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From Bricks to Bytes: Transforming Real Estate into the Core Platform of the Digital Ecosystem

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Abstract: The traditional concept of real estate, rooted in physical attributes—including land, buildings, and infrastructure—has undergone significant transformation in the digital age. This paper repositions real estate as a foundational platform within the broader digital ecosystem, serving as an integrative node that connects various digital platforms. By examining processes such as informatization, servicization, automatization, e-spatialization, dematerialization, and humanization, this study demonstrates how these elements collectively embed economic, social, and environmental value states into the digital framework of real estate. Leveraging advanced technologies and interdisciplinary methodologies, this paper constructs a comprehensive framework for understanding real estate's digital evolution. The findings highlight real estate's pivotal role in providing essential spatial and digital infrastructure that support the integration and operation of other platforms. It contributes to the discourse on platformization by offering a new model for understanding and utilizing real estate in a digitally driven society while proposing strategies crucial for its successful implementation in the ongoing digital transformation.

Keywords: digital transformation; real estate platforms; dematerialization; servicization; platformization

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1. Introduction

The platformization of various sectors is reshaping activities, processes, and societal structures, capturing the attention of researchers, policymakers, and industry leaders. In a rapidly digitizing world, platforms have emerged as critical infrastructures that not only organize digital ecosystems but also redefine economic models and technological systems [1]. These platforms have become central across multiple domains, influencing areas such as economics, social media, e-commerce, education, and healthcare and systematically organizing and managing structural, informational, and operational components [2]. The transition of socio-economic, political, educational, and environmental activities to digital platforms marks a fundamental shift, redefining how we engage with the world by moving from physical spaces to digital environments [3].

This digital transformation signifies a profound change in societal, enterprise, and governmental organizations, transcending economic transactions to emerge as critical arenas where knowledge, power, and interaction converge. Similar to the historical evolution of cities from simple gathering places to complex hubs, digital infrastructures must now adapt to the complexities of contemporary life. As these platforms reconfigure societal structures, they catalyze innovative organizational models, redefine user interactions, and transform regulatory situations. The shift from the physical to the digital embodies a paradigm change in value generation, measurement, and management, impacting decision-making processes across all levels of society [4,5].

Despite their growing ubiquity, defining and conceptualizing platforms remain challenging due to their multifaceted nature, encompassing elements that are not yet fully organized or understood [6]. The digital revolution demands organization and coherence within the rapidly evolving landscape of platforms, yet this is often hindered by fragmentation and a lack of a

unifying framework. Disparate systems frequently operate in silos, leading to inefficiencies and obstacles in creating a cohesive digital ecosystem essential for effective functioning in the digital era [7]. Addressing these challenges requires a deeper understanding of platform architectures, coordination processes, and the mechanisms of interoperability.

In response, this study proposes considering real estate development as a model for creating a global platform, leveraging its historical role in structuring the physical world and its potential to serve as a dynamic digital platform. Real estate and urban development have long functioned as a physical platform, with land and infrastructure supporting diverse activities such as residential, commercial, industrial, and agricultural functions. Over centuries, real estate has developed essential processes—like ownership rights, management, valuation, and transactions—through trial and error. Now, these processes are transitioning into the digital realm, digitizing the functions and activities that allow real estate to operate efficiently without making physical properties themselves digital. This shift encompasses digitization, servicization, automatization, and e-spatialization, transforming real estate into a global, integrative platform where other sectors and platforms can connect and thrive. By doing so, real estate offers the space and infrastructure needed to facilitate the seamless transition of processes and activities from physical to digital environments, positioning itself as a key component in the evolving digital ecosystem.

The primary objective of this research is to conceptualize digital platforms through the digitization of real estate, positioning it as a fundamental model to guide and integrate the development of platforms rooted in physical reality. This approach bridges the gap between the physical and digital worlds, offering insights that are both theoretically robust and practically applicable, particularly in the intelligent development and management of real estate. By presenting examples of the convergence of traditional real estate practices with modern technological advancements, this research establishes real estate as a global referential platform within the broader context of platformization. The proposed framework provides a basis for creating interconnected, intelligent ecosystems that enrich both digital and physical experiences, offering actionable strategies for integrating digital platforms into real estate and urban environments in a meaningful, sustainable, and value-driven manner.

2. Literature Review

The rapid advancement of digital technologies is fundamentally reshaping industries, transforming traditional business models, and redefining how value is created and exchanged. Digital platforms, serving as foundational infrastructures across various sectors, are at the forefront of this evolution, driving innovation, efficiency, and sustainability. A digital platform is more than just a technological framework; it acts as a mediator that facilitates interactions and value exchanges between interdependent user groups, creating network effects that increase in value as participation grows. In the context of real estate, platforms enable dynamic exchanges and connectivity by digitizing services and processes. This literature review explores the transformative potential of digital platforms, particularly within real estate, examining how these platforms revolutionize established sectors and pave the way for new economic and social paradigms [1,8].

