



A PropTech Primer and Why it Matters

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I. Abstract

Linneman Associates believes that the commercial real estate industry is at an inflection point, driven by process inefficiencies and increased computing power. With machine learning (ML), “smart,” climate-friendly buildings, and the proliferation of PropTech companies attacking both operational and transactional processes, we are already witnessing a distinct shift. We expect artificial intelligence (AI) to have the greatest near-term impact on margins, with the other technologies discussed in this report following a slower CRE adoption path. While the impact of AI/ML on performance metrics remains difficult to ascertain, we expect a potential annual profit margin improvement of 150-350 bps on a stabilized basis. At a 20x valuation multiple, this potential represents a 2-5% value increase. We believe that keeping up with (not necessarily leading) the technology wave over the next 10-15 years will be critical for commercial real estate firms. Thus, now is the time to educate ourselves and our workforce, as those who do so will be rewarded in the long-term. The fundamental business of real estate will be the same, but how we get things done on a day-to-day basis will look different.

II. Background

In 1997, Dr. Peter Linneman published a widely cited industry article in the *Wharton Real Estate Review* (“Forces Changing the Real Estate Industry Forever”) in which he discussed the trends impacting commercial real estate at that time and how he thought the industry would evolve over the coming decades. For the most part, as traditional debt sources scaled back, he correctly foresaw the massive shift toward equitization (i.e., public equity); the professionalization of the industry with more transparent reporting; the increased focus on operational competence (versus relying on leverage and tax gimmicks) to generate returns; and the trend

that saw real estate companies growing ever bigger to achieve economies of scale. In the mid-1990s, he felt that the industry was entering a maturation phase and moving toward becoming an accepted institutional investor asset class. The 1997 article was an assessment of what it would take (both out of necessity and through leadership decisions) to achieve that status. While at the time, he did not appreciate the extent to which private equity and CMBS would also become critical industry capital sources, he was on point with how the overall maturation of the industry has played out over the last 25 years.

In 2022, we believe the commercial real estate industry is at a similar inflection point. But this time, the driver is not the disappearance of debt capital or favorable tax treatments but the growing impact of technology and more specifically, artificial intelligence and machine learning, on business. To be clear, we do not purport to be technology experts, but we do seek to identify trends, technological or otherwise, that are impacting the commercial real estate industry. With “smart,” climate-friendly buildings and the proliferation of PropTech companies attacking both operational and transactional processes, we are already witnessing a distinct shift. We believe that keeping up with (not necessarily leading) the technology wave over the next 10-15 years will be critical for commercial real estate firms. Thus, now is the time to educate ourselves and our workforce, as those who do so will be rewarded in the long-term. In fact, research published in the MIT Sloan Management Review (2021) found “that large enterprises with digitally savvy executive teams outperformed comparable companies without such teams by more than 48% based on revenue growth and valuation.”

We believe that companies that wisely and strategically incorporate AI and ML tools into their

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businesses will have a competitive advantage in driving growth. This is a trend not unique to real estate. We can look to other industries such as healthcare, insurance, automotive, and banking to get a sense of what may lie ahead for real estate. In fact, many technology professionals consider AI to be a general-purpose technology (GPT), with the potential for widespread use across a range of sectors. Wharton professor, and author of *A Human's Guide to Machine Intelligence*, Kartik Hosanagar, notes that GPTs “can stimulate innovation, drive economic growth, and also inform product strategy and overall design of the organization itself.”

III. The PropTech Movement

While the technicalities of what qualifies as PropTech vary widely, we broadly define it as technologies that optimize real estate investment and ownership. It can be technologies that make existing processes (e.g., due diligence, reporting, leasing, managing, buying/selling, etc.) more efficient for all parties, thereby reducing operating costs, or it may refer to technologies that create new revenue opportunities. In a 2019 report, CBRE referred to PropTech as “any real estate company using technology to increase efficiency, visibility, experience, flexibility and productivity.” Others focus on companies that seek to improve value chain functionalities (e.g., financing, construction, site selection, diligence, asset management, etc.).

This paper is not a deep dive into PropTech start-ups, as volumes can be written about the growing landscape. For a detailed overview of the industry, including existing technologies and innovations, we highly recommend “PropTech 2020: the future of real estate,” published by the University of Oxford.

Our intended audience is the leadership of traditional commercial real estate companies that are forming their corporate strategies for the next 10-15 years. We urge you to not only think about how big your portfolio will be or what it will encompass in 10-15 years, but also how and why technology, including AI and ML, should be incorporated into those strategies. We seek to educate the reader about key emerging technologies, with a focus on the impact of AI. Specifically, we highlight how AI-driven technology impacts performance in real estate and other sectors, in order to form a view of the industry going forward.

