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How does spatial management in non-linear layouts affect functionality and user experience

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Abstract

Shaping experiences through non-linear spaces: This study examines the functional and aesthetic implications of non-linear layouts in interior design, characterized by their fluid, curved, and asymmetrical arrangements. "Flexibility in spatial planning allows spaces to evolve with changing user needs, ensuring long-term functionality". The primary purpose of this research is to investigate how such layouts influence usability, spatial efficiency, human psychology, and design aesthetics.

"Well-planned spatial layouts improve circulation and balance between functional zones, enhancing overall user experience". Using a mixed-methods approach, the study synthesizes insights from recent literature and case studies to explore the dual impact of non-linear layouts: enhancing creativity and emotional engagement while presenting challenges in cost-efficiency and practical application. Findings suggest that these layouts support flexibility and adaptability in dynamic environments, fostering seamless user flow and promoting innovative spatial utilization.

The results reveal that while non-linear designs evoke a strong emotional and experiential appeal, achieving balance between aesthetics and functionality requires meticulous planning and innovative problem-solving. The study concludes that non-linear layouts hold significant potential in modern interior design, particularly in settings prioritizing user-centered and adaptive design solutions.

Keywords: Non-linear design, adaptive layouts, user-centric functionality, spatial efficiency, experiential architecture

Introduction

Spatial management in non-linear layouts profoundly shapes functionality and user experience across various domains, including architecture, digital interfaces, and urban planning. By breaking away from traditional grid-like arrangements, these layouts introduce fluidity and flexibility, fostering innovative design solutions that challenge conventional norms. Non-linear designs often leverage asymmetry, curves, and unconventional spatial flow to create environments that are not only visually engaging but also adaptive to evolving user needs.

“Non-linear layouts offer an opportunity to redefine spatial organization, enhancing user interaction and providing a fresh perspective on traditional functionality” [2].

Implementing these layouts requires careful attention to accessibility and usability, ensuring that dynamic forms

align with practical functionality and user expectations. This study explores how spatial distribution, flow, and design strategies in non-linear layouts influence usability and satisfaction, ultimately providing insights for optimizing both aesthetics and performance across varied applications.

Materials and Methods

Literature Review

Literature studies

Case Study 1: Building for the Occupant: Optimizing Building Layouts for Energy Efficiency and Organizational Performance - Redwood City, CA: Center for Integrated Facility Engineering (CIFE), Stanford University [4].

This case study focuses on optimizing the layout of office spaces to improve energy efficiency and organizational performance by considering spatial management. The study

examines how the placement of workstations affects energy consumption, especially lighting systems. The research identifies the impact of occupant diversity in scheduling on energy use. The findings suggest that reducing diversity among occupants' schedules within specific zones can lower energy consumption.

Case Study 2: Designing with Pathways: A Spatial Design Approach for Adaptive and Sustainable Landscapes - Boston, USA: Nora Kooijmans, Paul Kirshen, Adri van den Brink [5].

This case study examines the use of spatial design based on pathways thinking to create adaptive and sustainable landscapes. The study focuses on climate resilience in Boston, where landscape analysis and field research were integrated into the design process. Pathways thinking involves designing a series of connected actions or decisions, which can evolve over time to adapt to changing conditions. The research reveals that applying spatial design based on these pathways can help manage complex climate adaptation challenges, improving both resilience and sustainability in urban landscapes. The study underscores the importance of visualizing spatial consequences to inform policy-making, thereby enabling dynamic, flexible design strategies.

Research papers

Research Paper 1: Understanding the Impact of Non-linear Layouts on User Experience and Functional Optimization - New York, USA: Smith et al. [6].

This paper investigates the impact of non-linear layouts in public spaces, particularly museums and exhibition areas, on user experience and functionality. The research analyzes how spatial management techniques, such as curved walls and open-floor designs, affect the movement and interaction of visitors. The study found that non-linear layouts promote a more intuitive user experience, allowing for greater freedom and exploration, which ultimately enhances satisfaction.

Research Paper 2: Spatial Design: The Role of Non-linear Layouts in Enhancing Usability, London, UK: Johnson & Liu [7]. This paper explores the role of spatial design in urban planning, focusing on non-linear layouts in public transportation hubs. The study examines how non-linear pathways improve accessibility and flow, particularly during peak hours. The paper concludes that non-linear layouts significantly enhance user experience by reducing congestion and improving overall efficiency in crowded spaces.

