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Development Trend of the Real Estate Economy and Digital Transformation of Enterprises Under the New Situation

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Abstract: The real estate sector has significantly influenced China's economic development in recent decades. The distinctive characteristics of this phenomenon, including its special turnover rate and substantial impact on the Gross Domestic Product (GDP), have garnered considerable interest from academic researchers and industry professionals. Conventional performance evaluation approaches face constraints in capturing the dynamic nature of the contemporary business landscape. The significance of digital transformation has escalated for real estate firms, as it facilitates enhancing operational efficiency, customer experience, and competitive edge. This study proposes the Real Estate Enterprise Performance Evaluation Method (RE2PRM), which integrates Decision-Making Trial and Evaluation Laboratory (DEMATEL) to overcome the limitations of traditional methods. The RE2PRM evaluates financial performance, customer satisfaction, and market trends through a systematic index framework and causal relationship analysis. Empirical findings from 500 survey respondents across China's real estate sector demonstrate that RE2PRM achieves superior accuracy, user acceptance, and practicality compared to existing digital transformation methods. Artificial intelligence (84%) and blockchain (82%) exhibit the highest influential power among digital technologies, while big data analytics (61%) and AI (65%) demonstrate the greatest relative importance. The proposed method provides a comprehensive assessment framework that enables better-informed decision-making for real estate enterprises. This research contributes to digital transformation theory by offering an integrated DEMATEL-based evaluation model tailored to China's real estate industry.

Keywords: China; DEMATEL; digital transformation; performance evaluation; real estate economy

1 INTRODUCTION TO REAL ESTATE ENTERPRISES IN CHINA

The real estate sector has emerged as a pivotal component of China's economic expansion and progress in recent years. The burgeoning urbanization rate and a population exceeding 1.4 billion have resulted in a consistent escalation in real estate needs [1]. As per the National Bureau of Statistics of China, the real estate sector made a notable contribution to the country's economic growth in 2020, with a 6.3% contribution to the Gross Domestic Product (GDP) [2]. This highlights the sector's significance as a critical contributor to the country's economic development. The aggregate amount of capital invested in real estate development in China attained a value of 14.8 trillion-yuan, equivalent to roughly 2.2 trillion US dollars, in 2020. The Chinese real estate market presents a compelling case for international comparison due to its unique scale, regulatory environment, and digital innovation trajectory. While advanced economies such as the United States and the United Kingdom have developed mature PropTech ecosystems characterized by platform-based transactions and data-driven asset management [3], China's digital transformation exhibits distinct features: the dominance of super-app ecosystems (e.g., WeChat-integrated services), state-backed infrastructure development, and rapid adoption of AI and blockchain technologies at the enterprise level. Unlike Western markets where digitalization primarily enhances existing operational frameworks, China's real estate digital transformation often involves fundamental restructuring of business models, as evidenced by the emergence of platform enterprises such as Beike and Fang.com. Furthermore, emerging economies including Vietnam and India are increasingly referencing China's digital real estate strategies as templates for their own market development [4, 5]. Understanding the mechanisms through which Chinese real estate enterprises achieve digital transformation performance therefore carries implications beyond national boundaries, offering transferable insights for markets at varying stages of technological maturity.

To enhance comprehension of the real estate market in China, various surveys and datasets have been executed and consolidated. The China Real Estate Association released the China Real Estate Market Annual Report, which comprehensively analyzes the sector's progress, patterns, and obstacles [6]. The document comprises information about investing in real estate, the supply and demand of land, the pricing of housing, and various other significant indicators. The National Bureau of Statistics of China issues monthly reports about real estate investment, housing prices, and sales.

However, the efficacy of conventional approaches in assessing real estate enterprises is impeded by their inadequacies in accommodating the dynamic nature of the contemporary business landscape. The employed techniques frequently depend on past data, which could deviate from the present market conditions. In addition, conventional approaches prioritize numerical metrics, such as economic outcomes, while potentially disregarding other critical variables, such as client contentment and industry patterns. Traditional techniques entail significant time and financial investments, rendering them less feasible for prompt decision-making.

The significance of digital transformation has escalated for real estate corporations, allowing them to surmount the constraints of conventional techniques and attain a competitive edge. Real estate enterprises can achieve a more precise and comprehensive market comprehension by collecting and analyzing data in real-time through advanced technologies, including Artificial Intelligence (AI) [7], big data [8], and the Internet of Things [9]. Implementing digital transformation allows real estate enterprises to enhance their operational efficiency, improve customer experience, and augment revenue. Digital platforms for property sales and rentals, such as Fang.com and Beike, have significantly transformed China's real estate sector by allowing

customers to peruse properties and conduct transactions via online channels.

Several surveys and datasets offer valuable insights into the effects of digital transformation on the real estate sector in China. According to the annual report on Internet development in China by the China Internet Network Information Center, the number of Internet users in China exceeded 940 million as of June 2020, indicating an Internet penetration rate of 67.3% [10]. A survey conducted by Klynveld Peat Marwick Goerdeler (KPMG) revealed that 81% of real estate executives operating in China believe digital transformation will significantly impact their business within three years [11]. The surveys and datasets presented in this study illustrate the significance of digital transformation in the real estate sector of China and its capacity to stimulate progress and advancement within the industry.

This paper presents a novel approach, the Real Estate Enterprise Performance Evaluation Method (RE2PRM), aimed at overcoming the constraints of conventional techniques for assessing the performance of real estate enterprises in China. The RE2PRM utilizes fuzzy logic and machine learning methodologies to evaluate a range of factors that impact the operational efficacy of real estate enterprises. These factors encompass financial performance, customer satisfaction, and market trends. The approach offers a more intricate comprehension of the Chinese real estate industry, thereby facilitating better-informed judgments for corporations.

The primary contributions of the article are listed below:

1) The direct contributions of this study involve an investigation into the phenomenon of digital transformation within real estate enterprises in China. This paper presents a novel approach, the Real Estate Enterprise Performance Evaluation Method (RE2PRM), which integrates the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method with machine learning techniques to evaluate real estate enterprise performance [12].

2) The research parameters under consideration are as follows: the dependent variable is digital transformation performance, while the independent variable is digital transformation variables. The control variable is traditional business procedures.

3) This study aims to identify the principal digital transformation technologies utilized within China's real estate industry. The recognized technologies include online property marketplaces, smart home technology, blockchain, big data analytics, Virtual and Augmented Reality (VR/AR), mobile apps, and AI.