There is a wide range of estimates of venture capital raised for PropTech companies, ranging from

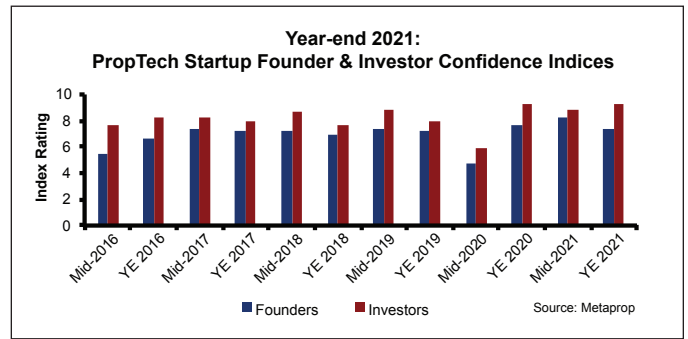


figure 1

\$10 billion in 2014-2018 (CB Insights), to \$20 billion over the same period (Venture Scanner), to \$15 billion in just 2018 (Unissu). PropTech start-ups have proliferated significantly in recent years. They seek to address existing “pain points” in the industry such as cumbersome processes, siloed or inaccessible data, or poor client and/or employee experiences, to name a few examples. But not all PropTech is developed by startups. Some traditional companies (not just in real estate) opt to develop in-house capabilities to address their specialized needs. This goes beyond a middle manager’s decision to upgrade a legacy software package. The type of technological change that the PropTech movement is bringing to the industry is much more impactful, and may require a change in corporate culture, starting in the C-suite.

In its year-end 2021 Global PropTech Confidence Index report, metaprop reports that PropTech investor confidence is at its highest level, at 9.3 out of 10, with 71% indicating that they will make new investments in the space in 2022. In comparison, Meta’s PropTech Startup Confidence Index stood at 7.4 out of 10, a drop from the 2020 high of 8.3, likely due to perceived macroeconomic uncertainty and stock market volatility.

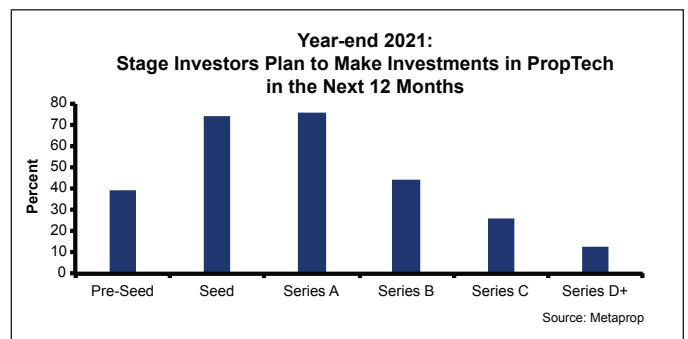


figure 2

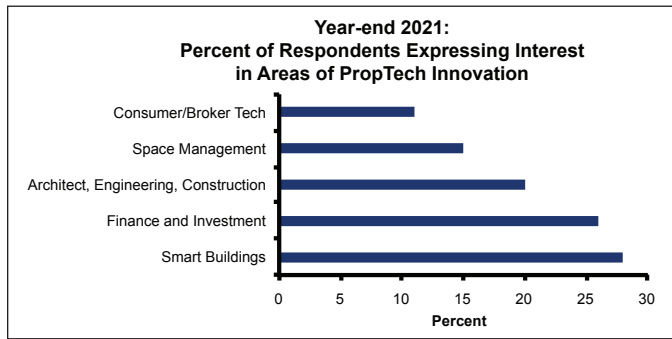


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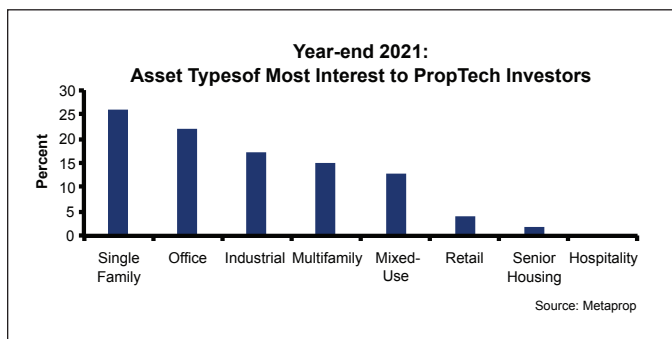


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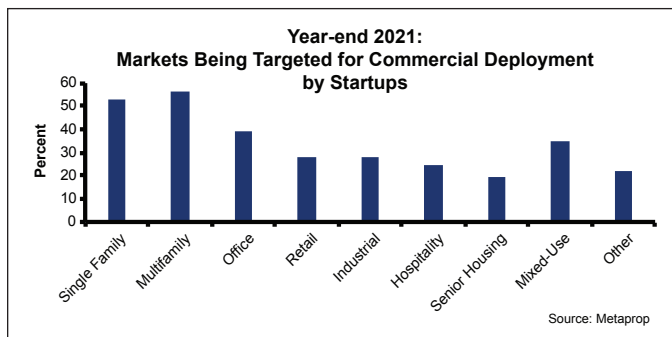


figure 5

IV. Key technologies that will shape the future of PropTech



a. Artificial Intelligence and Machine Learning

At its core, AI is about using computers to perform tasks that historically require human intelligence, such as learning a language, making decisions, or navigating the physical world. According to Wharton’s Hosanagar, “Machine learning is a subfield of AI that is focused on getting computers to learn without explicitly programming them.” ML takes AI a step further by

becoming a predictive tool that “learns” via complex iterative algorithms such as neural networks. Before AI, efficiency improvements were based on simply capturing and organizing data, requiring manual sharing. In many cases, legacy data sets are stored in silos, only accessible to certain stakeholders. The increase in cheap computing power, makes AI possible, meaning that huge amounts of data can be aggregated and analyzed, ultimately to the point of becoming a predictive resource.