In the current digital environment, platformization is altering economic structures, market dynamics, and labor relations. This shift, driven by digitization and automation, creates new forms of value while challenging conventional business models and regulatory frameworks [9]. Understanding the determinants of digital platforms, especially in dominant sectors like the economy, is crucial for leveraging them to encourage economic development [10]. Research has identified key factors, such as performance expectancy, trust in technology, perceived risk, and privacy concerns, as significant influences on the adoption and success of platformization [11]. The rise of e-commerce platforms, facilitated by increased internet and smartphone success, exemplifies how digital platforms generate value and promote innovation across various sectors [12]. By integrating the contingency theory and socio-economic marketing theory, research suggests that organizations must adapt to these platforms as strategic innovations, responding to shifts in consumer behavior

and the broader socio-economic dynamics. A study presented in [13] offers insights into the diverse ecosystem of platforms and their varying roles in meeting market needs.

Digital platforms have fundamentally transformed industries by shifting traditional business models towards decentralized, consumer-centric ecosystems. Initially rooted in multi-sided market theories, these platforms have evolved into essential digital infrastructures that facilitate complex interactions among users, services, and technologies [14]. They enable rapid scaling, help value co-creation, and redefine competitive dynamics [15] while also enhancing market efficiency and global communication [16,17]. Platforms are increasingly recognized as integral to broader ecosystems where multiple stakeholders collaborate in their business [18,19]. Foundational theories emphasize the importance of network effects, where the value of a platform grows with increased user participation, and modularity, which supports innovation [20,21]. However, as platforms aggregate data and generate value, they face governance challenges in balancing openness with control [22,23]. Maintaining standardization and interoperability is also critical for sustaining these network effects and ensuring the long-term viability of platform ecosystems [24].

In the energy sector, digital platforms have enabled decentralized and participatory energy generation, turning consumers into 'prosumers' who both produce and consume energy. This shift aligns with the broader trend of integrating complex systems, streamlining interactions, and facilitating innovation, particularly through peer-to-peer trading and decentralized production [25,26]. The integration of blockchain and AI technologies in these platforms has redefined energy distribution, management, and business models, enhancing efficiency and security in transactions [27–29]. These platforms illustrate how increased user participation drives growth, contributing to the democratization of energy production and the broader transition towards sustainable economic models [30,31]. By supporting renewable energy sources and offering personalized user experiences, these platforms are reshaping the energy market and highlighting the evolving role of digital platforms in modern industries [32,33].

Despite their widespread impact, platforms face significant conceptual and definitional challenges across various fields, exposing gaps in current platform studies that lack a comprehensive framework to integrate their diverse and complex nature. This often leads to inconsistent strategies and missed opportunities for cross-sectoral integration, particularly in emerging areas like real estate [34]. The integration of information structures and digital technologies is crucial across all domains, including real estate, where the implications of platforms are increasingly recognized but not fully understood [6]. The concept of a digital twin, which is a detailed digital replica of a physical asset, illustrates how real estate can transition from a purely physical entity to a digitally managed platform, enhancing maintenance, operational efficiency, and safety through data integration and real-time monitoring [35]. The move towards intelligent property management underscores the potential of real estate platforms to combine various digital tools and data sources for holistic management and value enhancement.

Information and expectation are integral to the value state of digital platforms and crucial for their long-term success and adaptability. Effective information management enhances value creation [36], while user and stakeholder expectations drive platforms to evolve in response to changing ecosystem demands [37,38]. Understanding these value states is key to how digital platforms facilitate interactions and embed value through evaluation, capture, and distribution [39]. Real estate embodies these properties, serving as a foundational digital platform capable of integrating various digital tools, from virtual property management to blockchain-based transactions, thereby redefining its role in the digital economy. The integration of blockchain and AI into real estate platforms, such as the tokenization of properties, transforms real estate into a fluid, accessible, and global asset class [40]. AI is revolutionizing property management and marketing, positioning real estate as a central node in emerging smart cities and IoT ecosystems [41]. Moreover, digital platforms in land administration and urbanization illustrate the potential of digital frameworks to optimize physical spaces, creating more transparent and efficient systems [42].

Digital technologies are transforming traditional advertising and customer engagement methods, creating rich, interactive brand experiences that transcend the physical world. This shift is mirrored in real estate, where the integration of VR, AR, and extended reality (XR) technologies offers virtual tours, property visualization, and immersive experiences, enhancing customer engagement and streamlining decision making. The potential of the metaverse and XR in real estate suggests a future where digital twins of properties or entire neighborhoods can be explored virtually, allowing buyers and investors to interact with real estate in a fully immersive environment before making any physical visits [43]. This underscores the importance of innovative digital promotion strategies, such as leveraging digital marketing tools and social media, to remain competitive in evolving markets. The concept of network externalities, where the value of a platform increases with its user base, is also crucial in understanding the scalability and sustainability of digital platforms [44]. This phenomenon is particularly relevant in real estate, where platform-based technologies facilitate new interactions and network formation, bridging geographical and organizational gaps through digital tools like cloud computing and social media [45]. The ability of platforms to create digital ecosystems that enhance value and functionality aligns with the evolving role of real estate as a foundational platform integrating various technologies.

