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The Role of Design Thinking and Technology in Innovation: A Bibliometric Analysis to Enhance Property Business Development

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Abstract

The property sector has undergone significant transformation through technological advancement and the strategic integration of design thinking. This paper employs bibliometric analysis to investigate the evolving intersection of technology applications and design thinking frameworks within property sector innovation. Specifically, it examines structural developments that enhance customer value, synthesizes current innovation trends, addresses practical challenges, and forecasts future trajectories. By evaluating academic contributions, thematic trends, and emerging frameworks, the study highlights how technology-enabled design thinking solutions contribute to business model innovation, product development, and user-centered approaches. The findings are intended to guide industry stakeholders in adopting sustainable innovation strategies to meet dynamic market demands. Through a bibliometric lens, this study positions design thinking and technology integration as critical mechanisms for advancing the competitiveness of the property sector.

Keywords: Design Thinking; Technology Integration; Innovation; Property Development; Bibliometric Analysis.

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Abstrak

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Page 317-331

Sektor properti telah mengalami transformasi signifikan melalui kemajuan teknologi dan integrasi strategis pemikiran desain. Artikel ini menggunakan analisis bibliometrik untuk menyelidiki perpotongan yang terus berkembang antara penerapan teknologi dan kerangka kerja pemikiran desain dalam inovasi sektor properti. Secara khusus, artikel ini menganalisis perkembangan struktural yang meningkatkan nilai pelanggan, mensintesis tren inovasi terkini, mengatasi tantangan praktis, dan meramalkan arah masa depan. Dengan mengevaluasi kontribusi akademis, tren tematik, dan kerangka kerja yang muncul, studi ini menyoroti bagaimana solusi pemikiran desain yang didukung teknologi berkontribusi pada inovasi model bisnis, pengembangan produk, dan pendekatan berpusat pada pengguna. Temuan ini dimaksudkan untuk membimbing pemangku kepentingan industri dalam mengadopsi strategi inovasi berkelanjutan untuk memenuhi permintaan pasar yang dinamis. Melalui lensa bibliometrik, studi ini menempatkan pemikiran desain dan integrasi teknologi sebagai mekanisme kritis untuk meningkatkan daya saing sektor properti.

***Kata kunci**: Design Thinking; Integrasi Teknologi; Inovasi; Pengembangan Properti; Analisis Bibliometrik.*

INTRODUCTION

Housing represents not only a fundamental human necessity but also an increasingly significant element within modern investment portfolios. Historically, residential property was primarily valued for its role as a basic shelter, fulfilling essential needs for safety, security, and stability. However, in today's economic landscape, property ownership has transcended its traditional function. Real estate is now widely perceived as both a lifestyle choice and a strategic financial asset, reflecting broader shifts in consumer perspectives and market dynamics (Wang, K. J., Chen, Y. H., Lee, Y. C., & Lin, 2024).

The motivations driving property purchases have likewise diversified. For many, acquiring a home remains rooted in the goal of personal occupancy purchasing a property to serve as a permanent or primary residence. Yet, for a growing segment of consumers, real estate represents an investment vehicle, utilized to facilitate wealth accumulation, portfolio diversification, and long-term financial security. This segment often focuses on factors such as property appreciation, rental income potential, and market liquidity, viewing housing not merely as a place to live, but as a means to generate and preserve capital (You, 2022).

This duality of purpose property as both shelter and investment illustrates the evolving complexity of consumer behavior within the property sector. Buyers are no longer motivated solely by functional needs;

considerations such as lifestyle alignment, future value, and potential returns are increasingly shaping purchasing decisions (Cai, Y., Lin, J., 2023). This complexity challenges property developers, marketers, and policymakers to adapt their strategies, ensuring that housing products and services address both the practical living requirements and the financial aspirations of contemporary consumers (Brown, 2008).In this context, understanding housing as a multi-dimensional commodity becomes essential, as it sits at the intersection of personal utility, emotional value, and economic potential, influencing individual purchasing decisions and broader market trends alike.