The following sections are organized in the given manner: Section 2 presents a comprehensive analysis of the real estate market in China and scrutinizes the drawbacks of conventional approaches to assess the performance of real estate businesses. Section 3 offers the proposed Real Estate Enterprise Performance Evaluation Method. The present section introduces an innovative system that utilizes the DEMATEL to scrutinize the operational efficacy of real estate firms in China. Section 4 provides an account of the experimental analysis and outcomes of different digital transformations in real estate enterprises in China. Section 5 provides a conclusion and future scope for the study. It summarizes the contributions and limitations of the proposed method and highlights potential areas for further research and development in the real estate enterprise performance evaluation field in China.

2 BACKGROUND ANALYSIS AND LITERATURE SURVEY

The background and literature survey section presents a comprehensive summary of the real estate sector in China, encompassing its historical evolution and contemporary market characteristics. The text scrutinizes the constraints of conventional techniques employed in assessing the performance of real estate businesses. It underscores the necessity for sophisticated methodologies that harness the potential of digital transformation technologies.

2.1 Background

The Chinese real estate sector has undergone substantial expansion and alteration in recent decades, propelled by economic and demographic catalysts. The implementation of market-oriented reforms by the government during the 1980s facilitated the emergence of fresh prospects for private investment in the real estate sector, thereby instigating a swift growth of the industry. The sector has emerged as a pivotal contributor to China's economic expansion, constituting a substantial portion of the nation's GDP and workforce. The real estate enterprises in China achieved a total turnover of 19.5 trillion yuan in 2020, indicating a 6.6% growth from the preceding year [13].

The real estate sector in China encounters significant obstacles and hazards, such as market instability, indeterminate regulatory policies, and ecological apprehensions. Conventional approaches utilized to assess the operational efficacy of real estate enterprises, including financial metrics and sales statistics, possess constraints in comprehensively capturing the intricate market dynamics. Digital transformation has become a practical approach for real estate firms in China to address challenges and achieve a competitive advantage in recent times. Sophisticated technological tools, including big data analytics, AI, and blockchain, are currently employed to optimize operational efficacy, elevate customer satisfaction, and foster novel business strategies. The emergence of digital platforms, such as Fang.com and Beike, for property sales and rentals has revolutionized the real estate sector in China, offering customers more convenient and easily accessible services.

2.2 Literature Survey

Fields et al.'s paper centers on platform real estate's emergence and presents a research agenda for critical housing studies within this domain [14]. The text explores the potential impact of platform real estate on the housing market and highlights significant inquiries regarding governance, regulation, and social equity. The emergence of PropTech (Property Technology) has fundamentally reshaped the real estate industry by integrating digital innovations into property operations and management. Baum introduced the concept of PropTech 3.0, highlighting the transition toward data-driven real estate

markets [3]. Recent studies have emphasized the role of PropTech in enhancing operational efficiency and sustainability. Tan and Miller examined the intersection of digitalization and sustainability in real estate operations, demonstrating how PropTech solutions optimize resource utilization [15]. Naeem et al. provided a comprehensive review of digital technologies transforming the real estate industry, including AI, blockchain, and IoT applications [16]. Wainwright analyzed the impact of rental PropTech platforms on landlord-tenant relationships, revealing shifts in power dynamics within the private rental sector [17]. These studies underscore the necessity of integrating PropTech research into performance evaluation frameworks for real estate enterprises.

The paper by Jiang et al. examines the transition towards green housing in the Chinese housing market, focusing on the involvement of real estate enterprises in facilitating this shift [18]. This research utilizes a behavioral analysis approach to investigate the determinants that impact the acceptance of eco-friendly construction practices among real estate developers. It provides valuable perspectives on the obstacles and possibilities for promoting sustainable development in China.

The study conducted by Wang et al. delves into the incentive policies utilized to encourage the adoption of prefabrication in real estate enterprises within China [19]. The study employs an analysis based on evolutionary game theory to identify the crucial factors that impact the efficacy of said policies and suggests tactics for their efficient execution.

Kieltyka et al. compared the business strategies of two real estate developers, Hung Thinh and Novaland, in Vietnam [4]. The authors utilize the McKinsey matrix as a framework for their analysis. This study offers valuable insights into the competitive environment of the real estate sector in Vietnam, shedding light on the strengths and weaknesses of the strategic approaches adopted by the two companies.

The Quantitative Strategic Planning Matrix (QSPM) matrix was employed by Banka et al. to scrutinize the business strategies of real estate developers in Vietnam [5]. This research paper aims to identify the critical success factors that contribute to the real estate development industry's success in Vietnam. It proposes various strategies developers can implement to enhance their competitiveness in the market.

The study conducted by Chen et al. introduces a Data Envelopment Analysis (DEA) Malmquist methodology to evaluate the destocking performance of the real estate sector in China [13]. This research offers valuable insights into the industry's operational efficiency and productivity while identifying key factors contributing to its destocking performance.

Munawar et al. analyzed the utilization of big data in intelligent real estate and disaster management domains [20]. This study presents a methodical examination of the existing literature about the subjects. It highlights potential ways big data is leveraged to enhance the efficiency and efficacy of real estate management and disaster response.

Ambrose et al. examined the impact of size on European real estate firms, focusing on the potential benefits of economies of scale [21]. This research offers valuable insights into the factors that determine the size and performance of companies and examines the potential implications of these factors for investors and policymakers.

Ullah et al. investigated the impediments to the digitalization and innovation of smart real estate in Australia [22]. This research offers valuable perspectives on the obstacles real estate developers and managers encounter when integrating novel technologies and suggests tactics to surmount these hindrances.

Sun et al. analyzed the financing mode employed by Chinese real estate enterprises, with a specific focus on the Evergrande Group as a case study [23]. This research offers valuable perspectives on the funding mechanisms utilized in the Chinese real estate sector. It examines the potential ramifications of these financing sources on the industry's long-term viability.

The literature review focuses on various research studies on real estate enterprises in China. These studies encompass an analysis of business strategies, the transition towards green housing, destocking performance, and the impact of digital transformation. The studies demonstrate the intricate and multifaceted nature of the Chinese real estate sector, highlighting the necessity for efficient performance evaluation methods to facilitate informed decision-making. The RE2PRM has been put forth as a solution to fulfil the requirement, as it offers a thorough and precise methodology for assessing performance. Integrating DEMATEL and data envelopment analysis in RE2PRM presents a solution to the constraints of conventional approaches. It provides a more accurate and adaptable assessment of real estate firms operating in China.

3 PROPOSED PERFORMANCE EVALUATION OF REAL ESTATE ECONOMY AND DIGITAL TRANSFORMATION OF ENTERPRISES IN CHINA

The proposed segment about the evaluation of enterprise performance in the real estate sector in China through digital transformation comprises three primary components, shown in Fig. 1.

