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Research Article

The impact of digitalization on real estate agencies: the case of Peru

Danila Raquel Neira Sacaski[a], Paola Graciano[b], Karina Cerna Risco[c], José Paul Campos Llerena[d], Aline Cafruni Gularte[e], Fernando Henrique Lermen[d,f]*

[a]Universidad Tecnológica del Perú, Facultad de Ingeniería de Sistemas y Electrónica, Lima, Perú
[b]Universidade Estadual do Paraná, Colegiado de Administração, Paranaguá, PR, Brasil
[c]Universidad Tecnológica del Perú, Programa de Posgrado en Propiedad Inmueble, Lima, Perú
[d]Universidad Tecnológica del Perú, Departamento de Ingeniería Industrial, Lima, Perú
[e]Universidade Federal do Rio Grande do Sul, Programa de Pós-Graduação em Engenharia de Produção, Porto Alegre, RS, Brasil
[f]Universidade Estadual do Paraná, Colegiado de Engenharia de Produção, Paranaguá, PR, Brasil
*fernando-lermen@hotmail.com

Abstract

Paper aims: This study investigates the influence of digital transformation, technology use, and business management on the digital maturity of real estate agencies in Peru. We strive to provide an empirical model to assess digitalization's role in enhancing operational efficiency within the real estate sector.

Originality: This is the first study to systematically quantify digital maturity levels in Peruvian real estate agencies through structural equation modeling. Our research bridges a critical gap by linking digitalization practices with tangible business outcomes in emerging markets.

Research method: The study employed a quantitative methodology, gathering data from 116 real estate agents and analyzing it using partial least squares structural equation modeling (PLS-SEM). It also utilizes robust statistical techniques, including confirmatory factor analysis and model fit indices, to validate constructs and ensure reliability.

Main findings: Digital transformation significantly enhances business management practices and the digital maturity level, while digital networking showed no direct impact. Technology use emerges as a pivotal driver of digital transformation, emphasizing its foundational role in real estate innovation.

Implications for theory and practice: The findings highlight a novel framework for real estate professionals to benchmark digital maturity and optimize digital investments. By outlining key enablers of digital transformation, this study provides actionable insights for policymakers aiming to foster innovation in the real estate sector.

Keywords

Digitalization. Technology use. Digital transformation. Real estate.

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The research was approved by the Research Ethics Committee of the Universidad Tecnológica del Perú. All participants provided informed consent before participating in the study.

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1. Introduction

Industry 4.0 has promoted a tech-shift in how many businesses conduct their operations. In real estate, one of the most disruptive changes was the digitalization of many relationships that used to be person-to-person. This new era of property management has even been called "Real Estate 4.0", with resources such as IoT, AI, cloud computing, and automation redesigning real estate operations from bottom to top (Starr et al., 2021).

Digitalization is a process that looks to generate value by combining data collection and proper analysis to create innovation in multiple markets (Gradillas & Thomas, 2025). In the real estate market, digitalization can be seen in property search and listing platforms (Folasade & Ogungbe, 2020), more flexible transactions (Saull et al., 2020), business intelligence and market insights (Oluwunmi et al., 2019). Other innovative features include visualization with virtual and augmented reality (May et al., 2017), besides property management software (Bassett & Pisano, 2022), blockchain, smart contracts (Saari et al., 2022), and document processing through machine learning (Huang et al., 2025). Digitalization is driving a significant transformation in the real estate sector. Technological tools such as Artificial Intelligence (AI), Machine Learning (ML), Virtual Reality (VR), and Augmented Reality (AR) have been incorporated (Ciudadmas, 2024).

Companies with a digital orientation can also test their business model using open innovation in partnership with users since clients and the value created by and for them are central elements of the innovation process (Andreasson & Mattsson, 2019; Sundbo et al., 2022). Digitalization also leverages decision-making and customer targeting, as data extracted from websites and social media interactions are key indicators in business strategy (Bilgihan et al., 2016). Urban expansion and the increased demand for accessible and personalized projects have prompted companies in the sector to integrate innovative tools that optimize their processes and redefine the customer experience (Olortegui, 2024).

Several examples worldwide advocate for digitalization as a key approach to profitability. REA Group in Australia has become a leading player in real estate through its platform realestate.com.au. By employing artificial intelligence to enhance property recommendations, the company has significantly improved its buying and selling process, becoming one of the most successful tech companies in the country, with arms stretched to India as well (Haidar, 2025). US rooted company CoreLogic has become a leading player in property data and analytics. Their platform provides services such as property valuation, risk assessment, and market trend analysis, employing big data and machine learning to improve decision-making for real estate professionals and investors (Tennant, 2021). Prologis, another American company, has focused on using technology to optimize warehouse operations in real estate logistics, seeking to improve supply-chain efficiency (Prologis, 2025).

At the same time, making good use of the possibilities offered by digitalization involves major challenges related to online data security (May et al., 2023), sales, maintenance, accounting, tenant management (Talamo & Bonanomi, 2020), personnel skills and proper training (Ullah et al., 2021), efficiency in remote work (Di Liddo et al., 2023), and general accessibility to all types of clients (Moro et al., 2023). A key component of digitalization and many digital transformation projects is hyper connectedness, that is the digital technology components integrated into a process to digitally connect things, processes, machine intelligence, and human resources (appliers/final users) (Chatterjee & Sarker, 2024). Hence, traditional companies must innovate in their business models (Bouwman et al., 2019) to transform and reinvent themselves to adapt to this new era.

Even though previous research has addressed the high impact of digitalization in real estate (Kytömäki, 2020; Lavrov et al., 2020; Veuger, 2018), especially during the COVID-19 pandemic (Moro et al., 2023), no publication has offered an objective instrument to verify how real estate agents evaluate their digital performance due to the growing necessity of digital literacy among real estate professionals. Peru was selected as the object of study due to its growth in terms of digitalization as the presidency of the council of ministers recently enacted the regulation of the national system of digital transformation with the supreme decree No. 157-2021-PCM (Peru, 2021). This represented an important attempt to strengthen digital governance, ensuring the development of a digital economy and incentive for innovation.

Given this scenario, this study examines the impact of digitalization (i.e., digital transformation and technology use) and stakeholder management (i.e., digital networking and business management) in the digital maturity level of 116 real estate companies in Peru, according to their agents. To pursue this objective, the paper is organized into (a) a theoretical background along with derived research hypotheses, (b) a method applied to attain the research purposes, (c) results, and (d) a discussion of the findings.

2. Theoretical background and research hypotheses

This section presents the variables that relate the digital maturity level constructs with digitalization (digital transformation and technology use) and stakeholder management (digital networking and business management).

Such variables were gathered through a literature search of elements influencing companies' digital maturity levels in the real estate sector.

