real estate, and assess the pros and cons of each.

4.1 Blockchain

4.1.1 Who is this for?

Blockchain technology is still in its infancy, and its widespread adoption would rely on some sort of a PPP (public private partnership) model. From the industries interviewed, it seems that blockchain is a good fit for situations where the volume of recurring transactions is very high, which means the parties involved have little incentive to close transactions outside the blockchain. Therefore, it works well in environments such as trading and forex conversion, where high volumes of repetitive trades allow for near critical mass adoption. Due to the fragmented nature of real estate, it will likely be difficult to create a common set of rules and make industry operators participate in one shared chain.

All of the blockchain pilot projects originating from land registries are expected to yield the right rules, structure, and legal framework, which could ensure a high adoption for blockchain in future. For instance, the Swedish land registry 'Lantmäteriet' has recently concluded phase 2 of a 'smart contracts' pilot (in partnership with a start-up and 2 banks) to test the technology and its execution risks. The expected benefits to the taxpayer are \$100m+ per year. Similar efforts have been initiated in Brazil, the Republic of Georgia, and Ghana. There are a number of start-ups that are helping land registries test this technology across the world: Bitland in Ghana, ChromaWay in Sweden, Ubitquity in Brazil, Bitfury in Georgia, Factom in Honduras, etc.

4.1.2 Benefits

Blockchain can be used to speed up processes such as legal contracts (smart contracts), KYC (know your customer), credit checks, reference checks, viewings automation, deposits, rental payments, users' (tenant/buyer/seller/asset) digital identities, etc. When implemented, the chain can be expected to reduce the time needed to complete a sale from 3-6 months to just a few days, and in some cases even hours.

4.1.3 Limitations, dependencies and risks

The main concerns around blockchain are as follows:

- It will take time for users to migrate their systems to blockchain and it will take a long time to get operator and regulator consensus globally or even locally, in order to shift systems onto the blockchain and decommission legacy systems.
- Legal enforceability issues – going through the courts to enforce the legality of smart contracts will take a long time.
- Blockchain will be commonly used in a decade or so, as the technology is still far from scalable and is in infancy. There have also been issue surrounding blockchain 'forks' where the code is edited and branches away from the main blockchain. This can create multiple versions of the chain and has created distrust in the system.
- Ethereum, an encrypted currency, was recently hacked; this shows the claim that the technology is tamper proof isn't true today.

Despite the above concerns, it is worth noting the following. Tech adoption occurs over time: an exciting new technology starts getting financial backing from corporates, venture capitalists and others (this is currently underway for blockchain). Next is a huge influx of engineering interest in improving the technology, and then some engineers will contribute to making the technology rock solid. Today, most real estate players haven't even heard of blockchain technology and by the time those that are lagging behind find out about such new technologies it is too late for them to evolve, and entire industry roles are wiped out.

4.2 Artificial intelligence, machine learning, deep learning and big data

4.2.1 Who is this for?

These 4 technologies and their data pools are usually interlinked to achieve optimum results. They will be applicable in business environments where there are a lot of interactions between users and the asset. Machine learning can typically only begin to function after 10,000 data points, and starts to learn from real time interactions between the users and the product. Naturally, extensive ongoing data creation across varied scenarios will make the machine more intelligent (AI). At some point, the machine starts to create a self-correcting algorithm.

There are only 3 ways to generate the necessary amount of data in the residential real estate space:

1. If large portfolio owners are willing to use machine or deep learning across their assets. However, since most portfolios have a specific investment strategy or structure, this might engender portfolio bias across asset and user types.
2. Aggregate hundreds and thousands of units with fragmented ownership onto one platform, and learn from them. This would of course help reduce any kind of bias, however it is harder and costlier for a technology business to implement this strategy. For example, Uber has ownership of extensive mobility data due to the sheer enormity of data points it has captured over the years on users and cabs. However, it was very expensive to aggregate the fragmented rider and cab markets, hence the company's need for hefty fundraising.
3. Use existing data as a proxy, to fill up data voids. For instance, there are data sources that exist currently in the land registry – Rightmove, Zoopla (which has an open application programming interface (API) and several other open API sources. To solve specific problems, a starting point could be to use the existing public data sources to create an initial logic model. This approach would still deliver estimated results. To make use of any meaningful real time opportunities, a ML product would need realtime data and constant interaction.

4.2.2 Benefits

Artificial intelligence is an extension of ML and DL, and mostly sits on the frontend layer of the product. A powerful ML and DL logical interaction with large data pools can be used to make the AI more intelligent and produce meaningful sales or customer service opportunities, which would in turn help grow revenue or reduce costs significantly.

The biggest benefit of these technologies is completeness in analysis. Historically, most statistical analysis was based on sampling a varied set of data points from the entire population. With ML/AI, the machine can scan the entire document or information packs and come up with a conclusion based on the entire data set in no time. This could potentially change the entire dynamic in document or audit heavy environments such as mortgages, conveyancing and valuations, and potentially relocate jobs of auditors, document checkers and analysts to something more creative and higher up the value chain to just supervise the machine.

4.2.3 Limitations, dependencies, and risks

Bias: The biggest limitation for ML/AI/DL is data availability. Real estate and technology companies would need to work hand in hand to produce data across scenarios and train the machine. A lack of scenarios would create strong biases that would train the machine incorrectly, and cause the machine to make wrong decisions on micro moments when it interacts with the user. This would cause bad customer experiences and would lead to immediate customer attrition. For example, chatbots are still evolving and have not yet been able to replace customer service advisory work. In time, however, they might start taking over some low-level tasks from customer services desks. There are several experiments currently under way to test the replacement of some of the reception desk's tasks with AI.

The AI/ML logic needs to operate within a strong (human) values-based governance framework since the machine has none to begin with. The biggest concern that is keeping academics, researchers and AI thought leaders across all industries awake at night is the ethics question. There are several morally challenging customer interaction touchpoints where the machine fails to respond in a way that is like a human being.

A hypothetical example often used is a driverless car, carrying a family of 4 on a rural 2-lane highway, spots a bouncing ball ahead. As the vehicle approaches a child runs out to retrieve the ball. Should the car risk its passengers' lives by swerving to the side—where the edge of the road meets a steep cliff? Or should the car continue its path, ensuring its passengers' safety at the child's expense? What's worrying is that the response to this scenario will lie in the training the self-driving car has received over thousands and millions of data points, which could inherently be biased.

4.3 Internet of things

4.3.1 Who is this for?

In the residential space, all owners should be able to benefit from the plethora of connected devices in their tenants' homes. In the office and retail sectors, there has been extensive investment into sensors, radio-frequency identification (RFID) chips, beacons, etc. to optimise asset utilisation, track users and sell them products or services at micro opportunities. The residential sector is lagging in this respect. However, there have been several attempts to digitalise the home through the likes of Nest, Alexa and installing sensors to capture meaningful user data. Alexa is a huge leap ahead in the objective of making a resident interact with their home, and is starting to create a speech-based operating system, independent of a person's phone. Residential portfolios can use these data pools to fine-tune their current asset design or create a completely new asset and consumer experience.

4.3.2 Benefits

Smart devices help optimise a product's usage. For example, energy usage across smart devices can be optimised with intelligent regulators. Additionally, the data created from devices helps suppliers design better products and services.

4.3.3 Limitations, dependencies, and risks

Since smart devices are expensive, they only make sense to be installed across very large portfolios. In the commercial and retail sectors, due to a wider usage of assets and sales opportunities, the cost benefit analysis is easier to defend. However, in the residential sector it becomes difficult to justify. With wider adoption over the longer term, the unit cost of devices and sensors is expected to come down and they will then become more widespread across the residential sector.

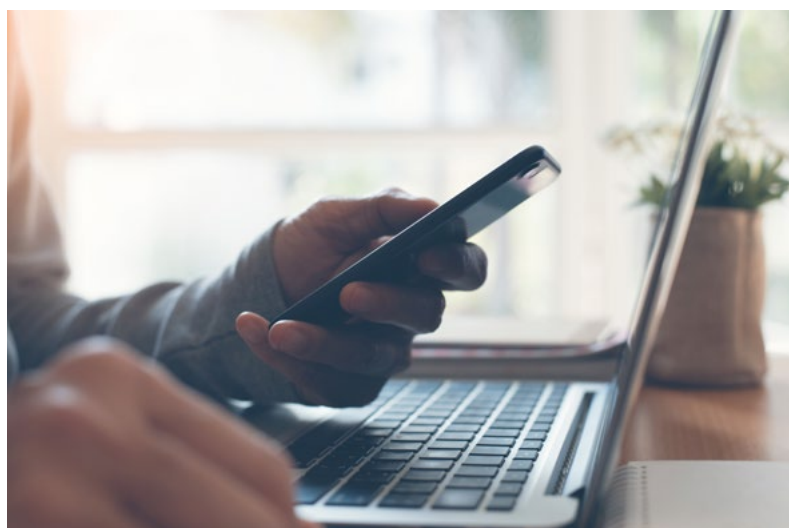
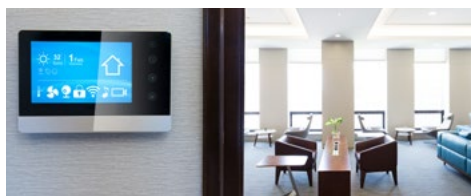
4.4 Conclusions

Though we are very engaged with most of the deep technologies, our favourite is a principle called IA – intelligence augmentation.