Advancements in construction materials, technologies, and automation are transforming real estate into a digital and intelligent platform, fundamentally reshaping the built environment by enhancing efficiency, sustainability, and adaptability [46–48]. This evolution is shifting real estate from a traditionally physical domain to a dynamic digital ecosystem, where value is increasingly created and delivered through digital means. The process of dematerialization, supported by servicization, reduces reliance on physical assets by leveraging digital alternatives to provide enhanced services [49]. As real estate integrates technologies like IoT, AI, and big data analytics, it plays a pivotal role in the broader concepts of smart properties and cities, creating interconnected ecosystems that interact in real-time with their environments and occupants [50]. The digitization of real estate, driven by sensors, data analytics, and intelligent systems, is revolutionizing the industry by enhancing connectivity, management, and decision making elsewhere [51]. This transformation is evident in how digital platforms now facilitate property management, leasing, and sales, increasingly moving away from traditional in-person interactions [52]. IoT and AI further enable the remote management of real estate assets, detaching value from physical presence and embedding it within digital frameworks [53,54].

Recent studies indicate that the integration of advanced technologies in real estate supports human–machine collaboration, optimizes urban infrastructure, and enhances urban service delivery, particularly in the context of smart cities, where platforms manage physical spaces and create digital commons for social connectedness and civic engagement [55]. This convergence is transforming traditional urban developments into dynamic, intelligent ecosystems crucial for addressing challenges in shaping the future of territorial planning and management [56]. Moreover, in the context of green development and urban transformation, real estate platforms are increasingly intertwined with urbanization financing mechanisms, positioning real estate as a foundational platform for broader initiatives. This integration is particularly significant in managing the balance between economic growth, urban development, and environmental sustainability, with robust governance structures being essential to navigating these complex dynamics [57].

In recent years, there has been an increasing focus on the practical applications of platforms within real estate [58,59], particularly in relation to PropTech (Property Technology). These applications, which focus on enhancing marketing, transactions, and property management, demonstrate how platforms are reshaping real estate through digitization [60]. Platforms such as *Craigslist.org*, *Realtor.com*, *Zillow.com*, *Airbnb.com*, and *Booking.com* have become pivotal in transforming the way properties are advertised, rented, and shared [61]. However, while these innovations are essential, they primarily address the operational aspects of real estate's digital transformation.

The literature shows that advanced digital technologies are revolutionizing real estate by digitizing key activities such as transactions, property management, and marketing. These transformations are particularly important in smart cities, where platforms manage physical spaces and enhance sustainability and governance. Practical tools and applications highlight the operational side of this evolution, improving connectivity, service delivery, and infrastructure management. However, the literature often overlooks the broader concept of platformization, which extends beyond these practical applications [62–64]. Real estate, with its deep-rooted fundamentals, knowledge, and central role in urban development, serves as an integrative framework that supports other platforms. This paper explores how platformization, combined with real estate's foundational elements, offers a richer model for both the sector and the broader digital economy.

3. Real E-State Platform

Real estate definitions are either concise or broad; a refined definition can be obtained based on insights from [65]: "Real estate is a multidisciplinary field that integrates finance, management, marketing, and property rights, serving complementary functions such as residential, commercial, and industrial uses, while supporting activities like renting, transacting, managing, analyzing, and developing, among others, in both private and public sectors." Historically, real estate has been deeply rooted in its physicality, consisting of land, buildings (improvements), and infrastructures. However, the advent of digital technologies is fundamentally reshaping this sector, shifting its traditionally physical functions into the digital realm. This transformation is not simply a migration of activities but a profound redefinition of real estate as a sophisticated digital platform that integrates technology, management, and intelligent systems. As digitization advances, real estate is evolving from a purely tangible foundation into a complex digital ecosystem driven by information and organized knowledge.

Traditionally, real estate has served as a physical platform for a wide range of activities—housing, commerce, education, health services, and more—each vital to societal functions. The real estate domain, as a matrix of interconnected activities, provides the structural and spatial support necessary for their realization, whether in the form of land or buildings. This physical platform, segmented into various usage types, interconnects essential urban and socio-economic activities. As these physical platforms evolve, the integration of advanced technologies, such as IoT, AI, and big data analytics, is transforming real estate into intelligent systems, reflective of broader trends in property and urban development.

The proposition of real estate as a global referential platform within the digital ecosystem is grounded in its evolution as a highly organized and structured system, providing a natural blueprint for digital platforms. This continuity from physical to digital platforms ensures that the complexities of human activities, which are already effectively managed in the real world, transition seamlessly into the digital ecosystem. Technological advancements now allow for the creation of digital representations of physical spaces, enabling real-time data collection, analysis, and interaction—core functionalities of digital platforms. As real estate embraces these technologies, it enhances its functionality and sustainability, positioning itself as a foundational platform capable of guiding and integrating developments across other sectors.