First, as digital technologies facilitate overall changes in business models, companies can adopt multiple business models to serve different market segments (Vărzaru et al., 2021), as well as create and modify new processes to implement innovative behaviors or create agility and continuous adaptation to ensure the future of the business (Ebersberger & Kuckertz, 2021). Due to these features, companies have intensified remote work and the use of devices, digital tools, platforms, and applications, reflecting profound changes in processes and digital business models, demonstrating that employees are expected to become increasingly integrated into digital environments (Mehedintu & Soava, 2022).

The improvement of digital transformation in a company depends on its responsiveness, scalability, and digital technology, which allows it to commercialize products with minimal costs in the shortest possible time, along with expanding the product's market, i.e., analyzing the needs of the population and enlarging the customer base (Aslakhanova et al., 2021). Recent research reinforces that digital transformation is accelerated when technology use is strategically aligned with operational and customer-facing processes. Emerging studies in PropTech indicate that technology integration is now central to real estate innovation, especially in dynamic markets (Gudimenko et al., 2024; Wang et al., 2024). Thus, we hypothesize:

H1: Technology use has a positive influence on digital transformation

Another critical factor is digital networking, as it significantly influences business management. Social networks in the virtual world are represented by websites and applications operating at various levels, allowing information exchange among consumers (Raza et al., 2023). There is an increase in the influence of social networks on consumer participation in the purchasing process. Increased participation with social networks can be measured by the time, membership of different social networking sites, and the general use pattern (Martínez-Domínguez & Mora-Rivera, 2020). Recently, the restrictions introduced by COVID-19 forced companies to adopt a technology-intensive business model that could quickly adapt to the disruptive environment generated by the pandemic (Ali et al., 2024). This episode increased the pressure on companies to apply digital innovation in an accelerated manner to update and transform their business models towards greater competitiveness in the marketplace (Kudyba, 2020). Social media offers ways to communicate with customers and potential buyers more effectively. Businesses looking to survive should see technology use as a means to grow exponentially. Therefore, we propose:

H2: The use of digital networking has a positive influence on business management.

The changes brought about by digital transformation impact the way we think, evaluate, and manage businesses (Dias et al., 2022) and revitalize commercial processes and customer relations (Philip & Gavrilova Aguilar, 2022). Likewise, organizations must improve their digital business capabilities through digital customer engagement, digital customer experience management, digital innovation, digital leadership, and others. These capabilities require competencies in digital transformation and digital business management (Busulwa et al., 2022). The latest literature emphasizes how digital transformation reshapes business management practices, enabling agile leadership, real-time decision-making, and process optimization (Bhuiyan et al., 2024; Ferreira et al., 2024). Therefore, we propose the following hypothesis:

H3: Digital transformation positively influences business management.

As this paper aims to define maturity levels in real estate companies to examine the impact of new digital technology, it is essential to understand its broader impact in real-life environments (Martin et al., 2019). Digital maturity measures how a company adapts and uses technology (Tilahun et al., 2023) as a transformative and disruptive tool, as well as the level of digital literacy, resources, and capacity to guarantee competitive advantages and innovation. As companies evolve digitally, maturity models are increasingly used to assess digital readiness and effectiveness. Recent frameworks highlight how both technological and managerial dimensions contribute to digital maturity growth (Tubis, 2023; Jäkel et al., 2024). Thus, we propose the following hypothesis:

H4: Digital transformation positively influences the digital maturity level.

The current ecosystem of organizations has generated a high degree of competition among business players, forcing them to develop a series of business management strategies to improve competitiveness and sustainability (Hurtado-Palomino et al., 2022). Technological maturity is a critical component of digital maturity. However, the fundamental vectors are organizational structure and cultural vision that should involve the entire organization (Álvarez Marcos et al., 2019), leading to the following hypothesis:

H5: Business management positively influences the digital maturity level.

We then propose a conceptual model (Figure 1) that analyzes the impact of these three input variables (DN, DT, and BM) on the output variable (the DML).

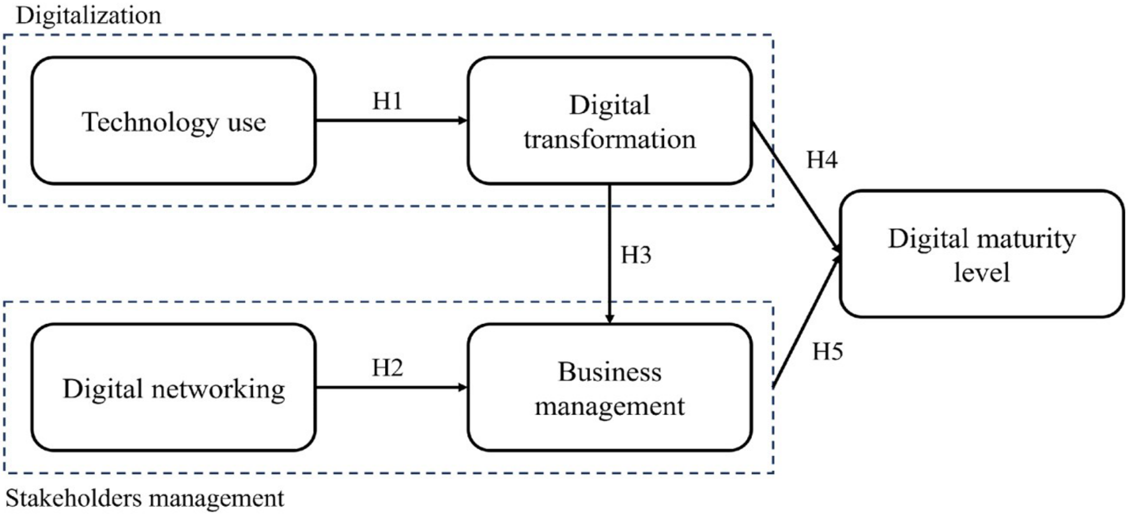

Figure 1. Description of the proposed conceptual model.

3. Method

3.1. Research scope

This study was performed with real estate professionals in Peru. Based in Lima, the population and sample were real estate agents registered with the Ministry of Housing and Construction and Sanitation according to Law No. 29080 (Peru, 2007).

3.2. Sample selection and data collection

The study included 500 real estate agents officially registered with the Ministry of Housing, Construction, and Sanitation of Lima, according to data available on its platform (Peru, 2024). They were contacted via email, attaching a cover letter with the objectives and scope of the study. Data collection took place between October 5, 2022, and March 27, 2023. The questionnaire used for data collection, which included items related to technology use, digital transformation, business management, and digital maturity, is provided in Appendix A to ensure transparency and long-term accessibility. From the initial population, a sample of 116 valid responses was obtained, which were considered for the analysis.

3.3. Measures and scales

Our questionnaire was based on articles that addressed the five constructs of interest, i.e., recent studies by Shankar et al. (2020), Kristoffersen et al. (2021), and Rezaei et al. (2022). These are Digital Networking (DN), Digital Transformation (DT), Technology Use (TU), and Business Management (BM). As for the Digital Maturity Level (DML), construct items were based on studies conducted by Devi et al. (2022) and Chanias & Hess (2016). All variables in the questionnaire are presented in Table 1.