AI and ML applications are already ubiquitous in our daily lives. When you click on a product on Amazon and a suggestion pops up for a similar or complementary product, that is AI at work. When your bank sends you fraud alerts, that is also AI. When your GPS suggests a route with less traffic, that is AI. Do AI suggestions translate into economic growth? Hosanagar reports that “nearly a third of the choices on Amazon’s retail website are attributed to algorithmic recommendations.” Similarly, recommendations on Google News increased usage on the site by 38%. And incredibly, one study reveals that 80% of video hours streamed on Netflix originate from algorithmic recommendations.

The difference between automating a process and artificial intelligence

Process Automation	Artificial Intelligence
<ul style="list-style-type: none"> • To date, centrally-planned, deterministic systems have been the core of software development • In such systems, the full model of inputs and outputs is known, and can be understood by tracing the progress of defined variables • These systems efficiently automate repeatable tasks with known boundaries and desired outcomes <p>EXAMPLES</p> <ul style="list-style-type: none"> • Manufacturing a car in a factory using robots • High frequency trading using structured data 	<ul style="list-style-type: none"> • New approaches to computing and machine learning have ushered in an age of probabilistic models that behave like human intuition • Knowing that something is likely is more useful than knowing something is true or false, and mirrors how the human mind is believed to work • The foundations for these approaches were laid decades ago, but new hardware has led to a resurgence in interest and precision <p>EXAMPLES</p> <ul style="list-style-type: none"> • Recognizing cats in billions of photos • Authenticating bank clients with their voice • Underwriting loans using social media data

figure 6

SOURCE: Autonomous © May 2018 The Financial Brand

What about commercial real estate? In 1997, the industry's capital intensiveness was a key factor in shaping our view on the emerging capital market disruption. Today, the key factor driving technological disruption is *data* intensiveness. Combined with repetitive processes and massively improved computing power, the industry is a strong candidate for AI disruption. To date, innovation in the residential real estate sector is leading the way through firms such as Zillow, Redfin, and Rocket Mortgage, etc. That is, AI is already present in transaction processes including home buying, selling, and obtaining a home mortgage. Computers process millions of data points or documents to determine the best options, whether it is a home or a mortgage. This results in a drastic acceleration of the process and incorporates an element of predictive power. For example, the residential real estate brokerage Compass uses ML to predict which houses will be put on the market in the next 12 months. In an interview with CNBC, CTO Joseph Sirosh estimates that "Compass agents have a 94% higher chance of winning a potential listing target with AI than not." The firm's algorithms examine millions of documents in seconds, analyzing market values, debt levels, home renovation activity and other homeowner information to predict the likelihood of when a home will be put on the market. This enables the company to reach out to prospects early, giving them a first-mover advantage. The result is a targeted prospect list with a much higher success rate than generic mass marketing lists. The company benefits from both enhanced revenues as well as cost savings due to process and labor efficiencies. In short, AI is not only making transactional processes more efficient, it is sourcing customers in a highly targeted manner.

While we believe that AI/ML will become impactful and widely adopted technology in the commercial real estate industry over the next 10-15 years, there are several other emerging technologies relevant to the sector. They include robotic automation and 3D printing, blockchain, and Web3 and the metaverse.

b. Robotic Automation and 3D Printing

Robotic automation and 3D printing are well established in the automotive and medical device sectors as well as in manufactured housing. We believe both technologies will have a growing presence in commercial real estate, particularly in construction and facilities and property management. Examples

may include having the ability to print spare HVAC and other critical parts or construction components, while robots will have a growing presence in construction, warehouse operations, and concierge services. We expect that the adoption of these technologies will run in parallel with AI adoption. In 2020, PWC estimated that one-third of all jobs globally could be at risk of (robotic and process) automation over the next decade, especially impacting workers with low educational attainment. In 2018, the World Economic Forum (WEF) ranked employment sectors by the percentage of automatable jobs. Accommodation and food services (73%), and manufacturing, transportation and warehousing, and agriculture (each 60%) are deemed to be the most automatable, while professionals and management (each 35%) and educational services (27%) were categorized as least automatable. The real estate sector falls to the lower end of the range at 40% of all jobs considered automatable. It should be noted that we expect new technology jobs to more than offset automation-related job losses.