The digital transformation of property business practices is reshaping how individuals seek, assess, and purchase housing units (Bresciani, S., Ferraris, A., & Del Giudice, 2021). Online property platforms now enable prospective buyers to browse extensive inventories without needing to visit physical locations (Pasman, G., & Wieringa, 2011). Advanced visualization tools, such as virtual tours and augmented reality (AR), further enhance the decision-making process by offering immersive experiences that simulate on-site visits.

At the core of this transformation is the synergy between design thinking and technological integration. Design thinking, with its emphasis on empathy, creativity, and iterative problem-solving, plays a crucial role in addressing customer needs through innovative, user-centric solutions (Micheli, P., Wilner, S. J. S., Bhatti, S. H., Mura, M., & Beverland, 2019). (Gallanis, 2020) emphasizes that traditional problem-solving approaches often neglect end-user perspectives, whereas design thinking places users at the center of innovation processes (Liedtka, 2020). Through iterative cycles of ideation, prototyping, and testing, design thinking facilitates the generation of bold, creative solutions responsive to real-world problems.

Despite technological advancements, structural development within the property sector still encounters several challenges, such as customer disengagement, operational inefficiencies, and stagnant business models. Integrating strategic technological applications with design thinking principles emerges as a critical strategy to navigate these challenges (Singhi, N., Verma, A., Agrawal, A., & Khan, 2024). This confluence fosters the development of property solutions that are not only aesthetically pleasing but also functionally superior and economically viable.

Bibliometric analysis serves as a structured and systematic method for evaluating scholarly research trends, identifying prevailing challenges, and uncovering opportunities for innovation within the property sector. By

leveraging techniques such as data visualization and thematic mapping, bibliometric studies offer valuable insights into the dynamic interplay between academic contributions and industry practices (Batty, M., & Zisch, 2020). This analytical approach not only reveals dominant research areas and evolving themes but also underscores the critical role of technology adoption and design thinking methodologies in driving advancements within property development, management, and marketing (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022).

The primary objective of this study is to provide comprehensive insights into how technology and design thinking collectively shape and influence innovation within the property business sector. Through the application of bibliometric methods, this research systematically maps historical research trends, analyzes current thematic focuses, and anticipates future developments at the intersection of design innovation and technological integration in property-related industries. The analysis captures both academic and practical perspectives, offering a clear understanding of how these domains converge to address emerging market needs and consumer expectations.

By contextualizing scholarly output alongside industry evolution, this study highlights not only the progress made but also the strategic areas where technology and design-driven innovations can be further explored. Ultimately, the findings of this research are intended to empower key stakeholders including property developers, marketers, investors, and policymakers to adapt more effectively to ongoing changes within the property sector. Insights derived from the bibliometric analysis aim to support stakeholders in formulating strategies that are sustainable, customer-centered, and innovation-focused, enabling them to capitalize on technological advancements and design thinking frameworks as critical levers for competitive advantage and long-term growth (Kang, J., Lee, H. J., Jeong, S. H., Lee, H. S., & Oh, 2020).

METHODS

This study adopts a bibliometric approach to conduct a systematic analysis of thematic developments concerning design thinking, product development, and technological innovation, specifically within the property sector spanning the period from 2001 to 2024. The research framework is grounded in the systematic retrieval of relevant scientific literature, which was sourced from reputable international journals indexed in the Scopus database . To ensure precision and relevance, the data collection process employed targeted keywords, including but not limited to terms such as

"design thinking," "product development," "innovation," and "technology-based design." These keywords were carefully selected to capture publications that directly or indirectly discuss the intersection of innovative methodologies and technological solutions in property and real estate development (Wölbling, A., Krämer, K., Buss, C. N., Dribbisch, K., LoBue, P., & Taherivand, 2012).