A closed-ended questionnaire format was selected as the instrument for this study to provide a more accurate analysis. The research tool was structured into four sections as presented in Appendix A. This choice is justified because web-based surveys are more convenient, less expensive, and give respondents more control than postal or loco-applied surveys (Wallace & Sheetz, 2014). The instrument was applied between December 2022 and

Table 1. Variables that influence digitalization and stakeholder management in the real estate sector.

Cod.	Items	References
DN1	I use at least one social network for work, such as WhatsApp, Facebook, Twitter, LinkedIn, Instagram, etc.	Raza et al. (2023)
DN2	I often accept communications and messages from real estate agents.	
DN3	Social networks provide accurate and helpful information about the real estate sector.	Yadav & Rahman (2017), Shankar et al. (2020)
DN4	I use social networks to meet real estate clients.	
DN5	The information provided by e-commerce in social networks is comprehensive.	
DN6	I sometimes read/watch materials on social sites that my friends do not send (sponsored).	
DN7	I use social networks to find solutions to my issues related to real estate.	Miranda et al. (2023)
DN8	I consult my social networking groups for advice before making a big decision about renting or buying a mobile phone.	
DN9	I accept the advice I receive on social media because it comes from real users.	Sharma et al. (2022)
DN10	Social media always informs me about the latest trends and technology in real estate.	
DT1	I adapt quickly to changes in the market.	Suryanto et al. (2023)
DT2	I create partnerships with other external players to become more competitive.	Junni et al. (2015), Weber & Tarba (2014)
DT3	I encourage fellow real estate agents to use technology to conduct real estate transactions.	Zuehlke (2010)
DT4	I encourage the use of digital technologies to generate new ideas.	Kwan & Chiu (2015)
DT5	I use technology solutions for forecasting in order to prepare for the future.	(Rodríguez-Espíndola et al., 2022)
DT6	I employ technology solutions to automate relevant data-driven processes for decision-making.	
DT7	I often transfer business information with our real estate clients through information technology (e.g., e-mail).	Li et al. (2017)
DT8	I have a technological system for managing information, people, and materials (e.g., CRM, ERP).	
DT9	I seek to develop and promote a culture of innovation and technology within the real estate sector.	Ślusarczyk (2018)
DT10	I have a strategy based on digitalization to achieve my objectives.	Khatib & Alshawabkeh (2022)
TU1	I use cloud-based services for data processing and analysis.	Kristoffersen et al. (2021), Gupta & George (2016), Mikalef et al. (2020), Wamba et al. (2017)
TU2	I use the Internet of Things	
TU3	I believe using technology and innovation in management processes helps me in my relationship with competitors.	Parthasarathy et al. (2021)
TU4	I employ an information system that is considered satisfactory by my co-workers.	
TU5	I can access high-quality data on real estate services, such as location and availability.	Gupta and George (2016), Kristoffersen et al. (2021), Mikalef et al. (2020), Wamba et al. (2017)
TU6	I have access to data throughout the life cycle of my real estate services.	
TU7	I integrate information from multiple sources into a data warehouse for easy access by real estate agents and clients.	
TU8	As a real estate agent, I integrate external and internal data to facilitate decision-making.	
TU9	I share information among the group of real estate agents.	Ashley & Tuten (2015)
TU10	Clients using real estate brokerage services follow real estate agent's websites, news, or other virtual platforms.	(Kaplan & Haenlein, 2011)
BM1	The real estate business model allows me to make informed decisions.	Tilahun et al. (2023)
BM2	I transparently show transactions so real estate clients can see information flows and usage.	
BM3	The real estate business model offers new combinations of services and information (e.g., scenario creation)	
BM4	I look for creative ways to meet the needs of my real estate clients.	Lubatkin et al. (2016)
BM5	I actively target new groups of real estate clients.	
BM6	I continually improve the loyalty of my service to clients and real estate agents.	
BM7	I continuously analyze and interpret the changing demands of the real estate market.	
BM8	I seek to hear the voice of the customer to improve the real estate brokerage business.	
BM9	I want to implement new services to acquire new customers of different profiles.	
BM10	The real estate company promotes the application of technology and innovation in all processes.	
DML1	I connect my own information and communication technology systems with systems operated by other business or administrative stakeholders.	Tsakalidis et al. (2020), Jović et al. (2022), Tijan et al. (2021)
DML2	I use file standards for electronic data exchange.	
DML3	I have funds available for the implementation of new digital technologies.	Gausdal et al. (2018), Acciaro & Sys (2020), Jović et al. (2022)
DML4	I systematically manage the risks of implementing new digital technologies.	Jović et al. (2022), Agrawal et al. (2020)

Table 1. Continued...

Cod.	Items	References
DML5	Existing technology allows me to upgrade to modern digital technologies.	Vidmar (2019)
DML6	As a real estate agent, I am motivated when it comes to the organization's digital transformation (e.g., encouraging the adoption of digital technologies).	Jović et al. (2022), Fuchs & Hess (2018)
DML7	I invest in employee knowledge in the context of digitalization and digital transformation.	Jović et al. (2022), Genzorova et al. (2019), Legner et al. (2017)
DML8	I carry out continuous training in digitalization and digital transformation.	Tijan et al. (2021)
DML9	I have the opportunity to participate in developing or adapting digital technologies.	Tijan et al. (2021)
DML10	I have introduced new ways of collecting my professional fees for services rendered in the context of digitalization and digital transformation.	Jeansson & Bredmar (2020)

March 2023. The questionnaire used a 5-point Likert scale (Strongly Agree, Agree, Somewhat Agree, Disagree, Strongly Disagree) to evaluate all constructs presented in Tables 2 to 4.

Table 2. Socio-demographic data of the sample.

Sex	N	Age	n
Female	44	Until 49 years-old	56
Male	72	More than 50 years-old	60
Income	N	**Regions**	n
Up to 2000 soles (US$547,22)*	29	Coastal	22
Between 2001 and 4000 soles (US$547,56 to US$1.094,57)	38	Metropolitan Lima	84
Between 4001 and 6000 soles (US$1.094,84 to US$1.641,86)	28	Mountains	10
More than 6001 soles (> US$1.642,12)	21		

*According to Trading Economics (2025) in May 2025.

Table 3. Heterotrait-monotrait ratio of correlations (HTMT).