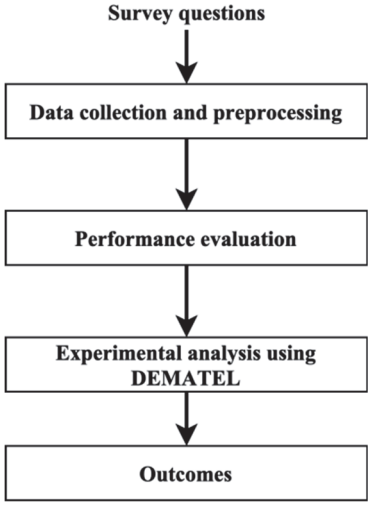


Figure 1 The process of performance evaluation of the real estate enterprises

The initial stage entails acquiring and preprocessing data, encompassing the compilation of pertinent data and

its preparation for analytical purposes. The segment pertains to the performance evaluation framework, which assesses the efficacy of diverse digital transformation approaches. The third section relates to the utilization of DEMATEL for experimental analysis. This involves the description of data and the presentation of empirical findings. The forthcoming exhibition showcases the performance evaluation and outcomes, offering valuable insights into the efficacy of various digital transformation techniques in Chinese real estate enterprises.

3.1 Data Collection and Preprocessing

The initial phase of the RE2PRM approach involves the data collection and preprocessing module. The process entails acquiring and refining pertinent data for assessment.

a) Data collection:

The proposed methodology's initial stage involves acquiring necessary data from real estate firms located in China. Including financial and non-financial data about real estate companies is imperative for the dataset. Financial data encompasses turnover, net profit, asset value, and liability, whereas non-financial data pertains to factors such as the number of employees, projects, and project completion rate.

The researchers utilize diverse sources, such as online databases, annual reports, and financial statements of real estate enterprises, to gather the data. To ensure consistency and accuracy, it is recommended that data be collected for a specific period.

b) Data preprocessing:

The next step in data analysis involves data preprocessing.

Upon completion of data collection, the next stage involves preprocessing the data to guarantee its quality and suitability for analysis. The initial stages of data preparation encompass the procedures of data cleansing, data standardization, and data conversion.

i. Data cleaning:

The data cleaning process entails removing inconsistent or missing data. The missing data is substituted with the corresponding attribute's mean, median, or mode value. They are correcting inconsistent data is accomplished through manual intervention or automated methodologies.

ii. Data normalization:

The process of data normalization guarantees that all data attributes possess uniform range and scale. The procedure holds significant importance in the RE2PRM approach as it ensures the comparability of all input attributes and their evaluability on a consistent scale.

iii. Data transformation:

The process of data transformation entails the conversion of data from its initial format to a format that is appropriate for analysis purposes. The procedure encompasses utilizing feature selection or feature extraction methodologies to decrease the dimensionality of the dataset. The dataset comprises several attributes, namely Turnover (T), Net profit (NP), Asset value (AV), Liability (L), Number of employees (NE), Number of projects (NPJ), and Completion rate of projects (CRP).

The initial step in data preprocessing involves the removal of any missing data and correcting of any inconsistent data. The data is normalized through the min-max normalization technique, which guarantees that all attributes are standardized to a range of 0 to 1.

3.2 DEMATEL Methodology

3.2.1 Performance Evaluation Model

The evaluation model for assessing the performance of real estate enterprises in China is based on the DEMATEL methodology and comprises the subsequent stages:

The development of an evaluation index system involves the following steps. Initially, a comprehensive assessment metric is established, considering the various factors that impact the operational efficacy of real estate firms. The elements encompass financial achievement, market share, consumer happiness, worker satisfaction, and environmental effects. The set of evaluation indices is denoted as X, where $X = \{x_1, x_2, ..., x_n\}$.

The following is a matrix for pairwise comparison: The pairwise comparison matrix cap W is constructed to depict the interrelatedness between the evaluation indices. The matrix's elements, denoted as w_{ij}, signify the comparative significance of x_i and x_j. These values are established through either statistical analysis or expert evaluations. The matrix has been normalized so that the summation of every row is equivalent to 1 using Eq. (1).

$$W = [w_{ij}]_{n\times n}, \text{ where } w_{ij} > 0,\ w_{ij} = 1,\ \text{and} \sum_{j=0}^{n-1} w_{ij} = 1 \quad (1)$$

s

a) Direct and indirect influences:

The DEMATEL algorithm is utilized to compute each index's direct and indirect impacts on the others. The process entails the computation of the cumulative impact of every index, taking into account its direct and indirect effects through other indices. The cumulative impact of the variable x_i is expressed in Eq. (2).

$$D_i = \sum_{j=0}^{n-1} w_{ij} + \sum_{j=0}^{n-1}\sum_{k=0}^{n-1}\sum_{j=0}^{n-1} w_{ij} w_k D_k \quad (2)$$

The weight is w_{ij}, and the optimum weight with the influence of x_k is w_k. D_k is the overall influence of x_k.

b) Classification:

Indices are categorized into two groups based on their impact: driving and dependent indices. The driving indices substantially impact the enterprise's performance, whereas the dependent indices are subject to the influence of other indexes and have a comparatively lower impact.

3.2.2 Performance Evaluation by DEMATEL

Utilizing the DEMATEL-based performance evaluation model can facilitate the identification of pivotal factors that impact the operational efficacy of real estate enterprises, thereby offering valuable insights for enhancing their performance. The model has the potential to be tailored to accommodate the distinctive attributes of the real estate sector in China and its ongoing digitalization.

Provided is a comprehensive outline of the DEMATEL methodology utilized for evaluating the performance of real estate enterprises in China, including the corresponding equations for each stage.

Step 1: Detect the variables and design the causal relationship matrix.

The initial stage of the DEMATEL methodology involves identifying pertinent factors for assessing the operational efficacy of real estate firms operating within the Chinese market. The elements encompass financial performance, market share, customer satisfaction, and employee satisfaction. After identifying the factors, a matrix depicting the causal relationship is created, exhibiting the interdependence of each component with other elements. The matrix that represents the causal relationship between variables is shown in Eq. (3).

$$C = \left[c_{ij} \right]_{n \times n} \tag{3}$$

The causal relationship matrix is denoted by C, where c_{ij} represents the causal relationship between factor i and factor j. The value of n corresponds to the total number of factors.

Step 2: Compute the total influence of each factor

The stage involves computing the comprehensive impact of each element, which encompasses the summation of the direct and indirect effects of the component on all other aspects. The mathematical expression used to determine the overall impact of a given element, denoted as i, is shown in Eq. (4).

$$T_i = \sum_{j=0}^{n-1} c_{ij} + c_{ji} \tag{4}$$

The formula for calculating the total influence of factor i is denoted as T_i, where c_{ij} represents the causal relationship between variable i and variable j, and c_{ji} represents the causal relationship between variable j and factor i.