The collected bibliometric data were subsequently processed using two advanced analytical tools: VOSviewer and BiblioShiny (Pinter, G., Mosavi, A., & Felde, 2020). VOSviewer facilitated the creation of network visualizations, enabling the identification of key research clusters and the relationships between them. This tool's capability to generate co-occurrence networks allowed the study to map how frequently specific concepts appear together within the same body of literature, thus revealing core thematic linkages and dominant research streams. In parallel, BiblioShiny, operating within the R programming environment, supported the generation of thematic maps and the performance of strategic mapping. Through this process, thematic clusters were systematically analyzed and plotted according to their centrality (indicating the theme's relevance within the wider research landscape) and density (representing the internal development and coherence of each theme) (Przybilla, L., Klinker, K., Lang, M., Schreieck, M., Wiesche, M. & H., 2020).

To enhance the interpretative clarity of the research findings, strategic diagrams were constructed, enabling the classification of themes into categories such as motor themes, niche themes, emerging/declining themes, and basic/transversal themes. These classifications provided insights into which topics are central and well-developed versus those that may be peripheral, underexplored, or in decline. Furthermore, the incorporation of Sankey diagrams enriched the analysis by visualizing the dynamic transitions and interrelationships among key themes across multiple time intervals (Pasman, G., & Wieringa, 2011). This approach allowed for a chronological depiction of thematic evolution, illustrating how certain concepts have emerged, converged, or diverged over the defined 24-year period.

Complementing the bibliometric visualizations, a quantitative-descriptive analysis was conducted to interpret the findings more comprehensively. This analysis contextualized observable innovation trends, traced the shifts in research focus over time, and identified potential gaps and opportunities within the existing body of knowledge. By synthesizing these insights, the study not only highlighted prevailing patterns in the adoption of design thinking and technological innovations in

the property sector but also proposed possible directions for future research and practical applications (Liedtka, 2020). These findings are particularly significant for industry practitioners, researchers, and policymakers seeking to leverage technology and innovative design methodologies for advancing property development practices, enhancing product offerings, and fostering sustainable industry growth.

Overall, the integrated use of bibliometric mapping tools, strategic thematic analysis, and quantitative-descriptive methods provided a robust analytical framework that allowed for a nuanced understanding of the evolving landscape of technological and design-based innovations within the property industry context.

RESULT AND DISCUSSION

Bibliometric Thematic Map

Figure 1 presents a strategic diagram that maps identified research themes based on two key dimensions: centrality and density. These dimensions are used to categorize themes into four distinct quadrants, each reflecting the theme's relative importance and developmental stage within the research landscape (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022).

1. The Motor Themes quadrant contains topics with high centrality and high density, indicating that these themes are both well-developed internally and highly connected to other themes, representing the core focus areas of the field (Wölbling, A., Krämer, K., Buss, C. N., Dribbisch, K., LoBue, P., & Taherivand, 2012).
2. The Niche Themes quadrant includes themes with high density but low centrality, signifying specialized areas that are well-developed within their scope but have limited influence across the broader research network (Przybilla, L., Klinker, K., Wiesche, M., & Krcmar, n.d.).
3. The Basic Themes quadrant is characterized by high centrality but low density, comprising foundational topics that are widely connected to other themes but remain less developed internally, acting as the essential building blocks for future research (Brown, 2008).
4. Finally, the Emerging or Declining Themes quadrant features themes with both low centrality and low density, representing areas that are either in the early stages of development or experiencing diminishing relevance (Gallanis, 2020).