Variables	1	2	3	4	5
Business management	**0.879**				
Digital networking	0.586	**0.790**			
Digital transformation	0.710	0.754	**0.862**		
Technology use	0.681	0.680	0.859	**0.842**	
Digital Maturity Level	0.735	0.587	0.729	0.771	**0.867**
External analysis					
Composite reliability (rho_c)	0.971	0.943	0.967	0.960	0.968
Average variance extracted (AVE)	0.773	0.624	0.744	0.709	0.752

Note: As the square root of the variance extracted from the AVE is greater than the correlations between the latent variables (> 0.5), there is discriminant validity; as for the rho_c, the acceptable value should be > 0.5. Moreover, all correlations are significant at 1%.

Table 4. Model measurement, convergence validity, and confidence.

Factor	AVE	Cronbach's alpha	Rho_a	CR
Business management	0.771	0.966	0.968	0.971
Digital networking	0.618	0.931	0.941	0.941
Digital transformation	0.741	0.960	0.963	0.966
Technology use	0.707	0.953	0.956	0.960
Digital maturity level (DML)	0.750	0.962	0.966	0.968

3.4. Data analysis

Data analysis was carried out in two phases. In the first phase, the quality of the instrument's application was validated using Cronbach's alpha (Hair et al., 2019), analyzing the reliability of each construct. The coefficients generated for each dimension should be greater than or equal to 0.7, including the total Alpha (Landis & Koch, 1977). Cronbach's alpha was verified for each construct. Indexes were between 0.931 and 0.966, which shows that constructs in the scale reached satisfactory reliability (CR > 0.9).

Next, a confirmatory factor analysis was conducted to obtain validation indices to submit the data to structural equation modeling (Hair et al., 2019). This analysis approach is useful when researchers intend to examine the causal relationships between variables. Given the nature of the constructs in this study, the research scenario provides an alternative that might help managers and decision-makers employ digital technology to leverage business opportunities by increasing digital maturity in real estate companies.

In the second phase, structural equation modeling was carried out. The choice of this technique was motivated by the assumptions related to sample size and multicollinearity. Given that the first phase analysis results revealed the presence of multicollinearity (highly correlated variables) in the data, which makes using the traditional structural equation technique unfeasible, PLS-SEM was chosen as an alternative. As Wold et al. (2001) stated, PLS was specially created to deal with multicollinear data and small sample sizes.

3.4.1. Confirmatory factorial analysis

One of the methods for analyzing the Likert scale is factor analysis. This evaluation method "assumes" that the observed (measured) variables are linear combinations of some source variables. Confirmatory Factorial Analysis (CFA) was selected to analyze our data and validate variables. The Kaiser-Meyer-Olkin (KMO) test was used to determine whether the data were fit for CFA.

Fit indices can also be adopted to ensure validity, such as the root mean square error of approximation (RMSEA), comparative fit index (CFI), and chi-square (χ^2). RMSEA measures the average of the residual variance and covariance with a better fit for small samples (Rigdon, 1996). Adequate models present RMSEA values of 0.008 or below (Atkinson et al., 2012). CFI is explored as an alternative to RMSEA and is considered satisfactory in a range between 0.9 and 0.95 (Rigdon, 1996). The χ^2 test can be used when comparing experimental and theoretical frequencies based on a hypothesis (Tallarida & Murray, 1987).

The standardized root mean square residuals (SRMR) were used as a fit measure for the CFA. SRMR evaluates the fit of the CFA model to the sample data. This indicator shows the distance between the correlations predicted by the CFA and those found by the study sample. The recommended index is ≥0.8) (Hair et al., 2019). Another indicator of the overall model fit is the Variance Inflation Factor (VFI). Significant multicollinearity may emerge when the VIF coefficient is greater than 4.0 (others use the more generous limit of 5.0). VIF is the inverse of the tolerance coefficient, and multicollinearity is detected when tolerance is less than 25 (others prefer a softer cut-off of 20) (Hair et al., 2022).

The indicator for the discriminant validity analysis is the heteroatom-hetero-method correlations (HTMT), which is the average of all correlations measuring several constructs compared to the (geometric) mean of the average correlations between indicators measuring the same construct. A high HTMT value indicates a lack of discriminant validity.

3.4.2. Discriminant validity analysis

The indicator for the discriminant validity analysis is the heteroatom-hetero-method correlations (HTMT), which is the average of all correlations measuring several constructs compared to the (geometric) mean of the average of correlations between indicators measuring the same construct. The HTMT ratio should be lower than 1.0 in a well-fitting model because heterotrait correlations should be smaller than monotrait correlations. According to Henseler et al. (2015), discriminant validity has been established between a particular pair of reflective constructs if the HTMT value is below 0.90.

3.4.3. Structural equation modeling

This research adopted SmartPLS version 4 for analysis, a software with a graphical user interface for variance-based structural equation modeling (Hair et al., 2022). According to the SmartPLS manual (Hair et al., 2022), nonparametric data is a prerequisite for using partial least squares while performing Structural Equation Modeling (SEM). Thus, we first confirmed the nature of our data as nonparametric.

PLS-SEM adopts three indicators for reliability and validity: Cronbach's alpha, composite reliability (rho_a), and average variance extracted (AVE). The values of rho_a should be above 0.70. The AVE of each construct must be above 0.5 (Hair et al., 2022). Evaluation of reflective measurement models is ideal for applying PLS (Giovanis et al., 2018). PLS-SEM evaluations include composite reliability to assess internal consistency, reliability of individual indicators, and AVE to assess convergent validity (Hair et al., 2019). Cronbach's alpha estimate's reliability is based on the correlations between the observed indicator variables. Values above 0.7 are considered a good fit, even though the desirable indicator is above 0.9. Path coefficients attest to the strength between latent variables. These measures present the direct effects that, when added to the "Indirect Effects," yield the "Total Effects." They vary from 0 to plus or minus 1, with the paths closest to the absolute one being the strongest (Hair et al., 2022).

Another critical indicator in SEM is the R-square (also known as the coefficient of determination). It is the overall effect size measure for the structural model, as it provides how much of the variance in the dependent variable is explained by the model. R-square (or R^2) values are interpreted according to the field of study. In general lines, results above 0.67, 0.33, and 0.19 are "substantial," "moderate," and "weak," respectively (Hair et al., 2022). However, studies that advanced a field still in its infancy might be considered substantial, even if the traditional cutoffs say otherwise. R-squared values in any field that attempts to predict human behavior, such as psychology, are typically lower than 0.5 (Karch, 2020).

4. Results

This section is made up of six subsections such as (i) socio-demographic analysis, (ii) Confirmatory factorial analysis, (iii) Tests of measurement models, (iv) Discriminant validity analysis, and (v) Validation of hypotheses.

4.1. Socio-demographic analysis

Initially, the surveyed population sample of the real estate sector must be presented. Table 2 shows respondents' socio-demographic characteristics; in the region's case, this study considered three regions related to Lima: coastal, Metropolitan, and Mountains.

Table 2 summarizes the total sample of 116 real estate agents in Peru. In terms of gender, 72 were men. Regarding age segments, the largest group was over 50 years (with 60 participants), and new electronic services should be developed for them (Zhang et al., 2022). As for income profiles, 21 people reported earning more than S/. 6,001, 38 people earned from S/. 2,001 to S/. 4,000. The largest group was in the metropolitan Lima region (84 respondents).