As real estate evolves from a physical asset into a digital platform, integrating Environmental, Social, and Governance (ESG) principles becomes increasingly vital [66]. These principles—including data privacy, inclusivity, social stability, and sustainability—are key to determining the long-term value and resilience of real estate in both physical and digital contexts. Social or political instability, labor conflicts, and risk perception can heavily influence property values, particularly in regions prone to disruption. Additionally, as smart technologies and digital connectivity expand, ensuring robust security systems to safeguard personal data and privacy is critical, as neglecting this could lead to social devaluation from privacy breaches. Proximity to education and healthcare, alongside inclusive design and policies, further enhances property attractiveness and social value [67]. To function

as a comprehensive digital platform, real estate must not only digitize operations but also embed ESG values into its governance structures, ensuring sustainable urban development that aligns with broader goals of equity, growth, and responsible governance.

This section will now explore how real estate, at both the property level and in broader urban spaces, embodies the fundamental properties of digital platforms, demonstrating its role as an ideal symbiosis where both realms mutually enhance each other's evolution.

3.1. Informatization

The informatization of real estate represents a transformative shift in how properties are conceived, produced, and managed. Traditionally valued for their physical attributes, real estate assets are now increasingly recognized for the wealth of information they generate and hold. This evolution marks the transition of real estate from being a static, physical asset to becoming a dynamic, data-centric platform. In this new paradigm, every aspect of a property—its structure, location, design, usage patterns, and environmental interactions—is captured digitally, transforming static entities into dynamic sources of actionable information. This shift underscores a broader trend where stakeholders, including owners, managers, and tenants, increasingly rely on data to optimize decision-making processes in real estate development and management.

A key aspect of informatization is the recognition that while physical goods are consumed and interacted with, their true value lies in the information they provide. This data-driven approach allows for the real-time collection and analysis of critical metrics such as energy usage, occupancy rates, and maintenance needs. Such insights enable more efficient operations, cost reductions, and enhanced overall property performance. By digitizing real estate assets and processes, information becomes richer, more accessible, and better integrated with other relevant data sources, including market trends and economic indicators. This integration not only facilitates sophisticated analysis and forecasting but also provides stakeholders with a comprehensive understanding of real estate foundations, leading to more informed and strategic decisions.

As real estate increasingly aligns with the digital and knowledge economy, its value is redefined by its capacity to generate and utilize information. This shift reflects a new valuation model where data and knowledge are the primary drivers of economic growth. Real estate thus emerges as a platform for information integration and exchange, fostering greater transparency, efficiency, and innovation. The implications of this shift are significant, opening new avenues for value creation through innovations such as predictive maintenance, personalized tenant experiences, and smart city connectivity. These developments contribute to the creation of more sustainable and resilient urban environments. To remain competitive and relevant, the real estate industry must fully embrace this transformation, harnessing the power of data to drive continuous innovation, enhance decision making, and build more valuable, sustainable assets for the future.

3.2. Servicization

The concept of servicization in real estate signifies a profound shift from viewing properties as mere physical assets to recognizing them as dynamic platforms that offer a spectrum of services and experiences. Traditionally, real estate was valued primarily for its tangible attributes, such as location and structure. However, as the expectations of occupants have evolved, there has been a growing emphasis on the utility and quality of services that properties provide. This transformation reflects a broader trend where the value of real estate is increasingly measured by the satisfaction and experiences of its users rather than just its material characteristics. Digital tools and platforms now play a crucial role in facilitating property management, leasing, and sales, underscoring the industry's evolution from a physical product to a service-oriented platform.

This shift towards servicization brings about a more dynamic and flexible approach to real estate management. Unlike static physical products, services can be tailored to meet the changing needs of users, reflecting a growing demand for adaptable and responsive

environments. The rise of flexible workspaces and co-living spaces exemplifies this trend, highlighting the importance of versatility in real estate. As properties evolve into platforms that support a variety of services, they become hubs for various activities, efficiently connecting users with the resources they need. This approach aligns with the broader trend of dematerialization, where the focus shifts from the ownership of physical assets to the access and consumption of services, emphasizing the role of real estate as an essential platform in the modern economy.

Furthermore, the servicization of real estate is closely linked to the concept of financialization, where properties are increasingly viewed as financial assets. This abstraction from the physical form into monetary terms, as seen with instruments like Real Estate Investment Trusts (REITs), underscores the industry's progression towards a more intangible basis of existence. The transition from seeing real estate purely as physical structures to recognizing it as a platform for delivering services and supporting financial assets illustrates the depth of this transformation. As real estate continues to evolve, the emphasis on service will reshape the industry, positioning it as a dynamic and adaptive component of the digital economy that is capable of meeting the changing needs of both users and the market.