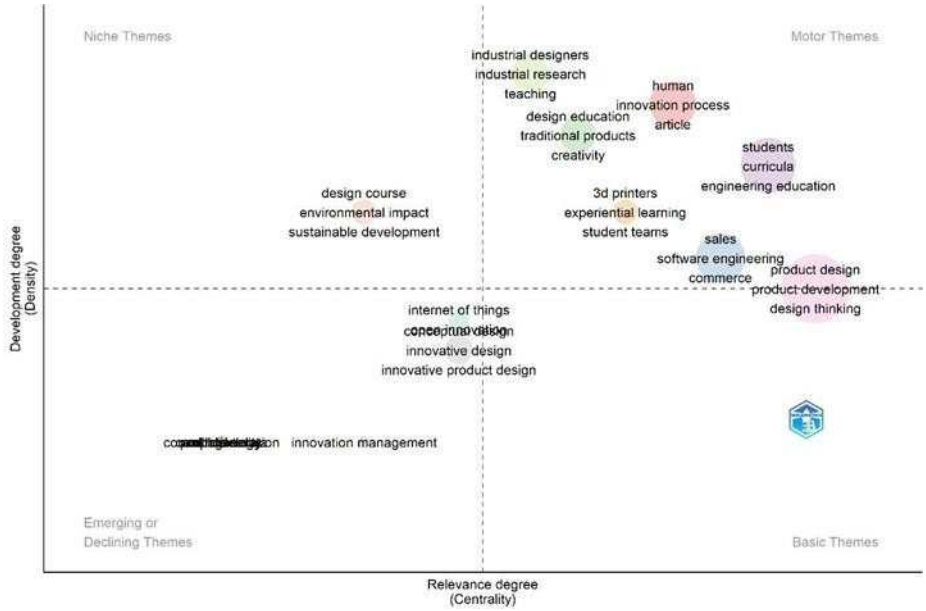

Figure 1. Bibliometric thematic map

In this figure, the Motor Themes quadrant identifies pivotal research areas that are both highly relevant and actively developed within the field. Notably, this quadrant encompasses topics such as product development, design thinking, and software engineering (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022). These themes occupy a central position in the thematic network, signifying their strategic importance as core areas that drive both theoretical advancements and practical applications. Their placement indicates that they are well-integrated into the broader research ecosystem while also maintaining strong internal development, making them prime candidates for future scholarly investigation and industry implementation.

Conversely, the Niche Themes quadrant includes specialized research areas like sustainable development and environmental impact. While these themes may exhibit limited direct applicability across broader contexts, they demonstrate significant internal coherence and developmental depth. Their high density suggests that research within these topics is mature and specialized, serving specific subfields or addressing targeted challenges (Przybilla, L., Klinker, K., Wiesche, M., & Krcmar, n.d.). Consequently, although not universally adopted, these themes offer focused opportunities for innovation, particularly in areas where environmental considerations and sustainability play a critical role.

JDBIM (Journal of Digital Business and Innovation Management)
Volume 4 No.2, December 2025
E-ISSN 2962-3898
Page 317-331

The Basic Themes quadrant is characterized by foundational topics, including conceptual design and innovative product design. These areas are marked by high centrality but lower developmental density, indicating their role as essential building blocks that support a wide range of studies (Brown, 2008). They function as core knowledge domains, providing the conceptual frameworks and design methodologies upon which more specialized or advanced
research is constructed. Their fundamental nature ensures their continued relevance, making them vital for both ongoing academic research and practical applications within the industry.

Finally, the Emerging or Declining Themes quadrant brings attention to research areas such as innovation management. Themes located in this quadrant exhibit low density and low centrality, suggesting that their relevance and developmental focus are in flux. These topics may represent either emerging research frontiers or areas experiencing declining interest within the scholarly community. As such, they warrant careful monitoring in future research strategies to determine whether they are poised for resurgence as innovative domains or are gradually losing significance (Gallanis, 2020). The ability to discern the trajectory of these themes is crucial for aligning research efforts with evolving industry needs and academic trends.

Collectively, the strategic diagram serves as a diagnostic tool for understanding the thematic structure and research dynamics of the field. By visualizing how themes are distributed across quadrants based on their relevance and developmental maturity, the figure provides actionable insights that can guide future research planning, strategic investment, and innovation management within the property sector and related industries (Singhi, N., Verma, A., Agrawal, A., & Khan, 2024).

Thematic Evolution Analysis

Figure 2 illustrates the evolution of dominant research themes across two decades using a thematic flowchart. This visualization traces the progression and transformation of key research topics from 2001 to 2024, highlighting how scholarly focus has shifted over time (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022).