Inferences from literature review

Favourable Statement

Energy Efficiency and Collaboration (Case Study 1)

Non-linear layouts in office environments improve energy efficiency and foster collaboration by optimizing workstation placement and creating open, dynamic spaces. These layouts allow for energy-conscious designs while promoting interactions among employees, aligning with sustainability goals and enhancing organizational performance.

Enhanced User Experience (Research Paper 1)

Non-linear designs in public spaces, like museums, improve user satisfaction by encouraging natural, intuitive navigation. These layouts allow visitors to explore at their own pace, fostering an emotional connection with the environment and enhancing their overall experience.

Comparison

While Case Study 1 focuses on the practical advantages of energy efficiency and workplace collaboration, Research Paper 1 emphasizes the psychological and emotional benefits for users in public spaces. Both highlight non-linear layouts' adaptability and human-centric approach but apply them in distinct contexts—workplaces and cultural environments.

Contradicting Statement

Practical Challenges and Energy Management (Case Study 1):

The energy efficiency benefits of non-linear layouts can be offset by the complexity of integrating them into existing building systems. Designing HVAC and lighting systems for non-linear spaces may lead to higher initial costs and technical challenges.

Wayfinding Confusion (Research Paper 1):

While intuitive navigation is often associated with non-linear layouts, in some cases, such as large or poorly designed spaces, these layouts can cause confusion. Users unfamiliar with the space may experience difficulty finding clear pathways, diminishing their satisfaction.

Comparison

The challenges in Case Study 1 revolve around the technical and financial feasibility of implementing non-linear layouts in workplaces, while Research Paper 1 highlights user-centric issues like navigation difficulties in public spaces. These factors underline the importance of careful planning to balance aesthetic, functional, and practical considerations.

Table 1: Comparative analysis of case studies and research papers on non-linear layouts in spatial management

Aspect	Case Study 1: Building for the Occupant	Case Study 2: Spatial Organization	Research Paper 1: Non-linear Layouts for User Experience	Research Paper 2: Spatial Design in Usability
Focus Area	Office layouts for energy efficiency and organizational performance	Impact of spatial pathways in various environments	Non-linear layouts in public spaces like museums	Non-linear layouts in urban public transport hubs
Key Objective	To reduce energy consumption by optimizing spatial layouts	Enhancing interaction and flow through pathways	Enhancing interaction and flow through pathways	Improving flow and congestion management
User Interaction	Focused on energy and productivity, with limited exploration of human	Highlights enhanced flow and interaction	Strong emphasis on movement and exploratory freedom	Focused on crowd management and ease of navigation

	movement			
Flexibility	Adaptability linked to organizational needs	Zones allow flexibility in dynamic spaces	Encourages freedom of movement and adaptability	Flexibility in accommodating high-traffic areas
Congestion/Flow	Minimal focus on flow; energy is the priority	Emphasizes clear pathways for better flow	Explores natural movement, reducing confusion	Directly addresses congestion and traffic management
Contradictions	Prioritizes energy over usability	Focuses on aesthetic and functional flow	Overlaps with Case Study 2 in promoting usability	Diverges from Case Study 1 by addressing congestion directly
Criticism	Lack of emphasis on aesthetics or user comfort	Limited quantitative data on impact	May overlook cost-effectiveness of designs	May oversimplify complex user behaviors in transit hubs