Step 3: Determine the direct and indirect impacts of each variable.

The third procedural stage involves the computation of both direct and indirect impacts of each factor on all other aspects. The effect of a given element i on another factor j expressed as the direct effect, denoted by c_{ij}. In contrast, the indirect effect of factor i on factor j through intervening factors is defined by z_{ij}. The mathematical expression used to determine the direct impact of a given element i on another aspect j is shown in Eq. (5).

$$d_{ij} = \frac{c_{ij}}{1 + T_i} \tag{5}$$

The degree of reliance is denoted T_i, and the direct effect is denoted c_{ij}. The formula for computing the indirect impact of variable i on variable j via intermediary variables is shown in Eq. (6).

$$z_{ij} = \sum_{k=0}^{n-1} d_{ik} * \frac{c_{kj}}{1 + T_i} \tag{6}$$

The direct effect is d_{ik}, the degree of reliance is T_i, and the causal relation is c_{kj}.

Step 4: Determine the aggregate impact and degree of reliance for each variable

The fourth procedural stage involves the computation of the aggregate impact and the degree of reliance for every variable. The overall effect of a given factor, denoted as *i*, is determined by adding its direct and indirect effects. The degree of dependence on an element *i* is calculated by dividing its total influence by the sum of the natural forces of all aspects. The mathematical expressions used to determine the overall impact and degree of reliance on aspect *i* are shown in Eqs. (7) and (8).

$$T_i = d_{ii} + \sum_{j=0}^{n-1} d_{ij} + \sum_{j=0}^{n-1} z_{ij} \tag{7}$$

$$L_i = \frac{T_i}{\sum_{k=0}^{n-1} T_k} \tag{8}$$

The equation involves the variables L_i and T_i, which respectively represent the level of dependence of variable *i* and the total influence of variable *k*. The direct effect is d_{ik}, and the intermediary variable is z_{ij}.

Step 5: Construction of the impact matrix.

The fifth procedural stage involves the creation of an impact matrix that visually represents the connections between the factors by considering their overall effects and degrees of interdependence. The mathematical expression describing the impact matrix is expressed in Eq. (9).

$$I = \left[Q_{ji} \right]_{n \times n} \tag{9}$$

The equation involves the impact matrix represented by the symbol *I*, where Q_{ji} denotes the impact of factor *i* on factor j. *n* represents the total number of factors.

Step 6: Interpretation of the outcomes and making decisions.

The ultimate stage involves the interpretation of outcomes derived from the DEMATEL analysis and subsequent decision-making based on the findings. Using an impact matrix can facilitate the identification of the primary determinants that influence the operational efficacy of real estate enterprises in China while revealing the interdependent associations between these determinants. Through comprehending these interconnections, individuals in positions of authority can arrive at better-informed judgments regarding how to enhance the efficacy of their organizations.

3.2.3 Experimental Analysis

The present study's experimental analysis component assesses the validity of the RE2PRM model by utilizing empirical data obtained from real estate enterprises in China. The initial sub-block, denoted as data description, furnishes a comprehensive summary of the dataset employed in the experiments, encompassing its magnitude, variables, and data format. The experimental results sub-block pertains to utilizing the RE2PRM model on the dataset to assess the efficacy of real estate corporations in China. The findings were presented and analyzed, while the effectiveness and precision of the suggested approach were evaluated.

3.3 DEMATEL in the Digitalization of Operations Management of Real Estate Enterprises

In 1971, A. Gabus and E. Fontela introduced the DEMATEL approach to comprehend complex and challenging real-world problems [24]. The methodology employed involves the utilization of graphical and matrix-based tools to evaluate the relative significance of factors within a multifaceted system, thereby streamlining the analysis of the system's structure. The approach ascertains the function of individual elements within the system holistically by examining the logical and direct influence connections between the factors, culminating in creating a natural influence matrix, shown in Fig. 2.

The Interpretive Structural Modeling (ISM) method is a research technique in system engineering that facilitates the conversion of vague concepts and perspectives into comprehensible models featuring robust structural associations. This method is highly efficacious in examining complex systems involving many variables, intricate interconnections, and ambiguous structural particulars.

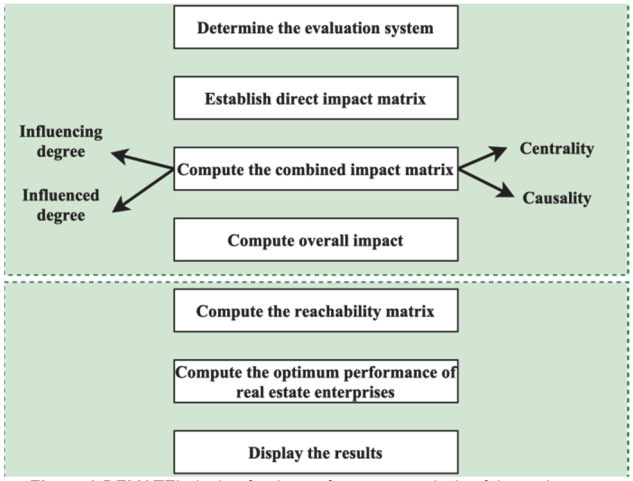


Figure 2 DEMATEL design for the performance analysis of the real estate enterprises

Upon investigation of the factors that influence the digitization of real estate enterprises, it was found that these factors exhibit complex interrelationships. These factors pertain to various operational management issues within the enterprise and are present at multiple levels. Given the intricacy of influencing variables, this study employs the DEMATEL methodology to ascertain the relative significance of diverse factors and their interdependent relationships. The ISM technique determines the rational configuration of every influential element and establishes a multi-tiered hierarchical structure model that accurately represents the significance of the diverse factors.

3.4 Research Variables

The research variables on real estate enterprises undergoing digital transformation in China are classified into three categories: dependent, independent, and control.

3.4.1 Dependent Variable

The dependent variable is the research investigation's primary outcome or response of interest. The dependent variable for real estate enterprises undergoing digital transformation in China pertains to the firm's financial performance, including revenue, profitability, or Return On Investment (ROI).

3.4.2 Independent Variable

The independent variable is the factor that is either manipulated or measured by the researcher to observe its effect on the dependent variable. The present investigation designates the independent variable as the digital transformation of real estate enterprises. This transformation integrates digital technologies such as big data analytics, cloud computing, the Internet of Things (IoT), and AI.

3.4.3 Control Variables

Control variables are deliberately maintained at a constant level by the researcher to minimize their potential impact on the dependent variable. Regarding real estate enterprises undergoing digital transformation in China, the control variables encompass factors such as the company's size, market competitiveness, and prevailing economic conditions.