c. Blockchain and Tokenization

Like AI, blockchain is a general-purpose technology. Blockchain is a decentralized (shared), immutable ledger made up of cryptographic computer coding. The coding is divided into blocks, each of which has a timestamp and contains information about the previous block, making it impossible to change one block without impacting the whole chain. For this reason, blockchain can serve as a secure shared record of ownership or transfer of ownership. With "tokenization," real estate (or any other asset) is divided into digital ownership units known as tokens. Tokens are stored on a blockchain and tradable through smart contracts, which are digital versions of traditional contracts. The terms of each contract are embedded into the computer code and are automatically verified and enforced. As a result, no middleman is required. The benefits of tokenizing real estate include low barriers to entry and diversification for investors (via low-priced tokens); liquidity for owners; and transactional efficiency and transparency for all parties. While to date, there have been a few verifiable real estate tokenization transactions in the U.S., several have failed. The primary bottleneck is the SEC registration process and increased regulations around Security Token Offerings (STO). While we believe that the tokenization of real estate will occur, it will

not be on a widespread basis anytime soon. As with any new technology, many issues need to be resolved, including standardizing the STO process, determining tax implications, conforming to compliance and anti-money laundering regulations, and educating all parties involved. We expect that there will be a handful of successful transactions over the next several years, but that it will take at least 3-5 years to truly iron out all or most of the issues. As this occurs, the tokenization of real estate will have the potential to see explosive growth.

d. Web3 and the Metaverse

Web3 is the latest iteration of the Internet, built on a decentralized blockchain foundation. In contrast, Web1 was the read-only version of the internet that we knew in the 1990s and early 2000s, while today's Web2 allows us to create our own content and execute transactions using social media and e-commerce platforms like YouTube and Amazon, respectively. Thus, Web2 is primarily monetized and controlled by large corporate centralized platforms like Facebook and Twitter. In contrast, Web3 is a decentralized tokenized Internet, where there are no third-party (i.e., corporate) gatekeepers, and information is accessible and automatically verified. It is owned by the creators and users whose ownership units are tokens. Non-fungible tokens (NFTs) by artists and other content creators are one widely reported example of Web3 content. CNN recently turned historical photographs from its archives into NFTs and posted them for sale on its (Web2) website. Video games that allow users to earn tokens are another example of a Web3 application. Earned tokens have value because of their scarcity, tradability, verifiability, and buying power.

The emerging concept of the metaverse is related to Web3. Blockchain-based Web3 is the critical infrastructure of a metaverse, and multiple metaverses make up a multiverse. A metaverse can be thought of as a 3-dimensional Internet where avatars interact in virtual worlds. But a metaverse is not just about games and socializing with other avatars. Real-world transactions can occur in virtual storefronts, and real-world decisions can be made in virtual meetings. As an example, Walmart is working with FlipKart to test virtual storefronts, NFTs and play-to-earn games. In April 2022, Logitech hosted the first metaverse music awards show, featuring hip hop/R&B celebrity, Lizzo. Perhaps most famously, Snoop Dogg is creating a virtual Snoopverse

on the Sandbox platform, and someone paid \$458,000 to be his virtual neighbor. An early-access pass to help Snoop design his new digs costs about \$3,000. Snoop plans to hold virtual concerts and host play-to-earn games as revenue generators.

How do Web3 and the metaverse relate to commercial real estate? In a post-Covid-19 world, the office landscape is already changing, with hybrid in-office and work-from-home schedules gaining acceptance. In his April 28, 2022, letter to employees, Airbnb CEO Brian Chesky announced that most employees can choose to work from home or the office. But even he is not completely eschewing physical space, saying, "The right solution should combine the best of the digital world and the best of the physical world. It should have the efficiency of Zoom, while providing the meaningful human connection that only happens when people come together." Some, including Bill Gates, argue that a shift to the metaverse is the next natural progression of the workplace. Gates wrote in a 2021 blog that "I predict most virtual meetings will move from 2D camera image grids...to the metaverse, a 3D space with digital avatars." In the extreme, what if all office and retail real estate tenants decided they only want space in the virtual world? It would negatively impact office and retail demand. While we are not worried about the demise of traditional real estate, there is no doubt that technology has impacted how we think about commercial real estate, especially office and retail.

We believe that physical office configurations will continue to evolve, with more collaborative space and a greater emphasis on what will attract workers (e.g., design aesthetics, green space, mental health space, food perks, etc.), but will not disappear. This is supported by CBRE research that finds 63% of organizations surveyed are designing their spaces differently to accommodate increased collaboration and flex space. Additionally, Deloitte's 2022 Real Estate Outlook Survey of 400 CRE executives reports that "over three-quarters of survey respondents say their companies will likely expand partnerships with or invest in PropTech, which could help firms deploy the real-estate-as-a-service (REaaS) delivery model." This means industry executives across functional areas are thinking about the business as a service-based experience. While the hotel sector has always been about service, other property sectors are trending in that direction, with greater tenant amenities

and a holistic view of the tenant experience. Stated differently, real estate providers are focusing on making the physical space better, not worrying about being replaced by virtual worlds. On the flipside, will real estate firms create their own virtual worlds in the multiverse? Perhaps, but only if other sectors (like entertainment) show the way.