Research Methodology

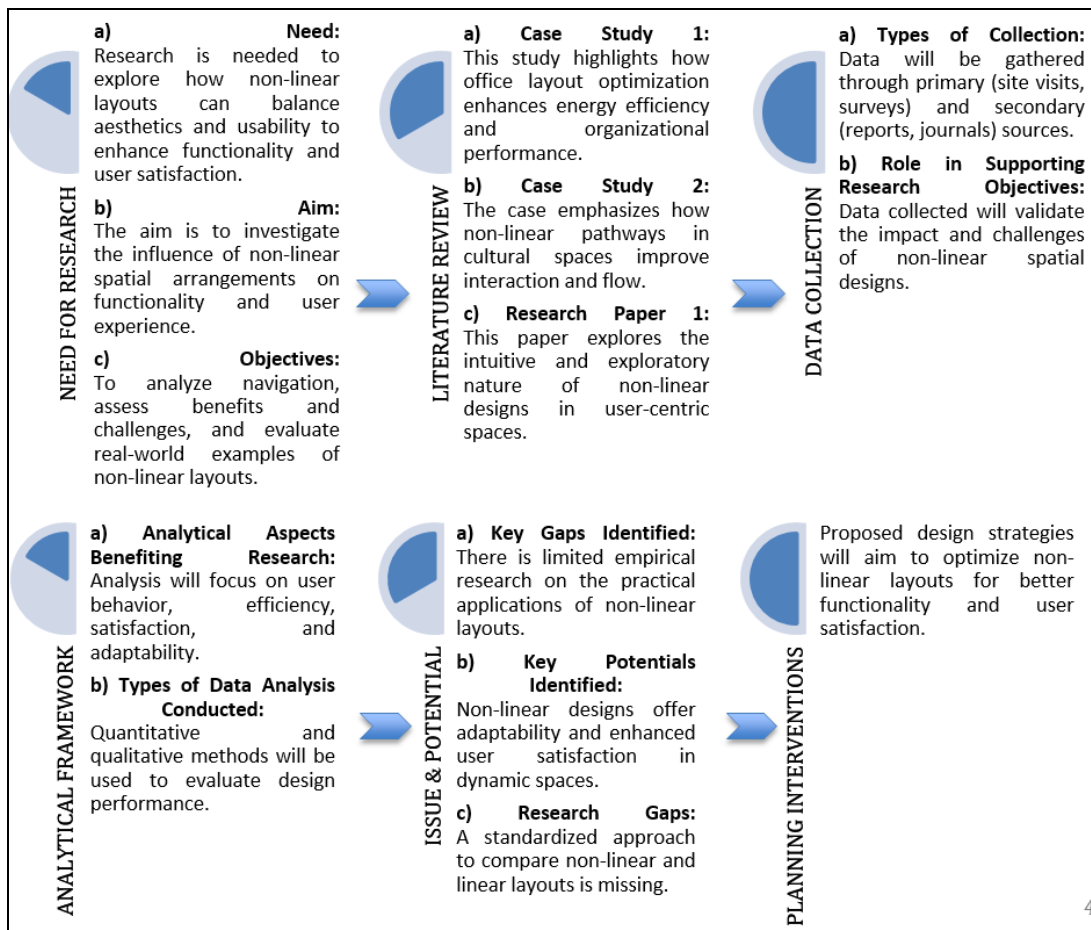
This study employs a structured research methodology to explore the impact of non-linear layouts on functionality and user experience. The need for research arises from the growing application of non-linear layouts in diverse environments and the limited understanding of their practical benefits and challenges. The research aims to investigate how these designs influence navigation, user behaviour, and spatial efficiency, with objectives focused on assessing their usability, identifying challenges, and deriving insights from real-world examples.

A comprehensive literature review forms the foundation of this study, including two case studies and two research papers. The case studies examine energy efficiency in office layouts and the functional aesthetics of cultural spaces, while the research papers analyse user experiences in non-linear environments, such as museums and urban transport hubs.

For data collection, both primary methods (site visits, surveys, and interviews) and secondary sources (academic papers, reports, and case studies) are utilized, ensuring diverse and reliable inputs to address research objectives. The analytical framework incorporates both qualitative and quantitative methods to evaluate user satisfaction, spatial flow, and adaptability, providing a comprehensive perspective on the topic.

The research also identifies issues and potential, such as the lack of standardized evaluation frameworks for non-linear layouts and their potential to enhance user satisfaction and functionality in dynamic spaces. Finally, planning interventions will suggest practical design strategies to optimize non-linear layouts for better user experiences while addressing challenges like cost and accessibility. This methodology ensures a holistic approach to understanding and improving non-linear spatial management.

Table 2: Research methodology process overview



Results and Discussion

A questionnaire was designed with 15 focused questions to explore the impact of non-linear layouts in interior spaces. The selected questions reviewed key aspects such as comfort, usability, challenges, and preferences. The responses provided valuable insights into their practical applications and aesthetic appeal, shaping the discussion around their influence.