What is the difference between IA and AI? The sole mission of AI (and to a large extent blockchain) is to build machines that learn and build on information from human interaction data, and eventually replace humans for specific tasks. On the other hand, IA aspires to give humans tools and information to eliminate dull and mundane tasks so they can focus on their core and experiential activities, thereby amplifying user productivity, creativity and gratification.

For example, in the residential real estate space, Houzen is attempting to not disrupt people, but rather all the inefficient processes, revenue and cost structures that the industry's players are subjected to. Applying IA would keep the actors (such as the landlord/seller, agent and tenant/buyer) in the chain in place, while automating everything around them so their productivity increases manifold and they can start focusing on value-adding activities.

Real estate, given it is a very people oriented business, thrives on relationships and human touch points. We strongly believe that, especially in the residential space, IA will define the future of how industry stakeholders will interact with deep technology.



5.0 What next for residential real estate?

In section 4.0, we aggregated and studied the best practices in deep technology across a variety of industries, and identified significant innovations that could potentially be transposed into the property industry, throughout the life cycle of residential assets. Before we attempt to shed light on the potential direct applications of this generalist tech in the residential space, or indeed showcase the PropTech innovation pipeline and the directions we think it can and should take, it is important to understand how the underlying asset and its consumption is likely to evolve over time.

In this part, we will leverage Houzen’s own primary research as well as drawing on insights from across real estate research to determine how demographics and consumer behaviour are expected to change in the next few decades. Section 6 will then look at how this in turn might affect the way real estate (both on the broader urbanistic level and the more specific residential level) is conceived and consumed.

5.1 How will demographics and consumer behaviour change in the next few decades?

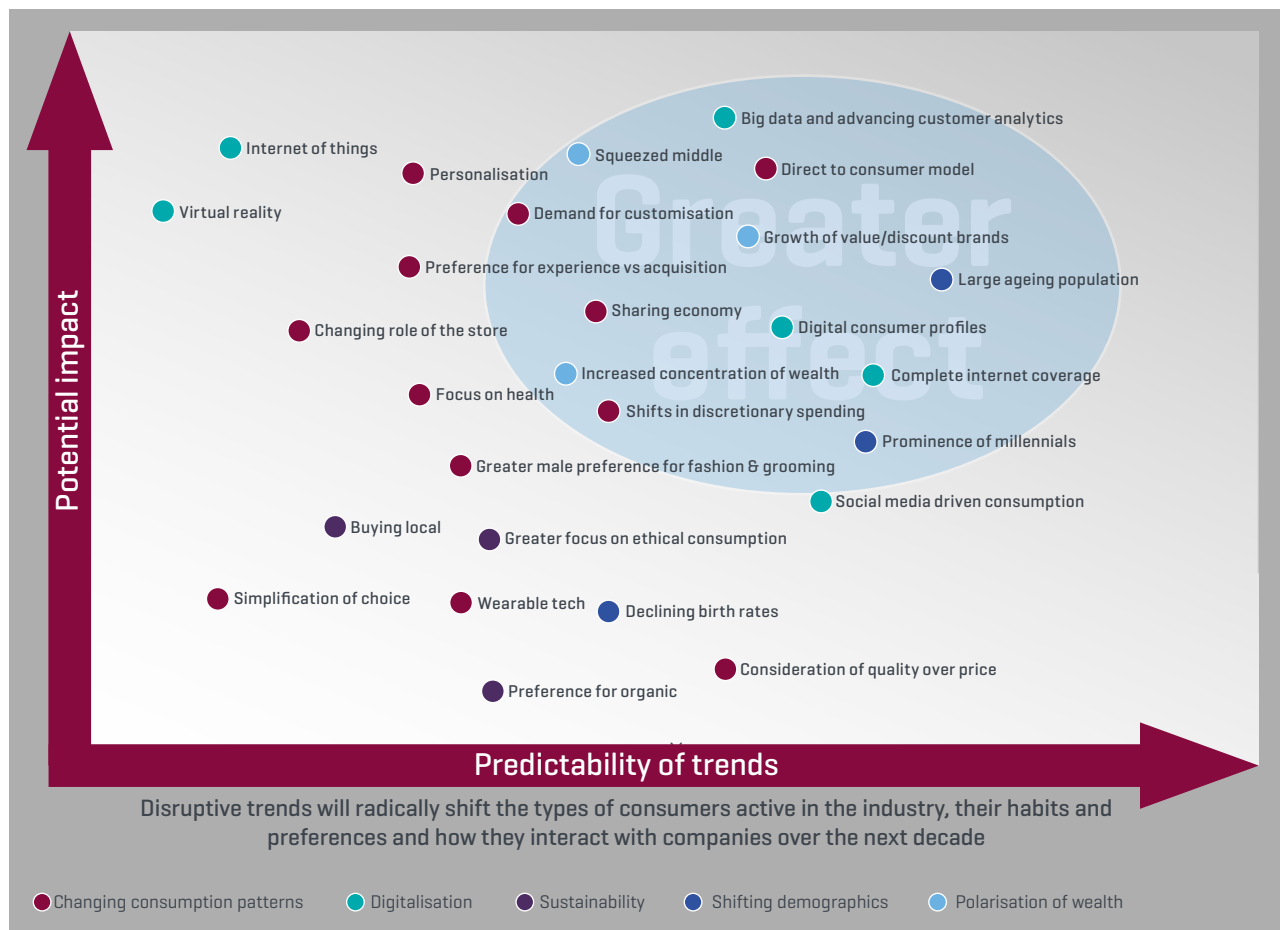
5.1.1 The consumer

Every business must think about its consumer first and foremost. So, how will consumption of real estate evolve over time? Figure 4 shows some key changes in consumption trends that will have a direct impact on people’s need for, and usage of, residential real estate.

The five key trends to look out for are:

1. polarisation of wealth
2. changing demographics
3. attention to sustainability
4. changing consumption patterns
5. the impact of tech and digitalisation on all of the above.

Figure 4: Key changes in consumption trends



People are buying less property and renting more, with a decrease in average tenancy lengths. They are less emotionally attached to assets, and are more interested in experiences. Even in other walks of life, they are noncommittal. Relationships, travel, education (for example, the rise of the ‘mooc’ (massive open online courses) for online education) and careers (exemplified by the rise of the gig economy) are becoming more and more temporary. With the rise of the sharing economy, consumer behaviour is becoming less involved across the board, as all sorts of things can now be borrowed, shared and passed on.

In the residential real estate space, investors and operators have historically focused on the asset and not the experience around the asset. This mind-set is dangerously disconnected from the direction consumer behaviour is taking. In supply-constrained markets such as London, any new stock that is brought to market has always been absorbed due to the critical shortage in residential accommodation. However, especially for the fledgling build-to-rent sector that wishes to justify pricing premiums of 15-20% on market averages, not listening to what their consumers want and not understanding how these needs are evolving, will result in assets that will not stand the test of time.

5.1.2 Technological shifts

In September 2015, the World Economic Forum ran a survey of over 800 executives from digital businesses with the aim of predicting the date in which 21 key technological shifts will hit mainstream society¹⁸.

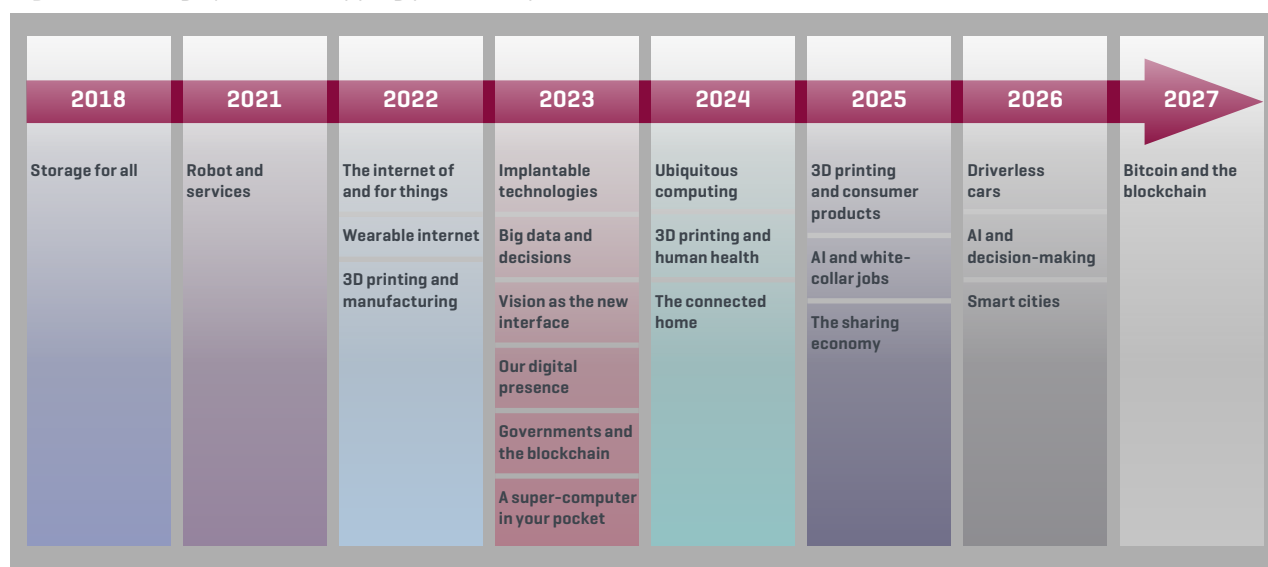
All these shifts will, in their own way, have a significant impact on our consumption of real estate. For example, Shift 4 in the WEF report, ‘wearable Internet’ predicts

that by 2022 at least 10% of people will wear clothes that are connected to the internet; Shift 8, ‘the Internet of and for Things’ predicts that by the same year there will be 1 trillion sensors connected to the internet. As we become more and more connected, we produce more and more data. This, in turn, will have immense positive spill-over effects on our planning and consumption of urban spaces and real estate. Through sophisticated analytics we will be able to adjust the flow of public transport, the tolls on congestion charges, set real time pricing on residential assets coming to market – all thanks to the increasing amounts of data an increasingly connected global population will continuously produce.