Linneman Associates has long held the view that brick retail can co-exist and thrive with online stores. This has proven to be correct for two decades and will continue with virtual stores in the metaverse. Just as companies adopted websites in the 1990s, when having a “www” url address was cutting edge, today’s companies will slowly join the metaverse, even if only to stay relevant. Some tech firms may try to forego physical office space altogether, but we expect that the norm will be a symbiotic relationship between physical and virtual worlds.

V. Assessing the impact of technology on financial performance

We sought to quantify the impact of technology on financial performance, both within and outside of the real estate sector. In its 2019 report on enterprise technology strategies, Accenture determined that tech Leaders (the top 10% of surveyed companies that most embraced technology across their organizations) were growing revenues at 2x the speed of tech Laggards (bottom 25% of the sample). Accenture updated the report in 2021 and found that the Leaders are now growing 5x as fast as the Laggards. Additionally, of the other 65%, 18% are categorized as “Leapfroggers,” defined as those with foundational systems strength and have recently shifted more of their IT budget toward innovation rather than operations. The Leapfroggers are growing revenues 4x as fast as the Laggards.

In a 2012 article published in the MIT Sloan Management Review on the impact of IT investments on profits, the authors report that company investments in information technology increase profits more than advertising or R&D investments. However, IT performance metrics were determined to have more variability. The authors surmise this is due to the novel and creative nature of technology versus advertising. In addition, of the many types of IT projects, the authors found that those which drive sales revenue and enhance profits are more effective than those focused on driving down costs. Specifically, a \$1 increase in IT expenditures

(1998-2003) focused on sales drove an increase in \$12.22 in sales per employee. In contrast, IT projects focused on cost reductions over the same period saw negligible results.

More recently, a 2018 study by Autonomous, a financial services research firm, found that AI has the potential to reduce banking industry costs by 22% or \$1 trillion by 2030. They report that traditional financial institutions could see savings in three major categories: \$490 billion due to efficiencies in the front office with the reduction of retail branches, security, tellers, and other staff; \$350 billion due to middle office efficiencies such as anti-fraud, compliance, customer authentication, and data processing; and \$200 billion in back office savings, such as underwriting and collections. Bain (\$1.1 trillion in savings) and Accenture (\$1.2 trillion by 2035) have published similar estimates for AI-driven savings in the financial services sector. It should be noted that the actual savings will be a function of both corporate and customer adoption.

In one case study, a global financial institution implemented AI into its know-your-customer / anti-money laundering (KYC/AML) compliance processes. With a combination of text mining, image recognition, and machine learning models, the institution estimates that it achieved a 25% improvement in operational efficiency in monitoring transactions.

Technology skills in the corporate workforce also have been shown to have a positive impact on firm value. In his February 2022 research (Engineering Value: The Returns to Technological Talent and Investment in Artificial Intelligence), Asst. Professor Daniel Rock of Wharton examined “the extent to which firms earn returns to their employees’ AI skill investments and what might drive this value capture.” Rock examined 180 million employment position records and 52 million skill records from LinkedIn “to measure market value of exposure to newly available deep learning talent from the open source launch of Google’s Tensor Flow (a deep learning software package).” He found that “AI skills are strongly correlated with market value and that the TensorFlow launch is associated with an approximate market value increase of \$11 million per 1% increase in AI skills exposure for firms with assets complementary to AI.” Thus, the use of open-source software in combination with a workforce with scarce skillsets can add a significant premium to firm value. Rock writes that “investment in data, assets, machine

learning and artificial intelligence, and technological human capital are critical margins for firm competition and social change.”

Despite these results, Rock’s research also highlights a paradox associated with general purpose technologies (GPT), including AI. He finds that “systems using artificial intelligence... or (which leverage) rapid advances in other technologies drive soaring stock prices, yet measured productivity has declined by half over the last decade.” Rock attributes this paradox primarily to a timing lag. He finds that productivity tends to follow a J-curve, with potential slowdowns during the implementation process but rises sharply on a lagged basis as complementary assets are also put in place. This is especially the case with new software but is also true for hardware.

In the 1990s, real estate operators shifted from spreadsheets to Property Management Systems (PMS) to better track vacancies, rent collections, escalations, and general bookkeeping. PMS track and organize data, allowing access to multiple parties (e.g., property, asset, and portfolio managers and accountants). In the 2000s, Revenue Management Systems (RMS) were among the earliest AI applications in the real estate sector, with origins from the airline industry. According to the National Apartment Association, RMS refer to “software-based programs that set apartment rents daily based on current supply and forward-looking statistics such as lease expiration timing.” RMS use a data-driven approach to determine and maximize rents based on customized inputs (e.g., move-in dates, unit size, lease length, and other amenities, etc.) and current market conditions (e.g., available inventory, leasing velocity, vacancy, etc.). While RMS-determined rents can be overridden, they reduce the guesswork and subjectivity.