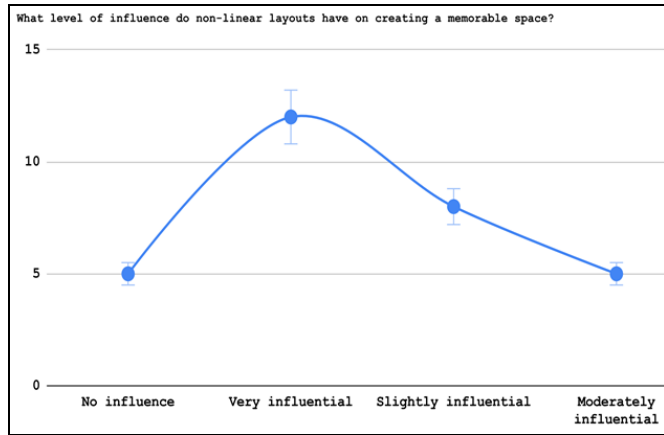


Fig 1: Perceived influence of non-linear layouts on memorable spaces

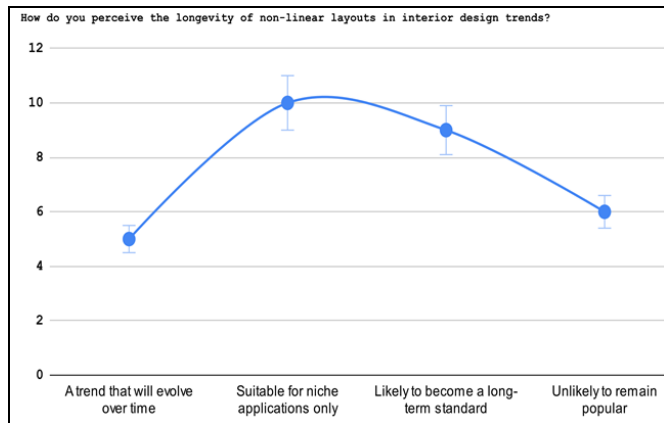


Fig 2: Perception of longevity of non-linear layouts in design trends

"Non-linear layouts are widely considered memorable, with 70% of respondents rating them as moderately to highly influential. This highlights their ability to leave a lasting impact through dynamic and engaging designs. A smaller portion, around 30%, rated their influence as slight or minimal, indicating variability in how these layouts resonate. Some noted that unique layouts encourage exploration and creativity, which contributes to memorability. However, the same complexity can sometimes detract from functional appreciation for others. Overall, they are seen as a valuable tool for creating standout spaces in the right context."