The WEF highlighted several other noteworthy shifts that will shape the way we consume real estate:

- Shift 9, the Connected Home – by 2024 over 50% of the internet traffic in our homes will be for appliances and devices. Our entire way of consuming residential space will drastically change with ever increasing connectivity.
- Shifts 10 and 12, Smart Cities and Driverless Cars – by 2026 entire cities and their private transport systems will be tech enabled.
- Shift 17, the Sharing Economy – by 2025, tech enabled sharing will maximise our utility from personal and corporate assets, reducing wastage vs. today and blurring the lines between private and public, own and shared, bringing the co-style society into the mainstream.
- Further, big data, AI, robotics, blockchain technology and 3D-printing are all shifts that by 2027 will have changed the way we live and consume.

Figure 5: Average year each tipping point is expected to occur



¹⁸ WEF, 2015 – http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf

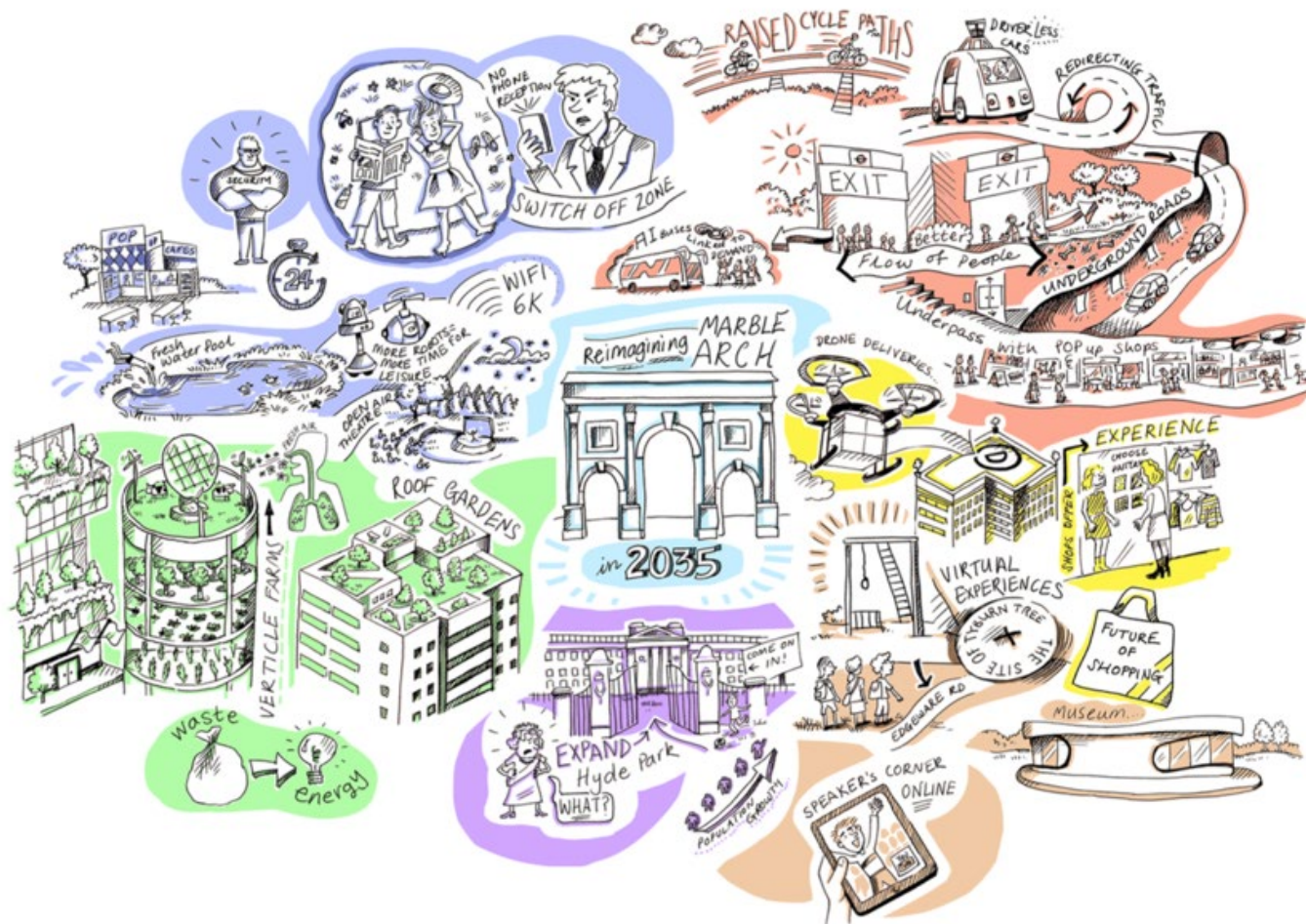
5.1.3 Generational trends

In its 2020 real estate report, PWC highlighted that migration flows will continue the trend of influx from rural to urban centres, such that by 2050 the urban population will increase by 75% to 6.3 billion¹⁹. This corroborates evidence by Savills that human capital wants cities²⁰. This human capital will be dominated by millennials as, by 2025, millennials will form over half the world's population and 75% of its workforce. It is therefore imperative that urban real estate investment satisfies the needs and expectations of this ever-important user group. As cities become more digitalised, they will be characterised by urban dispersal where mega-cities will be made up of many clusters of micro-local neighbourhoods. Sustainability will become a key concern for all urban development, as cities produce 70% of the world's greenhouse gases while occupying 2% of its land²¹.

Technology is seen across the board as having a lasting and significant impact on the production and consumption on real estate. The need for real estate is shrinking across some subsectors such as retail and to a degree offices (with the advent of office-sharing solutions such as co-working), while online shopping is making demand for well-situated warehouses balloon²². The internet of things, big data analytics and 3D printing are repeatedly hailed as technological disruptors for the future of the built environment.



19 PWC, 2014 – <https://www.pwc.com/gx/en/industries/financial-services/asset-management/publications/real-estate-2020-building-the-future.html> 20 Savills, 2017 – <http://pdf.euro.savills.co.uk/global-research/euro-cities-2017.pdf> 21 PWC, 2014 – <https://www.pwc.com/gx/en/industries/financial-services/asset-management/publications/real-estate-2020-building-the-future.html> 22 PWC, 2014 – <https://www.pwc.com/gx/en/industries/financial-services/asset-management/publications/real-estate-2020-building-the-future.html>



5.2 What will the real estate world look like in 2035?

Armed with these facts, Houzen set out to discover what some of the key real estate players in London think will be the impact of technology on real estate. During the Innovation Series events Houzen co-hosted with Assael Architecture in February 2017, they asked 30 specialists from across different industry fields to re-invent a famous urban place (Marble Arch) for 2035, and to identify the technologies that will shape it.

Technology was perceived as a unifying rather than dividing force, one that brings efficiency and delight to the daily lives of its users. Where sustainability was a key concern, participants uniformly saw technology as the solution that will ensure that everybody wins.

More specifically:

- Innovation in building technology will render projects feasible that were previously economically inviable. Therefore, we can expect road transport to be moved underground more, increasing pedestrian spaces aboveground.

- As buildings become taller and denser, the line between private and public spaces will become increasingly blurred and nature will become part of urban architecture in the form of vertical gardens or farms.
- Innovation in transport will create less congestion and therefore require fewer roads for a variety of reasons. Logistics and e-commerce providers will use drones for deliveries to residential and commercial areas.
- Half empty buses will be a thing of the past, with public transport becoming demand-driven with a big data and AI powered network.
- People will be picked up and dropped off by shared driverless cars on demand, with minimal resource wastage.
- Technology will become a tool for individual empowerment and personalised consumption. In the case study of Marble Arch and its surrounding area, some of the ideas that were aired within the group were: virtual reality tours of historical sites such as Tyburn's tree; augmented reality in the home to continuously personalise it at the click of a button; and the digitalisation of Speaker's Corner.