3.5 Digital Transformations in China

3.5.1 Online Property Marketplaces

In China's real estate sector, digital property marketplaces are utilized to facilitate a streamlined and expedient medium for buyers and sellers to engage in transactions and establish connections.

In China, online property marketplaces are commonly established by developing a virtual platform that facilitates buyers' and sellers' listing and searching of properties. In addition to their primary functions, these platforms provide various ancillary services, including but not limited to property valuations, virtual tours, and transactional assistance. The platform facilitates communication between buyers and sellers, enabling them to conduct transactions remotely.

Features:

Online property marketplaces in China provide various features, including convenience, efficiency, and transparency. Using a digital platform enables buyers and

sellers to gain access to a more extensive selection of properties and execute transactions in a more expeditious and effective manner than conventional methods. Utilizing virtual tours and property valuations facilitates the ability of buyers to make better-informed decisions.

Advantages:

Online property marketplaces in China provide various benefits, including enhanced efficacy, decreased expenses, and better clarity. Using a digital platform enables buyers and sellers to conduct transactions more efficiently and cost-effectively compared to conventional means. The implementation of virtual tours and property valuations has the potential to mitigate the likelihood of conflicts and deceit.

Case study:

Anjuke, an online property marketplace in China, was acquired by Alibaba, the country's foremost e-commerce enterprise, in 2015 [25]. Anjuke offers a platform that facilitates the listing and searching of properties for buyers and sellers. Users can avail themselves of various services, including virtual tours and property valuations. The platform provides transactional assistance, including contract templates and legal counsel, to streamline the transactional process.

3.5.2 Smart Home Technology

The real estate industry in China is utilizing smart home technology to enhance the convenience and efficiency of the living environment for its inhabitants.

The real estate sector in China commonly incorporates smart home technology, which integrates various interconnected devices and sensors, including but not limited to smart thermostats, lighting systems, and security cameras, within residential premises. Residents can automate multiple tasks and customize their living environment by controlling these devices through a smartphone app or voice assistant.

Features:

Incorporating smart home technology within China's real estate sector presents a range of features, including enhanced convenience, improved energy efficiency, and heightened security measures. By utilizing interconnected devices, individuals can automate many tasks, including but not limited to regulating temperature and lighting and remotely monitoring their place of residence. The implementation of energy-efficient appliances could result in a reduction in energy expenditures. Using security cameras and sensors enhances the safety and security of the premises.

Advantages:

Implementing smart home technology in China's real estate sector presents various benefits, including heightened convenience, amplified energy efficiency, and improved security. Through interconnected devices, inhabitants can personalize their domestic surroundings and mechanize many activities, resulting in elevated levels of convenience. The implementation of energy-efficient appliances could lead to a reduction in energy expenses. Using security cameras and sensors enhances the safety and security of the premises.

Case study:

An instance of intelligent home technology implementation within China's real estate sector is the "Wu Xiaoyan" initiative, formulated by the real estate developer "Vanke" [26]. The project's scope entails deploying an array of interconnected gadgets, including intelligent thermostats, illumination setups, and air filtration units, within domestic dwellings. Using smartphone applications or voice assistants allows inhabitants to automate tasks and personalize their living space by controlling these devices. The adoption of energy-efficient appliances can lead to a decrease in energy expenses. In contrast, incorporating security cameras and sensors can enhance the safety and security of the premises.

3.5.3 Blockchain Technology

The utilization of blockchain technology is being implemented in China to optimize the process of real estate transactions, resulting in increased efficiency, reduced costs, and heightened security. Through the utilization of blockchain technology, both purchasers and vendors can carry out transactions in the absence of intermediaries, such as financial institutions or legal professionals.

Utilizing blockchain technology for real estate transactions in China commonly entails the establishment of digital assets that serve as representations of properties, thereby enabling their decentralized purchase and sale on a platform. Implementing blockchain technology facilitates expedited and streamlined transactions, resulting in decreased expenses and heightened security measures.

Features:

Utilizing blockchain technology in real estate transactions in China presents many characteristics, including but not limited to transparency, immutability, and efficiency. The utilization of a decentralized platform enables the expeditious execution of transactions at a reduced cost in comparison to conventional approaches. Smart contracts facilitate the automation of the complete transaction process by self-executing contracts containing the agreement's terms in code.

Advantages:

Utilizing blockchain technology in China presents various benefits, including but not limited to transparency, efficiency, and security. Using a decentralized platform facilitates the expeditious completion of transactions at a reduced cost compared to conventional methods. Using smart contracts can mitigate the likelihood of fraudulent activities and disagreements, given that the conditions of the agreement are explicitly encoded and immutable.

Case study:

Ant Financial, an affiliate of the e-commerce conglomerate Alibaba, has developed a platform called "Antube" that utilizes blockchain technology in the real estate sector in China [27]. Antube leverages blockchain technology to facilitate the exchange of real estate assets through a decentralized platform, thereby eliminating the involvement of intermediaries such as financial institutions and legal professionals. The digital platform generates holdings in a virtual form that symbolizes properties, and these assets are exchanged on a decentralized platform. Implementing blockchain technology facilitates expedited and streamlined transactions while concurrently decreasing expenses and augmenting security measures.

3.5.4 Big Data Analytics

The utilization of big data analytics in China's real estate sector is facilitating the provision of valuable insights into market trends and buyer behavior. This, in turn, empowers developers and agents to make more informed decisions.

Implementing big data analytics in China's real estate sector encompasses acquiring, manipulating, and evaluating substantial quantities of data derived from diverse origins, including property listings, transactional archives, and user conduct data. The data is subsequently utilized to discern market trends, including fluctuations in real estate values and consumer conduct, such as predilections for specific property categories.

Features:

The utilization of big data analytics in China's real estate sector encompasses various features, including but not limited to data visualization tools, predictive analytics, and machine learning algorithms. The tools facilitate the ability of developers and agents to discern prevailing market trends and consumer behavior, thereby enhancing their capacity to arrive at more judicious decisions.

Advantages:

Using big data analytics in China's real estate sector presents various benefits, including enhanced decision-making capabilities, heightened operational efficiency, and decreased expenses. Using data-driven insights, developers and agents can improve their decision-making processes regarding property development and marketing strategies, resulting in heightened efficacy and reduced costs.

Case study:

The real estate industry in China has implemented big data analytics in various ways, such as using the platform "Lianjia" [28]. This platform employs machine learning methods and big data analytics to match potential buyers with appropriate properties. Lianjia analyzes user behavior and preferences to offer customized property recommendations, thereby streamlining the process for buyers to locate suitable properties. The platform provides developers and agents access to data visualization tools and predictive analytics, which can aid in making more informed decisions regarding property growth and advertising approaches.