4.2. Confirmatory factorial analysis

Given the aptitude of the data to go through a confirmatory factorial analysis (as seen in section 4.2), the next was to verify the KMO of our set of variables, which was found to be between 0.8 and 0.921. The outcomes were, thus, acceptable. We also validated the sample with Bartlett's test of sphericity ($p<0.001$). This test examines the hypothesis that variables in a population are uncorrelated. Results indicated that it was adequate to advance our analysis. Considering the relatively small sample in our research and the nonparametric nature of our data, we employed RMSEA as a fit measure (Hair et al., 2022). Due to an initial verification that indicated inadequate suitability (RMSEA>0.008), we discarded independent variables with outer loadings below 0.067. The final configuration of factors after this procedure and multicollinearity issues are detailed in Appendix B.

4.3. Discriminant validity analysis

In the next step, antecedents for SEM application were evaluated. First, heterotrait-monotrait ratio correlations were analyzed. According to Table 3, HTMT measured all constructs below the recommended index of 0.9, with two constructs below 0.85 (in a stricter analysis). Thus, discriminant validity was successfully achieved in our model. That is, there is little doubt whether the constructs are conceptually different.

The average variance extracted (AVE) varied from 0.618 to 0.771, above the recommended minimum index of 0.5. All values of rho_a are above 0.70, and they also reach the desirable index. Therefore, the convergent and divergent validity of the proposed reflective model was well demonstrated, as seen in Table 4.

Researchers recommend composite reliability in PLS-based research. Compared to Cronbach's alpha, CR may yield more accurate estimations of true reliability. Due to the reflective nature of our model, the convergent validity test was performed using the composite reliability indicator. Our CR was >0.9, which indicates an excellent fit for confirmatory purposes (Hair et al., 2022).

4.4. Tests of measurement models

Once we confirmed that our data met the criteria for creating a PLS-SEM model, we ran our database on Smart PLS 4.0 and extracted the fit indexes that would allow our model to be validated. The initial set of constructs is exhibited in Figure 2.

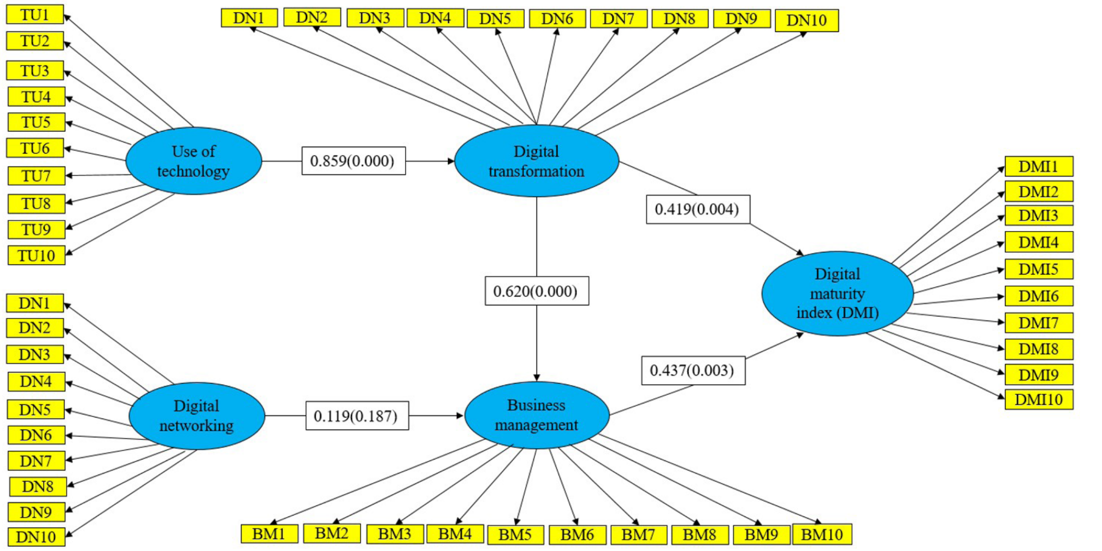

Figure 2. Initial CFA model.

Figure 2 shows the path coefficients in the association between the five constructs (latent variables) with their respective observed (independent) variables. The model also presents the significance level in every relationship established (represented by the second item in every parenthesis).

It is important to notice that all constructs had a significant positive influence on their respective dependent variables, except for the relationship between "Digital Networking" and "Business Management," which was not statistically significant (p-value = 0.187) and, thus, questionable. The latter finding led to removing the "Digital Networking" construct, a decision also motivated by the previous multicollinearity issues between the two constructs. After this modification, the model was re-run, leading to the results seen in Figure 3.

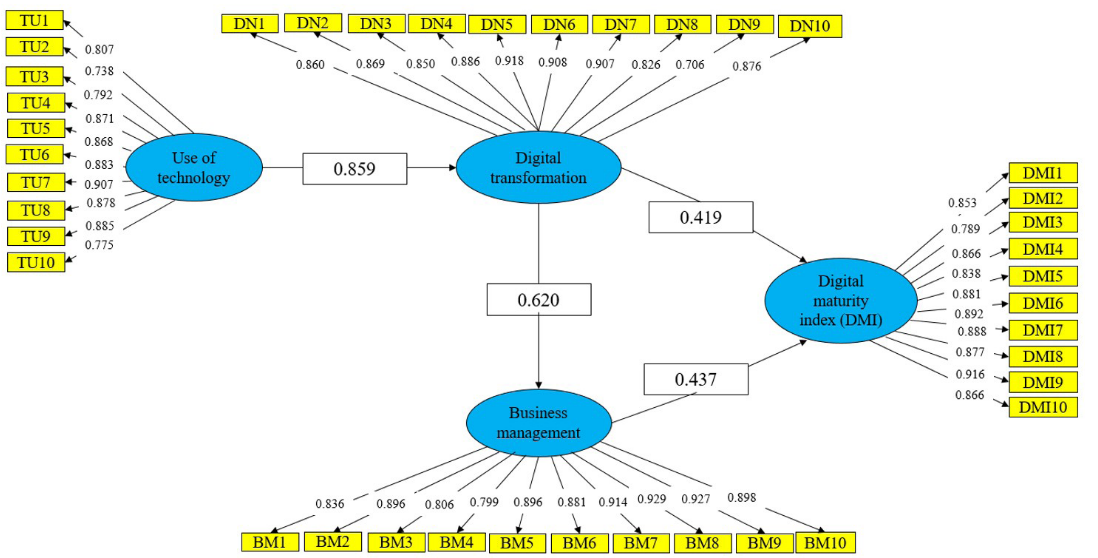

Figure 3. CFA model after dropping Digital Networking.