6.0 The relevance of PropTech for residential real estate

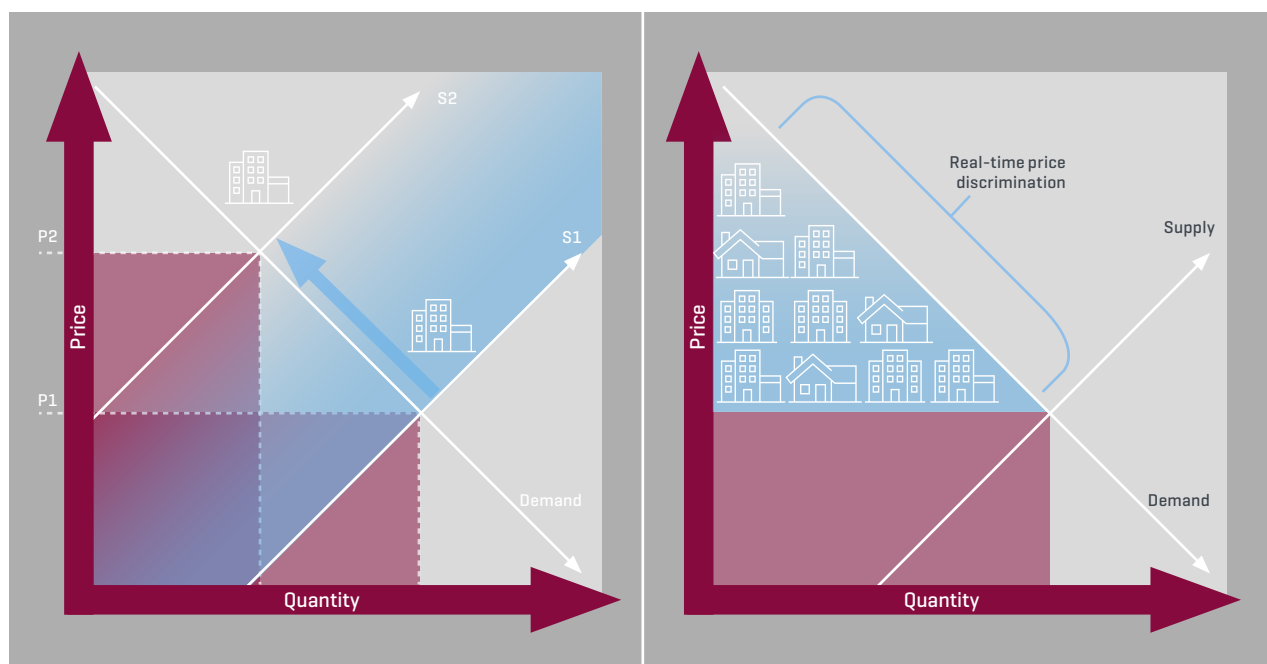
It is evident that PropTech is here to stay. Globally, property technology received \$2.67 billion of funding in 2016, up from only \$186 million in 2011²³. The question readers of this paper should now ask themselves is: 'does this matter for my business?'.

In this part, we endeavour to answer that question, presenting a case for the relevance of property technology across the life cycle of residential assets. We will build a framework to assist industry stakeholders in their assessment of the specific relevance of PropTech to their business.



²³ CB Insights – <https://www.cbinsights.com/blog/residential-real-estate-tech-market-map-company-list/>

Figure 6a: Key changes in consumption trends



6.1 Why should I care?

At a macro level, a residential real estate player should care about implementing change for one of two reasons: it adds value (or avoids the destruction of value) by impacting the top line or the bottom line of the business. So, does property technology affect either of these? We believe the answer is an absolute yes, in the long term.

- i. On a top line level, technology can add value by opening new revenue streams by extracting consumer surplus. In more mature industries such as travel, this has been made abundantly clear by the success of price discrimination methodologies such as those applied by Booking.com or airline advance purchase fares. In residential real estate, some initial inroads are being made by the nascent build-to-rent sector, where price discrimination versus conventional private rented sector (PRS) stock has been made possible via the 'housing as a service' model. This has allowed BTR providers to charge more for smaller, more spatially efficient units, thus maximising asset yields.

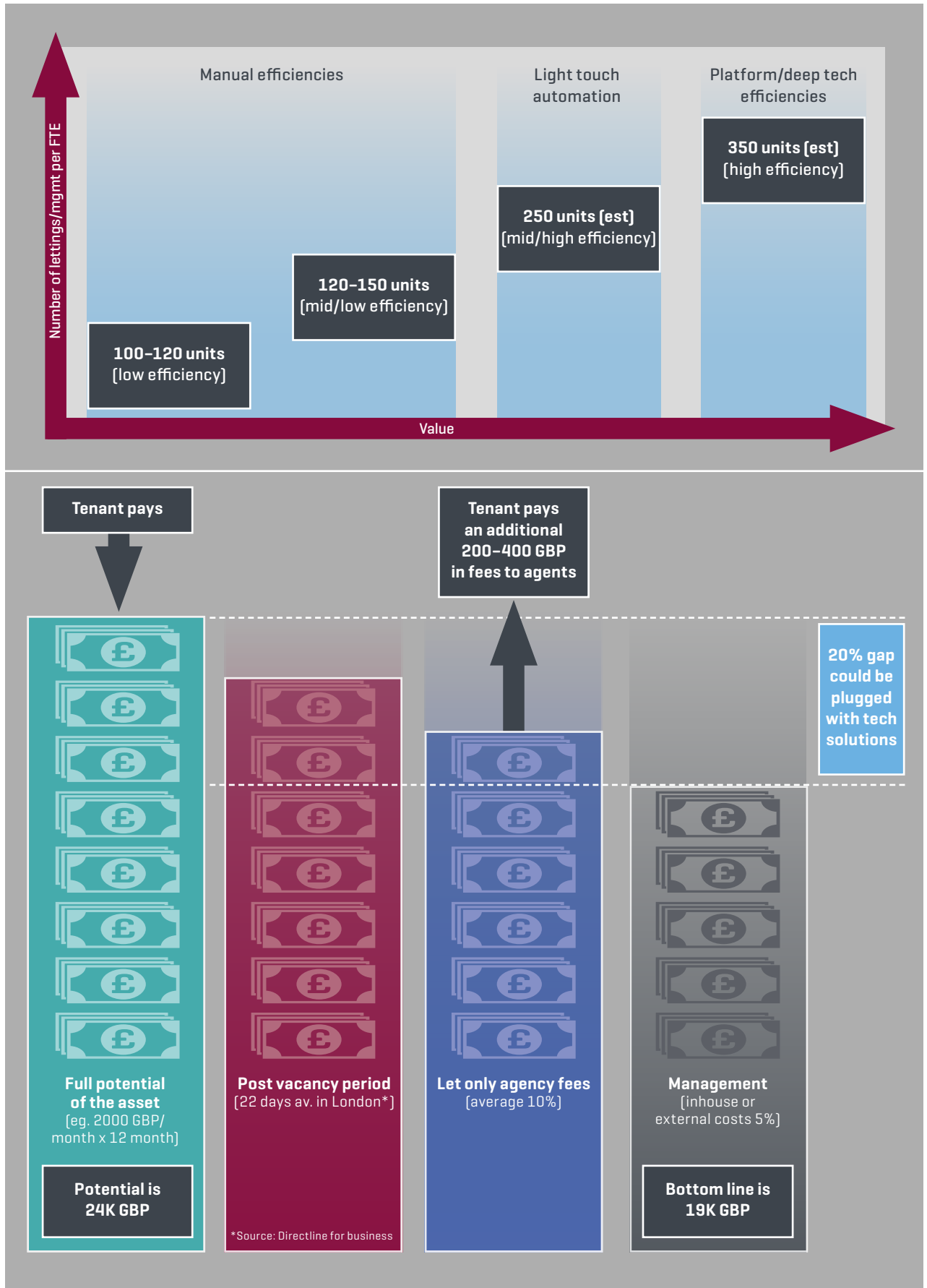
However, there has not been an instance yet in residential real estate where true extraction of consumer surplus has occurred. There is a significant opportunity for property technology to enable the residential market, at an aggregate level, to unlock this 'zen' through big data analytics driven price discrimination.

The figures 6a and 6b illustrate this point. Today, an investor/developer can choose to place an individual asset on S1 (traditional PRS) or S2 (build-to-rent) in

Figure 6a, pricing it accordingly. On an individual asset level, BTR yields will be higher, but demand at a market level is lower. Producing infinite new stock will eventually shift the supply curve down. On the other hand, price discrimination on the existing supply curve of rental stock (Figure 6b) will allow the market at an aggregate level, at any single point in time, to extract the most overall value from the existing pool of stock.

- ii. Technology can help businesses extract value from their bottom line by reducing costs and increasing efficiency. In the instance of property technology for the residential asset management space, this comes in a variety of guises, but the 2 most impactful categories in our estimation are:
 - a. Maximising lettings/management efficiency per FTE within the firm (Figure 6a).
 - b. Maximising retention of entire potential rental income into bottom line profit (Figure 6b).
- iii. Anyone not convinced about the added value that technology can bring to existing business models' top and bottom lines, by fostering operational change should take note of the staggering growth of the 2 biggest property tech start-ups and how they compare with more established industry players that have been on the market for decades.