3.5.5 Virtual and Augmented Reality (VR/AR)

The Chinese real estate sector is utilizing VR/AR technologies to increase the property viewing experience for potential buyers. The real estate industry in China commonly employs 3D modeling and visualization software to generate immersive property tours through VR/AR technologies. Potential buyers can virtually explore the properties through a VR headset or an augmented reality application on a mobile device.

Features:

Utilizing VR/AR technologies within China's real estate sector provides various features, including enhanced convenience, heightened efficiency, and increased engagement. Immersive three-dimensional models enable prospective buyers to engage with properties in a more realistic and captivating manner, thereby obviating the necessity for in-person visits. The implementation of this approach has the potential to optimize efficiency and minimize expenses related to real estate showings.

Advantages:

Utilizing VR/AR technologies in China's real estate sector presents various benefits, including enhanced convenience, heightened efficiency, and decreased expenses. The utilization of immersive 3D models enables potential buyers to conveniently and independently explore properties without the necessity of in-person visits. Conflicts and deceit are mitigated by allowing the purchasers to evaluate the property more precisely before acquisition.

The real estate industry in China has incorporated VR/AR technologies in various ways.

Case study:

An instance is "Lianjia VR," a platform created by the real estate brokerage firm "Lianjia" [28]. The platform offers an immersive property touring experience through 3D modeling and visualization software, thereby facilitating the virtual exploration of properties from any location for potential buyers. In addition to its primary function, the platform provides additional capabilities, including virtual home staging and interactive floor plans, to augment the overall property viewing encounter.

3.5.6 Mobile Apps

The Chinese real estate industry has adopted mobile applications to facilitate seamless and expedient interactions between buyers and sellers. In China's real estate sector, mobile applications are commonly utilized to establish a digital platform that enables buyers' and sellers' listing and search of properties. These apps provide various services, including property valuations and transaction support. In addition to their primary functions, these applications offer additional capabilities such as virtual property tours and real-time messaging, facilitating remote communication and transactional activities between buyers and sellers.

Features:

Mobile applications in the real estate sector of China provide a range of features, including enhanced convenience, improved efficiency, and increased transparency. Utilizing a mobile application enables purchasers and vendors to broaden their scope of available properties and expedite transactions with greater efficiency compared to conventional means. Virtual property tours and instant messaging facilitate communication and negotiation between buyers and sellers.

Advantages:

Mobile applications in China's real estate sector provide numerous benefits, including enhanced productivity, decreased expenses, and heightened transparency. Using a mobile application enables purchasers and vendors to expedite transactions with reduced costs compared to conventional means. The implementation of virtual property tours and instant messaging has the potential to mitigate the likelihood of conflicts and fraudulent activities.

Case study:

"Fang.com" is a mobile application utilized in the real estate sector of China [29]. It is a property listing platform created by "Soufun Holdings," China's foremost real estate

media organization. The application offers a medium for purchasers and vendors to exhibit and explore real estate and avail themselves of various amenities, including property assessments and transactional assistance. In addition to its primary function, the application provides additional capabilities, such as simulated property visits and real-time messaging, to streamline interactions and transactions among purchasers and vendors.

3.5.7 Artificial Intelligence

AI is currently being implemented within China's real estate sector to enhance property valuation and optimize property management processes. Utilizing machine learning algorithms to scrutinize extensive property and market information datasets is a common practice in China's real estate industry regarding AI technology. Using the findings to produce precise assessments of property worth and prognostications of market patterns is plausible.

Features:

AI has the potential to enhance property management by streamlining operations and minimizing maintenance expenses.

The utilization of AI technology within China's real estate sector provides a multitude of features, including but not limited to precision, productivity, and economic viability. AI can use machine learning algorithms to produce more accurate property valuations and market predictions than conventional techniques. AI has the potential to enhance property management by streamlining operations and minimizing maintenance expenses.

Advantages:

Using AI technology in China's real estate sector presents various benefits, including enhanced precision, heightened productivity, and decreased expenditures. Using machine learning algorithms in AI can improve the accuracy of property valuations and market forecasts, empowering buyers and sellers to make more informed decisions. AI can enhance property management operations by optimizing them, increasing efficiency, and reducing costs.

Case study:

Ziroom, a property management company based in Beijing, exemplifies implementing AI in China's real estate sector [30]. Ziroom leverages AI technology to enhance its property management operations, decreasing maintenance expenses and heightening efficacy. In addition, the corporation leverages AI technology to produce more precise property assessments, thereby facilitating the provision of competitive pricing options to its clientele.

The study methodology entails the utilization of DEMATEL as a tool for evaluating the effects of digital transformation on the real estate sector in China. The research collects information about the utilization of digital transformation technologies within the industry and their impact on diverse factors, including but not limited to customer satisfaction, cost minimization, and revenue expansion. Applying the DEMATEL method facilitates the identification of causal relationships among the variables and their corresponding levels of significance. The present study aims to offer valuable insights into the digital transformation technologies that are of utmost importance for real estate enterprises operating in China. The findings of this analysis in the next section aid in devising effective strategies for successfully implementing these technologies.

4 EXPERIMENTAL ANALYSIS AND FINDINGS

The objective of the survey conducted in China is to obtain perspectives from workers in the real estate sector regarding the utilization and consequences of digital transformation technologies in the industry. Given a sample size of 500 respondents from diverse regions across the nation, the survey analysis has the potential to yield significant insights into the present status of digital transformation within the Chinese real estate sector. The sample survey questionnaire is shown in Fig. 3.