The final model also reached satisfactory R-square indexes. As presented in Figure 4, the adjusted R-square in Digital Technology indicates that the model could explain 68% of the variance in this dependent variable. The Digital Matrix Index had 51% of its variance explained by the model, while Business Management reached an R^2 of only 25%.

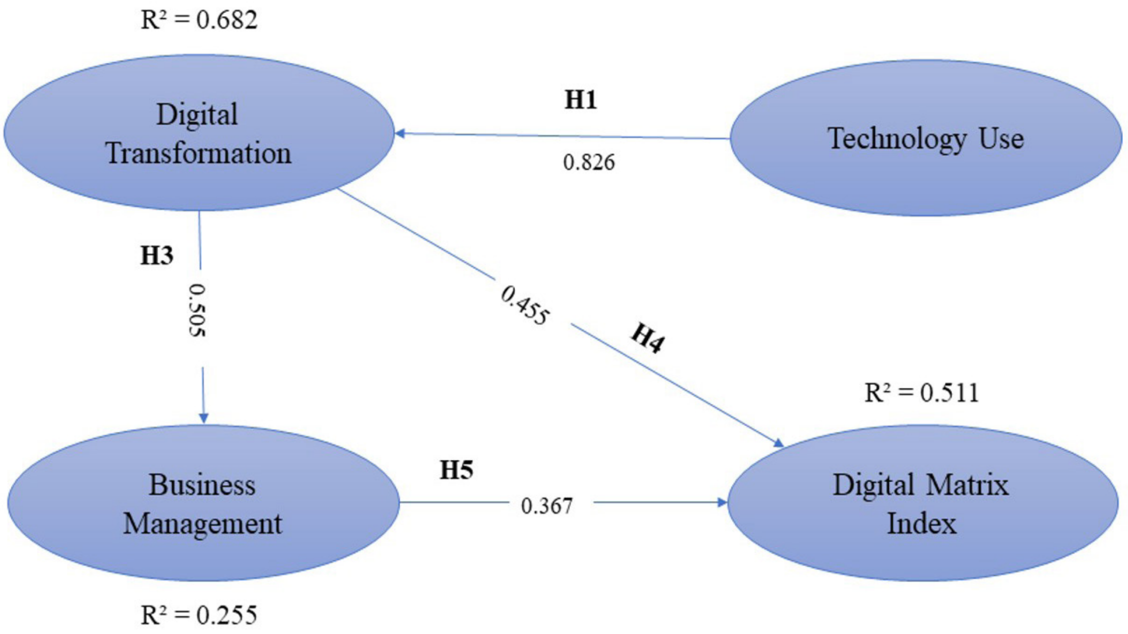

Figure 4. PLS algorithms results.

As explained in our Method section, the interpretation of R-square highly depends on the field and the amount of previous work published around a specific theme. As the variable Business Management has yet to be fully explored in terms of digital knowledge, it is possible that the independent variables presented in our research still need to explain more of this concept. Although the proposed model showed a substantial R^2 for Digital Transformation (0.68) and a moderate one for the Digital Maturity Level - DML (0.51), the Business Management construct showed a lower R^2 (0.25), indicating that only 25% of its variance was explained by the independent variables included. This result can be understood from different perspectives.

Firstly, the real estate sector in Peru, especially in emerging markets, is still in the process of adapting to more robust digital practices. Many of the management processes are still based on personal experiences and informal practices, which limits the direct impact of digital technologies on the management model used by real estate agents (Lavrov et al., 2020; Busulwa et al., 2022). In addition, the adoption of digital tools may be more associated with operational execution than with the strategic redesign of business models, which would explain the low variance explained by variables such as digital transformation or the use of social networks.

Secondly, it is possible that additional constructs not included in the model, such as organizational culture, resistance to change or the strategic maturity of managers, play a relevant role in the management of the real estate business, as studies of digital transformation in conservative sectors point out (Verhoef et al., 2021; Warner & Wäger, 2019). These elements can act as moderators or mediators in the relationship between technology and business.

Finally, the very methodological limits of the sample - made up mostly of agents over 50 years old and working in different regional contexts - may have contributed to a heterogeneous perception of management practices, reducing the consistency of responses in the Business Management construct (Zhang et al., 2022). As Kudyba (2020) and Kraus et al. (2021) suggest, the impact of digital transformation on business depends not only on technological availability, but also on the training of professionals and strategic alignment with organizational objectives.

4.5. Validation of hypothesis

After reaching an optimized model, we then moved to validate our hypotheses. As shown in Table 5, four correlations were statistically relevant: H1, H3, H4, and H5. Another aspect considered was the f-square (f^2) effect

Table 5. Coefficient significance test for structural model (hypothesis test).

Hypotheses	*β	f^2	p-value	95%CI**	Result
H1: Technology use has a positive influence on digital transformation	0.859	0.039	0.000	(0.766;0.922)	Supported
H2: The use of Digital Networking positively influences business management	0.119	0.091	0.191	(-0.076;0.282)	Not Supported (dropped from the model)
H3: Digital transformation positively influences business management	0.620	0.092	0.000	(0.444;0.808)	Supported
H4: Digital transformation positively influences the digital maturity level	0.418	0.148	0.005	(0.147;0.725)	Supported
H5: Business management positively influences the digital maturity level	0.438	0.147	0.003	(0.138;0.711)	Supported

Note: *β = path coefficients; **CI = confidence interval.

size measure. The f-square equation expresses how much of the unexplained variance is explained by R^2 change (Montazemi & Qahri-Saremi, 2015; Hair et al., 2019). Effect sizes are classified as modest, moderate, and strong at 0.02, 0.15, and 0.35, respectively (Li et al., 2020). Our model's f^2 indexes ranged from weak (H2 and H3) to moderate (H4 and H5). Concerning path coefficients (β), as the recommended indexes should be ideally >.5, we can conclude that H1 and H3 show strong path loading, with H4 and H5 coming close to the desirable fit.

5. Discussion

This study aimed to determine the relationship between digital maturity level, digital networking, digital transformation, and technology use in business management in real estate companies. For this purpose, confirmatory factor analysis and structural equation modeling were used to analyze data collected from 116 real estate agents.

As the main results, it was significantly supported that (i) technology use positively influences digital transformation, (ii) digital transformation positively influences business management, (iii) digital transformation positively influences the digital maturity level, and (iv) business management positively influences the DML. Among the hypotheses, the only one that needed to be supported was that digital networking positively influences business management. The contributions achieved were of two different natures: theoretical and managerial. Each is adequately discussed in the following subsections, along with limitations that need to be acknowledged in this study.