Figure 6b: Key changes in consumption trends



7.0 Implementation framework – what should I do next?

*'I keep six honest serving men
(they taught me all I knew);
Their names are What and Why and When,
And How and Where and Who.'*

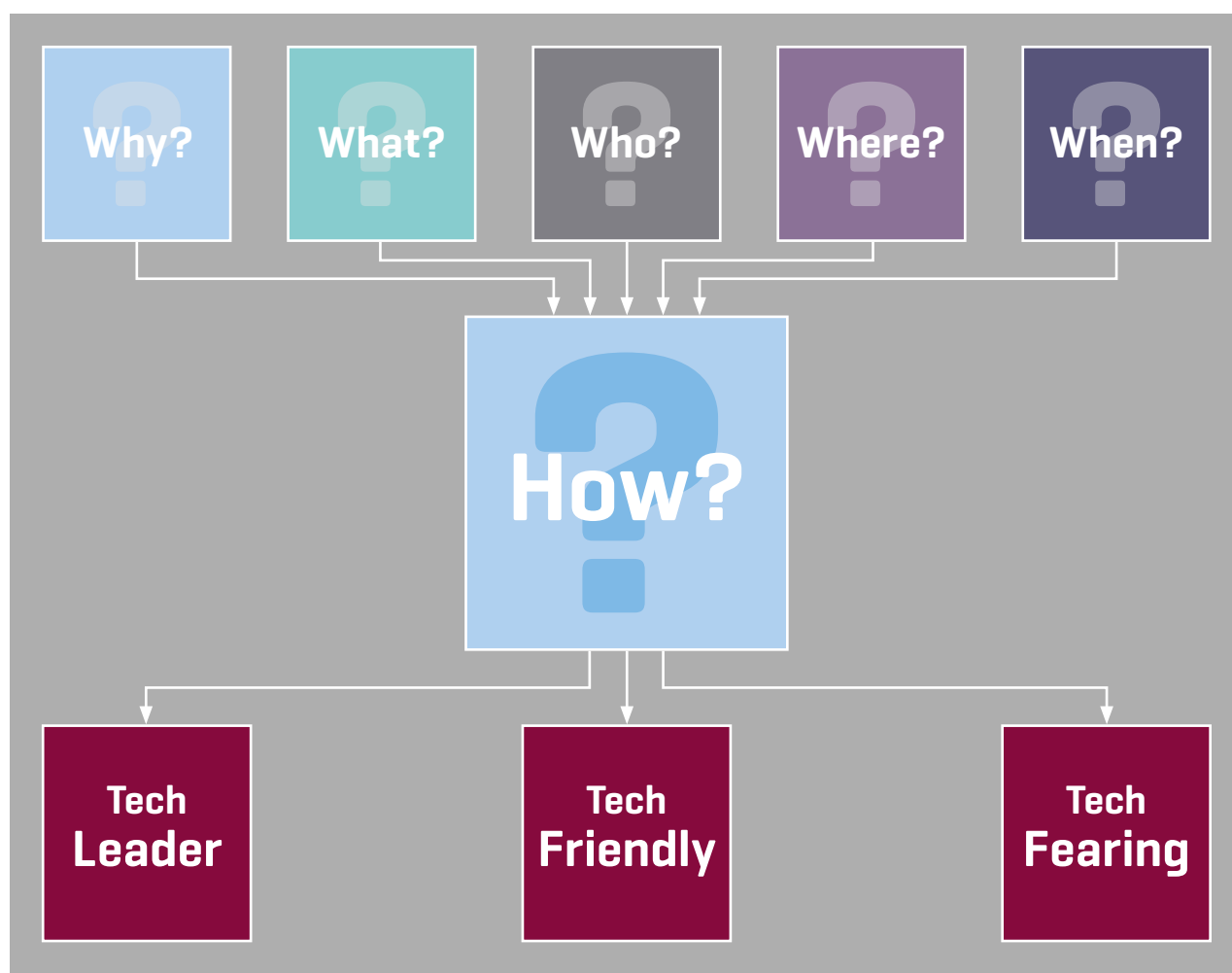
Rudyard Kipling

So, what next? In this section, we will address the question of what happens next. Using a framework devised around the 'six honest serving men' we will endeavour to explain the opportunities for residential real estate players to implement deep technology solutions in their businesses. Readers should answer the first 5, in order to understand what they should be doing for the sixth.

Why

Why should you start looking at deep tech?

- It will help increase **engagement with existing customers**, potentially increasing your share of the wallet from your existing customer base. For example, an asset or property manager could use AI tools to better manage rent collection, or repair and maintenance tasks across the entire property management lifecycle.
- **You can identify new customers** through using technology to improve your overall client value proposition and increase your market share. For example, an automated, AI-powered marketing CRM (customer relationship management) solution (online, email, social, etc.) can help you segment your customer prospects better and reach out to a wider customer base.
- **You will open new revenue streams** by bolting on new or better (deep tech powered) products to your value proposition. For example, a diversified portfolio owner can use machine learning to sell their tenants the option of buying new property even before they start researching the market.



- **Operational cost optimisation** by deploying ‘Lean’ processes coupled with (deep) technology could reduce costs across your entire portfolio by up to 80%. For example, Leverton uses a machine learning powered algorithm to read through entire lease documents (they have recently partnered with JLL)²⁴ and extract the most useful information quickly, thereby reducing the time and resources needed for the lease management process.
- **You can develop and introduce new products faster.** GE saved up to 80%²⁵ of their product development costs and brought their products to market faster by deploying the Lean start-up methodology ‘FastWorks’. Integrating this with deep tech solutions is expected to amplify these gains manifold. For example, a machine learning software can be used in construction and development to accelerate project management and reduce errors and hence costs.
- **Why explore deep tech?** Because if you don’t, someone else will! Your company will lose the opportunity to gain a significant competitive advantage, and might in the long term become uncompetitive and obsolete.
- **Define operational metrics.** Break down your objectives into easily manageable operational metrics. Identify the metric owners, who will typically be responsible for the day to day operations and might also be the direct users of the (deep tech) solutions you propose to bring into your organisation. For example, in to achieve a 20% growth in your portfolio size, the operations team will need to identify a scalable solution that will help them improve the number of properties managed by each person.
- **Identify all your customers.** Map out your internal and external customers – these could be end users of your product(s), internal stakeholders such as CXO/shareholders, internal users (typically operations, project managers, frontline staff) and suppliers. Segment your end customers by drawing out detailed customer personas and explore demographic insights on each of them.

What

What exactly should you do? Every thriving business has specific strategic targets and operational goals, therefore:

- **Identify the 3-5 year strategic goals** for your company. Do you wish for it to grow your portfolio size, increase your customer base, increase your share of the customer’s wallet, reduce your operational costs, optimise your asset management structure? It is important to plan from the top down to make influencing internal stakeholders easier. For example, targeting 20% year on year revenue growth (while competitors are targeting 5-7%) will require a company to unlock new revenue streams through customer, product or unit revenue expansion. The (deep tech) solutions will be aligned if they help add to the existing product portfolio, or cross sell and up sell extensively.

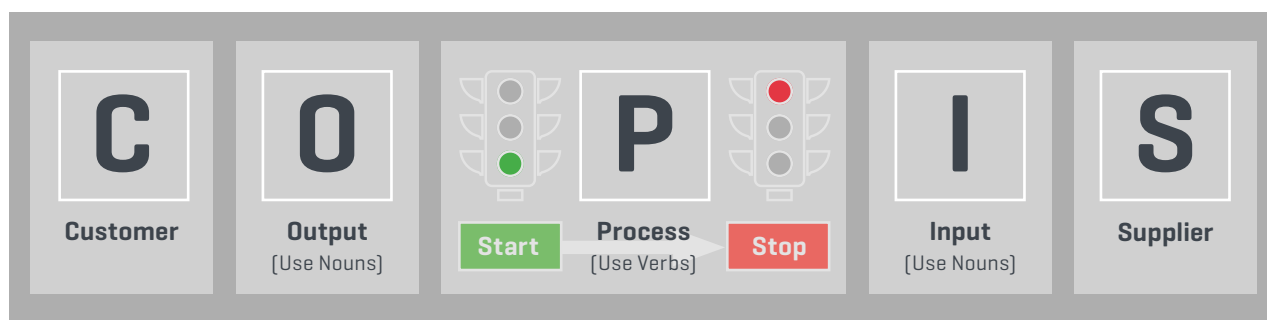
Who

Who should do it?

- **Assess your internal tech capability and tech user adoption.** Observe if most internal tasks internally are carried out over the phone, by email, in person or via software. If software is already routinely used in your organisation, this is a sign that user resistance for a new technological product is likely to be low. Another thing to take note of is the amount of tech users consume in their personal lives, such as ordering a cab or food, or booking a salon appointment. The more tech savvy the users are, irrespective of whether they routinely use technology at work, the easier it will be for them to start using a revolutionary new service or product. Finally, you should assess how change and tech savvy the C-Suite (CEO, CFO, etc.) is, and how quickly they will embrace a new solution (powered by deep tech), which will typically involve significant organisational (or team) change.

²⁴ <http://www.jll.eu/emea/en-gb/news/734/jll-signs-global-agreement-leverton-automate-lease-management> ²⁵ <https://www.collectivecampus.com.au/blog/how-ge-saved-80-in-development-costs>

Figure 7: COPIS



- Find champions and sponsors.** Here, we are suggesting you put in place a change management framework. Any change, whether organisation wide or an individual team level, requires a senior sponsor. Depending on how big the impact of the (deep tech) solution is, you will need to find a very senior sponsor to spearhead the change and more importantly manage all internal bottlenecks. If the solution has a potential to relocate or reduce workforce, you will absolutely need a senior sponsor to realise the programme. Next, you need champions from within who will promote the day to day implementation of the chosen solution. A solution may be revolutionary and make complete sense for the shareholders but if nobody engenders sufficient engagement within the organisation and enforces use on a day to day basis, the solution will eventually be deemed ineffective.

Where

Where within your business should you implement it ?

- Map out your value chain.** To understand where you should implement tech, you must first have an end to end view of your value chain including your customers, suppliers and internal operations. At the top level, a Lean tool called COPIS can be used to visualise this (figure 7).