Linneman Associates informally queried several of the largest U.S. apartment REITS to determine their usage of AI technology, finding that that all implemented some form of RMS around 2005-2007 and continue to rely on RMS. While we examined publicly available financial statements of these firms before and after the implementation of RMS, drawing any conclusions about the impact on financial performance is difficult due to the Financial Crisis in 2008. And while none of the respondents were willing to quantify the direct impact on performance, one RMS software vendor provides some benchmarks. Specifically, RealPage

claims that its RMS clients can achieve a 400% ROI and outperform markets by 2-5%. RealPage also reports that its RMS clients have seen an average of 150-200 bps of additional yield.

Since the early days of RMS, our informal survey respondents continue to be at the forefront of the sector’s “digitization,” with AI platforms focused on a range of processes, including client-facing interactions such as tenant leasing or the move-in experience. One respondent expects to increase margins by 200 bps once its self-service digitized leasing experience is fully implemented. Additionally, one respondent reported that its AI leasing agent can answer 85% of all questions from prospective tenants. The respondents also reported that property maintenance is an area where AI is playing an increasing role. These applications streamline the maintenance process, increase communication among parties and more importantly, detect problems early to minimize unnecessary capital expenditures and associated labor costs. Respondents also reported that they are shifting their portfolios toward “smart buildings,” with smart lights, locks, thermostats, utility control, parking, and package lockers to name a few. The energy-saving technologies particularly rely on connectivity, data capture, and AI algorithms to predict and control optimal usage.

In 2021, the WiredScore Smart Council, a collaboration of 90 global companies, developed a certification framework for smart buildings, called SmartScore. The Council defines a smart building as one that “delivers outstanding outcomes for all users, through digital technology... The four outcomes (include): an inspirational experience, a sustainable building, a cost-efficient building, and one that is future-proof by design.” According to the Council, the technological foundations of a smart building include digital connectivity, integration of building systems (e.g., air quality, access control, room booking, utility billing, preventive maintenance), a landlord integration network (e.g., asset and portfolio level intelligence), governance, cybersecurity, and data sharing

Similarly, LEED Certification refers to buildings that have been designed, built, and maintained using green building and energy efficiency best practices. While the LEED certification is not fundamentally about technology, technology drives many of its goals, including reduced energy and water usage, lower operating costs, less construction waste, more durable

Smart Building Case Study: enertiv*			
Building Operation	Cents per Square Foot		Description
	Cost to Deploy	Savings	
R&M - Workflow Mgmt	1-1.25	1.5-2	Data repository, inventory, maintenance management
R&M - Equipment Monitoring	4-6	7-9	Real-time monitoring with predictive analytics
Capital Expenditures	4-6	5-7	Preventive and predictive maintenance, distributed run-time hours
Utilities	2-3	7-9	Use optimization using data analytics
Insurance	2-3	3-4	Early detection of problems using Internet of Things
Technology	1-2	5-6	Software and hardware efficiencies
Whole system	10-15	30-45	

Source: enertiv
 *Linneman Associates has not independently verified this data, nor do we endorse or have any affiliation with the company
 Totals do not tie due to overlapping costs

figure 7

buildings, improved indoor air quality, and increased employee productivity.

a. Vendor Case Study 1

One PropTech company, enertiv, leverages AI to provide smart building technology. They estimate that implementing their integrated operations and maintenance solutions would cost a landlord an estimated \$0.10-0.15 per square foot while generating savings of \$0.30-0.45 per square foot. Note that Linneman Associates has neither independently verified any vendor estimates quoted herein, nor do we endorse or have any affiliation with the companies. We include them in this report as benchmarks for the potential impact of technology on profitability. The fundamental value in a company like enertiv is not only the collection and organization of vast amounts of real-time data but also analytics that can identify and address process inefficiencies. For example, the system can use AI to optimize utility and equipment usage by predicting demand given certain factors such as outside temperature, the time of day, etc. It theoretically can make workflows and communications between all parties (including the equipment) more efficient.

b. Vendor Case Study 2

Verdant, a provider of smart energy management solutions estimates that the payback period for its smart thermostats is 12-18 months, with significant savings on utility bills and an increase in property value. In one case study reported by Verdant, smart thermostats were installed at the Hyatt House in downtown San Jose, an asset of BRE Hotels & Resorts (a subsidiary of The Blackstone Group). They report that the HVAC property runtime was reduced by 48%, resulting in nearly \$9,000 in savings per month and an increase in asset value of almost \$2.8 million. In this case, the initial investment was recouped in 10 months. In another case study reported by Verdant, Delmonte Hotel Management saw a 51% reduction in HVAC runtime, about \$2,000 in monthly savings, and an 8-month average payback period over eight hotels.