5.1. Theoretical implications

Reliability results and validity advocate for the strength of the relationship between technology use and digital transformation. Figure 3 clearly shows how the increase in the technology used by real estate agents benefits growth in digital transformation. These outcomes are consistent with the results found by Kristoffersen et al. (2021), who highlighted that implementing circular strategies relies on digital technologies, which drives value creation and higher performance. Digital transformation is linked to the DML construct, with a favorable loading (0.419), concerning DML. This also confirmed studies conducted by Martin et al. (2019) and Correani et al. (2020), noting that an organization's digital maturity can directly influence the quality and integrity of data and performance reporting (Correani et al., 2020). Our results also coincide with those of Khatib & Alshawabkeh (2022), who demonstrated that digital transformation has a positive effect on digital human resource management by fostering a digitalization-oriented organizational culture. In addition, the Peruvian real estate sector's level of digital maturity is considered moderate compared to other economic sectors in the country (Ernst & Young, 2024). Furthermore, the use of digital platforms has shown constant evolution and an upward trend (Coloma, 2024) in the country.

Thus, this research sought to enlighten the theoretical aspects of a digital transformation approach to promote changes in business strategy (Verhoef et al., 2021) and in mentality, also fostering new business models and/ or the re-design of existing ones (Satalkina & Steiner, 2020) in Perú . The present study supports the idea that the traditional benefits of digitalization include the reduction of operating costs, the optimization of processes and the generation of competitive advantages; its strategic value lies in the ability to transform data into useful information, which strengthens decision-making (Xu & Sukpasjaroen, 2024).

5.2. Managerial implications

This study seeks to provide knowledge for real estate professionals, given that technology and digital transformation are important tools that every agent should acknowledge. Operational efficiency in the real estate sector refers to the ability to streamline key business processes such as property listing, client communication, appointment scheduling, and transaction execution. It also includes minimizing redundant tasks, accelerating decision-making, and reducing the need for in-person interactions. As such, digital transformation becomes a strategic tool not only for innovation but for improving the performance and agility of everyday operations (Gudimenko et al., 2024; Wang et al., 2024).

The implementation of technological solutions can help real estate agents survive in the real estate sector by improving processes such as managing virtual property tours. Our data analysis supports this claim. For instance, items such as DT6 ("I employ technology solutions to automate relevant data-driven processes for decision-making") and TU6 ("I have access to data throughout the life cycle of my real estate services") showed high factor loadings (> 0.90), indicating that technology directly contributes to more efficient task execution and faster service delivery. Likewise, BM10 reflects a company-wide commitment to integrating innovation into all processes, further reinforcing gains in operational performance.

The study also suggests that industry professionals incorporate these tools to increase their competitiveness (Sahray et al., 2023). Furthermore, recent research on the real estate market shows that digital transformation has revolutionized traditional business models, generating significant improvements in operational efficiency, increasing customer satisfaction, and strengthening their competitive position (Wang et al., 2024). A complementary analysis evaluated the impact of digital transformation on real estate processes, focusing on market trends to identify relevant patterns in technology adoption and analyze market trends (Noskov & Kazymov, 2024).

These technological capabilities are valuable for tasks such as analyzing the condition of properties, planning meetings, or scheduling appointments with clients. This finding can motivate managers to share best practices with other partners to demonstrate the impact of technology on their processes. This means that digital transformation in companies influences the talent management process, implying substantial changes in all areas of the organization. This work also demonstrates the importance of information in each of the constructs. As real estate agents become more adept at using technology and digital transformation in business management, their information needs also change. This work primarily seeks to help managers diagnose their digital maturity levels to leverage digital technology and take advantage of business opportunities in the real estate sector.

These insights reveal that operational efficiency is not just an indirect benefit of digitalization but a measurable outcome of increased digital maturity. Real estate agencies that adopt CRM systems, automate communication flows, and utilize client data for decision-making are likely to see reductions in process bottlenecks, improved customer satisfaction, and overall better performance. Therefore, promoting digital tools is essential not only for modernization but also for tangible improvements in how business is conducted daily.

In light of the validated hypotheses (H1, H3, H4, and H5), the results offer a roadmap for actionable improvements in operational efficiency. First, the strong relationship between technology use and digital transformation (H1: $\beta = 0.859$) implies that real estate agents should prioritize the adoption of advanced data systems, such as CRM and ERP platforms, as well as tools for process automation and customer data analysis. These systems can streamline workflows, reduce human error, and support faster service delivery.

The significant link between digital transformation and business management (H3: $\beta = 0.620$) underscores the need for organizational initiatives that align technology with strategic planning. Managers should establish digital governance frameworks, encourage interdepartmental data sharing, and integrate technology into decision-making routines to enhance business agility.

Furthermore, the influence of digital transformation (H4: $\beta = 0.418$) and business management (H5: $\beta = 0.438$) on the Digital Maturity Level reveals that maturity emerges from a balance of technological adoption and management strategy. Companies should invest in employee training, formalize digital KPIs, and promote a culture of innovation to ensure long-term digital competitiveness.

In summary, operational efficiency is achieved not only by adopting new technologies, but by actively transforming business logic, processes, and people's mindsets. The model presented in this study can serve as a strategic diagnostic tool for identifying improvement areas and guiding implementation plans toward digital excellence in the real estate sector.

Beyond the statistical confirmation of the relationships, the proposed model provides a structured guide for real estate companies to prioritize their digitalization efforts according to the expected operational gains. For example, agencies with low levels of digital maturity may begin by enhancing their technology use (e.g., TU1, TU5, TU6), which, as supported by H1, significantly drives digital transformation and enables automation, data accessibility, and integration. From there, progressing into strategic digital transformation initiatives (as per H3 and H4) fosters not only agility in client service but also reduces processing time and coordination inefficiencies across operations. Lastly, strengthening business management practices (H5) by embedding digital innovation into all service layers (BM10) reinforces sustained gains in performance, resource utilization, and customer satisfaction. Therefore, the model not only explains variance in operational efficiency indirectly (via DML) but also identifies leverage points for targeted interventions.

5.3. Limitations

As limitations, we must notice that, as it is expected from exploratory studies using scales generated from scratch, some statistical boundaries led the research to different paths than those initially drawn. Even though the pre-test revealed good reliability, applying the scale to a wider audience revealed problems of multicollinearity, which happen when two constructs measure highly similar behaviors. Although such constructs did not represent similar concepts at first, data analysis left little doubt that Digital Networking had multicollinearity issues with Business Management, which explained why the path coefficient between these two variables was low by PLS standards.

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Data availability

Research data is only available upon request.

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Author Contributions

Danila Raquel Neira Sacaski: Conceptualization, Methodology, Writing – original draft
Paola Graciano: Project administration, Formal analysis, Writing – review & editing
Karina Cerna Risco: Investigation, Data curation
José Paul Campos Llerena: Investigation, Visualization, Validation
Aline Cafruni Gularte: Data curation, Writing – review & editing
Fernando Henrique Lermen: Conceptualization, Methodology, Supervision, Writing – review & editing

Appendix A. Digital Maturity Assessment Questionnaire for Real Estate Professionals.