On the COPIS map the idea is to identify what part of your value chain is broken (e.g. customer engagement, internal processes, or supplier service levels, etc.), which is causing revenue erosion or has excessive cost heads. Once this is strategically aligned to your CFO/shareholder metrics, you will be able to go to the market looking for the right deep tech solutions and come back into the internal organisation to influence internal stakeholders easily. The next question is whether to make, buy or partner for these solutions, which we will answer under the 'how' section.

- Identify geographical locations.** Some teams, locations, or regions will often be more tech savvy and open to change than others for a variety of reasons. It makes sense to pilot a new deep tech solution in a location where the users are more engaged with the prospect of innovation. For example, it might be better to pilot a VR solution in new buildings. Big data solutions might work better in developed markets with extensive existing data, while blockchain might be an amazing opportunity in emerging markets.

When

When should you do it?

- Now!** As we explained earlier, if you don't act now, someone else will, and they will turn technology to their competitive advantage. You will always find ways to engineer internal change if there is buy-in at the top. There is a plethora of historical examples such as Kodak and Nokia, who were once market leaders and are now obsolete due to their failure to adopt innovation.

How

How should I do it?

- Your answers to the first 5 questions will help you define your technological standpoint. Every company's strategic needs and operational capabilities are different; thus, it is essential for these to be fully aligned to avoid wasting time and resources doing the wrong things. Your answers to the above questions should give you an indication of where you fit into the below tech categories.

7.1 Are you a tech leader, tech friendly or tech fearing?

Tech leaders, who use technology to their competitive advantage.

This type of firm will deploy a full-time resource to act as the special point of contact (SPOC) for the PropTech industry. This person may be responsible for identifying company needs, conducting ongoing due diligence on the PropTech market, understanding changing tech talent demographics and, most importantly, influencing internal stakeholders to absorb and deploy the chosen solutions. Additionally, the C-suite will have a single digit percentage of the company's budget allocated to deep tech research and development (R&D) and investments.

Most tech leaders across industries started by deploying tech champions or SPOCs, which then gradually transformed into a CVC (corporate venturing capital) arm. Some examples of this in other industries are Unilever Ventures, L'Oreal and Aviva's partnerships with Founders Factory, and, within the property world, the recent partnership by JLL with the Seedcamp – Starwood Concrete fund. Typically, such companies want to be at the forefront of tech innovation and will allocate a substantial percentage of their annual budget towards tech R&D and investments, and will share their internal data, customers and processes with the tech teams in order to come up with innovative solutions.

Over time, these firms may develop an environment that will compete with Google, Facebook and exciting high growth deep tech start-ups to attract the right talent, and will lead innovative product development. As per Houzen's research, no residential real estate fits this bill yet.

So, rather than internalising talent we would recommend that you partner with and invest in deep property technology companies, kept at arm's length to foster their creativity.

- **Acqui-hires** are a viable route to quickly build tech capabilities, i.e. by acquiring entire start-up teams. The hardest part for tech entrepreneurs especially in the deep tech segment, is to assemble a technically strong team that holds a shared vision. Irrespective of whether the start-up ends up producing value in the market, if it has a strong team of people that work well together in your deep tech segment of choice, it may be an ideal acquisition target. The team should be financially rewarded, allocated to the internal SPOC and assigned the task of building new products that may benefit their new owners.

This is a common trend in Silicon Valley and emerging markets.

Tech friendly

They tend to be more suited to buying, leasing or outsourcing the technology solutions and partnering with tech firms, rather than investing directly in companies. They would typically follow the example of the tech leaders, and mimic those solutions that have worked for them. Ideally, 'tech-friendly' firms should start by consuming deep tech solutions that start-ups are building and creating a friendly process and data sharing platform.

Tech fearing

They often stand the risk of running obsolete business models and being pushed out of the competitive landscape by the tech leaders and tech friendlies. These companies exist in every industry, and typically will not adapt, regardless of the rate of change in the outside world. If such firms don't expose their businesses to technological solution, they risk becoming obsolete.

Case 1: Portfolio managers

Traditionally, portfolio managers will optimise operations around the assets they are managing. However, there is an opportunity to look at the same problem from a different angle, making the process customer centric. In a diversified portfolio with commercial, retail and residential assets, the end user will be exposed to the portfolio's offices and its shops, while living in its residential accommodation. Today, each asset is marketed separately, so that a potential user will be targeted in three distinct ways (figure 8) – a huge inefficiency. However, it is possible to create a customer oriented product that interacts across all real estate asset classes. This is being done to some degree in the WeWork – WeLive model, where strong community ties allow the company to learn about its tenants across their office and personal lives (figure 9).

There is constant debate about the reasons why an age-old co-working model such as Regus isn't valued as highly as WeWork, even though their core business models have similarities. The real value add of WeWork lies in the strong community ties that it commands, which interact through the internal WeWork online social channels and create an immense data pool. This in turn is helping the company learn and shape the workspace of the future.

Our disruptive proposal for portfolio managers is to invest in tech that allows them to capture their tenants' digital identity across asset classes, and to then build assets and services the users want. The tech would also help the portfolio manager make decisions on timing of investments, location choices, enabling them to buy and sell more intelligently, thus maximising IRR.

Figure 8: Traditional model – limited

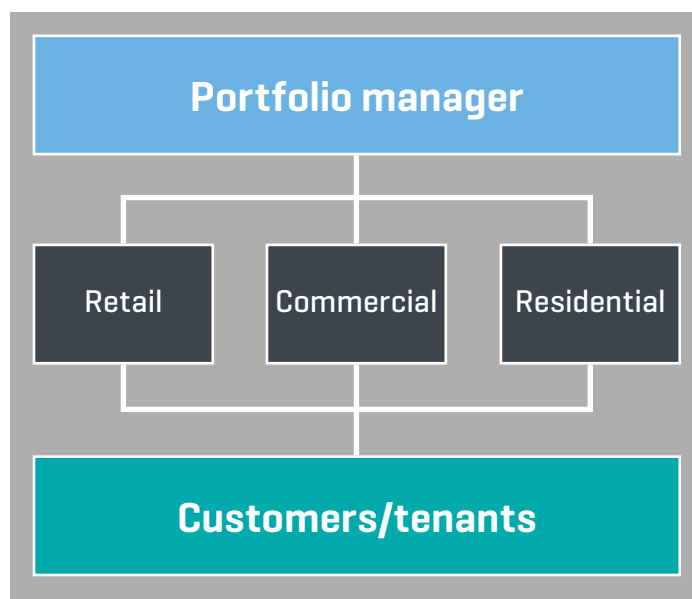
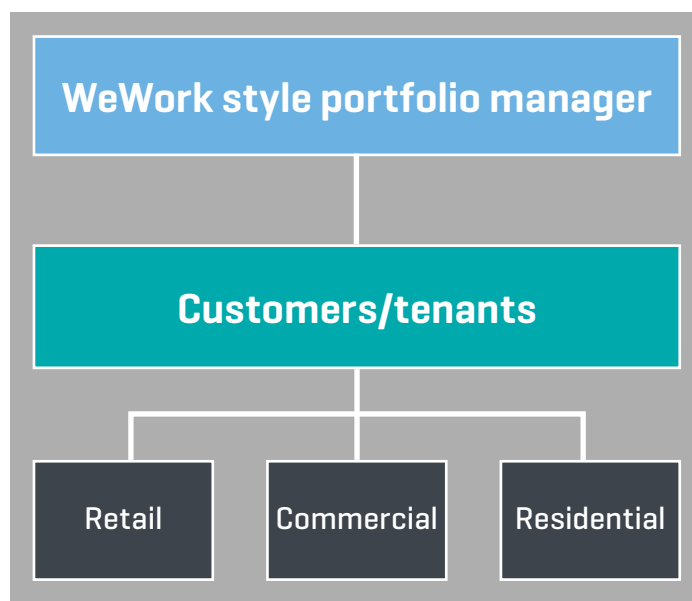


Figure 9: WeWork/WeLive model [engendered by tech, and can be enhanced massively with deep tech]



Case 2: Built-to-rent

Build-to-rent models seek and require scale of operations. To justify their investment thesis, process efficiency must keep pace with this scale growth. For many operators, a heavy tech implementation is a huge opportunity to redesign their business model and to scale easily with significant unit cost efficiencies. This is of additional significance now that there is demand side pressure as rental values have plateaued post Brexit.

Further, the typical BTR customer is younger and more tech savvy, and is already consuming deep tech powered solutions such as Amazon Prime Now deliveries, Uber, Snapchat and WeChat.