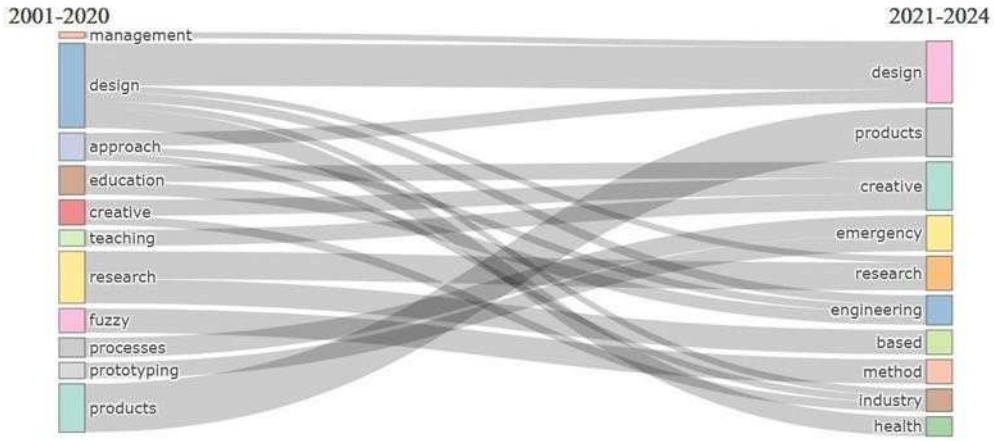

Figure 2. Bibliometric Thematic Evolution

During the early period (2001–2020), scholarly discourse was predominantly centered around themes such as “management,” “design,” “education,” and “prototyping.” These themes reflect the academic community’s focus on building foundational knowledge and methodologies related to design and innovation processes (Gallanis, 2020). Discussions during this phase were largely conceptual and theoretical, with emphasis placed on design methodologies, management strategies, educational approaches, and the role of prototyping as a tool for iterative development. This early focus laid the groundwork for future applied research, helping to establish core frameworks that continue to inform current studies.

However, in the more recent period spanning 2021 to 2024, there has been a noticeable shift in thematic focus toward practical, application-driven topics. Keywords such as “products,” “creative,” “engineering,” and “health” have gained prominence, reflecting the field’s evolution toward real-world applications and cross-sectoral integration. This thematic transition suggests an increasing emphasis on utilizing design and technological innovations not just for conceptual exploration, but for addressing tangible industry needs and societal challenges (Wang, K. J., Chen, Y. H., Lee, Y. C., & Lin, 2024). The rise of these practical themes indicates a maturing research landscape where academic insights are being translated into actionable solutions across various industries, including property development, healthcare, and creative sectors (Lee, S. M., & Trimi, 2021).

Significantly, core themes like “design” and “research” have persisted across both periods, underlining their enduring relevance within the academic discourse. These themes continue to serve as the backbone of innovation-related studies, connecting earlier conceptual discussions with newer, applied research areas. Their sustained presence highlights the importance of maintaining a strong theoretical foundation while expanding into emerging application domains.

JDBIM (Journal of Digital Business and Innovation Management)
Volume 4 No.2, December 2025
E-ISSN 2962-3898
Page 317-331

Additionally, the emergence of themes such as “emergency,” “health,” and “based” (often linked to terms like “technology-based” or “evidence-based”) reflects the field’s responsiveness to contemporary global challenges, including pandemics, public health crises, and the broader digital transformation affecting multiple sectors. These emerging themes signal a shift in research priorities toward addressing urgent societal needs and embracing digital solutions that facilitate rapid adaptation and innovation (Cai, Y., Lin, J., 2023).

The sustained connection between historical and emerging themes underscores a progressive transformation within the design and innovation research landscape. Rather than discarding foundational concepts, the field has demonstrated the capacity to evolve incrementally, integrating new challenges and technological advancements into its existing knowledge structures (Pasman, G., & Wieringa, 2011). This thematic continuity, combined with the adoption of contemporary topics, suggests a dynamic yet grounded research trajectory that balances innovation with theoretical rigor, offering valuable insights for both academia and industry stakeholders.

Frequency of Themes

Table 1 presents the frequency of various research themes across both periods, highlighting shifts in academic focus.