This questionnaire was designed to evaluate the level of digital maturity among real estate professionals by assessing their use of technology, digital transformation practices, networking, business management, and overall digital readiness. The responses are intended solely for academic purposes.

Section 1: Participation Agreement

Do you have the availability and interest to continue participating in this research?

( ) Yes

( ) No

Section 2: Technology use and digital transformation

Do you use digital tools to manage property listings?

( ) Never

( ) Rarely

( ) Sometimes

( ) Frequently

( ) Always

Do you interact with clients through digital platforms?

( ) Never

( ) Rarely

( ) Sometimes

( ) Frequently

( ) Always

Do you use digital tools to automate processes related to real estate management?

( ) Never

( ) Rarely

( ) Sometimes

( ) Frequently

( ) Always

Does your company have a defined digital strategy?

( ) No strategy

( ) In development

( ) Partially implemented

( ) Fully implemented

Which digital technologies does your company currently use? (Select all that apply)

( ) CRM

( ) ERP

( ) Cloud storage

( ) Business intelligence

( ) Artificial intelligence

( ) None of the above

Section 3: Please mensure in a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) the variables of each dimension: Technology Use, Digital Transformation, Digital Networking, Business Management, and Digital Maturity Level.

1. Technology Use (TU)

TU1. I use digital tools to manage property listings.

TU2. I use virtual tours or 3D imaging tools for property visualization.

TU3. I use CRM systems to manage customer relationships.

TU4. I use digital calendars and schedulers for appointments.

TU5. I use e-signature tools for signing contracts.

TU6. I use cloud-based platforms for file management.

TU7. I use business intelligence tools to support decision-making.

TU8. I use mobile apps to manage real estate operations.

TU9. I regularly evaluate the performance of technological tools used.

TU10. I invest in upgrading my digital tools.

2. Digital Transformation (DT)

DT1. I adapt quickly to changes in the market.

DT2. I create partnerships with other external players to become more competitive.

DT3. I encourage fellow real estate agents to use technology to conduct transactions.

DT4. I encourage the use of digital technologies to generate new ideas.

DT5. I use digital tools to monitor customer behavior.

DT6. I develop new services based on digital capabilities.

DT7. I explore data analytics to support decisions.

DT8. I rely on automation to improve operational processes.

DT9. I develop a digital roadmap for my business.

DT10. I integrate digital tools into daily decision-making processes.

3. Digital Networking (DN)

DN1. I use at least one social network for work (e.g., WhatsApp, Facebook, LinkedIn).

DN2. I often accept communications from other real estate agents.

DN3. Social networks provide accurate and helpful information about the real estate sector.

DN4. I use social networks to meet clients.

DN5. The information provided by e-commerce on social media is comprehensive.

DN6. I read/watch sponsored content on social media platforms.

DN7. I use social networks to find solutions to real estate-related problems.

DN8. I consult social networking groups before major decisions.

DN9. I accept advice from social media because it comes from real users.

DN10. Social media informs me about trends and technologies in real estate.

4. Business Management (BM)

BM1. I perform cost-benefit analyses to support strategic decisions.

BM2. I regularly review my business processes for optimization.

BM3. I define KPIs to measure business performance.

BM4. I implement quality management systems.

BM5. I delegate tasks effectively within the team.

BM6. I invest in employee development and training.

BM7. I create clear strategic plans for my business.

BM8. I monitor market trends to adjust the business model.

BM9. I use financial management software.

BM10. I conduct periodic internal audits for improvement.

5. Digital Maturity Level (DML)

DML1. I connect my ICT systems with systems of other stakeholders.

DML2. I use file standards for electronic data exchange.

DML3. I have funds available for implementing new digital technologies.

DML4. I systematically manage digital technology risks.

DML5. My current technology allows upgrading to modern digital tools.

DML6. I am motivated about digital transformation in my organization.

DML7. I invest in employee digital skills.

DML8. I provide continuous digital training.

DML9. I participate in developing or adapting digital tools.

DML10. I ***introduced new ways of collecting fees using digital tools.***

Section 4: Sociodemographic profile

Gender

( ) Female

( ) Male

( ) Other

( ) Prefer not to say

Age

( ) Under 25

( ) 25–34

( ) 35–44

( ) 45–54

( ) 55 or older

Highest Educational Attainment

( ) Primary education

( ) High school

( ) Undergraduate degree

( ) Graduate degree

( ) Postgraduate (Master's/PhD)

Years of Experience in the Real Estate Sector

( ) Less than 1 year

( ) 1–3 years

( ) 4–6 years

( ) 7–10 years

( ) Over 10 years

Type of Activity (You may select more than one)

( ) Real estate agent

( ) Property manager

( ) Broker

( ) ADMLnistrative staff

( ) Other: ________

Region of Operation

( ) Lima Metropolitana

( ) Coast (excluding Lima)

( ) Highlands

( ) Jungle

( ) Other: ________

Size of the Company You Work In

( ) Independent professional

( ) Small business (up to 10 employees)

( ) Medium-sized business (11 to 50 employees)

( ) Large company (over 50 employees)

Appendix B. Factor loadings and VIF.

Factors and items	Outer Loadings	VIF
Business management		
BM1	0.833	3.312
BM2	0.804	3.078
BM3	0.795	2.733
BM4	0.893	4.540
BM5	0.881	4.156
BM6	0.912	7.678*
BM7	0.927	11.166*
BM8	0.924	8.989*
BM9	0.897	5.887*
BM10	0.894	4.940
Digital Networking		
DN1	0.729	2.320
DN2	0.757	2.287
DN3	0.793	2.459
DN4	0.837	2.973
DN5	0.848	3.650
DN6	0.798	3.143
DN7	0.796	3.251
DN8	0.716	2.909
DN9	0.747	2.583
DN10	0.816	3.258
Digital transformation		
DT1	0.856	3.905
DT2	0.846	3.599
DT3	0.883	5.292*
DT4	0.916	8.100*
DT5	0.908	5.548*
DT6	0.906	6.296*
DT7	0.821	3.245
DT8	0.703	2.046
DT9	0.873	4.474
DT10	0.867	3.893
Technology use		
TU1	0.806	2.624
TU2	0.790	2.841
TU3	0.868	3.645
TU4	0.867	3.742
TU5	0.881	5.497*
TU6	0.906	6.769*
TU7	0.877	4.816
TU8	0.884	4.377
TU9	0.772	2.915
TU10	0.733	2.727
Digital Maturity Level		
DML1	0.853	3.691
DML2	0.864	4.429
DML3	0.836	3.774
DML4	0.880	4.999
DML5	0.890	4.880
DML6	0.887	4.707
DML7	0.874	4.894
DML8	0.915	6.713*
DML9	0.864	3.915
DML10	0.787	2.366

Note: VFI = variance inflation factors;
*variables present multicollinearity, but we opted to keep it in the model.