3.3. Automatization

The transformation of real estate into an intelligent framework is driven by the integration of advanced data analytics, automated systems, and digital tools. Properties are increasingly becoming intelligent through the incorporation of smart technologies like sensors, automated building management systems (BMSs), and the Internet of Things (IoT). These technologies enable real-time data collection and analysis, allowing properties to self-manage, adapt to changing conditions, and provide personalized environments for occupants. As buildings become more autonomous and efficient, operational costs decrease and sustainability increases, reflecting a shift towards structures that respond intelligently to their environments.

Beyond individual properties, cities are evolving into intelligent ecosystems where data from multiple properties and urban infrastructure are aggregated to enable comprehensive urban management. Smart cities utilize vast amounts of data from transportation networks, energy grids, and environmental monitoring systems to optimize urban functions and improve residents' quality of life. The intelligence of cities is characterized by their capacity to integrate diverse data streams, facilitate real-time decision making, and enhance urban services. This interconnectedness between intelligent properties and smart city frameworks creates a symbiotic relationship, wherein the collective intelligence of the city informs and is informed by the intelligence of its individual properties.

At the management level, sophisticated algorithms, predictive analytics, and decision support systems amplify the intelligence of real estate. Real estate managers now have tools that allow them to analyze market trends, forecast property values, and optimize asset portfolios with unprecedented precision. These intelligent systems reduce risks and enhance decision making by providing data-driven insights that support strategic planning. This shift towards intelligent real estate management positions the industry at the forefront of digital transformation, where properties are not just static assets but dynamic entities capable of learning, adapting, and evolving in response to their surroundings.

The stratified organization of real estate, from individual properties to entire cities, forms the foundation of its evolving intelligence. This layered structure ensures continuity and connectivity across various scales, supporting the development of platforms that manage both physical spaces and the flow of information, services, and resources across digital and physical domains. The convergence of intelligence at the property, city, and management levels creates a holistic approach that emphasizes efficiency, sustainability, and adaptability. These interconnected layers of intelligence enhance the broader digital infrastructure, positioning real estate as a foundational digital platform that supports modern urban life. As real estate continues to integrate intelligent systems, digital information, and technologies, it plays a pivotal role in shaping the future of urban living. The transition towards intelligent real estate

not only enhances the value and functionality of physical spaces but also aligns with the broader trends of digitization and platformization. This evolution necessitates the rethinking of traditional concepts of property ownership, valuation, and management.

3.4. E-Spatialization

The concept of space in real estate is undergoing a profound transformation as technological advancements diminish traditional constraints associated with physical spaces. Historically, real estate was defined by its physical boundaries—land, buildings, and geographic locations—which limited accessibility, communication, and movement. However, the rise of digital technologies and the ubiquitous reach of the internet are eroding these limitations, giving rise to a new paradigm referred to as 'e-spatialization.' In this emerging landscape, physical spaces are increasingly being supplanted by digital spaces (or lands) that are fluid, accessible, and largely frictionless. E-spatialization represents a world where space is less about physical distance and more about connectivity and accessibility to the properties of space through digital platforms. This shift has profound implications for real estate, as businesses and individuals can now interact, work, and transact without being physically co-located. Traditional demands on physical real estate are evolving, with office spaces increasingly being replaced by virtual workspaces and retail spaces transitioning into digital storefronts.

The transformation from a physical space to e-space also has significant implications for human perception and engagement with space. Traditionally, geographic space was defined by tangible attributes and was closely tied to human experience and identity. However, the acceleration of mobility and the increasing mediation of spatial interactions through digital platforms are redefining space as a mental or "cognitive space", which is more fluid and less bound by physical constraints. As digital platforms make space more accessible, its novelty and perceived value diminish, leading to more transient and less rooted interactions with our environment. The commoditization of spatial utility attributes, driven by advancements in information technology, further accelerates this shift. The ability to virtually access and experience distant locations without physical movement fundamentally alters our relationship with space. This phenomenon is evident in how urban dwellers increasingly rely on digital tools to bring spatial utilities into their immediate environment, reducing movement and the need for physical exploration.

Geographical Information Systems (GISs) play a critical role in the spatialization of data, bridging the gap between physical spaces and digital platforms. By integrating data from various sources—such as property attributes, environmental factors, and socioeconomic indicators—a GIS creates a cohesive digital platform that transforms traditional real estate functions. The spatialization of information through geographical coordinates enables new capabilities in site selection, transaction realization, value analysis, and spatial management. These functions are facilitated by the digitized environments within GISs, which serve as the backbone of modern real estate platforms. The integration of GISs highlights the sector's shift from a physical to a digital domain, aligning with the broader trend of dematerialization in real estate. As real estate evolves into a digital platform, a GIS becomes an indispensable tool, providing the spatial framework necessary for managing and optimizing this transformation.

As illustrated in Figure 1, the transformative power of a GIS in real estate management is further underscored by its ability to integrate and spatially code data across various disciplines. This comprehensive approach enables sophisticated visualization, querying, and analysis, allowing stakeholders to interpret spatial relationships and dynamics that significantly impact real estate values, usage, and development potential. A GIS excels in layering and connecting thematic data, turning static real estate information into a dynamic, interactive platform. By overlaying maps with data on land use, zoning, transportation networks, and environmental risks, a GIS provides a holistic view essential for strategic planning and decision making. The system's ability to offer real-time updates and scenario modeling enhances its utility, enabling a dynamic understanding of space and its attributes.