VI. Value Accretion Sensitivity Analysis

Property/asset management AI value accretion is illustrated in figure 9. The hypothetical analysis assumes a company generates \$100 million in revenue and has a 65% NOI margin, or \$35 million in operating costs and \$65 million in NOI. Applying a 20x valuation multiple to NOI results in an equity value of \$1.3 billion

Smart Building Case Study: Verdant Smart Thermostats*				
Verdant Smart Thermostats	Avg HVAC Runtime Reduction	Avg Monthly Savings	Payback Pd	Added Resale Value
The Courtyard by Marriott Shelton	36%	\$2,585	1.2 yrs	\$403,260
DelMonte Hotel Group	51%	\$2,011	8 mos	n/a
Hyatt House San Jose, CA	48%	\$8,921	10 mos	\$2.78 million

Source: Verdant
 *Linneman Associates has not independently verified this data, nor do we endorse or have any affiliation with the company

figure 8

Base Case Hypothetical Value-Add (\$ in millions)		AI Margin Expansion Sensitivity Value Increase	
Revenue	\$100		
Costs	\$35		
NOI	\$65		
NOI Margin	65%		
Valuation Multiple	20x		
Equity Value	\$1,300		
		AI Multiple Increase	
NOI Margin	65%	1.0%	1.5%
Exp. AI Margin Increase	3%	1.5%	2.3%
NOI Margin w/ AI	68%	2.0%	3.1%
Equity Value w/ AI	\$1,360	2.5%	3.8%
		3.0%	4.6%
		3.5%	5.4%
		4.0%	6.2%
		4.5%	6.9%
		5.0%	7.7%
AI Equity Value Increase	4.6%		

figure 9

(i.e., \$65 million x 20). Our base case assumes a 3% NOI margin expansion due to the introduction of AI technologies into existing operational processes. At a 20x multiple, this margin increase would result in a \$60 million value increase (4.6%). If the AI-driven margin expansion is just 1%, equity value is expected to rise by 1.5%, while a 5% margin expansion results in a 7.7% value accretion.

VII. How traditional real estate companies can be positioned to leverage new technologies

Although we believe that firms that incorporate AI/ML technology into their processes will have a long-term competitive advantage over non-adopters, it appears that most real estate firms are unprepared. The Deloitte outlook report mentioned above indicates that “eight in 10 (survey) respondents do not have a fully modernized core system that could easily incorporate emerging technologies.” It is also interesting that “only one-quarter of respondents say their companies are substantially increasing technology investments to bolster portfolio and asset management capabilities.” In contrast, many are planning to spend on retrofitting space to be more sustainable with dynamic reconfigurable designs.

Wharton professor Kartik Hosanagar interviewed Chris Child, Director of Product Management at Snowflake, a cloud-based data storage and analytics firm. Child provided his thoughts on what type of projects are good candidates for AI and how companies can get the most value from pursuing predictive data analytics.

Child states that “anyone who’s going to undertake this journey, (must) first think carefully about the types of questions that you wish you could ask but you can’t because you don’t have all

of the data. Also consider the types of questions that you are answering today, but which take considerable time. An example of that is anything where you ask someone on your team to spend two weeks collecting data and running analysis in Excel. Those are decent candidates for the types of problems that you could solve in minutes if you have the correct data infrastructure in place. And finally, think about what data you need to answer those questions. It’s generally not that useful to collect every single piece of data. Instead, figure out what data are important to your business and are going to help you answer those critical business questions to enable you to run your business better and more efficiently.”

As a first step, Hosanagar suggests a 2-3-hour meeting of C-suite and senior executives to identify several dozen activities across functions that could be potentially automated. Of those activities, choose 5-6 short-term (around six months) activities and 1-2 longer term (3 years) projects based on potential ROI to make up your AI portfolio. The shorter-term projects can produce potential “quick wins” that often pertain to processes or interactions, where off-the-shelf software such as smart building technology, chatbots, digital assistants (to coordinate internal meetings), or social media monitoring can be implemented relatively easily with immediate impact. Hosanagar believes the quick-win projects serve multiple purposes, including introducing AI into the corporate culture and winning over skeptics in the organization. In addition, quick-win projects build employee skillsets, such as gathering, processing, and labeling data, all of which are needed for AI algorithms to work effectively (i.e., make accurate predictions). In addition, getting an AI project up and running allows firms to efficiently capture new data, so the system can theoretically make better predictions over time. Of course, risks exist, such as if there are biases in the historical data, which will impact the quality of predictions. Implementing AI can also have rollout issues, but this can be hedged by first focusing on internal or lower-risk client-facing interactions.

Hosanagar says longer-term projects should be more impactful from a strategic or competitive advantage perspective and focus on end-to-end processes rather than one point in the process. For example, think about the life cycle of an acquisition

from reviewing offering memoranda to closing the transaction. How much time and resources could be saved if the first pass of culling through the dozens or hundreds of deals that come across an acquisition VP's desk could be automated? Pose the same question for due diligence, securing financing, coordinating JV documents, closing the deal, and everything in between. This approach to automation in the decision-making process can be impactful in terms of reducing costs, improving workflow, and perhaps ironically establishing positive human relationships with all involved parties. Wharton professor Lynn Wu's research shows that using AI to focus on process improvement, rather than new products is most effective. She finds "that data analytics capabilities are more likely to be present and are more valuable in firms that are oriented around process improvement and that create new technologies by combining a diverse set of existing technologies than they are in firms that are focused on generating entirely new technologies."