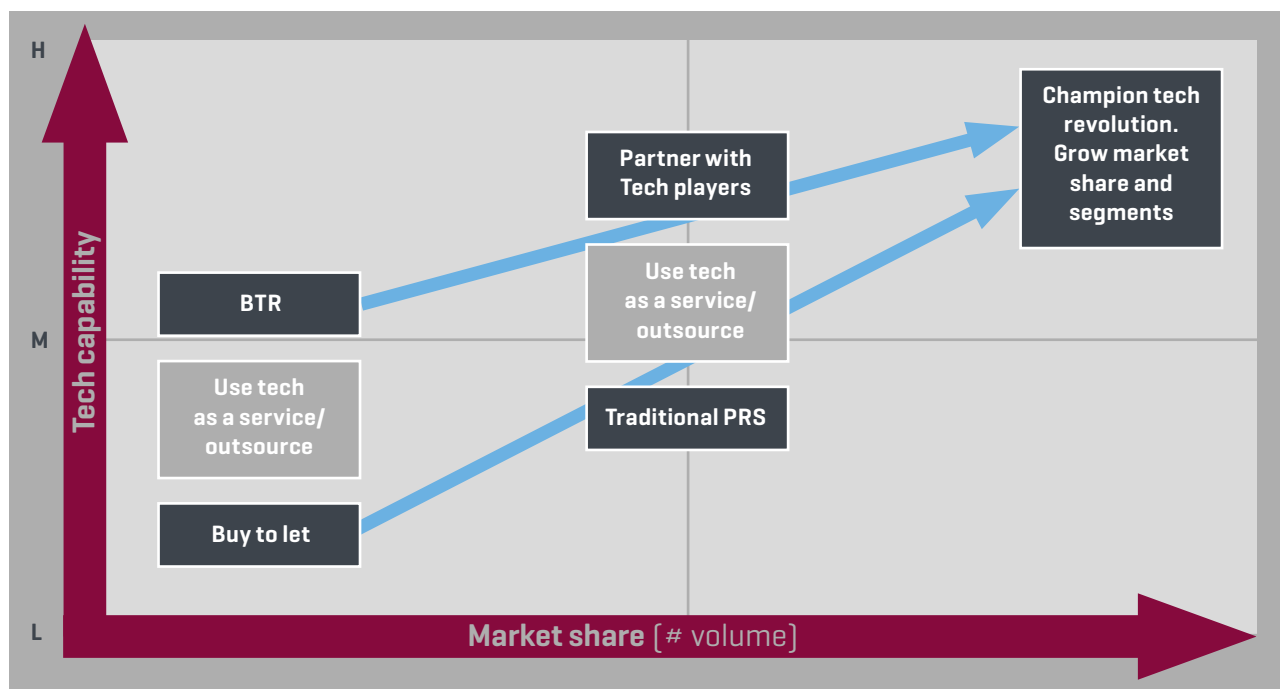
If a portfolio manager were thinking of making tech its competitive advantage, while keeping an eye on operational efficiencies (underpinned by tech platforms), it needs to consider the following matters:

- **Calculate unit production costs and keep them very low (using deep tech).** For example, by implementing AI solutions a property manager may be able to double or triple the number of units under management, without increasing headcount.
- **Build scalable and automated customer feedback and response loops.** For example, AI-powered architect software could recognise user demographics and cross triangulate them with user sentiment and usage of certain parts of the building and rooms, and use that feedback across millions of data points to design more accurately around the needs of the end user. This may then be used for modular construction as well as in the design of flexible home spaces.
- **Increase marketing reach and reduce customer acquisition costs (through strong network effects).** For example, build an AI-powered auto-incentivising mechanism for your tenants (segmented by big data) to encourage them to refer vacant

apartments in the building to their network, which will reduce overall customer acquisition costs and increase tenant retention.

- **Improve matchmaking** – this can be done by creating a seamless communication process or platform between customers, the company (internal) and suppliers, providing a real-time exchange of information, goods and services. The backbone of this system was devised by Toyota in the 80s, and implemented through process automation and seamless communication mechanisms. Today, it can be achieved with deep tech. A real-time match between demand and supply will minimise wastage from overproduction, delays, errors, etc. For example, a construction project manager could predict raw material supply (using big data on general supply trends) with a real-time data exchange with suppliers, and be able to forward commit a delivery timeline accurately to the development manager, which will in turn help bring the properties to market faster.

Figure 10: Tech capabilities



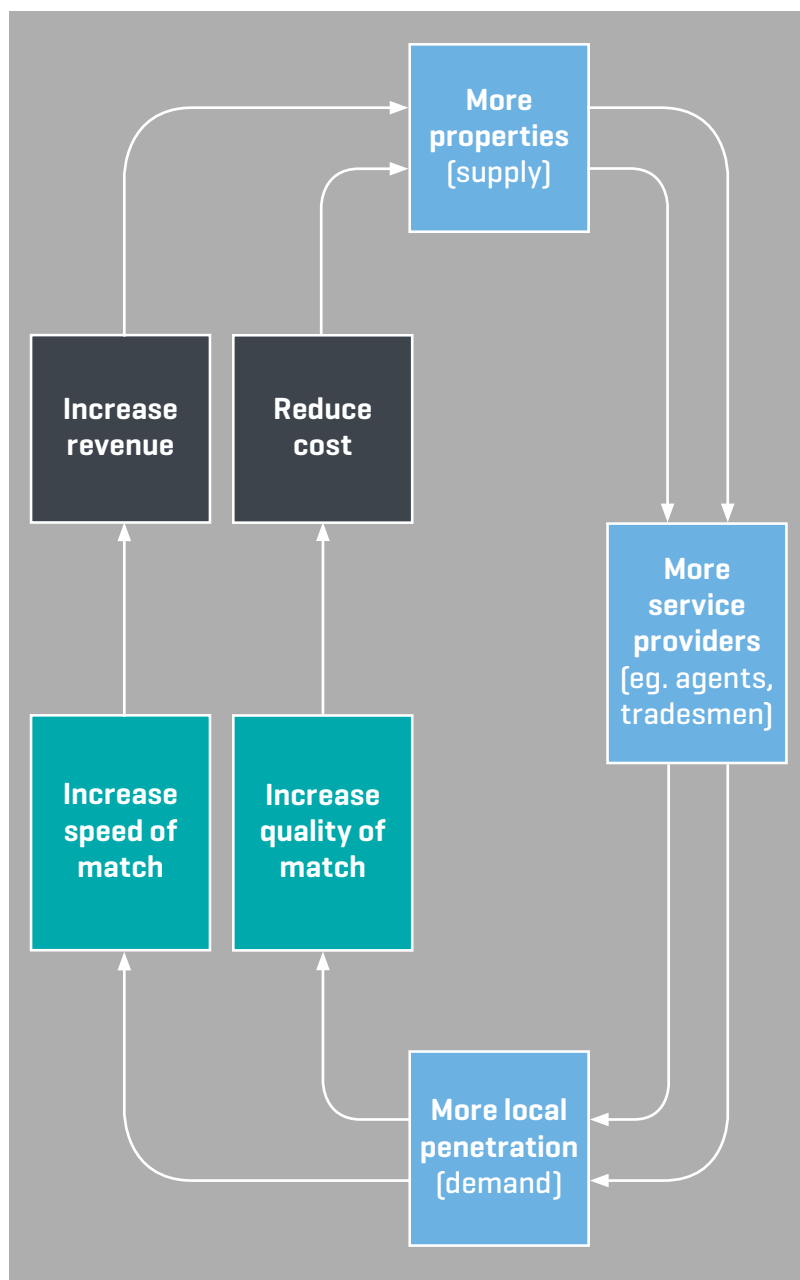
Case 3: Real-time data exchange

A two-part marketplace such as Uber (which is heavily underpinned by ML) uses the real-time information exchange principle seamlessly, matching demand to supply in real time. This helps to:

- a. massively reduce costs and lead times;
- b. open the market and acquire new customers. An Uber ride is so cheap and convenient that a person who would have otherwise taken public transport will often hail an Uber for short distances. Another example is the Uber pool or car sharing service that is enabled by the same app; and
- c. cross sell different products to the same customers. UberEATS has been launched across most markets globally and is seamlessly integrated with the core app.

The Uber model by David Sacks (the famous 'napkin drawing') illustrates what occurs when efficient real-time data exchange happens, namely the positive impact of Uber's geographic density, e.g. more demand, lower prices. By way of illustration, the same Uber principles can be applied to the Houzen business model (Figure 11) and explain how real-time data exchange can benefit the residential lettings market.