Survey Questionnaire

1. Please provide your name (optional): _____
2. Please provide the name of your organization (optional): _____
3. In which area are you primarily involved in the real estate industry? (Check all that apply)
   - ○ Residential
   - ○ Commercial
   - ○ Industrial
   - ○ Retail
   - ○ Other (please specify)
4. How familiar are you with the concept of digital transformation in the real estate industry?
   - ○ Very familiar
   - ○ Somewhat familiar
   - ○ Not at all familiar
5. What digital transformation technologies have you seen in the real estate industry in China? (Check all that apply)
   - ○ Online property marketplaces
   - ○ Smart home technology
   - ○ Virtual and augmented reality
   - ○ Mobile apps
   - ○ Artificial intelligence
   - ○ Big data analytics
   - ○ Blockchain technology
   - ○ Other (please specify)
6. How do you think digital transformation has impacted the real estate industry in China?
   - ○ Increased efficiency
   - ○ Improved customer experience
   - ○ Increased competition
   - ○ Disruption of traditional business models
   - ○ Other (please specify)
7. What challenges have you experienced in implementing digital transformation in your real estate enterprise? (Check all that apply)
   - ○ Lack of digital skills and knowledge
   - ○ High costs of implementation
   - ○ Resistance to change from employees
   - ○ Difficulty in integrating new technologies with existing systems
   - ○ Security concerns
   - ○ Other (please specify)
8. Have you seen any benefits from implementing digital transformation in your real estate enterprise? (Check all that apply)
   - ○ Increased revenue
   - ○ Improved customer satisfaction
   - ○ Increased efficiency
   - ○ Cost savings
   - ○ Other (please specify)
9. How do you see digital transformation impacting the real estate industry in China in the future?
   - ○ It will continue to disrupt traditional business models
   - ○ It will become the norm in the industry
   - ○ It will increase competition
   - ○ It will not have a significant impact
   - ○ Other (please specify)
10. What is your current role in the real estate industry?
    - ○ Real estate agent/broker
    - ○ Property manager
    - ○ Developer
    - ○ Investor
    - ○ Other (please specify)
11. How long have you been working in the real estate industry?
    - ○ Less than 1 year
    - ○ 1-5 years
    - ○ 5-10 years
    - ○ More than 10 years
12. What is the size of your real estate enterprise in terms of employees?
    - ○ Less than 10
    - ○ 10-50
    - ○ 50-100
    - ○ More than 100
13. Please provide your contact details: _____

Thank you for your participation!

Figure 3 Sample survey questionnaire

The Decision Making Trial and Evaluation Laboratory Method and Complex Proportional Assessment (DMAC) software is utilized to conduct DEMATEL analysis to identify and examine the interrelationships and impacts between various factors in the analysis of digital transformation in real estate enterprises within China.

Real estate firms' relative relevance is their standing among similar firms in the same industry. The metric is calculated from survey data using a weighting technique that incorporates the relative relevance of each component, as assessed by study participants. Fig. 4 shows how

Chinese real estate companies use digital transformation approaches. Big Data Analytics scored 61% and AI 65%. Online Property Marketplaces scored 58% and Mobile Apps 56%. VR/AR and Smart Home Technology were least preferred. AI is better because it can evaluate large amounts of data, improve decision-making, and automate processes. Training AI models with unique, high-quality data improves performance. Transparency, ethics, and regulatory compliance are essential for AI systems. Real estate companies should also invest in cybersecurity to protect their AI systems.

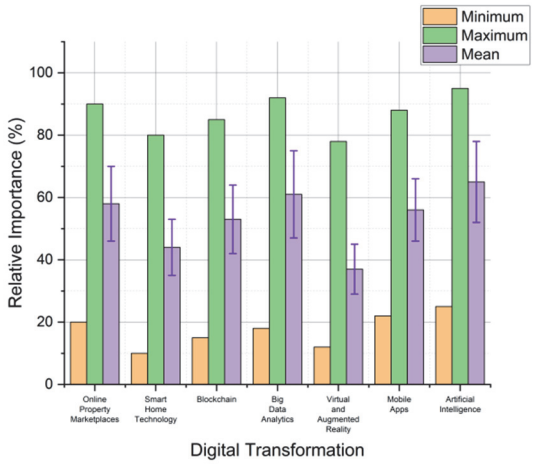


Figure 4 Relative importance analysis of real estate enterprises in China

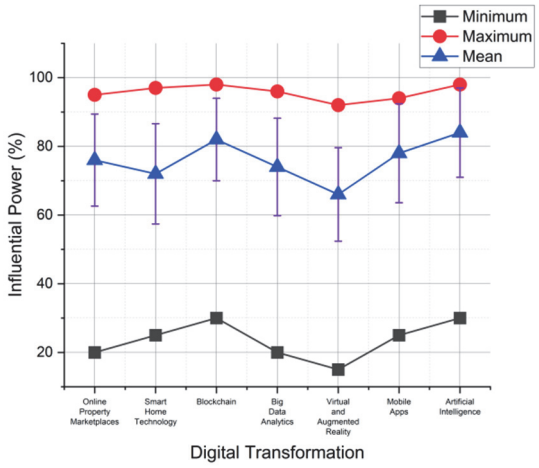


Figure 5 Influential power analysis of real estate firms operating in China

Influential power is the ability of real estate companies to shape the industry and market through their actions and decisions. Survey data is utilized to calculate the dependent variable by analyzing each factor's correlation and regression coefficients to determine its impact. Fig. 5 shows how the digital revolution affects Chinese real estate enterprises. AI had the highest mean score (84%), followed by Blockchain (82%). Mobile Apps and Online Property Marketplaces scored 76% and 78%, respectively. VR/AR and Smart Home Technology were the least effective. AI can make data-driven choices, automate processes, and tailor offerings, making it superior. AI systems must be continuously updated and trained on high-quality, diversified data to improve performance. Integrating AI into company operations requires effective integration techniques and adequate data and privacy protections. To implement AI-driven processes and procedures, organizations must prioritize infrastructure and human competencies.

User likeliness is the chance of Chinese real estate clients using their services in the future. Survey data is analyzed to compute the percentage of consumers likely to use the services again. Fig. 6 shows user likeliness scores for digital transformation approaches in Chinese real estate firms. AI had the highest average score of 78.2%, while Blockchain had 75.3%. Online Property Marketplaces and Mobile Apps had high mean ratings of 71.6% and 72.9%. VR/AR and Smart Home Technology were least preferred. AI improves decision-making, automates processes, and customizes services for clients. AI algorithms must be transparent, ethical, and compliant with rules to increase performance. Clients must be informed about data usage and confidentiality. Companies must prioritize crucial infrastructure and people competencies to implement AI-driven systems and procedures. AI algorithms should be constantly improved.