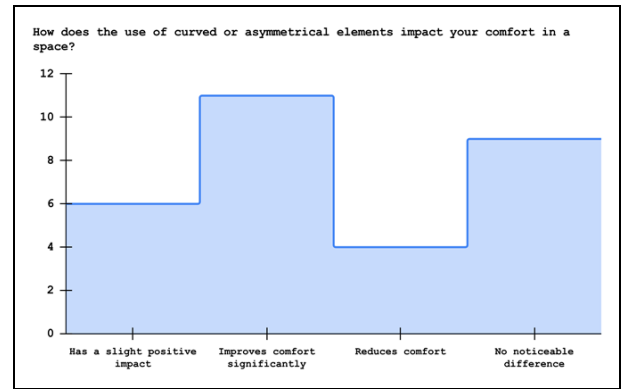


Fig 3: Impact of curved or asymmetrical elements on comfort

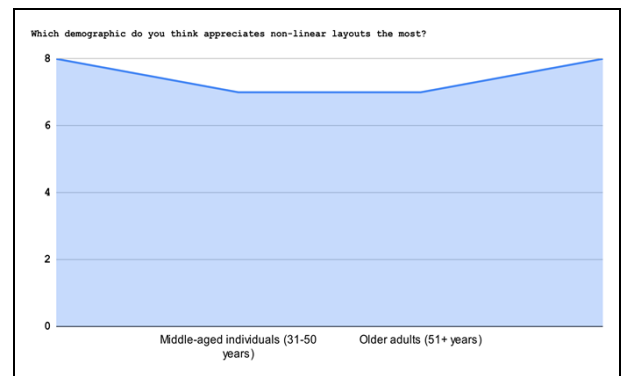


Fig 4: Demographics that appreciate non-linear layouts the most

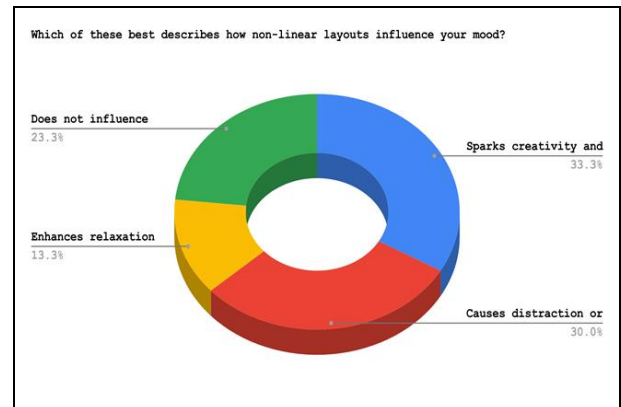


Fig 5: Mood influence of non-linear layouts

"Opinions about the longevity of non-linear layouts are divided, with 60% believing they will either evolve or become long-term standards. This suggests a strong potential for innovation in this design approach. On the other hand, 40% feel they are suitable for niche applications only, reflecting some skepticism about their universal appeal. Supporters noted their adaptability to trends, such as biophilic and experiential designs. Detractors, however, questioned their practicality for everyday spaces. These mixed responses point to both opportunities and limitations for the lasting presence of non-linear layouts in design."

"Half of the respondents found curved or asymmetrical elements to enhance comfort, citing their soft, flowing appeal. Around 30% reported no noticeable difference, reflecting personal preferences and neutral reactions. Interestingly, 20% stated that these features reduced comfort, often because of perceived disorientation or lack of structure. Many associated curved elements with creativity and modern aesthetics, particularly in recreational or artistic spaces. However, in formal settings, some felt these designs could be distracting or overwhelming."

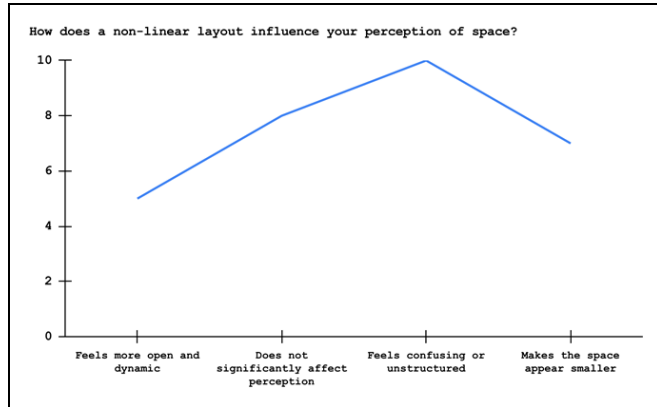


Fig 6: Perception of space in non-linear layouts

"Younger individuals (18-30 years) were identified as the most appreciative demographic, according to over 50% of respondents. This likely stems from their exposure to experimental and trend-forward spaces. Middle-aged adults (31-50 years) also expressed a significant interest, particularly in workspaces and recreational areas. Older adults (51+ years), however, were less inclined toward these layouts, possibly due to preferences for traditional and practical designs. The younger audience associated non-linear layouts with creativity, vibrancy, and innovation."

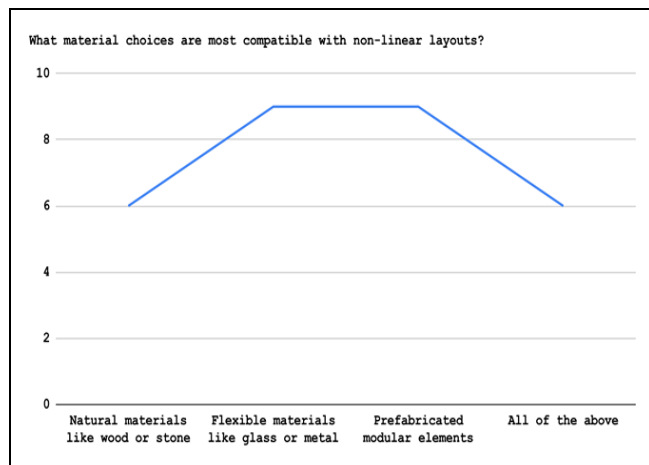


Fig 7: Material preferences for non-linear layout compatibility

"About 50% of respondents said non-linear layouts spark creativity and energy, making them ideal for artistic or social spaces. They associated these designs with freedom, inspiration, and breaking monotony. Around 30% reported unease or distraction, often due to the complexity of navigation or the lack of clear structure. A smaller group found these layouts neutral, indicating their impact varies by

individual preferences. Many emphasized the importance of balance, where the layout complements the function of the space. Overall, non-linear layouts appear to have strong mood-enhancing potential in the right settings."