Figure 11: The Houzen business model



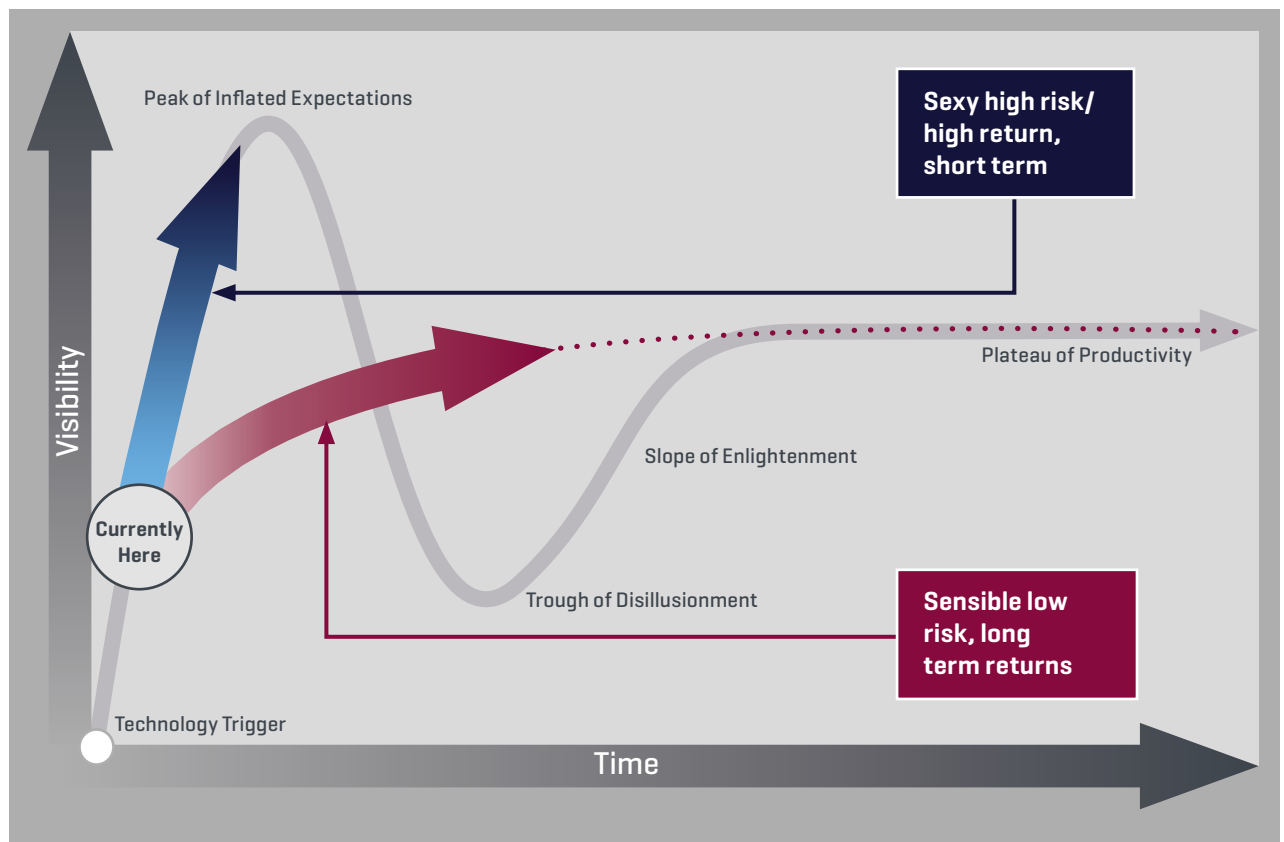
8.0 Conclusion

8.1 Be sensible not sexy

Below, we have applied the Gartner hype cycle to the UK PropTech industry.

- The industry is in the early stages of creating a hype cycle. Typically, across industries, early investors with a short to medium term view (who are hoping for a trade sale or initial public offering (IPO) exits) participate in the market with heavy capital commitments. Their typical investment thesis is that 1 in 10 to 15 of their investments will succeed to an exit, and the rest will crash and burn (this is the typical venture capital investment thesis). As we've seen in transport (e.g. taxi apps) and retail (the ecommerce rush) globally, when investors act due to a 'fear of missing out', this engenders inflated valuations that result in quite a few start-ups with strong trajectories crashing out.
- Our recommendation for those seeking to participate in PropTech is to follow the 'sensible' growth approach rather than the 'sexy' one. This can be achieved by taking an active role in building the businesses, helping clear out roadblocks across the industry, and by testing various propositions together with the businesses. Our interactions with PropTech advocates have shown us there are only a select few on the market that possess the knowledge required to build (deep) tech solutions or to build tech businesses in general.
- Though still at a very early stage, we have already started seeing some 'me too' investor sentiment as well as an 'idea clones' pattern forming, which could cause a lot of investor disappointment over the medium term. Conversely, were stakeholders planning to invest in tech to play an active role in co-creating deep tech businesses, this would reduce the friction between the real estate sector and the deep tech landscape. It would deploy resources into new value adding solutions for the market.

Figure 12: Gartner hype cycle



9.0 Summary



In this paper, we have attempted to shed light on what deep tech is, what it means for stakeholders across industries, and what it could mean for residential real estate. We have explained why it is important for this industry to wake up to the possibilities of deep PropTech, and the potential risk for those stakeholders who fail to recognise its potential for the future. We have also put together a framework within which our readers can assess their company-specific propensity towards innovation and deep technologies, so they may implement change appropriately.

We will leave you with one final takeaway. Hopefully by now, you will have learned more about PropTech, and how to assess its applications vis-a-vis your firm. But where do you go from here?

Through the interviews conducted so far, Houzen has created a strong ecosystem of deep tech industry thought leaders who are willing to come together and help us (and each other) solve some of the toughest problems facing the real estate industry. We believe in co-creating, partnering and solving problems together.

The best next step is putting together prototypes or MVPs (minimum viable products) for certain solutions. There has been a very good response from our interviewees (some of whom are senior figures within large companies and others from fast growth start-ups) who are willing to offer their support and build MVPs for residential real estate clients. The MVPs could be anything from big data streams, to a blockchain smart contract, to a computer vision scraper.

9.1 Getting started with deep tech solutions

The interviewees gave us the following invaluable insights on how to start flirting with deep tech solutions:

- 1. Talent sourcing in deep tech is difficult.** Most of the interviewees hire from leading tech universities in the US and India. In the UK, finding local talent is difficult, and in Europe, most talent is concentrated in Paris, Dublin, and Berlin. Most companies will find it extremely hard to compete with the likes of exciting start-ups, Google and Facebook to attract this limited talent pool. Real estate as an industry will find it even harder as it is not the top industry choice for this talent pool. Thus, it is better to outsource the development process.
- 2. Deep tech is expensive.** The salary of a typical deep tech software engineer ranges anywhere from £50,000 – £120,000 for a person with 2-6+ years of experience.
- 3. MVPs are the best value for money.** A typical MVP costs around £100,000 – £150,000 to build, and takes about 6 months.
- 4. Data and users are key.** A tech or data product is as good as the data and user interaction that runs through it. Therefore, it is important for real estate stakeholders to sponsor data sharing projects so that the MVP can grow quickly with user experience and demographic data.

9.2 How to build using deep tech within a lean product framework?

The lean product development framework below, known as the DMADV framework, is a great way to quickly build, iterate and improve on solutions that are targeted at your end user. This model is used extensively across manufacturing and services businesses.

- 1. Define:** Who is your customer? Define your customer demographic in detail and carry out persona mapping, i.e. age group, behaviour, purchasing behaviour, lifestyle, how much time per day do they spend doing what tasks? What are their pain points?

Gather VOCs (voice of customer) – for example, ‘house hunting in London is a full-time job’. Use the 5 whys approach to understand the true root causes of customer pain points (root cause analysis). With extensive data being generated, there is enormous capacity for meaningful insights on tenant demographics, their likes and dislikes, their mobility, their purchasing behaviour, etc. Each of these factors are defined as CTQs (critical to quality) or feature attributes that will help define the product later on.

- 2. Measure:** Measure each of these CTQs. Start measuring how much is the pain, how often, when, etc. Set up big data measurements, use machine learning to start collecting customer interaction data with existing products (with the apartment, landlord, etc.). Collect energy consumption, install sensors to check room usage, temperature and other statistics, install Alexa to measure how much the user interacts with or uses the device to give what commands.

We would suggest that tech leaders set up a ‘staging room’ where they use their existing stock and experiment with tech in different flat types, communal areas and, with the tenants’ knowledge and permission, with sensors and cameras to enable ethnographic studies. This will enable you to collect behavioural and engagement data directly from your end customer.

- 3. Analyse:** Slice and dice the data. Use all data from all the possible sources on the customer and their interaction with the asset.
- 4. Design:** Design product (housing) features, simulating them in virtual reality and with continued testing and iteration with different factors. Some tools that will be useful for this step are DoE (design of experiment) and factor analysis. Your goal is to find the optimum design parameters and then to start designing.
- 5. Verify:** Check your product-market fit by testing it in the real world. Find out what works and what doesn’t. For whatever doesn’t work, you must repeat the cycle. Don’t shy away from re-designing and re-verifying your product until you reach customer delight!

Deep PropTech is still in its infancy, and must be navigated with care. We believe the takeaway winners at this stage in the race are deep learning/machine learning intelligence augmentation tools. However, it is paramount that every stakeholder assesses their deep technology needs and firm-wide propensity to implement technology driven change, before making any kind of investment. We also recommend outsourcing the process to exciting (start-up based) talent pools in the MVP stage.

We hope this paper has helped you garner a working knowledge of deep tech in the real estate space, and that we have given you some useful tools with which to consider, and engender, the implementation of deep property tech in your business.

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11.0 Further acknowledgments

We would like to take this opportunity to thank all those who took the time to participate in our interviews. Your contribution to this paper has been invaluable.

Peter Czaban (Ethcore)

Robert de Jong (ULI)

Mark Edwards (KPMG)

Tyler Winklevoss (Gemini)

Rakesh Channaiah (Accenture)

Stephanie Swift (SF-based start-up)

Chlump Chatkupt (Placemake)

Anil Bharath (Cortexica)

Marc Crouch (Firedrop)

Rashid Mansoor (Hadean)

Adam West (Satalia)

Ben Sizer (Weave.ai)

Jannes Fischer (Zenhomes)

Rohit Kondapalli (housing.com)

Niccolo Sanarico (Dpixel)

Eric Risser (Artomatix)

Gianluca Gindro (Geophy)

James Carter (Gousto)

Haikal Pribadi (Grakn)

Matt Partridge (Infabode)

Rohit Jain (Centrica)

Paul (Swiftkey)

Ruzbeh Baccha (Cityfalcon)

Ashish Kr (Shell Foundation)

Anup Nair (Sumologic)

Tom Charman (Kompass)

Tracey Hartley (Grainger PLC)

Additionally, we thank all the interviewers who helped us bring these interviews to life. Your effort has helped us find a path to discover and create deep tech solutions for the real estate industry.

Dhanasree Molugu

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Isobel Johns

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