Once the AI portfolio roadmap is determined, executing the plan requires an infrastructure of hardware (much of which can be rented), software, organized data, machine learning models, tech-knowledgeable businesspeople, and data scientists. In addition, as alluded to earlier, creating a culture (at all levels) that is committed to innovation through AI and other technologies will increase your chances of successful implementation. Companies also need to think about whether a centralized or decentralized AI structure is best. Are your AI professionals in one centralized department or are they distributed throughout various departments? While there is no single answer, another study lead by Wu finds that "firms with a decentralized innovation structure have a greater demand for analytics skills and receive greater productivity benefits from their analytics capabilities." Wu and her colleagues further "find that analytics help decentralized structures to create new combinations and reuse of existing technologies, consistent with the ability of analytics to link knowledge across diverse domains and to integrate external knowledge into the firm. Furthermore, the effect primarily comes from the analytics capabilities of the non-inventor employees as opposed to inventors themselves." In other words, Wu finds that when technology and business professionals are integrated, firms reap greater productivity benefits.

VIII. Outlook

Of the PropTech discussed in this paper, Linneman Associates is most bullish on applications driven by AI and ML. While AI comes with risks, upfront costs and lagging returns, we believe that AI-driven technologies will proliferate and experience widespread adoption in the commercial real estate sector over the next 10-15 years. The barriers to entry have been lowered significantly in recent years, as many tech providers offer managed analytics platforms through hosted or cloud computing, which lowers up-front hardware costs. Additionally, open-source and off-the-shelf algorithms, a growing army of tech and tech-savvy workers, and numerous data options also increase accessibility. Ultimately, adoption is driven by: disruption (e.g., new technologies and computing power); a favorable regulatory environment; the desire for improved accuracy, efficiency, and lower operating costs; and a fear of missing out (FOMO).

AI technology will address industry process improvements but will also make buildings "smarter" (and greener) through the combination of retrofitting existing properties and building new properties to higher technological standards. Because only a small percentage of buildings across all property sectors are fully utilizing the available technology, Mordor Intelligence expects the smart building industry to grow by a compounded annual rate of 11.3% globally, through 2026.

We expect AI to have the greatest near-term impact on margins, with the other technologies discussed in this report following a slower CRE adoption path. While the impact of AI/ML on performance metrics remains difficult to ascertain, we expect a potential annual profit margin improvement of 150-350 bps on a stabilized basis. At a 20x valuation multiple, this potential represents a 2-5% value increase. Quantifiable returns on AI investment will take time, and companies should have a medium to long-term outlook when measuring ROI. Hosanagar believes that "early failures can lead to irrational retreats." He cites examples of general-purpose technologies such as the internet in the 1990s, cloud computing in the 2000s, and most recently mobile computing. These technologies ultimately took off despite early challenges (e.g., the dotcom bust, security and compliance concerns, etc.), but many non-tech companies abandoned their adoption too early and are struggling to catch up.

Our outlook on AI/ML is followed closely by robotic automation and 3D printing, both of which have proven track records in other industries. Blockchain and tokenization of commercial real estate will eventually gain traction but not likely this decade. However, we can envision, for example, multifamily or hospitality firms offering tokens to tenants/visitors as marketing incentives. For now, Web3 is still being defined, while the metaverse is a novelty. To be sure, we expect corporate metaverses to occur, but they will not replace physical real estate in any appreciable way.

The democratization of AI and other technologies will spread to less well capitalized firms as upfront costs decline. In the short-term (1-3 years), firms will focus on putting their data infrastructure in place, from securing

the necessary hardware and software, to scrubbing and labeling internal data (or acquiring data), to hiring the right team. Additionally, firms can immediately start to build their technology culture by implementing off-the-shelf or easily customizable AI algorithms. In the medium term (3-7 years), the focus will be on maximizing the efficiency of existing operational and transactional processes more widely across the organization. In the longer term (7-15 years), firms will be able to harness the data they will have collected over the years and potentially pivot toward innovative revenue opportunities. The fundamental business of real estate will be the same, but how we get things done on a day-to-day basis will look different.

About Linneman Associates, LLC

Founded in 1979, Linneman Associates, LLC is a premier consulting and research firm, specializing in commercial real estate investment strategy. Our clients represent a wide range of industries and countries but primarily include institutional investors, REITs, developers, and opportunistic private equity firms seeking to implement thoughtful and disciplined commercial real estate investment strategies. Our clients value our market insights and analyses as well as our ability to assess and simplify the ever-changing macroeconomic, political, and capital market environments.

For further information on Linneman Associates, *The Linneman Letter*, and Dr. Linneman's real estate finance textbook and webinars, please visit www.linnemanassociates.com.

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FCP® is a privately held real estate investment company that has invested in or financed more than \$9.3 billion in assets since its founding in 1999. FCP invests directly and with operating partners in commercial and residential assets. The firm makes equity and mezzanine investments in income-producing and development properties. Based in Chevy Chase, MD, FCP invests both its commingled, discretionary funds and separate accounts targeted at major real estate markets in the United States. For further information on FCP, please visit www.fcfdc.com.

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