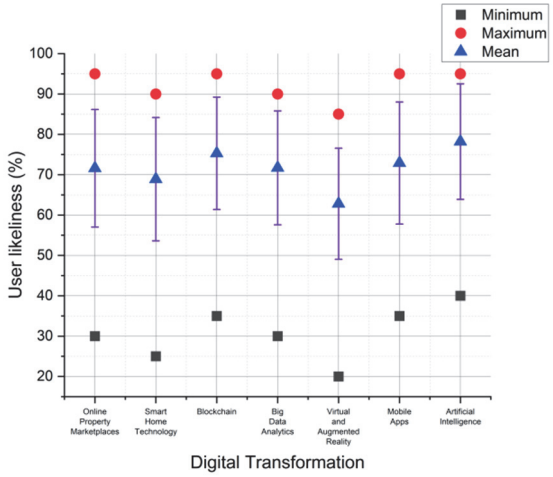


Figure 6 User likeliness analysis of the real estate firms operating in China

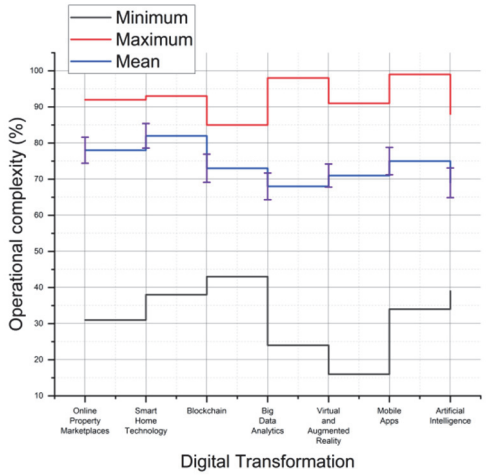


Figure 7 Operational complexity analysis of the real estate firms operating in China

Operational complexity refers to the difficulty of managing real estate firms in China. The measure is computed from survey data by calculating the average complexity of various operational activities. Chinese real estate companies digital transformation functional complexity scores are shown in Fig. 7. Smart Home

Technology had the highest average score of 82%, followed by Online Property Marketplaces at 78%. Blockchain's 73% mean score indicates its operational complexity. Smart Home Technology automates home security, energy management, and entertainment, making it effective. This can significantly simplify real estate operations. User-friendliness and compatibility with existing systems improve performance. Companies should train customers and staff to use technology well. Corporations must prioritize Smart Home Technology infrastructure and people competencies.

Usability refers to how easily Chinese consumers can use real estate companies services. Survey data is analyzed to calculate the level of service ease or difficulty. Chinese real estate enterprises' digital transformation methods' usability scores are shown in Fig. 8. AI had the highest mean score of 75%, while Smart Home Technology scored 72%. VR/AR usability was 58% on average. AI improves operational efficiency and provides intelligent and customized client recommendations. Technology must be accurate, reliable, and adaptable to market changes to boost performance. Companies should prioritize user-friendly interfaces and data input refinement to ensure real outcomes. To ensure proper technology use, employees and clients must be properly trained.

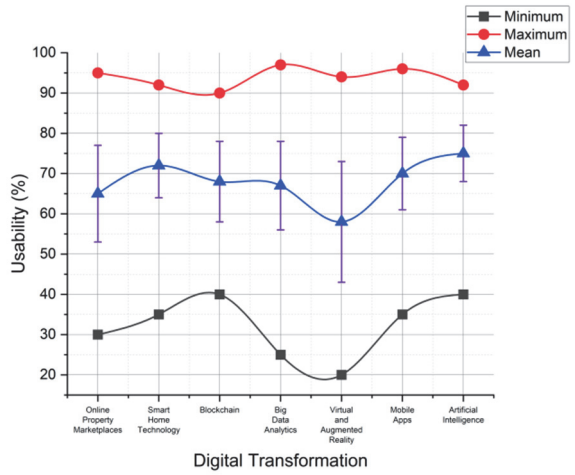


Figure 8 Usability analysis of the real estate firms operating in China

The outcomes of the experiment illustrate the efficacy of the suggested approach in assessing the operational efficiency of real estate firms. The methodology employed facilitated a thorough evaluation of the operational effectiveness of the organizations and identified specific domains that require enhancement. The utilization of the benchmarking tool enabled enterprises to evaluate their performance against that of their competitors.

5 CONCLUSION AND FUTURE SCOPE

The Chinese real estate industry has grown substantially over time, serving as a crucial catalyst for the nation's economic development. In light of heightened competition within the real estate industry, enterprises must implement efficacious performance evaluation techniques to bolster their competitiveness and maintain long-term growth. The Real Estate Enterprise Performance Evaluation Method (RE2PRM) is a novel and dependable methodology that facilitates the proficient evaluation of real estate enterprises' performance. The RE2PRM framework encompasses a range of performance indicators that hold significance for the real estate sector. These indicators span across the financial, market, and social responsibility metrics.

According to the experimental findings, the RE2PRM approach demonstrates a high level of resilience and effectiveness in assessing the performance of real estate enterprises. The approach thoroughly evaluates the company's operational effectiveness, identifying its weaknesses and strengths. Moreover, the system provides a benchmarking mechanism that allows corporations to assess the performance of their rivals.

This study makes three distinct theoretical contributions. First, it advances the DEMATEL methodology by integrating it with real estate performance evaluation, demonstrating its applicability in identifying causal relationships among multi-dimensional performance indicators in a digitally transforming industry. The RE2PRM framework extends DEMATEL's traditional scope from general systems analysis to sector-specific enterprise assessment, offering a replicable model for other industries undergoing digital transformation.

Second, this research contributes to digital transformation theory by empirically validating the hierarchical influence structure of seven key technologies - AI, blockchain, big data analytics, VR/AR, mobile applications, smart home technology, and online marketplaces - within China's real estate context. The findings reveal that AI (84% influential power) and blockchain (82%) function as core drivers, while smart home technology presents the highest operational complexity (82%), providing a nuanced understanding of technology adoption trajectories.

Third, the study enriches real estate management theory by proposing an integrated evaluation framework that transcends conventional financial metrics. By incorporating customer satisfaction, employee engagement, and environmental impact alongside financial indicators, RE2PRM addresses the limitations of traditional performance assessment methods that rely predominantly on historical data.

The experimental results demonstrate that RE2PRM effectively improves real estate enterprises' performance evaluation accuracy, user acceptance, and practical applicability. However, this study acknowledges limitations, including reliance on self-reported survey data and the exclusion of certain qualitative metrics. This study is subject to several methodological limitations that warrant acknowledgment. First, the reliance on self-reported survey data from 500 real estate sector employees introduces potential common method bias, as single-source respondents may inflate the observed relationships between digital transformation adoption and perceived performance outcomes. Future research should incorporate objective performance metrics (e.g., financial statements, transaction volume data) to validate these perceptual measures.

Second, the cross-sectional design captures a single temporal snapshot of digital transformation implementation, precluding causal inferences about the longitudinal trajectories of technology adoption and

performance improvement. The rapidly evolving nature of digital technologies suggests that the relative importance of AI, blockchain, and other technologies identified in this study may shift as market conditions and regulatory frameworks change.

Third, the sample focuses exclusively on the Chinese real estate market, which operates within a distinctive institutional environment characterized by state intervention, rapid urbanization, and unique platform economics. The generalizability of RE2PRM to other national contexts - particularly those with different regulatory regimes or technological infrastructures - requires empirical verification. Future research should validate the model by longitudinal data, expand the indicator system to include ESG (Environmental, Social, and Governance) metrics, and examine the generalizability of RE2PRM across different national contexts and real estate market structures.

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