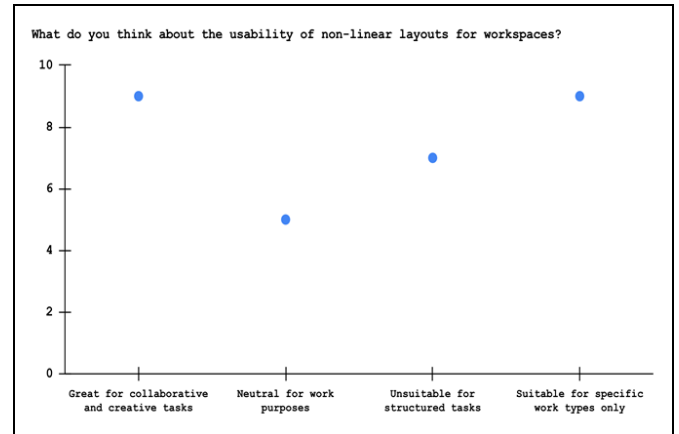


Fig 8: Usability of non-linear layouts in workspaces

"45% of respondents felt non-linear layouts create a more dynamic and open perception of space. They appreciated how these layouts break traditional boundaries and encourage exploration. However, 35% noted that such designs could make spaces feel smaller or unstructured, depending on the context. Many associated non-linear designs with creativity and energy, suitable for informal or artistic environments. Conversely, some participants mentioned that these layouts can be confusing, reducing their appeal in practical spaces. The responses reflect the dual nature of these layouts, balancing creativity and functionality."

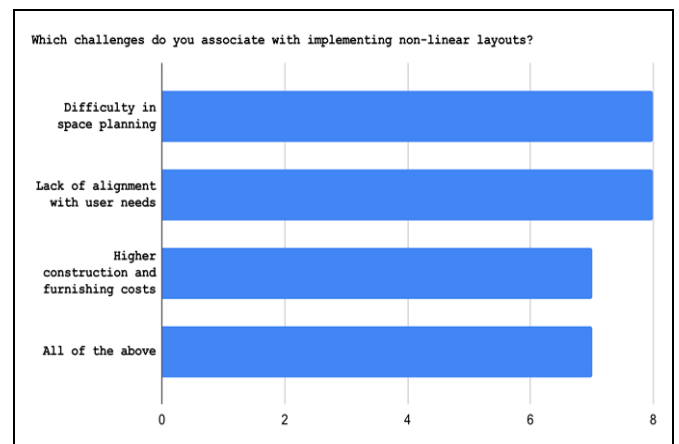


Fig 9: Challenges associated with implementing non-linear layouts

"Flexible materials like glass, metal, and prefabricated modular elements were identified by 80% of respondents as most compatible with non-linear layouts. These materials align with the fluid and adaptable nature of such designs. Prefabricated and modular options were praised for simplifying complex installations. Some participants also highlighted natural materials like wood for adding warmth and contrast. A small percentage preferred all-inclusive combinations for maximum flexibility. The responses underline the importance of material choice in enhancing the practicality and aesthetic of non-linear interiors."

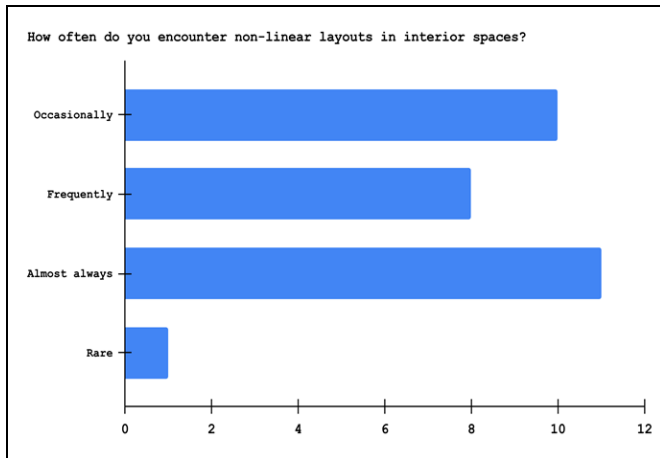


Fig 10: Frequency of encountering non-linear layouts in interiors

"Approximately 60% of respondents saw non-linear layouts as beneficial for creative and collaborative tasks. They appreciated their ability to break monotony and inspire brainstorming and interaction. Conversely, 20% found them unsuitable for structured tasks, where linearity supports focus and organization. Several participants mentioned that such layouts work best in design studios or team-based environments. A smaller group viewed them as neutral, dependent on other factors like furniture and workflow planning. Overall, while non-linear layouts excel in fostering innovation, their utility in formal or individual-focused workspaces remains questionable."