As real estate data become digitized and geocoded within a GIS, the system evolves into a spatial platform that supports traditional property management while enabling advanced functions like market analysis, risk assessment, and urban planning.

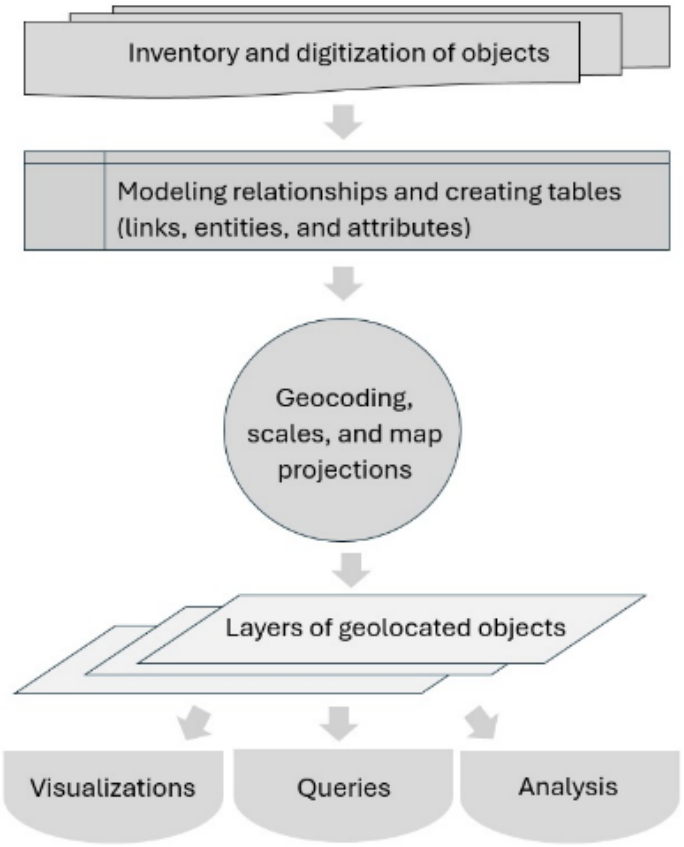

Figure 1. Components of GIS.

3.5. Dematerialization

Real estate, fundamentally rooted in its physical presence, is increasingly defined by the utility of the services it provides rather than its material form. This shift towards dematerialization represents a transformative change within the industry, where the focus moves from traditional, resource-intensive construction to more efficient, sustainable, and technologically advanced activities. Dematerialization in real estate involves reducing reliance on physical materials while maintaining or even enhancing the functionality and performance of buildings. This transformation is achieved through strategies such as optimizing resource use, miniaturizing structural components, minimizing material consumption, and integrating advanced technologies that support lighter and more efficient structures. Consequently, the real estate sector is evolving towards creating buildings and infrastructures that align better with sustainability principles, reducing environmental impact, and optimizing lifecycle energy requirements.

Dematerialization operates on multiple levels, extending beyond the reduction in physical materials to include the adoption of alternative materials and resource optimization and the substitution of traditional physical products and services with digital or service-oriented alternatives. This process involves a significant reduction in material consumption by replacing physical goods or processes with virtual equivalents, thereby enhancing resource efficiency and reducing dependence on resource-intensive sectors. This evolution is fundamentally reshaping how buildings are conceived, designed, and utilized, emphasizing the creation of spaces that are less material-intensive while remaining adaptable and responsive to the evolving needs of society. The integration of smart technologies within buildings exemplifies

this shift, enabling the real-time monitoring and management of building systems, which, in turn, enhances profitability, productivity, safety, and overall functionality.

Moreover, the dematerialization of real estate is closely intertwined with the broader trend of digital transformation, where physical spaces are increasingly complemented by digital tools and services. This transition facilitates the creation of digital twins—virtual replicas of physical buildings—that improve planning, management, and maintenance processes. By reducing the need for physical resources and enabling the more efficient use of space and materials, dematerialization is ushering in a new era in real estate and urban development. This era is characterized by technological innovation and advanced analytics, which address the pressing environmental challenges of the construction industry while meeting the evolving demands of modern society.

In practice, dematerialization in real estate applies across various scales and dimensions—from the early design stages of buildings to their entire lifecycles, including the deconstruction and recycling processes. This holistic approach enables architects and planners to incorporate virtual simulations and dynamic lifecycle scenarios, optimizing resource use and minimizing environmental impact. Additionally, dematerialization promotes the revised and improved use of existing materials and technologies, enhancing the long-term sustainability of architectural solutions. The overarching goal of dematerialization is to achieve a balance of economic, social, and ecological factors, creating self-supporting systems with minimal uncertainty and negative impacts.