Table 1. Theme Frequency

Theme (2001-2020)	Frequency	Theme (2021-2024)	Frequency
Design	120	Design	80
Education	90	Product	70
Research	85	Creative	65

While “design” consistently remained the most frequent theme throughout the analysis period, its slight decline in frequency suggests a

diversification of research interests within the field. This trend reflects a broadening of focus, where scholars have begun to explore more specific and applied areas of study rather than concentrating solely on overarching design concepts. The enduring presence of "design" nevertheless underscores its role as a foundational pillar in the discourse surrounding innovation and product development (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022).

At the same time, the ascendance of themes such as "product" and "creative" highlights a notable shift in research priorities. These themes signal a growing emphasis on tangible innovation outcomes, suggesting that scholars and practitioners are increasingly focused on the practical implementation of design methodologies to create market-ready products and innovative solutions (Kumar, 2018). This movement marks a departure from earlier periods dominated by educational or theoretical discussions, indicating that the field is moving towards more solution-driven research that bridges the gap between conceptual frameworks and real-world applications.

The rise of "product" as a theme suggests heightened interest in the commercialization aspects of design thinking and innovation processes, while the prominence of "creative" themes points to the increasing value placed on originality, aesthetic considerations, and user-centered design in developing competitive products and services (Liedtka, 2020). Collectively, these trends reflect a more application-oriented research landscape, where design is viewed not just as a conceptual tool but as a strategic driver of innovation and business value.

Thematic Relationships Based on Sankey Diagram

Table 2 depicts relational flows between dominant themes across both periods, based on Sankey diagram analysis.

Table 1. Theme Frequency

Initial Theme	Main Relationship	Final Theme
Design	45%	Product
Education	30%	Engineering
Management	25%	Health

A notable finding from the thematic transition analysis is that approximately 45% of studies initially centered on "design" progressively transitioned toward "product" themes, indicating a deepening focus on product-oriented innovation (You, 2022). This shift suggests that research, while retaining its conceptual design roots, increasingly channels its

JDBIM (Journal of Digital Business and Innovation Management)
Volume 4 No.2, December 2025
E-ISSN 2962-3898
Page 317-331

methodologies and insights into the development of tangible, marketable products, reflecting the industry's demand for practical and commercially viable solutions.

Similarly, around 30% of studies previously associated with "education" have evolved into themes related to "engineering." This transformation highlights a move from purely pedagogical discussions toward more technical and applied research domains, where design and innovation concepts are operationalized within engineering processes and systems (Pasman, G., & Wieringa, 2011). Such a transition underlines the importance of equipping engineering disciplines with creative problem-solving methodologies, bridging the gap between educational frameworks and industry-driven technical innovation.

In parallel, approximately 25% of "management" themed studies have shifted focus toward health-related applications, illustrating an interdisciplinary convergence largely driven by societal needs (Przybilla, L., Klinker, K., Wiesche, M., & Krcmar, n.d.). This trend reflects how management strategies and innovation models are being adapted and applied within the healthcare sector, particularly in response to contemporary challenges such as pandemics, digital health transformation, and the pursuit of operational efficiencies in medical service delivery.

Collectively, these thematic shifts underscore a progressive realignment of research priorities, characterized by increasing cross-sector integration and an emphasis on practical impact. The movement from conceptual themes toward product development, engineering solutions, and health applications demonstrates how design thinking and innovation research are expanding beyond their traditional boundaries, addressing pressing global challenges while fostering interdisciplinary collaboration (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022).

Concept Linkage Map Centered on Design Thinking

Figure 3 presents a concept relationship map that positions "Design Thinking" as the central node, illustrating its pivotal role within the research landscape. From this core concept, multiple thematic branches extend outward, representing interconnected research areas and application domains.