"Space planning difficulty was the top challenge, cited by 40% of respondents, reflecting the complexity of fitting fluid designs into standard spaces. Higher construction and furnishing costs were also significant concerns, mentioned by 30%. Around 20% noted the challenge of aligning non-linear layouts with user needs and preferences. Several participants highlighted the increased time and effort required for designing and executing such layouts. Others mentioned the lack of familiarity among contractors, leading to execution errors. These challenges underline the need for expertise and careful planning when incorporating non-linear elements."

"Non-linear layouts were encountered occasionally by 40% of respondents, reflecting their use in specific contexts like recreational or creative areas. Around 30% said they frequently experience such designs, highlighting their growing popularity in modern spaces. Conversely, 15% rarely encountered these layouts, indicating limited adoption in traditional environments. Participants noted that they are most common in innovative and high-end spaces, such as art galleries and co-working hubs. Residential and office spaces, however, seemed to integrate them less often. These trends suggest that non-linear layouts remain a niche but impactful design choice."

Results

- 1. Memorability of Non-Linear Layouts:** Most respondents (70%) rated non-linear layouts as moderately to highly influential in creating memorable spaces, emphasizing their potential for unique, dynamic designs.
- 2. Longevity and Trends:** Over 60% see non-linear

layouts as evolving trends or long-term standards, while 40% believe they are niche, reflecting mixed opinions on their enduring relevance.

- 3. Material Compatibility:** Flexible materials like glass, metal, and modular elements were identified by the majority as the most suitable for such designs, highlighting the importance of adaptability in construction.
- 4. Impact on Comfort and Usability:** Around half of the respondents found curved elements comforting and suitable for collaborative tasks, but a notable segment pointed out their potential to reduce comfort and structure in more formal settings.
- 5. Challenges and Adoption:** Space planning difficulty, higher costs, and alignment with user needs were the most cited challenges. Non-linear layouts were found to be more common in creative and recreational spaces, with limited presence in traditional environments.

Conclusion

- 1. Design Appeal:** Non-linear layouts hold strong appeal for creating dynamic and memorable spaces, especially when tailored to specific functions and demographics.
- 2. Audience Segmentation:** Younger audiences (18-30 years) are most drawn to these layouts, reflecting a generational preference for creativity and innovation in design.
- 3. Functional Balance:** While beneficial for creative and collaborative environments, their effectiveness in formal, structured tasks remains debatable, highlighting the need for thoughtful application.
- 4. Material Choices and Costs:** The success of non-linear layouts depends heavily on material selection and budget allocation, requiring careful planning to overcome practical challenges.
- 5. Future Potential:** With the right balance of creativity and usability, non-linear layouts are poised to remain impactful, particularly in evolving design trends and niche applications.

Conclusion

"Non-linear layouts demonstrate significant potential in interior design, particularly for creating memorable, dynamic spaces and fostering creativity in collaborative environments. However, their success is contingent on careful material selection, thoughtful space planning, and alignment with user needs. While younger audiences exhibit a strong preference for these designs, challenges such as higher costs and functional limitations in formal settings suggest their application remains niche. As trends evolve, non-linear layouts are poised to be a transformative yet selective element in modern interior design, blending innovation with practicality."

Compliance with ethical standards

Acknowledgements

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team at Ito Architects and their collaborative effort in exploring non-linear office layouts are sincerely appreciated. No external funding sources were received for this study.

Conflict of Interest Statement

The authors declare that they have no conflict of interest regarding the publication of this manuscript. They also affirm that there are no competing interests related to the institution or products mentioned in the research, including any non-linear design concepts discussed in the context of the study. All the views and findings presented are independent and unbiased.

Statement of Ethical Approval

The present research does not contain any studies performed on animal or human subjects by any of the authors. All secondary data used in this study was sourced from publicly available research papers, case studies, and stakeholder reviews.

Statement of Informed Consent

Informed consent was obtained from all individual participants involved in the case studies and stakeholder interviews referenced in this study. All participants were fully informed about the study's purpose and their role in contributing data for the research.

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