3.6. Humanization

Real estate management must recognize that properties are not merely structures made of bricks and mortar, but environments that encompass human lives, activities, emotions, and interactions. Just as living beings possess both physical bodies and emotional minds, real estate can be understood as dynamic entities whose vitality stems from the people who inhabit them. However, as real estate increasingly transitions into digital platforms, there is a risk that these spaces could become dominated by data and algorithms, with decisions driven solely by information. This deterministic approach, focused on past data, often overlooks the uncertainty and richness inherent in human emotions, motivations, and expectations. To develop more dynamic and human-centered platforms, it is essential to integrate both information and expectations as foundational elements. This integration ensures that digital platforms reflect not only the objective qualities of real estate but also the subjective experiences and emotional connections that users bring to these spaces, thereby bridging the gap between technological efficiency and human-centered design.

The concept of a "value state" offers a promising solution to the challenge of bridging the gap between digital information and the subjective expectations of users, as illustrated in Figure 2. The figure depicts the flow of informatization, where arrows from the "Physical world of expectations" to the "Digital world of information" represent the translation of subjective human experiences into structured data. A value state is not merely an economic measure but a holistic representation of human experiences across various domains, including historical, political, economic, and societal values. It encapsulates the subjective qualities that elevate real estate beyond its status as just a physical or digital asset. By embedding value states into digital platforms, the processes that currently dominate the industry can be humanized. This approach transitions the focus from managing properties as static assets to nurturing them as dynamic spaces that evolve and respond to human needs. Considering the emotional and experiential dimensions of real estate enables platforms to be more responsive to user needs, promoting environments that are both functional and fulfilling.

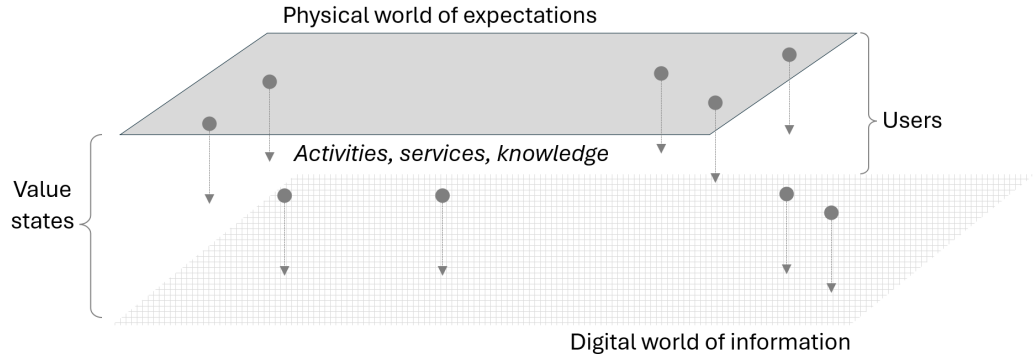

Figure 2. Value states.

Integrating value states into digital platforms also opens up new possibilities for measuring and understanding human expectations in a more scientific manner. These platforms could collect and analyze data on how individuals interact with spaces, how they feel about their environments, and what they expect from the real estate they use. This information can then be utilized to enhance the design, management, and operation of properties, ensuring that they align more closely with the values and desires of their occupants. By capturing and quantifying these subjective experiences, platforms can offer a more personalized and empathetic approach to real estate, ultimately creating spaces that are efficient and deeply connected to the human experience.

The shift towards integrating human emotions and expectations into digital platforms is not merely about enhancing user-friendliness; it requires fundamentally rethinking how we value and interact with space in the digital age. As digital platforms become the primary interface through which we engage with real e-estate, it is crucial that they reflect and accommodate our human nature. The concept of the value state is instrumental in achieving this by reminding us that at the core of every transaction, piece of data, and real estate decision, there are people with real emotions and expectations. By embracing this human-centric approach, we can create digital platforms that are not only efficient and innovative but also deeply connected to the human experience, ensuring that real estate continues to serve as a vital component of our lives in a meaningful and resonant way.

4. Discussion

The evolving role of real estate is highlighted as it transitions from a static physical asset to a dynamic, information-driven platform at the core of the digital ecosystem. Historically, real estate has served as the foundation for essential human activities—such as housing, agriculture, commerce, and industry—while naturally integrating key dimensions like value valuation, market analysis, management, transactions, ownership, policy, and development, many of which have progressively undergone digitization as fundamental components of platformization. Rather than representing an abrupt shift, this transition reflects the natural evolution of real estate's traditional roles, enabling improved service quality, connectivity, adaptability, and user engagement within today's digital environments. By accounting for the progressive development of real estate and its expanding functions, this study demonstrates its capacity not only to drive its own digital transformation but also to offer a solid foundation of conditioned knowledge that promises to effectively integrate and guide the platformization of other sectors.