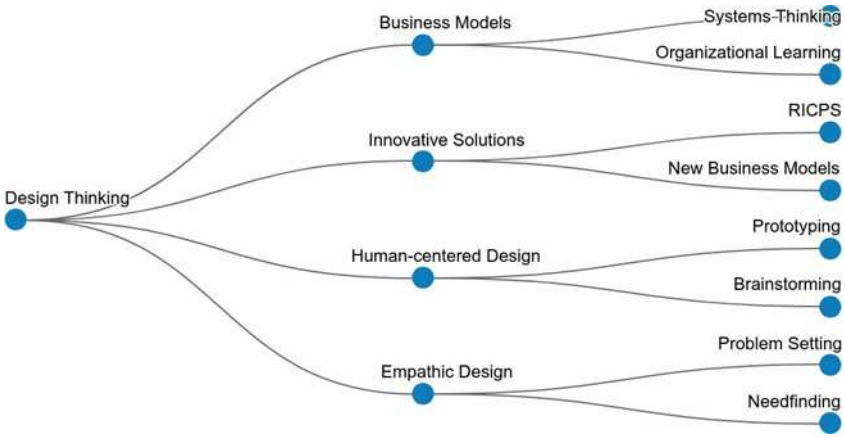

Figure 3. Concept Linkage Map with Design Thinking Main Themes

Figure 3 shows a concept relationship map with the main theme of Design thinking as the core that branches out into various sub-themes and derived concepts. This theme reflects how Design Thinking has evolved and been applied in various research and practice contexts (Magistretti, S., Bianchi, M., Calabretta, G., Candi, M., Dell'Era, C., Stigliani, I., & Verganti, 2022).

One of its branches is Business Models, which highlights the role of Design Thinking in the development of innovative business models. This branch extends to sub- concepts such as Systems Thinking, which manages complexity in business models, and Organizational Learning, which focuses on continuous organizational learning.Furthermore, the Innovative Solutions theme emphasizes the use of Design Thinking to create new solutions (You, 2022). Sub- themes include RICPS (Rapid Iterative Cycles of Prototyping and Sharing), which describes prototype-based iterative methodologies, and New Business Models, which highlights the development of new business models through design innovation. Another important theme is Human- Centered Design, which focuses on user needs with sub-concepts such as Prototyping, which explores ideas through prototype iterations, and Brainstorming, which involves creative collaboration to generate ideas according to user needs (Kumar, 2018).

Finally, the Empathic Design branch emphasizes the importance of understanding user needs and emotions (Mao, J. Y., Vredenburg, K., Smith, P. W., & Carey, 2005). This branch includes Problem Setting, which is the process of identifying problems with an empathetic approach, as well as Needfinding, which looks for unmet user needs. This concept map continues the pattern from the previous figure, where Design Thinking becomes a central theme associated with creativity, research, and cross-disciplinary design processes (Gallanis, 2020). It shows the role of Design Thinking as a strategic approach in developing innovative solutions, business models, and user- oriented designs.

CONCLUSION

This bibliometric analysis highlights the critical role of design thinking in driving innovation and enabling the development of customer-centered solutions within the property sector. The observed shift from earlier theoretical and educational focuses toward more practical applications—including product development, healthcare innovations, and engineering solutions—reflects a significant paradigm shift in response to both

contemporary challenges and technological advancements. This progression illustrates how research and industry practices have evolved from conceptual frameworks to solution-oriented strategies aimed at addressing real-world demands.

Design thinking stands out as a strategic framework that effectively integrates creativity, technological advancement, and empathetic problem-solving. Its inherent emphasis on understanding user needs and iterative development enables organizations within the property sector to create human-centered innovations that satisfy not only functional requirements but also aesthetic and experiential expectations. The combination of design thinking with technological solutions enhances the sector's capacity to deliver products and services that are both innovative and market-relevant (Zhang, W., & Chen, 2023). By mapping thematic trends and analyzing the interrelationships between key research areas, this study provides strategic insights that can guide property developers, investors, marketers, and policymakers in leveraging design thinking and technology as dual engines of sustainable innovation. The findings underscore the importance of adopting multidisciplinary approaches that merge creative methodologies with digital
tools to address evolving consumer behaviors and industry dynamics.

Looking ahead, future research should continue to explore emerging themes, particularly those linked to global exigencies such as climate resilience, digital transformation, and public health challenges. Ensuring that innovation within the property sector remains adaptive, inclusive, and forward-looking will be essential for fostering sustainable growth and meeting the complex needs of both present and future consumers.

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