This study builds upon existing research that has largely focused on the technological aspects of digitization, such as the integration of Geographic Information Systems (GISs), the Internet of Things (IoT), and data analytics into real estate practices. While previous studies have examined these technologies in isolation, our research positions real estate as a referential platform within the broader digital ecosystem, where technology, data, and service-oriented models converge. By framing real estate in this broader digital context, this study advances the discourse, contributing a holistic perspective that underscores real estate's longstanding foundational role, now extending into the digital age. This approach

deepens the conversation on how industries traditionally anchored in physicality can transition seamlessly into digital platforms.

The implications of this transformation extend far beyond operational efficiency. Real estate's shift towards platformization is driven by its digitization, servicization, automatization, dematerialization, and e-spatialization, moving the focus from its traditional role as a physical asset to the informatization of its activities and processes. This evolution aligns with the broader trend of platformization, where value is increasingly tied to digital connectivity, user interaction, and experience. Consequently, real estate emerges as a key enabler of innovation, facilitating the seamless flow of information, resources, and services across both digital and physical domains. This study highlights real estate's potential to serve as a flexible and adaptable infrastructure capable of supporting the integrated and resilient urban environments required by the modern digital ecosystem.

In practical terms, the platformization of real estate offers a robust framework capable of driving innovation and efficiency across multiple sectors and markets. The integration of advanced technologies such as IoT and GIS enhances real-time data collection, spatial analysis, and resource management, enabling more responsive and sustainable urban planning. Additionally, by aligning real estate with emerging trends in smart city development, this platformization model supports dynamic, adaptive property analysis and management systems that cater to evolving user needs.

5. Conclusions

The digital transformation of real estate marks a profound shift from its traditional role as a static physical infrastructure to a dynamic, intelligent platform embedded within the digital ecosystem. As societies increasingly rely on data, automation, and connectivity, real estate has emerged as a critical node in this evolving architecture, facilitating the seamless flow of information, optimizing various functions, and enhancing user experiences. This transformation challenges long-held perceptions of real estate, positioning it as a referential platform that integrates services and activities across sectors, driving smarter property management and urban development. Through processes like informatization, servicization, and automatization, real estate has transitioned from a passive asset into an active participant in the innovation ecosystem, enabling both digital and physical value creation.

The sector's transition from a physical to a digital platform—what we term the virtualization of real estate—represents its evolution into a fluid, adaptive system that retains foundational knowledge while expanding its reach within digital environments. This transformation creates an integrative framework that supports real estate's digital evolution and facilitates the platformization of other sectors that traditionally develop in isolation. Through platformization, real estate preserves its core role while enabling seamless integration across services, activities, and governance structures. This integrative platform forms a global digital infrastructure, or e-space, where other sectors can connect, utilizing real estate's established systems rather than creating fragmented solutions. As a comprehensive platform, real estate contributes to a globally integrated digital ecosystem, promoting coherence within an e-spatial framework that enhances efficiency, strategic development, and sustainability.

The interdisciplinary framework developed in this study shows how real estate functions as a flexible, intelligent system that bridges the physical and digital realms. This holistic approach provides both a strong theoretical foundation and practical solutions for the sector's digital transformation. The platformization of real estate has reshaped traditional concepts of space, service delivery, and property management, revealing it as an adaptable infrastructure capable of supporting new forms of interaction and value creation. By advancing platformization, real estate's evolution into a comprehensive digital ecosystem allows for coordinated e-spatial integration and smarter governance. Additionally, this study introduces key concepts such as e-state and e-spatialization, along with their humanization, which incorporates human emotions and experiences into platform design. These innovations not only ensure that digital real estate platforms are technologically advanced

but also make them responsive to the complexities of human experience, enhancing both functionality and user engagement.

Real estate thus plays a pivotal role in seamlessly integrating technologies across sectors, driving sustainability, adaptability, and innovation while enabling the convergence of physical and digital spaces. However, this transformation presents challenges, particularly concerning governance, data privacy, and equitable access. As technologies like blockchain and AI become integral to real estate's digital infrastructure, the complexity of managing these systems escalates, especially in relation to ownership, data control, and inclusivity. Without careful management, there is a significant risk of exacerbating existing inequalities, as smaller markets and underserved communities may struggle to access these advanced platforms. Addressing these limitations through robust governance structures and inclusive design strategies is crucial to ensuring that the digital evolution of real estate benefits all stakeholders equitably and develops a more connected, sustainable future.

The transformation of real estate into a digital platform redefines how we perceive and interact with spaces, evolving into a dynamic system that actively shapes the digital ecosystem through the integration of advanced technologies and a human-centered approach. This study positions real estate as a referential and integrative platform that drives cross-sector innovation, knowing that platformization is not without challenges. Issues such as labor conflicts, data protection, and inclusivity must be carefully addressed to build a resilient and sustainable digital real estate ecosystem. Ensuring privacy, operational continuity, and inclusivity is essential for the long-term success of these platforms. Future research should focus on incorporating these socio-economic dimensions to enhance both the functionality and social responsibility of real estate platforms. This integration opens new opportunities for economic engagement, resource management, and innovation, positioning real estate as a key contributor to a more connected, sustainable, and innovative future.

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